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Cryptocurrencies as an Alternative Asset Class

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Abstract

Bitcoin was the first digital currency to rely on a decentralized peer-to-peer network instead of a trusted third party. This was achieved through Bitcoin's revolutionary underlying technology based on cryptographic proof: the blockchain. After Bitcoin's emergence, many other so called cryptocurrencies entered the market and we have seen enormous price increases that promised large returns for early users. The return characteristics of cryptocurrencies have been studied by various scholars and some have even declared cryptocurrencies to be an asset class instead of a digital currency. Due to the fast changes in the cryptocurrency market and the increased importance of other cryptocurrencies than Bitcoin, we believe that research focusing on the financial performance of cryptocurrencies should be renewed on a regular basis. Therefore, with this work we aim to shed light on the return characteristics of cryptocurrencies in relation to traditional asset classes and on the potential of cryptocurrencies to improve portfolio diversification. In addition, we investigate the cryptocurrency market, describe selected cryptocurrencies in more detail and provide an overview of potential technological risks arising with the use of cryptocurrencies. Our results indicate that cryptocurrencies provide large return potentials with high levels of volatility but compared to traditional asset classes provide a higher level of return per level of risk. We also find that selected cryptocurrencies can improve diversification in a cryptocurrency portfolio, as well as in a portfolio of international equity and private equity investments.

Keywords: Alternative Asset Classes, Cryptocurrency, Portfolio Diversification, Risk-Reward Profile und Cryptocurrency Risks

1. Introduction

People have multiple options to transfer money online. The most established method is to use online banking while there are also online money transfer providers such as PayPal, that enable sending money from one online account to another. However, all options have one flaw in common: they rely on trust of a third party. This was challenged in 2008 with the introduction of Bitcoin, the first decentralized virtual currency. Bitcoin was developed to enable transferring money without the need to rely on a trusted third party through *blockchain technology*. It enables Bitcoin to rely on cryptographic proof instead of a third party, leading to the birth of cryptocurrencies. Many believe that the introduction of Bitcoin will have a similar impact on payments as emails had on communication: to disrupt an entire industry.

After Bitcoin's introduction it took over two years until Namecoin, the second cryptocurrency, was introduced in 2011. Namecoin's purpose was not to introduce another digital currency but to enable domain name registration without the need of a trusted third party. After Namecoin was introduced, many other cryptocurrencies emerged with the aim to either provide innovative decentralized features or to serve as other digital currencies based on blockchain technology. The underlying technology is considered to be more innovative than Bitcoin itself, as the blockchain allows to avoid the need for a trusted third party for many other means than just transferring money online. This is reflected by the growth of the cryptocurrency market, whose combined market value increased from around $11 billion in early 2014 to around $100 billion in June 2017: an increase of over 800% (CoinMarketCap, 2017).

Cryptocurrencies emerged as a form of payment but because of its stark increase in prices many people have started to purchase cryptocurrencies with the goal of financially benefiting from the positive market development.

This development did not go unnoticed by scholars and over the years the amount of research on cryptocurrencies steadily increased. The majority of work focused on Bitcoin as it is the most prominent cryptocurrency in the market. However, due to recent developments in the cryptocurrency market, scholars have begun to investigate other cryptocurrencies as well.

Research on cryptocurrencies spans different fields such

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as security (Barber et al., 2012; Eyal and Sirer, 2014; Bonneau et al., 2015), regulation of cryptocurrencies (Hughes and Middlebrook, 2014; Marian, 2015), competition in the cryptocurrency market (Iwamura et al., 2014; White, 2015), but also on individual's intended use when purchasing cryptocurrencies (Glaser et al., 2014).

Although there are many fields to investigate in the cryptocurrency universe, this work focuses on the financial performance of cryptocurrencies. More precise, the aim of this thesis is to shed light on the financial performance of cryptocurrencies in relation to traditional asset classes and on the potential of cryptocurrencies to improve portfolio diversification. Besides, we provide information regarding the cryptocurrency market, describe selected cryptocurrencies in more detail and provide an overview of potential technological risks arising with the use of cryptocurrencies. However, we do not present an in-depth description of the market for cryptocurrencies or on cryptocurrencies' underlying technologies but, whenever the case, we will point the interested reader to several other sources that provide more detailed information.

This work focuses specifically on five cryptocurrencies which were primarily selected based on their market capitalization. The cryptocurrencies in scope are Bitcoin, Ripple, Ethereum, NEM and Litecoin, which combined amount to over 80% of the total cryptocurrency market capitalization as of June 9th, 2017 (CoinMarketCap, 2017). We investigate their financial performance over the time period from mid of August 2015 until mid of June 2017 and compare it with the performance of six asset classes. The asset classes under investigation are equity, fixed income, commodities, real estate, hedge funds and private equity.

Scholars have addressed the financial performance of cryptocurrencies and its use to improve portfolio diversification in a number of publications.

Work by Baur et al. (2015) concentrates on whether Bitcoin is used as a currency or as an investment and investigates the correlation of Bitcoin with other asset classes. They find that Bitcoin is mainly used as a speculative investment and that its returns are uncorrelated with those of traditional asset classes.

Eisl et al. (2015) and Brière et al. (2015) focus on the diversification effect when including Bitcoin in an already well-diversified portfolio. They follow different approaches but come to a similar conclusion: investors should include Bitcoin in an optimal portfolio as it improves the risk-return ratio.

Elendner et al. (2016) widen the scope of prior research and include ten different cryptocurrencies in their work. They investigate cryptocurrencies as alternative investment assets and investigate correlations between different cryptocurrencies and between other asset classes. They find low correlations between cryptocurrencies and, in line with prior research, that adding cryptocurrencies to a portfolio consisting of traditional assets enhances the risk-return ratio.

Work by Chuen et al. (2017) reinforces prior research. They also find low correlations between cryptocurrencies and traditional assets, and argue that it is beneficial to include cryptocurrencies in a portfolio consisting mainly of traditional assets.

When starting this work there was only limited amount of research on the return characteristics of cryptocurrencies compared to other asset classes. Most scholars focused on Bitcoin in particular and did not include other cryptocurrencies in their research. We believe that investigating multiple cryptocurrencies is more relevant for people interested in their financial behavior, especially because of the increased importance of other cryptocurrencies besides Bitcoin. In addition, the market for cryptocurrencies is very dynamic, with daily price fluctuations of over 10% being commonly observed. Cryptocurrencies also only emerged recently and the amount of data is therefore quite limited. Increases in available data allow for more observations and this enables to reinforce or to reject prior findings. We therefore believe that work on cryptocurrencies should be renewed on a regular basis in order to support practitioners and interested individuals when making investment decisions.

1.1. Structure.

This work is organized as follows. In Chapter 2 we provide a cryptocurrency glossary, explain the blockchain technology and introduce standard financial terminology to help an unfamiliar reader better understand the following chapters. We continue with general information on cryptocurrencies and specific information on the cryptocurrencies we investigate in Chapter 3. In Chapter 4 we introduce common asset classes and provide insights on what these asset classes are used for. We explain our approach for collecting data and provide the reader with the methods we use for analyzing the data in Chapter 5. In Chapter 6 our findings regarding the risk-reward profile of cryptocurrencies and asset classes, including correlation analyses and potential limitations of our work are presented. We highlight selected technological risks of cryptocurrencies including their potential implications in Chapter 7 and finish with our conclusion in Chapter 8.

1.2. Contributions.

In this work we make the following contributions:

- The market for cryptocurrencies is very dynamic and has experienced large growth (Section 3.2)
- Bitcoin was the first cryptocurrency but lost market shares to other cryptocurrencies (Section 3.2)
- Cryptocurrencies emerged as an alternative payment system but their underlying technology can serve various purposes (Section 3.4)
- Asset classes can be used for market allocation decisions, performance measurement and investment product development (Section 4.2)
- Investments in cryptocurrencies provide large return potentials with high levels of volatility (Section 6.1)

- Cryptocurrency investments provide a higher level of return per level of risk compared to traditional assets (Section 6.1)
- Combining different cryptocurrencies in a portfolio provides beneficial diversification effects (Section 6.2)
- Combining investments in Ethereum with international equity or private equity investments provides beneficial diversification effects (Section 6.2)
- Costs for operating on Ethereum's blockchain can be hedged through international equity or private equity investments (Section 6.2)
- Technological risks of cryptocurrencies pose threats for both businesses and individuals concerning usability, potential fraud and anonymity (Chapter 7)

1.3. Used resources.

We used Coinmarketcap[1], an online website providing transparency on cryptocurrency metrics, to collect data for cryptocurrencies. We accessed data for asset classes through Bloomberg Terminals provided by Goethe University. For analyzing data we used Stata 15 provided by Goethe University and a private version of Microsoft Excel 2013.

2. Preliminaries

In this chapter we introduce a cryptocurrency glossary, explain how the blockchain technology works and define several financial notions which we believe will help an unfamiliar reader better understand the following chapters.

2.1. Cryptocurrency glossary

2.1.1. Peer-to-peer.

Peer-to-peer refers to decentralized interactions between network participants through a single mediation point (BlockchainTechnologies.com, 2016).

2.1.2. Altcoin.

The term altcoin refers to a decentralized digital currency. Cryptocurrencies differ from altcoins in a way that they are built creating a new purpose, while altcoins can be seen as clones of existing cryptocurrencies, only changing minor parameters such as currency supply or the way in which they are issued (Hileman and Rauchs, 2017).

2.1.3. Token.

Term for a coin that is used on a blockchain.

[1]The site can be reached at www.coinmarketcap.com.

2.1.4. Initial Coin Offering (ICO).

Process through which start-ups sell cryptocurrency tokens to the public with the aim of collecting funds to finance their project. An ICO can be compared to an Initial Public Offering through which a company that is getting listed on a stock exchange sells company shares in the form of stocks. Presale or crowdsale are different terms used to describe an ICO (BlockchainTechnologies.com, 2016).

2.1.5. Smart contracts.

Contracts with terms recorded in a computer language rather than in a legal language. Smart contracts synchronize their current state and can execute automatically through a computing system such as a blockchain (BlockchainTechnologies.com, 2016; Hildenbrandt et al., 2017).

2.1.6. DApps.

Decentralized applications built on top of blockchain technology.

2.1.7. Genesis block.

The genesis block is the first block of a blockchain (Decker and Wattenhofer, 2013).

2.1.8. Mining.

Process of verifying transactions by providing computational power, thereby adding new blocks to the blockchain (NEM.io Foundation Ltd, 2017).

2.1.9. Mining pool.

A mining pool refers to groups of miners that share mining rewards in relation to their contribution in terms of computational power (Tuwiner, 2017).

2.1.10. Node.

A node refers to an active computer/device that is connected to a certain network. In the case of cryptocurrencies, nodes are usually responsible for verifying transactions.

2.1.11. Consensus mechanism.

The process used by the network to collectively agree on the contents recorded on the blockchain (BlockchainTechnologies.com, 2016).

2.1.12. Block time.

Time required for a block to be added to the blockchain, which varies among different blockchains.

2.1.13. Cryptography.

In this work it refers to the encoding and decoding of information with the help of computers (Merriam-Webster, Incorporated, 2017).

2.1.14. Hashing.

Hashing refers to the transformation of original information into a shorter, fixed-length value or key representing the original data.

2.1.15. Cryptographic hash function.

A hash function is responsible for hashing original information by transforming the information and producing a hash value (Dwyer, 2015).

2.1.16. Mining difficulty.

The difficulty of finding a certain hash required to verify blocks in a blockchain network. The difficulty is adjusted to keep the block time at a predefined level (BlockchainTechnologies.com, 2016).

2.1.17. Merkle tree.

A merkle tree refers to a special way of structuring data to summarize and verify the integrity of large data sets efficiently. The word "tree" refers to its upside-down structure in the form of branches with a "root" at the top and "leaves" at the bottom (Antonopoulos, 2017). A Figure in the Appendix displays a typical Merkle tree.

2.1.18. Hard fork.

Major, permanent divergence from a previous version of a blockchain that requires all nodes to update to the latest protocol software. This creates a fork in the blockchain, as one path follows the upgraded blockchain, while one path follows the old way (Li, 2017).

2.1.19. Soft fork.

Change to the blockchain protocol introducing new rules, that invalidates some previously valid blocks but preserves the remaining valid blocks as valid. The majority of nodes in the network need to update to the latest protocol software in order to enforce the new rules (Li, 2017).

2.1.20. Double spending.

Double spending refers to spending the same account balance on two different transactions.

2.1.21. Multisignature transactions.

Blockchain adoption that increases protection against theft (BlockchainTechnologies.com, 2016).

2.1.22. Application Specific Integrated Circuit (ASIC).

ASICs are computer chips that are designed to perform one specific function. They are used by miners to process hashing algorithms and are especially used for processing the complex SHA-256 algorithm used by Bitcoin (BlockchainTechnologies.com, 2016).

2.1.23. Internet Protocol (IP) Address.

An IP address is a code of numbers that identifies a particular computer/device connected to the internet (PC.net, 2017).

2.1.24. Application Programming Interface (API).

An API is a set of functions and protocols for building software applications that enable communicating between different software components and accessing data of an operating system, application or other service (Schueffel, 2017).

2.2. Blockchain

A blockchain refers to a distributed, continuously growing, public database of permanent records, called blocks, which are linked to each other and secured using cryptography. It can be seen as a public ledger of all executed transactions, which is shared among its participants (Narayanan et al., 2016). Nakamoto proposed the blockchain technology in order to rely on cryptographic proof instead of a trusted third party for individuals willing to execute online financial transactions.

The blockchain technology was introduced through Satoshi Nakamoto's white paper on Bitcoin but its technology is used for a variety of cases in both the financial as well as non-financial world (Crosby et al., 2016). Due to its different applications, with Bitcoin as the most prominent one and its intrinsic link to Bitcoin, we explain the functioning of the Bitcoin blockchain in the following (ElBahrawy et al., 2017).

A general description of the process of how Bitcoins are transferred helps understand how the blockchain works. When a person wants to send an amount of Bitcoins to another person, the transaction is represented in the network as a block. The block is then broadcasted to every node in the network and the majority of nodes need to verify the transaction. As soon as the transaction is verified, the block is added to the blockchain and the amount of Bitcoins is moved to the account of the receiver. Thereby, new blocks are continuously added to the blockchain, which keeps growing with the amount of blocks verified.

In a more technical way, the blockchain technology orders hashed and encoded transactions in a Merkle tree in groups of data called blocks. These blocks are linked in a linear, chronological chain of transactions with each block containing a hash of the previous block as seen in Figure 1. Before a block is added to the blockchain, the majority of nodes within the network verify the validity of the transaction through a consensus mechanism. By linking each block with its preceding block, the blockchain can ensure the validity of all added blocks back to the genesis block.

A block consists of two parts: a header and transaction details. When transactions are executed they are broadcasted to all nodes in the network, which individually collect the transactions in a block. In order to add the block to the blockchain one node needs to solve a mathematical "puzzle", a process called mining. This puzzle refers to finding a value that when hashed with the SHA-256 algorithm[2], the hash

[2]More details on SHA-256 can be found at https://csrc.nist.gov/csrc/media/publications/fips/180/2/archive/2002-08-01/documents/fips180-2.pdf.

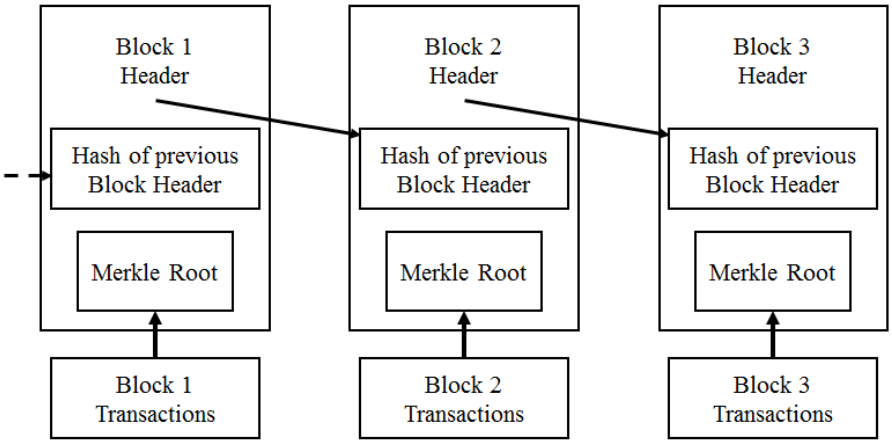

Figure 1: Simplified Bitcoin blockchain; Adapted from Bitcoin Project (Bitcoin Project, 2017a).

value shows a certain structure that starts with zeros. Solving the puzzle refers to the proof-of-work, the consensus mechanism on which Bitcoin's blockchain relies. After finding the proof-of-work, the block is broadcasted to all nodes in the network which accept the block if all transactions within the block are valid and funds are not already spent. This can be ensured through linking all the blocks on the blockchain with their previous block. Copies of the transactions within each block are hashed and the hashes consequently paired until only a single hash remains. This hash refers to the Merkle root of a Merkle tree and is stored in the block header of each block. Nodes express their acceptance of the current block by working on creating the next block using the hash of the accepted block as the previous hash. Thereby, a chain of blocks is created that rely on the information of the previous blocks and thus ensure validity of the transactions within the network (Nakamoto, 2009; Bitcoin Project, 2017a).

2.3. Financial terminology

2.3.1. Fiat money.

Fiat money refers to a currency without intrinsic value that a government or law declared to be legal tender (Mankiw, 2014).

2.3.2. Market capitalization.

Total value of a corporation's outstanding shares. It is calculated as the sum of the market price per share and the number of shares outstanding.

2.3.3. Trading volume.

Total amount of value that was traded during a predefined period.

2.3.4. Portfolio.

A portfolio refers to the totality of assets held by an investor.

2.3.5. Market index.

An index consists of different components of an asset class with the aim to represent certain sections of the market or the market as a whole. One of the most known market indices is the S&P 500 which consists of stocks of the 500 largest publicly listed U.S.-based companies aiming to provide a picture of the total U.S. stock market (Bodie et al., 2010).

2.3.6. Mutual fund.

A mutual fund is a pool of funds provided by investors and managed by a fund manager with the purpose of realizing positive returns by investing the capital (Bodie et al., 2010).

2.3.7. Index fund.

A mutual fund with the same positions and proportions as represented in a market index (Bodie et al., 2010).

2.3.8. Exchange traded fund (ETF).

An Exchange traded fund is a form of a mutual fund that can be traded on an exchange (Bodie et al., 2010).

2.3.9. Real Estate Investment Trusts (REITs).

REITs refer to publicly traded companies with pooled investments in real estate properties and/or real estate debt (Maginn et al., 2007).

2.3.10. Volatility.

Volatility provides a measure of how much the returns of an asset are likely to fluctuate. It is measured as the standard deviation of the returns of an asset (Mankiw, 2014).

2.3.11. Correlation.

The correlation coefficient is a measure that quantifies the linear relationship between two variables. The correlation coefficient can be any number between 1 and −1. If the coefficient is equal to 1 the variables move up and down in perfect unison. If the variables are uncorrelated, the correlation coefficient equals 0 and the variables do not move

irrespective of the state of the other variable. A negative correlation coefficient refers to one variable moving up while the other variable moves down (Weiss, 2011; Markowitz, 1968).

2.3.12. Hedge assets.

Hedge assets have a negative correlation with other assets in a portfolio and can be used to reduce the total level of risk in a portfolio (Bodie et al., 2010).

2.3.13. Futures contract.

The holder of a futures contract is obliged to purchase or sell an asset for a predefined price at a future point in time (Bodie et al., 2010).

2.3.14. Contracts for Difference (CFD).

A CFD is a contract that provides the holder with the option to receive the difference between an arranged future price and the current price of an underlying asset.

2.3.15. Bridge currency.

A bridge currency refers to a central currency that can be used as a bridge for cross-border payments. Instead of exchanging one fiat currency against another fiat currency, bridge currencies serve as the central medium of exchange (Pisa and Juden, 2017).

3. Cryptocurrencies

In this chapter we start with an overview of the historical development of cryptocurrencies in Section 3.1 and we continue with providing information on the market for cryptocurrencies in Section 3.2. We then explain major use cases of cryptocurrencies in Section 3.3 and finish this chapter with Section 3.4, where we provide detailed information regarding the cryptocurrencies we investigate in this work.

3.1. Historical development

The general idea of digital currencies was first explored through a research paper in 1982 by (Chaum, 1982). In further work, Chaum's aim was to develop a form of payment that allowed users to privately execute payments online (Chaum, 1985). Based on the ideas from his research, Chaum founded DigiCash in 1990, a company specializing in electronic payments (Kißling, 2003). However, as the market did not seem to be mature enough for this new development, Chaum's invention did not attract enough users and consequently failed.

In 1996, e-Gold was introduced, a centralized digital currency that was backed by gold, offering anonymous accounts for its users. In order to create a digital account balance denoted in the platform's digital currency *e-Gold*, users had to either send the company physical gold or wire money to the company. The platform allowed its users to instantly transfer value from one individual's digital account to another individual's digital account. However, due to legal and privacy issues, e-Gold suspended transfers after its management pleaded guilty to money laundering and for operating an unlicensed money transfer business (Condon, 2008; Miller, 2014).

The next major step towards digital currencies came with the introduction of PayPal in 1998. PayPal is a payment processor acting as an online intermediary for transferring money from one bank account to another bank account. However, instead of offering its own currency, PayPal uses fiat currencies as a medium of exchange (Skinner, 2007).

Although forms of digital currencies came into existence in the early 90's, all previous approaches had one major flaw in common: they relied on trust of a third party. This was challenged in 2008 through the release of Satoshi Nakamoto's paper *Bitcoin: A Peer-to-Peer Electronic Cash System*. Other than existing versions of digital currencies, Nakamoto introduced the concept of Bitcoin, a pure peer-to-peer version of electronic cash based on cryptographic proof instead of trust of third parties. With the release of Bitcoin, Nakamoto introduced the blockchain technology, which allows Bitcoin to serve as a decentralized platform that can be used to send and receive the platform's virtual currency *Bitcoin*[3] without relying on a trusted third party, thereby leading to the birth of cryptocurrencies (Nakamoto, 2009).

Bitcoin was officially launched in early January 2009 but it took over two years until Namecoin, the second decentralized digital currency, entered the market in April 2011. Instead of building its own blockchain, Namecoin is considered to be an altcoin that is based on Bitcoin's code, and arose as the first Bitcoin fork (Hileman and Rauchs, 2017). Namecoin's primary goal of development was to create an alternative cryptographic network enabling decentralized domain name registration instead of serving as a digital currency (Buterin, 2014). After the emergence of Namecoin, numerous other cryptocurrencies and altcoins were introduced and cryptocurrencies enabled more innovative new features, some of which are explained in more detail in Section 3.4, based on their underlying technology. Hence, launching new cryptocurrencies was mainly driven by innovative technological features and not in order to create other cryptocurrencies to compete with fiat currencies as was the case with the introduction of Bitcoin (Nakamoto, 2009). The market for cryptocurrencies kept growing over the years and as of June 9th, 2017, Coinmarketcap provided data for a total of 745 cryptocurrencies and altcoins amounting to a combined market capitalization of approximately $100 billion.

3.1.1. Note.

In the following, we will use the term cryptocurrencies interchangeably for both altcoins and cryptocurrencies.

3.2. Market for cryptocurrencies

In this section we provide information regarding the overall cryptocurrency market. We start by introducing the historical development of coins in the market, continue with the

[3] Bitcoin's internal currency is called Bitcoin.

development of the overall market capitalization and finish this section with information on daily trading volumes in the cryptocurrency market.

When thinking about cryptocurrencies the first thing that usually comes to people's minds is Bitcoin. However, as described in Section 3.1, there are far more cryptocurrencies in the market. We extracted the number of cryptocurrencies that are listed on Coinmarketcap from May 2013 until June 2017 in order to provide insights about the development of the number of coins in the market. To do so, we used `www.archive.org`, a service that enables to view historical snapshots of websites, to extract data presented in Figure 2. It is important to note that throughout time some cryptocurrencies go extinct while others are added. Thus, only active cryptocurrencies fulfilling certain minimum requirements (e.g. minimum trading volume) are taken into account.

Figure 3 provides insights about the development of the total market capitalization including the share of Bitcoin over the period from May 2013 until June 2017 based on data from Coinmarketcap. With Bitcoin as the most prominent cryptocurrency, we decided to provide a comparison of the development of Bitcoin with the remaining market.

Figure 4 shows daily trading volume including the share of Bitcoin over the period from August 2015 until June 2017 based on data from Coinmarketcap. We neglected data before August 2015 as there was little movement and to improve the visualization of recent developments.

By comparing the development presented in Figures 2 to 4 we can clearly see a stark increase in the amount of coins, the amount of money invested in coins and the value of trades executed per day. This is especially true for the development of the market capitalization and trading volume in 2017. It is interesting to see how the relative share of Bitcoin in terms of both market capitalization and trading volume decreased over time. Until 2017 Bitcoin's relative market capitalization constantly exceeded 74% - within less than six months it had reduced to 46%. When comparing the overall trading volume with that of Bitcoin, we see a relative trading volume averaging at around 74% until 2017, which decreased to an average relative trading volume around 60% in 2017 with a relative trading volume of around 47% by the beginning of June 2017. This implies that Bitcoin lost substantial shares to other cryptocurrencies.

3.3. Use of cryptocurrencies

Cryptocurrencies emerged with the purpose to be used as a digital currency but can serve a variety of purposes (Nakamoto, 2009). Most prominent use cases of cryptocurrencies are as a form of payment, as an internal pricing mechanism on the blockchain, for investment purposes but also for start-ups to receive funding (ElBahrawy et al., 2017).

3.3.1. Note.

It is important not to get confused between using a certain cryptocurrency and using a cryptocurrency's underlying technology. As our work focuses on specific cryptocurrencies, including the financial behavior of the respective coins, our focus is to provide insights about the usage of the cryptocurrencies' coins and not the usage of their technology.

Form of payment: Cryptocurrencies emerged with the purpose to pay for goods online and by now there are numerous merchants accepting different cryptocurrencies, with Bitcoin being the most widely accepted one (Hileman and Rauchs, 2017). According to a survey by Luca et al. (2015), the majority of people questioned used cryptocurrencies for online shopping, followed by online gaming or gambling and for paying credit card bills. However, cryptocurrencies are also used for illegal activities such as money laundering, tax evasion and illicit trade (Conti et al., 2017). One of the most well-known examples is the case of Silk Road, a hidden online marketplace where goods such as illegal drugs, fake identification documents but also hit men or computer hackers could be paid for in cryptocurrencies. Silk Road generated revenues of over $1.2 billion with almost one million customers before it was shut down in 2013 (Leinwand Leger, 2014).

Pricing mechanism on the blockchain: Usually it is required to pay a fee when sending transactions through a blockchain. This is mainly due to the characteristic of cryptocurrencies relying on miners to validate transactions. These miners have to provide computational power and thus use electricity for validating transactions. In order to provide a monetary incentive, miners receive the token of the cryptocurrency for their effort. Thereby, the cryptocurrency is used to keep the network running but also to mitigate spam on the network (NEM.io Foundation Ltd, 2015a; Wood, 2014).

Investment purposes: Similar to investing in stocks, many individuals and professional investors use cryptocurrencies as an alternative asset class (Baur et al., 2015). In this case, cryptocurrencies are bought with the aim to financially benefit from price increases. The price development is a cryptocurrency's only income component and thereby it differentiates from other assets such as stocks that pay dividends or bonds that pay coupons.

Investors of cryptocurrencies can pursue different approaches. The most common approach is to directly purchase a cryptocurrency from an online exchange. Exchanges provide the service to purchase and sell cryptocurrencies for fiat currencies but also to trade cryptocurrencies against other cryptocurrencies (Hileman and Rauchs, 2017). Thereby, an investor has the opportunity to directly invest in a cryptocurrency without the need of a broker as it is usually the case for investments in e.g. stocks.

Additionally, there is the option to invest through alternative approaches such as ETFs or investment trusts. Thereby, executing investments becomes easier and investors can benefit from fund manager's knowledge e.g. through the purchase of diversified cryptocurrency portfolios (Gao, 2017).

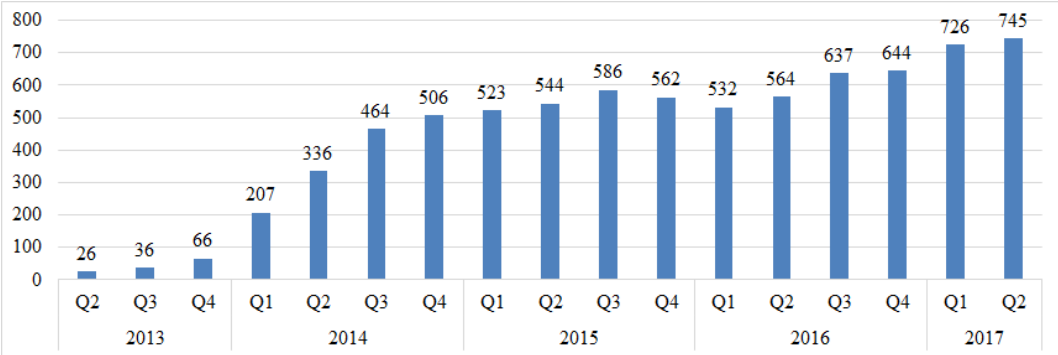

Figure 2: Development of listed cryptocurrencies.

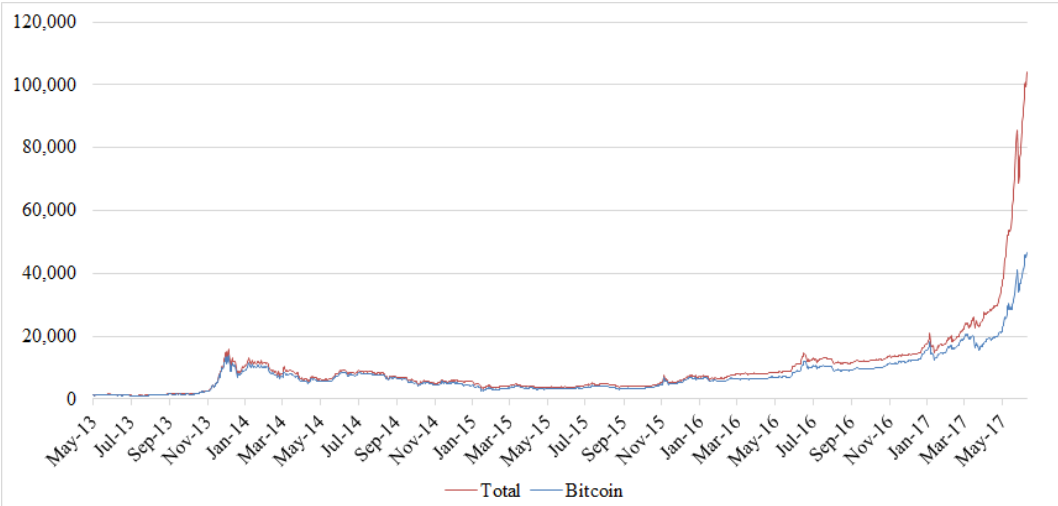

Figure 3: Development of the total market capitalization (Numbers in USD millions)

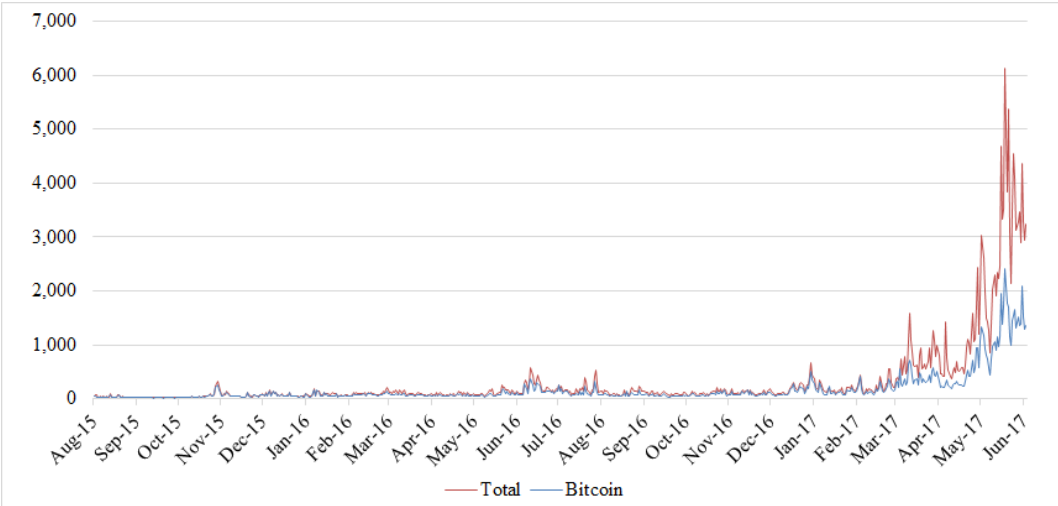

Figure 4: Development of the total daily trading volume (Numbers in USD millions)

Funding purposes. Start-ups have discovered the opportunity to collect funds by issuing their own cryptocurrency. This process refers to an *Initial Coin Offering* (ICO) and can be compared to an *Initial Public Offering* (IPO) of a company. In an IPO a company sells its shares when it is being listed on a stock exchange for the first time (Hern, 2017). The underlying cryptocurrency is thus used similar to stocks, thereby reinforcing its use as an alternative asset class.

3.4. Definition of considered cryptocurrencies

In the following we provide a general introduction of the cryptocurrencies we investigate in our financial analysis.

3.4.1. Bitcoin

The concept of Bitcoin was introduced by the pseudonymous Satoshi Nakamoto in 2008 and launched on January 3rd, 2009 as the first decentralized virtual currency (Meiklejohn et al., 2013). Although there are many rumors and speculations about the person or group behind the pseudonym, the true identity of the inventor of Bitcoin is still unknown (Chuen, 2017).

Bitcoin is an open source project (i.e. its source code is publicly available), providing anybody with the opportunity to contribute to the development process (Bradbury, 2013). As a blockchain validation mechanism, Bitcoin relies on the Hashcash proof-of-work function[4] using the SHA-256 algorithm with an average block time of approximately 10 minutes. The coin running on the Bitcoin protocol is listed under the code *BTC* and is mineable, with a maximum supply of 21,000,000 coins (Nakamoto, 2009; Chen et al., 2016). Similar to fiat currencies, a single Bitcoin can be divided into smaller units. The smallest unit denoted in Bitcoin is one *Satoshi*, with one hundred million Satoshi equaling one Bitcoin (Margaret, 2016).

Bitcoin underwent several upgrades since its introduction. One major upgrade of Bitcoin was *Segregated Witness (SegWit)*, which was first deployed on Litecoin in May 2017 and consequently on Bitcoin in August 2017 (Holmes, 2017). The upgrade allows for faster transactions, as it solves a blockchain size limitation, and for the development of innovations based on Bitcoin's blockchain. One of those innovations is the *Lightning Network* which allows for instant payments before they are written on the blockchain (Poon and Dryja, 2015). Initially, SegWit was supposed to be launched on Bitcoin first but due to resistance by the Bitcoin community it was first deployed on Litecoin (van Wirdum, 2017).

Since its launch in 2008, Bitcoin has remained the most prominent cryptocurrency and by 2015, Bitcoin was accepted by over 100,000 merchants globally (ElBahrawy et al., 2017). In April 2017 Bitcoin also became an official method of payment in Japan, and the technology merchants require to accept Bitcoin is currently being rolled out at around 260,000 Japanese stores (Williams, 2017; Helms, 2017).

Bitcoin's source code also served as the foundation of other cryptocurrencies such as Litecoin and Namecoin. These cryptocurrencies modified Bitcoin's source code to allow for technological changes such as decreased block time and innovations such as decentralized domain name registration (Ueland, 2013).

Based on data from Coinmarketcap, as of June 9th, 2017, Bitcoin had a price of $2823.81 per coin, with a 24 hour trading volume of $1,348,950,000, a circulating supply of around 16,390,000 coins and the highest market capitalization with approximately $45,987,100,000.

3.4.2. Ethereum

In late 2013 the concept of Ethereum was first described in a white paper by Vitalik Buterin, which became more formalized in early 2014 in a paper by Gavin Wood and launched in July 2015 (Buterin, 2014). Through a presale in 2014, Ethereum was able to raise approximately $18 million worth of Bitcoin and used these funds to establish the Ethereum Foundation, a Swiss nonprofit organization responsible for developing the Ethereum software (Extance, 2015).

Ethereum is based on a blockchain similar to Bitcoin's, but instead of serving as a form of digital payment it was developed with the purpose to provide *smart contracts* and to enable developers to build and deploy decentralized applications on top of its technology. Applications executing on Ethereum's blockchain are written in its internal programming language *Solidity*[5] (Hildenbrandt et al., 2017).

As validation mechanism, Ethereum relies on the Ethash[6] hashing algorithm for its proof-of-work function with an average block time of apprixametly 0.2 minutes (Dannen, 2017; Beck et al., 2016). Similar to Bitcoin, Ethereum provides a token on its plattform called *Ether* which is listed under the code *ETH*. The token is transferable between accounts and is used to pay for *Gas*, a special unit within the Ethereum network that measures how much computational power a certain action on the network requires. Thereby, gas is used as a transaction fee to prevent spam and to compensate participant nodes for mining (Wood, 2014; Chen et al., 2016). A single unit of Ether can be divided into smaller units. The smallest unit denoted in Ether is one *Wei* and one trillion Wei equal one Ether (Ethereum Community, 2016). Different to other cryptocurrencies, Ethereum pursues an inflationary approach as its total supply is unlimited (Bouoiyour and Selmi, 2017). This allows for a wider distribution of Ether and prevents that a few early miners own the majority of coins, which is usually the case for early adopters of a cryptocurrency.

Although Ethereum was publicly established because of introducing smart contracts, it attracted media attention during a scandal in 2016, when *The DAO*, a decentralized organization developed on the platform to fund Ethereum-based projects, became subject to an attack by hackers, resulting in the loss of approximately $50million worth of Ether. The event lead to a debate about hard forking the Ethereum blockchain to recover the funds, which resulted in the split of the network into two distinct cryptocurrencies: Ethereum listed under the code ETH and Ethereum Classic, listed under the code ETC (Hildenbrandt et al., 2017; Bradbury, 2016; Chen et al., 2016).

[4] More details on proof-of-work can be found in Nakamoto's white paper (Nakamoto, 2009).

[5] More details on Solidity can be found at `solidity.readthedocs.io/en/develop/`.

[6] More details on Ethash can be found at `https://github.com/ethereum/wiki/wiki/Ethash`.

Based on data from Coinmarketcap, as of June 9th, 2017, Ethereum had a price of $281.74 per coin, with a 24 hour trading volume of $557,986,000, a circulating supply of around 85,770,000 coins and the second highest market capitalization with approximately $24,165,000,000.

3.4.3. Ripple

Ripple is an open source, distributed peer-to-peer payment system, based on the idea of Jed McCaleb and Chris Larsen and was launched in 2012 by the Ripple Labs (Chuen et al., 2017; Reutzel, 2012).

Ripple uses the *Ripple Consensus Protocol*[7], an open source, decentralized consensus protocol, which allows participants instant, secure and nearly free global financial transactions without the need of a central correspondent (Hameed and Farooq, 2016; Chen et al., 2016; Armknecht et al., 2015). Additionally, Ripple serves as a currency exchange for both cryptocurrencies and fiat currencies, and its protocol is designed to route every transaction to the best price available in the network with transactions in four seconds or less (Hayden, 2017). The coins running on the Ripple protocol are called Ripples, listed under the code *XRP*, and are transferable between accounts (Chen et al., 2016; Hameed and Farooq, 2016). The smallest unit denoted in Ripples is one *Drop* with one million Drops equaling one Ripple (Hodl the Moon, 2017). If network participants want to exchange a fiat currency pair that is not available, XRP can be used as a bridge currency between the fiat currencies. It is furthermore used to mitigate spam, as transaction fees are paid in XRP and users have to keep a minimum balance of the coin in their account in order to participate in the network.

Ripple has a restricted total supply of 100 billion coins of which 20 billion were retained by Ripple's founders, 25 billion are held by Ripple Labs and the remainder of 55 billion are steadily distributed to promote network growth (Chen et al., 2016; Hameed and Farooq, 2016).

Within the Ripple network, participants can take three different roles: (1) participants that make or receive payments; (2) market makers that enable trade between participants and (3) validators, executing the Ripple Consensus Protocol to validate transactions within the network. Although Ripple's protocol is said to be decentralized, other than it is the case for e.g. Bitcoin, its validator nodes are individually selected, hence currently not making it completely decentralized (Hameed and Farooq, 2016; Armknecht et al., 2015; Thomas, 2017).

A major application of Ripple's payment network can be found in Japan. In 2016, a consortium of 15 banks was formed with the plan to use Ripple's technology to process payments. Within few months after founding the consortium, the number of banks grew to 47 and by July 2017, a total of 61 banks were participating. These banks together represent over 80% of total assets in Japan and plan to unite all of their customers through a common mobile application for payments by the end of 2017 (Elison, 2016; Yoshikawa, 2017).

Based on data from Coinmarketcap, as of June 9th, 2017, Ripple had a price of $0.286 per coin, with a 24 hour trading volume of $102,482,000, a circulating supply of around 38,864,200,000 coins and the third highest market capitalization with approximately $11,115,900,000.

3.4.4. NEM

The concept of the cryptocurrency and blockchain platform New Economy Movement (NEM) was introduced in early 2014 through a blog post on the forum Bitcointalk by the user Utopianfuture before it was launched, after extensive testing, on March 31st in 2015 (Utopianfuture, 2014; Beikverdi, 2015).

NEM's code was entirely set up from scratch and programmed solely using Java. Similar to Ethereum, NEM does not only provide a coin on its network but serves as a platform that allows individuals to develop applications and scripts that execute on its blockchain. NEM's blockchain features its own innovative consensus mechanism, called *proof-of-importance*[8], which requires less computational power and is hence more environmentally sustainable compared to traditional consensus mechanisms. Besides its innovative consensus mechanism, NEM offers multisignature transactions, a secure and encrypted peer-to-peer messaging system and a modified EigenTrust++ reputation system[9] (NEM.io Foundation Ltd, 2015a). NEM's technological approach further differs from other cryptocurrencies as it was the first to offer a private blockchain and a public blockchain. The private blockchain differs as it consists of a network of trusted nodes, providing faster transactions (NEM.io Foundation Ltd, 2014; Chuen et al., 2017). Besides, its blockchain offers an API interface that can be used with any programming language. NEM uses its internally-developed proof-of-importance function with an average block time of approximately one minute. The coin running on the NEM protocol is listed under the code *XEM*, which is transferable between accounts, with a total supply of 8,999,999,999 coins (Chen et al., 2016). The smallest unit denoted in XEM is one *microXEM*, with one million microXEM equaling one XEM (NEM.io Foundation Ltd, 2015b). The coin is used as a fee for transactions on the public blockchain, which is dependent on the complexity of the transaction, and passed to *harvesters*. Harvesters are responsible for verifying transactions on NEM's blockchain (NEM.io Foundation Ltd, 2017).

As no mining is required for the proof-of-importance mechanism, new coins cannot be created and therefore, the

[7] More details on the consensus protocol can be found at `https://ripple.com/build/ledger-format/`.

[8] More details on proof-of-importance can be found in NEM's technical reference (NEM.io Foundation Ltd, 2015a).

[9] An algorithm that enhances security. More information can be found at `https://steemit.com/nem/@jwiz168/nem-s-node-reputation-and-network-security-using-eigentrust`.

initial distribution of XEM was done through a crowdsale on the forum Bitcointalk (Utopianfuture, 2014).

One of the most prominent applications of NEM's blockchain technology is the private blockchain *Mijin*. This blockchain can be used for a variety of solutions such as asset management, as a payment system or as a contract system. Through its approach, Mijin aims to reduce the costs of financial infrastructure to 10% of its current costs by 2018 (Tech Bureau Corporation, 2017).

Based on data from Coinmarketcap, as of June 9th, 2017, NEM had a price of $0.202 per coin, with a 24 hour trading volume of $11,840,000, a circulating supply of around 8,999,999,999 coins and the fourth highest market capitalization with approximately $1,970,650,000.

3.4.5. Litecoin

Litecoin was launched by former Google employee Charlie Lee as an open source fork of Bitcoin on October 13th in 2011. Lee decided to launch Litecoin as a copy of Bitcoin with minor changes so that future improvements of Bitcoin could be easily implemented. Litecoin was developed with the purpose to complement Bitcoin instead of challenging it and is sometimes referred to as "the silver to Bitcoin's gold" (Ogundeji, 2017).

Similar to Bitcoin, Litecoin is an open source project and its blockchain relies on the proof-of-work mechanism. However, Litecoin has a lower average block time of 2.5 minutes and it is the first cryptocurrency that uses the Scrypt[10] hashing algorithm instead of SHA-256. Lee decided to use the Scrypt algorithm as it changes the computation to be memory intensive instead of processor intensive. The main reason for this was Bitcoin's market power, which made it difficult to attract miners to switch from mining Bitcoin to mining another coin that requires the same computation, as it was the case for Namecoin. Another reason for using Scrypt was to make mining possible with computer processors instead of graphics processors, and the different computation would make the costs for setting up ASICs extremely high compared to setting them up for Bitcoin. Thereby, Lee's goal was to keep mining from being centralized and allow anyone to mine Litecoin (Iddo, 2014). However, due to the increase in mining difficulty, by now the only profitable way of mining Litecoin is through the use of ASICs (Xie, 2017). The coin running on the Litecoin protocol is called Litecoin, listed under the code *LTC*, which is transferable between accounts and has a maximum supply limited to 84,000,000 coins (Lee, 2017; Chen et al., 2016). The smallest unit denoted in Litecoin is one *Litoshi*, with one hundred million Litoshi equaling one Litecoin (Dean, 2015).

Similar to Bitcoin's token, LTC can be used as a form of payment but its acceptance is far from that of Bitcoin.

Based on data from Coinmarketcap, as of June 9th, 2017, Litecoin had a price of $29.68 per coin, with a 24 hour trading volume of $176,841,000, a circulating supply of around 52,350,000 coins and the sixth highest market capitalization with approximately $1,553,630,000.

[10]More details on Scrypt can be found at http://www.bsdcan.org/2009/schedule/attachments/87_scrypt.pdf.

4. Asset classes

We start this chapter by giving a general introduction to major asset classes in Section 4.1 and we continue with providing use cases of the discussed asset classes in Section 4.2.

4.1. Introduction to asset classes

There is no general definition of an asset class and the specification of asset classes highly differs in the financial world. In this work we use the definition given by Greer (1997), who defines an asset class as "... a set of assets that bear some fundamental economic similarities to each other, and that have characteristics that make them distinct from other assets that are not part of that class". We use this definition as it is currently used by the CFA Institute in their study program for becoming a Chartered Financial Analyst, a well established programm for setting a standard for excellence for investment professionals (CFA Institute, 2017). Due to a missing clear classification of asset classes, there exist numerous forms of individual classes. However, commonly used asset classes are equity, fixed income, commodities, real estate, hedge funds and private equity, and we will briefly introduce these asset classes in the following (Maginn et al., 2007; Kräussl, 2014).

4.1.1. Equity.

Equity refers to stocks that represent an investor's share of ownership in a company. Companies that go public release shares of their corporation, in the form of stocks, which individual investors can purchase. Financial returns from investing in stocks come from increases or decreases in stock prices and from dividends, which are based on a company's current and future financial performance (Wells Fargo Asset Management, 2017; UniSuper Management Pty Ltd, 2017).

4.1.2. Fixed Income.

Fixed income refers to debt instruments that represent a certain value owed by governments, government agencies, or corporations to investors. The issuer of the debt instrument usually receives a certain amount of money from the investor and pays back the initial amount including an additial payment, in the form of one or multiple coupons, at a predefined future point in time (Wells Fargo Asset Management, 2017).

4.1.3. Commodities.

Commonly referred to as commodities are metals (e.g. gold), agricultural products (e.g. livestock), and energy (e.g. oil). Investment exposure to commodities can be achieved through different investment approaches. Selected approaches are direct purchase of a commodity, purchase of stocks of a company with revenues largely determined by commodity trade, such as oil refineries, or through the purchase of financial products that are tied to commodity prices, such as commodity futures contracts (Maginn et al., 2007; Wilcox and Fabozzi, 2013).

4.1.4. Real Estate.

Investments in the real estate asset class can be directly and indirectly. Typical direct investment approaches are investments in residences, commercial real estate, and agricultural land. On the other hand, indirect investments cover approaches such as investing in a real estate fund or by investing in REITs (Maginn et al., 2007).

4.1.5. Hedge Funds.

Hedge funds are investment funds that pool capital and are actively managed by a hedge fund manager. These funds apply a variety of portfolio strategies with the aim to generate positive returns irrespective of current market developments (Wilcox and Fabozzi, 2013).

4.1.6. Private Equity.

Private equity refers to companies which raise capital to purchase ownership in non-publicly-traded companies. Private equity companies usually invest with a short-term focus, are typically highly involved in the company and have a well defined exit strategy (Maginn et al., 2007).

Asset classes can be categorized into endless sub-classes based on different characteristics such as industry, geography or size. In order to specify an asset class appropriately, the following characteristics should be met: Assets within the same asset class should be relatively homogeneous and they should not be considered to be part of two different asset classes at the same time. Different asset classes should also not be highly correlated and the asset classes should be large enough to matter so that the combined asset classes make up a majority of world investable wealth. Finally, assets within the asset class should have a certain level of liquidity so that, if part of an investor's portfolio, they do not seriously threaten the portfolio's liquidity (Maginn et al., 2007).

4.2. Use of asset classes

Individuals and investors can use asset classes for a variety of purposes. Common uses of asset classes are for asset allocation decisions, performance measurement and for investment product development (Maginn et al., 2007; Bodie et al., 2010; Australian Securities and Investments Commission, 2012; Svetina and Wahal, 2008).

For market asset allocation decisions, investors can adopt active- or passive management decisions.

For active management, an investor takes into account the performance of an asset class as a whole but invests in selected components of the asset class. Thereby, the components of the asset class invested in can either be single components such as a single stock of a company or aggregate components within an asset class, such as an index following a certain industry. Furthermore, investors can use this approach to invest in single components across different asset classes. This enables the investor to receive a general picture about the asset classes under consideration but offers the possibility to exclude certain components of the asset class. However, investigating different components of an asset class and executing multiple orders involves high cost due to the time required for gathering information and for fees paid per transaction.

In the case of passive management, an investor purchases an index fund or exchange traded fund representing the asset class as a whole. This approach enables the investor to receive a general picture about the asset class under consideration and offers the possibility to invest in the asset class as a whole, leaving the investor with more diversification than if components were excluded (Fraser-Sampson, 2011; Greer, 1997; Maginn et al., 2007).

Asset classes are oftentimes also used as benchmarks to evaluate an investor's performance. In this case, investors compare the performance of their investment with the performance of a relevant asset class to gain insights about one's individual performance compared to the overall market's performance. Benchmarks can either comprise the whole asset class or sub-classes of the asset class, dependent on the comparability with the investor's portfolio composition (Maginn et al., 2007).

Another use of asset classes is in the development of investment products. In this case, investment professionals tie the performance of an asset class to a financial product. Common cases are CFDs based on the performance of an index or exchange traded funds that comprise the same components as an index in order to reproduce returns of a specific asset class (Australian Securities and Investments Commission, 2012; Svetina and Wahal, 2008).

5. Methodology

In this chapter we start by illustrating how and what data was collected in Section 5.1 and continue with presenting the approach we follow in our financial analysis in Section 5.2.

5.1. Data collection

In order to shed light on the characteristics and financial performance of cryptocurrencies, we collect data from August 10th, 2015 until June 9th, 2017 of five cryptocurrencies and six asset classes. We chose different cryptocurrencies primarily based on their market capitalization and secondarily based on their emergence. The time period was chosen based on the starting date of conducting this work and on the ability to access qualified data.

The cryptocurrencies in scope are Bitcoin, Ethereum, Ripple, NEM, and Litecoin and as asset classes we select fixed income, commodities, real estate, hedge funds and private equity.

As this work is aimed to represent the view of a U.S. investor and to control for changes in exchange rates, all exported data are denoted in U.S. dollars and all calculations are performed using U.S. dollar values.

In order to start this research, daily closing prices, trading volumes and market capitalizations for cryptocurrencies and daily closing prices for asset classes are required. Data

for cryptocurrencies were extracted from Coinmarketcap and data for asset classes, in the form of indices, were accessed through Bloomberg terminals, or directly exported from the website of the entity responsible for the index.

Cryptocurrencies

According to Coinmarketcap, as of June 9th, 2017 the six largest cryptocurrencies by market capitalization are Bitcoin (BTC), Ethereum (ETH), Ripple (XRP), NEM (XEM), Ethereum Classic (ETC) and Litecoin (LTC), respectively. Together, these six cryptocurrencies amount to 84.92% of the total cryptocurrency market capitalization (CoinMarketCap, 2017). As described in Section 3.4.2, Ethereum Classic emerged as a continuation of the original Ethereum blockchain after splitting the network in two in 2016, and therefore we exclude it from our analysis. As a result, the remaining five cryptocurrencies in scope amount to 83.35% of the total cryptocurrency market capitalization (CoinMarketCap, 2017).

Due to the relevance of Coinmarketcap as a source of information, in the following we describe the basics of Coinmarketcap's approach to gather and provide information.

Coinmarketcap does not act as an exchange for cryptocurrencies, but solely collects and merges data from different exchanges and provides those metrics on their website. Besides a vast variety of information on cryptocurrencies, the most relevant metrics provided on Coinmarketcap are average price, market capitalization and circulating supply for a variety of cryptocurrencies.

As of August 8th, 2017, Coinmarketcap accesses information from a total of 4,927 markets on which cryptocurrencies are traded. However, only markets are considered which incorporate trading fees. Reason for this is that without trading fees, it is possible to trade the same currency back and forth with multiple accounts, manipulating a cryptocurrency's trading volume, and thereby distorting the mechanism used for price determination.

For prices, Coinmarketcap uses the average price weighted by trading volume reported at each of the markets in scope. This method is known as the *Volume Weighted Average Price*, which can be expressed mathematically as seen in Equation 1.

$$VWAP_i = \frac{\sum_{i=1} P_i \times Q_i}{\sum_{i=1} Q_i} \tag{1}$$

where

$VWAP_i$ = Volume Weighted Average Price of cryptocurrency i,
P_i = Price at exchange i,
Q_i = Quantity traded at exchange i.

The market capitalization for each cryptocurrency is calculated by the sum of the cryptocurrency's price and its supply as seen in Equation 2. The approach uses the circulating supply to calculate market capitalizations, which is similar to the approach of calculating the market capitalization of companies listed on a stock exchange.

$$MC_i = P_i \times CS_i \tag{2}$$

where

MC_i = Market Capitalization of cryptocurrency i,
P_i = Price of cryptocurrency i,
CS_i = Circulating Supply of cryptocurrency i.

For approximating the number of coins that are in public hand or circulating in the market, Coinmarketcap uses the circulating supply instead of the total supply. The difference between total supply and circulating supply is that total supply takes into account coins which cannot be sold to the public as they are e.g. locked or reserved (CoinMarketCap, 2017). The circulating supply for each cryptocurrency is obtained from the exchange listing the cryptocurrency.

Asset classes

We aim to provide a comparison of the financial performance and characteristics of cryptocurrencies and traditional asset classes. To do so, we use the asset classes equity, fixed income, commodities, real estate, hedge funds and private equity as described in Section 4.1. As asset classes consist of numerous single assets, we select indices, either combined with other indices or independently, based on their ability to approximately represent the asset class as a whole. Table 1 shows the indices we use for composing each asset class and we briefly describe each index in the following.

5.1.1. MSCI US Broad Market Index.

The index aims to capture the performance of U.S. equity by tracking approximately 99% of the total U.S. equity (MSCI Inc., 2017a).

5.1.2. MSCI EAFE Index.

The index aims to capture the performance of large and mid cap equity across developed markets countries around the world, excluding the U.S. and Canada (MSCI Inc., 2017b).

5.1.3. MSCI Emerging Markets Index.

The index aims to capture the performance of large and mid cap equity across 24 emerging markets countries (MSCI Inc., 2017c).

5.1.4. Barclays Capital US Aggregate Bond Index.

The index aims to capture most U.S. traded bonds and some foreign bonds traded in the United States (Thune, 2016).

Table 1: Asset class compositions

Index Name	Asset Class
MSCI US Broad Market Index	Equity
MSCI EAFE Index	Equity
MSCI Emerging Markets Index	Equity
Barclays Capital U.S. Aggregate Bond Index	Fixed Income
Barclays Capital Global Aggregate ex U.S. Bond Index	Fixed Income
Barclays Capital High Yield Bond Index	Fixed Income
Bloomberg Commodity Index	Commodity
S&P Global REIT	Real Estate
HFRX Global Hedge Fund Index	Hedge Funds
LPX50 Index	Private Equity

5.1.5. Barclays Capital Global Aggregate ex U.S. Bond Index.

The index aims to capture the performance of the global bond market, excluding U.S. securities (T. Rowe Price Investment Services Inc., 2017).

5.1.6. Barclays Capital High Yield Bond Index.

The index aims to capture the performance of the global high yield bond market (Bloomberg L.P., 2017a).

5.1.7. Bloomberg Commodity Index.

The index, formerly known as the Dow Jones-AIG Commodity Index, is composed of futures contracts and physical commodities and aims to capture the development of global commodity prices (Bloomberg L.P., 2017b).

5.1.8. S&P Global REIT.

The index aims to capture the performance of global real estate investment by tracking the performance of global, publicly traded equity of real estate investment trusts (S&P Dow Jones Indices LLC, 2017).

5.1.9. HFRX Global Hedge Fund Index.

The index aims to capture the performance of the global hedge fund universe (Hedge Fund Research, Inc., 2017).

5.1.10. LPX50 Index.

The index aims to capture the performance of the global private equity industry by covering the 50 largest listed private equity companies (LPX AG, 2017).

For all indices, we extracted relevant data using Bloomberg terminals except for the HFRX Global Hedge Fund Index, for which data was directly extracted from the website of HFR[11], the company responsible for building the index.

[11] Data extracted from www.hedgefundresearch.com.

5.2. Data analysis

For our analysis, we compare return characteristics of cryptocurrencies and asset classes. To do so on an individual as well as on an aggregate basis, we compare portfolios of cryptocurrencies and individual cryptocurrencies with the six asset classes in scope. We therefore start this section with general assumptions for our analyses, followed by explaining our approach to set up different portfolios. We subsequently explain the methods we use and state the implications for using these methods.

Approach

Cryptocurrencies can be traded at all times, while trading of assets is usually limited to weekdays. In order to control for this difference in the amount of trading days, we calculate daily price returns of cryptocurrencies and asset classes based on weekdays and disregard the price development of cryptocurrencies on weekends.

For simplicity, in line with prior work on cryptocurrencies (Wang and Vergne, 2017; Eisl et al., 2015; Chuen et al., 2017; Elendner et al., 2016), we make several other assumptions: For all calculations we assume that the investor is not subject to trading fees, bid-ask spreads are non-existent, coins can be divided indefinitely and that enough liquidity exists in the market to execute each trade immediately. Besides, as commonly applied in mathematical finance, we assume that log returns of prices of cryptocurrencies and asset classes follow a normal distribution (Mota, 2012; Penza and Bansal, 2001).

5.2.1. Portfolios

In order to compare cryptocurrencies on an individual as well as on an aggregate level, we form three hypothetical portfolios reflecting different investment approaches. We construct an equally weighted portfolio (PF1), a monthly rebalanced, market value weighted portfolio (PF2) and a portfolio with medium Bitcoin focus (PF3). Each of the three portfolios consist of the five cryptocurrencies in scope. Table 2 shows the relative portfolio share per cryptocurrency, as the proportion of its value within the portfolio compared to the total portfolio value.

Table 2: Portfolio compositions

	BTC	ETH	XRP	XEM	LTC
PF1	20%	20%	20%	20%	20%
PF2	88.74%	1.00%	6.49%	0.03%	3.74%
PF3	40%	15%	15%	15%	15%

Portfolio compositions as of 10/08/2017. Note, that the composition is fixed at time of setting up the portfolio. Changes in prices result in a different composition over time.

The first portfolio (PF1) is an equally weighted portfolio with portfolio weights fixed at the time of purchase. Therefore, each cryptocurrency is represented with 20% value of the total portfolio value at the time of setting up the portfolio. Note, that the percental shares are only fixed at the time of purchase, as different price changes within time among the cryptocurrencies result in changes of the respective percental shares within the portfolio.

The second portfolio (PF2) is a market value weighted portfolio which is rebalanced every month. This means, that the relative share of the value of each cryptocurrency within the portfolio equals the relative market share of each cryptocurrency, given the market only consists of the cryptocurrencies in scope. We follow Equation 3 for the initial composition of the portfolio as well as for rebalancing it. As for the other analyses in this work, we set up the portfolio on August 10th, 2015. Therefore, the portfolio is rebalanced every 10th day of each month following August 2015 until June 9th, 2017 and hence, the portfolio is rebalanced a total of 21 times.

At the time of rebalancing, the relative market capitalization of each cryptocurrency is calculated in order to find a new portfolio target composition. By knowing the new target composition, the current prices for each cryptocurrency and the total value of the portfolio, it is possible to acquire and sell cryptocurrencies until the new target ratio is reached, while considering the capital constraint of the portfolio value at time of rebalancing. The capital constraint refers to the condition that the investor cannot invest more than his current portfolio value. By rebalancing the portfolio, we monthly align its composition according to the relative market capitalization of each cryptocurrency.

$$PFW_{it} = \frac{MC_{it}}{\sum_{i=1} MC_{it}} \tag{3}$$

where

PFW_{it} = Portfolio weight of cryptocurrency i at time t,
MC_{it} = Market capitalization of cryptocurrency i at time t.

For the third portfolio (PF3) we assume that 40% of the portfolio value is invested in Bitcoin, and the other 60% are split equally among the remaining four cryptocurrencies. We decide on this composition as we want to investigate the behavior of a hypothetical portfolio that does not invest equally in all cryptocurrencies (PF1) and that does not put a majority stake in Bitcoin at the time of set up (PF2). We are interested in a portfolio with a Bitcoin share of less then 50% and a majority focus on other cryptocurrencies than Bitcoin, while still having a large share invested in Bitcoin. As in PF1, the percental shares per cryptocurrency are only fixed at the time of setting up the portfolio and the percental composition can be influenced directly by price changes of the cryptocurrencies in the portfolio.

5.2.2. Remark.

The reason for setting up three different portfolios is to take into account different investment behaviors. It is important to note that some cryptocurrencies were launched close to the beginning of our investment period and can be considered to having had a "start-up-character" at the time of setting up the different portfolios. Therefore, the first portfolio provides a risky approach by investing the same amount in all cryptocurrencies. The second approach represents a more risk-averse behavior as the investment is based on each cryptocurrency's market share and each month the portfolio is rebalanced. Thereby, established cryptocurrencies are given a higher portfolio weight, hence neglecting the risk of investing large amounts in "less-established" cryptocurrencies. The third portfolio represents a medium risk-seeking behavior, as the investor focuses on a Bitcoin investment of 40%, the most established cryptocurrency, and equally invests the other 60% in the remaining four cryptocurrencies. Note, that our measure of risk for setting up the portfolios is solely based on how established, based on market capitalization, a cryptocurrency is in the market.

5.2.3. Methods

We follow selected methods of the approaches by Chuen et al. (2017), Elendner et al. (2016), Eisl et al. (2015) and Osterrieder et al. (2017) and calculate risk- and performance measures based on daily arithmetic returns as well as on daily log returns. To allow for comparison between the cryptocurrencies and asset classes in scope we control for differences in available data over the same time period.

Daily price returns for cryptocurrencies and asset classes are calculated similarly, as the percental price change in daily closing prices, as seen in Equation 4.

$$r_{\alpha i} = \left(\frac{P_{it+1} - P_{it}}{P_{it}}\right) * 100 \tag{4}$$

where

$r_{\alpha i}$ = Percental return of cryptocurrency/index i at time $t+1$,
P_{it} = Price of cryptocurrency/index i at time t.

In line with research by Eisl et al. (2015), we continue with the calculation of descriptive statistics, providing daily volatility, mean, different percentiles and percentage of negative returns for each cryptocurreny and asset class. We measure volatility as the standard deviation of daily returns following Equation 5.

$$\sigma_i = \sqrt{\frac{1}{N_i - 1}\sum_{i=1}^{N}(r_i - \overline{r_i})^2} \tag{5}$$

where

σ_i = Standard deviation of cryptocurrency/index i,
r_i = Return of cryptocurrency/index i,
$\overline{r_i}$ = Mean return of cryptocurrency/index i,
N_i = Number of observations of cryptocurrency/index i.

We then calculate log returns applying Equation 6. The reason for calculating log returns is that methods such as the Sharpe ratio require normally distributed data and one of the assumptions of log returns is that they follow a normal distribution (Mota, 2012; Penza and Bansal, 2001; Bodie et al., 2010).

$$r_{\lambda i} = \ln\left(\frac{P_{it+1}}{P_{it}}\right) \tag{6}$$

where

$r_{\lambda i}$ = Log return of cryptocurrency/index i at time $t+1$,
P_{it} = Price of cryptocurrency/index i at time t.

We need to adapt our data in order to calculate log returns for the asset classes equity and fixed income. These asset classes consist of multiple indices and we decided to give each index an equal weight and calculate the regular return of the asset classes as the equally weighted return of the underlying indices as categorized in Table 1. As equally weighting multiple log returns does not yield correct results, we use regular daily returns to calculate the daily development for a hypothetical investment. Thereby we are able to see how a hypothetical investment in a complete asset class behaves and we can use the development to calculate daily log returns for the respective asset classes using Equation 6.

To investigate the respective investment's risk profiles and their performance relative to their risk, we calculate measures such as value-at-risk, historical expected shortfall, Sharpe ratios and information ratios for each cryptocurrency and asset class. We calculate these measures according to Bodie et al. (2010) and take into account that this requires interpolation due to numbers not always being integers at the 1% and 5% level.

The value-at-risk framework is a downside measure that provides insights about the incurred loss given a certain probability. In line with research by Osterrieder et al. (2017), we calculate value-at-risk both at the 5% as well as on the 1% probability level following Equation 7. Therefore, calculating value-at-risk yields the highest return out of the 5% respectively 1% worst case scenarios (Maginn et al., 2007; Bodie et al., 2010).

$$VaR_{i\alpha} = \mu_i - z * \sigma_i \tag{7}$$

where

$VaR_{i\alpha}$ = Value-at-Risk of cryptocurrency/index i at probability level α,
μ_i = Mean return of cryptocurrency/index i,
z = Z-score according to normal distribution of 1.65 at 5%- and 2.33 at 1% probability level,
σ_i = Standard deviation of cryptocurrency/index i.

Another measure of downside risk is the expected shortfall. The measure is closely related to the value-at-risk framework but instead of focusing on one number, the expected shortfall measures the average loss given that we are in the 5% respectively 1% worst case scenarios. In line with research by Osterrieder et al. (2017) we calculate the historical expected shortfall as the mean of all losses that respectively exceed the 1% and 5% worst historical returns according to (Bodie et al., 2010).

In line with the approach by Chuen et al. (2017), we continue with calculating the Sharpe ratio, a commonly used risk measure that provides a ratio of an investment's risk premium relative to the investment's standard deviation (Bodie et al., 2010). Thus, it standardizes each unit of return per unit of risk, and thereby enables comparison among investments. The higher an investment's Sharpe ratio the better and vice versa (Burniske and White, 2017). The Sharpe ratio is calculated according to Equation 8. In line with prior research, we calculate the daily log risk-free rate to be 0.0015% as the average of the three month treasury-bill rate over the relevant period from August 2015 until June 2017, transformed to a daily log interest rate (Baur et al., 2015).

$$Sharpe\ Ratio = \frac{\mu_i - rf}{\sigma_i} \tag{8}$$

where

μ_i = Mean return of cryptocurrency/index i,

rf = Risk-free rate,
σ_i = Standard deviation of cryptocurrency/index i.

A further measure to compare risk-adjusted returns is the information ratio (Chuen et al., 2017). The information ratio measures the excess return of an investment per unit of risk and is calculated following Equation 9 (Bodie et al., 2010). The information ratio requires the benchmark to have a lower average return compared to the investment in scope. It is common to use stock indices as benchmarks but the high average return of both equity and international equity made them unfavorable. Therefore, we decided to use the sub-class international equity as our benchmark.

$$Information\ Ratio = \frac{\mu_i - \mu_b}{S_{i-b}} \tag{9}$$

where

μ_i = Mean return of cryptocurrency/index i,
μ_b = Mean return of benchmark,
S_{i-b} = Tracking Error: Standard deviation of the difference between returns of cryptocurrency/index i and benchmark.

In order to shed light on the ability of cryptocurrencies to improve portfolio diversification, we continue with calculating correlations between log returns of cryptocurrencies and asset classes. In line with research by Osterrieder et al. (2017) and Chuen et al. (2017), we calculate Pearson correlations following Equation 10. We calculate correlations between the individual cryptocurrencies and correlations between cryptocurrencies and asset classes including correlations between the single components within each asset class. For all calculations missing values were pairwise omitted.

$$Corr_{xy} = \frac{cov(x,y)}{\sigma_x * \sigma_y} \tag{10}$$

where

$Corr_{xy}$ = Correlation coefficient between cryptocurrency/index x and cryptocurrency/index y,
$cov(x,y)$ = Covariance between cryptocurrency/index x and cryptocurrency/index y,
σ_x = Standard deviation of cryptocurrency/index x,
σ_y = Standard deviation of cryptocurrency/index y,

with

$$Cov(x,y) = \frac{\sum(r_x - \mu_x) * (r_y - \mu_y)}{\sqrt{\sum(r_x - \mu_x)^2 * \sum(r_y - \mu_y)^2}}$$

where

$Cov(x,y)$ = Covariance between cryptocurrency/index x and cryptocurrency/index y,
r_x = Return of cryptocurrency/index x,
r_y = Return of cryptocurrency/index y,
μ_x = Mean return of cryptocurrency/index x,
μ_y = Mean return of cryptocurrency/index y.

5.2.4. Rationale.

We selected these methods based on approaches of prior research on cryptocurrencies. We believe that they are useful for providing us with information regarding the return characteristics of cryptocurrencies and asset classes, and enable us to draw a conclusion on cryptocurrencies' potential to improve portfolio diversification.

6. Findings

We start this chapter with providing our findings regarding the risk-reward profile of cryptocurrencies and asset classes in Section 6.1 and continue with a correlation analysis in Section 6.2. We finish this chapter with presenting potential limitations and arguments against these limitations in Section 6.3.

6.1. Risk-reward profile

Table 3 displays descriptive statistics of daily returns of cryptocurrencies and asset classes. In line with research by Chuen et al. (2017), Eisl et al. (2015) and Elendner et al. (2016) we found larger returns but also a remarkably higher dispersion of returns for cryptocurrencies compared to those of the asset classes in scope. Especially comparing the mean returns in Table 3 shows the large difference of returns that were generated by cryptocurrencies compared to those by traditional asset classes.

The first unexpected finding is that for all cryptocurrencies under investigation, except for Ripple, we found both a positive median and mean. This implies, as can be inferred from the row "Neg" in Table 3, that most returns were of positive nature. This challenges findings by Elendner et al. (2016) which found more negative than positive returns. However, this might be due to their focus on a different time period.

We furthermore found, that for all cryptocurrencies the upper decile is of higher magnitude than the lower decile and also that, except for Ripple, the upper quartile is of higher magnitude than the lower quartile. In line with research by Elendner et al. (2016), these findings imply that positive returns of cryptocurrencies are of higher magnitude than negative returns.

Comparing the different portfolios, we found that return characteristics highly differ. While PF1 and PF3 show similar characteristics concerning negative returns as well as for deciles and quartiles, PF2 shows quite different results. Although PF2 generated lower mean returns compared to the other two portfolios, we see that its median is relatively closer to that of the other portfolios and that values for the lower quartile are remarkably lower. This difference in mean return is likely to be explained by returns of large magnitude

by cryptocurrencies with larger weights in PF1 and PF3 than in PF2.

It is also interesting to note that PF2 exhibited the lowest percentage of negative returns among the portfolios with only 31.73%. This implies that there was a positive effect on the amount of positive returns when rebalancing a portfolio based on the market capitalization of its components. This can be explained by the mechanism used for rebalancing. When rebalancing, the weight of a cryptocurrency is increased if its relative market capitalization has increased. The relative market capitalization of any cryptocurrency only increases if its absolute market capitalization increases faster than the average absolute market capitalization of the other cryptocurrencies in the "market"[12]. Put simple, rebalancing based on relative market share results in increasing the weight of a cryptocurrency that has had a better performance compared to its peers.

When looking at asset classes, we found quite different results. For all asset classes except commodities the median and mean are positive and positive returns occurred more frequently than negative returns. However, compared to cryptocurrencies, the magnitude of daily returns is far lower. We further found that the magnitude of the upper and lower decile are quite similar and that three asset classes show a higher magnitude for the upper than for the lower decile. For the remaining three asset classes, however, the lower deciles are of larger or equal magnitude. It is interesting that for all asset classes the upper quartile is of larger magnitude than the lower one. This is quite different compared to our results for the respective deciles as both quartiles and deciles measure return behavior for extreme events.

Table 4 shows multiple risk- and performance measures of cryptocurrencies and asset classes. We found large differences in terms of volatility, skewness and excess kurtosis. Cryptocurrencies show high levels of volatility compared to asset classes. This is especially the case for NEM with a daily volatility of over 11%. For Bitcoin, as the most established cryptocurrency, we found relatively low volatility compared to other cryptocurrencies in scope. This might be due to its relatively long existence compared to cryptocurrencies such as NEM. This argument is reinforced when looking at Litecoin, the second oldest cryptocurrency in scope, for which we also found a relatively low volatility compared to the remaining cryptocurrencies.

In addition to high levels of volatility, all cryptocurrencies and cryptocurrency portfolios except Bitcoin and PF2 are positively skewed while for asset classes only commodities are positively skewed. Positive skew implies that the right tail of the probability density function of the log returns of an investment is longer and fatter than the left tail. This provides information about the downside risk of the investment, as positive skew implies that negative outcomes occur less frequently and extreme negative returns are not as likely and vice versa.

[12]In our case the market consists of the five cryptocurrencies in scope.

We also found positive excess kurtoses for all cryptocurrencies including cryptocurrency portfolios and asset classes. The excess kurtosis provides information regarding the historical return distribution. A normal distribution has a kurtosis of 3 and hence the excess kurtosis provides a measure of how the distribution of the data in scope differs from a normal distribution. A positive excess kurtosis refers to a leptokurtic distribution which is more peaked and has longer and fatter tails than a normal distribution. Thus, large returns occur more frequent and are potentially larger in magnitude compared to those of a normal distribution, which is in line with findings by Osterrieder et al. (2017) and Eisl et al. (2015). However, these results deviate from findings by Elendner et al. (2016) and Chuen et al. (2017), which respectively found negatively skewed returns for Litecoin and Ethereum and for Litecoin only.

The risk measures we calculated provide clear insights about the respective risk profiles. Comparing value-at-risk and expected shortfall at both the 1% and 5% level yields large differences for cryptocurrencies and asset classes. Remarkably are the high expected shortfall values for Ethereum and NEM. The magnitude of measures of both value-at-risk and expected shortfall are in line with findings by Osterrieder et al. (2017) but are generally smaller than those of Elendner et al. (2016). Recall that value-at-risk and expected shortfall can be interpreted as percentage losses that occur on a single day and thus these differences show the high risk profile of investments in cryptocurrencies compared to investments in asset classes.

To measure risk-adjusted returns, we calculated Sharpe ratios for all cryptocurrencies and asset classes. We found high Sharpe ratios for all cryptocurrencies and cryptocurrency portfolios we investigate. It is interesting to note that although Ethereum's returns are highly volatile with high levels of value-at-risk and expected shortfall, it yields the highest Sharpe ratio among the individual cryptocurrencies. This implies that Ethereum generated higher daily excess returns relative to its volatility compared to the remaining cryptocurrencies we investigate. We further found, except for fixed income, low Sharpe ratios for equity, commodities, hedge funds and private equity, and a negative Sharpe ratio for real estate, which did not generate mean excess return. Surprisingly, we found an equal Sharpe ratio for fixed income and for Litecoin, which can be explained by the low volatility of fixed income investments. According to the calculated Sharpe ratios, an investor should clearly favor investments in cryptocurrencies over investments in traditional asset classes.

The information ratio provides another measure to compare returns relative to their level of risk. We found high information ratios for cryptocurrencies, with Ethereum providing the largest with 0.137. For Litecoin we found the lowest information ratio among cryptocurrencies, which is not surprising given its low mean return. Surprisingly, the information ratios for asset classes are very low compared to our results for cryptocurrencies. Equity has the highest information ratio among asset classes with 0.054, which is even significantly lower than Litecoin's information ratio. The in-

Table 3: Descriptive statistics of daily returns for cryptocurrencies and asset classes

Crypto	Max	D90	Q75	Median	Mean	Q25	D10	Min	SD	Neg	N
PF 1	29.73	5.44	2.75	0.73	1.16	-0.81	-2.86	-14.52	4.34	37.16	479
PF 2	15.23	3.99	1.76	0.53	0.64	-0.26	-2.00	-17.02	3.35	31.73	479
PF 3	24.15	4.87	2.47	0.66	1.01	-0.62	-2.19	-15.03	3.79	36.33	479
BTC	15.90	3.73	1.60	0.52	0.55	-0.29	-2.51	-17.91	3.43	30.69	479
ETH	57.10	11.07	4.20	0.74	1.62	-1.93	-6.42	-32.00	8.69	40.29	479
XRP	110.34	4.97	1.31	-0.04	1.00	-1.45	-3.78	-18.67	8.33	51.15	479
XEM	98.36	11.46	4.53	0.82	2.06	-2.90	-8.02	-22.75	10.97	43.01	479
LTC	40.96	4.17	1.36	0.26	0.57	-0.64	-3.32	-21.86	5.53	36.74	479
Assets	Max	Q90	Q75	Median	Mean	Q25	Q10	Min	SD	Neg	N
EQT	2.87	0.92	0.47	0.03	0.03	-0.33	-0.88	-4.77	0.80	47.60	479
FI	1.26	0.31	0.16	0.02	0.02	-0.13	-0.25	-1.25	0.26	45.26	475
CMT	3.09	1.17	0.57	-0.02	0.03	-0.54	-1.07	-2.56	0.92	50.68	444
REIT	2.77	1.12	0.60	0.08	0.00	-0.55	-1.28	-4.69	1.00	46.28	443
HF	0.76	0.25	0.14	0.02	0.00	-0.10	-0.25	-1.13	0.22	47.07	444
PE	3.09	1.05	0.59	0.06	0.03	-0.39	-1.07	-5.97	1.01	45.51	479

Descriptive statistics of daily returns (in percent) of the five cryptocurrencies and six asset classes in scope over the time period 08/10/2015 until 06/09/2017. EQT refers to Equity, FI refers to Fixed Income, CMT refers to Commodities, REIT refers to Real Estate, HF refers to Hedge Funds and PE refers to Private Equity.

Table 4: Risk- and performance measures of cryptocurrencies and asset classes

Crypto	Mean (%)	SD	Skew	Kurt	VaR 1%	ES 1%	VaR 5%	ES 5%	SR	IR
PF 1	1.065	0.042	0.972	6.470	0.087	0.118	0.058	0.096	0.254	0.248
PF 2	0.581	0.034	-0.938	7.235	0.073	0.143	0.050	0.112	0.172	0.167
PF 3	0.934	0.037	0.431	5.971	0.077	0.119	0.052	0.098	0.251	0.244
BTC	0.494	0.037	-0.570	6.252	0.081	0.148	0.056	0.118	0.133	0.130
ETH	1.250	0.090	0.960	5.608	0.198	0.258	0.136	0.221	0.138	0.137
XRP	0.728	0.077	3.698	25.388	0.172	0.145	0.119	0.118	0.095	0.094
XEM	1.540	0.115	2.243	14.044	0.253	0.205	0.175	0.177	0.134	0.133
LTC	0.421	0.057	2.261	17.852	0.130	0.171	0.091	0.141	0.073	0.072
Assets	Mean (%)	SD	Skew	Kurt	VaR 1%	ES 1%	VaR 5%	ES 5%	SR	IR
EQT	0.023	0.008	-0.818	5.014	0.018	0.033	0.013	0.026	0.027	0.054
FI	0.021	0.003	-0.416	4.316	0.006	0.009	0.004	0.008	0.073	0.022
CMT	0.029	0.009	0.203	0.380	0.021	0.023	0.015	0.021	0.030	0.028
REIT	-0.002	0.010	-0.577	1.717	0.023	0.036	0.017	0.029	-0.004	-0.003
HF	0.002	0.002	-0.865	3.331	0.005	0.009	0.004	0.007	0.003	0.001
PE	0.029	0.010	-1.247	6.557	0.023	0.047	0.016	0.035	0.027	0.040

Risk- and performance measures, including value-at-risk, Sharpe ratio and information ratio for daily log returns and expected shortfall for daily returns of the cryptocurrency portfolios, individual cryptocurrencies and asset classes over the time period 08/10/2015 until 06/09/2017. EQT refers to Equity, FI refers to Fixed Income, CMT refers to Commodities, REIT refers to Real Estate, HF refers to Hedge Funds and PE refers to Private Equity.

formation ratio of real estate returns cannot be interpreted as the asset class did not generate positive daily mean returns. Based on our results, we can conclude that investments in cryptocurrencies yield much better risk-adjusted returns than investments in traditional asset classes, reinforcing our implications from the calculated Sharpe ratios. However, comparing our results with those by Chuen et al. (2017) highlights large deviations, as they found remarkably lower values for Sharpe- and information ratios.

6.2. Correlation analysis

Table 5 presents correlation coefficients between the cryptocurrencies in scope. The correlation coefficient measures the linear relationship between two variables and thus provides insights on how the returns historically behaved. Out of the total of ten correlations we calculated, we found eight to be significant at the 5% level. In line with findings by Osterrieder et al. (2017), all correlations between cryptocurrencies are of positive nature. A potential explanation for this result could be that individuals start to invest in cryptocurrencies in times of positive market movement as it was the case in the dotcom bubble in the late 1990s (Scherbina, 2013). This increase in demand usually results in positive price movements and hence implies positive returns for investors.

We found the strongest relationship between the returns of Bitcoin and Litecoin with a correlation of 0.53. This result is not surprising, taking into account that Litecoin emerged as a clone of Bitcoin with only minor changes. Our results further show that Bitcoin and Litecoin are both positively correlated with all cryptocurrencies in scope. This can potentially be explained by individuals to invest in times of positive movement of Bitcoin and Litecoin as they are the oldest cryptocurrencies under investigation. It is also interesting, that Ripple's returns show significant correlations with three out of the four correlations we investigate. This might be due to Ripple's use as an exchange for transferring cryptocurrencies. Hence, its importance could be correlated to the overall acceptance of cryptocurrencies.

According to Markowitz's Modern Portfolio Theory (Markowitz, 1952), individual investments within a portfolio have a diversifying effect if the investments provide a low correlation. Therefore, similar to findings by Osterrieder et al. (2017), we can conclude that when considering to invest in cryptocurrencies, at least for the cryptocurrencies we investigate in this work, combining different cryptocurrencies in a portfolio provides beneficial diversification effects. This can also be derived from our findings in Section 6.1 when looking at the results presented in Table 3 and Table 4. Comparing our findings regarding individual cryptocurrencies and the portfolios we set up, we can see that we found far larger risk-adjusted returns for our portfolios than for individual cryptocurrencies. Thereby, we can also conclude that the cryptocurrencies in scope provide a diversifying effect when combined in a portfolio.

Table 6 displays correlations between the five cryptocurrencies and six asset classes in scope including their individual components. We found significant negative correlations between the returns of Ethereum and international equity, represented by the EAFE Index, as well as between Ethereum and private equity returns. Therefore, we can conclude that for investments in international equity and private equity, including Ethereum in a portfolio provides the possibility to generate higher returns under the same level of risk compared to not including Ethereum (Fraser-Sampson, 2011; Credit Suisse Group AG, 2014). Furthermore, the negative correlations of international equity and private equity with Ethereum imply that these investments can be used as hedge assets. This allows to invest in international equity or private equity in order to hedge the risk of holding Ethereum, irrespecitve of Ethereum's intendet use (Bodie et al., 2010).

However, we could not find statistically significant results at the 5% level for the remaining correlations. This means that the respective returns of the variables are statistically independent and thus, we cannot confirm prior research which found that including these cryptocurrencies in a portfolio does improve portfolio diversification.

Although we did not find more than two significant correlations between the returns of cryptocurrencies and asset classes, we can say that adding cryptocurrencies to a portfolio does have a positive impact on the overall risk of a portfolio. This is due to the decreased exposure to systematic risk when adding an additional asset class to a portfolio (Fraser-Sampson, 2011).

6.3. Limitations

Our analysis is subject to several limitations that could potentially influence our results. Our main limitation is that we relied on Coinmarketcap as our primary source for data on cryptocurrencies. This implies that we need to trust Coinmarketcap's mechanisms in charge for calculating the data we extracted. We were not able to prove the validity of all mechanisms that Coinmarketcap uses due to missing access to exchanges and as this would be too time consuming. We therefore have to assume that data from Coinmarketcap is valid. This assumption is reinforced by the prominence of Coinmarketcap in the cryptocurrency community.

As explained in Section 5.1, Coinmarketcap does not act as an exchange but calculates prices from other exchanges. Therefore, the prices we used for our analyses are volume weighted average prices and not prices from a specific exchange. This implies that research that is based on data from other providers of cryptocurrency metrics or based on data from specific exchanges can differ from our findings due to the different mechanisms used for calculating the cryptocurrency metrics. However, the volume weighted average price measures the average prices paid on a variety of exchanges according to the cryptocurrency's trading volume on the respective exchange. We believe that this provides a better approximation of general market prices than solely relying on data from a single exchange.

We further made several assumptions in our methodology that are not accurate when considering actual investments in cryptocurrencies.

First, we assumed that trading is not subject to fees, which is not the case as fees have to be paid on the network per transaction and some exchanges require trading fees as well. However, these fees are considerably low and hence we neglected them.

Second, we assumed that no bid-ask spreads exists. This refers to the ability to acquire and sell a cryptocurrency for the same price. However, on actual exchanges, the required purchase price is usually above the price one can sell a cryptocurrency for. This only has a relatively strong impact on

Table 5: Correlations between cryptocurrencies

	BTC	ETH	XRP	XEM	LTC
BTC	1	0.22*	0.19*	0.29*	0.53*
ETH	0.00	1	0.00	0.01	0.11*
XRP	0.00	0.94	1	0.20*	0.22*
XEM	0.00	0.77	0.00	1	0.19*
LTC	0.00	0.01	0.00	0.00	1

The upper triangular displays the correlations of cryptocurrencies against each other and the lower triangular shows the corresponding $p-values$ over the time period from 08/10/2015 until 06/09/2017. Correlations with an asterisk are significant at the 5% level.

Table 6: Correlations between cryptocurrencies and asset classes

	BTC	ETH	XRP	XEM	LTC
Equity	-0.02	-0.07	0.00	-0.05	-0.01
U.S.	-0.01	-0.02	0.00	-0.02	-0.01
International	-0.03	-0.10*	0.00	-0.07	0.00
Emerging Markets	-0.02	-0.06	0.01	-0.04	-0.02
Fixed Income	0.02	-0.02	0.01	-0.02	-0.02
U.S.	0.02	0.01	0.03	0.03	-0.03
Global	0.02	0.00	0.01	-0.01	-0.02
High Yield	0.01	-0.07	-0.02	-0.05	0.00
Commodities	0.05	-0.06	-0.01	0.03	-0.01
Real Estate	0.00	-0.02	0.00	0.00	0.01
Hedge Funds	-0.02	-0.03	0.00	-0.05	0.00
Private Equity	-0.02	-0.10*	-0.01	-0.04	-0.02

Correlations between cryptocurrencies and asset classes including their components over the time period from 08/10/2015 until 06/09/2017. Correlations with an asterisk are significant at the 5% level. Tables in the Appendix provide information regarding the corresponding $p-values$.

PF2, as the assumption of no bid-ask spreads was required for rebalancing. This is also a relevant limitation for the descriptive statistics calculated in Table 3, but only given that an investor would have realized his return at the end of our investigation period. This would only impact the last of the 479 daily returns per cryptocurrency and hence does not result in a significant deviation of our results.

We additionally assumed that coins can be divided indefinitely for setting up our different portfolios. As stated in Section 3.4, there is a smallest unit for each cryptocurrency and thus this impacts our results. However, each coin can be traded in the smallest unit they are denoted in and all cryptocurrencies we investigate can be at least divided by one million. Therefore, this difference is only marginal.

Another potential limitation might be our assumption that the market provides enough liquidity to enable executing each trade immediately, which is usually not the case for large orders. This was relevant for rebalancing the portfolio and for potentially realizing returns. After considering daily trading volumes of the cryptocurrencies we investigate, we found this assumption to have barely any impact on our results.

Finally, we selected the cryptocurrencies under investigation based on their current market capitalization, implying that we selected cryptocurrencies which were already established in the market by the time of selection. This means that our analysis is based on the past performance of currently successful cryptocurrencies and we thereby neglected the possibility to select cryptocurrencies that decrease in value over the time period we considered. Therefore, our analysis does not account for all risks involved when investing in cryptocurrencies but provides information about the risks of currently prominent cryptocurrencies.

Although there are several limitations to our work, several other studies on cryptocurrencies (Wang and Vergne, 2017; Eisl et al., 2015; Chuen et al., 2017; Elendner et al., 2016) are subject to the same limitations. We therefore believe that neglecting these limitations does not alter the results of this work but is relevant to enable comparison with other research on cryptocurrencies.

7. Technological risks of cryptocurrencies

In this chapter we start with providing information regarding selected attacks on cryptocurrencies in Section 7.1 and continue with information regarding general threats in Section 7.2. We finish this chapter with explaining potential implications of the presented attacks and threats in Section 7.3.

7.1. Attacks

In this section we provide an overview of selected attacks that can put users of cryptocurrencies at risk.

7.1.1. Majority mining attack.

Cryptocurrencies are decentralized and rely on a large network of individuals to preserve the system by validating transactions. The validation is done through the respective consensus protocol of the cryptocurrency which is energy consuming but validators are rewarded by the network as an incentive to preserve the system. This opens the opportunity to monetize on the consensus mechanism and invest in equipment for validating. Therefore, the majority of validators choose to operate in countries where electricity is cheap, which leads to centralization of the network. This threatens a cryptocurrency in its key strength, decentralization, and opens the opportunity to a majority mining attack, the most known attack on cryptocurrencies. In this attack validators collude, if necessary, to generate more than 50% of the computational power in the network. Blockchain consensus mechanisms rely on a majority to verify transactions to be added to the blockchain. If a single group controls the majority, it can undergo the consensus mechanism. By doing so, the parties controlling the majority of the computational power have the ability to block transactions of others, double spend coins and also prevent other individuals from mining (Eyal and Sirer, 2014; Bonneau et al., 2015). This is especially threatening, as single mining pools are already controlling major stakes of the overall computational power within some of the cryptocurrencies' networks. As of September 15th, 2017 the four largest Bitcoin mining pools combined controlled over 50% of the computational power, while only two mining pools would be needed to collude for both Litecoin and Ethereum to enable a majority mining attack (Blockchain Luxembourg S.A., 2017; Litecoinpool.org, 2017; Etherchain, 2017; Conti et al., 2017).

Research by Eyal and Sirer (2014) found that this is especially threatening for Bitcoin. They propose the concept of *Selfish-mining attacks*, a strategy by which a minority mining pool receives more rewards than the ratio of its computational power. This in turn provides an incentive for individual miners to join mining pools pursuing this strategy as it provides larger financial benefits compared to mining individually. If individual miners have an incentive to join the selfish mining pool, this leads to a mining pool to grow towards a majority that threatens the decentralization of the cryptocurrency. Therefore, a majority mining attack poses an extreme risk for cryptocurrencies, especially with the development of mining pools causing cryptocurrencies to lose one of their greatest features: decentralization.

7.1.2. Sybil attack.

A Sybil attack refers to an attacker attempting to fill the network with nodes that are controlled by him. This can result in individuals that are on the network to only connect to nodes which are controlled by the attacker. Thereby, the attacker can disconnect individuals from the network and also has the ability to exercise double spending attacks. Sybil attacks are possible on public blockchains and thus Bitcoin, Ethereum, NEM and Litecoin are subject to this attack (NEM.io Foundation Ltd, 2015a; Conti et al., 2017).

7.1.3. Denial of service attack.

In a denial of service attack an attacker spams the network in order to slow it down or eventually cause it to crash. This results in transactions not being validated and is a vulnerability of all cryptocurrencies we investigate in this work. However, as discussed in Section 3.4, transactions on the network are subject to fees and thus a denial of service attack can be very costly for an attacker to succeed.

Although it might be expensive for an attacker to pursue the attack, the opportunity exists and attackers that could potentially monetize on a slowdown of the network of a particular cryptocurrency could still benefit while bearing the large costs involved in the attack. While it might be financially rewarding to directly attack a specific cryptocurrency, denial of service attacks are more commonly observed on cryptocurrency exchanges as this seems to be easier while having a strong impact on the prices of the cryptocurrencies traded on the exchange (Conti et al., 2017; Buntinx, 2017).

7.1.4. IP identification.

When a transaction is sent on the network, it is broadcasted to all miners which have to verify the transaction. As miners are based in different locations around the world, the time until the transaction reaches each miner differs according to their respective distance to the person executing the transaction. For each transaction a miner receives, a log file is created in which the IP address of the individual executing the transaction is saved (Bonneau et al., 2015). Research by Biryukov et al. (2014) found that, at least for Bitcoin, the possibility exists to combine the time required until a transaction arrives at the respective mining nodes and the respective log files, to de-anonymize the individual that executed a certain transaction.

7.1.5. Transaction graph screening.

In order to receive or send a transaction on a blockchain an address is required. This address is unique and can be compared to an email address, through which users can receive or send cryptocurrencies. If an individual provides her address publicly, as it is e.g. the case for many authors on cryptocurrency related topics asking for donations, it is possible to explore her complete transactional history through

a blockchain explorer[13]. Although it is suggested to use different addresses for each transaction, some merchants only use one address for receiving payments. This allows to explore the timing and value of each transaction sent to the merchant. If a person communicates her purchase at a merchant that uses only one address, it is possible to either narrow down or to find out her specific address, depending on the amount of information provided (Bonneau et al., 2015; Ron and Shamir, 2013; Ober et al., 2013; Bruno, 2017).

7.1.6. Exchange attack.

In order to receive an initial amount of a cryptocurrency there are numerous possibilities individuals can choose. The most convenient approach is to purchase cryptocurrencies on an exchange using a credit card (Wu et al., 2014). Due to legal requirements, many exchanges require individuals to pass certain security measures that require uploading identification documents such as a driver's license or passport. This implies that if an attacker is able to access the database of an exchange on which documents are stored and further finds out which blockchain address an individual used, the attacker has all personal information and can track all transactions of the individual. In addition to anonymity at risk, if a cryptocurrency exchange is subject to an attack this can also cause theft of coins stored on the exchange. This was the case for Mt. Gox, an exchange that became victim of a hacker attack resulting in the theft of over 740,000 BTC (Barber et al., 2012; Popper and Abrams, 2014).

7.2. General threats

In this section we provide an overview of selected general threats of cryptocurrencies, namely cryptographic breakthroughs, potential issues with open source code and security vulnerabilities in codes.

7.2.1. Cryptographic breakthroughs.

Cryptocurrencies rely on the security of cryptography. Advancements in cracking cryptographic codes are therefore a potential threat to the security of a cryptocurrency. Especially the development of quantum computers poses a threat as these computers are far more efficient than regular computers and could enable to decrypt cryptographic systems used by cryptocurrencies (Ethereum Foundation, 2017). However, the development of quantum computers is currently performed by a few large corporations such as IBM (Kandala et al., 2017) and Bergen (2017) and we do not believe that they would use their quantum computers for decrypting the algorithms that secure cryptocurrencies.

7.2.2. Open source.

Four of the cryptocurrencies we investigate in this work (Bitcoin, Ethereum, Litecoin and Ripple) rely on open source-software and NEM plans to be open source in the near future (Ethereum Foundation, 2017; Bitcoin Project, 2017b; Litecoin Project, 2016; Wong, 2016; Williams, 2017). This poses the threat that individuals working on the code of the cryptocurrency may potentially, either accidentally or on purpose, introduce security vulnerabilities into its code that can be exploited by attackers (Ethereum Foundation, 2017).

7.2.3. Security vulnerabilities in the code

As discussed in Section 3.4, a cryptocurrency may serve as a platform to develop applications on top of its blockchain. Therefore, risks may arise for the cryptocurrency itself due to security vulnerabilities of applications that are built on its platform, as it was the case for The DAO, built on Ethereum. When The DAO was attacked, the price for Ether fell by more than 50% within 48 hours (Bovaird, 2016). This in turn has an impact on other applications that run on the cryptocurrency's platform as the cryptocurrency itself is used as an internal pricing mechanism and its price determines the cost of operating on the platform (Ethereum Foundation, 2017).

7.3. Implications

After explaining specific attacks on cryptocurrencies and general threats inherent in using cryptocurrencies, we continue with the explanation of potential implications of the presented attacks and threats.

7.3.1. Double spending.

We believe double spending to be the most severe threat for cryptocurrencies. Despite mechanisms being in place prohibiting double spending, individuals can double spend their coins when reaching a majority in the network. This is especially important for merchants that accept the cryptocurrency. In the case of a double spend attack, a merchant believes to have received a payment and then provides the customer with his product or service. However, the attacker has the power to reverse the transaction and keep the product or service he received, which leaves the merchant without a payment. Therefore, if merchants perceive the likelihood of double spending as too large, they will stop using cryptocurrencies and thus it will drive honest users away from the network. However, one way to decrease the likelihood of this potential threat can be done by developers of cryptocurrencies through the breakup of mining pools (Barber et al., 2012).

7.3.2. Block transactions.

The goal of cryptocurrencies is to enable almost instant payments online. If this ability is not granted, users cannot rely on the ability of the network to ensure transactions. This can affect companies that operate on a platform e.g. a business using Ethereum's blockchain for smart contracts, as they will perceive the platform to be not reliable enough for using it for business purposes and hence cease operations. However, this can have a more severe implication. Prices of cryptocurrencies are determined by supply and demand (Narayanan et al., 2016). If there is a decrease in the demand for a cryptocurrency, due to users leaving the network,

[13] A Bitcoin blockchain explorer can be accessed at https://blockexplorer.com/.

while there is no change in the supply, we can expect the price of a cryptocurrency to fall. Therefore, this will have a direct impact on individuals that purchased a cryptocurrency, independent of their intended use, as the cryptocurrency is expected to lose in value.

7.3.3. Prevent mining.

Preventing individuals from mining refers to miners not being able to add blocks to the blockchain. This, however, does not mean that these miners do not provide computational power to the network, for which they have to pay the electricity. This means, that their blocks are simply not added to the blockchain and hence, they do not receive a reward for their efforts. This is a crucial threat for the decentralization of a network. All other things being equal, if miners perceive this possibility on one network to be larger than on another network, they will leave the vulnerable network and join the network that does not face this threat. Therefore, if honest miners leave the network, it will be left to those that initiated preventing others from mining. Thus, the amount of nodes in the network will be reduced, causing a decrease in the level of decentralization. This will on the one hand increase the threat of a majority mining attack and on the other hand also impact the price of the cryptocurrency, as demand is likely to decrease.

7.3.4. Network disconnection.

The threats arising from being able to disconnect users from the network are similar to those of blocking transactions on the network. If individuals cannot be assured that they will be able to participate in the network, they will disregard a certain cryptocurrency. Hence, if network participants are subject to this threat and decide to leave the network, this will cause the cryptocurrency's demand to decrease. This will likely cause prices to decrease, affecting all individuals that purchased a cryptocurrency, independent of their intended use.

7.3.5. De-anonymization.

It is difficult for individuals to find out whether their identity is known to an attacker or not. However, if individuals find out that their anonymity is not granted because an exchange is not able to provide the required level of security, these individuals are likely to switch to another exchange. This is likely to have a direct impact on prices of cryptocurrencies. Many exchanges specifically trade only few cryptocurrencies and if a majority of users leave such an exchange, the demand for a specific cryptocurrency is likely to decrease, hence affecting the price of the cryptocurrency. However, when wanting to obtain cryptocurrencies, individuals can pursue different approaches that decrease the likelihood of de-anonymization. Individuals that mine receive cryptocurrencies as a reward and it is not required to provide personal information for mining. A different approach is to purchase cryptocurrencies in cash, which can be done through e.g. the purchase of Bitcoin gift cards. Individuals can furthermore open a cryptocurrency wallet and accept payments in cryptocurrencies, thus receiving cryptocurrencies without the need to provide personal identification documents (Barber et al., 2012).

7.3.6. Cryptographic breakthroughs.

Although we believe that quantum computers will not be used for decrypting cryptocurrencies' security algorithms in the short term, we believe that in the long term these computers may pose a severe threat. This is because cryptocurrencies were not developed to exist only temporarily. After large corporations will have progressed further in the field of quantum computers, they are likely to monetize on their developments and sell quantum computers to the general public. Although we cannot estimate when this will happen, we believe this is a potential future scenario. It implies for developers of cryptocurrencies to keep their encryption at the highest level possible, and to consider employing new encryption mechanisms that cannot be decrypted by quantum computers. For users of cryptocurrencies we believe this is currently only a low threat, as all cryptocurrencies are subject to this problem and, as mentioned before, we do not believe large corporations to misuse their technological developments for decrypting cryptocurrencies' security algorithms.

7.3.7. Code vulnerabilities.

Depending on the extent of the vulnerability, this can result in minor impacts such as temporary inability to create new addresses but can also have major impacts such as loss of coins in user accounts. Therefore, the estimation of the extent of an impact is difficult. However, code vulnerabilities can have severe implications as was the case when The DAO was hacked. Therefore, developers should continuously review and improve their code in order to minimize potential code vulnerabilities that could be exploited by an attacker.

8. Conclusion

We started this work with providing information regarding the overall cryptocurrency market and explained five cryptocurrencies in more detail, namely Bitcoin, Ethereum, Ripple, NEM and Litecoin. We then continued with an explanation of common asset classes including insights on what asset classes are used for. Consequently, we explained our approach for collecting data and presented the methods used for analyzing the data including why we decided to use selected methods. We continued with presenting our findings regarding the risk-reward profile of cryptocurrencies and asset classes, provided a correlation analysis and stated potential limitations of our analyses. We finished this work with explaining selected technological risks of cryptocurrencies including potential implications of these risks.

The aim of this work was to investigate return characteristics of cryptocurrencies in relation to traditional asset classes and the potential of cryptocurrencies to improve portfolio diversification.

We found that cryptocurrencies provide larger returns with a higher dispersion than traditional asset classes and

at the same time show a higher level of volatility. We further identified that the relation of the magnitude for positive returns and negative returns is larger for cryptocurrencies compared to asset classes. The skewness of the returns of cryptocurrencies and asset classes reinforce prior results: cryptocurrency returns are mostly positively skewed while for asset classes this is only the case for commodities. We furthermore discovered positive excess kurtoses for all cryptocurrencies and asset classes with generally larger kurtoses for cryptocurrencies. This means that cryptocurrencies provide large returns more frequently and of potentially larger magnitude compared to traditional asset classes.

For investigating the risk associated with investments in cryptocurrencies we calculated value-at-risk and expected shortfall. Compared to asset classes, we found far larger values for cryptocurrencies for both measures, thus reinforcing the high level of risk involved with investments in cryptocurrencies. We additionally calculated risk-adjusted returns to improve comparison between cryptocurrencies and asset classes. Our results for both Sharpe ratios and information ratios of cryptocurrencies are generally larger compared to those of traditional asset classes. From these results we can argue that investing in cryptocurrencies provides larger returns per unit of risk compared to investing in traditional asset classes.

We set up three three portfolios to investigate different investment approaches. Surprisingly, for the portfolio which we assumed to provide the lowest level of risk (PF2), we found the lowest risk-adjusted returns among cryptocurrency portfolios. However, it does show the lowest level of volatility among cryptocurrency portfolios, but its comparably high values for value-at-risk and expected shortfall do not provide evidence that rebalancing a portfolio has a positive impact on its level of risk. For PF2 we had large investments in Bitcoin and only small investments in the remaining cryptocurrencies, and in PF1 and PF2 the investments were more distributed among all cryptocurrencies. Therefore, we can argue that broadly investing, with more equal shares in different cryptocurrencies has a positive impact an a portfolio's risk-return ratio.

In order to determine whether cryptocurrencies can improve portfolio diversification we calculated correlation coefficients between the cryptocurrencies in scope and between cryptocurrencies and asset classes including the single components of the respective asset classes. We found significant positive correlations between most individual cryptocurrencies and can thus argue that, when investing in cryptocurrencies, combining different cryptocurrencies in a portfolio provides beneficial diversification effects. For correlations between the returns of cryptocurrencies and asset classes including their individual components, we found significant correlations between Ethereum and international equity, and also between Ethereum and private equity. Therefore, we can argue that adding Ethereum to a portfolio that consists of international equity or private equity investments has a positive effect on portfolio diversification. This also implies that it is possible to hedge the price development of Ethereum with investments in international equity or private equity. However, we did not find the remaining correlations to be significant at the 5% level.

These results mostly validate prior research but our correlation analysis could only partially validate prior work on cryptocurrencies.

Research by Chuen et al. (2017), Eisl et al. (2015), Osterrieder et al. (2017) and Elendner et al. (2016) found almost similar return characteristics of cryptocurrencies. Our results, however, partially contradict prior work by Elendner et al. (2016) and Chuen et al. (2017), which respectively found negatively skewed returns for Litecoin and Ethereum and Litecoin only. Our results for risk measures are very close to prior work by Osterrieder et al. (2017) and are generally of larger magnitude compared to research by Elendner et al. (2016). Our findings for Sharpe ratios and information ratios differ to those of prior research: Chuen et al. (2017) found remarkably lower Sharpe ratios and information ratios, and significantly lower differences in their results for cryptocurrencies and asset classes.

With our correlation analysis we can confirm research by Osterrieder et al. (2017), which also found positive correlations between different cryptocurrencies. Our results for correlations between cryptocurrencies and asset classes are partially in line with work by Elendner et al. (2016) which also found correlations between Ethereum and other asset classes. However, due to statistical insignificance, we can neither validate nor invalidate research that found correlations between the remaining cryptocurrencies and asset classes.

We believe that deviations of prior work compared to our results are mainly caused by the dynamics of the cryptocurrency market. Our findings of high levels of volatility reinforce this belief, as large price changes are not surprising for cryptocurrencies. This also implies that future research will differ according to the time period under investigation. This should be taken into account when comparing results of work on cryptocurrencies based on different sample periods.

Research on cryptocurrencies is still in its beginning and we believe there is a lot of potential for future research on cryptocurrencies. As a means of payment it would be interesting to find out what the effect of an increase of the adoption of cryptocurrencies has on the value of fiat currencies in specific countries. Besides, it would be interesting to find out if there is a change in an individual's spending behavior when starting to use cryptocurrencies. When focusing on cryptocurrencies as an investment, we believe one of the most interesting research topics is to find causal relationships between different cryptocurrencies or other market metrics. This could provide investors with potential information that could result in large positive returns. Other interesting research topics are the potential of blockchain technologies to decrease operating costs for businesses and also to analyze success rates of start-ups that received funds through an ICO compared to those that were funded by venture capital firms.

Although it might be too early to conduct research regarding some of these topics, as the market might not be mature enough to provide enough relevant data, we believe

that there will be a strong increase in the amount of publications, especially with the positive current price development of cryptocurrencies.

Our work can provide value to individuals and firms already using cryptocurrencies and to those considering using cryptocurrencies, independent of their intended use.

For investment purposes we believe our work identified the large return potential of cryptocurrencies accompanied, however, with high levels of risk. In addition, our correlation analysis can be useful for asset allocation decisions as we have shown that cryptocurrencies can be used to improve portfolio diversification.

We believe investors should follow different approaches dependent on whether they want to solely invest in cryptocurrencies or if they want to add cryptocurrencies to a portfolio consisting of traditional assets.

For strict cryptocurrency-investments our findings provide insights about the high return potential of cryptocurrencies and that an investor can improve diversification of a portfolio consisting of the analyzed cryptocurrencies. We suggest that investors compare different risk measures when considering to invest in cryptocurrencies. Especially the high levels of value-at-risk and expected shortfall should be taken into account when evaluating investments in different cryptocurrencies.

When adding cryptocurrencies to a portfolio of established assets, potential investors can use our findings regarding the correlation of Ethereum with international equity and private equity investments to improve portfolio diversification.

We believe that price developments of cryptocurrencies are mainly driven by their assumed future usability. This implies that if an investor wants to directly invest in selected cryptocurrencies he should analyze and compare the potential of the underlying technology before investing. A more convenient method an investor can pursue is to invest in a cryptocurrency fund to benefit from diversification and guidance from an investment professional.

When considering using cryptocurrencies as a means of payment, we believe it is best to use Bitcoin. This is based on its comparatively broad acceptance. However, it is crucial to take into account the potential threats that go along with using Bitcoin or any other cryptocurrency. Large price fluctuations result in changes of the value of an individual's holdings and the technological risks of cryptocurrencies cannot be neglected. Especially businesses considering using cryptocurrencies need to have a sound understanding of this risk. Since the possibility to de-anonymize users of blockchain technologies exists, firms need to ensure that their anonymity is preserved. If they are unable to do so, it could lead to leaking of information that could potentially influence a company's stock price and hence would keep firms from using cryptocurrencies.

For individuals or firms that want to use a cryptocurrency's technology, it is important to evaluate how evolved the cryptocurrency's business model is. The market capitalization usually provides insights about the market's perception of a cryptocurrency and this is the first metric that should be taken into account. Additionally, we found high volatilities for all cryptocurrencies we analyzed. This should also be considered as it implies large changes in the costs of operating on a cryptocurrency's blockchain. If the price of the cryptocurrency in use increases, the operating costs of a firm increase and if the price decreases, the operating costs decrease but also the value of the cryptocurrency holdings of the firm decrease. The inability to predict future operating costs is a large drawback for blockchain technologies as it is likely to keep firms from adopting such technologies. However, our findings support that, at least for Ethereum, it is possible to hedge the risk of price changes by investing in international and private equity. Thereby, cost fluctuations for operating on a blockchain platform can be optimized, making it more useful for business purposes.

The market for cryptocurrencies has experienced tremendous growth over the past years and we believe this trend is not likely to stop. The adoption of cryptocurrencies is continuously increasing, thereby making cryptocurrencies even more usable on a daily basis. We have further discussed that cryptocurrencies enable innovative features such as smart contracts. The ability of individuals to build applications on top of a blockchain that enables to replace a trusted third party will push the market even further. Therefore, we believe that this growth is unlikely to stop and will keep providing investors with interesting investment opportunities.

We conclude that investments in cryptocurrencies provide large return potentials with high levels of volatility while at the same time providing a higher level of return per level of risk compared to traditional assets. Besides, the low correlations among cryptocurrencies and the correlations between Ethereum and investments in international equity and private equity provide beneficial diversification effects for investors. However, the risks arising with investments in cryptocurrencies, both financial and technological, can have large impacts on one's portfolio value. This implies that investors should take into account different investment approaches and investigate the potential risks and future purpose of a cryptocurrency. Therefore, individuals and investors that consider investing in this alternative asset class should follow market developments and consider all risks associated before investing in cryptocurrencies.

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Economic- and Non-Economic Goals of Family Firms

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Abstract

Motivated by a lack in the current literature, this thesis reviews academic research on the economic and noneconomic goals of family firms. Heretofore, no detailed overview of different goals embedded in the goal setting-, outcome-, and alignment process has been provided. Using a systematic literature search and review process, I identify 117 relevant studies in the fields of management, economics, and affiliated domains between 1963 and 2018. Beyond a more detailed overview of the current state of research, I outline goal setting, outcomes, alignment, and four different family firm goal classes. Lastly, I show avenues for future research in the family firm–goal field.

Keywords: Family firms, economic goals, non-economic goals, socioemotional wealth

1. Introduction

1.1. Problem and Relevance

Traditionally, family firms despite being one of the most essential forms of businesses have been viewed with incomprehension as they seemed to defy what classic management theory asserts. Indeed, family firms often do not act in accordance with the iron logic of profit maximization, pure shareholder focus, or mere fulfillment of annual financial statements. They instead follow more inclusive approaches encompassing firm-external stakeholders and the extended family pursuing widely varying goals (e.g., Gómez-Mejía et al., 2007). In particular, in the field of firm goals, the pursuit of profit maximization seems to be less imperative in family firms. Existing research either provides observations of how family firms behave differently in this regard or conceptual roots grasping at part of what comprises the goal process. A detailed overview of the entire process from the first individual's thought to the ultimate outcome of the pursued goals is, yet, to be published.

However, understanding, why families and their firms act the way they do, can be a crucial insight for not only for the owner families themselves but also the number of interacting parties. Particularly in today's world–a merry-go-round of volatility, ambiguity, complexity, and uncertainty (e.g., Bennett and Lemoine, 2014)–the right decisions have to be made fast, and decision points arise more often than before. Nonetheless, decision-making is only the consequence of the goal process that needs to proceed first, with the goal outcome being the basis that affects decision-making. This supremely concerns family firms since they as mostly private businesses have no stock market to appease, fewer regulations to comply with, and thus, in general, a higher degree of freedom. Adding to that, forfeiture of the firm is more painful to the owning families as the firm is the concentration point of mostly undiversified family wealth, a source of employment, as well as the basis for a sense of self-perception and identity (e.g., Aparicio et al., 2017; Shepherd et al., 2009). Furthermore, standing in a long, multigenerational tradition often leads to inertia as some family firms to only continue what has been done for the past decades. All of the aforementioned factors make family firms prone to the augmented difficulty of decision making. Notwithstanding, the negative consequences of potential firm loss are not solely limited to the sphere of family firms and their researchers but to the whole economy as family firms constitute the backbone of many economies due to their high number and them being a paradigm of embeddedness into local communities (Astrachan and Shanker, 2003).

1.2. Objective

The goal of this thesis is to consolidate existing literature on the goal process in family firms describing what goals exist, how goals are set, and what the outcome is by reviewing the existing literature. Direct inputs are derived by collating findings across academic literature from the domains of management, economics, and affiliated fields such as psychology

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or sociology. As a result, the central research questions to be answered are the following:

- Which processes do family firms use to set their organizational goals?
- How can the goals of family firms be systematically clustered?
- What is the outcome of the goals for both, the firm and the family?

After having presented my methodological approach and an overview over the investigated studies, I will portray how academic literature depicts family firms in setting their goals. Thereafter, emphasis is laid upon common goals that will be described and set into context in order to, first and foremost, provide a taxonomy of what drives family firms, in particular in comparison to their non-family counterparts, and demonstrate the high goal diversity many family firms and their members face. Following, the outcomes of the aforementioned organizational goals are depicted, and the process of goal feedback and alignment is delineated. Lastly, I will discuss the findings with regards to avenues for future research, limitations, and the practical implications, before concluding this thesis.

Nonetheless, the aim of this thesis is not to look in the logically subsequent decision-making process, which is based on the goal outcomes, since this would surpass the scope of this thesis. Ultimately, this thesis strives to, addressing both researchers and practitioners, fulfill two main goals: (1) Give an overview over existing literature with respect to family firm and organizational theory, and (2) place itself in the context of existing literature and outline avenues for future research as well as practical implications.

2. Methodology

To identify relevant research on family firms as well as their economic and non-economic goals, I follow the multistep process for systematic reviews as suggested by Tranfield et al. (2003) and applied in this form by a multitude of management researchers (David and Han, 2004). Based on replicable and systematic processes, systematic reviews are therefore considered an appropriate method for, first, identifying and, later, evaluating research articles (Mulrow, 1994).

As the first step, a bibliographic database search in EBSCO Discovery Services (EDS) as the primary data platform providing major coverage of multiple research fields was conducted. The initial focus was laid upon English, peer-reviewed academic journal articles, published between 1963 until March 2018. In order to identify relevant studies, I searched for a combination of family firm and goal specific terms in the title or abstract. I used the following keywords:

> Family firm" OR "family business" OR "family compan*" OR "family enterprise" OR "family manag*" OR "family-control*" OR "family-owne*" OR "founding family" OR "privately held" OR "family influence*" OR "family govern*" OR "family-led*" AND "emotion*" OR "goal*" OR "value*" OR "worth" OR "social capital" OR "*financial" OR "*economic" OR "wealth" OR "endow*"

Secondly, due to the vast amount of search results[1], I further limited the results by focusing only on A* to A ranked journals, with the exception of A* to C for journals specifically dealing with family firms as this focus might impair their ranking. For all rankings, I referred to the VHB ranking when applicable.

Next, I assessed the relevance of the identified articles by scrutinizing their abstracts. In this step, I eliminated 1,284 articles. Those articles did not focus on family firms or addressed other goal-related topics such as CSR without providing relevant insights into the goal process. I read the remaining articles in detail. This resulted in 55 articles that I identified as relevant for understanding family firms as well as their economic and non-economic goals.

Additionally, I complemented this approach by another search for working papers and dissertations in EBSCO, which, however, resulted in no relevant manuscripts. I also used Google Scholar and identified 15 additional, relevant articles that I added to this work. To further reduce the risk of missing out on important pieces of academic literature I applied the ancestry approach (Cooper, 1982). In this step, I applied a backward reference search to identify and examine the references cited in the selected publications from EBSCO and Google Scholar. The ancestry approach also allowed me to identify and include further studies on my subject of interest resulting in 48 additional publications. In total, I hence ended up with 102 studies on family firms, their goals, and adjoining fields.

3. General Characteristics of Investigated Papers

The selection process resulted in a sample of 102 articles, working papers, and other pieces of literature between 1963 and 2018. Prior to 2000, only 30 studies were published, and half of the studies were not published before 2008.

Specifically, Cyert et al. (1963) in their first version from 1963 were the first to publish, and thereby, laying a theoretical foundation. They analyzed and described the interaction of organizational members in the formation of coalitions as well as bargaining and stabilization behavior resulting in the emergence of organizational goals. Thirteen years later, Jensen and Meckling (1976) proposed the agency theory addressing the problems of the division of management and ownership. Also, building upon the prospect theory as introduced by Kahneman and Tversky (1979), Wiseman and Gomez-Mejia (1998) present the behavioral agency theory which incorporates elements of behavioral, agency, and prospect theory. Together with the stewardship theory that

[1] This EDS search yielded 8507 results.

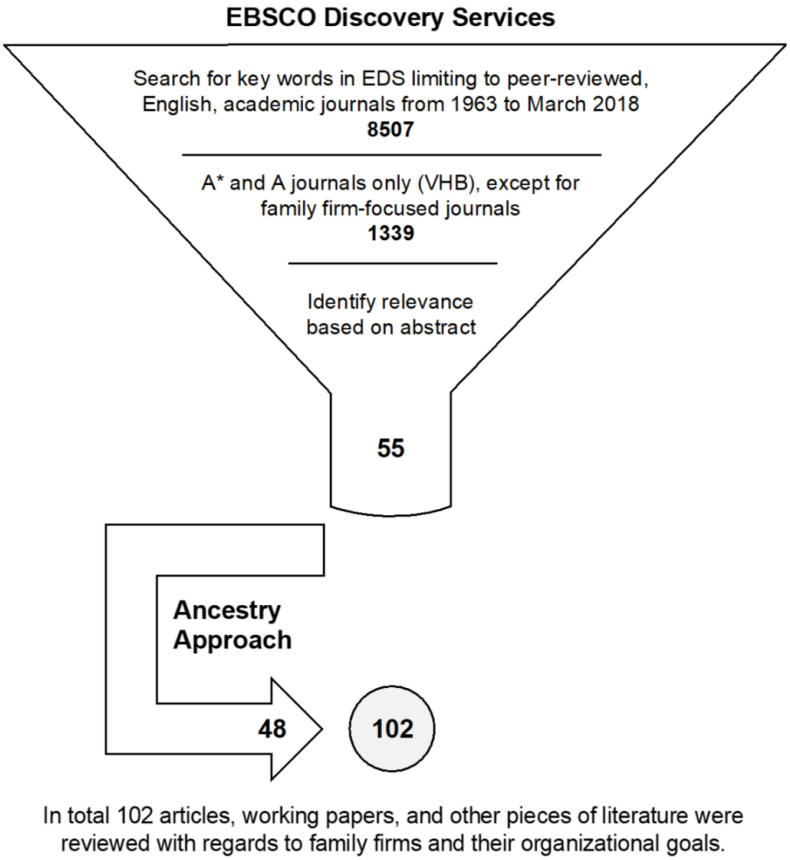

Figure 1: Methodological Approach; Source: own illustration

states managers if left uncontrolled will behave responsibly as firstly introduced by Davis et al. (1997), this forged an amalgam upon which modern family firm research was founded. Another crucial theory is the stakeholder theory as proposed by Freeman (1984) which assigns importance to different groups within the firm. Nevertheless, another aspect crucial for organizational goals of family firms, socioemotional wealth (SEW), was not developed into theory before Gómez-Mejía et al. (2007), despite being observed beforehand. SEW is the affective endowment of the emotions towards the firm but will be explained in more detail later. Since then, multiple advancements to the issue have been made and described in literature, such as numerous scales and measuring attempts. Overall, the rapidly growing number of publications from 2008 until now–accounting for more than 50% of the identified studies–attests a burgeoning interest in this field.

In addition, noteworthy sample characteristics are presented in the following: My analysis includes 109 academic journal articles (published in 39 different journals), seven book excerpts, and one unpublished working paper. Among the academic journals, Entrepreneurship: Theory and Practice published 19% of the articles, followed by Family Business Review with 12%, and Academy of Management Journal with 8%. Moreover, quantitative and conceptual approaches were applied in almost equal shares, with 44% and 40% respectively. Qualitative studies and mixed-method approaches follow with both 8%. The sample size in the investigated studies varies widely, ranging from country-wide investigations of more than 700,000 firms to single case studies. Nevertheless, this number has to be treated with caution. Excluding mass sampled studies with a six-digit number of anonymous firm observations, e.g., Wilson et al. (2013), the average sample consists of approximately 695 observations.

With regard to theories presented within the articles, socioemotional wealth (SEW), followed by agency theory and stewardship theory, are the dominant theoretical approaches in most of the studies. My review further indicates that 54% of the studies were conducted in the United States based on local data, 10% based on German data and 7% on Canadian, followed by Spain (4%), and the United Kingdom (4%). I could only sparsely find any research on Asian, African, or South American cases or samples, with each of the continents only providing one study respectively. Further analysis of the articles yielded that only 6% of the studies include data of multiple countries, while the remaining 94% include data of one country only.

In Appendix A, several illustrations of additional information and descriptive statistics can be found:

- Figure 1 provides an overview of the studied literature clustered by content and theory.

- Table 2 exhibits the different methodologies applied in the studies.
- Table 3 portrays the geographical spread of the quantitative studies over different countries sorted by regions.
- Table 4 delineates the most cited researchers, including co-authorships.
- Figure 8 illustrates an overview of publication years.

4. Current Status of Research

4.1. Key Definitions

4.1.1. Family firms

Family firms are prevailing institutions in the global economy (Astrachan and Shanker, 2003; Morck and Yeung, 2004; Panunzi et al., 2002; Sirmon and Hitt, 2003). The German industrial landscape is particularly influenced by family firms; a recent estimation classifies almost 95% of German businesses as family firms (Kay and Suprinovič, 2013). Nevertheless, academia is in disagreement about the very definition of a family firm and what constitutes one. The list of commonly cited attributes includes continuity with respect to transgenerational control (Zellweger et al., 2012) and the overlap between the firm and the family system (Tagiuri and Davis, 1992; Weigel and Ballard-Reisch, 1997) thereby increasing complexity in conceptualization.

4.1.2. Socioemotional wealth (SEW)

What is inherent to most family firms (Berrone et al., 2012) and vital in context of this thesis, is the concept of Socioemotional Wealth (SEW), which aims to explain why families and their members do not follow purely economic criteria but other ones (Chua et al., 2015; Gómez-Mejía et al., 2007). Instead, there is a range of emotions triggered by the individual relationships of the respective family members among themselves, with the firm, and other stakeholders, summed up as affective endowment (Chrisman and Patel, 2012) that influences the goal and decision-making process (Gomez-Mejia et al., 2011). This effect is particularly observable in small firms where relationships are more personal, and thus, it is of high importance in the field of family firm research (Berrone et al., 2012). The theory is mostly used in analyzing strategic decisions in family firms (Gomez-Mejia et al., 2011) and adjacent arrays, such as goal setting. A measure often used for the prevalence of Socioemotional Wealth is family involvement (Chrisman et al., 2012), which can be approximated with the equity stakes family members hold (Berrone et al., 2012; Gomez-Mejia et al., 2011). Researchers have introduced multiple, partially congruent models of SEW (e.g., Berrone et al., 2012; Debicki et al., 2016; Hauck et al., 2016; Miller and Le Breton-Miller, 2014), which will be introduced in the subsequent chapters.

4.1.3. Organizational goals

Understanding what constitutes an organizational goal is also a prerequisite for this thesis. Research defines them as "desired organizational outcomes that can be used to guide action and appraise organizational performance [...] but distinct from measurable targets." (Kotlar and De Massis, 2013, p. 3)

4.1.4. Goal Setting

Regarding the approach of setting organizational goals, Cyert et al. (1963) have argued in their theory-setting work A Behavioral Theory of the Firm that only individuals possess goals and collectives do not by design. Following this view, the organization consists of coalitions (if broken down further called subcoalitions), which in turn consist of individuals pursuing their own yet similar goals (Cyert et al., 1963, p. 31). These coalitions are likely to include as many organizational members as possible in order to maximize bargaining power and the desired outcomes for their members. As they do not exist by design, organizational goals are usually set in a complex process among all or most individuals involved. At first, coalitions are formed out of organizational members, and they bargain their individual goals to derive organizational goals using side payments in the form of money, authority, policies, among others. Second, the previously bargained goals are stabilized, i.e., they are fixated, and formulated in the organizational systems controlling the member actions, such as budgets. Later, organizational goals are in constant need of updates on progress so far and alignments within the coalition (Cyert et al., 1963, p. 33). For family firms, this the family constitutes one of the most important, if not the most important coalition, which is likely to also have specific family-influenced goals (Klein et al., 2005), hence goal clustering differs.

The usually applied dichotomy between financial and nonfinancial goals with regards to the content of the goal (Chrisman and Carroll, 1984; Venkatraman and Ramanujam, 1986), has been adapted in family firm research to economic and noneconomic goals. They encompass contents exceeding the mere financial in order to cover aspects such as growth (Kotlar and De Massis, 2013). The second dimension is internal and external goals depicting the direction in which the goal aims (cf. Cyert et al., 1963; Kotlar et al., 2018). For family firm research, scholars have adapted these dimensions to family-centered and nonfamily-centered goals (Kotlar and De Massis, 2013). The resulting goal categories as seen in Figure 3 will be subject in chapter 4.3 to 4.6. Although this selection claims to be mutually exclusive and comprehensively exhaustive, not all organizational goals can be assigned to a single class without a doubt. It may happen that a specific goal is subject to two or more classes (Miller and Le Breton-Miller, 2014), e.g., appointing a family member to the board of directors can increase family control over the firm (Family-Centered Economic goal), family identity (Family-Centered Noneconomic goal), as well as the family's external relations (Nonfamily-Centered Noneconomic

goal). Moreover, many goals are interrelated, have counter-influences on each other, or manifest in both dimensions, the family- and the nonfamily-centered dimension.

This results in a greater goal diversity within the firm (Chrisman et al., 2012). Therefore, alignment and mediation of these goals among the stakeholders involved are of great importance. Floyd and Wooldridge (1992) imply that if more organizational members, e.g., lower management, are involved and pursue a common strategy, the firm is more likely to attain its goals. However, research has also shown that goal alignment between family members is often low (Villanueva and Sapienza, 2009). Therefore, above all for family-centered goals, alignment is of utmost importance for family firms (Chrisman et al., 2012). Kotlar and De Massis (2013) identified two different types of alignment processes, that is to say, the familial social interaction process and the professional social interactions process. Both forms of interactions as described by the researchers share that after a first bargaining phase, stabilization must take place in order to reduce goal diversity (cf. Cyert et al., 1963). Without any stabilization, the effect of bargaining is negligible (Kotlar and De Massis, 2013).

Professional social interactions only happen in the business environment, e.g., management or board meetings, with certain clearly defined roles, e.g., CEO or VP. In the bargaining phase, rewards are promised, and threats are issued laying emphasis on mutual gains or losses, summed up administrative bargaining. Stabilization usually takes place in institutionalized forms, such as contracts, protocols, budgets, or at least a gentlemen's agreement, namely formal stabilization. In contrast to that, familial social interactions occur in both firm and family contexts, ranging from formal meetings to dinner chats with less defined roles, e.g., founder and father, director and son. They employ affective bargaining, i.e., the revocation of common values and shows of affect. The outcome is sustained using social stabilization mechanisms, such as moral codes or rituals, relying deeply on mutual trust. The names of the mechanisms are not exclusive with regards to the participating stakeholders.

With regards to further family firm-related theory adaptions, the behavioral theory was expanded by Fiegenbaum et al. (1996) most notably with elements of the Prospect Theory as introduced by Kahneman and Tversky (1979). This yielded one major change with regards to family firms. The reference point to which actions are taken (Kotlar et al., 2014) is not of purely financial nature anymore but it is also about the preservation of their stock of SEW (Berrone et al., 2010; Gómez-Mejía et al., 2007), hence driving strategic decisions (Chrisman and Patel, 2012).

The abovementioned behavioral agency model as presented by Wiseman and Gomez-Mejia (1998) only partially explains the goal setting process. Focusing on the different individuals that form a subcoalition, Mitchell et al., 1997 expanded the stakeholder theory as proposed by Freeman (1984). The latter describes stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (p. 64), and this still holds true for Mitchell et al. (1997). Stakeholders can influence goals, actions, and decisions of the firm. The influence depends on the respective stakeholder's Legitimacy and Power, as well as the Urgency of their claim to the firm (Pearce and DeNisi, 1983). The legitimacy of family members, which Patel and Cooper (Patel and Cooper (2014), p. 1625) define as "relative distribution of titles, compensation, and representation" is inherent to the family firm itself and strengthened through personal and emotional bonds (Gomez-Mejia et al., 2003). Power, as the individual's ability to influence behavior and events, is highly correlated with the equity stakes in the firm (Finkelstein, 1992; Martin et al., 2013; Pfeffer and Pfeffer, 1981). Lastly, urgency describes how immediate the stakeholder's required action is and steers attention (Mitchell et al., 1997) but is purely driven by the situation and environment. However, stakeholder theory hereby merely explains the behavior within and among coalitions better. Following Mitchell et al. (1997), the family is a stakeholder with high legitimacy and power, whereas non-family management is usually characterized by high legitimacy but lower power than the family. Yet, with family as management they do not necessarily act as a coalition (cf. Cyert et al., 1963; Pitcher and Smith, 2001). Chua et al. (2009) imply that differences between family and non-family members, especially within the top management team (TMT), are widely inherent. Moreover, recent research highlighted that the traditional view of the family as a homogenous block does not hold true in practice. Many firm-owning families, particularly, if associated with the firm for many generations, have broken into different branches constituting their own subcoalitions (e.g. Zellweger and Kammerlander, 2015).

4.2. Family-Centered Economic Goals

The first class of organizational goals to be evaluated are Family-Centered Economic Goals (FCE goals). They encompass all economically relevant goals that are only directed at the family and are usually targeted at "keeping company control in the hands of the family and to generate various forms of wealth for the family." (Kotlar and De Massis, 2013, p. 1272) Thus, standard financial goals such as economic performance are classified as Nonfamily-Centered Economic Goals (see chapter 4.5). Two of the most prominent examples include family control over the firm and family wealth (Kotlar and De Massis, 2013; Tagiuri and Davis, 1992).

4.2.1. Family Control over the Firm

A key FCE goal for many family firms is control over the firm sustained for generations (Zellweger et al., 2012). Family control is also what many scholars define as a key pillar constituting a family firm (Tagiuri and Davis, 1992). However, as the firm represents a major asset, it can be a point of conflict within the family and with other stakeholders.[2]

[2]This review lists the organizational goals of family firms in their specific goal class in chapter 4.3 to 4.6. Although the numbering of the goal described was done so intentionally in order to convey a structure, in par-

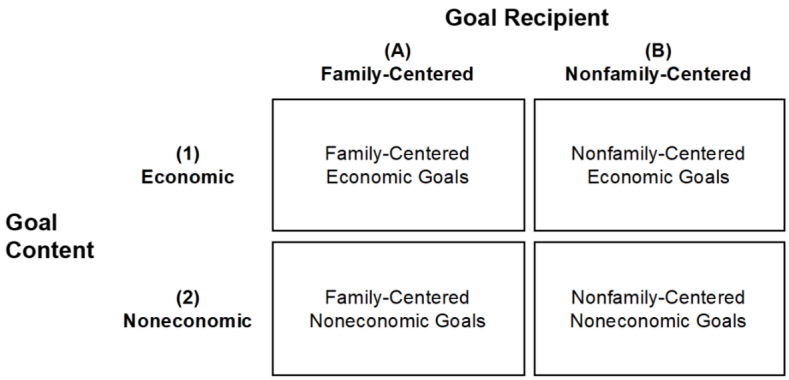

Figure 2: Overview of Goal Classification; Source: own illustration based on Aparicio et al. (2017), Kotlar and De Massis (2013)

Furthermore, control over the firm is also a prerequisite for the existence of SEW (Zellweger et al., 2012) since it is not possible to consume the non-financial benefits that are part of the SEW (Debicki et al., 2016) without a minimum level of control. Hence, the intention to sustain family control over the firm for the generations to come, also called transgenerational control intention (TGCI), is seen as complementary to SEW (Zellweger et al., 2012), which is also likely to rise over time with the self-attribution (Belk, 1988; Zellweger et al., 2012). Other studies directly attribute control by the family with its emotional bond to the firm, and therefore, SEW (Gomez-Mejia et al., 2003). Different models of SEW aim to capture this relationship. Berrone et al. (2012)'s FIBER model yields two dimensions that coincide with the goal of family control; Family Control and Influence as well as Renewal of Family Bonds to Firm Through Dynastic Succession. The former links SEW to organizational structures through which family members exert control over the firm. Families can exercise control by directly taking roles in the TMT, such as CEO or chairperson (Berrone et al., 2012; Zellweger et al., 2012). Likewise, families influence the firm indirectly. Appointing the TMT is most effective as an indirect influence (Berrone et al., 2012). Yet, other means such as communication with management (Kotlar and De Massis, 2013) or shaping values and a mission for the firm (Habbershon et al., 2003) are also applied to ensure that the firm follows the family's goals. The other dimension of SEW as described by Berrone et al. (2012) impacting the FCE goal of family control is the renewal of family bonds to firm through dynastic succession. With the firm being central to the family's identity (see chapter 4.4), family members regard to the firm as a long-term investment that is intended to be passed on to future generations (Berrone et al., 2010). Another commonly cited model is Debicki et al. (2016)'s SEW importance scale. Here the item of Family Continuity concurs with family control as a goal. It captures similar elements as the model by Berrone et al. (2012) but lies additional focus on the individual family member's intrinsic motivation regarding firm control.

However, this bears certain implications, in particular when dealing with outside investors. Following Carney (2005), increased ownership and control manifested through guaranteed property rights foster particularistic behavior and deviations from traditional management theory. Le Breton-Miller et al. (2011) imply that family involvement, i.e., in the form of control, acts as a major signal to outside investors that preserving SEW is a priority of the firm. Consequently, the family needs to create a level of legitimacy sufficient for outside investors. To that end, family firms need to invest more effort into conforming with other strategic norms (Le Breton-Miller et al., 2011). If they do not invest, they are at risk of lowering financial performance at the expense of sustained control (Gómez-Mejía et al., 2007). A commonly cited study in this array is Gómez-Mejía et al. (2007) which reviewed in a large-scale study that family-run olive oil mills are significantly less likely to join a cooperative[3], which is financially beneficial but represents a loss of family control. Furthermore, family control intentions can be a particular source of conflict in cases where the family is not the only shareholder. Specifically, when minority investors are involved, this yields a source of agency conflicts (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 2000). Therefore, the question if family control is sustained is not the most important question to answer. One should rather focus on how it sustained in order to not lose the needed minority shareholders.

Thus, family control over the firm thus denotes an important organizational goal since it is essential for the status as a family firm and is prerequisite for multiple other organizational goals. Hence, family firms that do not strive for

ticular cases, it can also serve as a hierarchy. However, the heterogeneity of family firm makes providing a universal hierarchy impossible and the structure should be seen with caution. The specific goal classes are not put into hierarchy but ordered according to the aforementioned matrix as there is even more variation between different family firms.

[3]A cooperative as described by Gómez-Mejía et al. (2007) is an association of persons that pursue common (financial) goals by jointly controlling and owning the enterprise.

a minimum level of control over the firm are not likely to remain as such.

4.2.2. Family Wealth

Family wealth as an FCE goal refers to the family's (business) assets. As for almost every other person, the individual wealth is of foremost importance. The firm itself usually comprises the basis of the family's wealth and especially in well-established family firms, there are many family members that lay claim to the resulting wealth (Zellweger and Kammerlander, 2015). However, as wealth is tied to the firm, it is more difficult to separate and distribute it, hence, further conflict potential is generated.

Astrachan and Jaskiewicz (2008) calculate the total firm value as the sum of the financial value and the emotional value (see Appendix B). The financial value can be determined using traditional financial valuation plus the sum of private benefits (Jensen and Meckling, 1976). Private benefits can include a large array of financial advantages arising from exerting control over a firm and include acts such as selling assets under fair value to related groups or consuming certain perks on the firm's expense (Nenova, 2003). Control over the firm is a prerequisite for private benefits (Grossman and Hart, 1988), therefore, in the case of family firms, this concerns the family only. Nevertheless, different family members may have different access to the benefits and thus the level of extraction differs (Zellweger and Kammerlander, 2015).

To mitigate the risk of conflicts over family wealth, a myriad of governance mechanism has been developed. Especially in the case of older, well-established family firms, wealth has often been accumulated over generations, and hence, has been reinvested. As money has multiplied, so has the family, too. The many family members are prone to argue about the fair distribution, allocation and investment of money (Chrisman et al., 2012; Gomez-Mejia et al., 2011; Kellermanns and Eddleston, 2004). A commonly used solution is the separation of the family and its assets (Zellweger and Kammerlander, 2015). Following that, there are different levels of separation ranging from no separation over medium form (family office) to complete separation (family trust) as described by Zellweger and Kammerlander (2015). This has implications on how individualistic family wealth as a goal is pursued. In the case of high separation, the potential for conflicts among family members is reduced as every member can have his or her share invested according to the own risk preference and is more easily accessible.

Recapitulating, the mere generation of family wealth is unquestionably a goal for almost the entirety of family firms, yet, the distribution and management of family wealth poses a much greater challenge. If this challenge is not overcome, the family, and consequently, the firm can be seriously impaired by the resulting conflict.

4.3. Family-Centered Noneconomic Goals

The class of Family-Centered Noneconomic Goals (FCNE goals) covers all those organizational goals that are only directed at the family but do not coincide with their economic matters. Consequently, social and emotional goals are prevalent, including family identity, family harmony, and family social status which have described as the most prominent ones by Kotlar and De Massis (2013). Furthermore, what Chrisman et al. (2012) note is that family involvement, proxied by family ownership share in the firm, is positively correlated with the tendency to pursue FCNE goals, but the authors do not elaborate on how this interrelation takes place specifically.

4.3.1. Family Identity

The self-perception of every family member can also be a goal of family firms. It is particularly relevant to foster a common sense of identity to preserve family harmony. Nevertheless, problems for family identity lay in the concept of how the family understands itself.

Family firm scholars have noted that the intertwined social systems combining family and firm (Tagiuri and Davis, 1992) contributes to a unique self-concept and identity for both (Berrone et al., 2010; Dyer Jr and Whetten, 2006). Consequently, family identity constitutes a source of SEW for the family (Aparicio et al., 2017). Therefore, preserving the family identity equals preserving SEW (Gomez-Mejia et al., 2010). Family identity as an FCNE goal is touched in Berrone et al. (2012)'s FIBER dimensions of SEW as Family Members' Identification with the Firm and Emotional Attachment. Pivotal for the family members' identification with the firm is that it often carries the family's name blurring the lines between family and firm further and making the family at least partially responsible for the firm's behavior (Dyer Jr and Whetten, 2006). This makes families see the firm as an extension of themselves. Thus, firm reputation, as it will be examined in chapter 4.6, is deeply interwoven with family social status and family identity. Moreover, transgenerational aspects play a role in forming the family's identity. The firm is a symbol standing for the family's tradition and heritage passed through generations (Tagiuri and Davis, 1992). In turn, the firm is seen as a vehicle for the continuation of the family's values (Gomez-Mejia et al., 2010), hence, adding to the view of the interlinkage of the firm and the family identity (Cabrera-Suárez et al., 2014). Another dimension of the FIBER, emotional attachment, also contains the goal of family identity. As mentioned above, it depicts how the family's emotions interact with the firm. The temporal aspect of how the firm demonstrates family identity is also present in this dimension. Berrone et al. (2012) quote Kleine et al. (1995) in illustrating emotional attachment to the firm as a way to ensure a family member's self-continuity providing an anchor for the past, desirably presented by fond memories, a reflection of the present, and an outlook into the future. Furthermore, emotional attachment gives the family legitimacy for controlling the firm as the potential firm forfeiture foments emotional stress (Shepherd et al., 2009).

Family identity is particularly salient in fostering family harmony and ensuring prolonged commitment to the firm. If

family identity is not strong or even fragmented, the family's efforts in the firm can be rendered futile.

4.3.2. Family Harmony

Harmony, from the Ancient Greek word for unity ($A\rho\mu\nu\iota\alpha$), as the prevention of conflicts and a general sense of unification, is a goal many families strive for. For firm-owning families, it is especially important to not impair the firm by creating conflicts. Research shows a reciprocal relationship between family harmony and the firm performance (cf. Habbershon et al., 2003). Damage to one dimension will eventually hurt the other one as well.

Research covers the goal of family harmony in various models. Miller and Le Breton-Miller (2014) describe, in particular, family harmony as connected to Restricted SEW, meaning that the influence is limited to the family only. Berrone et al. (2012) touch it in their SEW dimensions of Binding Social Ties and Emotional Attachment. Binding social ties relates to the family firm's social relations, in particular with the family. In accordance to Cruz et al. (2012), Berrone et al. (2012) illustrate the effect of the family's kinship ties on the enclosed members. After ties are formed, SEW enriches them with mutual trust, commitment to the firm, and feelings of closeness that result in collective social capital, hence fostering SEW. If those ties are severed, SEW is lost. Thus, the objective of family harmony aims at preserving SEW. The other dimension, emotional attachment, aims at capturing how emotions play a role in the context of both, the family and the firm (Berrone et al., 2012). The involvement of not only the family but also its emotions is what scholars use as a criterion for defining a family firm (Berrone et al., 2012; Eddleston and Kellermanns, 2007; Tagiuri and Davis, 1992). As the family and the firm system often lack clearly defined borders, family emotions can enter the firm and impact decisions and process (Baron, 2008). Since emotions range from positive ones (e.g., love or happiness) to negative ones (e.g., anger or hatred), their impact is as manifold as the emotions themselves.

According to Schulze et al. (2003) and Schulze et al. (2001), a common mechanism in family firms to ensure harmony based on mutual feelings of affect is altruism, i.e., "a trait that positively links the welfare of an individual to the welfare of others." (Kellermanns and Eddleston, 2004, p. 215) Based on the mutual affect, family members behave more caring and considerate, thereby fostering commitment and loyalty (Kellermanns and Eddleston, 2004; Schulze et al., 2003). If a family member were not to act altruistically, his or her utility would decrease. The negative consequences of not acting altruistically outweigh the benefit of saved resources. For this reason, acting altruistically also means acting egoistically at the same time (Schulze et al., 2003). Still, this consideration takes place inadvertently. Hence, altruism enhances the existing bonds between family members by increasing the affect component. In contrast to these positive effects, altruism can hurt the firm's performance by triggering decisions that may be self-less, hence, preserving family harmony and SEW. Yet, these decisions may not be sound from a purely financial perspective. Thereby, agency conflicts with potential non-family management could be created (Jaskiewicz and Klein, 2007; Kellermanns and Eddleston, 2004). These agency conflicts can, in turn, impose further problems on the firm. Following Schulze et al. (2003), also internal problems can be triggered by altruism such as free-riding or prolonged dependence on the family's generosity. In families with multiple family branches, altruism can also impair family harmony if a particular family branch is favored over another. In such a case, altruism increases family branch harmony but at the same time decreases overall family harmony. Agency theory as well as families have been concerned with this issue for a prolonged time and have found certain mitigation mechanism from the field of family governance (Schulze et al., 2003).

Debicki et al. (2016) also cover family harmony and altruism as part of the Family Enrichment dimension of their SEW importance scale. Additional focus is laid upon the feeling of family obligation. This plays into the sense of altruism as already outlined above. However, Debicki et al. (2016) view altruism as particularly salient when it comes to employing family members as a member to enhance overall happiness. Family harmony as a goal aims at keeping the relations within the family intact. If harmony is not preserved, conflicts within the family and the firm can erupt.

4.3.3. Family Social Status

How the family is perceived by the community is concentrated in the family social status. The third FCNE goal to be evaluated in this subchapter is family social status, i.e., how to the family values its perception by the community. It is primarily built from the family identity as well as how the firm and its relations to the community is seen over time. Their social status is important for many families as it provides them with certain feedback to their actions and rewards pact efforts. However, research on family social status is scarce.

Social status is commonly derived from the family making contributions to the community, either in the form of money or non-financial inputs (Berrone et al., 2010). What is most impactful is usually the employment of local community members as this provides a considerable number with jobs and secures their living. More prominent in people's perceptions, however, is sponsoring of charities, associations, and sports clubs, which therefore makes it an attractive activity for family firms (Berrone et al., 2010). Especially for future generations, family social status is important, and they wish to consume the benefits emanating from it (Le Breton-Miller et al., 2011). Also, family social status acts as a mediator for family control's influence on SEW. A high level of family control increases SEW only if the family is prestigious, i.e., family social status is high because otherwise, the family does not want to be associated with the firm.

Especially for family social status, individual goals of family members are critical. Schulze et al. (2003) argue that increased social status strengthens individual members' ego hence forming a collectivist individual goal. The family's social status if perceived as resulting from engagement with the

firm can foment further engagement. This implies, by argumentum e contrario, that if the family social status is low, engagement will be automatically lowered.

4.3.4. Further FCNE goals

Debicki et al. (2016) also list other FCNE goals taken from research by Gómez-Mejía et al. (2007), Gomez-Mejia et al. (2010), and Jones et al. (2008), which are partially congruent with the ones mentioned above. Collating with Aparicio et al. (2017), it yielded the following listing of further FCNE goals:

- Preservation of the firm's sentimental value to the family and its members
- Fulfillment of obligations to the family that are based on blood ties rather than on strict criteria of competence
- Perpetuation of entrepreneurial spirit and thereby following the founder's vision for the firm

4.4. Nonfamily-Centered Economic Goals

The class of Nonfamily-Centered Economic Goals (NFCE goals) encompasses all organizational goals that only relate to economic aspects and are not specifically directed at the family. They include aspects such as "disparate indicators of economic performance such as growth, survival, and profit." (Kotlar and De Massis, 2013, p. 1273)

4.4.1. Firm Survival

The first and foremost goal of every firm is to keep running its business. This goal, of course, also applies to family firms. In contrast to non-firm owning families, the firm is vital to firm-owning ones (Tagiuri and Davis, 1992). However, families can be forced to intervene when the very firm survival is threatened, and they often need to invest their own wealth to save it. Therefore, families have a profound interest to keep the firm running in order to avoid this compulsion to get actively involved.

Other researchers reviewed the survival of family firms in comparison to non-family firms, however, with ambiguous results (Wilson et al., 2013). Some distinct features of family firms, such as SEW (Gómez-Mejía et al., 2007), continuous efforts to preserve good relations (Berrone et al., 2010), and multigenerational perspectives (Miller and Le Breton-Miller, 2003) are proposed to enhance the likeliness of family firm survival. Nonetheless, other factors inherent to family firms decrease their likeliness of survival. In contrast, family firms are less likely to join a cooperative as a measure to decrease performance risk, which increases the chance of firm survival drastically but reduces SEW (Gómez-Mejía et al., 2007), and they are less likely to diversify (Carney, 2005; Gomez-Mejia et al., 2010).

Le Breton-Miller and Miller (2013) depict how family firms enhance their probability of survival with apt board compositions. In the founding phase, when the firm is most vulnerable although the founder and his or her family are most committed, resources are generally scarce. Hence, the board is appointed in such a way that it can provide needed resources, e.g., technological advice, legal counsel (Le Breton-Miller and Miller, 2013). In its post-founding phase, the family firm has already established itself, and the founder has handed the firm over to family successors or at least intends to. Since the family has also grown, the potential for intra-family conflicts and rivalry is elevated (Kellermanns and Eddleston, 2004), so that the family vs. non-family ratio in the board is increased to ensure a fair representation of all family branches. Yet, non-family members are included to provide access to the local community in order to grow the business further (Le Breton-Miller and Miller, 2013). In its final stage, ownership is more dispersed among different family branches, emotional attachment is reduced, and the firm is often professionally managed. Here, the most critical resource for the firm is still family harmony, which is maintained by appointing respected family members to the board (Le Breton-Miller and Miller, 2013). Chrisman et al. (2013) have found governance, in general, to be pivotal for firm survival.

Synoptically, the firm survival is an indelible goal of a family firm. Without it, the whole family firm system ceases to exist. Yet, family firms possess certain resources that can enhance or lower their chances of survival, requiring them to leverage their advantages.

4.4.2. Firm Growth

The growth of the firm as the pursuance and penetration of new ventures, products or markets is a goal of almost all firms. For family firms, sustained growth can ensure the long-term success of the firm, hence, satisfying transgenerational control intentions. Nevertheless, family-centered goals may inhibit firm growth as resources are tied up elsewhere.

Traditionally, growth opportunities are clustered using the matrix of Anderson and Reeb (2003) along the dimensions of product and market newness (see Appendix B). The resulting strategies are somewhat differently followed by family firms. Especially diversification, as represented by new products in new markets, is applied to a lesser extent by family firms (Gomez-Mejia et al., 2010). In general, family firms do not tend to start a completely new line of products but continuously innovate the existing portfolio (Chrisman and Patel, 2012). This is due to the fact that identification of family member's with the firm rather extends with focus on the products than the markets they serve (Berrone et al., 2012). However, Aparicio et al. (2017) list neither goal very high indicating a preference for other goals.

As another basis for firm growth, Kellermanns et al. (2008) characterize the firm's entrepreneurial spirit. The more entrepreneurial a firm is, the more likely it is to pursue new ventures, enter new markets, and improve its performance, hence, increasing revenue. Conversely, a lack of entrepreneurial spirit inhibits innovation, consequently limiting long-term opportunities (Kellermanns and Eddleston, 2006). The firm's founder is in a position to create this spirit,

and it is likely to last long (Schein, 1983). The involvement of more generations also provides more entrepreneurial opportunities that are seen vital for cross-general growth because of more diverse views and opinions (Eddleston and Kellermanns, 2007). In support, empirical studies such as Lee (2006) show that family firms show higher growth than their non-family peers, which is attributed to family involvement.

Firm growth is vital as it keeps the firm well and creates further resources, hence, enabling the pursuance of many other family firm goal. If the family firm is not growing over a sustained period of time, it can endanger firm survival, and thereupon, the family wealth, too.

4.4.3. Firm Economic Performance

The economic performance of a firm is rather short-term oriented and usually stated in a set of financial and economic figures or ratios, such as: EBITDA, sales, profit, ROA, cash flows, and many more. For family firms, these numbers have importance as they lay the basis for a sound business. Nevertheless, it may be the case that due to resource constraint, the goal of economic performance is in contradiction to other goals.

Following, literature has so far presented some evidence with regards to the importance of firm economic performance as an organizational goal (Wagner et al., 2015). However, theories on why family firms should be more profitable or less profitable than their non-family counterparts are numerous. Fama and Jensen (1983) have argued that the concentration of ownership and control as present in family firms reduces profitability as owners extract private benefits, many scholars have focused on why family firms are likely to be less profitable. Nevertheless, Wagner et al. (2015) demonstrated in their meta-study that family firms tend to outperform their non-family counterparts, especially in the case of publicly listed firms and when abstracting from financing structure, i.e. focus on metrics such as ROA instead of ROE.

In affirmation, Aparicio et al. (Aparicio et al. (2017), p. 166) list the item "meeting economic and financial ratios" first in their ranking of family firm goals. The underlying reason for that has already been introduced in chapter 4.3–the firm's economic performance has severe impacts on family wealth (Anderson and Reeb, 2003) and therefore the family's overall living conditions. In times of financial hardship, caused by lower firm performance, the family wealth is significantly impacted by lower living standards (Miller et al., 2008). Yet, several scholars showed in quantitative research that family firms performed better than non-family firms. Using a sample of 511 U.S. corporations, Demsetz and Lehn (1985) showed the superior economic performance of family firms qualifying Fama and Jensen (1983)'s theory by adding that the family can act as a governance mechanism safeguarding the firm from managerial opportunism. Anderson and Reeb (2003) confirmed the outcome, however, warning for a self-selection bias as families may exit non-performing firms.

In the construct of NFCE goals, firm economic performance takes the position of the most short-term oriented, sometimes myopic goal. Albeit economic performance may be ill some years, it is needed to ensure firm growth and firm survival in the long run.

4.5. Nonfamily-Centered Noneconomic Goals

The last class of organizational goals of family firms to be described within this academic research is Nonfamily-Centered Noneconomic Goals (NFCNE). They include "improvement and conservation of good relationships with internal and external stakeholders, such as employees and the external community." (Kotlar and De Massis, 2013, p. 1273) What most NFCNE goals have in common is that they are the slightly contorted reflections of FCNE goals into the firm; e.g., family social status to firm external relations, as how the family or the firm is seen by outsiders, respectively. This represents the relationship between Restricted SEW, i.e., the FCNE goals, and Extended SEW, i.e., NFCNE goals, as depicted by Miller and Le Breton-Miller (2014). Restricted SEW is solely focused on the family and creating benefits for it, while Extended SEW takes a broader approach and encompasses the creation of benefits also for non-family stakeholders.

4.5.1. Firm Internal Relations

First and foremost, the goal of strong internal relations focusses on the family firm's employees and how the relationship between family, firm, and employees is perceived. Based on the family members' identification with the firm (see chapter 4.4), they see the firm as an extension of the family (Belk, 1988; Berrone et al., 2012). Therefore, internal resources, such as employees, that constitute other aspects of the firm are frequently included in this view (Huang et al., 2015).

Berrone et al. (2012) cover this within the dimension Binding Social Ties in their SEW dimension model. While foremost capturing the ties between the family members themselves, following Miller et al. (2009), they argue that social ties are likely to be expanded to other, non-family stakeholders, with employees being the most prominent ones. This tie, however, is reciprocal since the family draws social status of the employee's affection. In turn, the employee's own social status builds upon with the family's social status and long-term commitment to the firm can increase the employee's self-esteem and influence the way he or she views him- or herself (Westhead et al., 2001). Anecdotal references in research document close interactions of employees, in particular, TMT, and the family blurring the lines as employees feel sentiments of emotional ownership of the firm (Kotlar and De Massis, 2013). Miller and Le Breton-Miller (2005) showed, using the examples of retailers Nordstrom[4]

[4]Nordstrom is a U.S.-American chain of department stores covering clothing, shoes, and more fashion items, recently, also expanding into e-commerce.

and L.L.Bean[5], that if the feeling of belonging to the family is shared by employees, their performance and long-term commitment increases. In combination with the dimension Family Members' Identification with the Firm, Berrone et al. (2012) outline that these ties can go beyond employees and include the firm's products and services as well as the internal processes. The identification is particularly salient if the product or service contains the family name (Dyer Jr and Whetten, 2006).

Hence, fostering a sound relation with the firm's employees is another important goal of a family firm. Arising from the identification with the firm, employees are also considered part of the family's endowment. Consequently, if the internal relations are ill, the family may suffer as their sense of identity is compromised.

4.5.2. Firm External Relations

Under the goal of firm external relations, similar ties as the ones mentioned above are captured. Family ties are not necessarily limited to internal stakeholders only (Cennamo et al., 2012) but family firms often also care about how the firm is interconnected with outside stakeholders, such as customers, suppliers, and others (Berrone et al., 2012; Micelotta and Raynard, 2011). As external stakeholders also influence how to the family is perceived (see paragraph on Family Social Status), this is highly relevant for families.

Here, the description by Debicki et al. (2016) of the dimension of Family Prominence also comes into play. It emphasizes how others see the family and the firm. Particular items of their research included "[the] recognition of the family in the domestic community for generous actions of the firm" (Debicki et al., 2016, p. 52) demonstrating the interrelatedness of family social status and the firm external relations. Such relations are established in two-fold ways, that is to say, by contributing to the community and by avoiding to trigger the community's concerns (Dyer Jr and Whetten, 2006). Then, again, the earlier these ties are established, the stronger they are likely to be, as particularly the founder leaves an imprint on the firm (Schein, 1983). Berrone et al. (2010) confirm that engagement is elevated in firms with local roots. For the family, these ties can act as an "insurance" (Dyer Jr and Whetten, 2006, p. 791), since in times of crisis the community might repay what the family and the firm contributed (Debicki et al., 2016). Hence, building up and fostering good external relations is partially done out of self-interest, partially to satisfy goals of family identity and family social status (Cabrera-Suárez et al., 2014). The latter makes engagement with the community more likely for family firms (Berrone et al., 2010) as non-family firms do not pursue such goals. On the other hand, the community is likely to accept the contribution as it will be beneficial to it. Instances of hindrances of due to a poisonous community culture have been described, which resulted in not only corrupted relations but also economic downturn, see Banfield (1958) as presented in Dyer Jr and Whetten (2006).

A common example of family firms engaging with the community are corporate social responsibility (CSR) actions, and family firms also demonstrate a higher level of community citizenship (Berrone et al., 2010). A well-researched example is family firms overfulfilling environmental standard (Dou et al., 2017). Because academia presented evidence both in favor of environmental compliance increasing financial performance and against (cf. Berrone et al., 2010), it is not clear if the increased economic risk of going beyond requirements will yield any return. Therefore, it is likely that non-financial elements even out the risk-reward discrepancy and motivate decision-makers to invest in environmental compliance. Rather do noneconomic motivates matter as Westhead et al. (2001), as cited in Berrone et al. (2012) and Dyer Jr and Whetten (2006), present evidence in support that a public outrage against a firm carrying the family's name can be emotionally desolating for the respective family members. Notwithstanding, Aparicio et al. (Aparicio et al. (2017), p. 166) list NFCNE items including "create and maintain ties with local community" and "assume commitments to society and the local networks" only midfield.

Firm external relations as a family firm organizational goal constitute a logical fusion derived from the identification process as described above, the goal of family social status, and the unique resources non-family stakeholders can contribute to the firm. Lacking good external relations, family engagement is reduced, and also firm performance may suffer.

4.6. Goal Outcomes

Family firm goals have an impact on various levels within the organization with the two most important of them being the family firm and the family itself. For each level, an array of possible outcomes will be reviewed.

On the firm level, a vital relationship lies between the involvement of family members in management and the pursuance of family-centered goals, as described in chapter 4.3 and 4.4 since family-centered goals also tend to be less tangible than nonfamily-centered goals. The more noneconomic goals are pursued, the harder it is to measure their attainment, hence reducing average executive compensation (Chua et al., 2009). For non-family managers, this is less attractive as their compensation will most likely be uncompetitive. Hence, the more noneconomic goals are pursued, the less professional the management in terms of non-family members will be (Chrisman et al., 2014). Additionally, a strong focus on family-centered goals increases the potential for conflicts between the family and non-family managers, hence, does the pursuance of family-centered goals also reduce the involvement of non-family managers (Lutz and Schraml, 2011; Zellweger et al., 2012). On the other hand, scholars have shown that the more non-family managers serve in the firm, the less family-centered goals are pursued (Achleitner et al., 2010; Miller et al., 2008). Therefore, a reciprocal relationship can be assumed and is

[5] L.L.Bean is U.S.-American chain of department stores specializing in outdoor equipment.

supported by academic literature. However, for the specific family-centered goal of intra-family succession as part of sustained family control, literature remains ambiguous. Smaller family firms hire less non-family managers when an intra-family succession is immanent. Conversely, the opposite holds true for larger firms. Nevertheless, research has shown that non-family employees can also be positively affected in their motivation and performance by the achievement of family-centered goals (Achleitner et al., 2010; Miller et al., 2008).

Also agency theoretic considerations come into play. Less goal diversity among all involved stakeholders reduces the need for a board of directors, as Pieper et al. (2008), showed since this implies stewardship behavior (Le Breton-Miller et al., 2011). Also, board composition is affected. High goal alignment favors not only small boards but also a lower ratio between non-family and family members on the board (Jaskiewicz and Klein, 2007). On the contrary, Jaskiewicz and Klein (2007) observed that large boards with many non-family members could indicate an agency conflict between owner and managers. Thus, goal diversity defining agency and stewardship behavior of stakeholders interacts with the size and composition of the board as well as other governance structures. Consequently, collective pursuance of goals reduces agency conflicts and hence the need for costly governance mechanisms (Davis et al., 1997).

As Chrisman et al. (2007) have shown that more alignment of family firm goals and hence reduced governance cost increase firm performance. Miller and Le Breton-Miller (2005) point out the superior performance of family firms compared to their non-family peers. This holds especially true if family ownership is high, hence connecting to the goal of family control over the firm.

4.6.1. Family Level

On the family level, goal alignment is of utmost importance. Major findings of how the relationship among family members is affected are based on how family interactions within their firm, markedly how relationship conflicts can negatively impact family firm performance (Eddleston and Kellermanns, 2007; Kellermanns and Eddleston, 2004). For no conflicts and thus high goal alignment, Lee and Rogoff (1996) noted that this could foster unification within the family. Likewise, goal success fosters family harmony (Philbrick and Fitzgerald, 2007).

Family members' individual attitude is impacted by several goal attributes, such as: (1) Goal difficulty, (2) goal novelty, and (3) goal duration (Kotlar et al., 2018). If a goal is achieved, family members feel more motivated and committed to the firm as well as perform better due to rewards in monetary or affective form (Kotlar et al., 2018). This holds especially true for difficult and novel goals, i.e., goals that have low probability of success given the firm's resources and situation (Locke and Latham, 2002) and goals that require new capabilities (Sitkin et al., 2011), respectively, as increased goal difficulty and novelty enhance the desire to perform in the best possible way, thus intensifying satisfaction once the goal is achieved (Kotlar et al., 2018; O'Leary-Kelly et al., 1994). The longer the goal duration, the lower the performance and later motivation and commitment will be since family members will reduce pace when driving the goal. However, too tight deadlines increase pressure to an extent where performance, motivation, and commitment will slack (Locke and Latham, 2002), hence setting forth a u-shaped relationship.

Although socioemotional wealth is also of high importance in the goal setting process (see chapter 4.2), it is also a goal outcome. Literature differentiates goal outcome-related SEW into SEW preservation and SEW generation (Williams Jr et al., 2018). As illustrated by Gómez-Mejía et al. (2007), SEW preservation as an ultimate goal and the reference point (Berrone et al., 2010; Kahneman and Tversky, 1979) drives many decisions in the firm, often increasing the performance risk, i.e., current performance is lower than past performance or competitors' performance. If SEW is preserved and even enlarged, SEW generation takes place. Nonetheless, SEW generation has not experienced much attention in literature yet. However, other scholars outlined the potential for the negative valence of SEW (Kellermanns et al., 2012; Miller and Le Breton-Miller, 2014). In their research, they describe cases in which both, family members felt pained and non-family parties were mistreated. Younger generations may feel pressured into taking over the firm hence only hesitantly accepting (Freudenberger et al., 1989; Schulze et al., 2001) or different branches of the family may be fighting over the control over the firm (cf. Kellermanns et al., 2012). Moreover, minority shareholders stake in the firm might have been expropriated, or employees have been mistreated (cf. Kotlar and De Massis, 2013; La Porta et al., 2000). Yet, from a SEW perspective, acting in this way preserves SEW for the family. Generally speaking, most family firm goals aim at preserving or even generating SEW, nevertheless, consequences can differ (Chua et al., 2018).

The outcome of the family firm's organizational goals concerns firm and family. Each system has unique dimensions into which the goals reverberate and later shape the decision-making process in the firm. However, for each family firm, a specific organizational goal leaves a unique imprint in the respective dimensions. Figure 15 in Appendix B shows this interplay graphically. Special focus is laid upon the fact that the family firm's organizational goals influence both, the firm and the family system (cf. Tagiuri and Davis, 1992).

4.7. Goal Alignment

Organizational goals do not constitute a static process but are subject to constant changes hence in need of feedback and alignment processes (Kotlar et al., 2018; Williams Jr et al., 2018). They require organizations to use alignment processes for the formation and realization of goals as well as changes in resource allocation based on the perception of the goal outcome. Other research highlights the importance of continuous evaluations of current performance against past performance or the competitors' ones (Iyer and Miller, 2008; Mishina et al., 2010). Therefore, most family firms

also apply formal and/or informal feedback processes for their organizational goals (cf. Kotlar and De Massis, 2013). What deeply impacts goal feedback processes is the fact there rarely is a sole goal that is pursued at a time only. Goals can be independent of another, but are often interrelated, either additive in effect, e.g., strengthened family identity and community relations increase family reputation or rivaling, e.g., economic performance might require a factory closing thus contradicting good community relations. For both cases, but especially the latter, a goal hierarchy needs to be established (Greve, 2008). Kotlar et al. (2018) illustrate this feedback process as following either a sequential (Ethiraj and Levinthal, 2009; Greve, 2008) or simultaneous attention rule (Labianca et al., 2009). The limiting feature of sequential attention that forces organizations to give up on one goal before pursuing another is what drives most organizations to follow a simultaneous attention rule (Kotlar et al., 2018). Also taking the decision which goal to pursue under the sequential rule can spark disagreement because reference points and outcome utility may differ among decision makers (Martin et al., 2013). For example, the family uses the preservation of SEW as the reference point while non-family investors follow primarily financial motives (Berrone et al., 2012). For some goals this may not be a problem withal as they are hierarchically-related with one another, i.e., the first goal is a prerequisite for the next, higher goal, e.g., good community relations for family social status, thus repealing both attention rules (Ethiraj and Levinthal, 2009; Kotlar et al., 2018). Having reviewed 36 family firms, Aparicio et al. (2017) provide a potential hierarchy of goals. The ranking does not confine to a single goal class but alternates between. As the foremost goal, they describe the firm's economic performance or more specifically meeting financial ratios, e.g., sales, profit. Second, the reviewed family firms strive for handing over the firm in a good state to the next generation. At the third and fourth place, they list retaining family control over the firm and the board respectively. Nevertheless, the heterogeneity of family firms does not allow for a definite and rigid list (Aparicio et al., 2017).

In the following, three different feedback elements, communication, conflict, and reputation, as in Williams Jr et al. (2018), will be presented. A common understanding of the specific organizational goal is the foremost prerequisite for attainment. Without that commitment to the common goal, it cannot be fostered hence reducing effectiveness (Anderson and Reeb, 2003). For family firms, there are unique ways of communicating within the family or with firm stakeholders. As described in chapter 4.2, family firms can use professional and familial social interactions in their goal process (Kotlar and De Massis, 2013). Familial social interactions are unmatched in the overlap of family and firm systems. Hence, literature finds them to be particularly effective when dealing with family-centered goals (Kotlar and De Massis, 2013). Notwithstanding, communication is not limited to the family only. Danes (2006) presents the advantage of open interaction including all stakeholders being a consistent performance assessment of the goals incorporating possibilities of beneficial changes. Consistent with Sharma et al. (1997), the culture of the family firm can drive communication in the goal process. In particular, paternalistic cultures that distinguishing themselves by high-power distance communication (Hofstede, 2001) is often impaired thus reducing the frequency of feedback (Kelly et al., 2008).

Conflicts arise within the firm because the resources of the firm and the family are limited, therefore they need to be allocated efficiently, and goals need to be prioritized, which is a frequent source of conflict (Achleitner et al., 2010; Lee and Rogoff, 1996). From a behavioral perspective, conflicts arise when organizational members feel a disparity in the perceived utility of outcome, in the case of family firms, mostly an imbalance between the prioritization of the firm and the family's member. Therefore, conflict can be considered as a feedback to the family firm's goals. Schulze et al. (2003) note that conflicts are particularly frequent when succession is immanent thus attributing to Kotlar and De Massis (2013)'s observation that goal diversity is notably elevated during the time of succession, circumstantially confirming the mediating effect of conflicts in the goal process of family firms. After all, if conflicts remain unresolved, they are, most likely, diminishing family member satisfaction and performance (Danes, 2006; Eddleston and Kellermanns, 2007; Kellermanns and Eddleston, 2004).

Outside feedback also serves as an alignment function. Particularly, family firms strive for a good reputation (Chen et al., 2010), thus, functioning as a control mechanism and goal at the same time. If SEW goals are perceived as positive by outside stakeholder, i.e., the community, non-family managers, etc., this will enforce the fostering of SEW goals and also enhances bonds between the family and the firm (Zellweger et al., 2013).

Goal feedback constitutes an essential part of the overall goal process, which will be illustrated later. By using communication, conflicts, or a mixture of both, there is constant alignment throughout the whole goal process. Additionally, reputation serves as a feedback mechanism from outside stakeholders.

5. Limitations and Avenues for Future Research

This thesis is based on a systematic literature review hence it is subject to all limitations of such a review. One limitation is that only the content that was found can ultimately be reviewed. I tried to mitigate that risk by not only using EBSCO Delivery Service but also the ancestry approach (Cooper, 1982), nevertheless, a certain bias will still existent. Since the field of the family firms and their goals is still emerging and the key papers used are quite recent, it could be likely that a relevant piece of literature has not been identified and included. Moreover, this field of research hitherto lacks a common terminology which increase the difficulty of finding the right keywords for the bibliographic database search. Hence, the ancestry approach yielded many articles and papers, also because the topic of organizational draws from many affiliated fields of research,

this step is afflicted with a certain selection bias. Likewise, I only focused on English, peer-reviewed journals, hence potentially relevant findings published in non-English journals or published elsewhere than academic journals have been excluded. Moreover, the studies analyzed in the review lack an international orientation and multi-country approach. As previously outlined in the chapter on the characteristics of the reviewed literature, most studies focus on Europe or the U.S. and examine on a single country or part of it only. An extension of the data pool might grant further insights, for example regarding geographical and cultural differences.

This thesis contributes to the field of family firm research but draws from a number of more or less affiliated fields of research, such as psychology or sociology. When reasonable, findings have been transferred, however, with caution. In particular, purely conceptual work taken from there may be based on certain assumptions, the field of family firm research cannot fulfill. Nevertheless, empirical evidence is still pending, and reality may prove some elements wrong.

Lastly, a certain limitation of this thesis is heterogeneity of family firms. Whatever findings are presented, and conclusions are drawn, they may apply to some family firms to a greater extent than to others. Aspects of culture, legislation, or general economic situation can severely impact the goal process, thus impairing the results and findings. In light of the almost exclusive focus on Europe and North America, which 93% of the investigated studies addressed, only the Western culture area has been covered, hence arising the need to investigate other culture areas. To that end, Studies focusing on Africa, Asia, and South America should also have been investigated. Furthermore, the difference in firm size and age of the samples included in the reviewed studies vary significantly, further contributing to the limitations of this thesis.

Overall, the findings should be regarded to with caution as the aforementioned factors may assume a certain underlying bias and generalization of findings is also limited due to family firm heterogeneity.

Although organizational goals of family firms have been researched in the recent years, there still exist various research avenues that should be followed in future research in order to gain a comprehensive understanding of family firms and their goals. Although the theory of the goal setting process dates back to Cyert et al. (1963), it yet not fully understood, especially with regards to family firms.

- Do family firms form coalitions differently?
- Are there mixed family/non-family subcoalitions and if yes how do they act?
- Are professional and familial social interactions often interrelated?

As another avenue for future research, organizational goals of family firms should be further investigated. In particular, many goals are overlapping and have been heretofore only insufficiently defined. Additionally, empirical work is lacking for many of them. Furthermore, goal outcomes have been researched as in comparison to non-family firms. However, as another avenue for future research, goal outcomes along the dimensions presented before can help to elucidate the goal process more clearly.

- How can goal outcomes be classified further?
- What are meaningful ways to investigate this array?

Next, the feedback process is a vital element for goal alignment. Nevertheless, so far little is known besides that more communication increases chances of alignment and that conflict can be beneficial. Drawing upon work from the fields of communication science and psychology, more specific ways of communication and conflict as feedback processes should be described. Also, how the influence of goal hierarchy and the learnings drawn from the outcome is so far not fully understood. The former may change during the feedback process, while the latter can difficult to quantify.

- Moreover, how do the firm's culture and the intra-family relations influence the feedback process?

Also, the interaction between the steps of the process would benefit from further research. The process as such is unlikely to run strictly linearly. When setting a goal, organizational do have a certain goal and outcome in mind, hence, there is presumably a particular interplay. Nevertheless, it has hitherto been insufficiently investigated.

- And if there is an interplay, how strong is it?

Another avenue for future research is understanding how the context of firm and family impacts its goal and goal process. As manifold as the context can be, the many-faceted the influence on the goals themselves and especially their outcome will be.

- Which role do macro factors like legislation, technology, and culture play?
- And which do micro factors, such as the education, equity stake, and personality of a certain organizational member?

Ultimately, the relation of the goal process to the subsequent decision-making process also needs further investigation. Albeit, research has shown that there is an interaction, yet, it is to be fully understood.

- How does each goal outcome dimension influence the decision-making process?
- Does the goal feedback process also affect decision-making and if it does, to what extent?

6. Conclusion

Building upon a systematic review of 117 articles, in this thesis, I depict the goal process of family firms. It differs

from the goal process of non-family firms in various points. First, when setting goals, family members are more influential and pursue more different individual goals than non-family members. Later, bargaining can also take place on an affective level and stabilization can be based on mutual trust, in addition to the regular process as described by Cyert et al. (1963). At this point, the conservation of Socioemotional Wealth (SEW) is highly impactful as it constitutes the reference point in regard to which decisions are taken.

From there, four distinct classes of family firm organizational goals emerge, differing in the dimensions of family-/nonfamily-centered as well as economic/noneconomic. This results in family-centered economic, family-centered noneconomic, nonfamily-centered economic, and nonfamily-centered noneconomic goals. Each goal class holds organizational goals. Goals are often interrelated and affect each other, thus, rather forming an alloy of goals that are pursued.

The goals reflect a certain outcome, which can be clustered in to influence on the firm and on the family. Here, future clustering is somewhat inconclusive and should be subject to further research as well as the alignment processes that continue through the whole goal process.

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Is the use of management accounting in startups a paradox? - A systematic literature review of how static management accounting practices can support dynamic startups

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Abstract

This paper uses a systematic literature review to study the antecedents and consequences of management accounting (MA) in startup companies. Most literature focuses on large enterprises because it has generally thought that the adoption of MA is counterproductive in small firms. However, some authors state the contrary as to why we examine the empirical literature on this topic to create a wider base of knowledge. Our results indicate that the entrepreneur's personal, professional and the firm's characteristics trigger the timing of adoption of MA and thereupon show beneficial implications to a startup. Besides the positive impact of venture survival, startups that used management accounting practices such as budgeting, financial planning and cost control achieved higher performance in terms of growth.

Keywords: Management accounting, Systematic literature review, Startups, Entrepreneurship

1. Introduction

Management accounting (MA) uses a broad range of different tools and practices to improve the firm's organisational and planning ability as well as creating incentives and control systems. These practices are characterized as static tools which on the one hand are applied in large and established firms and are needed for decision facilitating and -influencing purposes. On the other hand, small startups are totally different. They are in contrast to large enterprises described as operating in a highly dynamic and unstructured environment with a high level of uncertainty and have informal structures and communication channels. This creates the impression that management accounting is completely useless for startup companies. However, some sources state the opposite as to why the topic of management accounting in statup has found increasing interest in the last years.

Both management accounting and entrepreneurship are two frequently studied and important fields of research. Today one is aware of the characteristics of small and young startup firms such as the limited access to resources, the lack of formal structures and the high level of environmental uncertainty. That implicates some reasons why small firms require special attention with respect to management accounting (Lavia López and Hiebl, 2014).

However, only in recent years research has addressed the topic of management accounting in the world of entrepreneurship and combine the two fields of research (Moores and Yuen, 2001). Despite the increasing interest of the topic, published research is scarce and according to Lavia López and Hiebl (2014), it is "fragmented, spanning various fields such as accounting, small business and entrepreneurship, general management, and production and operations management". Consequently, the knowledge gap lies within the largely unconnected research on management accounting in small firms from various fields of study.

Hence, the goal of this thesis is to give an overview of the research that has been conducted in the field on management accounting in startups, and it aims to create a reliable source of knowledge through accumulating findings from a range of empirical papers.

As we are interested in the research of the connection of the two topics in the current literature and how entrepreneurs can benefit from management accounting, three research questions were formulated as follows:

1. What types of management accounting practices do startups adopt and use?
2. What are the antecedents of the adoption of these practices?
3. What are the consequences of the adoption?
4. What arguments do empirical papers offer for the adoption of management accounting in startups?

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In order to answer the research questions, a comprehensive literature review of the use of management accounting in startups was conducted based on the guidelines of Tranfield et al. (2003) and Briner and Denyer (2012). The method used consists of three key steps: 1) planning the review, 2) conducting the review and 3) organizing the results. Based on Dos Santos et al. (2011), Hesford et al. (2006), the ranking of The Financial Times and the VHB ranking, 23 high quality entrepreneurship and management journals have been selected. By using the databases Scopus and Google Scholar we located the papers. As only empirical papers were selected, we aimed to analyse the hypotheses formulated by the authors. By breaking them down into their individual constructs we use a framework (Figure 1) to structure the research questions. The constructs are either a management accounting construct or an antecedent, a consequence or a moderator/ mediator construct which were categorized and analysed for a comprehensive overview.

We identified that most notably the firm's characteristics such as age and size drive the adoption of management accounting. But also, the professional characteristics of the entrepreneur such as work experience, formal education in the field of management and accounting as well as the personal traits such as willingness to grow, self-efficacy and planning affiliation leads to a faster adoption of management accounting. Environmental factors such as competition and environmental uncertainty force a company to reduce uncertainty to a certain extent using management accounting. External pressure from financiers and venture capitalists has shown to drive the adoption as well as the 'import in effect' of skilled executives, i.e. CFO or professional accountants. Hence, the presence of these financial and human capital resources are important prerequisites when adopting management accounting.

Further, the review revealed that startups and small firms that adopt suitable management accounting practices generally benefit from the adoption. They experience better business performance in terms of growth and profitability in the long term. Management accounting enables the company to manage growth and gain professionalism. The findings are equivalent that not adopting management accounting was found to increases the likelihood of venture disbanding.

This paper contributes to the work of researchers as well as practitioners. Due to fact that some researchers argue about the benefits of using management accounting practices this paper provides a comprehensive understanding of the different research methods, outcomes and arguments. With this thesis, we found meaningful answers to the research questions because management accounting in entrepreneurship is a promising field of research has gained relevance in the world of management.

The remainder of the paper is structured as follows: First the research methodology is presented. Second, the finding of the review, including the construct analysis and the argumentation of the authors, are given. Lastly, we present the discussion of the findings, the implications for researchers and practitioners, as well as a conclusion.

2. Research methodology

In order to find the suitable literature of management accounting in start-ups, we conducted a systematic literature review. Our review aims to provide an analysis and summarizes the existing literature concerning the topic of management accounting in startups (Briner and Denyer, 2012). Using the approach of Tranfield et al. (2003), the method embodies three proposed key steps: 1) planning the review, 2) conducting the review and 3) organizing the results.

2.1. Planning the review

The ultimate goal of this paper is to provide an overview of the research that has been conducted to date on the field of management accounting in startups, and it aims to create a reliable source of knowledge by accumulating findings from a range of empirical papers. As the focus of interest of the paper is on the research of the connection of the two topics in the current literature and how entrepreneurs can benefit from the research, we propose the following four research questions: 1) What types of management accounting practices do start-ups adopt and use?, 2) What are the antecedents of the adoption of these practices?, 3) What are the consequences of the adoption?, 4) What arguments do empirical papers offer for the adoption of management accounting in startups?

First, we selected the most influential peer-viewed journals to guarantee the quality of the findings. Based on Dos Santos et al., 2011, the most influential entrepreneurship journals were 'Entrepreneurship, Theory and Practice', 'Journal of Business Venturing', 'Journal of Small Business Management' and 'Entrepreneurship and Regional Development'. Furthermore, Dos Santos proposes the management journals 'Administrative Science Quarterly' and the 'Strategic Management Journal' as the most influential ones for the entrepreneurship domain. We included 'Strategic Entrepreneurship Journal', 'International Small Business Journal', 'The European Accounting Review' and 'Small Business Economics' due to a good rating in the VBH Ranking. As Hesford et al. (2006) propose the most influential journals in management accounting, we include 'Accounting, Organisations and Society', 'Contemporary Accounting Research', 'Journal of Accounting and Economics' and 'Management Accounting Research'. Lastly, the ranking of the Financial Times provided 'Journal of Management', 'The Accounting Review', 'Journal of Accounting Research', 'Research Policy', 'International Entrepreneurship and Management Journal', 'International Journal of Entrepreneurship', 'International Journal of Entrepreneurship and Small Business', 'Venture Capital' and 'Long Range Planning'.

This sums up to a total of 23 entrepreneurship and management journals in which we conducted the search using the databases Scopus and the Google Scholar Advance Search. The reason for using Scopus is that it allows using Boolean operators and filters. We used Google Scholar to broaden the scope.

The search terms can be divided into entrepreneurial keywords and management accounting keywords: we chose ten entrepreneurship-related terms ("entrepreneurship*" OR "entrepreneur*" OR "startup*" OR "start up*" OR "small firm?" OR "young firm?" OR "SME" OR "small enterprise*" OR "new technology-based firm*" OR "small business*") and 14 Management Accounting keywords ("management account*" OR "account*" OR "controlling" OR "budget*" OR "financial plan*" OR "planning" OR "cost*" OR "cost control" OR "control" OR "management control" OR "financial statement" OR "performance measure*" OR "management" OR "activity based").

The use of asterisks (*) and question marks (?) allowed to find equivalent meanings among various suffixes (e.g. "entrepreneur*" and "small firm?"), such as "entrepreneurship", "entrepreneur" or "entrepreneurial" or "small firm" and "small firms". This helped to consider as many relevant papers as possible in favour of the comprehensiveness of the review.

2.2. Conducting the review

We scanned the entrepreneurship and management journals using both the management accounting related search terms and entrepreneurship terms. In order to be considered, a paper had to include the combination of one of the terms in either the title, abstract or the keywords. The papers that resulted from the search were not restricted by the published date, but only published papers were selected. The review with the keywords, defined in the previous section, was conducted in November 2017 and yielded a total number of 2371 papers that consisted of at least one combination of the groups in the title, keywords or abstract. The reason for restricting it to the title, keywords and abstract was that the consideration of the whole text delivered too many irrelevant papers.

We only selected the papers in which the author conducted an empirical study, case study or survey with explicit or inferred hypothesis testing, focused on small firms dealing with a management accounting topic. By going through the titles, keywords and a brief first scan of the abstract of the paper we were able to exclude 89,12 % of the papers due to a lack of relevance at first sight. Using the search term "management" was one reason to why many irrelevant papers appeared. The keywords in the search did match with the ones in the paper, but the title covered different topics, i.e. dealing with risk management (i.e. Britzelmaier et al., 2015) or general management topics i.e. strategic management competencies or education and exit decisions (i.e. Yamakawa and Cardon, 2017). The search term 'SME' appeared in 196 papers. We excluded papers that did not deal with small firms. We looked at the mean size of the samples and distribution of small firms and slightly larger organizations. The definition of Small and Medium Sized Enterprises (SME) by the European Commission[1] states the consideration of firms from 10 (micro and small firms) up to 250 employees (medium-sized firms). We considered those SME that had a larger amount of small than medium enterprises, otherwise excluded them. The word 'entrepreneur'[2] appeared in 839 papers. Irrelevant papers dealt with the motivation, incentives, personality traits of the entrepreneur and the creation of entrepreneurial firms (i.e. Jayawarna et al., 2013) or the direct effect on the startup performance (i.e. Kickul et al., 2009; Miao et al., 2017). Others addressed the gender roles and gender differences in entrepreneurship (i.e. Hechavarría et al., 2017) or the entrepreneurial education or orientation (i.e. Block et al., 2013).

Other topics that appeared which were not of interest for our paper were dealing with succession planning (i.e. Motwani et al., 2006) or the practice of bootstrapping as a management accounting practice. This practice was not counted as management accounting and therefore dismissed (i.e. Ebben and Johnson, 2006). We further excluded duplications (i.e. A. Davila et al., 2015).

By applying the steps mentioned above, we selected 46 papers for further research. Next, we performed a backward and forward reference search with the relevant papers. By using Scopus, we applied the filter to limit the results to the distinct papers as stated in the first stage. This led to additional seven relevant papers.

All in all, we selected 53 papers from 17 different journals. Four journals constitute 53% of all papers that were taken into account: Journal of Small Business Management (absolute number: 12), Small Business Economics (10), Accounting Review (4) and Journal of Business Venturing (4). Six journals (Research Policy, Journal of Accounting Research, Journal of Accounting and Economics, International Journal of Entrepreneurship, International Entrepreneurship and Management Journal and Administrative Science Quarterly) did not yield any contributions.

Table 1 illustrates how many papers were found in each journal.

2.3. Organizing the results

To be able to structure and organize the papers, we prepared a database with 'excel'. This helps to create a systematic, transparent and replicable knowledge base, stated as the 'core principles' of a systematic review. (Briner and Denyer, 2012)

As we only considered empirical studies, most of the papers used hypotheses. These hypotheses were broken down into their individual constructs to run a 1st level coding procedure. The construct in the centre of Figure 1 describes a management accounting practice and is the main construct for the analysis. Every main construct is composed of either an antecedent construct or a consequence construct. An antecedent construct describes a preceding event, condition or cause for the emergence of the construct. A consequence construct showcases the effect of the usage of management accounting practices. All in all, one can be say that the 1st

[1] http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_de 05.01.18

[2] including the words entrepreneurship, entrepreneur, entrepreneurial

Table 1: Selection of 53 papers from 17 different journals

Journal title	Number of Selected Papers
Journal of Small Business Management	12
Small Business Economics	10
Strategic Management Journal	5
Journal of Business Venturing	4
The Accounting Review	4
Management Accounting Research	3
Long Range Planning	2
Accounting, Organizations and Society	2
International Journal of Entrepreneurship and Small Business	2
Venture Capital	2
Contemporary Accounting Research	1
Entrepreneurship and Regional Development	1
Entrepreneurship, Theory and Practice	1
European Accounting Review	1
International Small Business Journal	1
Journal of Management	1
Strategic Entrepreneurship Journal	1
Total	53

level coding looks into the cause and effect relationships of the adoption of management accounting practices. Figure 1 showcases the relationship between the constructs and the dependency path from the left to the right. Besides that, it illustrates which research questions, labelled as RQ1, RQ2, RQ3 and RQ4, relates to the appropriate construct. In particular, RQ4 looks at the whole cause and effect relationship.

In addition to that, some hypotheses had either a moderator or mediator construct. A moderator construct is a third-party variable that in this case modifies the relationship between the antecedent construct and the management accounting construct or the management accounting construct and the consequence construct. The purpose of the moderator construct is to measure the strength of their relationship. The mediator construct's objective is to explain the relationship between the management accounting construct and the antecedent or consequence construct and causes a mediation between them. In the further course of this paper we do not distinguish explicitly between those two constructs, as they only make up a fraction of the constructs found.

The quality of the definition of the construct is of major interest as it is important to see how precisely the authors dealt with each construct in their study. By scrutinizing the definition of each different construct, we paid special attention to its quality. Using four different categories, the quality of each construct was assessed:

Next, we conducted the 2nd level coding for each construct. We looked closely at the different constructs that we found and grouped the constructs with the same or similar meanings. Then, we defined superordinate categories and assigned each construct to one of the groups. The reason for this procedure is to ensure the clarity of the review and accumulate the relationships between the constructs.

Table 3 illustrates the categories for the antecedent, management accounting and consequence constructs.

The definitions of the second level coding for the 36 different moderators and mediators that we found are described in the appendix.

3. Results

In the following sections, we will present our findings from the systematic literature review. First, the descriptive statistics will be described to highlight the major findings and give answer to the first research question. Second, we will showcase the antecedents and consequences of the adoption of management accounting in order to answer the second and third research questions.

3.1. Descriptive Statistics

We found a total of 205 relevant hypotheses in the selected 53 papers. 80 hypotheses were on antecedents and 125 on consequences of management accounting. We distinguished eight different 2nd level categories for antecedents and seven categories for consequences for the adoption of management accounting as described in Table 3. Besides that, eight distinct categories for management accounting practices were established.

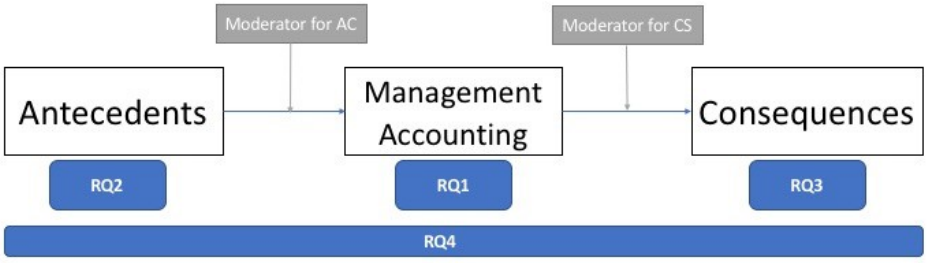

Figure 1: 1st Level Coding Constructs

Table 2: Quality of the Definitions

Category	Explanation
Explicitly defined from paper	The paper defines the construct explicitly or quotes a source of a clearly expressed definition.
Inferred from paper	The paper does not explicitly define the construct, but offers a description from which the construct can be deduced.
Equals measurement item	The paper explains the choice of measures for the study (e.g. questionnaire) in the variable part of the paper and makes clear the calculation of the construct.
No explicit definition	The paper does not provide a definition to describe the construct more precisely.

Table 4 presents the absolute frequencies of antecedents that were examined in the empirical work of management accounting in startups companies. The majority (75%) of the hypotheses on antecedents fall into three categories. The biggest part deals with the antecedents of 'accounting based control systems' (absolute number: 25), 'business planning' (19) and 'financial statements and reporting' (16). The remaining five categories only cover up twenty hypotheses in total: 'strategic use of information' (6), 'budgeting' (5), 'strategic management (systems)' (4), 'financial planning' (3) and 'costing method' (2). The antecedents that are the most striking ones in the research are the 'firm's characteristics' (24 hypotheses), the 'entrepreneur's professional characteristics' (14) and the internal and external pressures, respectively 'strategy' (11) and 'environmental factors' (9). Other categories that research focused on were the 'entrepreneur's personal characteristics' (7), the 'presence of venture capitalists' (6), the association to an 'outside network' (5) and the 'prior performance' of the company (4).

Table 5 presents the absolute frequencies of consequences that were examined in the empirical work of management accounting in startups companies. Of the all hypotheses on consequences 60% deal with implication of adopting 'business plans' (absolute number: 44) and 'accounting based control systems' (23). The remaining six categories only cover up 57 hypotheses in total: 'strategic management (systems)' (12), 'costing methods' (11), 'financial statements and reporting' (11), 'strategic use of information' (10), 'budgeting' (8) and 'financial planning' (6). 33 hypotheses address the firm's 'performance (growth)', 22 the 'survival of the firm' and 20 'subjective performance measure' as the consequences of adopting management accounting. The remaining categories make up the other 38 implications: 'acquiring financial resources' (14), 'entrepreneurial intensity' (13), 'profitability' of the company (12) and 'non-financial measures' (11). It is noteworthy that two hypotheses measure 'performance (growth)' and 'subjective measure' as consequences of 'strategic management (systems)' (Malagueño et al., 2018). Two hypotheses measure 'performance (growth)' and 'subjective measure' as consequences of 'business planning' (Rauch et al., 2000). Four hypotheses measure 'performance (growth)', 'profitability', and 'survival' as consequences of 'business planning' (Brinckmann et al., 2010). Four Hypotheses measure 'performance (growth)' and 'profitability' as consequences of 'accounting based control systems' (Voss and Brettel, 2014). These hypotheses are

Table 3: Second Level Categories for Antecedents, Management Accounting and Consequences

* "Entrepreneurial self-efficacy relates to an individual's belief that one is capable of successfully performing certain roles and tasks in the entrepreneurial domain", (Chen et al., 1998)
** "Management Control Systems are the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities", (Simons (1994))

Antecedents	Definition/ Explanation
Entrepreneur's Professional Characteristics	This antecedent covers the person and group specific characteristics such as education, work and founding experience that are related to the introduction and use of management accounting.
Entrepreneur's Personal Characteristics	This antecedent covers the person and group specific characteristics such personality traits, the aspects of self-efficacy* (i.e. motivation and achievement orientation) that are related to the introduction and use of management accounting.
Presence of Venture Capitalists	We describe the activities of Venture Capitalists (VC) that lead to the presence of financial and non-financial resource as antecedents that drive the adoption of management accounting.
Firm Characteristics	These characteristics are firm related aspects such as the structural (i.e. size, age and life-cycle stage) and behavioural variables (i.e. culture and management style).
Environmental Factors	They cover the aspects concerning external pressure such as the complexity and uncertainty of the environment as well as outside events and competition that lead to the adoption of management accounting.
Strategy	The strategy followed by the company explains its orientation for the future such as the pursued goals and development that influence the adoption of certain management accounting practices.
Prior Performance	It indicates the development of a company prior to the adoption of management accounting in terms of financial performance and growth indicators.
Outside Network	The network describes the influential outside factors and external parties such as the presence of international relations, number of outside owners or external financial advice.
Management Accounting	
Financial Planning	This construct comprises ex-ante financial projection activities to express future financial state predictions or estimations of the company.
Accounting Based Control Systems	These formal systems consist of multiple techniques in order to assist the entrepreneur to i.e. plan, complete internal control or comply (Definition according to Simons, 1994**).
Financial Statements and Reporting	This construct covers the aspect of the completion of ex-post financial statements containing at least a written balance sheet and income statement and reports about the current and past financial state.
Business Planning	We define business planning as all activities concerning the creation of formal business plans with a strategic purpose.
Budgeting	By budgeting, we mean the preparation of different budgets in order to expressing a plan in terms of money
Strategic Use of Information	This construct contains screening activities, the selection, presentation and usage of primary and secondary financial and non-financial information sources.
Costing Methods	These methods deal with the different costing and accounting methods such as accrual, standard and actual costing or ABC and factors used in the costing process.
Strategic Management (Systems)	Unspecific management, strategic and/or controlling practices such as BSC belong to the strategic management systems.

(Continued)

Table 3—continued

Antecedents	Definition/ Explanation
Consequences	
Performance (Growth)	The company's success measured in terms of sales growth and the revenue growth as well as employee growth are defined as performance.
Subjective Performance Measure	These measures describe the subjective evaluation of the firm's achievements in comparison with the past or with competitors.
Profitability	Profitability covers the indicators of the company value and contains well-established profitability measures such as ROA, ROI, etc..
Entrepreneurial Intensity	This intensity is measured by product quality and development and efforts in innovation outcomes influenced by management accounting adoption.
Acquiring Financial Resources	We count the acquisition of financial resources and external financing concepts to this construct category.
Survival of the Firm	This consequence indicates the continuance, respectively the termination of the venture or the entering of a new life-cycle stage.
Non-Financial Measures	This construct contains i.e. the accuracy of planning or forecasts or number of stores, goal alignment or goal clarity.

listed solely under 'performance (growth)'.

The 205 hypotheses that we found dealt with 85 antecedent constructs, 205 management accounting constructs, 153 consequence constructs and 45 mediator and moderator constructs. As many authors investigate multiple hypotheses, we had to exclude duplicates when checking the quality of each definition. After eliminating duplicates, we found a total amount of 331 constructs. 76 were antecedent constructs, 122 management accounting constructs, 97 consequence constructs and 36 moderator or mediator construct. Table 7 shows the proportions of the quality of each construct definition. It indicates that only 55% of the management accounting constructs are defined explicitly. Besides that, 22% of all constructs had to be either inferred from the paper or were not defined properly at all.

We also found that the moderator and mediator constructs are mainly used to describe or alter the relationship between the management accounting construct and the consequence construct (78%) and that they are less likely to be found between the antecedent and the management accounting construct (22%).

Figure 2 illustrates how many papers were published in each year. In the years of 2004, 2005, 2007 and 2015 five empirical research papers were published, followed by 2010 with four publications and 1998, 2001, 2009, 2012 and 2017 with three publications.

The following sections show the substantive results of the review. First, we highlight the content of the antecedents of the eight different management accounting practices with focus on 'accounting based control systems', 'business planning' and 'financial statements and reporting'. Thereafter, we show and explain the implications of the adoption of the different management accounting practices with focus on 'business planning' and 'accounting based control systems'.

3.2. Results of the antecedents

This section deals with the antecedents of the adoption of management accounting practices in startups and small companies. The antecedents of this review are seen as the drivers of an adoption in terms of timing and the scope of these practices, methods and systems. They explain the reasons and motives as to why and why not management accounting is adopted. Hence, the results in this section will help to answer our first and second research question.

To summarize, we identified that the firm's characteristics (age and size) drive the adoption of management accounting. An increase of size leads to more decentralized structures and demand systems to delegate decision making throughout the company and to gather (financial) information from the operational level. The professional characteristics of the entrepreneur such as work experience, formal education in the field of management and accounting as well as the personal traits such as willingness to grow, self-efficacy and planning affiliation leads to a faster adoption of management accounting. Environmental factors such as competition and environmental uncertainty force a company to reduce uncertainty to a certain extent using management accounting. External pressure from financiers and venture capitalists has shown to drive management accounting adoption as well as the 'import in effect' of skilled executives, i.e. CFO or professional accountants. The presence of these financial and human capital resources are important prerequisites when adopting management accounting.

3.2.1. Antecedents of accounting based control systems

First, we focus on the factors for the adoption of accounting based control systems. These systems are not named as such but rather found to have different names in the research (management accounting systems (MAS), management con-

Table 4: Absolute Numbers of Hypothesis on Antecedents of Management Accounting

	Entrepreneur's Professional Characteristics	Entrepreneur's Personal Characteristics	Presence of Venture Capitalists	Firm Characteristics	Environmental Factors	Strategy	Prior Performance	Outside Network	Total
Financial Planning	2	0	0	1	0	0	0	0	3
Accounting Based Control Systems	5	0	4	9	3	3	0	1	25
Financial Statements and Reporting	1	1	0	4	1	5	1	3	16
Business Planning	5	3	0	4	4	2	1	1	19
Budgeting	0	0	0	3	1	1	0	0	5
Strategic Use of Information	0	3	0	3	0	0	0	0	6
Costing Methods	0	0	0	0	0	0	2	0	2
Strategic Management (Systems)	1	0	2	1	0	0	0	0	4
Total	14	7	6	24	9	11	4	5	80

Table 5: Absolute Number of Hypotheses on Consequences of Management Accounting

	Performance (Growth)	Subjective performance measure	Survival of the firm	Profit-ability	Entrepreneurial Intensity	Acquiring Financial Resources	Non-Financial Measures	Total
Financial Planning	2	0	0	0	3	0	1	6
Accounting Based Control Systems	11	0	1	8	2	0	1	23
Financial Statement and Reporting	2	0	0	2	0	4	3	11
Business Planning	13	11	11	0	0	8	1	44
Budgeting	1	1	1	0	3	0	2	8
Strategic Use of Information	0	7	3	0	0	0	0	10
Costing Methods	1	0	6	2	0	2	0	11
Strategic Management (Systems)	3	1	0	0	5	0	3	12
Total	33	20	22	12	13	14	11	125

Table 6: Assessing of the Quality of the Construct Definitions

	Explicitly Defined	Inferred from Paper	Equals Measurement	Not Defined	% Total
Antecedent Constructs	42%	18%	34%	5%	23%
Management Accounting Constructs	55%	18%	20%	7%	37%
Consequence Constructs	25%	2%	66%	7%	29%
Moderator/Mediator Constructs	33%	33%	22%	11%	11%
% Total	41%	15%	37%	7%	100%

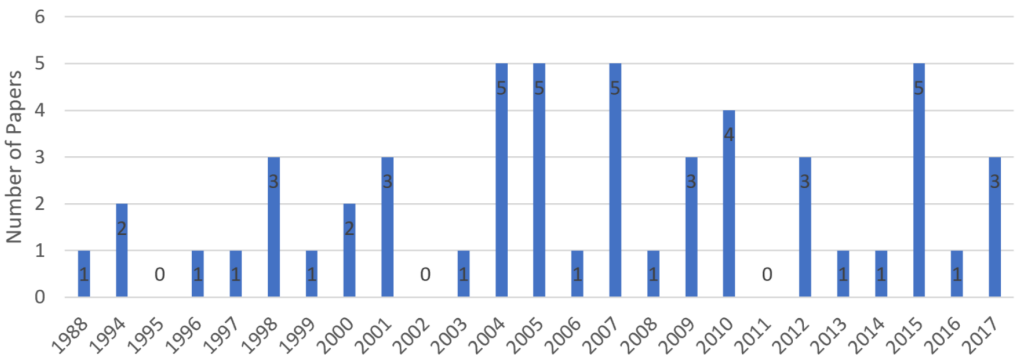

Figure 2: Published Empirical Research on MA in startups

trol systems (MCS) or control systems). These systems consist of a range of "formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities" (Simons, 1994, p. 5).

As motivated in the introduction, larger firms use management accounting to a greater extent than small firms. Our review confirms that the size of a company is an important antecedent of the adoption of accounting based control systems and that a higher number of employees is associated with faster implementation of MAS (Davila and Foster, 2005). The formality of MAS of the company increases as the company strives to reach the "growth stage" (Moores and Yuen, 2001). The life cycle theory is also applied by Granlund and Taipaleenmäki, 2005 to explain the adoption and development of MAS, but they contradict the findings of Moores and Yuen that the firm characteristics alone explain the MAS evolution. The internal complexity increases as the size of a startup increases (Cassia et al., 2005) as well as the sub-unit interdependence (Reid and Smith, 2000). It is proposed that a when a company grows and starts having departments, the need for information and sophisticated accounting systems increases.

The entrepreneur's professional characteristics represent a significant portion of the antecedents. Work experience of the CEO is related to a faster adoption of management accounting systems. This assumption goes hand in hand with the recruitment of an experienced CFO (Davila and Foster, 2005). These systems require a critical amount of knowledge as the implementation involves major changes within a company. Non-founder executive import knowledge and skills in accounting and controlling and thus lead to a faster adoption and use of management accounting systems (Davila and Foster, 2007). Besides that, an established network gained from founding helps the entrepreneur to perform well and hence remain in control of the company (Wasserman, 2017).

External contingencies force a company to adopt management accounting systems (Reid and Smith, 2000). By applying the contingency theory, they refer to cash-flow crises and shortages in funding sources and innovation. Main reason for the adoption is to cope and reduce the costs of the occurring events (Davila et al., 2009; Reid and Smith, 2000).

The lack of resources is a major characteristic of a startup but they are essential for growth prospects. Venture capital financing helps to overcome those shortcomings. An external pressure arises as financiers and venture capitalists (VC) demand factual information processing for controlling and monitoring financial activities (Granlund and Taipaleenmäki, 2005). The presence of venture capitalists leads to faster adoption of cash budgets as part of MAS (Davila and Foster, 2005) and specific monitoring activities by VCs are according to Wijbenga et al. (2007) positively associated with the degree of sophistication of a cost control system. The presence of VC is also positively related to the adoption of incentive and reward systems and its sophistication.

Lastly, the strategy being followed by a company leads to a certain management control system (Sandino, 2007). She particularly finds out that a firm following a low-cost strategy

is more likely to adopt 'Cost MCS[3] and 'Risk MCS'[4]. Companies that follow a differentiation strategy are more likely to implement 'Revenue MCS'[5] and the presence of international operations is associated with faster adoption of MAS (Davila and Foster, 2005).

3.2.2. Antecedents of business planning

This section illustrates the constructs that lead to the preparation of a business plan which in most cases is defined as a "written document that describes the current state and the presupposed future of an organization" (Honig and Karlsson, 2004).

The entrepreneur's personal characteristics, such as self-efficacy and entrepreneurial perseverance are found to be antecedents of business planning (Brinckmann and Kim, 2015). Next to that, greater ability expectations ("expectation of personality efficacy") and commitment ("refers to the entrepreneurs' willingness to exert effort in the venture creation process to make the venture work") are positively associated with a higher intensity of business planning (Hopp and Sonderegger, 2015). The entrepreneur's professional characteristics delivered mixed results. On the one hand, advanced academic education and entrepreneurial experience were positively associated with business planning (Brinckmann et al., 2010; Hopp and Sonderegger, 2015). On the other hand, no empirical support was found that entrepreneurs with a formal business education (Honig and Karlsson, 2004) or managerial experience (Brinckmann et al., 2010) have a greater tendency to create business plans.

Business planning increases with environmental complexity but not with environmental dynamics (Risseeuw and Masurel, 1994) because planning in static environments seems unnecessary and in a dynamic environment impossible. Firm characteristics like an increased professionalism due to the growth in size (Peel and Bridge, 1998) and the achievement orientation within a firm are antecedents for the detail and intensity of business planning (Rauch et al., 2000). Companies that experienced increased performance in the past are more likely to formulate a strategic business plan (Gibson and Cassar, 2005) as well as companies with a higher degree of complexity and variability of the strategies (Piëst, 1994).

3.2.3. Antecedents on financial statements and reporting

Financial statements record the financial activities and position of a company and mostly cover an income statement as well as the balance sheet (Cassar, 2009). Accounting experience (Cassar, 2009), external advice and auditing (Luypaert et al., 2016; McMahon, 1999) drive the quality and a more frequent preparation of financial statements of small firms. Additionally, the financial reporting climate[6] and the development orientation, meaning how forward looking a company is, increase the comprehensiveness of financial reporting (McMahon, 1999). Firm size is negatively related to quality and is explained that larger firms face "more severe agency problems and thus having a greater need for monitoring" (Luypaert et al., 2016). A negative relation to firm's age and filing lag was not found. Consequently, age is not an antecedent for the quality of financial statements. However, increasing competition in combination with a greater number of outside owners leads to a more frequent creation of financial statements in order to make decisions based on accounting information, as stated by Cassar (2009).

3.2.4. Antecedents of budgeting, financial planning and strategic management (systems)

A crucial answer to the first research question can be given here. Budgeting is considered one of the first parts of a management accounting systems to be implemented (Davila and Foster, 2005; Granlund and Taipaleenmäki, 2005). It is mostly defined as "a forward-looking set of numbers which projects the future financial performance of a business, and which is useful for evaluating the financial viability of the business's chosen strategy or deciding whether changes to the over- all plan are required" (Davila and Foster, 2005). The firm size, structure and the strategy are important antecedents for the implementation of budgets (King et al., 2010; Maes et al., 2005). They argue that a "more decentralised structure makes controls more necessary" and that following a low-cost strategy leads to a greater extent of use of budgeting that following a product differentiation strategy. Further, a high market competition drives the adoption of budgets as well (Cassar, 2009; Peel and Bridge, 1998).

Environmental factors delivered mixed results for the antecedents of budgeting practices. On the one hand a perceive stable environment increases the likelihood of the adoption of budgeting (King et al., 2010). On the other hand, Peel and Bridge (1998) measure a positive relation between the environmental turbulence measured in environmental change and the detail of strategic planning, specifically capital budgeting techniques.

Setting up a financial planning and strategic management systems requires human and financial resources. Hence, the educational background, work experience and availability of financial resources drive its adoption (Cassar, 2009; Maes et al., 2005; Mengel and Wouters, 2015).

3.2.5. Antecedents of costing method and strategic use of information

The findings from the previous paragraph also apply to more sophisticated management accounting methods. Activity-based costing (ABC) is a strategic cost management

[3] "Cost MCS focus on enhancing operating efficiencies and minimizing costs", (Sandino, 2007)

[4] "Risk MCS focus on reducing risks and protecting asset integrity", (Sandino, 2007)

[5] "Revenue MCS are introduced to foster growth and be responsive to customers", (Sandino, 2007)

[6] „reflecting how conducive the climate is to financial reporting in terms of financial reporting to financiers, relationships with financiers beyond financial reporting, external scrutiny of financial statements, and the availability of internal financial advice", (McMahon, 1999)

practice to precisely identify, assign or allocate cost to a specific activity (Jänkälä and Silvola, 2012). The researchers examined the prior performance and found that a better prior performance leads to a higher probability of adopting ABC. The financial performance measured in the growth of net sales has a negative relation to the extent of ABC implementation, whereas the financial performance measured using the Return on Investments leads to a positive relation.

The extent of information about R&D projects and the competitors of a small firm depends heavily on the entrepreneur's personal characteristics. A "higher information sensitiveness of his personality", the "willingness to grow" and less working experience lead to an increase of information use. Yet, pessimistic entrepreneurs are more interested in information (Lybaert, 1998).

3.3. Results of consequences

This section focusses on the consequences of management accounting in startups and will help to answer our third and fourth research question. The adoption of management accounting practices promises to offer major benefits that exceed the cost of the implementation. Management accounting practices are substantial for large enterprises for complying with internal regulations, for monitoring costs and expenses, assists in financial planning and budgeting and facilitate and influence decision making. As the implementation is cost intensive, time consuming and requires high skills, the benefits for small companies have been questioned. The consequences found in empirical papers are grouped into performance in terms of growth and subjective measures, profitability, the survival of the firm, the acquisition of financial resources, non-financial measures and entrepreneurial intensity as explained in the 2nd level coding in Table 3.

In summary, the review revealed that startups and small firms that adopt suitable management accounting practices generally benefit from the adoption. They experience better business performance in terms of growth and profitability in the long term. This finding is equivalent that not adopting management accounting was found to increase the likelihood of venture disbanding.

3.3.1. Consequences of business planning

Out of the 18 papers dealing with the performance outcomes of business plans, 13 confirm a general positive correlation, whereas five contradict the total positive implications of planning.

First of all, it is supported that strategic business planning improves the overall business performance of a small firm, as it helps in the context of better decision making (Peel and Bridge, 1998). Besides that, written business planning outcomes and the planning process itself increase the performance in terms of sales and employee growth and profitability because it allows a startup to better manage their limited available resources (Brinckmann et al., 2010; Rauch et al., 2000). Further, it has been suggested that a higher level of planning sophistication leads to an increase in sales (Wijewardena et al., 2004) and is positively related to the subjective performance as well as the profitability (Rue and Ibrahim, 1998). The term planning sophistication is used by researchers to describe the completeness of a planning document and the level of detail. Firms that employ planning on a regular basis will financially outperform others (Bracker et al., 1988; Gibson and Cassar, 2005) or have a general positive effect on venture performance when planning is well-suited to the firm's environment as a highly dynamic environment negatively moderates the relationship between marketing planning and venture performance (Gruber, 2007).

Opposing to the positive implications of business planning, some researcher failed to support the hypotheses posed above (Honig and Samuelsson, 2012; Lange et al., 2007). The authors argue that business planning alone does not lead to improved performance by itself. As the company grows during its operation, business plans that were made in the beginning become useless if not updated. Firms are better off creating general plans or no plans instead of a detailed strategic plan, especially when the environment is highly uncertain. Hence, the "use of a structured plan is either useless or even counterproductive" (Risseeuw and Masurel, 1994).

Despite the fact, that a more sophisticated plan leads to an increased performance, several authors suggest to only establishing basic plans (Brinckmann et al., 2010; Lange et al., 2007; Risseeuw and Masurel, 1994). Reason for this is that the positive effect of sophistication is greater in established firms due to the high uncertainty in the startup's environment (Brinckmann et al., 2010) and that limited time available would be better used in the value creation during the startup phase as it might be detrimental to a company when the costs might exceed the benefits in the short run (Maes et al., 2005).

Multiple empirical results show that business planning decreases the likelihood of company failure (Borges et al., 2013; Brinckmann et al., 2010; Delmar and Shane, 2003, 2004; Perry, 2001; Shane and Delmar, 2004). The time invested in such activities will have positive implications as it makes the startup appear legitimate to outside stakeholders (Delmar and Shane, 2004), increases the intensity of other entrepreneurial activities increases (Davila et al., 2009; Shane and Delmar, 2004) and provides information for preventing making bad decisions (Borges et al., 2013) of which the timing (Hopp and Sonderegger, 2015) and content (Delmar and Shane, 2003) are crucial for startups' survival. Only one study failed to support a positive relationship between planning and survival of the firm (Honig and Karlsson, 2004). Lastly, business plans failed to be positive associated with the acquisition of financial resources (Borges et al., 2013; Kirsch et al., 2009), concluding that business planning documents only "serve a limited ceremonial role" (Kirsch et al., 2009).

3.3.2. Consequences of accounting based control systems

The review of the empirical literature clearly shows that the implementation of cost control or accounting control contributes to a small firm's performance (Ahire and Golhar, 1996; Davila and Foster, 2007; Roper, 1997; Sandino, 2007;

Voss and Brettel, 2014; Wijbenga et al., 2007; Wijewardena et al., 2004). However, multiple moderators relating to the firm characteristics influence the findings. A good fit between the strategy and management accounting systems is essential to an improved performance in terms of growth because those systems then gain usefulness (Sandino, 2007). VC service activities positively moderate and VC monitoring activities negatively influence sales growth and profitability (Wijbenga et al., 2007). Besides that, the adoption of MCS has a positive influence on the tenure of the CEO as well as on employee growth (Davila and Foster, 2007). These system further accelerate business growth (Roper, 1997). But not only the mere existence leads to improved performance. Also the sophistication of the control systems such as budget variance analyses shows positive effects on sales growth (Wijewardena et al., 2004).

Davila and Foster (2005) discover that MCS lead to a higher valuation of the company because "financiers of startup companies believe formal MCSs lead to better decisions or that they signal firm quality and future growth potential". Still, when a founder remains in control as the startups growth it causes a negative effect for the valuation of the company (Wasserman, 2017).

Furthermore , Ahire and Golhar (1996) focus on the concept of total quality management (TQM). Satisfying customer is crucial for small companies for its survival especially in the manufacturing sector. The adoption of quality control empirically shows an improved product quality and other types of control namely output control, behaviour control and professional control drive the firm's performance (Voss and Brettel, 2014).

3.3.3. Consequences of the costing methods, financial planning and budgeting

The costing method, chosen by startup as well as the implementation of systems for an efficient and effective deployment of financial resources have a positive impact on the future performance. Hence, the adoption of the strategic costing method like activity based costing leads to a direct increase of performance in terms of sales growth (Jänkälä and Silvola, 2012). Choosing either a real option reasoning approach[7] or the net present value[8] approach in planning makes a difference concerning the company's success (Hayward et al., 2017). ROR leads to a greater innovation output than the NPV orientation because it provides a more realistic view on the investment and flexible alteration of actions. Through the usage of financial planning, the performance in terms of growth can be improved (Mengel and Wouters, 2015; Wijewardena et al., 2004), although the preparation of projected financial statements leads to overly optimistic forecasts in regard to venture sales (Cassar, 2010) as it might "encourage the nascent entrepreneur to adopt an inside view in regard to the financial performance of the venture, resulting in overly optimistic financial expectations".

Budget preparation is found to be a driver for a better forecast accuracy (Cassar and Gibson, 2008) and performance growth (Davila and Foster, 2005; King et al., 2010) as it assists in predicting changes in future growth even in a setting of greater uncertainty.

3.3.4. Consequences of financial statements and reporting

Startups experience an increase of their performance in terms of sales when preparing a financial statement more frequently (Cassar, 2009) and additional firm value when applying cash flow measures (Black, 2003). It further helps the firm to improve accuracy in the revenue forecast as they show less absolute forecast errors than firms without (Cassar and Gibson, 2008). A more detailed financial statement helps a company to reduce leverage[9] (Van Caneghem and Van Campenhout, 2012) but besides the elaborateness, the quality also matters and leads to lower leverage. This sophistication of the financial statement can be achieved using accrual accounting (Cassar et al., 2015) which has a favourable effect on the cost of debt[10], but not on the probability of access to loan (Vander Bauwhede et al., 2015). Despite those positive prospects of creating a financial statement, the positive effects are greater in larger companies (McMahon, 2001).

3.3.5. Consequences of strategic management (systems) and strategic use of information

The use of a balanced scorecard (BSC) as a strategic management system promotes growth, assists to track performance, to provide focus, to align with goals, gain goal clarity and accountability (Gumbus and Lussier, 2006). This shows that the adoption of the balanced scorecard not only affects financial implications for a firm. Yet, the use of BSC increases the financial performance measured change in sales per employee and perceived performance, as well as profitability measured with the ROA (Malagueño et al., 2018). Better exploitative innovation is another consequence that the BSC enhances. Contrary to the authors expectations the BSC is not negatively associated with the exploratory innovation. Taking these two consequences together, the results suggest that "the use of BSC for feedforward control helps organizations to be more efficient in their ability to develop exploitative innovations without reducing exploratory innovations." However, more established profit even more from the use of BSC in terms of the financial performance.

The a priori screening of clients and gathering non-financial information of secondary information have positive performance implications in terms of survival (Maes et al., 2005). Gathering secondary information has according to Gruber (2007) a positive subjective performance implication. In particular, the use of information about market and

[7] ROR orientation applies option valuation techniques to capital budgeting decision wherein the real option is the right rather than the obligation to undertake a project.

[8] NPV analysis measures the present value of project cash flows.

[9] Total liabilites devided by total assets

[10] explains the initial interest rate on approved loans

external information about competitors influences the expected (subjectively measured) performance of a startup for the upcoming years (Lybaert, 1998).

4. Discussion

The analysis of 53 papers has provided interesting and meaningful aspects in field of management accounting in startups which we want to highlight in this section.

Major finding in terms of the antecedents is that size, concomitant with higher complexity, is the most notible factor for the adoption of management accounting. The remaining issue is the trade-off between time spent on 'organisational' activities and 'value creation' activities because little is known about the 'perfect timing' for the implementation of formal management acccounting. The review shows that larger firms not only adopt management accounting to a greater extent but also benefit more from the adoption (King et al., 2010; Davila and Foster, 2005, Davila and Foster, 2007; Cassia et al., 2005). This finding aligns with the review of Lavia López and Hiebl (2014). However, early implementation has significant benefits and is proposed by many researchers in order to promote the infrastructure for growth. As to what hinders startups to implement management accounting, we found that the financial and human capital resources explain this to reasonable extent. Interestingly, the findings of Jänkälä and Silvola (2012) and Mengel and Wouters (2015) are in contrast to their expectations and show that scarce financial resources are not a driver of the adoption of management accounting but decrease the likelihood of implementing systems to manage scarce resources.

To what drives a startup to adopt management accounting, professional expertise and accounting skills are antecedents for a faster adoption because it was shown that management accounting professionalizes a startup. Hence, it requires trained staff to customize the systems to the company's characteristics and needs and the willingness to execute controlling and monitoring processes in a sophisticated manner in order to profit from it.

However, the conflict about benefits of business planning remains. We found more benefits of the creation of business plans and even sophisticated planning. As a consequence, startups should put effort into their planning because it helps to make decisions based on a more accurate and precise information basis. As every decision in the startup phase is crucial for the survival of the firm, they should take the time to plan, even if constraints only allow basic planning. However, business plans do not facilitate the acquisition of financial resources, as to why the planning of startups should be primarily serve internal purposes. The implementation of business and financial plans as well as budgets alone does not lead to improved performance by its own. The matching with the business's strategy and environment is key for enabling company success. This result is also supported by the findings of the moderators and mediators as shown in the appendices. The moderators 'firm characteristics' and 'contingences' play a significant role for the relationship between management accounting and its consequence constructs.

Our study shows that budgeting is one of the first management accounting practices to be implemented in a small firm. This allows the company to better manage their scarce financial resources which turned out to drive the company performance. However, the measures for company performance vary heavily and make a comparison of the different research difficult. It is worth noting that success measures are different from measuring survival. Not to fail as a startup is certainly positive, yet, it does not mean that it is successful. Our study has shown that the differentiation between the performance measures is important in order to compare the studies. Nevertheless, the heterogeneous samples with a relatively wide range of size makes comparisons more complicated. We examined nascent entrepreneurs that were just about to launch their business and others that were small, but in business for years.

A critical aspect in accumulating and synthesizing the findings of management accounting practices is that the definition of MCS, MAS, and especially business plans is not clearly given in a reasonable amount of papers. This recognition supports an already observed problem (Bisbe et al., 2007). Most authors draw upon the definition of Simons (1994) for MCS, which delivers a very broad explanation. This in some cases is unsatisfactory because MCS consists of a wide range of tools and practices that need to be distinguished.

Reviewing our methodology, we need to be critical with our chosen keywords. The keyword search yielded a scope that was overwhelming and time consuming to manage. On the basis that we excluded almost 90 % of the papers, we would propose to restrict the search to fewer words and focus on the forward and backword reference search. It also showed that empirical research in this particular field of research is still scant and multiple closely related topics are studied to a greater extent.

5. Conclusion

The goal of this systematic literature review was to draw a precise overview of the empirical literature on management accounting practices in startups and young companies. We focused on the antecedents and consequences of management accounting to get insights of the drivers and reasons for the adoption of management accounting as well as its implications for the startup. The review was conducted according to the guideline of Tranfield et al. (2003) and revealed evidence that startups generally benefit from the use of management accounting. This understanding evolves from the analysis of the hypotheses that were empirically tested. Subsequently, we categorized the constructs into a 2nd level coding in order to condense similar constructs. By this attempt we were able to offer a comprehensively view on the relationship of the antecedents and management accounting as well as on the link between management accounting and its implications.

The use of management accounting is generally found in large and established companies and offers considerable benefits for them. However, small firms with limited time, financial and human resources and their informal communication and information flows and an aspiration for innovation might suffer disadvantages because management accounting seems not applicable for them and their uncertain environment. However, there are good reasons as to why management accounting paradoxically help entrepreneurship. This review confirms this assumption made by some authors and further indicates the different drivers and implications of management accounting.

We identified that the firm's characteristics such as age and size drive the adoption of management accounting. The professional characteristics of the entrepreneur such as work experience, formal education in the field of management and accounting as well as the personal traits such as willingness to grow, self-efficacy, planning affiliation leads to a faster adoption of management accounting. Environmental factors such as competition and environmental uncertainty force a company to reduce uncertainty to a certain extent. External pressure from financiers and venture capitalists has shown to drive management accounting adoption as well as the "import in effect" of skilled executives, i.e. CFO or professional accountants. The presence of these financial and human capital resources are important prerequisites when adopting management accounting.

Further, the review revealed that startups and small firms that adopt suitable management accounting practices generally benefit from the adoption. They experience better business performance in terms of growth and profitability in the long term. This finding is equivalent that not adopting management accounting was found to increase the likelihood of venture disbanding.

Our study contributes to the research of management accounting in young and small firms. It helps to assess the decision making of whether a startup should or should not implement MAS and to understand and reduce startup failure as consequence of not adopting management accounting.

The review contains some limitations that need to be considered. Contrary to the suggestion of Briner and Denyer (2012), we did not look into "grey literature" but only focussed on journals with the best reputation. Also, we only considered empirical studies. Other theoretical papers, case studies or exploratory studies as well as other well ranked journals might have broadened the scope and give more insights. In these limitations lies the avenue for further research.

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Corporate Social Responsibility: A Qualitative Analysis on the Strategy Formulation Process

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Abstract

The urge for firms to contribute positively towards the society and the environment is increasing significantly. Demands of employees, customers, governments, NGOs and many more are putting firms under pressure to respond accordingly. Thus, it is vital for firms nowadays to formulate effective corporate social responsibility (CSR) strategies which provide guidelines for the firm's commitment towards the challenges of the society and environment. Plenty of research exists on the components of CSR strategy formulation, particularly regarding stakeholders, organizational vision and the CEO's influence. However, it is important to consider the whole process of the strategy formulation and to link the components together. By means of a qualitative analytical approach, I show that the internal input provided by the CEO and the CSR team plays an important role in deciding on certain CSR initiatives. Furthermore, the strategic fit between the potential CSR issues and the core business is a significant criterion. Through assessing the potential value creation, and thus the expected impact scope, prioritizations of CSR issues take place. The continuous monitoring and evaluation of the stakeholders' needs form an iterative process which leads to a constantly changing CSR strategy focus of the firm. My aim in this paper is to contribute to the understanding of CSR strategy formulation through a CSR strategy formulation process model. The model provides insights into firms' CSR strategy formulation from which I derive implications for management and further research.

Keywords: Corporate Social Responsibility, Strategy Formulation, Sustainability

1. Introduction

Constituting a key part of General Electric's business strategy, the Ecomagination initiative is a good example of a response to external pressures concerning the environment (Chesbrough, 2012; Dowling and Moran, 2012). Described as "a corporate-wide commitment to help customers meet their environmental challenges in ways that also benefit GE and the world" (GE, 2005: 9) the Ecomagination initiative was formulated using input from GE's stakeholders (Spitzeck and Hansen, 2010).

Practical relevance and theoretical research on the concept of Corporate Social Responsibility have tremendously increased in the last decades (Heli et al., 2016). Ongoing concerns and thus pressures from the external and internal environment of the company have raised the need for the management to take responsibility for the society and the environment. Responsible behavior of businesses nowadays is not limited to maximizing profits but includes contributing positively to the world (Heli et al., 2016). As the focus on CSR has shifted from debating whether a firm should engage in such practices to how the firm should do so, considerable attention is paid to the firms' specific CSR strategies (Smith, 2003). The Ecomagination initiative by GE is often mentioned as an example when discussing CSR strategies. It was intended to increase GE's use of green and renewable energy and thus relates to the firm's business operations and stakeholder demands simultaneously (Chesbrough, 2012; Dowling and Moran, 2012).

Paying attention to the stakeholders and the environment of the firm is not only morally correct but also accounts for increased employee commitment, customer satisfaction and an improved financial performance (McGuire et al., 1988). Thus, the handling of CSR as a side-line commitment became insufficient. However, CSR engagement is not only accompanied by positive effects. Being judged for engaging in CSR activities only in order to use it in marketing campaigns or for green-washing the firm's operations can reduce the expected impact considerably (Banerjee, 2008; Smith, 2003). Concluding, it seems reasonable that firms pay considerable attention to the formulation of their CSR strategies. Herein

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the respective strategies should not only peripherally address CSR issues but constitute the firm's activities in such a way to have an actual impact (Porter and Kramer, 2006). Researchers have already expressed the lack of clearly formulated, effective CSR strategies (McElhaney, 2009). In fact, sustainability reports or codes of conduct often seem like a rather diffuse set of CSR attempts mostly unrelated to the firm's core business (Galbreath, 2009). Thus, the strategies fail to pursue their underlying reason; to align the commitments towards society to the business's operations and purpose (Rangan et al., 2015). Yang et al. (2013) identified the prioritization and tackling of CSR issues by firms as a difficult challenge. Firms are faced with a myriad of potential issues to address, such as improved workplace amenities, non-animal-tested ingredients or proactive environmental practices (McWilliams and Siegel, 2001). Identifying the issues which are most relevant to the firm but also generate maximum value to society and environment exposes the firm to important decisions (Yang et al., 2013).

Literature on the constituents of CSR strategy formulation has particularly addressed stakeholder perspectives (Basu and Palazzo, 2008). Bundy et al. (2013) showed how management responds to issues put forward by stakeholders instead of focusing merely on stakeholder prioritization, as done by the majority of the existing literature. The scholars state that the management and response of firms to stakeholder demands depend significantly on the salience of the stakeholder issue. Another research field relating to CSR strategy formulation addresses the influence of CEO values on CSR strategy, describing how the CEO's personal values and ideologies might change the CSR approach of the firm (e.g. Adams et al., 2011; Chin et al., 2013; Hambrick and Mason, 1984). However, studies on the particular topic of CSR strategy formulation have been sparse. Literature addressing the CSR strategy formulation has mainly discussed the components that play a role when formulating the strategy (e.g. Galbreath, 2009; Husted and Allen, 2001; Husted and Allen, 2007; Mostardeiro, 2007; Smith, 2003). Through approaching CSR strategically and thus considering stakeholders, organizational values and organizational fit, firms can form a proactive CSR strategy (Galbreath, 2009; Husted and Allen, 2007; Mostardeiro, 2007).

Even though the important constituents regarding the CSR strategy formulation have been discussed rather extensively, only a few studies in the management literature exist that take into account several influences on this process. In an attempt to fill this research gap, my study addresses the question: How do firms formulate their CSR strategy and what influences their decisions when formulating the strategy? Using an inductive analytical approach, I conducted expert interviews with CSR managers of different firms. Aiming for qualitative rigor in the analysis of the interviews, I explored the stakeholder and individual-level inputs used by firms to form their strategy whilst considering influences such as core business relation. Thus, this paper contributes to the existing literature with a model of the CSR strategy formulation process, demonstrating how firms set their CSR strategy focus.

2. Theoretical Background

For many years organizational scholars have been trying to agree on one definition for CSR (Carroll et al., 1991). However, CSR is hard to specify due to being a dynamic, ever-changing and country-specific concept (Holme and Watts, 2000; McWilliams, 2000). An example for a broad definition of the concept is "business firms contributing in a positive way to society by going beyond a narrow focus on profit maximization" (McWilliams, 2000: 1). The overlap with other related concepts or synonymous business-society concepts such as corporate sustainability and corporate citizenship further complicates the definition of CSR (Matten and Crane, 2005; Matten and Moon, 2008). Since many scholars sum up those overlapping concepts as CSR, I will also address all related concepts as CSR to provide a consistent terminology (e.g. Garriga and Melé, 2004; Matten and Moon, 2008). According to Waldman and Siegel (2008) a firm's decision on whether to engage in CSR should be handled as a strategic choice. Among many different perspectives of strategy, Mintzberg (1978) defined strategy as a pattern in a stream of decisions, stating that strategies can be formulated as deliberate strategies from the top-management but also emerge on an unplanned level from lower-level employees. Herein the question comes up which decisions play a role in the development of a CSR strategy. In contrast to the general business strategy, the CSR strategy differentiates itself in aspects such as consideration of stakeholder demands and influence of values (Galbreath, 2009; Husted and Allen, 2001, 2007; Mostardeiro, 2007; Smith, 2003). Additionally, balancing the strategy with the strategic vision and mission of the firm is very complex (Galbreath, 2009; Smith, 2003). The following sections examine the literature on these aspects carefully in order to prepare the background for the research in this paper.

2.1. Stakeholder Input

Freeman (1984) already articulated the relevance of addressing the demands and needs of a firm's stakeholders through the concept of stakeholder theory. The scholar defined stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984: 46) and without which the firm would not be able to survive (Freeman, 1984). With numerous scholars trying to specify the scope of stakeholder groups, ranging from employees, customers, suppliers and shareholders to public and non-profit organizations, there is a consensus on the vagueness of stakeholder definitions (Clarkson, 1995). Nevertheless, stakeholder theory has played a significant part in the strategic management literature during the last decades. While Clarkson (1995) described the importance of balancing out the distribution of value creation among stakeholders, Mitchell et al. (1997) proposed that stakeholder groups should be prioritized based on the legitimacy, power and the urgency of their

claims. Stakeholder-related literature addresses all types of issues: identifying who stakeholders are, the importance of addressing stakeholders, distribution of attention towards stakeholder groups and many more (Donaldson and Preston, 1995; Wood, 1991). While stakeholder theory is also treated as a general strategic management issue it is regarded as especially relevant in the context of CSR (Campbell, 2007). Therefore the next sections address the relevance of stakeholder input to CSR.

2.1.1. Stakeholder theory in the CSR context

Solely the definition of CSR as "businesses bearing a responsibility to society and a broader set of stakeholders beyond its shareholders" (Heli et al., 2016: 534) demonstrates a relation between stakeholders and CSR. Basu and Palazzo (2008) identified that a main part of the CSR literature classifies CSR as stakeholder-driven. CSR acts as a response to the demands of the firm's stakeholders regarding its business transactions and social commitments (Basu and Palazzo, 2008). Thus, a significant reason why firms get involved in CSR is the pressure from stakeholders (Campbell, 2007; McWilliams and Siegel, 2001). CSR defines the appropriate behavior of firms towards their stakeholders and hence stakeholder management is a necessary but not sufficient condition to successfully integrate CSR in the firm (Campbell, 2007; Matten et al., 2003).

2.1.2. Stakeholder input in CSR strategic decision-making

Stakeholder influence on corporate decision-making has been proven several times (Clarkson, 1995; Freeman, 1984). Depending on the importance or salience regarding the power, legitimacy and urgency, the stakeholder will have an influence on the strategy of the firm (Mitchell et al., 1997). With regard to this pressure and the power of stakeholders over firms, stakeholder management has become a significant research field (Laplume et al., 2008). One part of effectively managing stakeholders is the dialogue with them, described as the "involvement of stakeholders in the decision-making processes that concern social and environmental issues" (Pedersen, 2006: 140). This dialogue accounts for the main exchange of CSR related issues between the firm and its stakeholders and therefore plays a crucial part in developing CSR (O'riordan and Fairbrass, 2008). Whilst literature on stakeholder dialogues is quite extensive, it merely focuses on the interchange of demands and issues between the two parties. Limited research has been spent on the phase after this exchange, namely how the exchanged information is processed and handled within the firm (Bundy et al., 2013; Wood, 1991). Bundy et al. (2013) addressed this research gap through the concept of issue salience as the "degree to which a stakeholder issue resonates with and is prioritized by management" (Bundy et al., 2013: 352). In the hereby developed framework, the relationship of the issue to the firm's strategic frame and organizational identity shapes the way managers evaluate it (Bundy et al., 2013). Even though this paper contributes to the existing research in this field, literature regarding this particular process in CSR strategy formulation is missing. As already identified, stakeholder theory is the essence of CSR (Watts and Holme, 2000); therefore it should be researched embedded in the CSR context in order to find out which other aspects influence the decision of CSR management when prioritizing a certain stakeholder issue.

2.2. Internal Input on the Individual-Level

Stakeholder theory and decision-making is often researched on the organizational-level (Bundy et al., 2013). However, the individuals within the firm making the decisions and evaluating strategic actions play an important role in the process and should therefore be considered as well (Adams et al., 2011). In this section I review the literature on the role of the CEO as the person with the final say on any strategic decision and the CSR team preparing the groundwork for it.

2.2.1. CEO influence

The influence of the top management's values on strategic decisions has already been introduced by Hambrick and Mason, 1984. Managers' values have been found to moderate the stakeholder salience function and partially mediate the relationship between a firm's resources and corporate giving (Agle et al., 1999; Buchholtz et al., 1999; Mitchell et al., 1997). Thus the question about the exact role of the CEO's attributes in stakeholder theory is a major concern.

The values of CEOs influence their behavior and accordingly have a huge impact on the firm's operations (Simsek et al., 2005). Most leaders will adhere to their principles when making decisions, subsequently the strategic decisions made in firms are not only shaped by external injections but also by the director's beliefs and goals (Adams et al., 2011). In the CSR context this CEO influence plays a crucial role because some initiatives in CSR might not be linked directly to the firm, therefore other aspects must play a role in deciding on them (Buchholtz et al., 1999). Several other scholars have discovered similar findings concerning the impact of top managers' values on CSR decision-making (e.g. Godos-Díez et al., 2011; Huang, 2013; Waldman and Siegel, 2008). However, in many of those papers the focus is only on the influence of CEO values without considering other attributes such as organizational vision. Therefore an interesting examination would be, how the impact of CEO values on CSR decision-making interacts with other influences in the CSR strategy formulation. It can be concluded that even though some literature exists in this individual-level field of research many aspects remain unclear, which might be due to the fact that values and correspondingly personal preferences are hard to observe (Adams et al., 2011; Chin et al., 2013).

2.2.2. CSR team influence

Employees are often mentioned as one of the most important stakeholder groups (Berman et al., 1999). Thus, the CSR team which is responsible for defining and implementing the CSR strategy throughout the firm, has a significant

influence in its role as internal stakeholder and contributor to the firm's CSR practices (Mittal et al., 2008). Especially in large firms the position of the "head of CSR", leading a CSR team and directly reporting to the CEO of the firm, is common nowadays (Strand, 2013). Therefore, according to van Doorn and Reimer (2016) it is important to differentiate between the CEO of the firm and the top-management's team members when formulating a CSR strategy. Though the two parties are closely related, differences in the interactions exist (van Doorn and Reimer, 2016). Although most of the research on the individual-level relates to the CEO influences on CSR, some of these aspects can be reflected onto the CSR team members. It is said that generally on an organizational-level the cultural norms affect the attitudes towards CSR which might show when the CSR team tackles specific chosen projects together (Angus-Leppan et al., 2010; Sharp and Zaidman, 2010). However, organizational literature on the influence of the CSR team on the strategy formulation is rare. Thus, the question about the impact of the team in CSR strategy making seems adequate.

2.3. Organizational Vision in Strategy Formulation

Another aspect that influences a firm's strategy is its organizational vision. Organizational vision is a concept without a generally agreed upon definition (Larwood et al., 1995). A broad definition provided by Collins and Porras (1991) is that "vision consists of two major components – a guiding philosophy that, in the context of expected future environments, leads to a tangible image" (Collins and Porras, 1991: 33). Further confusion about vision exists because of overlapping concepts such as vision, mission and values (Collins and Porras, 1991). While a vision is mostly formulated in the mission statement of an organization, many organizational members use those terms interchangeably (Collins and Porras, 1991). During strategic planning all of the goals and activities developed should be derived from the vision of the firm, thus having a clear strategic vision is often mentioned as a mature premise of strategy formulation (Collins and Porras, 1991; Langley, 1988). Therefore it seems reasonable that an organization's vision also shapes the CSR strategy formulation process. Aligning the CSR program to the values, norms and mission of the firms and hence incorporating what the firm is trying to achieve in the long-term is essential for a successful CSR approach (Galbreath, 2009; Maon et al., 2009). Burke and Logsdon (1996) named this "centrality", a measurement of the fit between a CSR program and the firm's mission and goals. It allows the firm to decide whether a given CSR initiative is consistent with the firm's mission or vision (Burke and Logsdon, 1996). Another important aspect in this context is that some firms even have CSR stated as their fundamental purpose (Galbreath, 2009). In both cases, the balance between CSR and strategic vision or mission of a firm has to be taken into account when formulating a strategy and consequently the question of the exact role of strategic vision in CSR strategy formation comes up (Galbreath, 2009).

3. Methodology

In order to investigate the process companies undertake in CSR strategy formulation, I undertook a qualitative empirical study. Qualitative studies are especially useful and adequate approaches when studying dynamic processes such as strategy formulation (Maitlis, 2005). The following section explains the researched content, demonstrates the study sampling and design and describes the analytical approach following the data gathering.

3.1. Research Content

The subject of this research revolved around the formulation process of CSR strategies. The leading question of this study was: Which aspects influence the strategy formulation of a firm's CSR strategy? I wanted to find out why certain CSR topics are considered in the strategy of a firm and why others are neglected.

To investigate which processes underlie this question, I conducted interviews with ten CSR managers of different firms. Some of the interviewees are head of a distinct CSR department, whereas others are linked directly to the top management and work with a task force of representatives from different divisions. Furthermore two of the ten firms have completely unified their CSR and general business strategy, in contrast to the other eight firms where the CSR strategy is a separate formulated strategy. All of the firms comply with the Global Reporting Initiative in their sustainability reporting measures, thus the content of the sustainability reports has to adhere to the principles of materiality, sustainability context, stakeholder inclusiveness and completeness (GRI, 2011). An overview of the experts interviewed can be found in the appendix A; however the names have been changed to provide anonymity.

3.2. Qualitative Study Samplings and Design

To gain an in-depth view of the researched content I chose purposeful sampling as the sampling strategy. According to Patton (1990) purposeful sampling is especially valuable in the context of information-rich subjects. In this sampling technique the researcher chooses specifically who could give him or her deep insight into the subject. This explains why I chose to interview CSR managers as they have the main responsibility when it comes to formulating the CSR strategy. They are the cross-cutting link among all the departments regarding the CSR activities of the firm and are in close contact with the top management which supplements their key role in the CSR strategy formulation. Another element of purposefully selecting the interviewees was the extent of the firm's CSR activities. Two basic criteria's dominated the decision of contacting a specific firm. They either had a lot of information on their website in the CSR rubric or they had already been awarded for their CSR efforts. I then contacted the firms via email explaining my research intention and why the firm should be a part of my research.

All interviews were conducted via telephone and took approximately 25 minutes. The interview protocol was a

semi-structured questionnaire providing the possibility for an adaptable question sequence with all topics being discussed at some point. The questionnaire was constructed using three general topics with each containing several questions. The main question regarding the CSR strategy formulation was very broadly formulated, allowing the interviewees to elaborate on the topic. Books about the appropriate structuring of interview questionnaires were used to ensure high quality outcomes (e.g. Gläser and Laudel, 2010). The detailed interview questionnaire is shown in the appendix B. As the research followed a qualitative study design with inductive reasoning, I limited my literature research prior to the conduction of the interviews in order to avoid biased beliefs about concepts.

3.3. Analytical Approach

According to Ketokivi and Mantere (2010) the use of credible and understandable ways in inductive reasoning is one of the major problems in qualitative research. Considering this difficulty, I aimed for qualitative rigor in my analytical approach. In order to ensure a high standard of rigor but still being able to discover new concepts I followed the approach of Gioia et al. (2013). The authors point out that using their systematized inductive method helps to achieve plausible interpretations of data on the essence of organizational dynamics (Gioia et al., 2013). The method is built upon three basic assumptions: The world is socially constructed, the interviewees are "knowledgeable agents" whose explanations are a correct reflection of their thoughts and actions and the researchers are also "knowledgeable agents" who are capable of analyzing the data (Gioia et al., 2013).

After fully transcribing all of the interviews, I reviewed the transcripts and roughly marked the relevant parts. Thereafter I thoroughly analyzed the content searching for words and phrases related to my research question and then coding those parts using informant-terms through in-vivo coding and 1st-order codes as advised by Gioia et al. (2013). In this first-order coding I ended up with twenty-five codes, which I examined for similarities and discrepancies to summarize those into categories for the 2nd-order analysis. The 2nd-order analysis produced eleven topics which I grouped further into four aggregate dimensions. The whole coding process can be reviewed in the data structure as established by Gioia et al. (2013) in the appendix C. After obtaining the data structure I analyzed the content further through browsing for relations between the 2nd-order codes which resulted in the conceptual model shown and explained in the next chapter.

4. Findings

During the conduction of the expert interviews I talked to managers of departments such as CSR, sustainability, corporate citizenship and corporate responsibility. Answers to the question about the scope of the firm's corporate responsibility ranged from the three pillars of economical, ecological and social aspects to explicit examples such as fair labor conditions, transparency, corruption prevention, quality issues and human rights. After discussing the structural circumstances in which the interviewee is working, the questions focused on the strategy formulation process of the firm. In the following sections I analyze the interview contents closely through explaining and summarizing the statements of the interviewees and underpinning it with examples of specific citations. They are structured according to the 2nd order themes, first showing the antecedents of the model and then the consequential process. Further citations which are not displayed in the text can be found in the appendix D.

4.1. Antecedents

It became clear in the interviews that some aspects are generally mentioned first when asking about the formulation of the CSR strategy in the respective firms. Thus the following chapters explain those antecedents.

4.1.1. Stakeholder input

All interviewees indicated that they include stakeholders in their CSR strategy formulation. Mentioned stakeholders included but were not limited to customers, employees, business partners, NGOs, neighbors, and investors. Due to the variety of the stakeholder groups they have to be prioritized based on their impact on the firm or the firm's impact on them. The consideration of stakeholders was mentioned as one of the most important aspects of defining a CSR program. This stakeholder perspective allows the firm's CSR initiatives to gain a wide acceptance. The stakeholders on the other side anticipate that the companies' contribution to their life is not limited to products and services.

> "And we don't only have values, we also have a purpose. Yes, we defined a purpose for us. That means, what are we here for as a firm? And that is 'to be essential'. And being essential only has a meaning, if someone else says 'you're essential to me'. I can never claim I am essential based on my perspective. Well, I could but it doesn't mean anything. It is this particular external view which plays a role and which is really a 360 degrees perspective. And this basically involves everyone, customers, business partners, local communities, and citizen, really everyone." (Interviewee 1, High Tech)

Considering stakeholders makes sure that the CSR initiatives cater to everyone's needs. As mentioned by the CSR manager of Force One, "if your only concerned with your own issues, [...], the outcome won't be the best. Other external perspectives should be taken into account as well." (Interviewee 10, Force One). Surveys to customers, employees and others are sent out on a regular basis to find out which topics are relevant to the stakeholders. The concerns, ideas and

thoughts from the stakeholders are used as input for potential CSR programs or focal points which the firm wants to set.

> "Well you can't just say 'Okay, well, for us as a firm the issue water is especially significant.' You rather have to show that this issue is actually significant according to your customer groups and your whole environment." (Interviewee 2, Smart Living)

Consequently, including stakeholders in the process of defining a CSR strategy serves as a crucial idea generator while ensuring that the CSR programs have a stakeholder perspective and will meet the demands of the stakeholders. However, the firms cannot deal with all of the concerns at the same time. Therefore the stakeholder input is seen as an antecedent to the underlying, dynamic process happening in the firm.

4.1.2. Internal input

Next to the input gathered from stakeholders, it became apparent that the CSR team is a significant driver of developing the CSR strategy. The interviewees stated several times that it is their job as CSR managers to identify new topics and to foresee issues that could become relevant soon. Many impulses arise through the identification of the current status of the firm's CSR strategy and brainstorming about further development. During this process the influences of the firm on the environment and society are evaluated, determining the scope of the responsibility of the firm. The following quote shows that next to surveying stakeholders it is also the job of the CSR team to identify the potential issues and develop further actions.

> "And if it's about particular issues, then we, the CSR team often bring new impulses into the firm. That among other things is my job, to gain an overview of what's happening in the world and what we could do to improve the circumstances. So, basically how can we realize our responsibility, what can we contribute." (Interviewee 10, Force One)

The interviewees stressed the importance of the CEO's personal preferences concerning the social commitment of the company. This can be traced back to the CEO's personal interest in the firm's CSR contribution and furthermore his or her interest in certain topics. It can be said that the CEO has an impact on the CSR team in setting the general direction of the strategy but also on the evaluation process when it comes to prioritizing CSR issues. The representative from Force One argued that some initiatives are not directly related to the firm but chosen because they are "closer related to the fact that our CEO is very involved in sports and personally interested and is very committed to social issues." (Interviewee 10, Force One). Another aspect mentioned was the commitment of the CEO as the most important driving force for the development and the successful implementation of a CSR strategy.

> "And you need this long-term orientation of the firm, and the CEO really has to believe in it. If you have this in the background, and that's really the case here, our CEO is the strongest sustainability driver which we have in the firm. That's worth a lot. If you don't have that, then it can quickly become a fight against windmills." (Interviewee 6, Light It Up)

This chapter shows that internal perspectives and impulses play a significant role in the CSR strategy. As it is the job of the CSR team to foresee potential problems and issues, impulses are not only assembled externally. Additionally the personal preferences of the CEO shape the way CSR is approached in the firm.

4.1.3. Strategic vision and values

When setting the focus on a certain CSR strategy, the firm's vision and values are used to define the strategy. The findings of the interviews prove that the firms' vision and values, outlined in the general business strategy, have a strong impact on the CSR strategy. In most cases the CSR strategy derives from the general strategy of the company or is completely incorporated into the general strategic vision. Therefore CSR initiatives are considered as part of the strategic decisions of a company.

> "Yes, we have a firm vision, [...]. And yes, we form all strategies in line with it. And we derived a CSR strategy from it. But there is not a one or a single CSR strategy phrase, but instead we defined action fields and focus points. (Interviewee 3, Square 46)

Moreover, the values shared by the firm and often formulated in the firm's vision likewise play a role in formulating the strategy.

> "So, these elements which I have written down here are important. The values play a role. Which values does the firm have, what does it stand for?" (Interviewee 1, High Tech)

The CSR team has to bear those aspects in mind when formulating a CSR strategy. Thus, the strategic vision and values of the firm which identify the long-term orientation of the firm, have a compelling impact on the way the CSR team sets its focus when defining the strategy.

4.2. Evaluation Process

The antecedents explained above influence the process which the firm undergoes when deciding how they want to set the CSR strategy: Where do they want to get involved? Which main issues are they addressing? The stakeholder input influences this process in so far as it generates potential

problems or issues that are demanded from the society. The strategic vision and values affect the CSR team's focus. This team and the CEO with his or her personal preferences undergo several decisions, take into account different aspects and evaluate all of the potential issues for the CSR strategy. Those aspects and evaluation processes are described in the following chapters, starting with the constituents followed by the evaluation practices.

4.2.1. Constituents

The constituents of the evaluation process play an important role as they showcase the main aspects which the CSR team considers when evaluating CSR initiatives.

Macro problems. The stakeholder input depicts the problems which the society currently deals with. Those macro problems relate to environmental or societal issues that are a concern for the stakeholders such as resource scarcity and migration issues.

> "And then you have societal developments which bother you as a firm and you have to react to those and integrate such aspects." (Interviewee 3, Square 46)

As stated from the interviewees, those societal developments offer the firms potential issues to which they can contribute something or where they have to in order not to fall short.

> "Yes, and what I always say and from what I am really convinced of, is that the CSR strategy, through the outside-in, through taking in of 'where is the society moving to? What does the society need? Where are potential points of conflict?'" (Interviewee 1, High Tech)

Through the stronger focus on the CSR commitment those macro problems and the firms' actions against them are getting even more recognition than before. Though this also means that if an issue is currently highly urgent and prominently discussed in the media, it will be easier for the firm to gain acceptance when tackling this issue. The bottom line is that stakeholder input reveals and gives voice to macro problems which the firm has to process and evaluate in order to form a CSR strategy which addresses stakeholder needs.

Core business. A topic that appeared to be quite significant for the interviewees was that CSR should be a part of the core business. In the best case, the processes and products or services of the firm should be aligned to the CSR issues and contribute towards the identified macro problems.

> "And there the focus topics are defined. But they all count towards the core business; we want to be part of this core business. And, of course, we want to extend our business through sustainable products and solutions, through the generation of sustainability contributions." (Interviewee 3, Square 46)

In addition to this quote, the comment of the CSR manager from Smart Living that "sustainability should be part of the service offer of the firm" (Interviewee 2, Smart Living) points in the same direction. Hereby, the customers want the firm to supply them with products that help them to be more efficient. As already briefly mentioned in chapter 3.1, for two of the firms CSR is the main direction of the business and hence the core business revolves around sustainability issues. For other firms it is less about integrating sustainability into the products but more about ensuring that the business processes and supply chain prevent the business from causing damage to the environment or society.

> "And the third topic, as I just mentioned, the topic business integration. The topic 'how can we get this into the business?' That's a significant component of our strategy, that sustainability should be a cross-cutting topic if you're serious about it." (Interviewee 2, Smart Living)

Many of the interviewees pointed out, that the focus on integrating CSR into the core business has increased in the last years. However, that is also the reason why the impact of the CSR strategy – both economically and for society and environment plays a much larger role nowadays.

Expected impact scope. The scope of the potential impact that could be achieved through the firm's activities in a certain CSR issue is crucial to the decision whether the firm will get involved in the issue. This expected impact can be differentiated into two components, the economic impact and the impact for society and environment. It became clear that most of the time the firm will not pursue a CSR initiative if it does not contribute to either one of those components. The relevance of loss and profit was revealed as a crucial criterion for deciding on a certain topic.

> "And I believe that whatever you do, the three dimensions (ecology, economy, social) should still be in the back of your mind. A firm is not here to save the world, if that means it won't be successful economically and cannot survive. So, you always have to be sure this goes hand-in-hand." (Interviewee 5, World Cloud)

In relation to achieving an economical impact through CSR initiatives it was often brought up that through sustainable products and services the business can be extended. CSR as a business case was considered quite important as it functions to serve the society or environment as well as the firm's success. It was not the case though that CSR would only be done if it generates profits, rather that it will generate a larger impact for the stakeholders if it also helps the business grow. Estimations on the impact of CSR programs for the society and environment were mostly connected with how a specific firm and its capabilities can contribute to the solution of the problems, evaluating where the firm can actually offer something significant.

> "Those results were than discussed with the team, in the previously mentioned task force, and then we thought: where do we have a chance to offer something? In which topics do we have an impact? Basically how the GRI proposes to do and where can we realize something together?" (Interviewee 7, Pencase)

The expected impact both economically and for society and environment therefore serves as a major criterion for the CSR team and CEO to decide in which topics the firm should engage in.

Doing good in Philanthropy. Philanthropy, or donating and supporting non-profit associations, is often mentioned as a significant part of the firm's CSR activities. However, according to the interviewees, recent developments have put the focus a lot more on incorporating CSR into the core business. Nevertheless, it remains an important part of firms CSR strategies. The interviewees stated that philanthropic activities do not necessarily have to be related to the core business, even though it would be preferable that some kind of connection exists. Especially if no connection to the core business exists, the personal preferences of the CEO play a significant role in deciding what initiatives the firm should support. Another important aspect is that in many firms the philanthropic actions are clearly separated from the CSR management which also takes into account strategic considerations.

> "...for example, we founded our own association in 2015, it is called [...] and this association is purely responsible for the societal component and supports children and teenagers' education. And this association is explicitly distinguished from the CSR management at Conscious Life. That means we separated the societal component a little bit from CSR." (Interviewee 8, Conscious Life)

However, some firms even expressed that philanthropy is only a minor thing to them because it does not create value and neglects the long-term orientation of the firm's CSR activities. Due to the changing focus on incorporating CSR into the core business, philanthropic activities become less important. As a result I separated doing good in philanthropy from the core business in the conceptual model proposed in this paper, supposing it has sort of lost its significance and is often not related to the core business. Nevertheless, the macro problems of the society are connected to the philanthropic activities of the firm.

4.2.2. Practices

The following chapter explains the evaluation practices the firm undergoes when deciding on certain CSR issues.

Preparing for the future. The interviews demonstrated that a main reason why some CSR initiatives are put into effect is because they will prepare the firms for the future. Tackling the macro problems through the core business not only potentially extends the business but also ensures the sustainability of the firm's products and services. This can be traced back to the fact that the demands of the future, as explained by the interviewees, can be found where the needs of the society are. If customers demand certain products to be more efficient than before, or to provide more sustainability driven solutions, the firm will have to comply with those demands, otherwise the customers will turn to a competitor.

> "This fig leaf discussion is in so far rubbish as those who pursue sustainability as a green fig leaf today will disappear from the market in the long-term." (Interviewee 2, Smart Living)

A problem that accompanies this anticipation of the future is the unpredictability that comes with it.

> Because in the end, the timing is quite difficult here, but in the end the markets of the future are to be found where the society in sum needs it. (Interviewee 1, High Tech)

Nonetheless, the relation between the macro problems and the core business can partially be explained through the firms preparing themselves for the future. Catering towards the needs and demands of the society will possibly widen their future competitive advantage whilst avoiding losing market share. This contributes to the evaluation process of CSR programs in so far that some issues might merely be tackled because if the firm will not do so, future business success might deteriorate. Accordingly, the macro problems influence the core business as they offer aspects that the core business must deal with in order not to lose significance in the future market.

Determining strategic fit. The interviews with the CSR managers showed that the relation between the macro problems and the core business are a crucial part of the evaluation process. It was identified that those two constituents somehow have to be linked with each other in order to make sure that a strategic fit exists between the potential CSR tackling points and the features of the core business. Two reasons that can account for this are firstly that through this strategic fit it can be ensured that the general strategy is in balance with the CSR strategy and furthermore it contributes to a successful approach of the issue. The firm has to identify which potential overlaps exist between the macro problems and the core business and if there are options that could be adapted in a way so the core business addresses the macro problems. The interviewees stated that the specific features and core capabilities of the firm have to be taken into account in order to find out where overlaps exist. Moreover, the core business might also be questioned critically in reference to the current societal problems, to evaluate what it contributes to this problem and how it could improve it.

> "[...] that we want to do more for the society, so basically extend our products in relation to societal needs, scrutinizing the core business criti-

cally and developing it further." (Interviewee 8, Conscious Life)

As showcased in the quote above, the firms try to reflect the societal needs in their core business and therefore some kind of strategic fit has to be given. In regard to this, the relevance of the topic to the firm's features has to be evaluated again. Another reason why the strategic fit is so important is because it offers a relatively easy starting point for a CSR strategy.

> "It's really important that you systemize everything. Because then you end up with a lump of topics and you have to debate, okay, which topics are absolutely important, what are the time-critical topics. And here it really helped us, this perspective of looking at the core business. That's usually how firms start, because it's easier, because you have the right influence there." (Interviewee 6, Light It Up)

In the context of the firms where the general strategy is completely related to CSR this strategic fit should be apparent in every action they undertake. Consistent to the future preparation aspect, the strategic fit is a main decision criterion for firms when evaluating which CSR programs to conduct. It offers the possibility to tie the CSR initiatives directly to the core business whilst not having to completely think of something new. Furthermore, CSR initiatives revolving around macro problems that are not related to the core business will be harder to pursue as the commitment from employees might be missing.

Assessing potential value creation. As already explained previously, the societal and environmental problems the firm tackles should either have a strategic fit with the core business or be pursued to prepare the firm for future developments. A further part of the strategy formulation process is the analysis of the expected impact scope mentioned earlier. The constituent core business influences the expected impact scope through the assessment of the potential value creation. The interviewees stated that it is important to concentrate on the firm's strengths when addressing macro problems. Hereby it should be analyzed how much the firm can actually contribute to the specific topics with its know-how and assets. It was clearly expressed that the firms want to create value towards addressing the macro problems with their CSR strategy. Due to the fact that the firm is part of the society, the core business contributions should generate more value for the society besides offering products or services.

> "No, no, no, no. Philanthropy is a minor thing to us. We are focusing on several areas that give more value to us in our business model. And we think that's important; to create value for the world, not just to be philanthropic." (Interviewee 4, 360 Degrees)

One question I asked the interviewees was if they see CSR as a driver for innovation and efficiency. This strongly relates to the value creation aspect since innovation and efficiency help firms to create more value. Through the development of CSR initiatives in the firm many new and creative ideas arise on how things can be dealt with.

> "[...] because if you have this mentality, trying to find creative solutions for something, a lot of innovation potential can be unfolded. Completely new ways and options can arise. Both for technologies and materials as well as for processes and the firm's organization. Yes, so that's why the orientation towards sustainable management is an absolute innovation driver to us." (Interviewee 6, Light It Up)

Examples of potential value creation through innovations related to CSR activities ranged from organizing tech festivals for students to the new invention of a resource efficient product. The potential value creation of the firm determines the scope of the expected impact. Through focusing on the firm's strengths and the relation of the CSR activity to the core business, additional value for the society can be generated which then results in an increased expected impact of the initiative. Herein innovations and new ways of how to conduct business contribute a major part to the firm's CSR strategy. Furthermore, it was identified that if the value created will not be very significant, the firm might rather decide to engage in a different issue.

4.3. Outcome

All of the findings presented above were related to the question how the firms form their CSR strategy, therefore which aspects they consider and what input they use. As the answers mostly focused on how the firm decides on topics or projects it will get involved in, the outcome of the conceptual model presented below is the CSR strategy focus. Should the firm focus its CSR activities on water scarcity, education support or migration issues? The CSR strategy focus identifies topics in which the firm can then define its detailed course of action. Developing an authentic and balanced CSR strategy which addresses the most important issues concerning the firm and its stakeholders involves complex decision-making.

4.3.1. Feedback loop

An essential aspect mentioned by the interviewees was that the formulation of a CSR strategy does not have an exact sequential arrangement. Moreover it takes a lot of time and continuous re-definition and evaluation to keep up with the societal developments and adapt the strategy accordingly. Thus the evaluation process leads to the CSR strategy focus but will occur constantly, leading to a dynamic and progressive process with changing outcomes.

> "Hmm, what comes with this sustainability idea and the implementation of sustainability topics in the firm or in other firms per se, is a continuous change and improvement process, because

> you will never be 100 percent sustainable. You never reach perfection. That means there is always something to do, there is always something to change and to optimize." (Interviewee 6, Light It Up)

By being attentive to changing internal and external stakeholder demands and needs, the strategy must be monitored and it should be tested if the firm is still on the right track. Consequently, a lot can be learned from the process which will then change the perception and evaluation again. Furthermore, the interviewees stated that it is not possible to develop everything at once; hence the process takes up a lot of time.

4.4. Conceptual Model

The displayed findings are all part of the strategy formulation process model which is presented below. The antecedents stakeholder input, internal input and strategic vision influence the following evaluation process which leads to a CSR strategy focus. Reconnecting the outcome to the evaluation process is the continuous evaluation and re-definition of the strategy. Figure 1 shows the conceptual model of the CSR strategy process, which the firm is considering in their evaluation process. Therefore, it influences one constituent of the evaluation process in contrast to the strategic vision which has an impact on the antecedent internal input. The strategic vision affects the internal input considerably because the CSR team and the CEO have to adhere to this vision when setting their focus and taking into account their personal preferences. Subsequently, the internal input has an impact on the complete evaluation process, as it is the CEO and the CSR team who go through this dynamic process, making the decisions and deliberating about the potential CSR issues.

The commencing point of the evaluation process are the macro problems because when deciding on where the firm wants to get involved all relevant options have to be considered. As explained earlier, the core business should be linked strategically to the macro problems or overlaps between those two constituents should exist. The macro problems are furthermore connected to the core business through the firm preparing for the future when choosing a certain CSR aspect. Further evaluating the fit of potential CSR action fields is the expected impact scope. The predicted economic impact and the impact for society and environment are defined through the potential value creation of the firm's core business towards a specific issue. The CSR team and CEO therefore assess how large the contribution to the issue could potentially be, which provides another important evaluation criterion when formulating the CSR strategy.

One aspect which is not necessarily linked to the core business is the firm's efforts in philanthropy. Nevertheless this is still a relevant part of most firms' CSR strategy and is therefore incorporated into the evaluation process of the CSR team and CEO. Through undertaking this dynamic process, it is proposed that the CSR team and CEO take into account all the presented constituents of the process and evaluate the macro problems accordingly. The result of this process is the CSR strategy focus. However, CSR is a constantly changing topic and therefore continuous evaluation and re-definition of the strategy has to take place.

5. Discussion

This study addresses the question of how a CSR strategy is formulated in firms, and thus contributes to the existing research about CSR strategy and its relation to stakeholders, CEO influence and strategic choices. It seizes the changing focus on CSR literature as "it is no longer about whether to make substantial commitments to CSR, but how?" (Smith, 2003: 55). Galbreath (2009) already expressed that the research on building a CSR strategy which leads to an increased competitive advantage and responsibility of the firm is fairly scant.

5.1. Individual-Level Input

As identified in chapter 2.2, one research gap in CSR strategy is the specific influence of the individual-level input on the formulation process, precisely the impact of the CEO and the CSR team. This study tries to provide answers to fill this gap. One major finding of my research is that the personal preferences of the CEO and the focus of the CSR team can significantly change the outcome of the CSR strategy formulation. CEO values and characteristics have already been proven to be related to the implementation of CSR strategy in a firm (e.g. Chin et al., 2013; Tang et al., 2015). Herein, it was identified that CEOs interpret, filter and process information according to their values (Chin et al., 2013; Tang et al., 2015). The research focused mainly on specific psychological characteristics of the CEO and the relation to CSR. Thus, this paper takes into account the whole CSR strategy formulation process and analyses where the CEO's personal preferences is actually influencing the process and which interactions come in to play. Furthermore, it was identified that the CSR team also has a significant impact on the formulation process. This finding develops the researched antecedents of CSR strategy further as it states that it is not only the CEO who influences the strategy on the individual-level but also the CSR team. Contrary to most of the research which primarily studies the perspective of employees as stakeholders with CSR demands, the model presented here focuses on the CSR team as employees of the firm with a significant stake in the decision on a CSR strategy. Research about the employees' role in demanding increased CSR activity of the firm, perception of organizational justice through the firm's CSR initiatives and concluding stronger organizational commitment do not take into account the employees' potential influence on which CSR activities the firm engages in (Aguilera et al., 2007; Yang and Rivers, 2009). The findings delineate the individual-level input of the CSR team setting the patterns in the CSR strategy formulation. This is due to the fact that the CSR team foresees important topics, generates

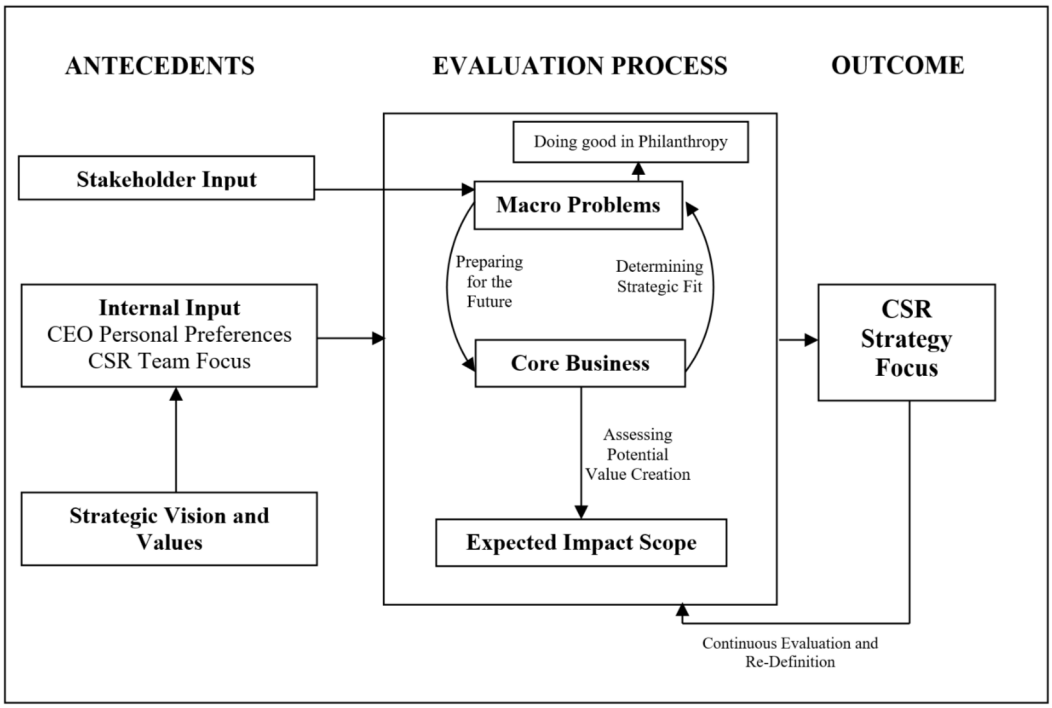

Figure 1: Conceptual Model of the CSR Strategy Formulation Process

new ideas and evaluates the stakeholders' demands. Undergoing the process of critically evaluating and analyzing risk and chances of the stakeholders' demands and wishes, the CEO and the CSR team decide on the CSR strategy focus. In the philanthropic part of the CSR strategy the influence of the individual-level input is even stronger as this part does not necessarily relate to core business attributes.

However, some additional aspects regarding the individual-level input have to be considered. Firstly, the impact of the individual-level input can change according to the size of the firm. In smaller firms the influence might be higher because others will not scrutinize the decisions regarding the CSR strategy (Schneper et al., 2015). Moreover, due to the closer contact between the CEO and the CSR team, the personal preferences of the CEO might play a larger role. Furthermore, this can also depend upon the importance of CSR in the firm. In firms with a strong focus on CSR, decisions on the CSR strategy might be highly systemized, limiting the individual-level input. But it could also be argued that in this case the CSR team is granted even more time to develop a strategy, leading to an increased individual-level input. Nevertheless, it is essential to recognize that it matters who the CEO is and of whom the CSR team consists of, because their characteristics, values and therefore personal preferences and prioritizations influence the CSR strategy focus.

5.2. Strategic Fit to Core Business

As identified preliminarily, a vital part of developing a CSR strategy is the adherence to the strategic vision of the firm (Galbreath, 2009). Yet, the findings in this study show that the acknowledgment of the attributes of the core business and processes of the firm are even more important than considering the strategic vision. Therefore, the focus should be less on "where do we want to go?" but more on "how is our business constituted and how can we use it for our CSR strategy?" Even though CSR has moved away from being solely a myriad of philanthropic activities, it still does not live up to its full potential in most firms (McElhaney, 2009). The limited research on the topic of integrating CSR strategy into the business emphasizes that a predominant number of firms' CSR strategies are still a "hodge-podge of disconnected activities" (McElhaney, 2009: 34) separated from the business operations and failing to see the connection of business and society (McElhaney, 2009; Porter and Kramer, 2006; Yuan et al., 2011).

The findings of this study show that the relation to the core business of the firm is a fundamental criterion when evaluating potential CSR issues. It is essential that the social or environmental problems addressed are a strategic fit to the firm's core business, precisely to the product, service or the processes of the business operations. Sustainability as a service offer or CSR as a general strategy are two constructs that align with this core business relation. Significant economic and social or environmental impacts have been identified as only being feasible and sustainable if the addressed CSR issues are linked to the business operations. Moreover, innovation and efficiency were predicted to be interrelated with CSR as well. Those findings align with the view of CSR serving as a incorporated business strategy that is connected to the core business and takes advantage of the firm's strengths (McElhaney, 2009; Yuan et al., 2011). The perspective of

sustainability as a service offer strongly relates to the statement of Dawkins and Lewis (2003) that CSR issues should be chosen if the firm can offer a solution to the problem. Through focusing the CSR strategy on the core competencies of the firm and thus simultaneously addressing business and society or environment, the firm can advance their competitive advantage, possibly enter new markets and strengthen its market position (McElhaney, 2009; Yang et al., 20133). My research findings show that firms evaluate a large part of their CSR issues according to the fit with the core business and the potential value created through it. The findings underline that the CSR strategy has moved from a collection of unrelated activities to a streamlined incorporation into the business strategy. The benefits emerging out of aligning the CSR strategy to the business operations, such as employee commitment to CSR, sustainable impact and economic performance are important reasons to this development.

Yet, the question about the actual degree of the CSR issue integration into the core business remains appropriate. This degree probably varies according to the specific market and industry of the firm (Dawkins and Lewis, 2003). Depending on the industry sector more or less weight might be put into the core business relation to CSR. For instance, a chemistry firm has a lot more environmental issues to tackle than a financial service firm. For some firms the importance of CSR issues to relate to the core business might not always be considered essential. As an example, the CSR manager of World Cloud argued, that even though their products are increasingly addressing sustainability issues, this is not necessarily due to the firm's CSR strategy. Thus, it was stated that the CSR strategy takes into account many other aspects as well and not only focuses on the product. Rangan et al. (2015) criticized the recent "pressures to dress up CSR as a business discipline" (Rangan et al., 2015: 1) and proposed to divide CSR activities among three theaters: philanthropy, improving operational effectiveness and creating shared value. However, my research findings show that creating value for society is considered increasingly important. Yet, doing good in philanthropy is still seen as a significant aspect of a CSR strategy, therefore it can be concluded that even though the focus on aligning the CSR strategy to the core business is growing, firms still adhere to their individual style when developing the CSR strategy.

5.3. Iterative Process

Another contribution of this study to the existing research is the finding that the CSR strategy formulation process is an iterative and dynamic process, requiring constant monitoring and development. This follows Mintzberg (1978) perception of strategy as a pattern in a stream of decisions, because through adhering to the societal and environmental developments constant decisions form the CSR strategy. It was identified that the formulation process demands continuous re-definition due to the fact that the outcome depends on the global social and environmental developments. As those aspects often change in a fast and unforeseen way, the strategy has to be adapted accordingly. Rather than seeing the process as a sequential step-by-step arrangement, it was explored that continuous adaption is vital to attend to the demands of stakeholders. This finding is contrary to a large part of literature which often depicts CSR through several dimensions, neglecting the interrelations and the dynamism between them (e.g.Burke and Logsdon, 1996; Carroll et al., 1991; Galbreath, 2009). However, Galbreath (2009) added a social dynamics variable to the markets dimension, recognizing the "potential changing nature of social expectations" (Galbreath, 2009: 116). Calling for a more dynamic view of CSR instead of a static one, Tang et al. (2012) emphasized this facet of CSR as a changing process as well. My research findings confirm this statement as the CSR strategy formulation has to be perceived as a situational, environment responding and therefore highly dynamic process. If new developments occur, the stakeholders could demand different CSR attention from the firm than prior to the development. This matches with the work of Mitchell et al. (1997) who proposed the urgency of a stakeholder claim as a criterion of who managers should pay attention to. Conclusively, the CEO and CSR team undergo the evaluation process of the CSR strategy formulation multiple times. The repeated evaluation of the macro problems proposed by the stakeholders could lead to a differing outcome than before. This fast changing-, and dynamic nature of the process leads to challenges in formulating a balanced and successful CSR strategy. Repeatedly aligning the CSR issues to the core business requires constant work from the CSR team as well as the whole firm. This however might not be possible in many cases, leading to a rather imbalanced CSR strategy. Accordingly, increased attention should be paid to this aspect since my research findings emphasize that the firm's constant monitoring of its external and internal environment is an essential part of the CSR strategy formulation.

6. Managerial Implications

In order to form a CSR strategy which reflects important elements such as stakeholder consideration, core business relation and value creation, several requirements should be considered by the firm. In the current business world a wide spectrum of firms' commitments to CSR can be found. This changes the prospect of how to formulate a strategy. From a peripheral perspective of philanthropic activities or attempts to balance the general and CSR strategy, through to CSR as the purpose of the firm, many differing approaches to CSR exist (Pearce II and Doh, 2005). This spectrum was also represented accurately through the firms whose CSR managers I interviewed. Therefore, the practical implications drawn from my research can be applied to a vast number of differing firms, individualizing the specific steps to their need. As the model in this paper shows an iterative process the recommendations to formulate a CSR strategy will adhere to this process addressing the most important steps.

As identified earlier, an important antecedent of the evaluation process is the input gathered from stakeholders. Thus, an important task for the management, and particularly for

the CSR team, is the screening of demands and needs of stakeholders. Thorough research about the potential needs of society and environment and evaluation of the affected suspects and the main hurdles when attacking the issue should be conducted to gain deeper insight into the CSR issue (Pfitzer et al., 2013). Following the screening of potential topics, the evaluation process through the CSR team and CEO to prioritize certain issues should start. Thereby it is vital that the intersections between the core business and the macro problems are identified (Porter and Kramer, 2006). Through analyzing the contact points between the business's operations and society or environment, the potential issues that are affected by or affect the firm can be exposed (Porter and Kramer, 2006). This step can be conducted through the CSR team and the top-level management in brainstorming sessions and be further refined using checklists, for instance provided by the GRI (Porter and Kramer, 2006). Additionally, it seems important to mention that when it comes to supporting certain social issues the personal preferences of the CEO should only be considered if there is at least some connection to the firm's social commitment strategy and the decision to engage in the issue will still be supported by the employees of the firm (Raggio et al., 2010). Another implication for the management is the deconstruction of the potential value creation towards the issue by the firm (Pearce II and Doh, 2005; Porter and Kramer, 2006). It is essential that the management focuses on the firm's core capabilities and uses the expertise and assets of the firm when evaluating what it can do to improve the social issue (Pearce II and Doh, 2005). Furthermore, the impact on both the economic performance and the societal and environmental obstacles should be measured to gain an overview of the potential contribution of the firm (Porter and Kramer, 2006; Rangan et al., 2015). Depending on the outcomes which are measured, external help might have to be consulted (Rangan et al., 2015). When measuring economic impacts the firm can depend on its traditional methods, whilst in measuring environmental issues such as CO2 emissions or social outcomes like the improvement of children's progress in working on computers, NGO's can provide valuable knowledge (Rangan et al., 2015). Combined with these steps, a significant part of a successful CSR strategy formulation is the constant monitoring of the progress and screening of changing social and environmental problems (Kramer, 2011).

Taking account of these recommendations, the firm should be able to prioritize CSR issues to be included in its CSR strategy. Following these steps, an exact plan on how to address the prioritized issues should be developed (Porter and Kramer, 2006), though this aspect is not included in my research.

7. Limitations

One limitation of the presented research is the sample size of ten interviews. Due to time and length restrictions in assembling the present study, the number of interviews had to be limited. It can be assumed that additional interviews would have generated more data and could have possibly changed the conceptual model. Potential impacts of this limitation could be that an aspect of the CSR strategy process was missed or the current constituents and practices might have been perceived differently. Another limitation is the so called interviewer bias which relates to the fact that different interviewers can provoke different answers of the interviewees (Kavale, 1983). As I was the only interviewer in this study, the style of asking questions can influence the respondents' answers. During the coding process this one-person-study problem caused an additional limitation. Reaching a consensus in the coding process through a team of several researchers could have possibly led to different results. Even though in qualitative research the limited generalization of the findings often decreases the external validity, it can be stated that the interviewed firms offered a good mix of size and industry. However, problems in the generalization of the findings can occur. This is due to the fact that the approach of firms concerning CSR issues is quite different across firms and industries.

8. Future Research

The model presented offers a general perspective of the CSR strategy formulation process, while providing possibilities for individualization. Hence, I suggest that future qualitative and quantitative research takes into account the size and industry of firms and incorporates those variables into the strategy formulation process. In order to explore this further, a larger sample size might be needed. Although some research looks at differing firm sizes and their CSR strategy further research in this field is needed (e.g. Perrini et al., 2007). I advocate to not separate the research according to the studied firm sizes but rather to research how the strategy formulation process changes depending on those aspects. The same recommendation accounts for the distinction of specific industries. As aforementioned, the potential CSR issues to address can differ from industry to industry; offering further research material. Additionally, research about the degree of commitment to CSR and the respective CSR strategy formulation has been scant to date. Therefore, increased attention to this aspect is important, looking at the distinctive CSR commitment types independently to offer useful insights for management. As proposed in chapter 5.3, the fast changing society and environment requires constant diligence from the firm in adapting their CSR strategy. This aspect of the CSR strategy formulation process requires increased attention, because it unquestionably demands a fast response in the CSR approach and thus adaption to changes in the firm. Last but not least, the research about the CEO influence on CSR has been rewarded with quite some attention. As my research results showed, the CSR team also has considerable influence on the formulation of a CSR strategy and thus future research may explore this further to provide a better understanding of the sometimes irrational decisions made by individuals when deciding on CSR issues to address.

9. Conclusion

The goal of this study was to explore the CSR strategy formulation, hence researching the influences and interactions which determine the process of making a CSR strategy. The findings show that CSR strategy formulation is not only influenced by the stakeholders' demands but also by the internal input and the strategic vision. Firms evaluate those aspects according to their fit to the firm's core business and expected impact. The conceptual model developed out of the findings from the conducted interviews contributes to the existing literature on CSR strategy, and thus the research findings implicate considerable knowledge for firms when formulating a CSR strategy. Nonetheless, additional research in this field is needed to explore the dynamism of CSR strategy formulation further.

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International Strategic Emphasis, Marketing Capabilities und Shareholder Value: Die finanziellen Implikationen des Trade-offs zwischen internationaler Wertgenerierung und internationaler Wertschöpfung

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Abstract

Das Management multinationaler Unternehmen ist heutzutage mit dynamischen Umweltbedingungen konfrontiert. Der unternehmerische Erfolg auf den internationalen Märkten hängt maßgeblich von einer effizienten und effektiven Ressourcenallokation ab. Im Zuge dessen müssen Trade-off-Entscheidungen zwischen den Strategieoptionen der internationalen Wertgenerierung und der internationalen Wertschöpfung getroffen werden. Die Beziehung zwischen der Internationalisierung und der finanziellen Performance eines Unternehmens wird in der Literatur seit 50 Jahren diskutiert. Aus unterschiedlichen methodischen Herangehensweisen resultieren uneindeutige Ergebnisse. Für die Operationalisierung internationaler Aktivitäten werden insbesondere wertgenerierende und wertschöpfende Größen herangezogen. Eine Relation zwischen beiden Maßen, und damit die Berücksichtigung internationaler Trade-off-Entscheidungen, wird jedoch bislang vernachlässigt. Diese Forschungslücke wird in der vorliegenden Studie geschlossen, indem der Einfluss des internationalen Strategie-Trade-offs auf den Shareholder Value untersucht wird. Die Studie prognostiziert hier einen negativen Wirkungszusammenhang. Die Vermutung lautet, dass ein positiver Effekt erst durch ausgeprägte Innovations- und Vermarktungsfähigkeiten ausgelöst werden kann. Der Resource-Based-View, die Theorie der Liabilities of Foreignness und das Konzept der Dynamic Capabilities bilden ein komplementäres Framework zur Erklärung dieser Wirkungsbeziehungen. Die empirische Untersuchung basiert auf einer Paneldatenanalyse für ein Sample von 1.399 Unternehmen im Untersuchungszeitraum von 1982 bis 2016. Für die Modellierung der Wirkungszusammenhänge zwischen den Variablen werden Mehrgleichungsmodelle verwendet. Die zentralen Ergebnisse der Studie zeigen, dass der Einfluss des internationalen Strategie-Trade-offs auf den Shareholder Value insignifikant ist. Investoren ziehen internationale Trade-off-Entscheidungen erst dann in Betracht, wenn das Unternehmen über Marketing Capabilities verfügt. Einer der Forschungsbeiträge dieser Studie ist die Entwicklung einer neuen relevanten Internationalisierungsvariable. Darüber hinaus werden Erkenntnisse aus der Internationalisierungsliteratur mit Erkenntnissen aus der Marketingliteratur verknüpft. Dabei ist die Relevanz bestimmter Marketingaktivitäten für multinationale Unternehmen hervorzuheben. Ferner können Managementimplikationen bezüglich der Kommunikation dieser Marketingaktivitäten im Internationalisierungskontext gegeben werden.

Keywords: Internationalisierung, Marketing, Shareholder Value, Strategischer Trade-Off, Regressionsanalyse

1. Internationale strategische Ausrichtung

Die Entwicklung ausländischer Märkte nimmt seit dem Ende des Zweiten Weltkrieges kontinuierlich zu. Diese Tatsache wird insbesondere durch das progressive Wachstum des Welthandelsvolumens und der ausländischen Direktinvestitionen bewiesen (vgl. Dittfeld, 2017, S. 2). Das Welthandelsvolumen wuchs im Zeitraum von 1948 bis 2016 von 59 Milliarden US-Dollar auf 16 Billionen US-Dollar und zeigt somit eine 270-fache Erhöhung des Welthandelsvolumens aus dem Jahr 1948. Die weltweiten ausländischen Direktinvestitionen wiesen im Jahr 1980 einen Wert von 559 Milliarden US-Dollar auf und stiegen auf eine Summe von 26 Billionen US-Dollar im Jahr 2016 an (vgl. UNCTAD, 2016a). Die Auflistung dieser Kennzahlen führt zu der Frage, welchen Einfluss die Entwicklung internationaler Märkte auf den Unternehmenserfolg ausübt (vgl. Dittfeld, 2017, S. 2).

Für die Beantwortung dieser Frage ist es notwendig, die Internationalisierungsstrategien von multinationalen Unternehmen zu untersuchen (vgl. Lu und Beamish, 2004, S.

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599). Aus der Managementpraxis können zwei entscheidende Strategieoptionen herausgefiltert werden, aus denen die Internationalisierungsstrategie zusammengesetzt ist. Einerseits sind multinationale Unternehmen zu beobachten, die ihren Schwerpunkt auf Operationen in mehr als einer Region legen. Andere international aktive Unternehmen ziehen es vor, ihre Umsätze aus mehreren Regionen zu genieren, aber nur in einer Region zu operieren (vgl. McKinsey & Company, 2012). Präferieren Unternehmen multiregionale Operationen, wird dieses Verhalten mit der Strategieoption der internationalen Wertgenerierung in Verbindung gebracht. Internationale Unternehmen, die ihren Fokus auf multiregionales Umsatzwachstum legen und dabei lediglich aus einer Region operieren, sind der Strategieoption der internationalen Wertschöpfung zuzuordnen (Mizik und Jacobson, 2003, S. 63; Thomas und Eden, 2004, S. 92). Die internationale Wertgenerierung stellt den Ressourcenzugang auf internationalen Märkten in den Vordergrund. Die Leistungserstellung wird dabei in das Ausland verlagert. Die Vorteile dieser Strategieoption ergeben sich zum einen durch die Ausnutzung von Kostenvorteilen und zum anderen durch die Entwicklung neuen Knowhows und innovativer Produkte (vgl. Boston Consulting Group, 2010, S. 5). Bei der internationalen Wertschöpfung wird hingegen der internationale Marktzugang fokussiert. Das multinationale Unternehmen kann beispielsweise durch die Erschließung neuer internationaler Märkte das Nachfragepotenzial erhöhen. Ferner können mittels internationaler Marktdurchdringung bereits bestehende Kunden- und Produktsegmente intensiver bearbeitet werden (vgl. Boston Consulting Group, 2010, S. 4).

In der Vergangenheit wurde das strategische Denken multinationaler Unternehmen primär vom Ansatz der internationalen Wertschöpfung bestimmt. Die Philosophie dieses Vorgehens beruht auf der Replikation des Geschäftsmodells aus dem Heimatmarkt und dessen Anwendung auf ausländischen Märkten. Der Wettbewerbsvorteil im Heimmarkt sowie Skalen- und Synergieeffekte sollen mit dieser Herangehensweise gleichermaßen im Ausland genutzt werden. Aus Sicht der Managementpraxis reicht dieser Ansatz jedoch nicht mehr aus, um international erfolgreich zu sein. International agierende Unternehmen sind heutzutage mit Umweltbedingungen konfrontiert, welche in einer Studie der Boston Consulting Group (2010) als „New Global Reality“ betitelt werden (Boston Consulting Group, 2010, S. 3). Im Zuge der Globalisierung treten Gefahren in Form von neuen Wettbewerbern auf, während neu zu erschließende Märkte Wachstumschancen bieten. Diese neuartigen Chancen und Gefahren ergeben sich vor allem aus dem zunehmenden internationalen Einfluss schnell wachsender Volkswirtschaften. Die Manager US-amerikanischer Unternehmen sind beispielsweise mit den kulturellen und nachfragespezifischen Besonderheiten des chinesischen oder indischen Marktes konfrontiert.

Dieses neue dynamische Umfeld erfordert daher die Einbeziehung wertgenerierender Strategieoptionen, um lokale Präferenzen in den jeweiligen Märkten zu berücksichtigen. Ein multinationales Unternehmen kann demzufolge nur dann den optimalen Mehrwert der Internationalisierung erreichen, wenn es sowohl neue Kundensegmente erschließt als auch Kernkompetenzen in ausländische Märkte überträgt (vgl. Boston Consulting Group, 2010, S. 3). Welche Herausforderungen sich durch diesen internationalen Strategie-Trade-off ergeben, zeigt eine Studie von McKinsey & Company (2012). Hier werden über 300 internationale Manager aus 17 der erfolgreichsten globalen Unternehmen befragt. Die Führungskräfte bestätigen die zunehmende Bedeutung der lokalen Anpassungsfähigkeit in ausländischen Märkten. Mehr als 60 % der Befragten glauben, dass lokale Konkurrenten die Kundenanforderungen besser verstehen als das eigene Unternehmen. In Bezug auf die wachsende Vielfalt von Märkten, Kunden und Absatzkanälen besteht weiterhin eine große Schwierigkeit in der internationalen Ressourcenallokation (vgl. McKinsey & Company, 2012).

Die Frage nach den Auswirkungen des internationalen Strategie-Trade-offs auf den Unternehmenserfolg ist in der Managementpraxis also von hoher Relevanz. Da die Internationalisierungsliteratur diese Frage bislang unbeantwortet lässt, widmet sich die vorliegende Studie dieser Thematik. Diverse Praxisstudien weisen zudem daraufhin, dass multinationale Unternehmen bestimmte Ressourcen, Kompetenzen und Fähigkeiten benötigen, um international erfolgreich zu sein (vgl. McKinsey & Company, 2012; Boston Consulting Group, 2010). Vor diesem Hintergrund wird in dieser Studie das Konzept der Marketing Capabilities in das Forschungsmodell integriert.

Das Framework hat sich in der Erklärung der Wirkungszusammenhänge zwischen Internationalisierung und Performance bereits bewährt (vgl. Morck und Yeung, 1991, S. 185; Berry und Sakakibara, 2008, S. 297). Einen besonderen Stellenwert beinhaltet die Internationalisierung darüber hinaus für die Shareholder der Unternehmen. In einer weiteren Praxisstudie wird gezeigt, dass die Marktkapitalisierung der 50 größten multinationalen Unternehmen in den Jahren 1990 bis 2015 dreimal stärker wuchs als die vieler renommierter Aktienindizes. Zu den Vergleichsportfolios gehören etwa Indizes wie der S&P 500 COMPOSITE, der MSCI AC WORLD oder der STOXX EUROPE 600 (vgl. Oliver Wyman, 2017, S. 3 ff.). Der Shareholder Value ist demnach eine relevante Erfolgsgröße im Internationalisierungskontext und wird folglich in dieser Arbeit untersucht. Aus den vorangegangenen Ausführungen lassen sich vier Forschungsfragen für die aktuelle Studie ableiten:

1. Wie lässt sich der internationale Strategie-Trade-off operationalisieren?
2. Inwieweit unterscheidet sich die neue internationale Trade-off-Kennzahl von den bestehenden Internationalisierungsvariablen?
3. Übt der internationale Strategie-Trade-off einen Einfluss auf den Shareholder Value aus?
4. Welche Rolle spielen Marketing Capabilities in dieser Beziehung?

Nach der Darstellung der Relevanz des Themas und der formulierten Zielstellung der Arbeit folgen im zweiten Kapitel

die konzeptionellen Grundlagen. Hier werden mit der Internationalisierung, den Marketing Capabilities und dem Shareholder Value die drei Hauptkonstrukte der Arbeit vorgestellt. Am Ende des Kapitels wird die Forschungslücke aus der bisherigen Internationalisierungsliteratur abgeleitet. Das dritte Kapitel befasst sich mit relevanten Theorien, um die Wirkungszusammenhänge der darauffolgenden Hypothesen zu erklären. Final wird hier das Gesamtmodell der Studie aufgestellt. Die empirische Untersuchung wird im vierten Kapitel dargelegt. Dabei wird zunächst Bezug auf das Sampling und die Datenbasis genommen, bevor anschließend die Modellspezifikation folgt. Das Kapitel wird mit der Vorstellung der empirischen Ergebnisse abgeschlossen. Das fünfte und letzte Kapitel dient zur Diskussion der gewonnenen Erkenntnisse und zur Beantwortung der Forschungsfragen. Ferner sollen hier die Limitationen der Studie aufgezeigt werden. Anschließend wird die Arbeit in den Kontext der Internationalisierungsforschung eingeordnet. Den Abschluss bilden Implikationen für die Managementpraxis.

2. Konzeptionelle Grundlagen

2.1. Internationalisierung

Im folgenden Kapitel soll die konzeptionelle Grundausrichtung der vorliegenden wissenschaftlichen Arbeit dargestellt werden. Mit der Internationalisierung des Unternehmens wird zunächst das Kernelement der Untersuchung thematisiert. Von Bedeutung sind hierbei insbesondere die verschiedenen Strategieoptionen der internationalen Wertgenerierung und Wertschöpfung und der daraus resultierende Trade-off. Im weiteren Verlauf wird der Einfluss von Marketing Capabilities der Unternehmung auf den Internationalisierungserfolg behandelt. Im Fokus stehen dabei die Vermarktungsfähigkeit und die Innovationsfähigkeit der Unternehmung. Darauf folgt die Erläuterung des Shareholder Values, welcher die finanzielle Erfolgsgröße der Untersuchung darstellt. Nach einer Vorstellung der Treiber soll anschließend aufgezeigt werden, inwieweit der Shareholder Value geeignet ist, Strategien zu bewerten. Am Ende des Kapitels werden die Ergebnisse bisheriger Studien zur Beziehung zwischen Internationalisierung und finanzieller Performance diskutiert, um abschließend die Forschungslücke abzuleiten.

Als Internationalisierung wird die Ausdehnung der Unternehmenstätigkeiten auf ausländische Märkte verstanden. Die Anzahl der internationalen Märkte, in denen das Unternehmen operiert und die strategische Wichtigkeit des jeweiligen Marktes spiegeln dabei den Internationalisierungsgrad wider (vgl. Hitt et al., 1997, S. 767). Verschiedene Autoren im Bereich des strategischen Managements betiteln die Internationalisierung weiterhin als Wachstumsstrategie, welche verschiedene Ausprägungen aufweisen kann (Capar und Kotabe, 2003, S. 345; Chari et al., 2007, S. 185). Diese unterschiedlichen Strategiegewichtungen werden von den Bartlett und Ghoshal (1987) im Integration/Responsiveness-Framework formuliert (vgl. Bartlett und Ghoshal, 1987, S. 43). Hier wird postuliert, dass sich multinationale Unternehmen in einem internationalen Spannungsfeld zwischen konfligierenden Umfeldkräften bewegen. Die strategische Ausrichtung des Unternehmens findet in diesem Modell zwischen der lokalen Anpassung an ausländische Marktbedingungen und einer global standardisierten Herangehensweise statt (vgl. Ghoshal und Nohria, 1993, S. 26). Die genannten Strategieoptionen bilden das konzeptionelle Fundament des Internationalisierungsaspektes in dieser Arbeit und werden im Folgenden vorgestellt. Praxisbeispiele aus dem Einzelhandelssektor sollen die Aktualität der Thematik verdeutlichen.

2.1.1. Lokale Reagibilität

Ein multinationales Unternehmen ist in diversen Ländern präsent. Die jeweiligen Niederlassungen sind daher mit verschiedenen nationalen Umfeldbedingungen konfrontiert. Die jeweiligen Auslandseinheiten müssen auf lokale Kunden, Regierungen und Substitutionsprodukte reagieren und simultan verschiedenen Markt- und Distributionsstrukturen entsprechen. Der lokale Anpassungsdruck kann je nach länderspezifischem Umfeld unterschiedlich ausgeprägt sein. In der Literatur zum internationalen Management werden diese, auf das international agierende Unternehmen einwirkenden Effekte, als Einflüsse der lokalen Reagibilität verstanden (vgl. Ghoshal und Nohria, 1993, S. 26). Mit dieser Strategieoption strebt das Unternehmen nach einem starken lokalen Anpassungsgrad der Produkte und Prozesse, indem den Niederlassungen eine hohe Eigenverantwortung in der Ausübung der Geschäftstätigkeiten zugesprochen wird.

Das Zuschneiden der Leistungserbringung auf den lokalen Kontext verursacht hohe Kosten. So müssen Produkte und interne Prozesse verändert oder gänzlich neu aufgelegt werden, wodurch Standardisierungsvorteile verringert werden. Zusätzlich wird die Koordination zwischen der Firmenzentrale und den Niederlassungen erschwert, weshalb hier eine wechselseitig intensive Interaktion nötig ist. In diesem Kommunikationsprozess muss festgelegt werden, inwieweit die Kernkompetenzen des Unternehmens auf die ausländischen Niederlassungen übertragen werden können, während lokale Produkt- und Prozessadaptionen stattfinden (vgl. Meyer und Estrin, 2014, S. 4). Im Rahmen dieser Strategieoption erwirbt und bewirtschaftet das Unternehmen die für die Leistungserbringung relevanten Assets direkt im ausländischen Markt. Infolgedessen und in Kombination mit der Verwendung von lokalen Ressourcen finden Produkt- und Prozessinnovationen im jeweiligen Land statt (vgl. Meyer und Estrin, 2014, S. 2 f.; Thomas und Eden, 2004, S. 92). Der Wert für den Kunden wird nicht im heimischen Markt, sondern auf den internationalen Märkten geschaffen, weshalb diese Strategieoption in der vorliegenden Arbeit als internationale Wertgenerierung betitelt wird (vgl. Mizik und Jacobson, 2003, S. 63). Der Mehrwert dieser internationalen strategischen Ausrichtung zeichnet sich durch das spezifisch angepasste Leistungsangebot aus (vgl. Mauri und Neiva de Figueiredo, 2012, S. 39). Durch hohe Kundenanpassung und Wettbewerbsdifferenzierung werden Kundenzufriedenheit und folglich nachhaltige Wettbewerbsvorteile generiert (vgl. Devinney et al., 2000, S.

688).

Am Beispiel des Lebensmitteleinzelhandels kann die Strategieoption der internationalen Wertgenerierung verdeutlicht werden. Die britische Supermarktkette Tesco etwa unterliegt kontinuierlich dem Druck, ihre Produkte an die lokalen Präferenzen der Konsumenten anzupassen und Lieferketten in den jeweiligen Gastländern zu installieren (vgl. Swoboda et al., 2014, S. 322). In der Folge fokussiert die Internationalisierungsstrategie des Unternehmens nicht die Ausschöpfung von Skaleneffekten, sondern vielmehr die Anpassung an lokale Gegebenheiten. Im Zuge des zentral- und osteuropäischen Markteintritts eröffnete das Unternehmen zunächst kleinere Convenience Stores in den jeweiligen Ländern, um Marktkenntnisse zu entwickeln. Im Kontrast zu den Supermärkten, in denen Tesco üblicherweise Produkte vertreibt, verfügen diese Geschäfte über eine relativ kleine Verkaufsfläche. Der Vorteil dieser untypischen Vorgehensweise liegt in der ersten Kontaktaufnahme zu Lieferanten und in der Erforschung von Wettbewerbsdynamiken, ohne größere Investitionen zu tätigen. Diese Maßnahmen sollen das sukzessive, organische Wachstum des Unternehmens in den betreffenden Märkten vorbereiten (vgl. Palmer, 2005, S. 31). Zur Befriedigung lokaler Kundenbedürfnisse schließt Tesco Partnerschaften mit örtlichen Lebensmittellieferanten und unterstützt diese finanziell bei der Gründung eigener Handelsmarken, welche unter der Dachmarke des Unternehmens verwaltet werden. Auf diese Weise macht sich Tesco das Knowhow lokaler Marktteilnehmer zunutze (vgl. Palmer, 2005, S. 41).

2.1.2. Globale Integration

Die internationalen Märkte, in denen das Unternehmen operiert, können hingegen auch miteinander verflochten sein. Übereinstimmende Kundenpräferenzen sowie die Präsenz wichtiger Stakeholder des Unternehmens wie Kunden, Lieferanten oder Wettbewerber über Landesgrenzen hinaus, sind maßgeblich für eine Verknüpfung der verschiedenen Auslandsmärkte. Die internationalen Niederlassungen werden durch den wachsenden Integrationsdruck dazu getrieben, ihre Aktivitäten zu koordinieren. In der Literatur des internationalen Managements werden diese Effekte als die Einflüsse der globalen Integration bezeichnet (vgl. Ghoshal und Nohria, 1993, S. 26). Die verschiedenen Auslandseinheiten können als gegenseitige Replikate verstanden werden, welche dem hohen Einfluss der Firmenzentrale unterliegen und versuchen, Standardisierungsvorteile zu nutzen (vgl. Zaheer, 1995, S. 343; Meyer und Estrin, 2014, S. 3).

Aufgrund der komplementären Ausrichtung der Geschäftsaktivitäten in den Niederlassungen verursacht diese Strategieoption Koordinationskosten. Die einheitliche Unternehmenspolitik führt zu einer weniger agilen und flexiblen Markthaltung, die dagegen beim Ansatz der lokalen Anpassung gegeben ist. Ferner ist die globale Integration nur dann erfolgreich, wenn alle Niederlassungen ihre Geschäftspraktiken aufeinander abstimmen. Verhält sich ein Glied in der Kette opportunistisch, wirkt sich dieses Verhalten negativ auf den Standardisierungsnutzen aus (vgl. Mauri und Neiva de Figueiredo, 2012, S. 39). Zwei unterschiedliche Arten von Vorteilen sind bei Anwendung des Integrationsansatzes festzustellen. Zunächst können zentralisierte Ressourcen von allen internationalen Niederlassungen genutzt werden, wodurch das Unternehmen von Skalen- und Verbundeffekten profitiert (vgl. Rašković et al., 2013, S. 152). Die Fixkosten können somit verteilt und die Stückkosten reduziert werden. Bei dieser Strategieoption wird der Wert für den Kunden im Heimmarkt generiert und sukzessive auf die ausländischen Märkte ausgedehnt (Meyer und Estrin, 2014, S. 3). Durch die erwähnten Skalierungs- und Verbundvorteile soll ein Teil des kreierten Wertes abgeschöpft werden, weshalb diese Strategieoption als internationale Wertschöpfung beschrieben wird (vgl. Zaheer, 1995, S. 343; Mizik und Jacobson, 2003, S. 63).

Eine international wertschöpfende Strategieausrichtung wird am Beispiel des Luxusmodeherstellers Gucci deutlich. Die Internationalisierung des Unternehmens basiert auf einer starken Markenorientierung (vgl. Swoboda et al., 2014, S. 320). Hierbei soll den weltweiten Kunden ein einheitliches Image durch eine zentralisierte Marketingstrategie vermittelt werden. Im global definierten Marktsegment der wohlhabenden Konsumenten hat das Unternehmen einen konsistenten Modegeschmack feststellen können, weshalb das Leistungsangebot international standardisiert ist. Ungeachtet der signifikanten Kulturunterschiede zum europäischen Heimmarkt setzte das Unternehmen diese Internationalisierungsstrategie im chinesischen Markteintritt fort. Das Gucci-Management entschied sich gegen eine lokale Adaption, um einer Schädigung des Markenimages vorzubeugen, das standardisierte Produktangebot international aufrechtzuerhalten und von Skaleneffekten zu profitieren (vgl. Goldman, 2001, S. 230).

2.1.3. Strategischer Trade-off

Die erläuterten internationalen Strategieoptionen stellen konträre Anforderungen an das Unternehmen und dessen Auslandseinheiten. Folglich entstehen strategische Trade-off-Entscheidungen für alle multinationalen Unternehmen, die beide Ansätze gleichzeitig in der Internationalisierungsstrategie implementieren wollen (vgl. Meyer und Estrin, 2014, S. 4). Es besteht allerdings keine immanent wechselseitige Abhängigkeit in der Ausprägung zwischen internationaler Wertgenerierung und internationaler Wertschöpfung. Ein Unternehmen mit einem geringen lokalen Anpassungsgrad operiert folglich nicht automatisch mit einer hohen globalen Integration et vice versa (vgl. Ghoshal und Nohria, 1993, S. 26). Die Kombination der beiden strategischen Grundausrichtungen entsteht infolge von hohem Wettbewerbsdruck auf internationalen Märkten. Mit einer Balance zwischen den beiden Strategiepolen zielen multinationale Unternehmen darauf ab, sich gegen Konkurrenten durchzusetzen und einen nachhaltigen Wettbewerbsvorteil zu generieren. Die einzelnen Komponenten der Wertschöpfungskette müssen dabei, in unterschiedlicher Weise, entweder global integrativ oder lokal adaptiv auf Umweltanforderungen reagieren (vgl. Mauri und Neiva de Figueiredo, 2012, S. 43).

Eine solche Auslegung der Internationalisierungsstrategie ist beim schwedischen Möbelhändler Ikea zu beobachten. Das globale Marketing des Unternehmens basiert, speziell in der Preis- und Produktpolitik sowie bezüglich des Warenhausdesigns, sowohl auf globaler Integration als auch auf lokaler Reagibilität. Das Produktsortiment betreffend ist jede Filiale weltweit verpflichtet, ein bestimmtes Kernproduktsortiment anzubieten. Hierdurch können Skaleneffekte geniert werden, und für die Konsumenten wird auf allen internationalen Märkten ein Wiedererkennungswert geschaffen. Außerhalb dieses Sortiments passen die Auslandseinheiten des Unternehmens das Angebot den lokalen Bedürfnissen an. In japanischen Filialen werden beispielsweise kleinere Sofas verkauft als in US-amerikanischen Filialen, um dem jeweiligen kulturellen Umfeld zu entsprechen. Vom wettbewerbsstrategischen Standpunkt aus strebt Ikea eine Kostenführerschaft an, weshalb die Preise in allen Märkten konstant niedrig gehalten werden müssen. Dieser zentralisierte Ansatz ist nicht in allen Ländern gleichermaßen umsetzbar. Polnische Konsumenten reagierten zunächst misstrauisch auf das Niedrigpreisangebot des Unternehmens, sodass die Preise erhöht werden mussten. Durch die Preiserhöhungen stieg das Vertrauen der Konsumenten in die Warenqualität. Die standardisierte Preispolitik wird bei negativen Kundenreaktionen folglich lokal angepasst. Das Design und die Größe der Warenhäuser sind ebenfalls von Trade-off-Entscheidungen geprägt. Das Basisformat der Filialen unterliegt bezüglich Farbe und Form einer internationalen Standardisierung. Weiterhin folgen alle in den jeweiligen Filialen enthaltenen Restaurants dem gleichen Aufbau und bieten die gleiche Menükarte an, welche sich auf schwedische Spezialitäten bezieht. Lokale Anpassung findet jedoch bezüglich der Nutzung des erworbenen Grundstückes statt. Da die Grundstückpreise in den verschiedenen Ländermärkten stark differieren, nutzt Ikea an einigen Standorten eine geringere Fläche. Die Filialen werden über mehrere Etagen gebaut und Parkhäuser integriert. Hier erfolgt also eine teilweise Adaption an lokale Marktbesonderheiten (vgl. Jonsson und Foss, 2011, S. 1089 ff.).

2.2. Marketing Capabilities

Eine von Trade-Off-Entscheidungen geprägte Internationalisierungsstrategie kann erfolgreich sein, wenn das Unternehmen bestimmte marktorientierte Fähigkeiten entwickelt. Diese in der Literatur als Marketing Capabilities bezeichneten Potenziale sind nötig, um die Internationalisierungsstrategie eines Unternehmens erfolgreich umzusetzen (vgl. Kotabe et al., 2002, S. 82). Marketing Capabilities sind als eine komplexe Zusammenstellung von unternehmensinternen Fähigkeiten und Wissenspotenzialen definiert, die benötigt werden, um Marketingaktivitäten zu realisieren und auf Änderungen am Markt reagieren zu können (**?**, S. 6). Die Marketingressourcen sollen in diesem Prozess möglichst effizient in Umsätze transformiert werden (vgl. Bahadir et al., 2008, S. 52). Die entscheidende Rolle von Marketing Capabilities in der Beziehung zwischen Internationalisierung und der finanziellen Performance wird in der empirischen Literatur mehrfach bewiesen (vgl. Dittfeld, 2017, S. 27; Bae et al., 2008, S. 73). Dittfeld (2017) stellt sowohl positive Effekte auf bilanzielle als auch auf marktorientierte Kennzahlen fest (vgl. Dittfeld, 2017, S. 27). Die Präsenz von Marketing Capabilities im internationalen Kontext kann daher aus Shareholderperspektive als Erfolgsindikator bewertet werden (vgl. Berry und Sakakibara, 2008, S. 298).

Trotz der starken Beachtung von Marketing Capabilities in der Literatur herrscht kein einheitliches Verständnis über dieses Konstrukt (vgl. **?**, S. 12). So identifizieren Vorhies und Morgan (2005), neben sieben weiteren Fähigkeiten, beispielsweise die Produktentwicklung als wichtige Marketing Capability eines Unternehmens (vgl. Vorhies und Morgan, 2005, S. 82). Andere Studien definieren Marketing Capabilities als das Management von Marktinformationen, um maximales Marketingknowhow abzuschöpfen (vgl. Narasimhan et al., 2006, S. 512). Weiterhin wird die Expertise in den Bereichen Markenmanagement, Kundenmanagement und Marketingplanung den Marketing Capabilities zugeordnet (vgl. Morgan et al., 2009, S. 286; Day, 1994, S. 44 f.). Ungeachtet der unterschiedlichen Interpretationen des Begriffs fokussiert eine Vielzahl von Arbeiten zwei bestimmte Arten von Marketing Capabilities, welche in der vorliegenden Arbeit durch die Vermarktungsfähigkeit und die Innovationsfähigkeit des Unternehmens dargestellt sind (vgl. Dutta et al., 1999, S. 550 f.).

Diese sind in das Framework nach Day (2011) einzuordnen, welches den Marketing Capabilities grundlegende Funktionen zuschreibt. Die erste Funktion der Marketing Capabilities beschreibt die effiziente Verwertung vorhandener Ressourcen und wird durch die Vermarktungsfähigkeit abgebildet. Dabei sollen bereits existierendes Marktwissen sowie Marktbearbeitungsprozesse und -fähigkeiten verbessert und weiterentwickelt werden (vgl. Day, 2011, S. 186 f.; Atuahene-Gima, 2005, S. 62). Die zweite Funktion bezieht sich auf die Erschließung neuer Ressourcen und wird durch die Innovationsfähigkeit dargestellt. Die Aneignung neuer Kenntnisse, Prozesse und Fähigkeiten steht hierbei im Vordergrund. Durch verstärktes Variieren und Experimentieren sollen die Flexibilität im Innovationsprozess und der Neuheitsgrad der Endprodukte erhöht werden (vgl. Slater & Narver, 1995, S. 68; Atuahene-Gima, 2005, S. 62).

2.3. Shareholder Value

Im Folgenden soll das Konzept des Shareholder Values thematisiert werden. Darüber hinaus wird dargelegt, mit welcher Motivation diese finanzielle Erfolgsgröße für die empirische Untersuchung in der vorliegenden Arbeit herangezogen wird. Der Shareholder Value beschreibt allgemein den Grad der Wertschöpfung für die Anteilseigner eines Unternehmens. Im Speziellen bewertet der Ansatz den Ertragswert eines Investments durch die Berücksichtigung von Cashflows. Diese setzen sich aus den Barwerten der aktuellen Wachstumsperiode sowie den langfristigen Residualwerten am Ende der Wachstumsperiode zusammen (vgl. Day und Fahey, 1988, S. 46). Diese Cashflows bilden die Basis für den Shareholder-Ertrag, welcher sich aus Aktienrenditen und Dividendenausschüttungen zusammensetzt (vgl. Rappaport,

1987, S. 59). Aufgrund der zukunftsorientierten Investmentbewertung, welche dem Shareholder Value zugrunde liegt, können spezifische Treiber dieser finanziellen Größe identifiziert werden (vgl. Kim et al., 1995, S. 260).

2.3.1. Treiber

Als erster Treiber des Shareholder Values wird die Beschleunigung von Cashflows angeführt. Durch schneller generierte Zugänge von Cashflows werden Risiko- und Zeitadjustierungen, durch die der Wert zukünftiger Cashflows gemindert wird, auf lange Sicht vermieden. Für den Anteilseigner folgt daraus die Erzielung eines höheren gegenwärtigen Kapitalwertes. Der Shareholder Value wird weiterhin durch eine Erhöhung der Cashflows aufgewertet, welche sich zum Beispiel durch gesteigertes Umsatzwachstum ergibt. Analog können verringerter Anlagen- und Betriebskapitalbedarf sowie gesenkte Gesamtkosten zu erhöhten Cashflows führen. Eine weitere wichtige Komponente ist die Senkung von Volatilität und Vulnerabilität der Cashflows. Aktienkurse lassen sich dementsprechend effektiver vorhersagen und weisen eine höhere Stabilität auf. Es folgt eine Senkung des Kursrisikos. Abschließend ist der Residualwert eines Investments als wichtiger Treiber des Shareholder Values anzuführen. Dieser entsteht aus dem Barwert, welcher dem Ende der Wachstumsperiode zugerechnet wird und einen signifikanten Anteil des Kapitalwertes darstellt. Der Residualwert ist demzufolge ein Erwartungswert, der zukünftig erwartete Cashflows berücksichtigt (vgl. Srivastava et al., 1998, S. 13). Die vorangegangenen Ausführungen beziehen sich auf wichtige Treiber des Shareholder Values und bilden gleichermaßen eine solide Grundlage für die Bewertung von Strategien (vgl. Day und Fahey, 1988, S. 45).

2.3.2. Strategiebewertung

Ein bedeutender Anteil des Unternehmenswertes ergibt sich aus dem wahrgenommenen Wachstumspotenzial und dem damit verbundenem Risiko. Der Shareholder Value berücksichtigt diese Kriterien und basiert demzufolge auf der Erwartungshaltung gegenüber zukünftigen Performancewerten (vgl. Kim et al., 1995, S. 260). Aufgrund myopischer Tendenzen neigen Manager dementgegen zur kurzfristigen Gewinnerzielung, weshalb häufig bilanzielle Kennzahlen zur Erfolgsmessung verwendet werden (vgl. Day und Fahey, 1988, S. 45). Beispielhaft kann die Kapitalrendite angeführt werden. Dieser betriebliche Messwert basiert neben zukünftigen Investments und Cashflows insbesondere auch auf nicht abgeschriebenen Investments aus vergangenen Perioden. Wenden zwei Unternehmen etwa identische Strategien an, so ist es vorstellbar, dass eines der Unternehmen die Planungsperiode mit höheren Investmentausgaben beginnt als das andere. Dieses Unternehmen weist folglich eine geringere Kapitalrendite auf, welche bei gleich hohen Cashflow-Erträgen zu strategischen Fehleinschätzungen auf Topmanagementebene führen kann. Strategien sind auf langfristige Ziele fokussiert und können somit als prospektive Konstrukte bezeichnet werden (vgl. Rappaport, 1983, S. 31). Marktorientierte Performancestandards wie der Shareholder Value sind in strategischen Entscheidungsprozessen daher von signifikanter Bedeutung. Bilanzielle Kennzahlen eignen sich nicht, um Strategien zu bewerten (vgl. Srivastava et al., 1998, S. 2 ff.).

Dieser Erklärungsansatz lässt sich auf das Handeln multinationaler Unternehmen übertragen. Der langfristige Wert einer Internationalisierungsstrategie spiegelt sich in der jeweiligen Börsenperformance der Unternehmen wider (vgl. Contractor et al., 2003, S. 9; Chari et al., 2007, S. 188). Aus Managementperspektive ist dabei zu beachten, dass etwaige Trade-off-Entscheidungen bei der Auswahl von verschiedenen Strategieoptionen einen Mehrwert für die Aktionäre schaffen müssen. Um Shareholder Value zu generieren, sollte jede mit Investments verbundene Strategieänderung im internationalen Kontext einen höheren Barwert zukünftiger Cashflows schaffen (vgl. Day und Fahey, 1988, S. 46). Analog werden die Marketing Capabilities, welche synergetisch mit der Internationalisierungsstrategie eines Unternehmens interagieren, vom Shareholder Value erfasst. Wie beschrieben, bezeichnen Marketing Capabilities die Fähigkeiten der Integration und Konvertierung von Ressourcen, um ein bestimmtes Marketingziel zu erreichen. Demgemäß setzen sich diese Fähigkeiten überwiegend aus immateriellen Bestandteilen zusammen (vgl. Xiong und Bharadwaj, 2013, S. 712). Hier besteht eine Parallele zum Marktwert von Unternehmen, der in signifikantem Maße auf immateriellen Vermögenswerten basiert. Dies wird durch die Betrachtung des Kurswert/Buchwert-Verhältnisses von börsennotierten Unternehmen deutlich (vgl. Srivastava et al., 1998, S. 4). Exemplarisch wird auf den Wilshire 5000-Aktienindex verwiesen, dessen Relation zwischen Kurs- und Buchwert 2,94 beträgt. Dies lässt vermuten, dass über 70 % des Marktwertes der im Wilshire 5000 gelisteten Unternehmen aus immateriellen Vermögenswerten resultieren (Wilshire Associates Incorporated, 2017). Sowohl Internationalisierungsstrategien als auch Marketing Capabilities eines Unternehmens können infolgedessen durch den marktorientierten Ansatz des Shareholder Values bewertet werden.

2.4. Forschungslücke

Die Literatur des internationalen Managements befasst sich seit über 50 Jahren mit der Wirkungsbeziehung zwischen der Internationalisierung eines Unternehmens und der finanziellen Performance. Die bislang veröffentlichten Studien kommen jedoch zu uneindeutigen Ergebnissen (vgl. Nguyen, 2017, S. 311). Einige Untersuchungen stellen positiv lineare Beziehungen zwischen den genannten Konstrukten fest, wobei die Vorteile der Internationalisierung im Vordergrund stehen (Kim et al., 1993, S. 284). Dementgegen existieren zusätzlich Studien, welche einen negativ linearen Effekt von Internationalisierung auf die Performance registrieren. Diese Sichtweise wird durch zu hohe Komplexitätskosten multinationaler Unternehmen begründet (Wan und Hoskisson, 2003, S. 32).

Nichtlineare Beziehungen berücksichtigen ferner sowohl den Nutzen als auch die Kosten der Internationalisierung. U-förmige Beziehungen deuten an, dass die Performance internationaler Unternehmen zunächst aufgrund zu hoher

Kosten sinkt. Im weiteren Verlauf der Internationalisierung entwickelt das Unternehmen erforderliches Knowhow und Fähigkeiten, um die entstandenen Herausforderungen zu bewältigen und zu profitieren (Lu und Beamish, 2001, S. 571 ff.). In Kontrast stehen die Arbeiten, denen eine invertiert U-förmige Relation zugrunde liegt. Die Autoren postulieren einen Anstieg des Nutzens bis zu einem bestimmten Schwellenwert. Nach Erreichen dieses Punktes überwiegen die Kosten und führen zu negativer Performance (vgl. Gomes und Ramaswamy, 1999, 181 ff.). Die Kombination aus den zwei vorgenannten Szenarien wird in S-förmigen Internationalisierung-Performance-Beziehungen diskutiert. Dem U-förmigen Zusammenhang ähnelnd, wird angenommen, dass Unternehmen in frühen Internationalisierungsphasen negative und im weiteren Verlauf positive Performancewerte aufweisen. Analog zur invertiert U-förmigen Relation folgt ein Grenzbereich des Internationalisierungsgrades, bei dessen Überschreiten das Unternehmen negative Performancewerte erreicht (vgl. Lu und Beamish, 2004, S. 606).

Für die konfligierenden Ergebnisse in der Beziehung zwischen Internationalisierung und Performance gibt es unterschiedliche Erklärungsansätze, die in zwei Gruppen separiert werden können. Die erste Gruppe befasst sich mit verschiedenen methodischen Herangehensweisen und deren Wirkung auf die Internationalisierung-Performance-Beziehung. Dazu gehören uneinheitliche Untersuchungszeiträume, verschiedene Ansätze für Endogenitätskontrollen und unterschiedliche Operationalisierungen der Hauptvariablen (vgl. Marano et al., 2016, 1080). So verwenden einige Studien bei der Darstellung der Performance-Variable langfristige, marktorientierte Größen. Die Mehrzahl der Untersuchungen zieht jedoch einen kurzen Zeithorizont berücksichtigende bilanzielle Kennzahlen heran (vgl. Nguyen, 2017, S. 322). Aus den in Unterabschnitt 2.3.2. genannten Gründen bezieht sich diese Arbeit auf marktorientierte Messgrößen. Demzufolge werden in der Forschungslücke (Tabelle 1) ausschließlich Studien präsentiert, welche den Zusammenhang zwischen Internationalisierung und Shareholder Value untersuchen. Um eine übersichtliche Tabelle sicherzustellen, werden die Moderatoren Innovationsfähigkeit und Vermarktungsfähigkeit einmalig mit IF und VF abgekürzt.

Dabei ist hervorzuheben, dass die Mehrzahl der Arbeiten die marktbasierte Kennzahl Tobin's Q verwenden, welche auf dem Verhältnis zwischen dem Marktwert des Unternehmens und dem Wiederbeschaffungswert aller Vermögensgegenstände basiert (vgl. Servaes und Tamayo, 2013, S. 1050). Einige Studien verwenden stattdessen die Aktienrendite (Stock Return) als abhängige Variable, welche die Gewinn- und Verlustentwicklungen eines Aktienkurses im Zeitverlauf angibt (vgl. Srinivasan und Hanssens, 2009, S. 299). Beide Kennzahlen können als aktienpreisbasierte Größen verstanden werden (vgl. Luo und Bhattacharya, 2006, S. 6). Dennoch weist die Aktienrendite, speziell die abnormale Aktienrendite, für die Darstellung des Shareholder Values einen entscheidenden Vorteil auf. Die Kennzahl ist im Gegensatz zu Tobin's Q risikoadjustiert. Mit der Einbeziehung des Anlagerisikos wird folglich ein wichtiger Bestandteil des Shareholder Values abgebildet. Deshalb bildet die abnormale Aktienrendite die erste abhängige Variable dieser Arbeit (vgl. Srinivasan und Hanssens, 2009, S. 299 ff.).

Der langfristige Shareholder Value basiert darüber hinaus neben Höhe und Wachstum von Aktienrenditen auf der Volatilität des Aktienpreises (vgl. Srivastava et al., 1998, S. 9). Höhere Volatilitätskennzahlen des Aktienkurses repräsentieren ein steigendes Investmentrisiko und instabilere zukünftige Cashflows (vgl. Srivastava et al., 1998, S. 12). Ohne eine geeignete Volatilitätskennzahl kann demzufolge nicht bestimmt werden, ob die erwarteten Aktienrenditen das Investmentrisiko des Anlegers kompensieren (vgl. Anderson, 2006, S. 587). Die Volatilität wird in der Studie von Michel und Shaked (1986) beispielsweise als Standardabweichung der Aktienrenditen (σ Stock Return) und durch das systematische Risiko operationalisiert (vgl. Michel und Shaked, 1986, S. 93). Eine weitere mögliche Volatilitätskennzahl ist das idiosynkratische Risiko (vgl. Hughes et al., 1975, S. 628). Das systematische Risiko betrifft alle Aktien gleichermaßen, da der Ursprung in Ereignissen liegt, welche vom Unternehmen nicht beeinflusst werden können. Der Anteil am Gesamtrisiko beträgt ca. 20 %. Das idiosynkratische Risiko bezieht sich auf Unternehmensspezifika und kann daher von Unternehmen beeinflusst werden. Die Kennzahl bildet ca. 80 % des Gesamtrisikos ab. Da Trade-off-Entscheidungen der Internationalisierung zu unternehmensspezifischen Aktivitäten gehören, wird in dieser Arbeit das idiosynkratische Risiko als zweite abhängige Variable herangezogen (vgl. Luo und Bhattacharya, 2009, S. 199 f.). Abschließend ist festzuhalten, dass die Aktienrendite und das Aktienrisiko bislang wenig Beachtung in der Beziehung zwischen Internationalisierung und SV finden. Durch die Implementierung der beiden Variablen wird also ein wissenschaftlicher Mehrwert generiert.

Eine weitere methodische Schwierigkeit ergibt sich aus der Operationalisierung der unabhängigen Variable, da die Arbeiten jeweils verschiedene Aspekte der Internationalisierung adressieren. Das Scale-Maß oder die Internationalisierungstiefe beschreibt beispielsweise die strategische Wichtigkeit, welche das jeweilige Unternehmen der Bearbeitung ausländischer Märkte beimisst. Die Operationalisierung erfolgt hier über Verhältnisgrößen. Eine beispielhafte Kennzahl ist die Relation zwischen den Mitarbeitern im Ausland und der Mitarbeitergesamtzahl des Unternehmens. Eine optionale Variante der Operationalisierung ist das Scope-Maß oder die Internationalisierungsbreite. Der Fokus liegt auf dem Spektrum der zu bearbeitenden internationalen Märkte, wodurch die Heterogenität der Internationalisierung abgebildet wird. Häufig wird die Anzahl der Länder, in denen das Unternehmen operiert, für die Messbarmachung herangezogen (Marano et al., 2016, 1080). Weitere Studien messen die Internationalisierung mit multidimensionalen Konstrukten durch die Kombination von Scale- und Scope-Maßen (vgl. Hitt et al., 2006, S. 1145). Darüber hinaus stützen sich einige Studien auf Entropiemaße. Diese werden verwendet, um die Ausmaße der Internationalisierung in verschiedenen ausländischen Märkten in Relation zueinander zu setzen. Hitt et al. (1997)

Tabelle 1: Übersicht der Forschungslücke; Quelle: Eigene Darstellung

	Maße der Internationalisierung			Shareholder Value		Marketingmoderatoren	
Studie	Input vs. Output	Input	Output	Aktienpreis-basiertes Maß	Aktienrisiko	VF	IF
Doukas und Lang (2003)		√ (FDI)		√ (Stock Return)			
Berry (2001)		√ (FDI)		√ (Tobin's Q)		√ (ADV.)	√ (R&D)
Berry (2006)		√ (FDI)		√ (Tobin's Q)			
Berry und Sakakibara (2008)		√ (FDI.-Scope)		√ (Tobin's Q)		√ (ADV.)	√ (R&D)
Chari et al. (2007)			√ (FSTS-Scope)	√ (Tobin's Q)			
Rugman und Oh (2010)			√ (FSTS)	√ (Tobin's Q)		√ (ADV.)	√ (R&D)
Dittfeld (2017)		√ (FATA)	√ (FSTS)	√ (Tobin's Q)		√ (SGA)	√ (R&D)
Eckert et al. (2010)		√ (FATA)	√ (FSTS)	√ (Tobin's Q)		√ (SGA)	√ (R&D)
Hughes et al. (1975)		√ (FATA)	√ (FSTS)	√ (Stock Return)	√ (System. Risk Idiosyncr. Risk)		
Michel und Shaked (1986)		√ (FDI-Scope)	√ (FSTS)	√ (Stock Return)	√ (System. Risk Stock Return)		
Diese Studie	√ (ISE Ratio)	√ (FATA)	√ (FSTS)	√ (Stock Return)	√ (Idiosyncr. Risk)	√ (SGA)	√ (R&D)

messen etwa die nach Marktregion gewichteten internationalen Umsätze (vgl. Hitt et al., 1997, S. 780). Die vorgestellten Maße lassen sich in Input- und Outputgrößen differenzieren. Internationale Wertgenerierung wird beispielsweise durch das Verhältnis zwischen den im Ausland befindlichen Vermögenswerten und den gesamten Vermögenswerten des Unternehmens ausgedrückt und bildet damit eine Inputgröße (vgl. Thomas und Eden, 2004, S. 92 ff.; Tseng et al., 2007, S. 962 f.). Dieses Verhältnis ist in Tabelle 1 durch die Abkürzung des englischen Begriffs Foreign Assets to Total Assets (FATA) markiert. Internationale Wertschöpfung kann sich zum Beispiel auf die Relation zwischen den im Ausland generierten Umsätzen und den gesamten Umsätzen des Unternehmens beziehen. In Tabelle 1 ist diese Relation durch die Abkürzung des Begriffes Foreign Sales to Total Sales (FSTS) dargestellt. Hiermit wird eine mögliche Outputgröße der Internationalisierung dargestellt (vgl. Thomas und Eden, 2004, S. 92 ff.; Upadhyayula et al., 2017, S. 73).

Wie Tabelle 1 verdeutlicht, können in Bezug auf den Input-Output Kontext der Internationalisierung-Shareholder Value-Beziehung drei verschiedene Literatur-Streams identifiziert werden. Aus dem ersten Stream gehen Studien hervor, die sich ausschließlich auf Inputgrößen konzentrieren. Doukas und Lang (2003) messen den Input der Internationalisierung etwa mithilfe ausländischer Direktinvestitionen (siehe Tabelle 1: FDI) im Rahmen einer Event-Studie. Der Fokus liegt auf dem Erwerb neuer Produktionsanlagen im Ausland. Die Autoren kommen zu dem Ergebnis, dass die Erweiterung des Kerngeschäfts auf ausländische Märkte einen positiven Effekt auf den Shareholder Value erzielt (vgl. Doukas und Lang, 2003, S. 167). Weitere Studien messen die Internationalisierungstiefe ebenfalls durch eine Inputgröße. Berry (Berry, 2001); Berry, 2006) beispielsweise nutzt in zwei verschiedenen Studien die Anzahl der Auslandsniederlassungen eines Unternehmens, um den Grad des Internationalisierungsinputs zu bestimmen. Die Studie aus dem Jahr 2001 Studie zeigt länderspezifische Unterschiede hinsichtlich des Einflusses der Internationalisierung auf den Shareholder Value. Dabei werden positive Effekte für japanische und negative Effekte für US-amerikanische Unternehmen festgestellt (vgl. Berry, 2001, S. 4 ff.). In der zweiten Untersuchung des Jahres 2006 erfolgt eine Aufgliederung der Inputgröße. Die Zahl der Auslandsniederlassungen in Entwicklungsländern wird der in Industrieländern gegenübergestellt. Zudem werden wissensintensive mit nicht wissensintensiven Branchen verglichen. In dieser Studie wird festgestellt, dass die Internationalisierung unter bestimmten Voraussetzungen einen positiven Einfluss auf den Shareholder Value ausüben kann. In wissensintensiven Branchen reagieren die Shareholder beispielsweise positiv, wenn das Unternehmen seine Auslandsinvestitionen sowohl in Entwicklungs- als auch in Industrieländern tätigt (vgl. Berry, 2006, S. 1137 f.).

Der zweite Literatur-Stream fokussiert Outputgrößen zur Operationalisierung der unabhängigen Variable. Exemplarisch ist die Studie von Chari et al. (2007) zu nennen. Das von den Autoren verwendete FSTS-Verhältnis spiegelt den Output der Internationalisierung wider. Als zweite Komponente fließt die Anzahl der Länder ein, in denen das Unternehmen tätig ist. Anhand einer Hauptkomponentenanalyse wird ein Index erstellt, welcher sowohl die Tiefe als auch die Breite der Internationalisierung darstellt. Den Untersuchungskern bildet die moderierende Wirkung von IT-Investments auf die Beziehung zwischen Internationalisierung und Shareholder Value. Dabei wird konstatiert, dass multinationale Unternehmen mit hohen IT-Investments positive Effekte auf den Shareholder Value durch internationale Diversifikation zu erwarten haben. Unternehmen mit schwach ausgeprägten IT-Investments zeigen hingegen negative Internationalisierungseinflüsse auf den Shareholder Value (vgl. Chari et al., 2007, S. 188 ff.). Der Internationalisierungsoutput findet ferner in der Arbeit von Rugman und Oh (2010) Beachtung. Anders als in der vorangehend erläuterten Studie findet hier ausschließlich die Betrachtung der Internationalisierungstiefe statt. Die Outputgröße wird dabei in zwei unterschiedliche Kennzahlen aufgeteilt, welche anschließend in ihrer Wirkung auf den Shareholder Value verglichen werden. Die erste Kennzahl misst Umsätze, die innerhalb der Heimatregion des Unternehmens generiert werden. Die potentiellen Heimatregionen gliedern sich hierbei in Nordamerika, Europa und Asien/Pazifik. Eine zweite Kennzahl soll all jene Umsätze erfassen, die außerhalb der Heimatregion erzielt werden. Die Autoren stellen heraus, dass Shareholder internationale Aktivitäten in der Heimatregion positiver bewerten, als solche, die darüber hinausreichen (vgl. Rugman und Oh, 2010, 485 f.).

Die Untersuchungen des dritten Literatur-Streams thematisieren Input- und Outputvariablen der Internationalisierung simultan. Hughes et al. (1975) etwa vergleichen multinationale Unternehmen mit nicht international aktiven Unternehmen. Durch die Betrachtung zweier Portfolios werden die verschiedenen Unternehmensarten miteinander verglichen. Die Selektionskriterien der Autoren legen fest, dass ein multinationales Unternehmen mindestens 10 % ausländische Vermögenswerte oder mindestens 10 % im Ausland generierte Umsätze aufweisen muss. Die Studie identifiziert multinationale Unternehmen demnach sowohl über Inputals auch über Outputgrößen (vgl. Hughes et al., 1975, S. 631). Eine ähnliche Vorgehensweise findet sich in der Arbeit von Michel und Shaked (1986). Hier wird die Bedingung formuliert, dass die Unternehmen im multinationalen Portfolio mindestens 20 % im Ausland generierte Umsätze aufweisen müssen und mindestens in sechs Ländern mit ausländischen Direktinvestitionen tätig sind. Das letztgenannte Kriterium beschreibt eine Inputgröße, die gleichzeitig die Anzahl der Länder berücksichtigt und somit neben der Internationalisierungstiefe ebenfalls die Breite behandelt. Beide Studien kommen zu dem Ergebnis, dass das Aktienrisiko der multinationalen Unternehmen geringer ausfällt als das Risiko der rein inländisch operierenden Unternehmen. Die Arbeit von Hughes et al. (1975) belegt weiterhin höhere Aktienrenditen multinationaler Unternehmen. Konträr beweisen Michel und Shaked (1986), dass multinationale Unternehmen signifikant geringere Aktienrenditen generieren als Inlandsunternehmen. (vgl. Hughes et al., 1975, S. 636; Michel und

Shaked, 1986, S. 99). Während die vorgenannten Studien Input- und Outputgrößen zur Identifikation von multinationalen Unternehmen nutzen, untersucht Dittfeld (2017) den direkten Einfluss von Input- und Outputvariablen auf den Shareholder Value separat voneinander. Der Internationalisierungsinput wird durch das FATA- und der Internationalisierungsoutput durch das FSTS-Verhältnis abgebildet. Für beide Kennzahlen werden positiv lineare Effekte auf den Shareholder Value festgestellt (vgl. Dittfeld, 2017, S. 22).

Die vorangehenden Erläuterungen zeigen, dass für die Operationalisierung der Internationalisierungsvariable verschiedene Ansätze genutzt werden, die zu unterschiedlichen Implikationen für den Shareholder Value führen. In Anlehnung an Mizik und Jacobson (2003) sollten wertgenerierende und wertschöpfende Faktoren in Relation zueinander untersucht werden, um die strategische Schwerpunktgewichtung des Unternehmens zu berücksichtigen (vgl. Mizik und Jacobson, 2003, S. 65). Eine solche Verhältniskennzahl zwischen Input und Output findet in der Internationalisierung-Performance-Beziehung bisher keine Beachtung. Diese Forschungslücke wird in der vorliegenden Arbeit durch die Operationalisierung des Trade-offs zwischen internationaler Wertgenerierung, dargestellt durch das FATA-Verhältnis, und internationaler Wertschöpfung, ausgedrückt durch das FSTS-Verhältnis, geschlossen. Zur Überwindung der methodischen Schwierigkeiten versucht eine zweite Gruppe von Studien, die konfligierenden Ergebnisse mit verschiedenen aus der Theorie hergeleiteten Moderatoren zu erklären. Wie in Abschnitt 2.2. erwähnt, bestätigen empirische Untersuchungen die signifikante Bedeutung von Marketing Capabilities in der Beziehung zwischen Internationalisierung und Performance. Die methodische Darstellung von Marketing Capabilities kann auf verschiedene Arten erfolgen. Mishra und Modi (2016) verwenden zum Beispiel ein Maß, das die Marketing Capability eines Unternehmens in Relation zu dem Durchschnittswert der jeweiligen Branche misst (vgl. Mishra und Modi, 2016, S. 32). Eine weitere Möglichkeit der Messbarmachung besteht darin, zwei entscheidende Funktionen von Marketing Capabilities in Relation zueinander darzustellen (Mizik und Jacobson, 2003, S. 66). In der Internationalisierungsliteratur werden Marketing Capabilities vorwiegend durch deren grundlegende Funktionen dargestellt. Diese werden mit der Vermarktungs- und der Innovationsfähigkeit eines Unternehmens abgebildet und separat in ihrem Einfluss auf den Shareholder Value betrachtet (vgl. Rugman und Oh, 2010, S. 485).

Beispielhaft ist die Studie von Berry und Sakakibara (2008) zu nennen, welche die Vermarktungsfähigkeit durch Werbeausgaben (Advertising - ADV) und die Innovationsfähigkeit durch Forschungs- und Entwicklungsausgaben (Research & Development - R&D) charakterisiert (Tabelle 1). Konträr zu den Ergebnissen vorheriger Studien können die Autoren keine signifikante Wirkung der Marketingmoderatoren auf die Internationalisierung- Shareholder Value-Beziehung herausfiltern. Dies wird durch das japanische Unternehmenssample begründet, auf dessen Grundlage die Forschungsergebnisse basieren. Die Annahme lautet, dass Investoren aufgrund kultureller und internationalisierungspolitischer Unterschiede japanische Unternehmen anders bewerten als beispielsweise US-Unternehmen. (vgl. Berry und Sakakibara, 2008, S. 297). Die Mehrheit der Studien aus Tabelle 1 hingegen identifiziert signifikante Einflüsse der genannten Marketingmoderatoren, die sich sowohl positiv als auch negativ auf den Shareholder Value auswirken können (vgl. Rugman und Oh, 2010, S. 485 f.; Dittfeld, 2017, S. 26). In Anlehnung an Dittfeld (2017) und Eckert et al. (2010) werden in dieser Arbeit Vertriebs-, Verwaltungs- und Gemeinkosten für die Vermarktungsfähigkeit herangezogen (vgl. Eckert et al., 2010, S. 569; Dittfeld, 2017, S. 19). In Tabelle 1 werden diese durch die Abkürzung des englischen Begriffs Selling, General and Administrative Expenditures (SGA) kenntlich gemacht. Auf Basis der Studien aus Tabelle 1, basiert die Innovationsfähigkeit auf den Forschungs- und Entwicklungsausgaben (Research & Development Expenditures – R&D) der Unternehmen.

3. Theorien und Hypothesen

3.1. Resource-Based-View

Auf Basis der konzeptionellen Grundlagen sollen im Folgenden Theorien vorgestellt werden, welche die Beziehung zwischen Internationalisierung und dem Shareholder Value erklären. Dafür werden der Resource-Based-View, das Konzept der Liabilities of Foreignness und die Theorie der Dynamic Capabilities zunächst jeweils separat erläutert. Ferner wird das Zusammenwirken der Theorien in Bezug auf die Internationalisierungsforschung herausgestellt. Aus den empirischen Ergebnissen bisheriger Studien werden im Anschluss die Hypothesen für die Beziehung zwischen dem internationalen Strategie-Trade-off und dem Shareholder Value hergeleitet. Zudem wird der prognostizierte Moderationseffekt der Marketing Capabilities formuliert. Aus den unterschiedlichen Wirkungsbeziehungen ergibt sich infolgedessen das Gesamtmodell der Studie.

Der Resource-Based-View ist ein Denkansatz des strategischen Managements und legt die Ressourcen eines Unternehmens als dessen Erfolgsfaktoren fest. Die Theorie postuliert, dass die externe Marktausrichtung von den internen Stärken des Unternehmens abhängt. Der Leitgedanke des Konzepts wird von Barney (1991) anhand der Beziehung zwischen Ressourcen, Wettbewerbern und der Erzeugung von Mehrwert formuliert. Ein Unternehmen muss Leistungen demnach so erstellen, dass diese durch Alleinstellungsmerkmale für Konkurrenten nicht imitierbar sind. Gleichermaßen darf der Mehrwert dieser Leistungen langfristig nicht durch den Wettbewerb reproduziert werden (vgl. Barney, 1991, S. 99 ff.). Diesen nachhaltigen Wettbewerbsvorteil kann das Unternehmen durch den Einsatz und die Kombination bestimmter Ressourcen generieren. Als Ressourcen werden gemeinhin alle tangiblen und intangiblen Vermögenswerte definiert, welche dazu dienen die Unternehmensziele zu erreichen (vgl. Kozlenkova et al. (2014), S. 5 ff.). Beispielhafte Ressourcen können Maschinenanlagen, Handelsverträge, Kapital oder Markennamen sein (vgl. Wernerfelt, 1984, S. 172).

Diese ressourcenbasierte Perspektive setzt zwei fundamentale Annahmen voraus, mithilfe derer die Entstehung nachhaltiger Wettbewerbsvorteile erklärt werden kann. Unternehmen besitzen zunächst unterschiedliche Ressourcenbündel im Vergleich zu ihren Konkurrenten. Dies trifft auch für Unternehmen zu, die in der gleichen Branche operieren. Eine solche Ressourcenheterogenität impliziert, dass einige Unternehmen bestimmte Aktivitäten qualifizierter ausführen können als der Wettbewerb, da sie über spezifische Ressourcen verfügen (vgl. Peteraf und Barney, 2003, S. 316 f.). Eine weitere Annahme der Theorie betrifft den potentiellen Transfer der Ressourcen. Gemäß dieser Annahme sind die Eigenschaften der verschiedenen Unternehmensressourcen zu unterschiedlich, um zwischen Unternehmen transferiert zu werden. Diese Ressourcenimmobilität suggeriert das langfristige Fortbestehen der durch heterogene Ressourcen erzeugten Wettbewerbsvorteile (vgl. Kozlenkova et al. (2014), S. 3). Dabei ist zu beachten, dass nicht alle Ressourcen des Unternehmens dazu geeignet sind, nachhaltige Wettbewerbsvorteile zu generieren. Um dieses Potenzial ausschöpfen zu können, müssen bestimmte Kriterien erfüllt sein, welche nachfolgend erläutert werden.

Unternehmensressourcen müssen demnach wertvoll, selten, nicht vollständig imitierbar und vom Unternehmen verwertbar sein. Die Wertigkeit einer Ressource ist gegeben, wenn dessen strategischer Einsatz dem Unternehmen hilft Chancen zu nutzen und Bedrohungen zu neutralisieren. Steigende Kosten können beispielsweise als externe Bedrohung aufgefasst werden, und die Steigerung des Umsatzes kann eine Chance darstellen. Der Besitz von wertvollen Ressourcen allein ist noch nicht ausreichend, um Wettbewerbsvorteile zu generieren, da Konkurrenten ebenfalls über solche Ressourcen verfügen können. Das zweite Kriterium legt fest, dass eine Ressource durch einen gewissen Seltenheitswert gekennzeichnet sein muss. Die Ressource darf sich folglich nur im Besitz einer geringen Anzahl konkurrierender Unternehmen befinden. Wertvolle Ressourcen, die keinen Seltenheitsfaktor aufzeigen, sind dennoch nicht zu ignorieren, da sie Wettbewerbsparität schaffen können. Hierdurch wird das Fundament für wirtschaftliches Überleben gelegt. Wertvolle und gleichzeitig seltene Ressourcen können ferner zu kurzfristigen Wettbewerbsvorteilen führen. Wenn Wettbewerber die Ressource jedoch zu minimalen Kostennachteilen kopieren können, ist kein langfristiger Wettbewerbsvorteil möglich.

Eine Ressource muss daher zusätzlich die Eigenschaft der nicht vollständigen Imitierbarkeit aufweisen. Dieses Kriterium ist erfüllt, wenn die Akquisition oder die Entwicklung der Ressource für Konkurrenten mit zu hohen Kosten verbunden sind. Andere Unternehmen können die Ressource also nicht direkt duplizieren oder substituieren. Die drei vorangehend erläuterten Merkmale bilden die Basis für einen langfristigen Wettbewerbsvorteil. Das letzte Kriterium betrifft nicht die Ressource, sondern die Fähigkeiten des Unternehmens. Für die ganzheitliche Ausschöpfung eines nachhaltigen Wettbewerbsvorteils muss das Unternehmen in der Lage sein, das vollständige Potenzial der Ressourcen zu verwerten. Mangelhafte organisatorische Prozesse und Methoden können das Ressourcenpotenzial unterminieren. Aus diesem Grund muss das Unternehmen die erforderliche organisatorische Expertise besitzen, um aus wertvollen, seltenen und nicht imitierbaren Ressourcen nachhaltige Wettbewerbsvorteile zu erzielen (vgl. Barney, 1991, S. 106 ff.; Kozlenkova et al. (2014), S. 3).

Im Kontext der Internationalisierungsliteratur kann die ressourcenorientierte Unternehmenssicht zur Erklärung der Vorteile von internationalen Aktivitäten herangezogen werden (vgl. Nguyen, 2017, S. 318). Die Kernthese dieses Ansatzes lautet, dass die oben beschriebenen erfolgversprechenden Ressourcen in ausländische Märkte übertragen werden können, wodurch das Unternehmen von verschiedenen Vorteilen profitiert. Die Ausweitung der Ressourcen auf internationaler Ebene kann dabei zu Skalen- und Verbundeffekten führen. Hieraus ergibt sich eine Steigerung der Kapitalrendite hinsichtlich der eingesetzten Ressourcen und eine Reduktion der Cashflow-Variabilität (vgl. Tallman und Li, 1996, S. 179). Ein weiterer ressourcenbedingter Vorteil für international agierende Unternehmen entsteht aus einem Anstieg der Erfahrungskurve. Durch Lerneffekte und dem daraus resultierenden Aufbau eines internationalen Ressourcennetzwerkes, können beispielsweise Wissensressourcen effizient in verschiedene ausländische Märkte transferiert werden, um einen nachhaltigen Wettbewerbsvorteil zu erwirken (vgl. Kogut, 1984, S. 160; Hitt et al., 1997, S. 771). Aufgrund dieser Eigenschaft können multinationale Unternehmen flexibler auf Schwankungen in wichtigen ökonomischen Parametern reagieren. Exemplarisch ist die Abwertung einer Landeswährung zu nennen, wodurch die Lohn- und Materialkosten im jeweiligen Markt sinken. Mit einer internationalen Ressourcenbasis und der nötigen Verwertungsfähigkeit bietet sich die Chance, die Produktion schnell und effizient in den kostengünstigeren Markt zu verlagern. Diese Flexibilität ermöglicht dem multinationalen Unternehmen einen Wettbewerbsvorteil gegenüber einem rein inländisch wirtschaftenden Unternehmen und führt zu Gewinnsteigerungen (vgl. Kogut, 1984, S. 162).

Ressourcen werden weiterhin als alle Vermögenswerte erfasst, die das Unternehmen zur Entwicklung und Implementierung einer effizienten und effektiven Strategie befähigen (vgl. Barney, 1991, S. 101). In Bezug auf die Internationalisierungsstrategie eines Unternehmens können insbesondere zwei Ziele identifiziert werden. Einerseits können multinationale Unternehmen bereits vorhandene Ressourcen nutzen, um in neue Märkte vorzustoßen. Dieser strategische Pfad bezieht sich auf die internationale Wertschöpfung. Andererseits eröffnet sich die Möglichkeit, neue Ressourcen in neuen Märkten zu entwickeln. Diese Herangehensweise betrifft die internationale Wertgenerierung. (vgl. Kozlenkova et al. (2014), S. 6). Der Trade-off zwischen den Strategieoptionen wird, aus Sicht des ressourcenorientierten Ansatzes, in der erforderlichen internationalen Ressourcenallokation widergespiegelt. Da der Ausgangspunkt des Resource-Based-View auf der Annahme der Ressourcenknappheit basiert, müssen die Vermögenswerte möglichst effizient inner-

halb des Unternehmens verteilt werden (vgl. Mizik und Jacobson, 2003, S. 63). Der Ideologie dieser Ausführungen folgend, kann eine Internationalisierungsstrategie und die damit einhergehenden Trade-off-Entscheidungen nur dann erfolgreich sein, wenn die Kriterien der ressourcenorientierten Unternehmenssicht erfüllt sind (vgl. Barney, 1991, S. 103 f.). Studien der Internationalisierungsliteratur beweisen ferner, dass Shareholder die erläuterte Betrachtungsweise teilen. Berry und Sakakibara (2008) drücken es wie folgt aus: "[...] our findings suggest that shareholders do indeed view firms as the Resource-Based-View suggests: as bundles of resources and routines." (Berry und Sakakibara, 2008, S. 298). Die Investoren stehen dem internationalen Engagement allerdings skeptisch gegenüber. Einen Erklärungsansatz für diese Vorbehalte liefern die wahrgenommenen myopischen Tendenzen internationaler Manager, durch welche der Shareholder Value vernachlässigt wird (vgl. Morck und Yeung, 1991, S. 166). Das Hauptargument für die Ablehnung der Internationalisierung liefern jedoch die sogenannten Kosten der Internationalisierung (vgl. Denis et al., 2002, S. 6). Diese werden allgemein als Liabilities of Foreignness bezeichnet und werden im nachfolgenden Abschnitt behandelt.

3.2. Liabilities of Foreignness

Während der Resource-Based-View Vorteile Benefits für multinationale Unternehmen erklärt, bietet das Konzept der Liabilities of Foreignness ein geeignetes Framework, um die Internationalisierungskosten zu beschreiben (vgl. Nguyen, 2017, S. 318). Laut Zaheer (1995) fallen darunter alle Kosten, die für multinationale Unternehmen, im Vergleich zu rein inländisch agierenden Unternehmen, zusätzlich anfallen. Als Konsequenz kann sich ein Wettbewerbsnachteil ergeben (vgl. Zaheer, 1995, S. 342 f.). Einige Arbeiten der finanzwissenschaftlichen Literatur finden negative oder insignifikante Wirkungsbeziehungen zwischen Internationalisierung und Shareholder Value. Die Autoren führen diese Ergebnisse auf die Liabilities of Foreignness zurück (vgl. Denis et al., 2002, S. 33; Christophe, 1997, S. 460). Im Folgenden werden daher die vier zentralen Ursachen dieser Internationalisierungskosten dargestellt. In Verbindung damit werden die Auswirkungen auf den Shareholder Value erläutert. Zur Veranschaulichung sollen Beispiele zu den Beziehungen zwischen chinesischen und US-amerikanischen Geschäftspartnern dienen.

Der erste Kostenfaktor bezieht sich auf die räumliche Distanz und die verschiedenen Zeitzonen zwischen der Firmenzentrale und den unterschiedlichen ausländischen Märkten. Beispielhaft sind Transport-, Reise- und Koordinationskosten zu nennen (vgl. Zaheer, 1995, S. 343). Aus Shareholder-Perspektive wird hierdurch die Kommunikation und Koordination der Unternehmenspolitik erschwert. Investoren fürchten ferner die Entstehung von Informationsasymmetrien zwischen der Firmenzentrale und den Managern in den Niederlassungen. Folglich gestaltet sich die Überwachung der Entscheidungsfindung im Management komplexer, wodurch der Shareholder Value sinkt (vgl. Denis et al., 2002, S. 6 f.). Bei Investments in die chinesische Wirtschaft bevorzugen US-amerikanische Unternehmen etwa den Austausch im direkten Gegenüber. Diese Art der Kommunikationskultur führt jedoch durch lange Reisezeiten und daraus resultierende Jetlags zu erschwerten Bedingungen der Auslandsgeschäfte (vgl. Chen et al., 2006, S. 639).

Eine zweite Schwierigkeit für internationale Unternehmen entsteht durch unternehmensspezifische Kosten in Bezug auf den jeweiligen lokalen Markt (vgl. Zaheer, 1995, S. 343). Durch ein unvertrautes soziales, rechtliches, politisches und ökonomisches Umfeld wird der Erfolg internationaler Operationen gehemmt (vgl. Chen et al., 2006, S. 639). Die mangelnden Kenntnisse über den ausländischen Markt führen aus Sicht der Shareholder beispielsweise zu erhöhten Kosten des Aufbaus von Kunden- und Lieferantenbeziehungen (vgl. Li, 2007, S. 120). Exemplarisch werden die Geschäftsbeziehungen zwischen US-amerikanischen und chinesischen Unternehmen angeführt. Im Verlauf der Geschäftsverhandlungen versuchen beide Seiten ein gutes Verhältnis zueinander aufzubauen. Es hat sich jedoch herausgestellt, dass die chinesischen Partner die Geschäftsbeziehung erst langfristig pflegen wollen, wenn der US-amerikanische Partner versichert, das Unternehmen bei Konflikten nicht zu verklagen. Dieser Streitpunkt resultiert aus der jeweils kulturell unterschiedlichen Interpretation von Freundschaft. US-amerikanische Unternehmen interpretieren ein freundschaftliches Verhältnis mit der Bedingung, Geschäftsvereinbarungen ohne Ausnahme einzuhalten. Eine Absicherung gegen etwaiges Fehlverhalten des Gegenübers kann dabei auf rechtlichen Schritten beruhen. Die chinesische Auffassung von Freundschaft hingegen schließt das Verklagen von Geschäftspartnern von vornherein aus. Somit entstehen kulturelle Differenzen, welche den Internationalisierungserfolg eindämmen (vgl. Chen et al., 2006, S. 639).

Kosten, die aus dem lokalen behördlichen Umfeld des Ziellandes entstehen, bilden den dritten Teil des Konstruktes der Liabilities of Foreignness. Die mangelnde Legitimität des Unternehmens im ausländischen Markt oder die Ausübung von Wirtschaftsnationalismus gehören zu den Ursachen (vgl. Zaheer, 1995, S. 343). Diese bürokratischen und administrativen Beschränkungen, verursacht durch ausländische Behörden, werden von Shareholdern als Risiko wahrgenommen (vgl. Michel und Shaked, 1986, S. 90 f.). Als Beispiel dient erneut der chinesische Markt. Wenn US-amerikanische Unternehmen Investments in China vornehmen wollen, sind häufig konfligierende Interessen zwischen dem Regierungsapparat und dem investierenden Unternehmen zu beobachten. Ein Ziel der chinesischen Außenhandelspolitik ist die Exporterhöhung lokaler Güter, um Gewinne aus Devisengeschäften zu erwirtschaften. In Verträgen mit ausländischen Geschäftspartnern verspricht die Regierung Provisionen, wenn eine bestimmte Mindestanzahl chinesischer Güter exportiert wird. US-amerikanische Unternehmen hingegen sind oftmals ausschließlich an der Nachfrage im lokalen Markt interessiert. Zum einen befürchten die Manager von US-Unternehmen, dass chinesische Produkte auf ausländischen Märkten nicht wettbewerbsfähig sind. Zum anderen kann der Export zu

Kannibalisierungseffekten bei Produkten führen, die das US-Unternehmen auf Märkten außerhalb Chinas anbietet. Die erläuterten Zielkonflikte können folglich den Erfolg des internationalen Engagements schmälern (vgl. Björkman und Osland, 1998, S. 442; Chen et al., 2006, S. 639).

Das Umfeld des Heimatlandes der internationalen Organisation wird als letzter Bestandteil der Liabilities of Foreignness angeführt (vgl. Zaheer, 1995, S. 343). Neben dem Staatsapparat im Zielland, nehmen auch die Behörden im Heimatland Einfluss auf die Strategien international agierender Unternehmen (vgl. Mayrhofer, 2004, S. 84). Marano et al. (2016) untersuchen diesen Zusammenhang empirisch im Hinblick auf bilanzielle und marktorientierte Erfolgskennzahlen. Hierbei wird eine negative Beziehung zwischen zu starken Restriktionen der Heimatregierung und dem Internationalisierungserfolg festgestellt. Diese Ergebnisse lassen vermuten, dass der Shareholder Value gemindert wird (vgl. Marano et al., 2016, S. 1098). US-Unternehmen können zum Beispiel staatlichen Restriktionen hinsichtlich bestimmter internationaler Geschäftsabwicklungen und Technologietransfers unterliegen. In diese Kategorie sind moderne Computersysteme und militärische Ausrüstung einzuordnen, welche die nationale Sicherheit betreffen. Investitionen und Technologietransfers in etwa den chinesischen Markt, sind für die Unternehmen dieses Industriezweiges häufig untersagt (vgl. Chen et al., 2006, S. 639).

Zusammenfassend beschreibt die ressourcenorientierte Unternehmenssicht die Vorteile der Internationalisierung. Das Konzept der Liabilities of Foreignness hingegen identifiziert die Kosten der Internationalisierung. Verschiedene Studien stellen fest, dass die Internationalisierungskosten kompensiert werden müssen, um einen positiven Effekt auf die Performance multinationaler Unternehmen zu erzielen (Zaheer, 1995, S. 343; Vahlne und Ivarsson, 2014, S. 245). Zudem wird ein solcher Zusammenhang in der Internationalisierungsliteratur hinsichtlich des Shareholder Values untersucht. Dabei sind konsistente Ergebnisse zu erkennen. Zur Überwindung der Nachteile gegenüber lokal operierenden Konkurrenten müssen multinationale Unternehmen bestimmte firmenspezifische Fähigkeiten aufweisen (vgl. Morck und Yeung, 1991, S. 185; Berry und Sakakibara, 2008, S. 281). Devinney et al. (2000) postulieren darüber hinaus, dass der Trade-off zwischen internationaler Wertgenerierung und Wertschöpfung durch die genannten Fähigkeiten gelingen kann (vgl. Devinney et al., 2000, S. 681). Im folgenden Abschnitt werden diese Erfolgseigenschaften eines multinationalen Unternehmens auf Basis der Dynamic Capabilities erklärt.

3.3. Dynamic Capabilities

Die Interpretation der Dynamic Capabilities-Theorie wird in der Literatur kontrovers diskutiert. Einige Forscher argumentieren, dass der Ansatz als eigenständige Theorie beurteilt werden muss (vgl. Teece et al., 1997, S. 513 f.). Andere verstehen die Theorie als direkte Weiterentwicklung des Resource-Based-View und lehnen die separate Betrachtung ab (vgl. Peteraf und Barney, 2003, S. 321 f.). Im Rahmen der Internationalisierung weisen Ressourcen und dynamische Fähigkeiten des Unternehmens ein komplementäres Verhältnis auf (vgl. Oh, 2010, S. 30). Die Theorie der Dynamic Capabilities wird in dieser Arbeit folglich der ressourcenorientierten Unternehmenssicht zugeordnet. Capabilties beschreiben daher die Fähigkeit eines Unternehmens, Ressourcen mithilfe organisatorischer Prozesse zu kombinieren und einzusetzen. Auf Basis komplexer Interaktionen mit den Unternehmensressourcen, werden diese firmenspezifischen Prozesse entwickelt. Die Capabilities verfolgen das Ziel, die Ressourcenproduktivität zu steigern sowie die strategische Flexibilität und den Schutz der Endprodukte zu erhöhen (vgl. Amit und Schoemaker, 1993, S. 35).

Makadok (2001) betont weiter, dass sich die Capabilties, als spezielle Ressourcenart, durch zwei Merkmale von den übrigen Ressourcen unterscheiden lassen. Erstens sind Ressourcen kein direkter Bestandteil der organisatorischen Prozesse. Die dynamischen Fähigkeiten hingegen übernehmen eine intermediäre Funktion zwischen den Ressourcen und den finalen Leistungen des Unternehmens. Somit sind sie direkt in die Prozesse der Organisation eingebettet. Aufgrund dieser Eigenschaft können Capabilities nicht auf andere Unternehmen übertragen werden. Hierfür wäre es erforderlich, das gesamte Unternehmen oder zumindest in sich geschlossene Teile des Unternehmens zu übernehmen. Die vollständige Liquidation eines Unternehmens bedeutet somit gleichermaßen die Auflösung der Capabilities. Die übrigen Ressourcen können indes in den Besitz anderer Organisationen übergehen. Zur Veranschaulichung dient ein fiktives Beispiel des US-amerikanischen Halbleiterherstellers Intel. Im Falle der Auflösung des Unternehmens können die Mikroprozessorpatente des Unternehmens dennoch in den Besitz von Konkurrenten gelangen, da es sich um Ressourcen handelt. Demgegenüber könnte die Innovationsfähigkeit des Unternehmens, neue Mikroprozessoren zu entwickeln, nicht an Wettbewerber übertragen werden, da sie den Capabilities zuzuordnen ist (vgl. Makadok, 2001, S. 388 f.).

Zweitens unterscheiden sich die beiden Ressourcenarten in ihren Funktionen. Ressourcen stellen die Hygienefaktoren für den Erfolg einer Strategie dar (vgl. Barney, 1991, S. 101). Als übergeordnete Aufgabe der Capabilities ist die Produktivitätserhöhung eben dieser Ressourcen zu verstehen (vgl. Amit und Schoemaker, 1993, S. 35). Als Beispiel wird das von Walmart intern entwickelte Cross-Docking System angeführt. In diesem komplexen System organisatorischer Prozesse werden Güter an Warenhäuser geliefert, direkt selektiert, neu verpackt und versandt. Hierdurch entfällt die kostenintensive Lagerung der Waren. Mit der Cross-Docking Capability wird die Produktivität weiterer Ressourcen, zu denen die LKW-Flotte, Geschäftsimmobilien, Arbeitskräfte oder Informationstechnologien gehören, nachhaltig gesteigert. Auf diese Weise wird eine Umsatzkostensenkung erreicht, woraus ein Wettbewerbsvorteil für Walmart resultiert (vgl. Stalk et al., 1992, S.58 ff.; Makadok, 2001, S. 389).

Die Theorie der Dynamic Capabilities findet in der Internationalisierungsforschung hohe Beachtung. Durch die Ausschöpfung der Unternehmensressourcen, ermöglichen

die dynamischen Fähigkeiten die erfolgreiche Implementierung der Internationalisierungsstrategie und führen zu besserer finanzieller Performance (vgl. Birkinshaw und Hood, 1998, S. 783 f.; Augier und Teece, 2007, S. 186 f.). Dies führt bei Shareholdern zu der Annahme, dass multinationale Unternehmen ohne dynamische Fähigkeiten langfristig nicht erfolgreich sind (vgl. Berry, 2006, S. 1138). Die Investoren reagieren besonders positiv auf die Marketing Capabilities eines Unternehmens, welche eine spezielle Form der Dynamic Capabilities bilden (vgl. Day, 2011, S. 187 f.; Dittfeld, 2017, S.28). Eckert et al. (2010) betonen in ihrer Studie die entscheidende Bedeutung von Marketing Capabilities im Internationalisierungskontext. Aus den Ergebnissen der Studie wird abgeleitet, dass Shareholder nur dann Erträge aus Internationalisierungsaktivitäten erwarten können, wenn Unternehmen über ausgeprägte Marketing Capabilities verfügen (vgl. Eckert et al., 2010, S. 573).

Zunächst spiegeln Marketing Capabilities die Fähigkeit eines Unternehmens wider, erfolgreiche Kommunikationspolitik zu betreiben (vgl. Wiles et al., 2012, S. 40). Eine starke Kommunikationsfähigkeit führt zu höherer öffentlicher Sichtbarkeit der unternehmerischen Internationalisierungsaktivitäten für Konsumenten und Shareholder, sodass Letztgenannte diese in ihre Investitionsvorhaben einbeziehen (vgl. Mishra und Modi, 2016, S. 31; Oh, 2010, S. 32). Weiterhin ermöglichen Marketing Capabilities das effektive Management von Marktinformationen. Diese Marktintelligenz ermöglicht die effiziente Nutzung von Konsumenten- und Wettbewerberdaten auf den ausländischen Märkten (vgl. Contractor et al., 2003, S. 6; Narasimhan et al., 2006, S. 513). In der Folge können die Internationalisierungsaktivitäten an die Bedürfnisse und Ansprüche verschiedener Stakeholder angepasst werden. Zusätzlich trägt eine hohe Marktintelligenz dazu bei, agil auf Gegenmaßnahmen von Wettbewerbern zu reagieren. Das Aktienrisiko in internationalen Märkten wird somit reduziert, woraus eine Stärkung des Shareholder Values resultiert (vgl. (vgl. Mishra und Modi, 2016, S. 31; Berry und Sakakibara, 2008, S. 298). Wie in Abschnitt 2.2. erläutert, fördern Marketing Capabilities ferner die Umsetzung der Internationalisierungsstrategie, indem ressourcenbezogene Kosten gesenkt werden (vgl. Kotabe et al., 2002, S. 82; Griffith und Harvey, 2001, S. 598). Zusammenfassend wird postuliert, dass Marketing Capabilities das Potenzial besitzen, den internationalen Strategie-Trade-off zwischen Wertgenerierung und Wertschöpfung erfolgreich zu koordinieren und folglich den Shareholder Value zu steigern (vgl. Mauri und Neiva de Figueiredo, 2012, S. 40; Berry und Sakakibara, 2008, S. 281).

3.4. Entwicklung der Hypothesen

Aus den Erkenntnissen der vorgestellten Theorien und anhand empirischer Ergebnisse zur Beziehung zwischen Internationalisierung und Shareholder Value, werden im Folgenden die Hypothesen hergeleitet. Zunächst wird der Wirkungseffekt vom internationalen Strategie-Trade-off auf die Aktienrendite sowie das idiosynkratische Risiko formuliert. Weiter werden jeweils die Moderationseffekte von Innovations- und Vermarktungsfähigkeit prognostiziert. Final bildet eine grafische Gesamtdarstellung der Wirkungszusammenhänge den Abschluss dieses Kapitels.

3.4.1. Internationaler Strategie-Trade-off und Shareholder Value

In dieser Arbeit wird ein negativer Einfluss des internationalen Strategie-Trade-offs auf den Shareholder Value unterstellt. Die Wirkungsbeziehung zwischen der Internationalisierung eines Unternehmens und dem Shareholder Value ist ferner Gegenstand einer kontroversen Diskussion. Die Forscher identifizieren hier sowohl Vorteile als auch Nachteile (vgl. Eckert et al., 2010, S. 573). Dess et al. (1995) argumentieren, dass die Internationalisierung per se Vorteile für Investoren erzeugt. Die Autoren vermuten, dass die Aktien multinationaler Unternehmen die Diversifikation eines Investmentportfolios erhöhen und somit das Anlagerisiko reduzieren. Diese Annahme basiert auf der Theorie, dass Vermögensgegenstände, dessen Erträge nicht miteinander korrelieren, das Risiko senken. Soweit die wirtschaftlichen Rahmenbedingungen auf Märkten verschiedener Regionen nicht zusammenhängen, sollte ein multinationales Unternehmen daher stabilere Erträge generieren können als ausschließlich inländisch operierende Unternehmen (vgl. Dess et al., 1995, S. 360). Ein weiterer Nutzen liegt in der Verbesserung der internationalen Wettbewerbssituation. Auf verschiedenen internationalen Märkten präsent zu sein, bietet multinationalen Unternehmen die Möglichkeit, vielfältig auf Konkurrenzangriffe zu reagieren. Zum Beispiel können Interventionsmaßnahmen auf Märkten, in denen das angreifende Unternehmen eine schwache Position hält, erwogen werden. Das multinationale Unternehmen verfügt daher über eine höhere strategische Flexibilität im Wettbewerb als Unternehmen, die einzig im Heimatmarkt wirtschaften. Hierbei wird unterstellt, dass das Risiko aggressiver Auseinandersetzungen mit Wettbewerbern aus Investorensicht sinkt (vgl. Hamel und Prahalad, 1985, S. 35; Kim et al., 1993, S. 284). Aus der Vielfalt ausländischer Märkte ergibt sich ein weiterer internationalisierungsimmanenter Vorteil. Dieser liegt in der flexiblen Reaktion auf Änderungen der Zins- und Lohnkostensätze sowie der Waren- und Rohstoffpreise in einem Land. Multinationalen Unternehmen bietet sich bei solchen Szenarien die Option, Produktions- und Beschaffungsstandorte in kostengünstigere Märkte zu verlagern (vgl. Kogut, 1985, S. 33).

Die erläuterten Vorteile sollen die Überlegenheit multinationaler Unternehmen, im Vergleich zu ausschließlich inländisch aktiven Unternehmen, verdeutlichen (vgl. Dess et al., 1995, S. 62). Konträre Erkenntnisse liefert die Studie von Michel und Shaked (1986). Die Autoren vergleichen die Aktienportfolios von multinationalen mit denen von nicht international agierenden Unternehmen. Dabei stellen sie fest, dass die Aktienrenditen rein inländisch operierender Unternehmen signifikant höher ausfallen, als die der internationalen Unternehmen (vgl. Michel und Shaked, 1986, S. 95). Diese Ergebnisse sind konsistent mit den Forschungen von Oh (2010) und Eckert et al. (2010) (vgl. Oh, 2010, S. 41; Eckert et al., 2010, S. 568). Hieraus ist abzuleiten, dass die imma-

nenten Vorteile der Internationalisierung, aus Sicht der Investoren, durch die Liabilities of Foreignness neutralisiert oder sogar zu Lasten multinationaler Unternehmen überkompensiert werden. Diese Sichtweise wird von Studien bestätigt, welche keine signifikanten Effekte für den Einfluss von Internationalisierung auf den Shareholder Value finden (vgl. Morck und Yeung, 1991, S. 185; Christophe, 1997, S. 460).

Aus weiteren Arbeiten geht hervor, dass der separate Einsatz von internationaler Wertschöpfung positive Effekte auf den Shareholder Value ausüben kann (Rugman und Oh, 2010, 485 f.). Dittfeld (2017) beweist beispielsweise eine positiv lineare Wirkungsbeziehung zwischen dem FSTS-Verhältnis und dem Tobin's Q-Maß. (Dittfeld, 2017, S. 22). Bei der gesonderten Betrachtung von internationaler Wertgenerierung hingegen werden negative Einflüsse auf den Shareholder Value registriert. In einem linearen Regressionsmodell identifizieren Christoph und Lee (2005) etwa einen negativen Einfluss der FATA-Relation auf Tobin's Q. Der Anstieg internationaler Assets mindert demzufolge den Shareholder Value. Die Schlussfolgerung lautet daher, dass Investoren die internationale Streuung von Vermögensgegenständen als destruktiv bewerten (vgl. Christophe und Lee, 2005, S. 642; Click und Harrison, 2000, S. 12). Die Autoren vermuten, dass für internationale Projekte eine große Vermögensbasis benötigt wird, welche allerdings geringe Erträge produziert. Diese Behauptung wird durch die hohen ressourcenbezogenen Komplexitätskosten internationaler Aktivitäten erklärt (vgl. Christophe und Lee, 2005, S. 642). Ein multinationales Unternehmen hat zwar einen höheren Marktwert, aber auch einen fünfmal höheren Vermögensbestand, als national agierende Unternehmen. In Bezug auf die Strategieoption der Wertgenerierung werden multinationale Unternehmen somit schlechter bewertet als inländisch operierende Unternehmen (vgl. Eckert et al., 2010, S. 570; Click und Harrison, 2000, S. 2).

Zusammenfasend können multinationale Unternehmen die immanenten Internationalisierungsvorteile, aufgrund der Liabilities of Foreignness, nicht ausnutzen. Zudem unterstellen Investoren bei Investitionen in internationale Wertgenerierung eine zu hohe Komplexität der Ressourcenallokation. Die Kosten des internationalen Strategie-Trade-offs übersteigen demnach den Nutzen der Internationalisierung, weshalb Folgendes prognostiziert wird:

> H1(a): Der strategische Trade-off zwischen internationaler Wertgenerierung und internationaler Wertschöpfung wirkt sich negativ auf die Aktienrendite eines Unternehmens aus.
>
> H1(b): Der strategische Trade-off zwischen internationaler Wertgenerierung und internationaler Wertschöpfung wirkt sich positiv auf das idiosynkratische Risiko eines Unternehmens aus.

3.4.2. Moderationseffekte der Innovationsfähigkeit

Für die Herleitung der Hypothesen H1(a) und H1(b) werden die immanenten Benefits der Internationalisierung erklärt. Ein Unternehmen kann zudem weitere Vorteile der Internationalisierung nutzen, wenn es die notwendigen Marketing Capabilities besitzt. In dieser Arbeit wird die Annahme getroffen, dass sich die Innovationsfähigkeit eines Unternehmens positiv auf die Beziehung zwischen dem internationalen Strategie-Trade-off und dem Shareholder Value auswirkt. Einige Vorteile der Innovationsfähigkeit können erst mit dem Beginn der Internationalisierung genutzt werden. Andere können bereits im Heimatmarkt einen positiven Effekt auf den Shareholder Value auslösen. Heimatmarkt-Effekte resultieren insbesondere aus der Markt- und Kundenorientierung des Unternehmens. In der Marketingliteratur werden mehrfach positive Einflüsse von Innovationsfähigkeit auf den Shareholder Value festgestellt (vgl. Rubera und Kirca, 2017, S. 744). Die Innovationsfähigkeit ermöglicht es dem Unternehmen, kontinuierlich die aktuellen Präferenzen der Konsumenten zu erfassen und entsprechend zu reagieren. Diese Eigenschaft führt zu einer Erhöhung der potentiellen Cashflows und generiert, wie in Abschnitt 2.3. angedeutet, Shareholder Value. Weiterhin dienen Innovationen der Ergänzung des Produktportfolios, wodurch das Unternehmen neue Kundensegmente erschließen kann. Infolgedessen sinkt die Volatilität der Cashflows. Hieraus resultiert eine Abnahme des Aktienrisikos (vgl. Srinivasan et al., 2009, S. 27 f.). Abschließend signalisieren Innovationen, dass das Unternehmen auch zukünftig in der Lage ist, das Produktportfolio zu erweitern. Aus Investorenperspektive steigt dadurch der Residualwert ihres Investments (vgl. Sood und Tellis, 2009, S. 444; Rubera und Kirca, 2017, S. 744). Kotabe et al. (2002) betonen, dass die Innovationsfähigkeit vom Heimatmarkt auf ausländische Märkte übertragen werden kann. Folglich können die kundenbezogenen, positiven Performanceeffekte auch auf internationaler Ebene ausgeschöpft werden (vgl. Kotabe et al., 2002, S. 83).

Weitere Vorteile der Innovationsfähigkeit ergeben sich erst im Internationalisierungskontext. Die ressourcenorientierte Unternehmenssicht lässt vermuten, dass im Zuge der Internationalisierung Potenziale zur Senkung der Produktionskosten entstehen (vgl. Tallman und Li, 1996, S. 179). Die Potenziale können aus Sicht der Shareholder genutzt werden, wenn das Unternehmen innovative Produktionsverfahren entwickelt und auf ausländische Märkte überträgt. Die Innovationsfähigkeit eines multinationalen Unternehmens ermöglicht daher die Ausschöpfung von Skaleneffekten (vgl. Lu und Beamish, 2004, S. 602; Kotabe et al., 2002, S. 83). Die Vielfalt der zu bearbeitenden Märkte löst weiterhin Stimuli für die Bildung neuer dynamischer Fähigkeiten aus. Durch Investitionen in Forschung und Entwicklung auf ausländischen Märkten kann das Unternehmen neue Innovationsfähigkeiten und Produkte entwickeln, um lokal adaptiv reagieren zu können (vgl. Ghoshal, 1987, S. 431). Diese neu gewonnenen Fähigkeiten können Synergien mit den bereits vorhandenen Ressourcen in Märkten anderer Länder schaffen. In der Neuentwicklung vielfältiger Fähigkeiten identifizieren Investoren einen Wettbewerbsvorteil gegenüber lokal agierenden Unternehmen (vgl. Oh, 2010, S. 30).

Investoren bewerten Internationalisierungsaktivitäten als

nutzenbringend, wenn das Unternehmen seine Innovationsfähigkeit in ausländische Märkte transferiert und international weiterentwickelt (vgl. Florida, 1997, Berry und Sakakibara, 2008, S. 280). Dittfeld (2017) zeigt zudem, dass die Innovationsfähigkeit eines Unternehmens die Beziehung zwischen internationaler Wertgenerierung und dem Shareholder Value positiv beeinflusst (vgl. Dittfeld, 2017, S. 23 ff.). Als Konsequenz werden Synergien zwischen den Ressourcen und der Innovationsfähigkeit unterstellt, welche eine effizientere und effektivere Nutzung der internationalen Assets ermöglichen (vgl. Yildiz, 2013, S. 339). Die Komplexitätskosten der internationalen Wertgenerierung werden folglich gesenkt. Neben den wertschöpfenden werden nun auch die wertgenerierenden Internationalisierungsaktivitäten positiv von den Shareholdern bewertet. Die Innovationsfähigkeit eines multinationalen Unternehmens führt aus Investorenperspektive zu einem erfolgreichen Management des internationalen Strategie-Trade-offs. Daher werden folgende Annahmen getroffen:

> H2(a): Die Innovationsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und der Aktienrendite eines Unternehmens positiv.

> H2(b): Die Innovationsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und dem idiosynkratischen Risiko eines Unternehmens negativ.

3.4.3. Moderationseffekte der Vermarktungsfähigkeit

Der Vermarktungsfähigkeit wird ein positiver Einfluss in der Beziehung zwischen internationalem Strategie-Trade-off und Shareholder Value unterstellt. In der Marketingliteratur wird gezeigt, dass Investoren die Vermarktungsfähigkeit eines Unternehmens bei der Aktienbewertung berücksichtigen (vgl. Xiong und Bharadwaj, 2013, S. 712). Analog zur Innovationsfähigkeit ergeben sich zunächst heimatmarktbedingte Performanceeffekte. Eine ausgeprägte Vermarktungsfähigkeit ermöglicht eine detaillierte Marktanalyse und den Aufbau starker Kundenbeziehungen. Dies befähigt das Unternehmen zur Antizipation des Kundenverhaltens, wodurch die Volatilität der Cashflows reduziert werden kann (vgl. Dutta et al., 1999, S. 550; Xiong und Bharadwaj, 2013, S. 712). Damit kann das Unternehmen effizienter und effektiver auf Kundenbeschwerden reagieren. Im Falle unrechtmäßiger negativer Nachrichten ist das Unternehmen beispielsweise in der Lage, schnell die Kommunikation mit den verantwortlichen Kunden aufzunehmen. Hierdurch werden die Service Recovery-Kosten gesenkt und infolgedessen Zahlungsabflüsse verringert (vgl. Xiong und Bharadwaj, 2013, S. 712). Ferner können Unternehmen mit hoher Vermarktungsfähigkeit proaktiv Anpassungen des Produktionszyklus vornehmen. Diskrepanzen zwischen dem Warenbestand des Unternehmens und den Kundenanforderungen können beispielsweise durch agile Distributionskanäle schnell behoben werden. Dementsprechend wird eine höhere Produktdiffusion erreicht, welche die Cashflows beschleunigt und schließlich den Shareholder Value erhöht (vgl. Bharadwaj et al., 2007, S. 440 f; Xiong und Bharadwaj, 2013, S. 712). Die Übertragung der Vermarktungsfähigkeit in internationale Märkte führt zu einer optimalen Ausschöpfung der genannten Wettbewerbsvorteile (vgl. Oh, 2010, S. 32).

Andere performanceorientierte Vorteile der Vermarktungsfähigkeit können im Internationalisierungsprozess entstehen. Aufgrund von globalisierten Märkten bilden sich länderübergreifende Produktsegmente. Das multinationale Unternehmen kann an dieser Stelle profitieren, wenn es standardisierte Marketingprogramme entwickelt und auf ausländische Märkte ausweitet. Bei der jeweiligen ausländischen Marktpenetration kann das Unternehmen auf Erfahrungswerte zurückgreifen, die in vergleichbaren Ländern gesammelt werden (vgl. Helsen et al., 1993, S. 60). Zudem kann die internationale Standardisierung einer Marke vorteilhafte Effekte bewirken. Unternehmen mit starken Markennamen können Preisaufschläge auf ausländischen Märkten implementieren und zusätzlich den Bekanntheitsgrad der Marke erweitern (vgl. Kotabe et al., 2002, S. 82; Hitt et al., 1997, S. 771). Eine hohe Vermarktungsfähigkeit führt demnach zu steigender Profitabilität, die den Shareholder Value positiv beeinflusst.

Die Aktienbewertung der Investoren kann positiv ausfallen, wenn das multinationale Unternehmen die Vermarktungsfähigkeit in ausländische Märkte überträgt und standardisiert nutzt. In der Studie von Lu und Beamish (2004) wird weiterhin ein positiver Einfluss der Vermarktungsfähigkeit auf die Beziehung zwischen internationaler Wertgenerierung und Shareholder Value festgestellt (vgl. Lu und Beamish, 2004, S. 605). Daher wird die gleiche Annahme getroffen wie zuvor beim Moderationseffekt der Innovationsfähigkeit. Die Vermarktungsfähigkeit kann genutzt werden, um das Potenzial der internationalen Ressourcen besser auszuschöpfen (vgl. Yildiz, 2013, S. 339). Shareholder nehmen bei der Strategieoption der internationalen Wertgenerierung folglich eine Reduktion der Komplexität wahr. Aus der positiven Bewertung beider Strategieoptionen lassen sich dementsprechend folgende Hypothesen ableiten:

> H3(a): Die Vermarktungsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und der Aktienrendite eines Unternehmens positiv.

> H3(b): Die Vermarktungsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und dem idiosynkratischen Risiko eines Unternehmens negativ.

3.5. Übersicht der Wirkungszusammenhänge

Das Gesamtmodell dieser Arbeit wird in Abbildung 1 veranschaulicht. Der internationale Strategie-Trade-off bildet die unabhängige Variable. Die Aktienrendite und das idiosynkratische Risiko des Unternehmens bezeichnen die abhängigen Variablen und repräsentieren den Shareholder

Value. Weiterhin stellen Innovationsfähigkeit und Vermarktungsfähigkeit die Moderatoren des Modells dar. Der internationale Strategie-Trade-off hat einen negativen Einfluss auf die Aktienrendite und einen positiven Einfluss auf das idiosynkratische Risiko. Diese Wirkungsrichtungen werden durch den Moderationseffekt der Innovationsfähigkeit umgekehrt. Unter Berücksichtigung dieses Moderators wirkt sich der internationale Strategie-Trade-off positiv auf die Aktienrendite und negativ auf das idiosynkratische Risiko aus. Diese Wirkungsbeziehungen wiederholen sich bei der Betrachtung des zweiten Moderationseffekts. Bei der Hinzunahme der Vermarktungsfähigkeit wird postuliert, dass der internationale Strategie-Trade-off zu einer Erhöhung der Aktienrendite und zu einer Reduktion des idiosynkratischen Risikos führt.

4. Empirische Untersuchung

4.1. Sampling und Datenbasis

In diesem Kapitel wird die methodische Vorgehensweise dieser Studie behandelt. Zunächst werden die Zusammensetzung des Forschungssamples und die Datenerfassung erläutert. Weiter wird die Operationalisierung aller relevanten Variablen thematisiert, worauf eine grafische Übersicht aller Metriken folgt. Anschließend sollen die in Abschnitt 3.4. aufgestellten Hypothesen anhand eines geeigneten Modells überprüft werden. Dafür werden auf Basis der Datenstruktur die Modellspezifikationen aufgestellt. Abschließend werden die empirischen Forschungsergebnisse vorgestellt.

Für die Kalkulation der abhängigen Variablen, Aktienrendite und idiosynkratisches Risiko, muss auf die jeweiligen Aktienpreise der Unternehmen zurückgegriffen werden. In dieser Arbeit werden daher ausschließlich börsennotierte Unternehmen untersucht. Eine hohe Anzahl US-amerikanischer Unternehmen sind börsennotiert, weshalb hier ein transparentes Reporting der Unternehmensdaten angenommen wird. Um auf eine möglichst hohe Datenmenge zugreifen zu können, werden demnach US-amerikanische Unternehmen herangezogen. (vgl. Berry und Kaul, 2016, S. 2278). Hierfür wird der Wilshire 5000 Total Market Index herangezogen. Seit der Gründung im Jahr 1974 stellt der Wilshire 5000 Zeitreihendaten bereit, die bis zum 31.12.1970 zurückreichen. Ziel der Verwendung des Aktienindex ist die Manifestierung eines Benchmarks für den gesamten US-amerikanischen Aktienmarkt. Der Indexwert des Wilshire 5000 wird dabei durch Veränderungen in der Marktkapitalisierung der gelisteten Unternehmen beeinflusst. Bei der Gründung im Jahr 1974 enthielt der Index 5.000 Unternehmen. Die Anzahl der gelisteten Unternehmen wuchs stetig bis zum 31.07.1998, wo der Index 7.562 Aktien zählte. Anschließend sank die Zahl bis zum 31.12.2013 auf 3.776 Aktien (vgl. Wilshire Associates Incorporated, 2014). Das verwendete Sample basiert auf einer Mitgliederliste, die auf der Wilshire-Homepage verfügbar ist. Nach dem Download und der Modifizierung der Liste im Dezember 2017, ergibt sich für diese Studie ein Ausgangsdatenset von 3.772 Unternehmen. Der aktuelle Stand dieser Liste beläuft sich auf Dezember 2016 (vgl. Wilshire Associates Incorporated, 2016).

Die Methodik zur Berechnung der abhängigen Variablen orientiert sich ferner an einem Kapitalmarktmodell der Ökonomen Eugene Fama und Kenneth French. Das Modell stützt sich auf drei Faktoren zur Erklärung von Aktienentwicklungen. Die Faktoren wurden der Homepage des Finanzprofessors Kenneth French entnommen. Hier werden neben US-amerikanischen auch internationale Finanzmarktinformationen bereitgestellt. Neben den erwähnten Marktfaktoren werden zudem Aktienportfolios zur Verfügung gestellt, die nach verschiedenen Kriterien berechnet werden. Die für diese Arbeit benötigten Faktoren liegen für tägliche, wöchentliche, monatliche und jährliche Aktienrenditen vor. Da die Kalkulation der abhängigen Variablen auf Basis der monatlichen Aktienpreise erfolgt, werden die monatlich kalkulierten Marktfaktoren für den US-amerikanischen Aktienmarkt verwendet. Diese Daten sind bis Juli 1926 erhältlich und werden monatlich aktualisiert (vgl. French, 2017).

Die Aktienpreise und alle weiteren relevanten Unternehmensdaten werden mit dem Ziel beschafft, die Untersuchung über einen möglichst langen Zeitraum durchzuführen, um so viele Informationen wie möglich einfließen zu lassen. Für dieses Vorhaben wird der Datenbestand von Thomson Reuters verwendet. Insgesamt werden, mit Datastream und Worldscope, zwei Datenbanken des Anbieters genutzt. Datastream beinhaltet Markt- und Finanzdaten und bietet über 10 Millionen ökonomische Zeitreihen für 162 Märkte an. Damit verfügt die Datenbank über den weltweit größten Bestand an finanzmarktorientierten Zeitreihendaten (vgl. Reuters, o. Jg.). Worldscope enthält detaillierte Profil- und Abschlussdaten börsennotierter Unternehmen. Die Daten stammen von 37.450 Unternehmen aus über 75 Ländern und erfassen circa 95 % der globalen Marktkapitalisierung. Die Datenbank stellt darüber hinaus Daten von inaktiven und nicht mehr existenten Unternehmen bereit. Die Unternehmensdaten können in Worldscope ab 1980 abgerufen werden. Da unter anderem die Daten zu den internationalen Assets und Umsätzen aus der Worldscope-Datenbank stammen, ergibt sich hier bereits eine erste Limitation für den Untersuchungszeitraum dieser Arbeit (vgl. Reuters, 2013, S. 27). Weiterhin reduziert sich die Zahl der Unternehmen im Sample, da einige Identifizierungscodes der Unternehmen nicht aufzufinden waren oder es sich um Duplikate handelte. Beim Download eines jeden Items traten zusätzlich immer Unternehmen auf, welche die jeweilige Kennzahl im gesamten Untersuchungszeitraum nicht reportet hatten. Abschließend können für die Berechnung der abhängigen Variablen nur Unternehmen berücksichtigt werden, die für mindestens ein Jahr zwölf monatliche Observationen des Aktienpreises aufweisen (vgl. Mishra und Modi, 2016, S. 32). Die Aktienpreise werden auf monatlicher und alle anderen Unternehmensdaten auf jährlicher Basis verwendet. Das finale Datenset besteht aus 1.399 Unternehmen über einen Zeitraum von 1982 bis 2016 und weist 17.326 Observationen auf.

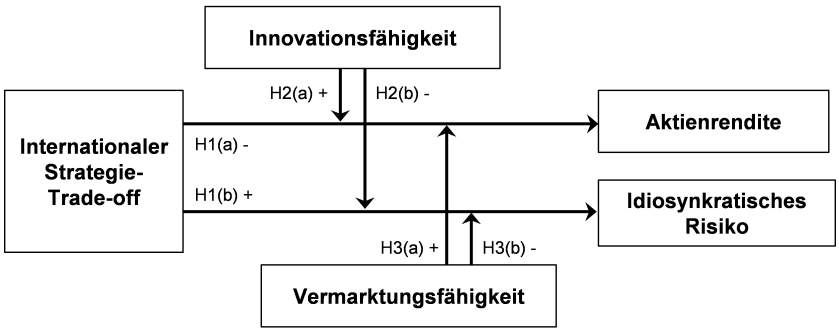

Abbildung 1: Gesamtmodell; Quelle: Eigene Darstellung

4.2. Operationalisierung der Variablen

Im Folgenden wird die Operationalisierung aller für das Gesamtmodell relevanten Variablen beschrieben. Die Abkürzungen der Variablen beziehen sich auf die englischen Begriffe, um die Studie besser mit anderen Arbeiten der Internationalisierungs- und Marketingliteratur vergleichen zu können. Frühere Studien der Marketing- und Finanzliteratur identifizieren in der Aktienrendite und im idiosynkratischen Risiko zwei Metriken, die den Shareholder Value messen (vgl. Luo, 2009, S. 155; Srinivasan und Hanssens, 2009, S. 297 f.). Die Aktienrenditen werden als abnormale Renditen berechnet und spiegeln unerwartete Abweichungen der erwarteten Aktienperformance wider. Diese werden mittels des aus der Finanzliteratur stammenden Fama-French-Dreifaktorenmodells bestimmt (vgl. Fama und French, 1992, S. 451 f.; Barber und Lyon, 1997 S. 355). Das idiosynkratische Risiko bezieht sich auf die Volatilität des Aktienkurses und erfasst 80 % des Gesamtrisikos des Unternehmens. Die Kalkulation erfolgt über die Standardabweichung der Residuen des Fama-French-Dreifaktorenmodells, das im weiteren Verlauf dargestellt ist (vgl. Goyal und Santa-Clara, 2003, S. 980 ff.). Vor der Anwendung des Modells werden zunächst die logarithmierten Aktienrenditen anhand folgender Formel kalkuliert:

$$R_{im} = log\frac{(\text{Aktienpreis}_{im} - \text{Aktienpreis}_{im-1})}{\text{Aktienpreis}_{im-1}} \quad (1)$$

R_{im} beschreibt die Aktienrendite für Unternehmen i in Monat m. Die errechneten Renditen werden logarithmiert (vgl. Srinivasan et al., 2009, S. 33; Srinivasan und Hanssens, 2009, S. 297). Zur Berechnung der Überschussrendite wird in Gleichung (2) das Fama-French-Dreifaktorenmodell herangezogen.

$$R_{im} - R_{fm} = \beta_{0i} + \beta_{1i}(R_{mm} - R_{fm}) + \beta_{2i}SMB_m + \beta_{3i}HML_m + \epsilon_{im} \quad (2)$$

R_{mm} steht für die Rendite eines wertgewichteten Marktportfolios m und R_{fm} zeigt die Rendite der risikolosen Anlage f. Die Differenz zwischen R_{im} und R_{fm} ergibt die Überschussrendite. SMB_m ist die Abkürzung für „small minus big“ und beschreibt die Renditedifferenz zwischen Aktien von Unternehmen mit geringer Marktkapitalisierung und Aktien von Unternehmen mit hoher Marktkapitalisierung. HML_m bedeutet „high minus low“ und integriert die Renditedifferenz zwischen Aktien von Unternehmen mit hohem Buchwert/Marktwert-Verhätnis und Aktien von Unternehmen mit geringem Buchwert/Marktwert-Verhätnis. Abschließend bilden β_{0i} den Y-Achsenabschnitt der Überschussrendite und ϵ_{im} den Fehlerterm des Modells (vgl. Barber und Lyon, 1997 S. 355). Für Modell (2) wurde eine Rolling Window Regression mit 12 Monaten vor dem Ereignismonat durchgeführt. Anschließend werden die abnormalen Renditen aus der Differenz zwischen der tatsächlich beobachteten Rendite und der erwarteten Rendite in Modell (3) berechnet (vgl. Luo et al., 2013b, S. 152).

$$AR_{im} = (R_{im} - R_{fm}) - (\hat{\beta}_{0i} + \hat{\beta}_{1i}(R_{mm} - R_{fm}) + \hat{\beta}_{2i}SMB_m + \hat{\beta}_{3i}HML_m) \quad (3)$$

Das idiosynkratische Risiko wird anschließend in Modell (4) als die Standardabweichung der Residuen aus Modell (1) auf jährlicher Basis kalkuliert (vgl. Luo et al., 2013b, S. 152).

$$IR_{it} = [\frac{1}{12}\sum_{m=1}^{12}(\epsilon_{im} - \bar{\epsilon}_{im})^2]^{\frac{1}{2}} \quad (4)$$

IR_{it} bildet das idiosynkratische Risiko auf jährlicher Basis ab. Für die Berechnung der abnormalen Renditen auf Jahresbasis werden die monatlichen abnormalen Renditen aggregiert. In Modell (5) ist das Verfahren in Anlehnung an Mishra und Modi (2016) formal dargestellt.

$$AR_{it} = \prod_{m=1}^{12}(1 + AR_{im}) \quad (5)$$

AR_{im} beschreibt die monatlichen abnormalen Aktienrenditen. AR_{it} steht für die aggregierten abnormalen Renditen auf jährlicher Basis (vgl. Mishra und Modi, 2016, S. 32).

Die Operationalisierung der unabhängigen Variable erfordert zunächst die Berechnung der internationalen Wertschöpfung und die der internationalen Wertgenerierung. Die internationale Wertschöpfung wird über das FSTS-Verhältnis und die internationale Wertgenerierung über das FATA-Verhältnis kalkuliert (vgl. Thomas und Eden, 2004, S. 92 ff.):

$$FSTS = \frac{\text{Foreign Sales}}{\text{Total Sales}} \tag{6}$$

$$FATA = \frac{\text{Foreign Assets}}{\text{Total Assets}} \tag{7}$$

Wie in Abschnitt 2.4. angedeutet, wird der internationale Strategie-Trade-off als Relation zwischen der wertgenerierenden und wertschöpfenden Strategieoption operationalisiert. Diese Kennzahl orientiert sich in dieser Studie an den Ausführungen von Mizik und Jacobson (2003) und wird folgendermaßen berechnet (vgl. Mizik und Jacobson, 2003, S. 73):

$$ISE = \frac{(FSTS - FATA)}{(FSTS + FATA)} \tag{8}$$

ISE ist die Abkürzung für International Strategic Emphasis und beschreibt den strategischen Trade-off zwischen internationaler Wertgenerierung und internationaler Wertschöpfung. Je negativer die Kennzahl, desto mehr fokussiert das Unternehmen die internationale Wertgenerierung (FATA). Positive Werte bedeuten hingegen, dass der strategische Schwerpunkt eher in Richtung der internationalen Wertschöpfung (FSTS) rückt (vgl. Mizik und Jacobson, 2003, S. 66).

Die Moderatorvariablen dieser Arbeit werden durch die Innovationsfähigkeit und die Vermarktungsfähigkeit eines Unternehmens abgebildet. In Abschnitt 2.4. wird gezeigt, dass Marketing Capabilities durch verschiedene methodische Ansätze dargestellt werden. Die separate Erfassung von Innovationsfähigkeit und Vermarktungsfähigkeit hat sich in der Internationalisierungsliteratur jedoch bewährt, weshalb die vorliegende Studie sich dieser Vorgehensweise anschließt (vgl. Rugman und Oh, 2010, S. 485):

$$R\&D = \frac{\text{R\&D Expenditures}}{\text{Total Assets}} \tag{9}$$

$$SGA = \frac{\text{SGA Expenditures}}{\text{Total Assets}} \tag{10}$$

Durch R&D Expenditures werden die Ausgaben für Forschung und Entwicklung angezeigt. R&D steht für die Innovationsfähigkeit eines Unternehmens. Unter SGA Expenditures sind die Vertriebs-, Verwaltungs- und Gemeinkosten angegeben. Die Abkürzung SGA gibt die Vermarktungsfähigkeit eines Unternehmens wieder (vgl. Kurt und Hulland, 2013, S. 64).

Die Motivation für die Verwendung der abhängigen, unabhängigen und moderierenden Variablen wird bereits ausführlich in Abschnitt 2.4. dargelegt. Ergänzend wird herausgestellt, mit welcher Begründung die nachfolgend aufgeführten Kontrollvariablen in das Modell integriert werden. Bei der Variablenauswahl orientiert sich diese Arbeit an Studien im Marketing-Finance-Interface, welche ebenfalls die Aktienrendite und das idiosynkratische Risiko als abhängige Variablen nutzen. Der Shareholder Value kann systematisch von der Größe des Unternehmens beeinflusst werden. Der Literatur folgend, wird für den Einfluss des Gesamtvermögens (Total Assets) und für den Einfluss des Marktwerts (Market Value) kontrolliert (vgl. Nam und Kannan, 2014, S. 32; Luo et al., 2013a, S. 13). Größere Unternehmen verfügen über mehr Ressourcen und können somit eher von Skaleneffekten profitieren. Kleinere Unternehmen hingegen haben eine höhere strategische Flexibilität und können schneller auf Ertragschancen reagieren (vgl. Luo und Bhattacharya, 2006, S. 8). Zusätzlich wird das Buchwert/Marktwert-Verhältnis als Kontrollvariable herangezogen (vgl. Nam und Kannan, 2014, S. 32). Unternehmen mit einem hohen Buchwert/Marktwert-Verhältnis (Book-to-Market Ratio) wird ein geringeres Aktienrisiko unterstellt, wodurch sich ein positiver Effekt auf den Shareholder Value ergibt (vgl. Srinivasan et al., 2009, S. 30).

Neben den vorgestellten Firmenspezifika werden weiterhin Kennzahlen der Accounting Performance eines Unternehmens berücksichtigt. Zunächst wird der Verschuldungsgrad (Leverage) als Kontrollvariable implementiert (vgl. Mishra und Modi, 2016, S. 33). Einerseits tragen Unternehmen mit einem hohen Verschuldungsgrad ein höheres Insolvenzrisiko. Ein hoher Verschuldungsgrad kann das Unternehmen andererseits dazu befähigen Steuervorteile auszunutzen und somit höhere Cashflows zu generieren. Der Leverage-Effekt kann demnach positive und negative Einflüsse auf den Shareholder Value haben (vgl. Groening et al., 2016, S. 60). Zudem wird der Liquiditätsgrad (Current Ratio) des Unternehmens berücksichtigt (vgl. Luo et al., 2013b, S. 153). Verglichen mit fixen Assets, werden liquide Assets, aus Investorenperspektive, mit weniger volatilen Renditen in Zusammenhang gebracht (vgl. Luo et al., 2010, S. 1049). Als weitere Kontrollvariable wird der Profit Markup eines Unternehmens in das Modell integriert. Für profitable Unternehmen steigt die Chance, höhere Renditen zu generieren. Gleichermaßen kann Profitvolatilität zu einem höheren Risiko führen (vgl. Mishra und Modi, 2016, S. 33). Ferner dient die Kapitalrendite (Return on Assets) als Kontrollvariable (vgl. Luo et al., 2013b, S. 153). Der Kapitalrendite wird ein direkter Einfluss auf die Profitabilität des Unternehmens und folglich ein indirekter Einfluss auf den Shareholder Value unterstellt (vgl. Kang et al., 2016, S. 68). Alle Metriken sind nachfolgend in einer Übersicht dargestellt (Tabelle 2). Mit den Items werden die Identifizierungscodes der Variablen in Datastream und Worldscope gekennzeichnet.

Tabelle 2: Übersicht der Variablen; Quelle: Eigene Darstellung

Variablen	Abkürzung	Messung	Datenquelle	Items	Literatur
Unabhängige Variablen					
Internationaler Strategie-Trade-off	ISE	Differenz zwischen FSTS und FATA, dividiert durch die Summe von FSTS und FATA	Worldscope	WC08731 WC08736	Mizik und Jacobson, 2003
Moderatorvariablen					
Innovationsfähigkeit	R&D	Quotient aus Forschungs- und Entwicklungsausgaben und totalen Assets	Worldscope	WC01201 WC02999	Kurt und Hulland, 2013
Vermarktungsfähigkeit	SGA	Quotient aus Vertriebs-, Verwaltungs- und Gemeinkosten und totalen Assets	Worldscope	WC01101 WC02999	Kurt und Hulland, 2013
Kontrollvariablen					
Unternehmensgröße	SIZE	Logarithmus der totalen Assets	Worldscope	WC02999	Luo et al., 2013a
Marktwert	MV	Logarithmus des Marktwerts	Datastream	MV	Nam und Kannan, 2014
Buchwert-/Marktwert-Verhältnis	BTM	Quotient aus totalen Assets und Marktwert	Worldscope Datastream	WC02999 MV	Nam und Kannan, 2014
Verschuldungsgrad	LVG	Quotient aus langfristigen Verbindlichkeiten und totalen Assets	Worldscope	WC03251 WC02999	Mishra und Modi, 2016
Liquiditätsgrad	CR	Quotient aus Umlaufvermögen und kurzfristigen Verbindlichkeiten	Worldscope	WC08106	Luo et al., 2013b
Profit Markup	PROFIT	Differenz zwischen totalen Umsätzen und Umsatzkosten, dividiert durch Umsatzkosten	Worldscope	WC01001 WC01051	Servaes und Tamayo, 2013
Kapitalrendite	ROA	Quotient aus operativem Ergebnis und totalen Assets	Worldscope	WC01250	Luo et al., 2013a

4.3. Modellspezifikationen

Die vorliegende Studie basiert auf Längsschnittdaten, welche auch als Paneldaten bezeichnet werden. Diese Daten werden als zeitabhängig bezeichnet, da im Zeitablauf wiederholte Datenerhebungen an der gleichen statistischen Einheit durchgeführt werden (vgl. Diggle et al., 2013, S. 1 f.). Die Daten liegen zwar auf jährlicher Basis vor, jedoch variieren die jährlichen Observationen pro Unternehmen. Folglich ergibt sich ein Unbalanced Panel (vgl. Backhaus et al., 2013, S. 203).

Für das Unbalanced Panel kann postuliert werden, dass sich die Observationen innerhalb der Unternehmen ähnlicher sind als Observationen zwischen den Unternehmen (vgl. Servaes und Tamayo, 2013, S. 1051 f.). Diese unbeobachtete firmenspezifische Heterogenität in den Unternehmenscharakteristika kann die Regressionsschätzung verzerren (vgl. Srinivasan et al., 2009, S. 31; Mittal et al., 2005, S. 550). Die Heterogenität kann durch Fixed Effects oder durch Random Effects spezifiziert sein (vgl. Groening et al., 2016, S. 68). Aus der Implementierung des jeweiligen Effekts in das Regressionsmodell kann eine Reduktion der Endogenität resultieren (vgl. McAlister et al., 2007, S. 44). Bei der Random Effects-Spezifikation stellt die Heterogenität eine zufällige Abweichung vom Mittelwert dar. Der Random Effects-Schätzer kann die Effekte der unabhängigen Variablen nur dann konsistent schätzen, wenn diese nicht mit der firmenspezifischen Heterogenität korrelieren. Dementgegen wird beim Fixed Effects-Schätzer die Annahme getroffen, dass die firmenspezifische Heterogenität in jedem Unternehmen eine fixe Konstante ist. Der Random Effects-Schätzer besitzt eine geringere Varianz als der Fixed Effects-Schätzer und gilt somit als effizienter (vgl. Landwehr et al., 2008, S. 178; Tang et al., 2012, S. 1294). Der Vorteil des Fixed Effects-Schätzers liegt darin, dass auch dann Konsistenz gewährleistet wird, wenn die unabhängigen Variablen mit der firmenspezifischen Heterogenität korrelieren. (vgl. Tang et al., 2012, S. 1294). Durch die Erklärung der Varianz innerhalb der Unternehmen wird das Regressionsmodell um die firmenspezifische Heterogenität bereinigt (vgl. Rabe-Hesketh und Skrondal, 2008, S. 157 ff.).

Die Entscheidung, welcher der beiden vorgestellten Schätzer in das Modell integriert werden soll, kann mit dem Hausman-Test getroffen werden (vgl. Wang und Qian, 2011, S. 427). Hierbei ist zu prüfen, ob eine Korrelation zwischen der unbeobachteten firmenspezifischen Heterogenität und den unabhängigen Variablen vorliegt. Ist dieses Kriterium erfüllt, wird ein Fixed Effects-Schätzer implementiert. Nach Tang et al. (2012) ist die Wahl des Fixed Effects-Schätzers für die Paneldatenanalyse berechtigt, da die Schätzung der Parameter hierdurch konsistenter wird. Beim Hausman-Test wird für die H0-Hypothese prognostiziert, dass keine Korrelation zwischen der firmenspezifischen Heterogenität und den unabhängigen Variablen vorliegt (vgl. Tang et al., 2012, S. 1294). Beim Testen der Regressionsmodelle dieser Studie liegen stets Werte vor, die kleiner als der Orientierungswert von 0,05 sind. Folglich muss die H0-Hypothese abgelehnt werden (vgl. Benson und Davidson, 2010, S. 945). Hieraus wird abgeleitet, dass die unbeobachtete firmenspezifische Heterogenität durch Fixed Effects erfasst wird. Daher werden Fixed Effects in das Modell aufgenommen (vgl. Wang und Qian, 2011, S. 427). Die aus den Firmenspezifika resultierende Endogenität kann demnach im Modell bereinigt werden (vgl. McAlister et al., 2007, S. 44).

In Anlehnung an Mishra und Modi (2016) wird in dieser Arbeit ein Mehrgleichungsmodell konstruiert (vgl. Mishra und Modi, 2016, S. 36). Die Regressionen werden dabei simultan in einem System geschätzt (vgl. Morgan und Rego, 2009, S. 65). Dieses Verfahren (Seemingly Unrelated Regression) stellt ein statistisch flexibles, robustes und einfach zu interpretierendes methodisches Framework dar, um die finanzielle Performance von Unternehmen zu analysieren (vgl. Mishra und Modi, 2016, S. 36; Dotzel et al., 2013, S. 270). Bei der Berechnung separater Regressionen für die abhängigen Variablen Aktienrendite und idiosynkratisches Risiko ist anzunehmen, dass die Störterme beider Gleichungen signifikant miteinander korrelieren. Die Aktienrendite und das idiosynkratische Risiko werden daher in zwei simultan geschätzten Regressionen modelliert (vgl. Mishra und Modi, 2016, S. 36). Das Mehrgleichungsmodell führt hier zu effizienteren Schätzungen als separate Regressionen nach der Methode der kleinsten Quadrate (vgl. Morgan und Rego, 2009, S. 289). Die Haupteffekte dieser Studie werden im folgenden Gleichungssystem erfasst:

$$\begin{aligned} AR_{it} =& \beta_0 + \beta_1 MV_{it} + \beta_2 LVG_{it-1} + \beta_3 CR_{it-1} + \beta_4 PROFIT_{it-1} \\ &+ \beta_5 ROA_{it-1} + \beta_6 R\&D_{it-1} + \beta_7 SGA_{it-1} + \beta_8 ISE_{it-1} \\ &+ \beta_9 (ISExR\&D)_{it-1} + \beta_{10} (ISExSGA)_{it-1} + \epsilon_{it} \end{aligned} \tag{16a}$$

$$\begin{aligned} IR_{it} =& \delta_0 + \delta_1 SIZE_{it} + \delta_2 BTM_{it} + \delta_3 LVG_{it-1} + \delta_4 CR_{it-1} \\ &+ \delta_5 PROFIT_{it-1} + \delta_6 ROA_{it-1} + \delta_7 R\&D_{it-1} \\ &+ \delta_8 SGA_{it-1} + \delta_9 ISE_{it-1} + \delta_{10} (ISExR\&D)_{it-1} \\ &+ \delta_{11} (ISExSGA9_{it-1} + \epsilon_{it} \end{aligned} \tag{16b}$$

β und δ bilden die Regressionskoeffizienten, während ϵ_{it} und $\in_{it}$ die Störterme repräsentieren. Neben dem Hauptmodell, bestehend aus den Teilmodellen (16a) und (16b), werden ergänzend fünf weitere Mehrgleichungsmodelle nach dem gleichen Muster geschätzt. Nähere Erläuterungen hierzu folgen bei der Vorstellung der Ergebnisse in Abschnitt 4.4.

Ferner werden die Kontrollvariablen der Accounting Performance sowie die Moderator- und Internationalisierungsvariablen der Vorjahresperiode berücksichtigt. ROA_{it-1} bedeutet beispielsweise, dass die Kapitalrendite des Unternehmens i des Jahres t-1 berücksichtigt wird. Diese zeitversetzte Wirkung der Variablen auf die Aktienrendite und das idiosynkratische Risiko wird aus zwei Gründen getestet. Eine

der größten Herausforderungen in der Marketing-Finance-Forschung ist die umgekehrte Kausalität zwischen erklärenden und abhängigen Variablen. Die erklärenden Variablen beeinflussen also nicht nur die abhängigen Variablen, sondern auch die umgekehrte Wirkungsrichtung ist denkbar (vgl. Hanssens et al., 2009, S. 117). Die Aktienrendite kann beispielsweise den Profit oder die Forschungs- und Entwicklungsausgaben eines Unternehmens beeinflussen (vgl. Mishra und Modi, 2016, S. 36). Beim „Laggen", also dem Zurücksetzen der erklärenden Variablen um eine Periode, ist eine reverse Kausalität ausgeschlossen. Die gegenwärtige Aktienrendite kann zum Beispiel nicht den Profit aus dem Vorjahr beeinflussen (vgl. Murthi et al., 1996, S. 331). Zudem lassen zeitlich versetzte erklärende Variablen eine bessere Bewertung des Shareholder Values zu. Einerseits nehmen Investoren den internationalen Strategie-Trade-off und die Kosten für Vermarktung und Innovation als strategische Investitionen wahr. Die Wirkung dieser Maßnahmen kann nur über einen langfristigen Zeitraum bewertet werden (vgl. Chen und Hsu, 2010, S. 1105). Andererseits stehen den Investoren bei der gegenwärtigen Bewertung der Marktperformance eines Unternehmens keine aktuellen Zahlen zur Verfügung. Die Vermutung liegt nahe, dass dabei auf vergangene Jahresabschlüsse zurückgegriffen wird. Dieser Umstand wird durch zeitversetzte erklärende Variablen zusätzlich berücksichtigt. Die Kontrollvariablen aus dem Bereich der Unternehmenscharakteristika werden, analog zu den abhängigen Variablen, im jeweils aktuellen Zeitraum gemessen. Die Annahme für dieses Vorgehen lautet, dass sich beispielsweise die Unternehmensgröße zwischen zwei jährlichen Bewertungszeiträumen nicht entscheidend ändert. Weiterhin können Investoren jederzeit auf den aktuellen Marktwert eines Unternehmens zurückgreifen, weshalb sich hier keine Effekte aus einer zeitversetzten Messung ergeben.

Eine weitere Spezifikation des Modells bezieht sich auf die fehlenden Werte der Moderatorvariablen SGA und R&D. Basierend auf der Arbeit von Servaes und Tamayo (2013) werden die fehlenden Werte mit 0 ersetzt, da Unternehmen nicht dazu verpflichtet sind die Marketingausgaben separat offenzulegen (vgl. Servaes und Tamayo, 2013, S. 1051). Einige Autoren argumentieren, dass Unternehmen ihre Marketingausgaben nur dann preisgeben, wenn daraus eine Erhöhung des Marktwertes zu erwarten ist (vgl. Simpson, 2007, S. 425). Ein anderer Erklärungsansatz lautet, dass Unternehmen die Offenlegung der Marketingausgaben zurückhalten, um den Wettbewerbern keine wertvollen Informationen zu überlassen (vgl. Kurt und Hulland, 2013, S. 72). Diese Argumentationen lassen sich auf die Forschungs- und Entwicklungsausgaben des Unternehmens übertragen. Daher ist davon auszugehen, dass die fehlenden Werte für die beiden Moderatorvariablen aus einer bewussten Nichtoffenlegung des Unternehmens resultieren. Sie werden folglich mit 0 ersetzt (vgl. Servaes und Tamayo, 2013, S. 1051). Die Haupteffekte werden zudem, vor der Nullsetzung der fehlenden Werte in den Moderatorvariablen, getestet und bleiben robust. Um abschließend zu überprüfen, ob konjunkturelle Einflüsse die jährlichen Beobachtungen systematisch beeinflussen, werden in alle Modelle Jahres-Dummies integriert (vgl. Wang und Qian, 2011, S. 427).

4.4. Ergebnisse

4.4.1. Deskriptive Statistik

Nachfolgend werden zunächst die deskriptiven Ergebnisse der Arbeit vorgestellt. Hierfür wird eine Korrelationsmatrix dargestellt, in der die paarweisen Korrelationen zwischen allen relevanten Variablen gezeigt werden. Im Anschluss folgen die multivariaten Ergebnisse. Dabei wird mittels der Mehrgleichungsregressionen geprüft, ob die in Abschnitt 3.4. formulierten Hypothesen angenommen oder abgelehnt werden.

Tabelle 3 zeigt die Korrelationsmatrix der Studie. Die Korrelationen werden dabei auf einem Signifikanzniveau von 5 % ($p < 0{,}05$) getestet (vgl. Mishra und Modi, 2016, S. 35). Der höchste Korrelationskoeffizient wird für die Beziehung zwischen der Unternehmensgröße und dem Marktwert angezeigt. Ein Wert von 0,8496 deutet auf eine starke lineare Beziehung zwischen den Variablen hin. Dieses Ergebnis ist konsistent mit der Literatur, welche sowohl die logarithmierten totalen Assets als auch den Marktwert eines Unternehmens berücksichtigt, um die Unternehmensgröße zu simulieren (vgl. Kurt und Hulland, 2013, S. 64). Ein weiterer auffälliger Wert von 0,4010 ergibt sich für die Korrelation zwischen den Moderatorvariablen. Daraus lässt sich schließen, dass eine Erhöhung der Forschungs- und Entwicklungsausgaben auch einen Anstieg der Vertriebs-, Verwaltungs- und Gemeinkosten zur Folge hat. Für das Verhältnis zwischen ISE und FSTS ist ein Wert von 0,2516 zu beobachten. Wenn die ISE-Kennzahl steigt, erhöht sich simultan auch der FSTS-Wert. Der Korrelationskoeffizient zwischen ISE und FATA beträgt hingegen -0,5642. Während die ISE-Kennzahl steigt, findet demnach eine Senkung des FATA-Wertes statt. Dieser Mechanismus wird bereits in Abschnitt 4.2. angedeutet. Eine Erhöhung in ISE deutet einen Anstieg der internationalen Wertschöpfung an. Gleichzeitig führt diese Erhöhung ebenfalls zu einer Senkung des FATA-Wertes bzw. der internationalen Wertgenerierung. Dieser Beziehungsvergleich deutet auf Trade-off-Entscheidungen hin. Da die Korrelationen in Tabelle 3 mehrheitlich gering sind, kann angenommen werden, dass Multikollinearität die empirische Untersuchung dieser Studie nicht gefährdet (vgl. Bahadir et al., 2008, S. 56).

4.4.2. Multivariate Ergebnisse

Die Ergebnisse der Mehrgleichungsmodelle sind für die abnormale Aktienrendite in Tabelle 4 und für das idiosynkratische Risiko in Tabelle 5 festgehalten. Die Regressionskoeffizienten sind auf fünf Nachkommastellen gerundet. Dabei sind die Ergebnisse zwar nach den abhängigen Variablen separiert, jedoch müssen die beiden Tabellen im Zusammenhang verstanden werden. Modell (11a) ist beispielsweise ein Teilmodell, welches erst mit Teilmodell (11b) das vollständige Mehrgleichungsmodell bildet. In diesem Mehrgleichungsmodell 11 werden zunächst die Einflüsse der Kontrollvariablen berücksichtigt. Zu diesem Variablenset gehören in die-

Tabelle 3: Übersicht der Forschungslücke; Quelle: Eigene Darstellung

*p < 0,05

	AR	IR	ISE	FSTS	FATA	R&D	SGA	SIZE	MV	BTM	LVG	CR	PROFIT	ROA
AR	1													
IR	-0,0203*	1												
ISE	0,0071	0,1022*	1											
FSTS	0,0011	0,0662*	0,2516*	1										
FATA	-0,0045	-0,0305*	-0,5642*	0,3529*	1									
R&D	0,0013	0,0917	0,2035*	0,1768*	-0,1008*	1								
SGA	0,0003	0,0829*	0,0878	0,0163*	-0,0602*	0,4010*	1							
SIZE	0,0007	-0,3870*	-0,0146	0,0297*	0,0409*	-0,1166*	-0,1175*	1						
MV	-0,0059	-0,3597*	0,0672*	0,0828*	0,0047	-0,0519	-0,0579*	0,8496*	1					
BTM	0,0006	0,0267*	-0,0764*	-0,0585*	0,0294*	-0,003	-0,0035	0,0553*	-0,0126*	1				
LVG	0,0081*	0,0088*	-0,0848*	-0,0470*	0,0457*	0,2319*	0,2508*	0,1330*	0,0925*	0,0349*	1			
CR	-0,0149*	0,1181*	0,2021*	0,1140*	-0,0890*	0,0133*	-0,0099*	-0,2079*	-0,1349*	-0,0562*	-0,1395*	1		
PROFIT	-0,003	0,0442*	0,0170*	0,0252*	-0,0144*	0,1209*	0,0603*	-0,0704*	-0,0505*	-0,0007	-0,0074	0,0144*	1	
ROA	0,0001	-0,0657*	-0,0931*	-0,0613	0,0490*	-0,3059*	-0,7445*	0,0490*	0,0479*	0	-0,1375*	0,0012	-0,1249*	1

ser Studie auch die separat getesteten Einflüsse der Moderatorvariablen. In Modell 12 wird die FSTS-Kennzahl hinzugefügt. Diese wird im darauffolgenden Modell durch die FATA-Kennzahl ersetzt. In Modell 14 wird FSTS wieder hinzugefügt, um beide Variablen gleichzeitig zu testen. Im vorletzten Modell werden FSTS und FATA durch die ISE-Kennzahl ersetzt. Abschließend werden die Interaktionen mit den Moderatorvariablen hinzugefügt, sodass Modell 16 das Hauptmodell abbildet.

Im unteren Teil der beiden Ergebnistabellen sind einige statistische Parameter aufgelistet. Diese werden im Folgenden erläutert. R^2 ist das Bestimmtheitsmaß und gibt an, wieviel von der Varianz der abhängigen Variable erklärt wird. Hiermit wird überprüft, inwiefern das geschätzte Regressionsmodell geeignet ist, um die Realität widerzuspiegeln. Das R^2 wird berechnet, indem die erklärte Streuung in Relation zur Gesamtstreuung gesetzt wird. Der Wertebereich dieses Gütemaßes liegt zwischen 0 und 1. Je näher die Kennzahl an 1 liegt, desto mehr Streuung wird von der Gesamtstreuung erklärt (vgl. Backhaus et al., 2013, S. 81 ff.). Der Variance Inflation Factor (VIF) bestimmt, ob Korrelationen zwischen zwei oder mehreren Regressoren vorliegen (vgl. Urban und Mayerl, 2006, S. 232). Bei VIF-Werten, die 10 übersteigen, ist anzunehmen, dass Multikollinearität vorliegt. (vgl. Backhaus et al., 2013, S. 108). Um dies zu überprüfen, wird für jedes Teilmodell eine einfache Regression gerechnet. Anders als bei den Mehrgleichungsmodellen werden hier keine Fixed Effects in die Modelle integriert. Der höchste VIF-Wert der jeweiligen Variablen wird anschließend in der Tabelle gepflegt. Das Bayesian Information Criterion oder BIC, bezeichnet ein Informationskriterium zur Modellauswahl. Hiermit wird die Variablenanzahl in einem Modell auf Sparsamkeit geprüft. Zwar kann sich die Güte eines Regressionsmodells mit jeder weiteren Variable erhöhen, jedoch passt sich das Modell immer mehr an die Daten der Stichprobe an. Da die Kernaufgabe lautet, die Realität zu prognostizieren, gilt es, eine Balance zwischen Einfachheit und Komplexität zu finden. Der BIC-Wert hilft hierbei, Modelle mit unterschiedlicher Variablenanzahl zu vergleichen. Das Entscheidungskriterium lautet: Je kleiner der BIC-Wert, desto geeigneter das Modell (vgl. Backhaus et al., 2013, S. 333 f.).

In der letzten Zeile der jeweiligen Tabelle ist abschließend die Anzahl der Observationen für jedes Mehrgleichungsmodell angegeben.

Zunächst ist festzustellen, dass sich das R^2 im Modell für die abnormale Aktienrendite mehr als verdoppelt, wenn Internationalisierungsvariablen integriert werden. Das R^2 beträgt im Kontrollvariablenteilmodell (11a) 0,1312 und steigt im finalen Teilmodell (16a) auf 0,2852. Für das idiosynkratische Risiko als abhängige Variable steigt das R^2, bei der Berücksichtigung der Internationalisierungsvariablen, ebenfalls an. Teilmodell (11b) weist einen R^2-Wert von 0,5963 auf, während das finale Teilmodell (16b) ein R^2 von 0,6446 besitzt. Die R^2-Werte der Teilmodelle (12a) und (12b) bis (16a) und (16b) unterscheiden sich marginal voneinander. Das Ersetzen der FSTS- und FATA-Kennzahlen durch die ISE-Kennzahl kann die Güte des Regressionsmodells demnach nicht signifikant steigern. Dennoch wird sie gleichermaßen nicht verschlechtert. Beim BIC ist eine ähnliche Entwicklung wie beim R^2 in umgekehrter Richtung zu beobachten. Sobald Internationalisierungsvariablen in das Modell integriert werden, sinkt der BIC-Wert rapide ab. Da der BIC-Wert jeweils für ein gesamtes Mehrgleichungsmodell gilt, kann hier auf die Bezeichnung „Teilmodell“ verzichtet werden. So beträgt der BIC etwa in Modell 5 noch 599.838,9 und fällt in Modell 12 auf einen Wert von 181.452,1. Der Wert von Modell 16 liegt bei 178.280,7 und stellt somit den geringsten BIC-Wert aller Mehrgleichungsmodelle dar. Das Hauptmodell der Studie ist folglich am besten geeignet, um die abnormale Aktienrendite und das idiosynkratische Risiko zu prognostizieren. Ferner weisen die Teilmodelle (16a) und (16b) maximale VIF-Werte von 4,35 und 4,32 auf. Die Regression ist daher nicht durch Multikollinearität gefährdet (vgl. Backhaus et al., 2013, S. 108).

Zur Überprüfung der Hypothesen werden nachfolgend die Teilmodelle (16a) und (16b) betrachtet. Für die ISE-Kennzahl wird postuliert, dass sie die abnormale Aktienrendite negativ und das idiosynkratische Risiko positiv beeinflusst. Der ISE-Koeffizient in Teilmodell (16a) weist einen Wert von 0,02783 auf und ist nicht signifikant ($p > 0{,}1$). In Modell (16b) beträgt der ISE-Koeffizient einen Wert von 0,20171 und ist ebenfalls nicht signifikant ($p > 0{,}1$). Da die ISE-Werte in beiden Teilmodellen nicht signifikant sind, müssen die Hypothesen „H1(a): Der strategische Trade-off zwischen internationaler Wertgenerierung und internationaler Wertschöpfung wirkt sich negativ auf die Aktienrendite eines Unternehmens aus“ und „H1(b): Der strategische Trade-off zwischen internationaler Wertgenerierung und internationaler Wertschöpfung wirkt sich positiv auf das idiosynkratische Risiko eines Unternehmens aus“, abgelehnt werden.

Ferner ist der Interaktionseffekt von ISE und R&D zu prüfen. Hier wird prognostiziert, dass die Innovationsfähigkeit die Beziehung zwischen der ISE-Kennzahl und der abnormalen Aktienrendite positiv moderiert. Der Moderationseffekt von R&D auf die Beziehung zwischen ISE und dem idiosynkratischen Risiko soll die entgegengesetzte Wirkungsrichtung aufweisen und zu einer Senkung des Risikos führen. Der R&D-Koeffizient in Modell (16a) hat mit 1,79425 einen positiven Wert und ist zu einem Niveau von $p < 0{,}01$ signifikant. In Modell (16b) ist mit -4,43208 ein signifikant negativer Wert des Koeffizienten ($p < 0{,}01$) zu beobachten. Die Wirkungsrichtungen für den Interaktionseffekt zwischen ISE und R&D wurden folglich korrekt prognostiziert. Die Hypothesen „H2(a): Die Innovationsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und der Aktienrendite eines Unternehmens positiv“ und „H2(b): Die Innovationsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und dem idiosynkratischen Risiko eines Unternehmens negativ“ werden daher bestätigt.

Der zweite Moderationseffekt ergibt sich aus dem Einfluss von SGA auf die Beziehung zwischen ISE und den abhängigen Variablen. Dabei wird der gleiche Wirkungszusammenhang wie bei der Moderation durch R&D unterstellt. Die

Tabelle 4: Abnormale Aktienrendite

* p < 0,1; **p < 0,05; ***p < 0,01; Jahres-Dummies in allen Modellen integriert

	(11a)	(12a)	(13a)	(14a)	(15a)	(16a)
Intercept	1.580 79	2.191 32***	2.071 05***	2.120 71***	2.129 84***	2.132 61***
SIZE						
MV	-0.168 18***	-0.283 20***	-0.271 21***	-0.282 30***	-0.281 74***	-0.282 00***
BTM						
LVG	2.439 71***	-0.062 14	-0.044 75	-0.045 08	-0.052 45	-0.065 86
CR	-0.002 47***	0.009 49	0.008 18	0.019 17**	0.018 83**	0.019 25**
PROFIT	3.12E-06	0.000 03***	7.01E-06	0.000 03***	0.000 03***	0.000 03***
ROA	-0.797 50***	-0.398 99***	-0.221 61***	-0.259 48**	-0.262 23**	-0.263 71**
R&D	2.021 41***	1.028 47***	0.414 76	1.428 95***	1.435 89***	0.796 39**
SGA	-0.550 85***	-0.146 34	-0.131 60	-0.213 29**	-0.209 73**	-0.157 66
FSTS			0.001 33**	0.001 94**		
FATA		-0.000 38		-0.000 43		
ISE					0.059 43	0.027 83
ISE x R&D						1.794 25***
ISE x SGA						-0.177 07
R^2	0.1312	0.279	0.2808	0.2842	0.284	0.2852
BIC	599 838.9	181 452.1	218 602.2	178 308.9	178 289.7	178 280.7
Max. VIF	1.93	1.61	2.00	1.77	1.71	4.35
Obs.	44 854	18 715	22 539	18 488	18 488	18 488

Tabelle 5: Idiosynkratisches Risiko

* p < 0,1; **p < 0,05; ***p < 0,01; Jahres-Dummies in allen Modellen integriert

	(11b)	(12b)	(13b)	(14b)	(15b)	(16b)
Intercept	19.655 11**	20.402 45***	18.378 05***	19.192 75***	19.217 59***	19.234 14***
SIZE	-1.039 92***	-1.017 57***	-0.928 35***	-0.986 52***	-0.992 39***	-0.989 34***
MV						
BTM	0.000 31***	0.000 40***	0.000 01***	0.000 40***	0.000 40***	0.000 40***
LVG	1.802 60***	1.941 38***	1.580 12***	2.055 48***	2.050 36***	2.078 51***
CR	-0.022 18***	-0.103 87***	-0.026 29	-0.099 75***	-0.104 81***	-0.104 76***
PROFIT	9.68e-06***	0.000 03	0.000 01	0.000 01	0.000 13	0.000 02
ROA	-2.437 38***	-5.492 64***	-4.934 64***	-5.479 75***	-5.431 80***	-5.433 52***
R&D	-0.764 60**	-7.405 70***	-6.211 23***	-7.464 76***	-7.419 06***	-5.889 58***
SGA	-0.662 36***	1.579 96***	1.534 41***	1.756 67***	1.773 64***	1.444 66***
FSTS			0.002 07	0.001 38		
FATA		0.000 95		-0.000 71		
ISE					0.251 07**	0.201 71
ISE x R&D						-4.432 08***
ISE x SGA						0.867 72***
R^2	0.5963	0.6449	0.6352	0.6442	0.6443	0.6446
BIC	599 838.9	181 452.1	218 602.2	178 308.9	178 289.7	178 280.7
Max. VIF	1.91	1.59	1.97	1.75	1.68	4.32
Obs.	44 854	18 715	22 539	18 488	18 488	18 488

Interaktion zwischen ISE und SGA soll zu einer Erhöhung der abnormalen Aktienrendite und zu einer Reduktion des idiosynkratischen Risikos führen. Der Regressionskoeffizient in Teilmodell (16a) zeigt einen Wert von -0,17707 und ist nicht signifikant ($p > 0{,}1$). In Modell (16b) beträgt der SGA-Koeffizient 0,86772 bei einem Signifikanzniveau von $p < 0{,}01$. Beide Wirkungszusammenhänge entsprechen nicht den in Abschnitt 3.4. formulierten Vermutungen. Daraus resultiert eine Ablehnung der Hypothesen „H3(a): Die Vermarktungsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und der Aktienrendite eines Unternehmens positiv“ und „H3(b): Die Vermarktungsfähigkeit moderiert die Beziehung zwischen dem internationalen Strategie-Trade-off und dem idiosynkratischen Risiko eines Unternehmens negativ“.

Neben den Effekten im Hauptmodell sind weiterhin nennenswerte Befunde in den übrigen Mehrgleichungsmodellen festzustellen. Der ISE-Koeffizient ist beispielsweise in Modell (15b), für das idiosynkratische Risiko, mit einem Wert von 0,25107 signifikant positiv ($p < 0{,}05$). In Modell (15a) ist der Koeffizient jedoch nicht signifikant ($p > 0{,}1$). Zudem ist zu beobachten, dass die FSTS-Kennzahl in den Teilmodellen (13a) und (14a) signifikant positive Regressionskoeffizienten aufweist ($p < 0{,}05$). In den zugehörigen Teilmodellen für das idiosynkratische Risiko, (13b) und (14b), ist der FSTS-Koeffizient nicht signifikant ($p > 0{,}1$). Die FATA-Koeffizienten hingegen zeigen in keinem der Teilmodelle signifikante Werte. Abschließend ist darauf hinzuweisen, dass die Moderatorvariablen R&D und SGA, in ihrem separaten Einfluss auf die abhängigen Variablen, in der Mehrzahl der Teilmodelle signifikant sind ($p < 0{,}01$). Zudem bleiben die Wirkungsrichtungen, außer in Teilmodell (11b), erhalten. R&D führt zu einer Erhöhung der abnormalen Aktienrendite und zu einer Reduktion des idiosynkratischen Risikos. SGA bewirkt eine Senkung der abnormalen Aktienrendite und einen Anstieg des idiosynkratischen Risikos.

5. Schlussbetrachtung

5.1. Diskussion

Das Ziel der vorliegenden Studie ist es, die Wirkung des Trade-offs zwischen internationaler Wertgenerierung und internationaler Wertschöpfung auf den Shareholder Value zu untersuchen. Dabei wird der moderierende Effekt von Marketing Capabilities in Betracht gezogen. Die Ergebnisse zeigen, dass der internationale Strategie-Trade-off keinen direkten Einfluss auf die abnormale Aktienrendite und das idiosynkratische Risiko ausübt. Diese potentielle Wirkungsbeziehung wird signifikant, sobald die Innovationsfähigkeit und die Vermarktungsfähigkeit der multinationalen Unternehmen berücksichtigt werden. Die Innovationsfähigkeit komplementiert den internationalen Strategie-Trade-off positiv und führt somit zu einer Erhöhung des Shareholder Values. Dementgegen bewirkt die Vermarktungsfähigkeit in dieser Beziehung eine Senkung des Shareholder Values.

In der ersten Forschungsfrage dieser Arbeit wird die Operationalisierung des internationalen Strategie-Trade-offs adressiert. Hierfür wird zunächst die Strategieoption der internationalen Wertgenerierung mit der lokalen Anpassungsfähigkeit von multinationalen Unternehmen verknüpft. Die Strategieoption der internationalen Wertschöpfung wird entsprechend mit der Fähigkeit zur globalen Integration in Verbindung gebracht. Diese Schlussfolgerungen stammen aus der Managementpraxis, die verstärkt internationale wertgenerierende Strategieoptionen berücksichtigt, um lokale Präferenzen zu bedienen. (vgl. Boston Consulting Group, 2010, S. 3 ff.). In der Internationalisierungsliteratur wird die internationale Wertgenerierung als die FATA-Relation und die internationale Wertschöpfung als die FSTS-Relation interpretiert (vgl. Thomas und Eden, 2004, S. 93; Dittfeld, 2017, S. 18). Um den Trade-off zwischen den beiden Größen zu messen, nimmt diese Studie Bezug auf die Vorgehensweise von Mizik und Jacobson (2003). Der Trade-off zwischen den Strategieoptionen findet primär vor dem Hintergrund knapper Ressourcen statt. Die Berücksichtigung dieser Ressourcenallokation kann laut den Autoren durch die Relation zwischen den Input- und Outputgrößen dargestellt werden (vgl. Mizik und Jacobson, 2003, S. 66). Der internationale Strategie-Trade-off wird in dieser Studie daher durch das Verhältnis der FSTS-Kennzahl zu der FATA-Kennzahl operationalisiert.

Zweitens sollte untersucht werden, in welchen Punkten sich die neuartige Internationalisierungsvariable zu den bisher genutzten Internationalisierungsvariablen unterscheidet. Während FSTS und FATA entweder den Wert für die internationale Wertschöpfung oder für die internationale Wertgenerierung anzeigen, bestimmt die ISE-Kennzahl die relativen Werte der beiden Strategieoptionen zueinander. Das Unternehmen Apple weist im Jahr 2016 beispielsweise einen FATA-Wert von 3,31 und einen FSTS-Wert von 64,91 auf. 3,31 % des Gesamtvermögens befinden sich im Ausland, und 64,91 % der Gesamtumsätze werden auf ausländischen Märkten generiert. Der ISE-Wert des Unternehmens beträgt 0,903. Je näher der Wert an 1 liegt, desto mehr setzt das Unternehmen seinen strategischen Schwerpunkt auf die internationale Wertschöpfung. Hier kann geschlussfolgert werden, dass Apple einen starken Schwerpunkt auf die internationale Wertschöpfung legt. Die internationale Wertgenerierung besitzt hingegen geringe strategische Bedeutung für das Unternehmen. Für ein weiteres Beispiel kann das Unternehmen Univar herangezogen werden. Univar ist ein US-amerikanischer Chemiedistributor und bietet in diesem Bereich Zusatzdienstleistungen an. Im Jahr 2016 liegt ein FATA-Wert von 54,45 und ein FSTS-Wert von 41,7 vor. Das Unternehmen besitzt daher zu 54,45 % ausländische Assets, und 41,7 % der totalen Umsätze werden auf internationalen Märkten erwirtschaftet. Die ISE-Kennzahl hat einen Wert von -0,133. Die Zahl ist relativ weit von -1 entfernt und liegt näher an 0. Univar legt den Fokus daher zwar auf die internationale Wertgenerierung, jedoch wird auch der internationalen Wertschöpfung ein signifikanter strategischer Stellenwert beigemessen. Die FSTS- und FATA-Werte beweisen diese Annahmen. Ferner wird die ISE-Kennzahl in Abschnitt 4.4. auf ihre statistische Robustheit im Vergleich zu den bewährten Internationalisierungsva-

riablen getestet. Auf Basis mehrerer statistischer Erfolgsgrößen wird konstatiert, dass die FSTS- und FATA-Modelle 12, 13 und 14 keine Vorteile gegenüber Modell 15 zeigen, in dem die ISE-Variable integriert wird. ISE repräsentiert demzufolge ein neues geeignetes Internationalisierungsmaß und ergänzt das bisherige Variablenset der Internationalisierungsliteratur.

In der dritten Forschungsfrage wird der Einfluss des internationalen Strategie-Trade-offs auf den Shareholder Value thematisiert. Die Forschungsfrage stellt damit den Kern der Untersuchung dar. Im Hauptmodell dieser Studie kann kein signifikanter Effekt der ISE-Kennzahl auf die abnormale Aktienrendite oder das idiosynkratische Risiko festgestellt werden. Diese Erkenntnis ist konsistent mit den Resultaten der Studien von Morck und Yeung (1991) und Christophe (1997) (vgl. Morck und Yeung, 1991, S. 185; Christophe, 1997, S. 460). Die Vermutung liegt nahe, dass die Investoren einerseits keine Vorteile in internationalen Trade-off-Entscheidungen identifizieren. Andererseits löst die Problematik der Ressourcenallokation auch keine negative Wahrnehmung des internationalen Strategie-Trade-offs aus. So kann geschlussfolgert werden, dass die alleinige Betrachtung des Trade-offs irrelevant für die Investmententscheidungen der Shareholder ist. Weitere Ergebnisse der Studie zeigen, dass der Trade-off erst bei der Interaktion mit Marketing Capabilities von Shareholdern wahrgenommen wird. Diese Wirkungsbeziehung spiegelt sich in der vierten Forschungsfrage wider.

Wie in den Hypothesen H2(a) und H2(b) postuliert, bewirkt die Innovationsfähigkeit in der Beziehung zwischen ISE und Shareholder Value einen Anstieg der abnormalen Aktienrendite und eine Senkung des idiosynkratischen Risikos. Der positive Einfluss der Innovationsfähigkeit geht bereits aus der Marketing-Finance-Literatur hervor (vgl. Rubera und Kirca, 2017, S. 744). Eckert et al. (2010) zeigen die hohe Relevanz der Innovationsfähigkeit zudem im Internationalisierungskontext. Die Autoren konkludieren aus ihren Untersuchungen, dass der Shareholder Value auf internationaler Ebene maßgeblich von der Innovationsfähigkeit des Unternehmens abhängt (vgl. Eckert et al., 2010, S. 573). Diese Erkenntnis kann von der vorliegenden Studie bestätigt werden. Dabei ist die Innovationsfähigkeit in das Konzept der dynamischen Fähigkeiten einzuordnen. Insbesondere die Strategieoption der internationalen Wertgenerierung kann von Investoren destruktiv bewertet werden (vgl. Christophe und Lee, 2005, S. 642; Click und Harrison, 2000, S. 12). Das Potenzial von wertgenerierenden Ressourcen kann durch Innovationsfähigkeit international besser ausgeschöpft werden (vgl. Yildiz, 2013, S. 339). Die Shareholder bewerten den internationalen Strategie-Trade-off aufgrund dieser Fähigkeit positiv.

Für den Moderationseffekt der Vermarktungsfähigkeit werden zunächst ähnliche Annahmen getroffen. Auch hier wird unterstellt, dass die dynamische Fähigkeit zu einer synergetischen Interaktion mit den Ressourcen führt und den Shareholder Value erhöht (vgl. Yildiz, 2013, S. 339). Die Vermarktungsfähigkeit führt in der Beziehung zwischen ISE und Shareholder Value jedoch zu einer Reduktion der abnormalen Aktienrendite und zu einer Erhöhung des idiosynkratischen Risikos. Mehrere Erklärungsansätze sind für diese Ergebnisse in Betracht zu ziehen. Zum einen ist anzunehmen, dass die Vorteile der Vermarktungsfähigkeit aus dem Heimatmarkt nicht vollständig auf ausländische Märkte übertragen werden können. Die Shareholder nehmen daher an, dass die Liabilities of Foreignness überwiegen und das multinationale Unternehmen sich nicht gegen lokale Konkurrenten durchsetzen kann (vgl. Bae et al., 2008, S. 57). Zum anderen ergeben sich die Vorteile der Vermarktungsfähigkeit auf internationaler Ebene aus der Nutzung von Standardisierungsprozessen. So können multinationale Unternehmen beispielsweise standardisierte Marketingprogramme entwickeln, um diese auf internationale Märkte zu übertragen (vgl. Helsen et al., 1993, S. 60). Folglich kann die Annahme getroffen werden, dass Standardisierungsvorteile aus Investorensicht nicht ausreichen, um den internationalen Strategie-Trade-off erfolgreich zu managen. Um neben wertschöpfenden auch wertgenerierende Ressourcen zu verstärken, muss eine dynamische Fähigkeit zusätzlich die lokale Adaption in einem ausländischen Markt fördern können. Wie im Unterabschnitt 3.4.2 erläutert, sind diese Eigenschaften bei der Innovationsfähigkeit gegeben (vgl. Kotabe et al., 2002, S. 83; Ghoshal, 1987, S. 431).

Dieser Erklärungsansatz lässt den Schluss zu, dass die Vermarktungsfähigkeit Vorteile für Unternehmen schafft, welche einen starken Fokus auf die internationale Wertschöpfung legen. Diese Strategieoption ist erfolgreich, wenn ein hoher Standardisierungsnutzen entsteht (Meyer und Estrin, 2014, S. 3; Zaheer, 1995, S. 343). Ein solcher kann durch eine ausgeprägte Vermarktungsfähigkeit auf internationalen Märkten ausgeschöpft werden (vgl. Kotabe et al., 2002, S. 82; Hitt et al., 1997, S. 771). Letztgenannte Annahme wird empirisch durch die Studie von Oh (2010) bestätigt. Hier wird ein positiver Moderationseffekt der Vermarktungsfähigkeit für die Beziehung zwischen dem FSTS-Verhältnis und dem Shareholder Value festgestellt (vgl. Oh, 2010, S. 37 ff.).

5.2. Limitationen und weiterer Forschungsbedarf

Ein mögliches Bias der vorliegenden Studie hängt mit dem Aktienindex Wilshire 5000 zusammen, aus dem die für die Untersuchung benötigten Unternehmen entnommen werden. Laut der Angaben von Wilshire Associates (2014) besteht die Aufgabe des Wilshire 5000 darin, die aktuelle Performance des US-amerikanischen Aktienmarktes wiederzugeben. Um dies zu gewährleisten, muss der Index kontinuierlich angepasst werden. Unternehmen können im Laufe der Zeit einen finanziellen Zusammenbruch erleiden oder von anderen Unternehmen gänzlich akquiriert werden. Konträr finden gleichermaßen Börsengänge statt, wodurch neue Aktien im Markt vorhanden sind. Der Index wird demnach fortlaufend durch neue Aktien ergänzt oder um inaktive Aktien bereinigt (vgl. Wilshire Associates Inc., 2014, S. 2). Hieraus ergibt sich für jedes Jahr des Untersuchungszeitraums von 1982 bis 2016 eine unterschiedliche Unternehmensanzahl im Sample. Die Daten solcher Unternehmen, die nur eine bestimmte Zeit des Untersuchungszeitraums vorhanden sind, werden in der aktuellen Studie dennoch nicht entfernt. Alle

Unternehmen, die mindestens für ein Jahr zwölf monatliche Observationen des Aktienpreises aufweisen, werden berücksichtigt. Ferner werden die Unternehmen des Wilshire 5000 anhand einer online zur Verfügung gestellten Liste ausgewählt. Hierbei können einige Identifizierungscodes in Datastream nicht lokalisiert werden. Zudem handelt es sich bei einigen Codes um Duplikate. Um diese Fehler zu beheben, kann die zukünftige Forschung monetäre Investitionen in vollständigere Datensets erwägen. Das Ziel dieser Arbeit ist es, erste Untersuchungen zur Beziehung zwischen dem internationalen Strategie-Trade-off und dem Shareholder Value durchzuführen. Für dieses Anliegen wird ein möglichst langer Untersuchungszeitraum mit möglichst vielen Untersuchungsobjekten angestrebt. Die erläuterte Vorgehensweise wird, auf Basis der zur Verfügung stehenden Mittel, als eine erfolgreiche Annäherung an die neue Thematik wahrgenommen.

Eine weitere Limitation kann in der Operationalisierung der unabhängigen Variable vermutet werden. Einige Studien empfehlen die Nutzung von Entropiemaßen, um die Internationalisierung eines Unternehmens zu messen. Die Autoren argumentieren, dass der Umfang der Internationalisierung in den jeweiligen Märkten in Relation zueinander untersucht werden muss. Hierzu können zum Beispiel die im Ausland erwirtschafteten Umsätze nach den Marktregionen Afrika, Asien/Pazifik, Europa und Amerika gewichtet werden (vgl. Hitt et al., 1997, S. 780). Zukünftige Studien können diesen Ansatz bei der weiteren Erforschung der Beziehung zwischen ISE und Shareholder Value implementieren. In der vorliegenden Arbeit werden Entropiemaße aus mehreren Gründen nicht in Betracht gezogen. In Worldscope liegen zunächst für eine Vielzahl von Unternehmen keine Daten zu den Umsätzen in den jeweiligen geografischen Segmenten vor (vgl. Wan und Hoskisson, 2003, S. 36). Zwischen Studien, die Entropie-Maße verwenden und solchen, die ausschließlich Scale-Maße nutzen, wird ferner ein Vergleich vorgenommen. Die Studien von Hitt et al. (1997) und Chang und Wang (2007) verwenden eine nach geographischen Regionen gewichtete FSTS-Kennzahl. Beide Studien kommen zu dem Ergebnis, dass die Beziehung zwischen Internationalisierung und Performance einen positiv linearen Verlauf darstellt (vgl. Hitt et al., 1997, S. 788; Chang und Wang, 2007, S. 71 f.). Die Autoren Capar und Kotabe (2003) sowie Elango und Sethi (2007) messen die Internationalisierung über die FSTS-Kennzahl, ohne Entropie-Maße einzubeziehen. In beiden Untersuchungen werden ebenfalls positiv lineare Internationalisierung-Performance-Beziehungen aufgezeigt (vgl. Capar und Kotabe, 2003, S. 351; Elango und Sethi, 2007, S. 381 f.). Aufgrund der Konsistenz in den Ergebnissen der Studien wurde in dieser Arbeit die Annahme getroffen, dass die Einbeziehung von Entropie-Maßen nicht zu signifikanten Unterschieden in den empirischen Resultaten führt. Weiterhin wird in dieser Studie die internationale strategische Ausrichtung eines Unternehmens untersucht. Die strategische Wichtigkeit der Bearbeitung ausländischer Märkte wird durch Scale-Maße, wie FSTS und FATA, wiedergegeben (vgl. Marano et al., 2016, 1080). Aus diesem Grund wird die ISE-Kennzahl durch die Relation von Scale-Maßen gebildet.

Abschließend tritt bei der Berechnung der Mehrgleichungsmodelle in Unterabschnitt 4.4.2. eine Limitation auf. In dieser Studie werden sechs Mehrgleichungsmodelle geschätzt, in denen jeweils die abnormale Aktienrendite und das idiosynkratische Risiko als abhängige Variablen implementiert werden. Studien aus dem Marketing-Finance-Interface zeigen, dass mehr als zwei abhängige Variablen erfolgreich in ein Mehrgleichungsmodell integriert werden können (vgl. Morgan und Rego, 2009, S. 65; Dotzel et al., 2013, S. 267 ff.). Hierdurch können wechselseitige Wirkungsbeziehungen zwischen unabhängigen, moderierenden und abhängigen Variablen untersucht werden (vgl. Vorhies et al., 2011, S. 746). Berry und Sakakibara (2008) beweisen ferner, dass solche wechselseitigen Beziehungen zwischen Marketingvariablen und Internationalisierungsvariablen vorliegen (vgl. Berry und Sakakibara, 2008, S. 293). Mit diesen Erkenntnissen kann die aktuelle Studie empirisch sowie inhaltlich ausgeweitet werden. Es besteht die Möglichkeit das Mehrgleichungsmodell um R&D-, SGA- und ISE-Kennzahlen als abhängige Variablen zu erweitern, um somit das Gesamtkonstrukt besser zu verstehen.

5.3. Forschungsimplikationen

In der vorliegenden Studie wird erstmalig die Beziehung zwischen dem internationalen Strategie-Trade-off und der Performance eines multinationalen Unternehmens untersucht. Damit knüpft die Studie an die Ausführungen von Bartlett und Ghoshal (1987) an. Die Gründer des Integration/Responsiveness-Frameworks weisen bereits auf die Relevanz des Trade-offs zwischen internationaler Wertgenerierung und internationaler Wertschöpfung hin (vgl. Bartlett und Ghoshal, 1987, S. 43). Obwohl diese Thematik in der Internationalisierungsforschung über Jahrzehnte hinweg Anerkennung findet, werden die Performanceimplikationen des Trade-offs bislang nicht untersucht (vgl. Meyer und Estrin, 2014, S. 9). Die aktuelle Studie führt hier die Integration/Responsiveness-Literatur mit der Forschung zur Beziehung zwischen Internationalisierung und Shareholder Value zusammen. Für den letztgenannten Literatur-Stream eröffnet sich damit die Möglichkeit, auf eine neue Internationalisierungsvariable zurückzugreifen. Zudem reiht sich diese Arbeit in die Studien von Hughes et al. (1975) und Michel und Shaked (1986) ein. Die Autoren implementieren in ihren Studien die in der Internationalisierungsforschung unterrepräsentierten Variablen der Aktienrendite und des Risikos (vgl. Hughes et al., 1975, S. 630; Michel und Shaked, 1986, S. 93 f.). Die aktuelle Arbeit schließt sich dieser Vorgehensweise an. Durch die Berücksichtigung der abnormalen Aktienrendite und des idiosynkratischen Risikos fließen ferner bewährte Performancekennzahlen aus dem Marketing-Finance-Interface ein (vgl. Luo et al., 2013b, S. 152).

Die Ergebnisse dieser Studie verweisen darüber hinaus auf die übergeordnete Rolle der Marketing Capabilities im Internationalisierungskontext. Dittfeld (2017) und Eckert et al. (2010) bestätigen die Relevanz des Marketings in der Beziehung zwischen Internationalisierung und Shareholder Value.

Hier wird die positive Wirkung von Marketing Capabilties auf die Beziehung zwischen FSTS- sowie FATA-Kennzahlen und dem Shareholder Value festgestellt (Dittfeld, 2017, S. 26; Eckert et al., 2010, S. 571). Die vorliegende Studie kann diese Wirkungsbeziehung für die ISE-Kennzahl als unabhängige und die Innovationsfähigkeit als moderierende Variable bestätigen. Zudem wird die Marketingliteratur durch diese Ergebnisse ergänzt. Morgan und Rego (2009) stellen etwa die Relevanz von Marketing Capabilities für die vollständige Ausschöpfung von Ressourcen heraus (vgl. Morgan und Rego, 2009, S. 290 f.). In der vorliegenden Arbeit werden diese Erkenntnisse bestätigt. Marketing Capability, in Form von Innovationsfähigkeit, erlaubt es einem multinationalen Unternehmen, seine internationalen Ressourcen optimal zu nutzen und Shareholder Value zu generieren. Das Konzept des Resource-Based-Views und die Theorie der Dynamic Capabilities können daher als ein zusammenhängendes Framework verstanden werden (vgl. Peteraf und Barney, 2003, S. 321 f.). Das Framework wird in der aktuellen Studie als ein geeigneter Erklärungsansatz für die Beziehung zwischen Internationalisierung und Shareholder Value präsentiert.

5.4. Managementimplikationen

Aus den Praxisstudien, welche zu Beginn dieser Arbeit diskutiert werden, ist abzuleiten, dass der Einfluss von internationalen Trade-off-Entscheidungen auf den Shareholder Value ein relevantes Thema in Managementkreisen darstellt (vgl. McKinsey & Company, 2012; Oliver Wyman, 2017, S. 3 ff.). Bezüglich dieser Thematik können aus der vorliegenden Studie praxisrelevante Implikationen gegeben werden. Zunächst kann kein direkter Einfluss des internationalen Strategie-Trade-offs auf den Shareholder Value festgestellt werden. Aus Managementsicht haben internationale Ressourcenallokationen zwischen den Strategieoptionen daher weder positive noch negative Effekte auf Investoren. Entscheidend für den Erfolg von internationalen Trade-off-Entscheidungen ist der Einsatz von Marketing Capabilities. Hierbei sollten Marketing Manager und internationale Manager sowohl den positiven Effekt der Innovationsfähigkeit als auch den negativen Effekt der Vermarktungsfähigkeit in Betracht ziehen.

Die Innovationsfähigkeit wird in dieser Studie durch die Forschungs- und Entwicklungskosten der Vorperiode gemessen. Der Kostenpunkt wird jeweils in der Bilanz der multinationalen Unternehmen kommuniziert (vgl. Servaes und Tamayo, 2013, S. 1051). Sofern internationale Trade-off-Entscheidungen angestrebt werden, sollten die Forschungs- und Entwicklungsausgaben daher in der letzten aufgestellten Bilanz kommuniziert werden. Die Ausführungen von Chen und Hsu (2010) bestätigen diese Empfehlung. Shareholder bewerten die Kosten für Forschung und Entwicklung als strategische Investitionen, welche erst über einen langfristigen Zeithorizont wirksam werden (vgl. Chen und Hsu, 2010, S. 1105).

Die Vermarktungsfähigkeit von multinationalen Unternehmen weist hingegen einen negativen Effekt auf die Beziehung zwischen internationalem Strategie-Trade-off und Shareholder Value auf. Die Vermarktungsfähigkeit wird in Form von Vertriebs-, Verwaltungs- und Gemeinkosten der Vorperiode gemessen. Die Kosten werden ebenfalls in den Bilanzen der Unternehmen kommuniziert (vgl. Kurt und Hulland, 2013, S. 64). Bei anstehenden internationalen Trade-off-Entscheidungen ist es daher nicht ratsam, die Vertriebs-, Verwaltungs- und Gemeinkosten als separaten Kostenpunkt offenzulegen. Diese Implikation wird von Kurt und Hulland (2013) gestützt. Die Autoren stellen heraus, dass der Shareholder Value bei falscher Kommunikation der Vermarktungsfähigkeit gemindert oder gänzlich aufgelöst wird (vgl. Kurt und Hulland, 2013, S. 72). Dennoch ist es für multinationale Unternehmen mit ausgeprägter Vermarktungsfähigkeit empfehlenswert, diese auszuschöpfen (vgl. Nath et al., 2010, S. 326). Folglich können andere Kommunikationswege, wie Roadshows oder Aktionärsversammlungen, gewählt werden (vgl. Xiong und Bharadwaj, 2013, S. 712). Das Unternehmen Unilever kommunizierte seine Vermarktungsfähigkeit zum Beispiel anhand einer Präsentation des Marketingvorstands auf einem „Investor Relations Seminar“ (vgl. Unilever, 2007). Diese Art der Kommunikation kann für den Erfolg von internationalen Trade-off-Entscheidungen vom Management ebenfalls in Betracht gezogen werden.

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The influence of political regulations and market design on energy storage systems

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Abstract

This study examines the profitability of residential storage systems in combination with photovoltaic systems for varying political scenarios and under different market conditions. By comparing the energy flows of a photovoltaic rooftop facility to an average German household's consumption pattern, this thesis calculates the additional self-consumption that can be achieved through a battery storage system and values the resulting savings via a net present value approach. The simulations of this study identify boundaries for specific political regulations and market environments that can enable battery storage systems to be operated in a profitably way. Based on the assumptions of this thesis, current market conditions do not allow battery storage installations to generate positive returns on investment. Nevertheless, there could be lucrative opportunities in battery storage systems for future electricity price movements and sinking system costs.

Keywords: Battery storage, Solar photovoltaic power, Distributed electricity, Energy policy, Market regulation

1. Why energy storage matters

The German energy transition, the so called "Energiewende", heralds a new era in the German power system. With the Japanese reactor meltdown in 2011, the German government passed a law to a shutdown of several nuclear reactors and a nuclear phase-out by 2022, clearing the way for more renewables in the grid.[1] The basis for this energy transition was already planned in the regulations for renewables 'Gesetz für den Vorrang Erneuerbarer Energien' (EEG) in 2000. A huge uptake of renewable energy facilities will substitute current power generation and change the market entirely. The newest targets of the German government include a renewable share of 40-45% of the total electricity generation until 2025 and a share of 55-60% until 2035.[2] The massive addition of renewable energy sources was politically incentivized by regulations to compensate the higher investment costs of renewable facilities.[3] Due to higher scaling and technical improvements, the prices of certain technologies dropped. This decrease of prices, for example for photovoltaic systems, led to a global growth of the corresponding industry.[4] With a share of already 33% of the total German electricity production in 2015, the energy mix of wind, hydro, solar and biomass plants are foreseen to reach the governmental targets.[5] This energy transformation accelerated the renewable energy development, making Germany one of the world leaders in clean power technologies.[6] Since renewable energy technologies are becoming more and more efficient and cheaper, they provide an alternative to diesel power and other fossil plants.[7] The biggest amount of the renewable energy production will come from variable sources like wind and solar power.[8] However, the substitution of dispatchable fossil-fuel plants with intermittent energy resources implies challenges for the grid and the general power supply.

Unlike fossil-fuel generation facilities, photovoltaic power plants and wind generators depend on the current weather conditions and time of day, leading to peak productions on very sunny or windy days while the facilities stand still during windless nights. With about 35 Gigawatts of fluctuating power generating facilities already in 2010, the renewables and their dependency on weather have a major impact on current market situations.[9] Since the demand does not necessarily follow this generation pattern, additional flexibility

[1] International Renewable Energy Agency (2015) p. 35.
[2] Bundesregierung (2017) Ein neues Zeitalter hat begonnen.
[3] Bundestag (2000) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2000).
[4] Mundada et al. (2016) p. 693.
[5] Bundesregierung (2017) Ein neues Zeitalter hat begonnen.
[6] Borden and Schill (2013) p. 2.
[7] Diaf et al. (2008) p. 743.
[8] Borden and Schill (2013) p. 15.
[9] Ehlers (2011) pp. 58-59.

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measures have to assure a stable grid and power supply.[10]

Building more interconnected grids is a way to increase flexibility in the system. Most wind power plants are stationed in the north of Germany whereas photovoltaic technology is more present in the south.[11] If the transmission grid connecting the north and south has enough capacity, one-sided production can be distributed to the other part as well. A windy night in the north might produce enough wind energy to meet the demand of the southern German households as well. In contrast, a windless but sunny day might provide enough solar energy to compensate for the lack of wind if the transmission capacities are sufficient. However, a better interconnection fails when even in other regions or countries the weather conditions are simply not adequate for generation.[12] In addition to that, long transmission grids face high efficiency losses.[13]

Another way to smoothen the grid stress would be a more sophisticated demand management. Demand management measures are seen to have potential in certain circumstances but are not able to shift the demand entirely. By pricing the consumption at times of higher production with lower electricity retail rates, people could be incentivized to consume along with the production patterns of the renewable facilities. However, the daily and nightly patterns of consumption can not be changed entirely. People tend to use lights usually at night when no photovoltaic production is possible, and therefore demand management also fails.[14]

Energy storage systems can tackle these issues by storing excess energy and discharge it at times of higher demand.[15] Energy storage systems provide multiple application possibilities. By storing energy at times when the prices are low and selling the energy when prices are high, storage systems can serve as an arbitrage tool. Quick changes in the production pattern of the renewables due to sudden weather changes can be absorbed by energy storages. Peak production facilities might be obsolete if there is enough storage capacity that is ready to meet peaks in demand.[16] Thus, energy storage has a grid relieving effect by bridging the gaps between production and demand as well as shaving peaks of renewable energy generation.[17] [18]

Depending on where the energy storage system is stationed – behind the meter, the distribution or transmission level – different use cases are possible. According to Fitzgerald et al. (2015), energy storage would unfold its capabilities best, if it is located on site of the customer's residence.[19]

About 80% of the German photovoltaic power generation is placed decentralized in low voltage distribution grids.[20] All photovoltaic systems in a local grid usually produce at the same time due to their regional affiliation. Thus, when the sun stands high, the regional grid might be overburdened by a large number of grid feeding facilities within an area. The electrical equipment, like transformators and power cables, might be harmed by being exposed to too much excess power.[21] [22] To avoid overstressed regional grids, the energy storage systems might as well be decentralized along with the production facilities to handle the issue where it originates and to avoid transmission losses. Batteries are an effective, decentralized energy storage system and a way to increase the self-consumption of the otherwise grid-stressing photovoltaic power.[23]

Due to falling investment costs, battery storage systems become more and more attractive for households with a photovoltaic installation. By increasing the self-consumption rate, the battery lowers the electricity bill and can hedge against rising electricity prices.[24] Battery storage systems can deliver auxiliary services at low costs that may be necessary to integrate more renewable energy facilities in the grid.[25]

Governments, including the United States, Japan, China and Germany, have supported renewables and the implementation of battery storage systems.[26] However, only 3.5% of the declared photovoltaic systems in Germany were equipped with an energy storage system in 2015.[27] As Sioshansi et al. (2012) suggest market and policy issues, as well as incomplete valuation methods of potential benefits and risks, might be strong influencers on energy storage systems.[28] Current market conditions do not provide appropriate measures and incentives that would compensate the battery investment costs.[29] Substantial cost reductions are needed to incentivize storage installations.[30] Governmental interference is necessary to blaze the trail for further cost improvements and further deployment of storage systems.[31] But which political measurements are affecting the economic profitability of energy storage systems and how sensitive is the economic value of battery storage systems towards changes in the market design?

This thesis identifies influencing political measures and evaluates the sensitivity of storage systems to politically affected parameters by simulating different market conditions and regulations. I deal with the interference of taxes on electricity retail rates, feed-in tariffs as well as subsidy regula-

[10] Crossley (2014) pp. 2-3.
[11] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) pp. 25-26.
[12] Flatley et al. (2016) p. 6.
[13] Cortekar and Groth (2015) p. 14.
[14] Flatley et al. (2016) p. 6.
[15] Crossley (2014) pp. 2-3.
[16] Sioshansi et al. (2012) p. 48.
[17] Crossley (2014) p. 4.
[18] Flatley et al. (2016) p. 5.
[19] Fitzgerald et al. (2015) p. 6.
[20] Kairies et al. (2015c) p. 201.
[21] Kerber (2011) pp. 31-33.
[22] Farrell (2014) p. 3.
[23] Wirth (2017) p. 65.
[24] International Renewable Energy Agency (2015) p. 35.
[25] Fitzgerald et al. (2015) p. 12.
[26] International Renewable Energy Agency (2015) p. 39.
[27] Kairies et al. (2015a) p. 44.
[28] Sioshansi et al. (2012) p. 61.
[29] Truong et al. (2016) p. 1.
[30] De Sisternes et al. (2016) p. 30.
[31] Kempener and de Vivero (2015) p. 4.

tions and feed-in curtailments. My findings include sensitivity analyses showing potential financial opportunities in battery storage systems with minor changes in the electricity prices as well as opportunities if investment subsidies minimize the battery costs. Assuming total system costs of 600€ per Kilowatthour (kWh) of usable battery capacity, a subsidy of 90€ per kWh could be already sufficient to incentivize installations. An electricity price of 31.6 Cents/kWh would lead to a similar result. Feed-in tariffs would have to decrease by 2.70 Cents/kWh to place battery storage systems in a financially profitable position. Current regulations regarding feed-in limitations could not incentivize installations in battery storage systems if they are above 26% of the nominal photovoltaic power installed.

Chapter 2 identifies different political measurements that influence the financial attractiveness of battery storage systems. Chapter 3.1 demonstrates a method to assess the value of a combined photovoltaic and battery storage system with a net present value (NPV) approach. Furthermore, chapter 3.2 deduces the parameters and input data, which are used for the simulation. Chapter 4 presents and discusses the simulation results and shows sensitivity analyses with respect to different political measures. Chapter 5 gives a summary and presents open research questions.

2. Identification of influencing regulatory measures

The grid must be balanced in a way that the current supply equals the current demand at any point in time to prevent system failures.[32] While demand varies with the behavior of the consumers, the renewable production varies with weather conditions. The grid needs to compensate these fluctuations. Since residential energy storage systems can mellow down grid stressing peaks, incentivizing installations can be profitable for the public infrastructure.

There are many influencing parameters to drive or lessen the installations of battery systems. The decision to buy a battery storage system for a photovoltaic rooftop depends on financial aspects as well as the personal attitudes of the investor. In a survey in 2015, batteries were not recognized for being a good investment opportunity and maximizing returns but are known and seen as an option to be more independent from the energy supplier.[33] Sioshansi et al. (2012) point out, that next to manufacturing costs, roundtrip efficiency and technical characteristics, also non-technical aspects influence further implementations. Limited support of the technology, market design, regulatory treatment as well as issues with storage valuation could slow down a storage update.[34] Taylor et al. (2013) emphasize, that a financial lucrative investment, controllability, performance as well as aesthetics are important for a purchase. Without strong incentives, the installations of energy storage systems might be low.[35] According to Gährs et al. (2015), 69% of the surveyed photovoltaic owners are highly willing to invest in a battery storage system. Some owners base their decision on governmental subsidies.[36] This shows that the market for battery systems is driven by economic incentives and thus highly influenced by political decisions, market design and subsidies. Subsidies are therefore a method to stimulate the market of energy storage systems.[37]

Policy and market barriers, however, can prevent storage systems to overcome financial barriers.[38] If rates of remuneration for feed-in electricity are very high, self-consumption makes no sense for an economic perspective. Governments could indirectly catalyze storage installations by lowering feed-in tariffs and rising retail electricity prices. At higher electricity prices, photovoltaic owners will try to increase their self-consumption to reduce their electricity bill, especially when the compensation for selling electricity to the grid is not lucrative. "Market-pull"-incentives through price interference can boost a technology like storage systems.[39] In addition to that, limiting the feed-in energy and promoting a local use of electricity can influence the profitability of storages as well. Curtailments on energy fed to the grid force photovoltaic owners to increase their self-consumption to avoid energy losses. Therefore, curtailments can be an important governmental driver.[40] Another way of supporting technologies could be giving out securities, loan guarantees to investors so that the associated risks of new technologies are covered by governmental programs. Low interest rates on loans for new technology projects may enable an implementation which would otherwise not be possible to finance.[41]

The following chapters present four politically regulated ways to effect further installations of battery storage systems. Each subchapter presents the current state of political regulations or market parameter and lists results of previous studies in this field. Chapter 2.1 deals with investment subsidies as a political influencer on storage systems. The successive chapters handle the more indirect political measurements: Chapter 2.2 focusses on electricity costs. Chapter 2.3 covers feed-in tariffs and chapter 2.4 deals with feed-in curtailments.

2.1. Investment subsidies

If photovoltaic owners are asked for major reasons against storage systems, the high investment costs are ranked first.[42] High system costs are a major barrier for a broad market launch of small stationary battery systems.[43] Taylor et al. (2013) point out, that potential storage owners must face a lucrative, financial investment to effectively convince them to invest.[44] Thus, the probably most obvious way of boosting

[32] Flatley et al. (2016) p. 2.
[33] Gährs et al. (2015) p. 32.
[34] Sioshansi et al. (2012) p. 49.
[35] Taylor et al. (2013) p. 238.
[36] Gährs et al. (2015) p. 31.
[37] Kantor et al. (2015) p. 223.
[38] Kempener and de Vivero (2015) p. 21.
[39] Borden and Schill (2013) p. 3.
[40] International Renewable Energy Agency (2015) p. 40.
[41] Borden and Schill (2013) p. 11.
[42] Gährs et al. (2015) p. 33.
[43] Kairies et al. (2015c) p. 200.
[44] Taylor et al. (2013) p. 238.

households to implement battery storage systems is lowering the investment costs. The tipping point for a storage boom is expected within the next ten years as batteries become cheaper.[45] Susbidies for investment costs could move up this trend even before. Reducing the investment costs with governmental subsidy programs may stimulate energy storage systems.[46] The survey of Gährs et al. (2015) shows, that 66% of 552 questioned German private photovoltaic owners would invest, if there was a 25% reimbursement of the costs of the storage system.[47] In a study of Kantor et al. (2015) regarding used lithium-ion vehicle batteries being repurposed in household applications, the installation of the system would require a subsidy of $29/kWh capacity for the households to gain net-benefits.[48] Naumann et al. (2015) suggest that an additional subsidy of about 50€ /kWh would turn storages for photovoltaic households profitable. In addition to that, due to decreasing battery prices and improvements in battery performance, investment subsidies might be obsolete by 2018.[49] Nevertheless, at the time this thesis was written, incentive programs are still running and might still be important for the storage market in Germany.

The incentive program with the number 275 of the German ministry for economy and energy 'Bundesministerium für Wirtschaft und Energie (BMWi)' and the German public funding bank 'Kreditanstalt für Wiederaufbau' (KfW) stimulated the photovoltaic storage market since 1st May of 2013, leading batteries from a niche-product to the mass market.[50] The program with an initial fund of 25 million Euros promoted the technology and lowered the prices for household-systems by offering low interest loans with a maximum of 30% reimbursement of the eligible cost.[51] Qualification standards for the program assure, that the incentive leads to further development in the technology of the product and that the storage systems provide grid-relieving features and stability.[52] [53] The program is highly appreciated and seems to be a big success. Initially planned until the end of 2015, the program got extended in a second phase with additional 30 million Euros until the end of 2018 for a maximum reimbursement-rate of 25% per battery.[54] The reimbursement rate is now lowered every six months. Since the 1st January of 2017, the reimbursement is limited to 19% of the costs that are eligible for the grants.[55] Nevertheless around 50% of the storage owners did not use the subsidy.[56] Since only batteries for photovoltaic systems which are installed after 31/12/2012 are qualified for the program, most of the batteries are installed together with a new photovoltaic system. Only a relative small percentage of 17% are installed post hoc to an existing photovoltaic system.[57] The budget-limit for storage installations in 2016 was already reached in September.[58]

Why does it come that still only around 3.5-13% of photovoltaic systems are combined with a storage system?[59] At what investment costs do battery storage systems become economically feasible? What further price decreases or alternatively governmental subsidies are necessary to create a lucrative investment opportunity for photovoltaic owners? Simulations with different investment subsidies will answer this questions in chapter 4.1 by presenting the sensitivity analysis of battery price movements.

2.2. Electricity costs influenced by taxes, fees and levies

Battery storage systems with focus on increasing self-consumption can shift the supply of the electric power produced by the photovoltaic system to the demand of the household. By increasing the self-consumption, the household requires less energy purchases from the grid, and therefore saves money. These savings depend on the electricity price, which the household would have paid instead, and the remuneration rate, the household would have received, if it sold the produced energy to the grid instead of using it.[60] In this passage I want to focus on political tools to influence the electricity price or the "buying-price" from a household perspective. Assuming that the electricity retail rate is always higher than the rate of remuneration, self-consumption of produced energy must be favored over its selling to the grid. The higher the electricity price is, the more money can then be saved by using self-produced energy instead of purchasing the demanded power. Taxes, fees and levies with an influence on the electricity price have therefore also an indirect influence on the profitability of storage systems. Jülch et al. (2015) expect electricity prices to rise, so that battery storage systems in combination with a photovoltaic production facility will be profitable in less than ten years.[61] Hoppmann et al. (2014) assume scenarios with an increase in the electricity retail rate between 0-2% per year. They find optimal battery capacity sizes between 3-5 kWh, depending on the retail rate.[62] The study of Truong et al. (2016) for electricity prices of constant 28.72 Cents/kWh did result in a neutral return of investment of 0% for a Tesla battery model.[63]

In May 2016, one kWh of residential electrical power cost 28.73 Cents.[64] 54% of the electricity costs of an average German household in 2016 are caused by taxes. Only 21.4%

[45] AECOM (2015) p. 12.
[46] Kantor et al. (2015) p. 223.
[47] Gährs et al. (2015) pp. 30-31.
[48] Kantor et al. (2015) p. 222.
[49] Naumann et al. (2015) p. 45.
[50] Kairies et al. (2016a) p. 1.
[51] International Renewable Energy Agency (2015) p. 36.
[52] Kairies et al. (2015c) p. 201.
[53] Borden and Schill (2013) p. 22.
[54] Kairies et al. (2016b) p. 8.
[55] Kreditanstalt für Wiederaufbau (2017) Erneuerbare Energien – Speicher.
[56] Sterner et al. (2015) p. 24.
[57] Kairies et al. (2015a) p. 51.
[58] Enkhardt (2016) KfW verkündet vorläufigen Stopp der Photovoltaik-Speicherförderung bis Jahresende.
[59] Kairies et al. (2015a) p. 44.
[60] Truong et al. (2016) p. 8.
[61] Jülch et al. (2015) pp. 25-26.
[62] Hoppmann et al. (2014) p. 1111.
[63] Truong et al. (2016) p. 14.
[64] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016b) Energiedaten.

are based on the actual electricity costs for production and sale. The remaining 24.6% of the electricity costs are caused by grid fees.[65] Those taxes can be divided into value added tax, concession levy, EEG reallocation charge, combined heat and power addition, §19 "StromNEV" reallocation charge, offshore liability charge and the electricity tax.[66]

The composition of costs since 1998 show that taxes and levies increased by 281%. The costs of producing energy in the power plants only grew about 1%, giving an indication how big the influence of taxes and levies on the electricity retail rate is in comparison to the costs of production.[67] The EEG reallocation charge is used to distribute the costs of the renewable energy funding and subsidies to the consumers.[68] Introduced as a way to finance the German "Energiewende", the charge has grown rapidly, leading to higher taxes on electricity and therefore higher total electricity retail rates for consumers.[69] The EEG reallocation charges, grown by nearly 600% since 2009, are the biggest public influencer on the electricity price.[70] The taxes on electricity prices, especially the EEG reallocation charge and the combined heat and power addition, are expected to further rise in the next few years, leading to higher electricity prices.[71] It is estimated that the EEG reallocation charge might find its peak 2023 with 7.6 Cents/kWh before going down again.[72] If those taxes are not charged on self-produced and self-consumed energy, self-consumption leads to lower tax payments. Thus, energy storage in form of batteries can take advantage of higher electricity prices.

Storage lacks an individual regulatory and formal definition next to consumption and production.[73] In the EEG regulatory it is handled as a consumer when energy is stored and as a producer when energy is released, which can cause situations where storage owners are forced to pay fees and taxes for storing energy.[74] Since 1st January 2015 generating systems - also when used for self-consumption purposes - underlie EEG reallocation charges whereas renewable energy plants are only obligated to 40% of the charges.[75] As soon as taxes are applied on self-consumed energy, battery storage systems become less attractive since the savings on the electricity bill are diminished by taxes that have to be paid anyway.[76] However, small residential photovoltaic systems being not bigger than 10 Kilowatt-peak (kWp) power, with a maximal yearly production of 10 Megawatt-hours (MWh), which fulfill certain requirements, are freed from EEG charges for 20 years.[77] In cases where the photovoltaic system and the battery storage have not more than 10 kWp power each and the limit of 10 MWh of generated electricity is not exceeded, the whole system is again freed from any EEG charges.[78] Therefore, 10 kWp marks a border as the maximum size of a photovoltaic system for households, with no EEG reallocation charges to be paid.

The value-added tax regulatories do also account for electricity generated by a photovoltaic system. If the photovoltaic system is installed as an investment opportunity to gain revenues, the value-added tax of the system's purchase gets refunded. On the other side, the household is then in the duty to pay taxes on the revenues of selling electricity to the grid and also on self-consumption, where a fictive net electricity price is used to determine the value-added tax.[79] If a household with a photovoltaic system is eligible to choose a so called "small-scale-business"-regularization, the system can be operated without value-added tax. Simplified said, only households with photovoltaic systems that generate less than 17500€ revenues per year are allowed to choose this regularization-method. The downside is that at the time of the purchase, no value-added tax of the investment is reimbursed. In return, selling power to the grid or self-consumption is also free of value-added tax.[80] In most cases, the "small-scale-business"-regularization should be applicable. Photovoltaic systems with battery storage for self-consumption are therefore usually free of value-added tax if this regulation is applied. A battery which is installed after the 04/08/2011 and takes on operation within the next 15 years is free of grid fees for 20 years. Electricity tax costs do not occur when the energy is produced by renewable production facilities.[81]

A combined photovoltaic and battery storage system, which is only used to increase self-consumption and does fulfill the bespoken size limits and the additional requirements, is free of electricity taxes, grid fees, value-added tax and EEG reallocation charges.[82] Assuming no taxes, fees and levies on self-consumption, every kWh of produced energy being consumed, reduces the electricity bill by the complete electricity price per kWh. Likely scenarios of rising electricity prices could make battery storage systems used for increasing self-consumption economically profitable. But which electricity price could now justify the high investment costs of a battery installation? How much would taxes have to rise to make battery storage financially attractive? The simulation results in 4.2 present answers with a sensitivity analysis regarding different electricity prices.

[65] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016a) pp. 33-34.
[66] §19 of the "StromNEV" regulation distributes the costs of discounts for energy intensive industries towards all consumers.
[67] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016a) p. 33.
[68] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) p. 9.
[69] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016b) Energiedaten.
[70] Deutscher Industrie- und Handelskammertag (2016) p. 29.
[71] Bundesverband Energiespeicher e.V. (2016) p. 8.
[72] Deutscher Industrie- und Handelskammertag (2016) p. 31.
[73] Sterner et al. (2015) p. 25.
[74] Bundesverband Energiespeicher e.V. (2016) p. 7.
[75] Deutscher Industrie- und Handelskammertag (2015) pp. 4-5.
[76] Truong et al. (2016) p. 14.
[77] Deutscher Industrie- und Handelskammertag (2015) p. 6.
[78] Bundesverband Energiespeicher e.V. (2016) pp. 10-11.
[79] Kairies et al. (2016b) p. 70.
[80] Kairies et al. (2015a) p. 69.
[81] Sterner et al. (2015) p. 25.
[82] Borden and Schill (2013) p. 21.

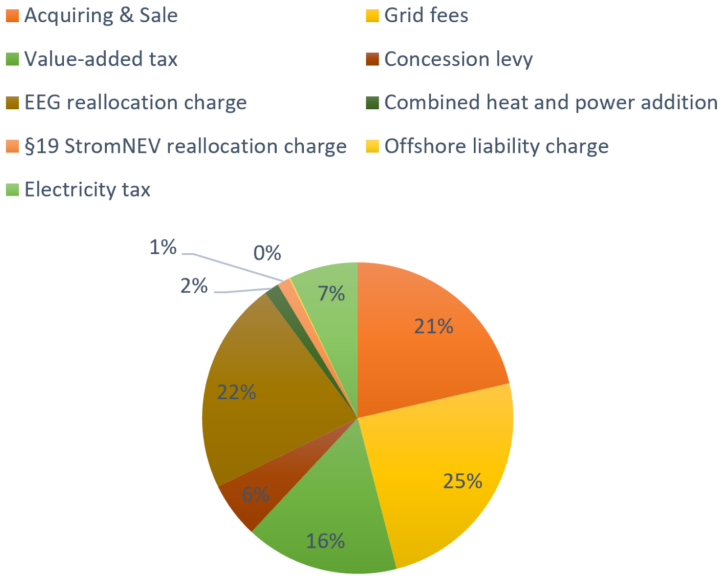


Figure 1: Composition of German electricity costs (in May 2016).
(Based on data of Bundesverband der Energie- und Wasserwirtschaft e.V. (2016b) Energiedaten.)

2.3. Feed-in tariffs

With the regulations of the EEG in 2000, the German government introduced a fixed remuneration rate during a period of 20 years after installation for renewable generation facilities. Per §3, §8 and §9 grid operators are under obligation to purchase all produced photovoltaic energy by a fixed price of initially 45.7 Cents/kWh with additional 11.7 Cents/kWh for systems smaller than 30 Kilowatts (kW) at that time.[83] The rates of remuneration are lowered with respect to the photovoltaic addition in the energy mix.[84] By giving this incentive of fixed compensations, the German government boosted the installation of photovoltaic systems. The fixed rate gives investment security and takes away the risks an energy investor would face otherwise.[85] On the other side, these fixed rates of remuneration have a reverse effect on storage applications.[86] The relatively high and fixed compensation of electricity fed into the grid prevents storage systems to become financially attractive. As long as the rate of remuneration was higher than the electricity retail rate, photovoltaic owners would have lost money if they used the power on their own instead of selling it. Thus, there was no incentive for self-consumption and therefore no financial reason for buying a battery storage system. Current rates of remuneration are lower than the initial compensation and lower than the latest electricity price.[87] [88] If there is lower compensation for selling energy to the grid, the reward of self-consumption rises. Thus, the lower the feed-in tariff, the higher the return of self-consumption. The selling price of produced energy is, therefore, a big driver of the profitability of battery storage systems.[89] Until 2011 the rates of remuneration were higher than the electricity retail rates at that time.[90] [91] But since the rates of remuneration are fixed for 20 years, older photovoltaic systems don't have any incentive to consume the energy rather than selling it to the grid as long as those contracts guarantee the fixed compensation. This will only change if either electricity retail rates rise dramatically or when the production facilities are fading out of the contracts after 20 years. Systems that have lower contracted rates of remuneration might have a theoretical incentive for self-consumption but it is questionable if this financial incentive is big enough to justify the expenses for a battery storage system. However, in 2020, the first installed photovoltaic systems will fall out of the fixed remuneration regulation and therefore face actual market prices. This huge drop in the compensation for the produced energy could actually be incentive enough to switch to self-consumption. Truong et al. (2016) simulated with a retrofitted storage system for a photovoltaic system installed in 2000 with an average remuneration rate of 3.21 Cents/kWh. The scenario for retrofitted installations in 2020 showed big financial potential.[92]

[83] Bundestag (2000) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2000).
[84] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.
[85] Ehlers (2011) pp. 58-59.
[86] Kempener and de Vivero (2015) p. 32.
[87] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.
[88] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016b) Energiedaten.
[89] Doetsch et al. (2014) pp. 163-164.
[90] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) p. 48.
[91] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) p. 63.
[92] Truong et al. (2016) pp. 8-12.

Fitzgerald et al. (2015) assume rates of remuneration around 3.5 Cents/kWh in a scenario in the United States, where net metering is fading out, finding positive returns if the battery storage system is additionally used for secondary services.[93] According to Doetsch et al. (2014) batteries would be profitable in scenarios without any feed-in compensation. In these scenarios self-consumption would be the only way to use produced energy. Under these circumstances, lithium-ion batteries could generate 58 € per kWh capacity on average a year. Lead-acid and redox-flow batteries would earn 40 € and 42 € per kWh capacity a year.[94] The situation for new combined installations together with a photovoltaic system is very different. Current feed-in tariffs are already below the average electricity retail rate for households and thus incentivizing self-consumption.[95] [96] But according to Borden and Schill (2013), the low rates of remuneration could not yet justify the high initial investment costs of a battery storage system in their study carried out in 2013.[97]

With the EEG 2017, the policy makers introduced a new system with investors bidding on feed-in tariffs for photovoltaic facilities of 750 kW or more. The bids with the lowest required feed-in tariffs are eligible for the governmental program. Smaller systems still have a fixed rate.[98]

With decreasing rates of remuneration, battery systems become more and more financially attractive. Is there a specific feed-in tariff where battery storages become profitable together with an installation of a new photovoltaic system? At which rates of remuneration would batteries provide investment opportunities? Chapter 4.3 simulates current and probable future feed-in tariffs and presents the corresponding sensitivity analysis towards the profitability of battery storage systems.

2.4. Feed-in curtailments

The power generation of photovoltaic systems depends on the current weather conditions and the daytime. The supply of these renewables can therefore be very unstable. Due to a high share of solar energy, a very sunny day could lead to a power surplus destabilizing the grid.[99] According to a survey of grid operators, asymmetric load and overload of grid-facilities are the main problems resulting out of the German energy transition.[100] Curtailments are a way to smoothen the feed-in power and assure a stable energy supply.[101] §6 in the German renewable energy regulations of 2012 forces photovoltaic owners with systems not bigger than 30 KW to either partly restrict their feed-in power to 70% of their nominal installed power or install remote controls for shutdowns. Photovoltaic systems above 30 kW must be equipped with technical gear to be controlled and regulated if the grid is overloaded.[102]

These curtailments should secure a stable grid by cutting off solar peaks that could otherwise stress the balance of supply and demand. For the owner of the photovoltaic system, these curtailments can cause financial losses since feed-in power above 70% is simply turned down and is not generating any returns. With a higher self-consumption of the produced energy, the owners can decrease their feed-in power and therefore avoid wasting energy.[103] A battery storage system can support the self-consumption. The subsidy of the "KfW"-bank for storage systems required the corresponding photovoltaic systems to decrease their feed-in power to 60%.[104] Short time after that, the regulation got more restrictive with curtailments above 50% of the nominal power.[105] These limits can enable the grid to deal with a higher share of solar and wind energy. With increasing curtailments, more and more renewables can be installed without overloading the capacities of the grid.[106] The charging strategy thereby is essential to the peak-shaving effect. If batteries are optimized for increasing self-consumption, they will already start storing excess energy in the morning. The simultaneous charging of thousands of batteries in a swarm finds a sudden end in the afternoon when the batteries reach their maximum state of charge. This can cause a massive peak, when excess energy is fed into the grid again.[107] If lots of batteries are charged with a market-driven pattern during low-price hours, this might also harm the stability of local grids.[108] For the financial aspects of a storage owner, this might not be of big importance. Nevertheless, the charging strategy can also have influence on the household's electricity bill by shifting the charging of the battery to peak production times. Weniger et al. (2016) show that a prediction based charging algorithm can decrease the curtailed power from 8% to 2% of the average yearly photovoltaic energy with a 50% curtailment regulatory. By charging with peak power, the battery can operate in a grid-stabilizing mode and enable a higher share of solar power in Germany's energy mix.[109] Since a prediction-based algorithm over multiple years would go beyond the scope of this thesis, I will restrict myself to a self-consumption optimizing algorithm. A previous study of Truong et al. (2016) shows, that a further limitation of feed-in power has noticeable, but small influence on the return of investment with negative effects for the combined photovoltaic and storage system.[110] Kairies et al. (2015b) recommend a dynamic curtailment by grid operators with limits between 40% and 60%

[93] Fitzgerald et al. (2015) pp. 32-34.
[94] Doetsch et al. (2014) pp. 163-164.
[95] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) p. 48.
[96] Bundesverband der Energie- und Wasserwirtschaft e.V. (2015) p. 63.
[97] Borden and Schill (2013) p. 21.
[98] Bundesministerium für Wirtschaft und Energie (2016) EEG 2017: Start in die nächste Phase der Energiewende.
[99] Weniger et al. (2016) p. 7.
[100] Sterner et al. (2015) p. 4.
[101] Kairies et al. (2015a) p. 13.
[102] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).
[103] Weniger et al. (2016) p. 7.
[104] Kairies et al. (2015a) p. 18.
[105] Kairies et al. (2016b) p. 20.
[106] Weniger et al. (2014a) p. 1.
[107] Sterner et al. (2015) p. 5.
[108] Kays et al. (2014) p. 1.
[109] Weniger et al. (2016) p. 3.
[110] Truong et al. (2016) pp. 11-12.

so that the curtailments can be adjusted to the current demand and supply.[111]

It is questionable if the curtailment regulations should only be addressed to systems with storage installations. As soon as newly installed photovoltaic systems would face lower curtailments even without a subsidized storage system, a battery could avoid big losses and offer a lucrative investment opportunity. If the 70% limitation for photovoltaic systems is lowered in the future, new questions will arise. Is there a specific curtailment limit where battery storage systems become profitable? Chapter 4.4 will present a sensitivity analysis regarding different feed-in limitations.

3. Simulation model

This thesis aims to determine political and market driven influencers on future battery storage installations by calculating their financial value towards the owner. The assumption that all independent variables can be changed in a continuous way, allows multiple options for optimization algorithms e.g. towards an optimal size of the battery system. I simulate a household using a photovoltaic system together with a battery storage system under various market conditions and regulations to determine for which environmental parameters batteries could provide a financial lucrative investment opportunity. The net present value of the combined photovoltaic and battery storage system serves as a reference value to compare different simulations and setups. However, there are multiple ways to operate a battery system. Frequency regulation or backup-power for blackouts are only two of many possible applications that would generate calculative or real revenue streams in a net present value calculation.[112] In this approach, the battery is solely used to increase the self-consumption of the produced photovoltaic power and, by this, reduce the electricity bill of the household.

As it is illustrated in Figure 2, the battery is plugged to the local home alternating current (AC) grid. The battery and the photovoltaic system store or produce the energy in direct current (DC). The inverters transform the energy to be used for the household. The photovoltaic system feeds the home and the battery with energy. In times where the photovoltaic system does not produce enough energy to meet the household‘s demand, the battery takes care of the load. In times where the battery power is not sufficient for the household‘s demand, additional energy can be purchased from the grid. Excess production which cannot be utilized neither within the household nor be stored in the battery at the time is fed into the grid, limited by the curtailment regulations as mentioned in chapter 2.4. Grid power is only used for additional demand in the household and is not allowed to be stored in the battery for later use, since these would cause complex issues regarding renewable and fossil electricity declarations that are not covered in this thesis. Stored energy is solely used to increase the self-consumption and is not used to fed the grid. Thus, the battery is only operated to reduce electricity costs. The reduction in electricity costs in the following years after installation must exceed the initial costs of the system to be economically reasonable.[113] The challenge is to find the battery size that maximizes the net present value. Too big batteries would lead to unnecessarily high investment costs if the capacity cannot be fully utilized. On the other hand, a battery system, which is too small, would not come up for the daily demand shifting. So, for every environmental setup, the algorithm simulates different battery sizes up to the point, where the highest net present value can be achieved and where no further financial improvements are possible by neither decreasing or increasing the battery size. Thus, the optimization with respect to the battery size reveals the environmental states, where battery systems would provide financial benefit to the owner, independently from the net present value of the photovoltaic system. If a stand-alone photovoltaic system without a battery would lead to a higher net present value than a combined system, the simulation algorithm identifies 0 kWh as the optimal battery size.

The following subchapters include a method to calculate the net present value for a combined photovoltaic and battery storage system and deliver values for the input parameters.

3.1. Net present value of a combined photovoltaic and storage system

The net present value serves as an economic performance indicator to evaluate, compare and rank different setups regarding the size of the battery system. The following section describes a way to calculate the net present value of a combined photovoltaic and battery system with a linearized approach. For the basic concept I use a similar approach to Glenk and Reichelstein (2017). I adjust the calculations by adding the battery system and further political and battery-specific technical parameters into the equations. The net present value of the combined system is determined by the present value of future after-tax cash flows subtracted by the system's price of the battery and the photovoltaic system.[114] The revenues and costs are assumed to occur at the end of a year.

$$NPV(k_{PV}, k_{bat}) = -(k_{PV} * SP_{PV} + k_{bat} * SP_{bat}) + \sum_{i=1}^{I} CFL_i * \frac{1}{(1+\gamma)^i} \quad (1)$$

k_{PV}: Size of photovoltaic system in kW
k_{bat}: Usable battery capacity in kWh
CFL_i: After tax cash flow of the system in year i
γ: Discount rate
SP_{PV}: Price of photovoltaic system per kW
SP_{bat}: Price of usable battery capacity per kWh

[111] Kairies et al. (2015c) pp. 4-5.
[112] Lazard (2015) p. 3.
[113] Naumann et al. (2015) p. 38.
[114] Glenk and Reichelstein (2017) p. 20.

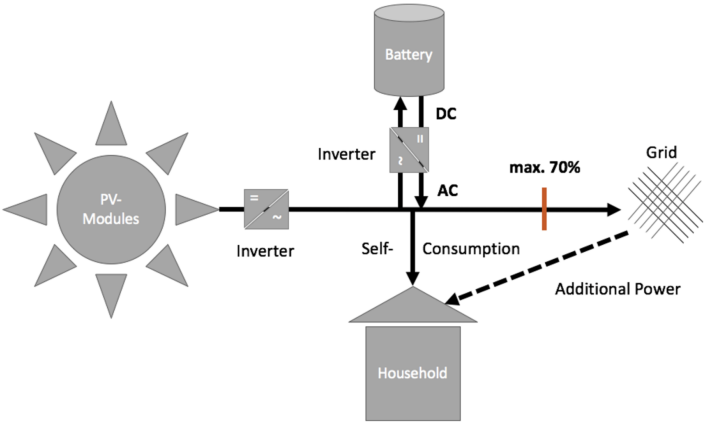


Figure 2: Energy scheme in the simulation.

The after-tax cash flow in year i is calculated by subtracting taxes towards each pre-tax cash-flow with their respective taxable income and the tax rate.[115]

$$CFL_i(k_{PV}, k_{bat}) = CFL_i^{PT}(k_{PV}, k_{bat}) - \alpha * I_i(k_{PV}, k_{bat}) \quad (2)$$

α: Income tax rate
$I_i(k_{PV}, k_{bat})$: The taxable income in year i
$CFL_i^{PT}(k_{PV}, k_{bat})$: Pre-tax cash flow in year i

The taxable income in year i is determined by the pre-tax cash flow minus the depreciation of the battery and photovoltaic system.[116]

$$\begin{aligned} I_i(k_{PV}, k_{bat}) = & CFL_i^{PT}(k_{PV}, k_{bat}) - (k_{PV} * SP_{PV} \\ & + k_{bat} * SP_{bat}) * d_i \end{aligned} \quad (3)$$

d_i: Allowed deprecation in year I in %

I calculate the pre-tax cash flow in year i as the contribution margin of the system subtracted with its operating costs in the respective year.[117]

$$\begin{aligned} CFL_i^{PT}(k_{PV}, k_{bat}) = & CM_i(k_{PV}, k_{bat}) - (k_{PV} * F_{PV} \\ & + k_{bat} * F_{bat}) \end{aligned} \quad (4)$$

$CM_i(k_{PV}, k_{bat})$: Contribution margin of the system in year i
F_{PV}: Fixed operating costs per kW of the installed photovoltaic system
F_{bat}: Fixed operating costs per kWh of the installed usable battery capacity

The photovoltaic production data offers information in a frequency of one hour throughout the year. With 365 days per year I consider m = 8.760 as the number of hourly timeframes iterated in the simulation per year.[118] The contribution margin of the system in year i is then given by:

$$CM_i(k_{PV}, k_{bat}) = \int_{t=0}^{m} CM(t|k_{PV}, k_{bat}, i)dt \quad (5)$$

t: Time hour
$CM(t|k_{PV}, k_{bat}, i)$: Optimized contribution margin

I define R_{Buy} as the electricity retail rate or the price for buying energy and $R(t)_{Sell}$ as the rate of remuneration or the price for selling produced energy to the grid at time t. For the revenue of the system I value self-consumed energy with the opportunity costs of alternatively buying it from the grid. Income taxes on returns for self-consumed energy in Germany are usually calculated by assuming a theoretical electricity price.[119] I do not distinguish between the returns of feed-in compensation and the returns of self-consumption, since taxation saving actions, which are individual to specific regions and persons, would distract from the core results. The taxes are calculated on the total return, where the self-consumed energy is valued with the full electricity price. Thus, with this conservative approach, the calculated taxes in the simulations could be higher than in real business cases.

If energy is stored in the battery for later consumption, the electricity is valued with $R(t)_{buy}$ at the time the electricity is used and consumed by the household. The algorithm does not allow storing purchased energy. Thus, the simulation theoretically holds for constant or time-invariant as well as dynamic or time-variant prices if following constraints are valid:

1. $\forall t : R(t)_{Buy} \geq R(t)_{Sell}$ and
2. $\forall t : min(R(t)_{Buy}) \geq max(R(t)_{Sell})$

[115] Glenk and Reichelstein (2017) p. 20.
[116] Glenk and Reichelstein (2017) p. 20.
[117] Glenk and Reichelstein (2017) p. 20.
[118] Glenk and Reichelstein (2017) p. 20.
[119] Bayerisches Landesamt für Steuern (2015) pp. 27-35.

The first restriction simply prevents arbitrage scenarios of endlessly buying and selling energy and assures that there is no point in time where selling produced energy and buying demanded energy is more lucrative than self-consumption. As obvious this might be from a market perspective, this constraint is not fully valid in the German market as I clarified in the previous chapters. Owners of photovoltaic systems usually have signed a price-binding contract, which guarantees them fixed and constant rates of remuneration for 20 years.[120] Due to high feed-in tariffs, energy might better be sold to the grid, even when it could be utilized in the household. The household's demand in this case is then fully satisfied by purchasing the energy from the grid. Simulations with a higher rate of remuneration than electricity retail rate would lead to an optimal battery size of 0 kWh.

In compensation systems where excess power can only be sold to the grid within certain power limits, the charging strategy of the battery can have influence on the profitability of the battery as well. The study of Weniger et al. (2016) with a prediction-based charging strategy in an environment with 50% feed-in curtailments calculates additional revenues of 30c€ per year for their setting by reducing the curtailed energy.[121] However, battery storage systems do not necessarily face these strict regulations as long as they don't use the subsidies of the "KfW"-bank program.[122]

This approach does not consider arbitrage or price-optimized strategies for movements in the spread between the selling and buying price of energy. The simulation assumes that there is no way of earning money by buying energy and selling it later. Hence, the second restriction prohibits scenarios where bought energy could be stored and kept as a speculative option for later selling. The charging-strategy does not consider optimizations for potential higher revenues due to price movements. In some scenarios, it could be economically reasonable to save stored energy and buy electricity from the market to meet the households demand, even if the demand could also be satisfied by the battery. If $R(t+n)_{Buy} > R(t)_{Buy}$, the consumption of stored energy at time t+n leads to higher revenues. If the price movement is substantial, the higher revenues could exceed potential losses of not utilizing the battery in t. The algorithm excludes these speculations. The restrictions towards $R(t)_{Buy}$ and $R(t)_{Sell}$ limit the battery operations to a simple charging strategy, excluding speculations on price movements that would justify additional charging, discharging or preventions of doing so besides of a simple greedy algorithm.

Due to the bespoken restrictions and assumptions, the net present value is maximized by maximizing self-consumption. Similar to the simulations of Truong et al. (2016), this leads to the simple strategy that the battery charges with excess energy as long as there is battery capacity to store it.[123] A higher battery capacity therefore leads to a higher rate of self-consumption.[124] At times where the energy consumption is higher than the production, the energy used is (as far as possible) taken out of the battery. With this approach, the battery usually starts charging in the morning when the photovoltaic production first exceeds the household's demand. On clear days, the battery is usually fully charged at noon and ready to discharge as soon as the sun goes down and the household's demand exceeds the produced photovoltaic power.[125]

To implement the strategy, the optimized contribution margin is then given by:

$$CM(t|k_{PV}, k_{bat}, i) = P_{SC}(t|k_{PV}, k_{bat}, i) * R(t)_{Buy} + P_{Grid}(t|k_{PV}, k_{bat}, i) * R(t)_{Sell} \quad (6)$$

$P_{SC}(t|k_{PV}, k_{bat}, i)$: Produced power which is consumed by the household in kWh
$P_{Grid}(t|k_{PV}, k_{bat}, i)$: Produced power which is sold to the grid in kWh
$R(t)_{Buy}$: Revenue of self-consumption / Price of buying energy in € per kWh at time t
$R(t)_{Sell}$: Revenue of feeding energy to the grid / Price of selling energy in € per kWh at time t

The self-consumed energy of the household is the minimum of the load demand of the household and the available energy of the photovoltaic system plus available energy of the battery at time t. Even when the battery is fully charged, the available energy which can be discharged for self-consumption is limited by the maximum discharging power and reduced by efficiency losses of the inverter and the battery:

$$P_{SC}(t|k_{PV}, k_{bat}, i) = Min[Prod(t|k_{PV}, i) + Min[SOC(t-1, i); d_{bat}] * Eff_{bat}; L(t)] \quad (7)$$

$Prod(t|k_{PV}, i)$: Production profile / energy produced by the photovoltaic system in kWh
$SOC(t-1, i)$: State of charge / energy available from the battery at time t due to preceding charging in the periods before in kWh
d_{bat}: Maximum capacity that can be discharged within a period t in kWh
$L(t)$: Load profile / energy consumed by the household at time t in kWh
Eff_{bat}: Efficiency of the battery and the corresponding inverter

The production function of the photovoltaic system is given by the current capacity factor of the photovoltaic

[120] Bundestag (2000) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2000).
[121] Weniger et al. (2016) pp. 12-13.
[122] Kairies et al. (2016b) p. 102.
[123] Truong et al. (2016) p. 3.
[124] Naumann et al. (2015) p. 40.
[125] Weniger et al. (2014a) p. 1.

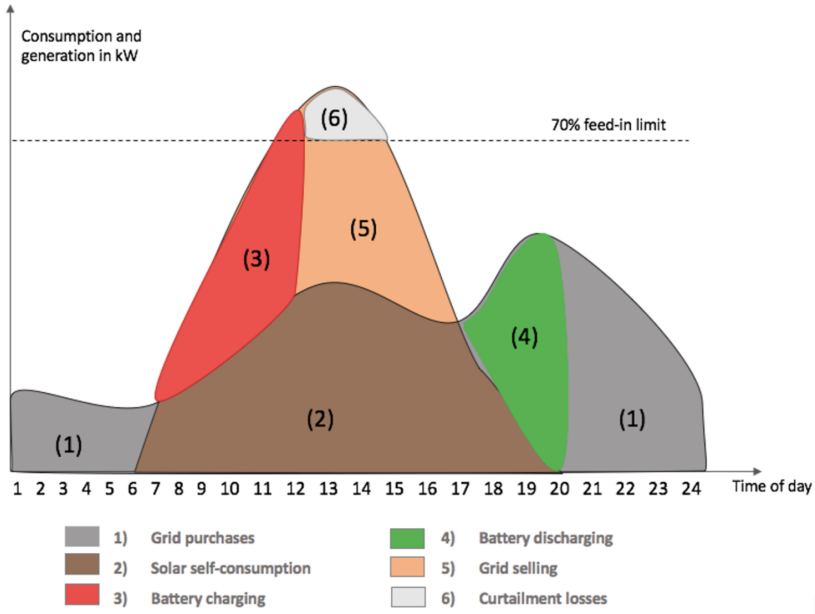


Figure 3: Model for daily pattern of photovoltaic generation and consumption.
(Partly based on similar model of Fitzgerald et al. (2015) pp. 32-33.)

rooftop multiplied by the size of the facility and a factor for losses due to aging of the panels. The production of the system is then given by:

$$Prod(t|k_{PV},i) = CF(t) * k_{PV} * (1 - x * (i - 1 + \frac{t}{8760})) \quad (8)$$

$CF(t)$: Capacity factor of the photovoltaic system per kW installed for the period t in kWh
x: Factor for capacity losses of the photovoltaic system

The state of charge of the battery system is calculated by taking the state of charge of the previous period and adding charged energy or subtracting discharged energy. The charged or discharged energy is again limited by the maximum charging or discharging power and diminished by efficiency losses of the inverter and battery. The maximal usable capacity of the battery as well as the minimal state of charge limit the energy, which can be stored or taken out of the battery. Battery aging and cyclic fading decreases the maximum capacity.[126] [127] Within this simulations, a battery can never have a state of charge higher than its current usable capacity. On the other hand, a battery can never discharge more energy than it is currently storing. Thus, the battery has a minimum state of charge of 0 kWh in usable capacity.

$$\begin{aligned} SOC(t,i) = & Max[Min[SOC(t-1) \\ & + Max[EE[(t|k_{PV},i); c_{bat}]; -d_{bat}] \\ & * Eff_{bat}; k_{bat} * (1-\varphi)^{i-1+\frac{t}{8760}}]; 0] \end{aligned} \quad (9)$$

$EE(t|k_{PV},i)$: Surplus energy or energy deficiency of the household at time t in kWh
c_{bat}: Maximum capacity which can be charged within a period t in kWh
φ: Capacity fading of the battery

The excess energy, if there is an overproduction or deficiency energy at times of higher consumption, is determined simply by:

$$EE(t|k_{PV},i) = Prod(t|k_{PV},i) - L(t) \quad (10)$$

The remaining energy which can be sold to the grid is limited by politically determined curtailments.[128] The feed-in power is then given by:

$$\begin{aligned} & P_{Grid}(t|k_{PV},k_{bat},i) = \\ & min[Prod(t|k_{PV},i) - P_{SC}(t|k_{PV},k_{bat},i) \\ & -(SOC(t) - SOC(t-1)); k_{PV} * \epsilon] \end{aligned} \quad (11)$$

ϵ: Feed-in limitation

3.2. Input parameters for the simulations

To simulate the energy flows between a photovoltaic facility, the household and a battery, load and production profiles are needed. I compare a photovoltaic production profile located in Munich with a load profile of a representative German household to determine at which times energy can be

[126] Sankarasubramanian and Krishnamurthy (2012) pp. 250-251.
[127] Ecker et al. (2014) p. 842.
[128] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).

sent to the battery and when stored energy can be utilized within the household. Battery characteristics, like the maximum capacity or the charging speed, influence the model and are therefore critical values for the simulation. Basic parameters like the project lifetime or interest rates are necessary to evaluate the financial impact of different measures. The following chapters determine these basic parameters in chapter 3.2.1 and give an introduction into the load and production profile in the chapter 3.2.2 and chapter 3.2.3. In addition to that, chapter 3.2.4 declares the basic battery characteristics and input parameters used for the simulations.

3.3. Project lifetime, discount factor and taxes

The depreciation period of photovoltaic systems in Germany is 20 years.[129] Batteries installed after 04/08/11 are also free of grid-fees for 20 years.[130] To avoid complicated tax changes within the simulation and to be comparable with previous studies, the simulation stops after 20 years, too. I consider a total project lifetime of 20 years. The end of life of batteries for automotive applications is usually reached, when the discharge capacity falls below 80% of the initial capacity.[131] However, this limit does not exclude repurposing the batteries in a residential stationary environment as presented in the study of Kantor et al. (2015). The following graph shows the expected lifetime for different battery systems of a data collection of the Technical University of Munich. Thus, most battery systems already have a lifetime equal to the considered project lifetime.

In this simulation, I do not consider a replacement of the battery storage system. Even after the capacity reached the limit of 80%, these batteries are usually still working beyond this limit.[132] Thus, the depreciation period of the battery system is analogously to Truong et al. (2016) also set to 20 years.[133] A previous study assumes a lifetime of 18 years for the inverter.[134] For reasons of simplicity, I assume a lifetime of 20 years for the inverter as well. To limit complexity, the simulation does not consider replacements for the inverter. I depreciate the combined photovoltaic and battery storage system linearly over 20 years. Lorenz and Schröder (2014) as well as Jülch et al. (2015) consider a discount rate of 3.5%.[135] [136] The studies of Zerrahn and Schill (2015) and Naumann et al. (2015) choose a discount rate of 4%. [137] [138] I will also simulate with a discount rate of 4%.

Per §6 of the EEG regulations of 2012, photovoltaic owners with systems not bigger than 30 KW must usually partly restrict their feed-in power to 70% of their nominal installed power.[139] This curtailment value is set as a standard regulatory measure for the following simulations.

Profits generated by the facility must be taxed with the owner's income tax rate. This includes virtual profits on self-consumed energy.[140] The income tax rate varies widely depending on the income structure of the photovoltaic owner and can therefore not be determined to match every investors' situation. Comello and Reichelstein (2017) calculate with a corporate tax rate of 30%.[141] I also assume a tax rate of 30%, as it would be accounted in Germany for an unmarried person with a yearly taxable income of 65.000 € .[142]

3.3.1. Load profile of the household

According to an analysis of different datasets in 2011 by Bost et al. (2011), a German single-person-household consumes approximately 1.7 MWh, two persons need 3 MWh, three persons consume 3.9 MWh and four persons would have a demand of 4.5 MWh on average per year.[143] Naumann et al. (2015) use 4.4 MWh as an average consumption for a household with four persons.[144] Truong et al. (2016) simulate with a 4.5 MWh yearly load for an average household and consider 7 MWh for a large household in a second simulation.[145] The installation statistics show, that households with an installed battery have a consumption nearly twice times higher than the average household, leading to the conclusion, that households with higher consumption are more likely to invest into a battery storage system.[146] Households with a higher consumption could make a more frequent and more intense use of a storage system. A higher utilization of the battery system can gain more savings and the system will pay off earlier.[147]

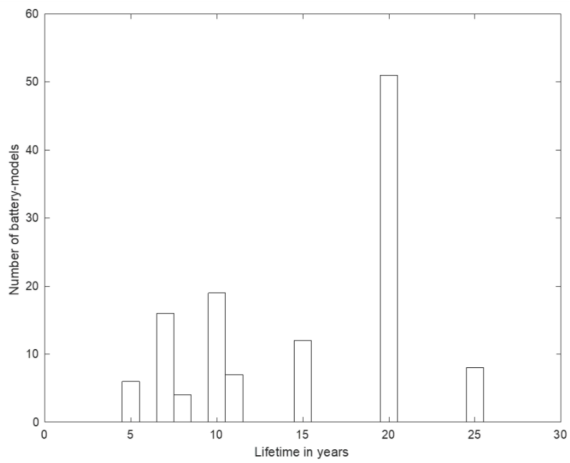
I use the dataset of the "HTW Berlin – University of Applied Science", which published representative load profiles in 2015.[148] The load profiles are based on a dataset of 74 German single family households in 2010 with a frequency of one second.[149] The dataset comes in separated files for idle and effective power in three phases and had to be prepared for the simulation. I sum up all effective power phases and aggregate the data to 8670 hourly loads for each household to have the same periodical time-frames as I have for the photovoltaic production data I will describe in the following chapter. The load profiles of the underlying dataset vary between 1.4 and 8.6 MWh per year with a mean of 4.7 MWh.[150]

[129] Bundesministerium der Finanzen (2000) AfA-Tabelle für die allgemein verwendbaren Anlagegüter (AfA-Tabelle "AV").
[130] Sterner et al. (2015) p. 25.
[131] Schmidt et al. (2015) p. 1231.
[132] Kantor et al. (2015) p. 222.
[133] Truong et al. (2016) p. 5.
[134] Lorenz and Schröder (2014) p. 8.
[135] Lorenz and Schröder (2014) p. 14.
[136] Jülch et al. (2015) p. 21.
[137] Zerrahn and Schill (2015) p. 13.
[138] Naumann et al. (2015) p. 42.
[139] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).
[140] Bayerisches Landesamt für Steuern (2015) pp. 27-35.
[141] Comello and Reichelstein (2017) p. 6.
[142] Bundeszentralamt für Steuern (2016) p. 1.
[143] Bost et al. (2011) p. 28.
[144] Naumann et al. (2015) p. 39.
[145] Truong et al. (2016) p. 2.
[146] Kairies et al. (2015a) p. 62.
[147] Kantor et al. (2015) p. 231.
[148] Berlin (2015) Repräsentative elektrische Lastprofile für Einfamilienhäuser in Deutschland auf 1-sekündiger Datenbasis.
[149] Tjaden et al. (2015) p. 2.
[150] Tjaden et al. (2015) p. 3.

Table 1: Overview of input parameter values.

(a) Marked values are not constant over all simulations and may vary for specific scenarios.

Parameter	Description	Value	Unit
d_i	Allowed deprecation in year I in %	5	%
ϕ	Capacity fading of the battery	1.58	%
γ	Discount rate	4	%
Eff_{bat}	Single-sided efficiency of the battery and the corresponding inverter	92.6	%
x	Factor for capacity losses of the photovoltaic system	0.7	%
ϵ	Feed-in limitation	70 (a)	%
F_{bat}	Fixed operating costs of the installed battery	0	€ /kWh
F_{PV}	Fixed operating costs of the installed photovoltaic system	19.05	€ /kW
α	Income tax rate	30	%
c_{bat}	Maximum capacity which can be charged within a period t	0.5	kWh/kWh capacity
d_{bat}	Maximum capacity which can be discharged within a period t	0.5	kWh/kWh capacity
SP_{PV}	Price of PV-system per kW	1270	€ /kW
SP_{bat}	Price of usable battery capacity	600 (a)	€ /kWh
$R(t)_{Sell}$	Revenue of feeding energy to the grid / Price of selling energy at time t	0.1230 (a)	€ /kWh
$R(t)_{Buy}$	Revenue of self-consumption / Price of buying energy at time t	0.2872 (a)	€ /kWh
k_{PV}	Size of photovoltaic system	5.5	kW



Mean	Median	Maximum	Minimum	StdDeviation
14.97	15.00	25.00	5.00	6.06

Figure 4: Lifetime of battery systems.
Based on analysis of Technical University of Munich (2016) Dataset market overview battery storage systems.

Since the electricity profile can have major impact on the self-consumption within the simulation, the profile data should be chosen in a way that it does reflect most households. Households with very specific consumption patterns could distract from the core findings of this thesis. Thus, I take the average of the 74 households' hourly load profiles within the simulations. The simulations are only run on this averaged household's profile-data containing 8670 hourly consumption data values. Since this profile is based on multiple households, the pattern might be more smooth and balanced than an actual household's pattern. Some households might have nearly no consumption at times when the house residents are not at home, but since other households do consume energy within this time, the averaged profile will also show some consumption. Strong peaks in single households will not have that large influence on the simulation, since the other 73 households might have consumed energy as usual. Nevertheless, the averaged data profile is particularly suitable to serve as a general pattern that most households share.

The household consumes a total of 4685.07 kWh over the year. Similar to the data of Kairies et al. (2015a), there is a visible correlation between the season and the consumption of the household. The summer months could require a lower

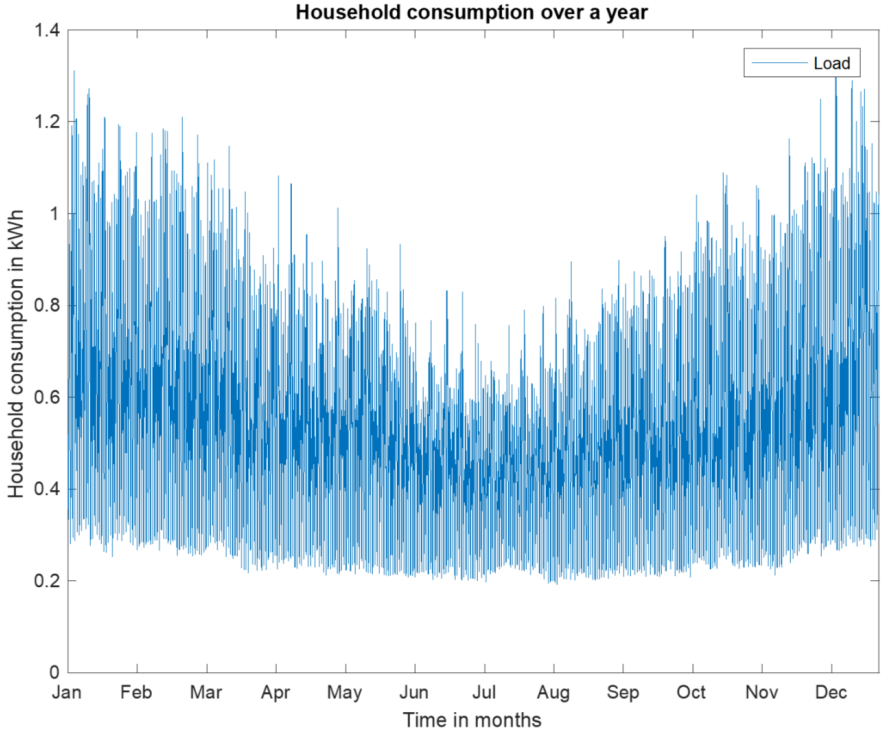


Figure 5: Load profile of an average household in hourly steps over a year.
(Based on analysis of data from Berlin (2015).)

energy consumption due to longer and warmer days.[151] The white zone below the blue line is visualizing the base load of the household that is needed at any time, since the graph does not reach these low areas. Depending on the current season, the base-load is slightly above 0.2 kWh per hour for the summer months and at around 0.3 kWh per hour in the winter. In addition to the base load and a trend towards higher consumption in the winter months, the hourly data can reveal further consumption patterns. I divide the dataset into a "warm" and a "cold" half, whereas the "warm" half covers the summer months from April to September, and the "cold" half consists of the profile-data from October until March. The grouping of the dataset by the time of day, allows a closer look to the actual pattern of the household's demand.

The household shows local maxima at midday and at the evening around 8pm. The consumption drops during night and slightly at the afternoon. The pattern in the winter months is mostly parallel to the summer pattern whereas the winter shows a way higher amplitude between night and day demand. The demand in the winter season peaks at around 7 pm with 1 kWh per hour and a following drop below 0.3 kWh per hour at night.

3.3.2. Photovoltaic system

The simulation requires the capacity factor of a photovoltaic system over a year. The horizontal solar irradiation, the outside air temperature, solar cell temperature and material, azimuth or orientation and tilt angle as well as other performance characteristics of the photovoltaic system have an impact on the energy generation.[152] [153] The website "Renewables.ninja" offers hourly estimated data for wind and photovoltaic systems of the year 2014 based on weather data and satellite observations.[154] [155] As location for the photovoltaic system rooftop I choose Munich with a latitude of 48.13 and longitude of 11.57. The "CM-SAF SARAH"-dataset is chosen as it is said to have higher data quality for Europe.[156] The capacity factor can be generated by choosing one kW as the photovoltaic size. The system is oriented southwards with a 35°tilt. The orientation is chosen to maximize the solar radiation, but not necessarily to optimize self-consumption. The orientation of the facility determines at what time of the day electricity will usually be produced and be available for consumption.[157] Depending on the household's load demand, electricity in the evening or in the morning might be more profitable for self-consumption than a huge production during midday. To maximize self-consumption independently from a battery storage system, the photovoltaic system should be aligned in a way, that the production occurs at the same time as the household's consumption and that the size

[151] Kairies et al. (2015a) p. 61.

[152] Hoppmann et al. (2014) pp. 1105-1106.
[153] Diaf et al. (2008) p. 745.
[154] Pfenninger and Staffell (2016) pp. 1262-1263.
[155] Staffell and Pfenninger (2016) pp. 1237-1238.
[156] Renewables.ninja (2016) Photovoltaic dataset.
[157] Weniger et al. (2014b) p. 82.

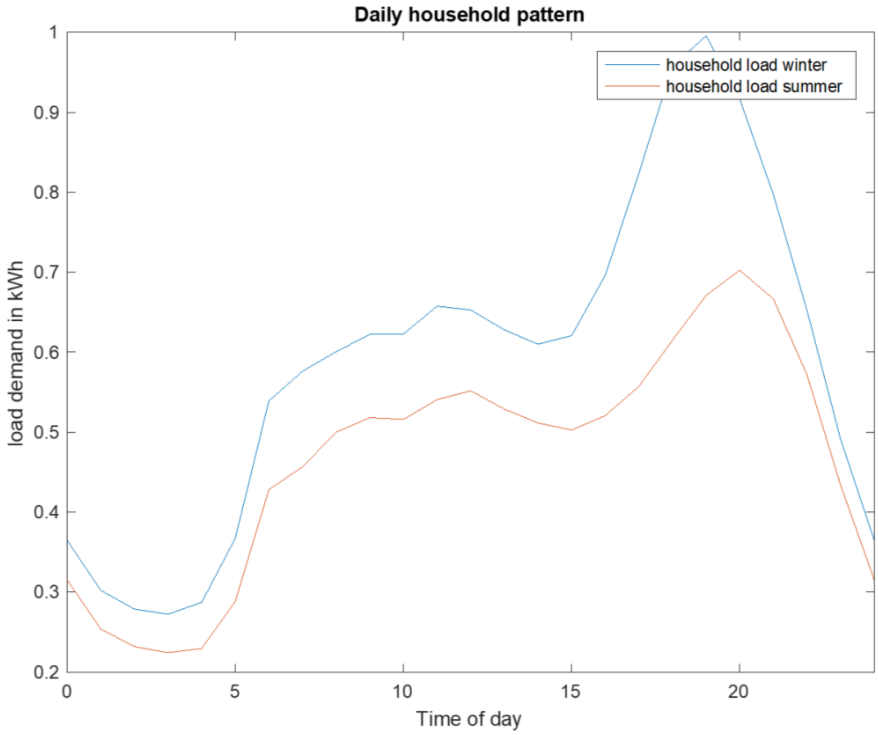


Figure 6: Daily pattern of the household consumption in winter and summer
(Based on analysis of data from Berlin (2015).)

of the system fits the load demand.

Hoppmann et al. (2014) assumed 15% losses in the photovoltaic module electronics generating about 981 kWh/kWp.[158] I use the default value of 10% for system losses as suggested by "Renewables.ninja" leading to an annual production of 1148 kWh/kWp.[159] The estimated production seems to be quite high, but due to ongoing research and development of photovoltaic technology, the facilities have not stopped improving.[160] Newly planned facilities would reach yearly performance ratios of 80% up to 90%.[161] To analyze the capacity degradation by aging, I look at multiple randomly chosen photovoltaic panel data sheets. Specifications of different producers give warranties for 90% of the initial capacity for 10 years and a minimum of 80% remaining capacity after 25 years or promise a maximum linear performance decrease of 0.7% per year.[162] [163] [164] Thus, for the capacity factor of the photovoltaic system in my simulation I assume a continuous yearly linear decrease of 0.7% of the initial production.

To determine the size of the photovoltaic system, multiple aspects must be considered. Systems above 10 kWp are excluded, since EEG-reallocations would otherwise have to be billed against the storage owner.[165] Weniger et al. (2014b) find, that depending on the consumption behavior, a self-sufficiency of 30% can be reached by installing one kWp photovoltaic facility per MWh of yearly household's load demand. With oversized photovoltaic systems, the self-sufficiency-rate stagnates since additional surplus can not be consumed at the time when the demand is already satisfied.[166] Looking at the previously bespoken average household data, a system of 4.7 kWp should be a good choice in terms of self-consumption. Nevertheless, many photovoltaic systems might initially not be aiming on increasing self-consumption but focus on maximizing overall production. High fixed compensation at the beginning of the governmental subsidy program might have led multiple households to invest in photovoltaic systems that might be oversized in terms of self-sufficiency but maximize total production for a given rooftop-area. In times where the compensation for feed-in power was higher than the actual electricity price, facilities maximized return by generating as much feed-in power as possible. So, the actual installed photovoltaic sizes might be way bigger than necessary. Thus, I analyze the data of the German grid operators regarding the

[158] Hoppmann et al. (2014) pp. 1105-1106.
[159] Renewables.ninja (2016).
[160] Kairies et al. (2015a) p. 9.
[161] Wirth (2017) p. 74.
[162] SolarWorld AG (2013) Sunmodule Plus SW 265 – 280 mono Product description.
[163] LG Electronics Deutschland GmbH (2015) LG Solarmodule MonoX Product description.
[164] Luxor Solar GmbH (2015) Luxor ECO LINE P60/240 – 260W Product description.
[165] Deutscher Industrie- und Handelskammertag (2015) p. 6.
[166] Weniger et al. (2014b) p. 82.

installed photovoltaic systems.[167] By excluding facilities bigger than 10kW, a system has on average a capacity of 5.95 kW. The analysis contains 589070 reported photovoltaic systems not bigger than 10 kW.

Naumann et al. (2015) follow the suggestions of Weniger et al. (2014b) for an economical ideal size with 4.4 kWp according to their load demand profile.[168] Truong et al. (2016) use with 5 kWp for an annual load of 4.5 MWh and 8 kWp for 7 MWh annual load slightly bigger photovoltaic systems.[169] Kairies et al. (2016b) assume an average photovoltaic system size of 8.1 kWp.[170] Jülch et al. (2015) suggest a self-consumption of 30% with a 5 kWp photovoltaic system in a German household with 4.5 MWh yearly demand.[171] I choose 5.5 kWp as the photovoltaic system size for my simulation, compromising between the recommended size for newly built systems and the actual average installation size.

The total production of the facility with 5.5 kWp system size over the whole year equals 6313.83 kWh. As the photovoltaic profile reveals, the generation facility produces peaks independent from the season. The difference in the summer and winter pattern becomes visible, when the data is grouped to hourly time frames separated by winter and summer months. The production in the winter starts later, ends earlier and is less intensive. Thus, the production pattern behaves contrary to the consumption pattern of the household. In months with higher consumption, the photovoltaic production is limited to a few hours of sunlight. In months with lower consumption, the photovoltaic production is very high. Therefore, the battery will have two different phases of workloads as well.

The prices of photovoltaic systems vary widely depending on material, country produced, manufacturer and further factors. Mundada et al. (2016) find systems between \$0.50/W to \$4.00/W.[172] According to Kairies et al. (2015a), the investment costs of photovoltaic systems are shrinking on average by 13% each year. In the mid of 2015, a price of 1500€ /kWp was on average considered for an investment.[173] In the report of the Fraunhofer Institute 2017, the prices already decreased to 1270€ /kWp.[174] For the simulation, I assume this price of 1270€ /kWp.

In addition to the initial investment, yearly maintenance and operation costs might arise. Diaf et al. (2008) calculate 1% of the investment costs of photovoltaic systems and inverter for maintenance.[175] For the operation costs I go along with the study of Weniger et al. (2014b) and assume 1.5% of the respective investment costs as annual operation and maintenance costs.[176] Since the investment costs are set to 1270€ /kWp the fixed annual operational costs will be 19.05€ /kWp.

3.3.3. Battery system

In addition to the photovoltaic production and the load profile, the battery characteristics are very important for a simulation to be diagnostically conclusive. The used technology as well as efficiency losses, charge rates and aging behavior influence the power flow tremendously. The cost of the battery system is vital for the NPV calculation. Thus, these parameters must be determined as accurately as possible.

I narrow the simulation to AC-coupled lithium-ion systems. According to Kairies et al. (2016b), AC-coupled systems are with 57% in the German market slightly in the majority of the systems installed. AC-coupled systems would be very flexible to be added into a house-grid, especially if they are retrofitted to already installed photovoltaic systems. DC-coupled systems on the other hand would require modifications of the already installed PV-electronics.[177] The storage-technologies for household-applications available on the market are mainly based on lead-acid or lithium-ion. High energy and power densities made lithium-ion batteries the dominant rechargeable system for mobile devices.[178] But the technology also started its triumph in stationary storage applications as the fastest growing storage technology.[179] Already in 2012, this technology showed big potential for future applications in small and large scales.[180] For stationary applications, lead-acid batteries tended to be cheaper per usable kWh of capacity, but in the last years, the price of lithium-ion systems decreased rapidly. Whereas Hoppmann et al. (2014) noted, that lithium-ion systems with a price 3.5 times as expensive as lead-acid models, might be too expensive to be competitive in the market, already a few years later the situation dramatically changed.[181] Lithium-ion systems convince with long lifetime and efficiency and are now affordable. In the first quarter of 2015, about 70% of the new battery installations in Germany were based on lithium-ion technology.[182] In the last quarter year of 2015, lithium-ion batteries had a share of over 90% in new installations in the German market.[183] On average, the lithium-ion battery installations in German households have 5.55 kWh of usable capacity.[184]

To determine suitable input parameter values for the battery characteristics, I mainly use previous literature to verify my parameters and to be comparable to other studies.

[167] Netztransparenz.de (2016) EEG-Anlagenstammdaten Gesamtdeutschland zur Jahresabrechnung 2015.
[168] Naumann et al. (2015) p. 39.
[169] Truong et al. (2016) p. 2.
[170] Kairies et al. (2016b) p. 69.
[171] Jülch et al. (2015) p. 20.
[172] Mundada et al. (2016) p. 694.
[173] Kairies et al. (2015a) p. 9.
[174] Wirth (2017) pp. 8-9.
[175] Diaf et al. (2008) p. 749.
[176] Weniger et al. (2014b) p. 85.
[177] Kairies et al. (2016b) pp. 52-53.
[178] Kassem et al. (2012) p. 296.
[179] Akhil et al. (2013) p. 96.
[180] Simbolotti and Kempener (2012) p. 14.
[181] Hoppmann et al. (2014) pp. 1105-1106.
[182] Kairies et al. (2015a) p. 50.
[183] Kairies et al. (2016b) p. 52.
[184] Kairies et al. (2015a) p. 51.

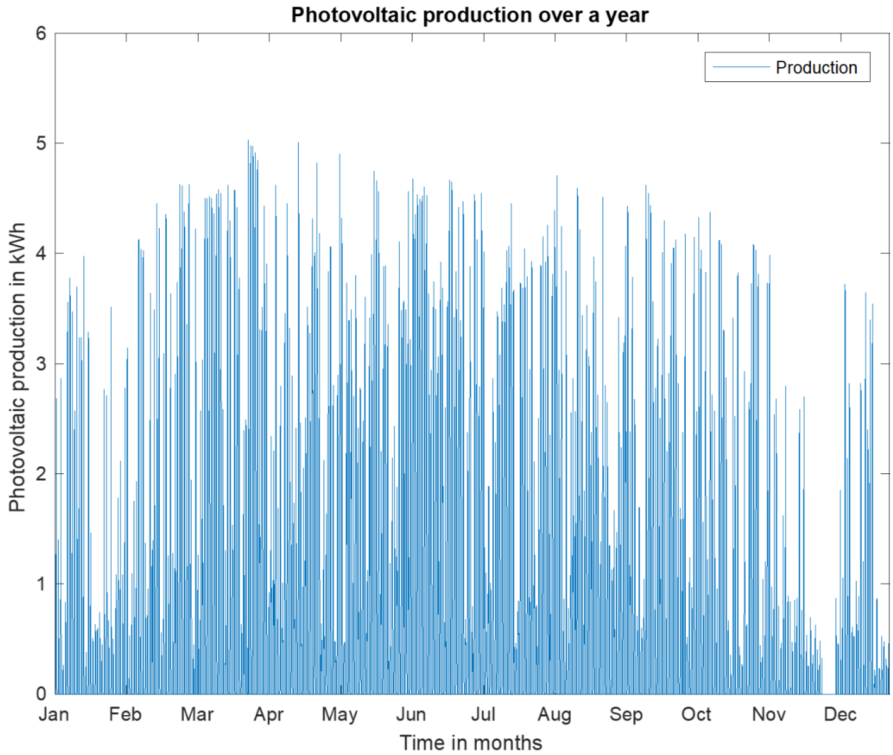


Figure 7: Hourly photovoltaic generation over a year.
(Based on analysis of data from Renewables.ninja (2016).)

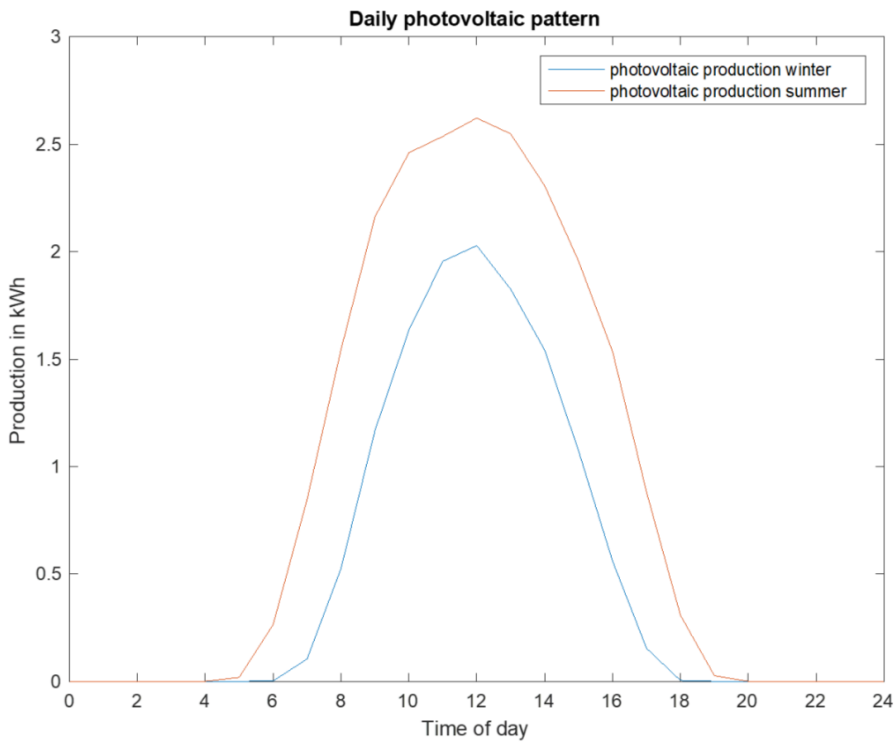


Figure 8: Daily production pattern of the photovoltaic system in winter and summer.
(Based on analysis of data from Renewables.ninja (2016).)

In addition to that, the Technical University of Munich collected market data with currently available battery systems together with their main characteristics.[185] The data set contains 488 battery systems. I filter out all battery systems except of lithium-ion based batteries and exclude systems for industrial purposes and where price, usable capacity or efficiency is missing. The resulting data-set contains 123 battery systems and serves as a reference for the cost of battery systems as well as the efficiency and lifetime parameters.

To gain information regarding common charge- and discharge-rates, further data samples were collected via the database of the "pv-magazin.de"-website.[186] At the time of this study, 140 batteries were listed in this database, after filtering by lithium-ion and AC-systems as well as excluding those with missing or unusable values. Based on previous literature and descriptive analysis of the underlying samples, the following chapters present values for battery parameters used in the optimization simulations.

Cost of lithium-ion battery systems

The simulation considers investment costs as well as fixed costs that arise during the operation of the system. Costs of a battery are a function of multiple qualitative parameters like roundtrip efficiency, depth of discharge, size and lifetime of a system.[187] Therefore, the market offers wide price ranges between different systems. Battery costs are usually given per instantaneous power capacity and potential energy output – also called the usable energy. The potential energy output describes the energy which can be stored in a system at one point in time.[188] The model requires the total costs in potential energy output per usable kWh of battery-capacity installed.

The German market offered lithium-ion batteries in 2015 with an average retail price above 2000 EUR/kWh.[189] An analysis of the underlying battery sample of available batteries offered in the German market shows mean costs above 1900€ /kWh. The cheapest available battery system was already offered at a price of 750€ /kWh.

Battery costs may face a deep price decline in the next years. Customer prices for lithium-ion battery systems are currently shrinking 18% per year.[190] [191] Nykvist and Nilsson (2015) show that price estimates between 2007 and 2014 declined yearly by approximately 14% in automotive applications.[192] Only up to 40% of the total system costs arise out of the energy storing components.[193] Therefore, reducing material costs is only one way to achieve cheaper storage. Lithium-ion batteries as a rather new technology promise big potentials in further price decreases. Economies of scale as well as improvements in the manufacturing process will lead to further cost drops.[194] By producing in a giant factory, Tesla wants to achieve cost reductions in 2017 of 30% compared to costs in 2013.[195] The U.S. Department of Energy for example has also set tough targets in reducing future battery costs.[196] With a short-term drop below $250/kWh and a more long-term target of $150/kWh, lithium-ion battery technology promises further cost advantages.[197] Mundada et al. (2016) assume battery costs between $250-1000 per kWh.[198] Schneider et al. (2015) use 800€ per kWh of storage capacity.[199] Naumann et al. (2015) assume 500 € /kWh.[200] Yet-Ming Chiang, founder of the company 24M, speaks already about producing below $100/kWh for the cells.[201] With these potentials, prognoses and values in mind, I use 600 € /kWh usable capacity for the simulation.

In terms of fixed operational costs, the model allows the consideration of yearly maintenance of the system to keep it running. Beyond maintenance, parts of the system might break over time and cause further costs to repair the damages. The warranty of the system therefore serves as an indicator of quality and the prevention of defects in responsibility of the manufacturer.[202] The warranty of most of the battery systems in the sample is 15 years, giving an indicator from which time on the owner will be in charge for the payment of damages. Thus, defects in the last 5 years of operation would cause additional costs.

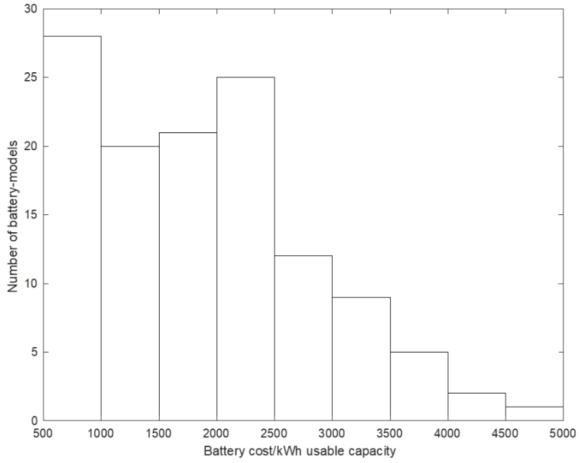
I have no reliable statistical data regarding operational costs and maintenance. Lorenz and Schröder (2014) list various batteries and assume 20 € /kWh per year for maintenance of a battery and 200€ for an exchange of the inverter.[203] Some producers claim that no maintenance is required at all, so that other studies had omitted these costs and so do I.[204] [205]

Efficiency losses of inverter and battery

Power losses appear on multiple steps in the storing process. Storing energy in an AC-system requires an inverter, which converts the power in the house-grid into DC-power for storing in the battery system. When the energy of the battery is used, the inverter must convert the power back to AC for the household's side.[206]

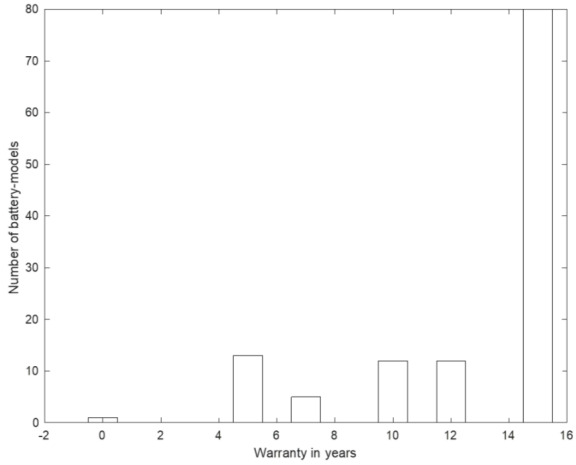
Thus, stored energy underlies efficiency losses of the inverter in both directions. Schneider et al. (2015) use a single-sided conversion efficiency of 0.9.[207] Weniger et al. (2014a)

[185] Technical University of Munich (2016).
[186] pv-magazin.de (2016) Produktdatenbank Batteriespeichersysteme für Photovoltaikanlagen.
[187] Kempener and de Vivero (2015) p. 5.
[188] Lazard (2015) p. 1.
[189] Kairies et al. (2015a) p. 55.
[190] Kairies et al. (2015a) p. 54.
[191] Kairies et al. (2016b) p. 56.
[192] Nykvist and Nilsson (2015) p. 329.
[193] Gyuk et al. (2013) p. 30.
[194] Doetsch et al. (2014) pp. 138-139.
[195] TESLA p. 1.
[196] U.S. Department of Energy (2011) p. 15.
[197] Gyuk et al. (2013) p. 33.
[198] Mundada et al. (2016) p. 694.
[199] Schneider et al. (2015) p. 55.
[200] Naumann et al. (2015) p. 43.
[201] Fehrenbacher (2015) This startup is looking to revolutionize lithium ion batteries.
[202] International Renewable Energy Agency (2015) p. 10.
[203] Lorenz and Schröder (2014) p. 13.
[204] Truong et al. (2016) p. 2.
[205] Diaf et al. (2008) p. 748.
[206] Truong et al. (2016) p. 2.
[207] Schneider et al. (2015) p. 54.



Mean	Median	Maximum	Minimum	StdDeviation
1935.47	1852.32	4801.59	750.00	931.51

Figure 9: Histogram of battery costs per kWh usable capacity.
(Based on analysis of data from Technical University of Munich (2016).)



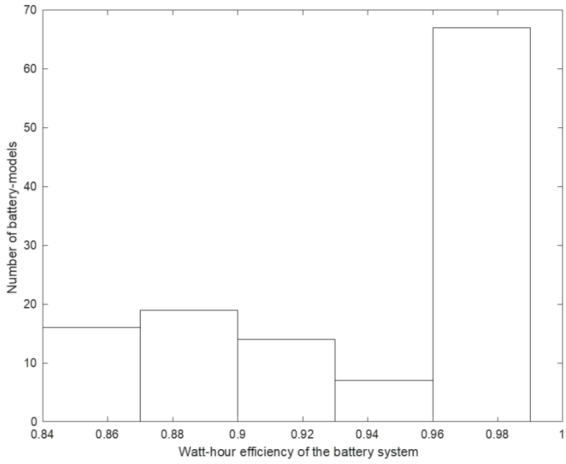
Mean	Median	Maximum	Minimum	StdDeviation
12.72	15.00	15.00	0.00	3.63

Figure 10: System warranty in years based on the battery sample.
(Based on analysis of data from Technical University of Munich (2016).)

assumed the bidirectional battery inverter to have a constant efficiency of 94% and so do I.[208] Battery systems have a very high cycle efficiency compared to other storage methods.[209] Nevertheless, there are differences regarding varying battery systems. The systems of the battery sample have a mean-efficiency of 93%, which is a relatively weak performance resulting out of a few systems with very bad characteristics. Most of the systems already perform with a watt-hour efficiency of 97%, which is also used as the efficiency-parameter for the simulation. Along with Truong et al. (2016), I assume the same efficiency behavior for charging and discharging.[210] With these parameters, the round-trip efficiency of the system is about 0.86. I calculate the losses for a one-directional charging/discharging with $\sqrt{0.97 * 0.94^2} \approx 0.926$, which is used as the single-sided conversion efficiency for the simulation.

Battery systems need energy by themselves to operate their controllers, causing standby-losses. According to

[208] Weniger et al. (2014a) p. 3.
[209] AECOM (2015) p. 10.
[210] Truong et al. (2016) p. 4.



Mean	Median	Maximum	Minimum	StdDeviation
0.93	0.96	0.97	0.85	0.04

Figure 11: Watt-hour efficiency of the battery sample.
(Based on analysis of data from Technical University of Munich (2016).)

Kairies et al. (2016b) these standby-losses add up to 90-350 kWh per year.[211] The simulation in this study ignores these losses. The simulations within this thesis do not consider changes in the operational temperature of the battery system, which might have also effects on the efficiency performance and losses.[212] [213] Lithium-ion batteries usually have a relatively low self-discharge of only some percent per month.[214] Thus, these effects are negligible as well.

Charge and discharge power of the system

The electrical power, which can be charged or discharged from a battery system within a given time span, is limited by the maximum charge or discharge rate. The power which can be directed into the battery is proportional to the number of cells being added to the system.[215] This means that bigger scaled systems can charge or discharge linearly more electricity in each time span than a small system with the same characteristics apart from the size. This aspect is very important for the ability of the battery system to store peak photovoltaic production or handling very high load demands of the household. Since many battery systems for household applications have equal charge- and discharge-rates, the parameters are set to the equal value ($c_{bat} = d_{bat}$).[216] The second sample of batteries offers values for maximal discharge-power in kW and the usable capacity of each system in kWh. By dividing the maximal discharge-power by the total usable capacity, I get the charging-power per usable kWh of capacity, which can be charged or discharged within an hour. If the rate of each battery in the sample is illustrated within a histogram, a big peak in values of around 0.5 kW/kWh can be observed. The median of the sample is positioned to the same value of 0.5 kW/kWh, whereas the mean is with 0.6 kW/kWh slightly above.

Within the simulations, I assume a constant maximal charge and discharge power of 0.5 kW/kWh for the usable capacity installed.

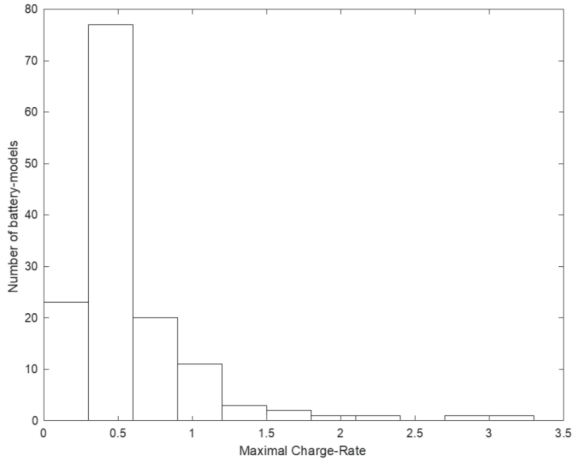
Aging and capacity fade of lithium-ion batteries

Depending on the chemistry, the operation temperature, the number of cycles and other parameters, lithium-ion batteries face irreversible damages in their capability of storing electrical energy.[217] [218] The effects are distinguished between calendar aging with respect to the time and cyclic aging, dependent on the cycles of the system.[219] The loss of cyclable lithium diminishes the capacity of the battery system.[220]

The cyclic aging effect is heavily influenced by the depth of the cycles and the operation temperature of the system.[221] [222] The consideration of these capacity losses is important for the simulation but also very complex to model from a technical perspective. Batteries tend to lose a relatively high percentage of their initial capacity in the first few cycles. This effect slows down after some time and takes on a linear shape of fading before a sudden drop in capacity takes place.[223]

In a study of Wright et al. (2003), lithium-ion cells being tested for 44 weeks with a 25°C operation temperature

[211] Kairies et al. (2016b) p. 67.
[212] Schmidt et al. (2015) p. 1236.
[213] Zhang and White (2008) p. 792.
[214] Schmidt et al. (2015) pp. 1236-1238.
[215] Kairies et al. (2015a) p. 53.
[216] Based on analysis of pv-magazin.de (2016).
[217] Sankarasubramanian and Krishnamurthy (2012) pp. 250-251.
[218] Ecker et al. (2014) p. 842.
[219] Schmidt et al. (2015) p. 1231.
[220] Kassem et al. (2012) p. 304.
[221] Millner (2010) p. 351.
[222] Peterson et al. (2010) p. 2389.
[223] Spotnitz (2003) p. 72.



Mean	Median	Maximum	Minimum	StdDeviation
0.60	0.50	3.15	0.17	0.45

Figure 12: Maximal charge and discharge power per kWh of usable battery capacity.
(Based on analysis of pv-magazin.de (2016).)

showed a nearly linear fade rate. In contrast to that, a nearly square rooted fade rate in function of the time was observable with a 45°C operation temperature.[224] In a calendar life study of lithium-ion pouch cells, Zhang and White (2008) observe a linear capacity fade in low temperatures and non-linear losses in temperatures above 25°C.[225] Most of the aging curves of Ecker et al. (2014) appear also in a nearly linear shape.[226] The rate of capacity losses decreases over time.[227] Since a complex technical model would go beyond the scope of this economic analysis, I assume a similar fading-behavior and use a simple time-dependent approach to take all capacity losses (cyclical, calendrical or other) into account. The fading-factor is assumed to stay constant over time and is chosen to meet literature observations in capacity tests. Different literature defines the battery end of life by reaching 80% of initial capacity.[228] [229] Truong et al. (2016) observed 80% remaining capacity for lithium-ion cells after 15 years in operation.[230] Thus, to reach the same fading after 15 years, the battery in this simulation continuously loses 1.58 % of the remaining capacity within a year, leading to a decreasing function with a slightly concave slope in the total capacity like shown in the following graph:

The fading-factor is set to 1.58 % to reach 80% remaining capacity after 15 years. Nevertheless, most of the battery systems in the sample are promoted with a life-span of 20 years. For the remaining 5 years of operation, I assume the same fading behavior as before.

[224] Wright et al. (2003) p. 865.
[225] Zhang and White (2008) p. 786.
[226] Ecker et al. (2014) p. 842.
[227] Spotnitz (2003) p. 73.
[228] Millner (2010) p. 350.
[229] Spotnitz (2003) p. 72.
[230] Truong et al. (2016) p. 7.

4. Results and discussion

Before presenting and discussing the results, I want to touch upon some basic problems and limitations of the model and its simulations. The optimization, run in the MATLAB R2016b – version, works with a golden section search and parabolic interpolation.[231] The simulations determine the optimal battery sizes by technically minimizing the negative-inverted net present value. The underlying data allows calculations in hourly steps. Therefore, small battery micro-cycles, for example when clouds prevent solar production for a few minutes, are not considered within these simulations. The optimization is fully linearized, which means that optimal but also continuous battery sizes might arise that are not actually available at the market. All costs are also assumed to be linear, which enables theoretically setup constellations that would not be possible in real business cases, for example a battery installation of just 0.1 kWh. According to Kairies et al. (2015a) installations smaller than 2kWh are usually not profitable since fixed costs for the additional required electrical equipment would be too high.[232]

The simulations in this study assume a fixed photovoltaic system size of 5.5 kW. However, I have to critically mention that an investor, who is interested in buying a photovoltaic system and a battery storage system at once, would try to optimize the sizes of both systems simultaneously, if he had appropriate tools to do so. If a photovoltaic system is not properly sized according to the needs of the household, the over- or underproduction can affect the self-consumption ratios even without storage.[233] The photovoltaic system size

[231] Mathworks Matlab (2017) fminbnd function documentation.
[232] Kairies et al. (2015a) p. 45.
[233] Hoppmann et al. (2014) p. 1104.

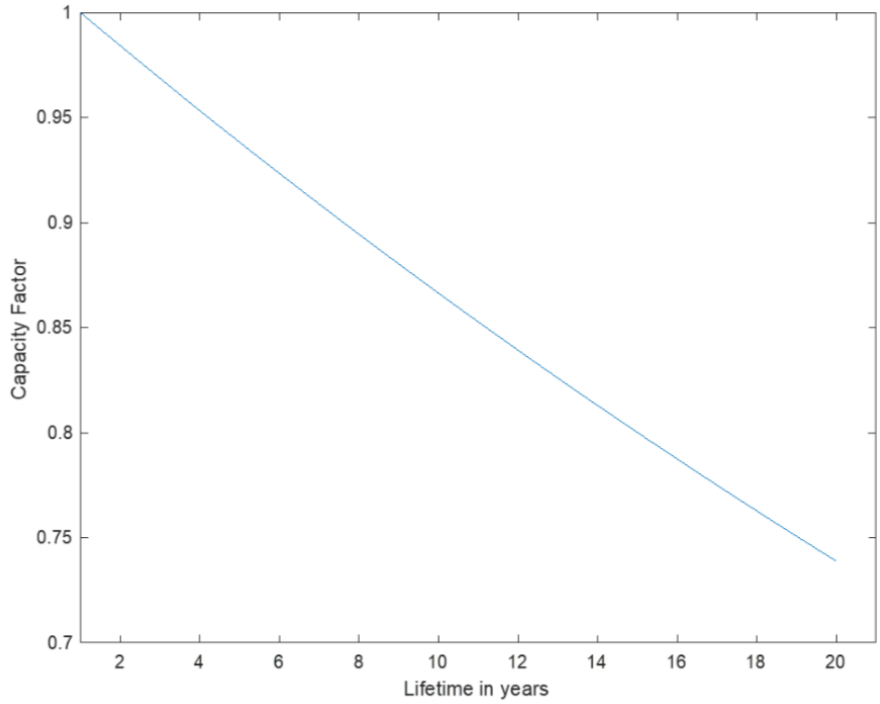


Figure 13: Capacity Factor Function.

for my simulations is set according to the recommendations of previous literature to be well-fitted to the household's load demand without storage.[234] This is important to assure that the results are also meaningful for retrofitting battery installations. Thus, the photovoltaic generation facility might not necessarily be optimally sized for a usage together with a storage system. Therefore, the calculated scenarios could be biased so that battery installations might already be financially lucrative if they were operated together with an appropriately sized corresponding photovoltaic system, even before the simulation results would say so. On the other hand, the battery system could be obsolete if the photovoltaic system would be properly sized and orientated to produce along with the consumption pattern of the household. The total photovoltaic production is with 6313.83 kWh per year theoretically more than enough to cover the 4685.07 kWh of the household's demand. If the energy storage system would work without efficiency losses and had enough charging and discharging power as well as total capacity to store the surplus, the household could live without grid power. Nevertheless, a high autarky in this model can only be achieved by an effective energy storage system that generates more calculative revenues than initial costs. If the production and consumption is grouped in hourly patterns, the intersection of both curves in Figure 14 shows the self-consumed energy without battery storage system. Since a big part of the produced energy can not be utilized immediately, it can either be stored or sold to the grid.

Although this linearized approach underlies multiple assumptions and can only serve as a model framework, the results can give an indication at which boundaries political regulations and market-driven parameters would lead to profitable installations of battery storage systems.

The following graphs show the battery sizes that are optimizing the net present value. The photovoltaic system without battery storage system would generate a net present value of 3268.28€ within 20 years assuming electricity retail rates of 28.72 Cents/kWh and 12.30 Cents/kWh rate of remuneration. A rational investor would only consider projects that have a positive net present value. With 3268.28€ , the photovoltaic modules can generate positive returns on investment and are therefore a profitable investment opportunity.

The following chapters cover five different simulations regarding the bespoken political regulations and market driven parameters. Since every influencing parameter has different consequences to the profitability of battery storage systems, I discuss every parameter separately. For each regulation or market driven parameter, I first present the results of the simulations and then discuss shortly the implication of my findings. Chapter 4.1 outlines the effect of subsidies on battery storage systems. Consequences of changing electricity retail rates and feed-in compensations are presented in chapter 4.2 and 4.3. Chapter 4.4 presents the impact of cuts in feed-in power. The last subchapter plots a possible scenario for an investor in the year 2020.

[234] Weniger et al. (2014b) p. 82.

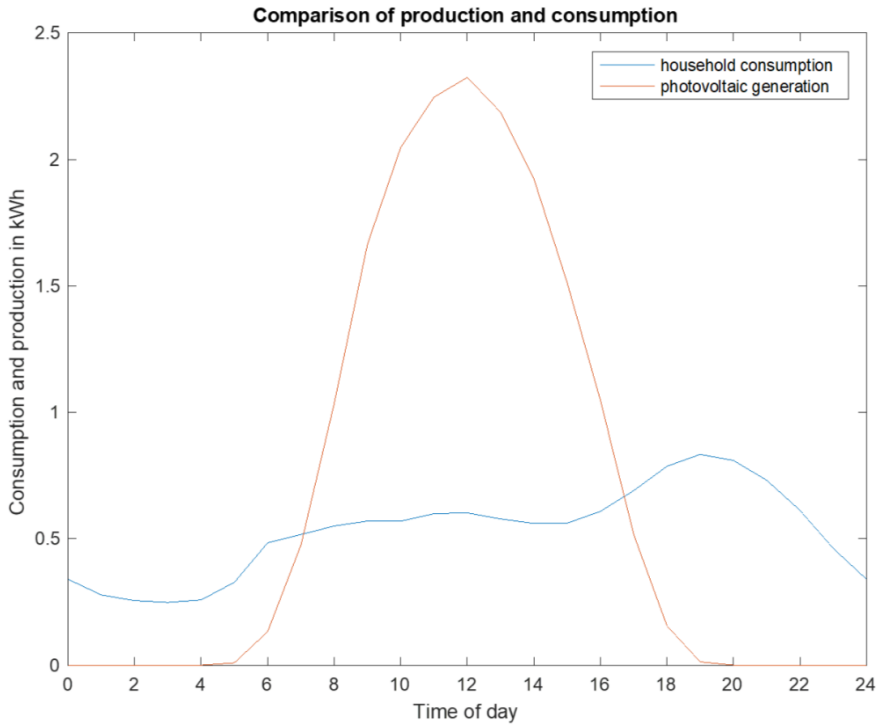


Figure 14: Comparison of the daily consumption and production pattern.
(Based on analysis of data from Renewables.ninja (2016).; Based on analysis of data from Berlin (2015).)

4.1. Sensitivity towards battery subsidies

This first simulation tries to identify a breakpoint of subsidies or alternative drops in battery prices that would lead to profitable battery storage installations. Thereby, I determine the optimal battery sizes with respect to investment costs between 100 € /kWh and 600 € /kWh of usable capacity. Since a subsidy is only in the interest of investors that consider a new installation, I use current market values. For the rates of remuneration I assume the latest feed-in compensation of 12.30 Cents/kWh for January 2017.[235] Similar to Truong et al. (2016), I assume a constant electricity price of 28.72 Cents/kWh over the whole lifetime.[236] The battery price is set to 600 € /kWh of usable storage capacity. The simulation with battery prices from 100 € /kWh to 600 € /kWh leads to the same results as calculating with subsidies between 0 € /kWh to 500 € /kWh. From a financial perspective, subsidizing the battery system does only affect the investment costs of the battery system. Therefore, varying battery costs and subsidies results in the same optimal system setups. Figure 15 shows the return-maximizing battery sizes for different initial investment costs for the battery system.

Battery costs above 510 € /kWh lead to a relative sudden drop in the optimal battery size. With costs above 530 € /kWh the optimal battery size tends to null. The net present value of the overall investment is positive for all battery costs. The photovoltaic system, as I already stated, has a net present value of 3268.28€ . Since the battery size is only bigger than 0 kWh when the net present value of the overall investment can be increased, the net present value is rising with the battery size.

The simulation confirms the results of Kantor et al. (2015), according to which the investment costs would prevent the profitable implementation of batteries under the current environmental circumstances.[237] With prices for lithium-ion systems around 600€ /kWh, a battery storage system does not provide financial benefit and has therefore an optimal battery size of 0 kWh. From another point of view, 525€ /kWh marks a barrier, at which the optimal battery sizes start to become financially lucrative. Assuming market prices of 600€ /kWh, battery costs must either decrease by more than 75€ /kWh or governmental subsidies would have to partly come up for these costs to give a financial incentive for the investor. The difference of the optimal battery size between costs of 510 € /kWh with 2.27 kWh and 530 € /kWh with 0.31 kWh is quite extreme. If future battery prices come down to 530 € /kWh, policy makers could boost further installations of battery storage systems rapidly by subsidizing with rather minor costs to overcome the small gap. The subsidy of the German "kfW"-bank with the program number 275 currently gives a reimbursement for a maximum of 19% of the costs that are eligible for the

[235] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

[236] Truong et al. (2016) p. 6.

[237] Kantor et al. (2015) pp. 222-223.

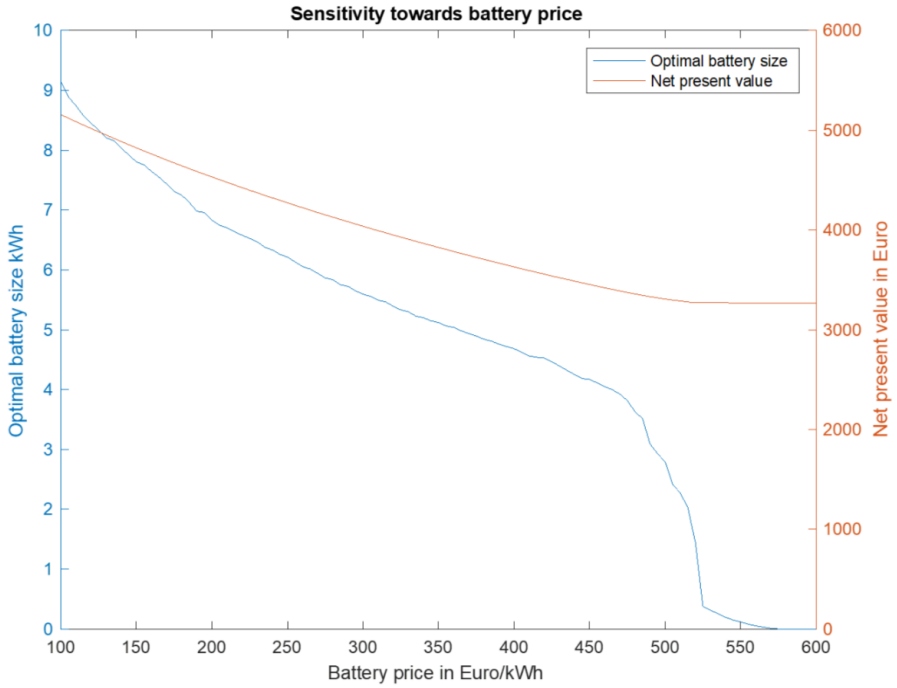


Figure 15: Return-maximizing battery sizes for different battery costs.

grant.[238] Assuming a price of 600 € /kWh of usable storage capacity, the subsidy would add up to 114 € /kWh and could therefore decrease the battery investment costs to 486 € /kWh. Looking at the results of the simulation, the battery storage systems should already be profitable together with this subsidy. However, around 50% of the storage owners did not even use the subsidy.[239] The reasons that this subsidy is not beneficial for every investor are hidden in the requirements of the grant. The reimbursements are calculated upon the eligible costs. The eligible battery costs can differ extremely from the actual system costs. As the calculation tool on the website of the bank reveals, the eligible costs are calculated by taking the total costs of the combined system and subtracting 1.600 € /kWp of photovoltaic power.[240] The remaining costs are considered as the costs of the battery system and tolerated for grant repayments. Since newer photovoltaic modules are already available for prices around 1270€ /kWp and therefore way cheaper than 1600€ /kWh, the calculated eligible costs are way lower than the actual battery costs.[241] To clarify this problem, I will make a simple calculation. Let us assume that a 5kWp photovoltaic rooftop costs 6350€ and the battery with 5 kWh capacity is priced at 3000€ . This adds up to total system costs of 9350€ . Since the grant regulations subtract 1600€ for each kWp of photovoltaic power, the remaining costs that are considered for the storage system are 1350€ . The calculative costs in this example would be way lower than the actual costs of 3000€ for the battery system. With a reimbursement of 19% of 1350€ eligible costs, the grant would only come up for 256.50€ . Thus, the effective subsidy does only add up to 51.30 € /kWh of usable battery capacity. As shown in the simulation results, the subsidy would have to be at least higher than 75 € /kWh to have an impact on the optimal battery size. In addition to that, by making use of the grant, the corresponding facility is additionally forced to limit the feed-in power to 50% of the installed photovoltaic capacity.[242] Since this subsidy comes along with some drawbacks and does not provide enough financial support, the program does not effectively incentivize a battery installation in every business case.

To sum up, I can say that under current market conditions a subsidy program would be elemental for an installation of a battery storage system. To incentivize residential storages, the program would have to be designed in a way that its requirements do not discriminate storage owners towards photovoltaic owners without storage system. Furthermore, depending on the assumptions, the program would have to come up for at least 75 € /kWh to trespass the identified boundary.

[238] Kreditanstalt für Wiederaufbau (2017) Erneuerbare Energien – Speicher.

[239] Sterner et al. (2015) p. 24.

[240] The 1600€ /kWp subtractions are based on the "Tilgungszuschussrechner"-application on the website of the "KfW"-bank, accessed on the 18/02/17: Kreditanstalt für Wiederaufbau (2017) Erneuerbare Energien – Speicher.

[241] Wirth (2017) pp. 8-9.

[242] Kairies et al. (2016b) p. 20.

4.2. Sensitivity towards taxes, fees and levies

Taxes, fees and levies are a governmental tool to influence the electricity price and thereby supporting or preventing further installations of battery storage systems. To measure the effect of changes in electricity tax and fees regulations, the second simulation optimizes the battery size at different electricity prices. This simulation now considers 600€ initial investment costs per kWh usable capacity of the battery storage system. The rate of remuneration is still set to 12.30 Cents/kWh.[243] I simulate constant electricity prices over the whole project lifetime with electricity retail rates between 20 Cents/kWh and 40 Cents/kWh.

The battery size curve in Figure 16 shows a major incline above 31.20 Cents/kWh. The optimization algorithm with 31.20 Cents/kWh calculates an optimal size of 0.43 kWh usable battery capacity. With 2 Cents/kWh more, the simulation finds the optimum battery size at 3.91 kWh for electricity prices of 33.20 Cents/kWh. Since self-consumed energy is valued with the electricity retail rates, the NPV-curve of the system is increasing with the retail rate. Even when the household does not operate any battery system, the photovoltaic power is favorably consumed before the excess energy is fed into the public grid. Nevertheless, within the price of 20-40 Cents/kWh and a rate of remuneration of 12.30 Cents/kWh, the net present value of the overall system is positive. Assuming prices of 28.72 Cents/kWh, an increase of 3 Cents/kWh would lead to an instant investment opportunity in battery storage systems ceteris paribus. A 3 Cents/kWh price increase could occur naturally by market movements, which might for example be triggered by the nuclear phase out. A rise of taxes would lead to the same effect. A rise of the EEG reallocation charges to 7.6 Cents/kWh, assumed to be reached in the year 2023, could already lead to an overall electricity price increase of around 1.3 Cents/kWh.[244] [245]

Even if the electricity price would only grow in a marginal rate, every price increase can have influence on the overall profitability of the battery system. Whether the influence is enough to justify installations, depends on the other influencing parameters as well.

4.3. Sensitivity towards changing feed-in tariffs

Analogously to the price of electricity, also the feed-in tariff influences the profitability of energy storage systems. With a fixed rate of remuneration for a 20-year-period for renewable generation facilities, the German government secured a stable compensation for photovoltaic facilities.[246] If photovoltaic owners can take big profits on selling energy to the grid, there is a lack on a sufficient incentive to increase the self-consumption with a battery storage system. The feed-in tariffs have already decreased to 12.30 Cents/kWh.[247] This simulation should now identify how far the compensation would have to decline to make battery storage systems financially attractive, if all other parameters stay constant. For this simulation, I consider two different kinds of investors and photovoltaic profiles:

- Investor A: The investor purchases a new combined photovoltaic and battery storage system in January 2017. Thus, the new owner contracts an EEG feed-in tariff which guarantees him a fixed compensation for the energy that is fed into the grid. The panels of the photovoltaic system are new and do not show losses due to wear or aging at the beginning of the simulation. The production profile of the solar modules as well as the battery system start with full capacity in all systems. Due to the EEG regulations of 2012, the newly installed photovoltaic systems cut of feed-in power above 70% of the nominal installed capacity.[248]
- Investor B: The scenario is settled in 2020 when the first photovoltaic systems will fade out of the remuneration contracts. I assume that the investor purchased a photovoltaic system 20 years ago and could now install a retrofitted battery storage system to increase self-consumption. The EEG-contract faded out, so the remuneration rate is way lower. The production profile has losses due to 20 years of aging. Since the photovoltaic facility was installed before 2012, no feed-in limits reduce the feed-in power of the system. All other parameters stay constant as in the simulations of investor A.

I simulate each profile with feed-in tariffs between 0 Cents/kWh and 20 Cents/kWh. Thus, this simulation covers the interests of new investors facing the current remuneration rate of 12.30 Cents/kWh as well as photovoltaic owners at the end of the EEG-program facing rates around 3 Cents/kWh.

Figure 17 shows a steep downfall in the optimal battery size for rates of remuneration above 9.6 Cents/kWh for investor A. The optimal battery size at a feed-in tariff of 9.6 Cents/kWh is 2.02 kWh. With an increase of only 0.2 Cents, the optimal battery size already declines to 0.44 kWh. The simulation for investor B shows a similar curve. The optimal battery size is slightly below the line of Investor A due to the lower production efficiencies of the aged photovoltaic system. Since the photovoltaic modules are simulated with 20 years of efficiency degradation, the production profile values are assumed to be lower than for new facilities. The aged photovoltaic rooftop does not produce that much energy. So, the battery does not require that much capacity to store all

[243] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

[244] Deutscher Industrie- und Handelskammertag (2016) p. 31.

[245] Based on data of Bundesverband der Energie- und Wasserwirtschaft e.V. (2016b) Energiedaten.

[246] Bundestag (2000) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2000).

[247] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

[248] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).

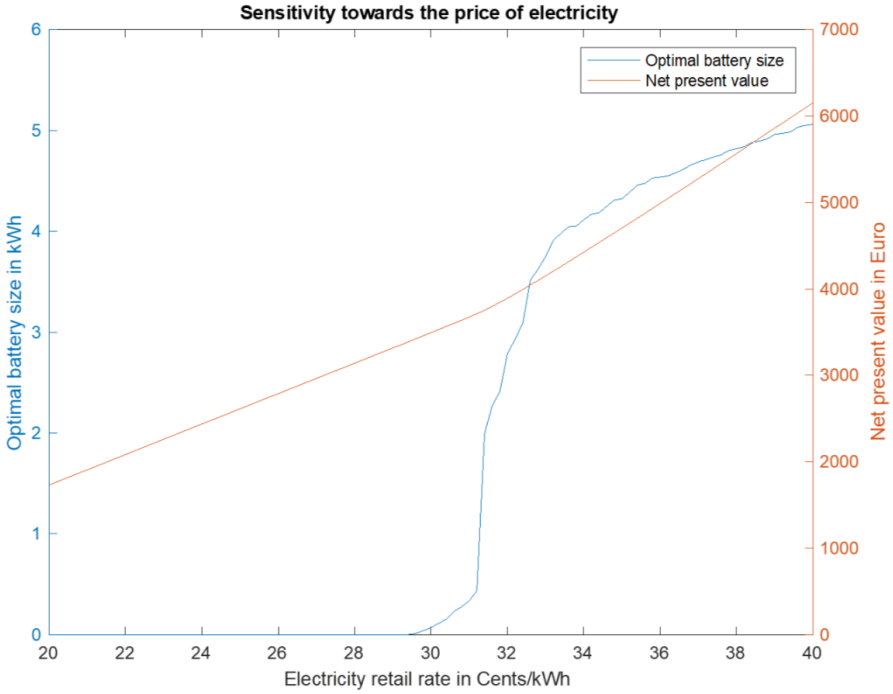


Figure 16: Return maximizing battery sizes at different electricity retail rates.

excess energy for the later consumption. Consequently, also the size of the battery shrinks. The lower photovoltaic power can lead to smaller optimal-sized batteries that do have lower charging and discharging rates. The line of Investor B shows a parallel behavior, but it tends to drop slightly earlier with less steepness. The NPV curve is only shown for investor A since the photovoltaic costs of investor B are already sunk and therefore not relevant for the overall buying decision. The overall project has a negative NPV for rates of remuneration below 1.8 Cents/kWh.

A fall of the current feed-in tariff of 12.30 Cents/kWh to 9.60 Cents/kWh would place battery storage systems in the position of a financially attractive investment opportunity. At rates of 9.60 Cents/kWh, investor A would have a recommended optimal battery size of 2.02 kWh. Battery sizes bigger than 0 kWh already occur at rates of 11.40 Cents/kWh but those battery sizes are very small and probably not yet economic in a real business case. The feed-in tariffs are coupled to the total photovoltaic addition.[249] If the rate of remuneration decreases, also the profitability sinks, which should lead to a slower photovoltaic addition ceteris paribus. Not surprisingly, the net present value grows for higher rates of remuneration or sinks with decreasing feed-in compensation. However, since the battery is increasing the NPV, the NPV for rates below 10 Cents/kWh does not decrease as fast as for rates where no battery storage system would be profitable. The curve shows a salient point at this rate, since the sudden uptake of the battery storage system breaks the constant linear sinking. The NPV curve sinks with 387.37 € per Cent of the rate of remuneration if the system does not include a battery storage system. At rates of remuneration below 9 Cents/kWh, an optimally sized battery storage system can lower the shrinking of the NPV to values between 266 and 305 € per Cent. Assuming that investor A acts rational and according return-maximization, A will not invest for negative NPVs. A rational and profit maximizing investor would only invest, if the net present value is positive. However, in some constellations and scenarios the photovoltaic costs are sunk and battery storage systems can minimize the losses for investments that would otherwise have negative returns. For investor A, the rates of remuneration can only incentivize a battery installation if they are settled between 1.8 Cents/kWh and 9.6 Cents/kWh. If the rates are higher, investor A would only install a photovoltaic rooftop without battery storage system. If the rates are lower than 1.8 Cents, investor A should neither invest in the photovoltaic system nor the battery.

The picture looks completely different for investor B, who is already owning a photovoltaic system. For photovoltaic owners, who are fading out of the EEG-program, a battery would be a good way to increase self-consumption and therefore avoid selling energy to the grid for a very low compensation. Those investors face a selling price of around 3 Cents/kWh at which the optimal usable battery capacity would be above 4 kWh. There is no need in changing any feed-in tariffs for investors of type B to generate an investment opportunity. These findings go in hand with the recommendations of the German storage association "Bundesver-

[249] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

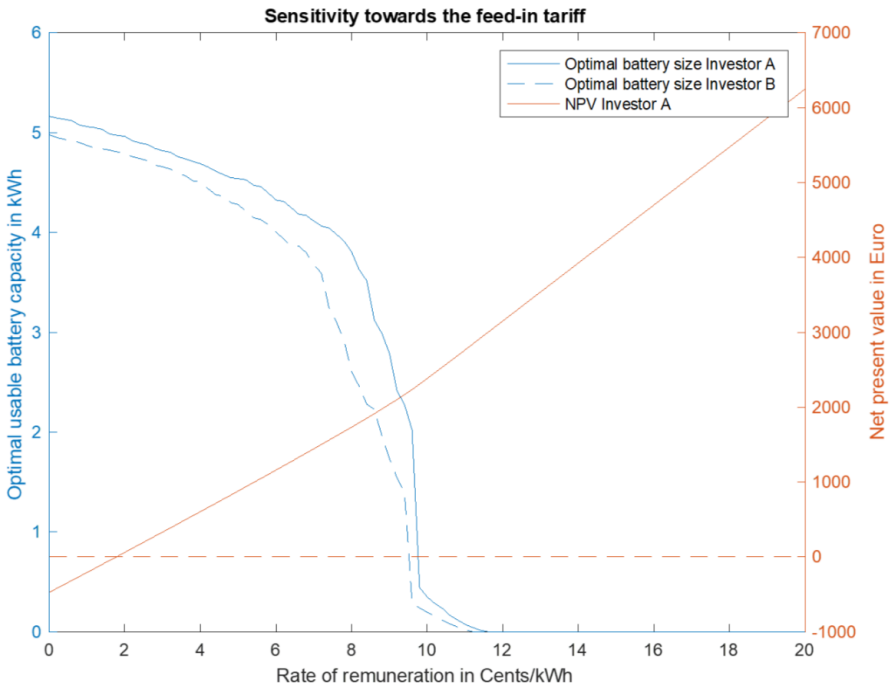


Figure 17: Return-maximizing battery sizes for different feed-in tariffs.

band Energiespeicher e.V. Berlin" regarding the retrofit of storage systems for photovoltaic facilities fading out of the fixed remuneration rates.[250] However, due to the lack of a production profile of an old facility, I have to critically mention, that this simulation is also based on the photovoltaic production profile of the website "Renewables.ninja" of the year 2014.[251] The production profile is simulated with previous linear capacity losses for 20 years due to aging of the facility, but the fading of older photovoltaic systems from the year 2000 might be completely different after 20 years. It is questionable, if the production profile would still have a linear efficiency fading.

4.4. Sensitivity towards curtailments

Curtailment regulations should incentivize photovoltaic owners to increase their self-consumption to avoid losses due to curtailments. In times of very high solar radiation, the feed-in energy is cut if the power exceeds the curtailment limit. Thus, there is no compensation for this energy. The current feed-in limit for photovoltaic systems is 70%.[252] The curve in Figure 18 shows an optimal battery size of 3.93 kWh for a curtailment above 20% of the nominal power. At a feed-in limit of 30% the optimal battery size already dropped to nearly 0 kWh. The first optimal battery size that could be realistically operated in a profitable way for a real business case is at a feed-in limit of 26%. For this feed-in limit, the calculated optimal battery size would be 1.96 kWh. The NPV-curve of the overall project is negative at feed-in limits below 5%. The net present value without battery storage system is already negative at around 10% feed-in power.

Thinking of the current feed-in limit for photovoltaic systems of 70%, a radical political interference would be needed to incentivize a battery storage uptake only via curtailments. There are already lower feed-in limits for EEG-subsidized battery storage systems. To receive an investment subsidy for a new battery system, the photovoltaic system must not feed-in more than 50 % of its nominal power.[253] However, these limits are not incentivizing a battery storage installation since these regulations do not apply on systems without battery storage. The limit that is applied to all photovoltaic systems and that could promote a battery storage installation, is currently set to 70% and is therefore not influencing the optimal battery size at all. If the rational investor is only investing in projects with a positive net present value, curtailments could prevent an investment in a photovoltaic system only at feed-in limits below 10%. If the investor additionally installs a battery storage system, the project generates a positive NPV until a feed-in limit of 5%. An investment in a combined photovoltaic rooftop and residential storage system would therefore only be profitable and financially beneficial for feed-in limits between 5% and 26%. For all feed-in limits above 26% the investor would only purchase a photovoltaic system without installing a battery storage system. At feed-in limits below 5% the investor would neither invest in the photovoltaic modules nor in a battery. The current feed-in limit that is

[250] Bundesverband Energiespeicher e.V. (2016) p. 20.
[251] Renewables.ninja (2016).
[252] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).
[253] Kairies et al. (2016b) p. 20.

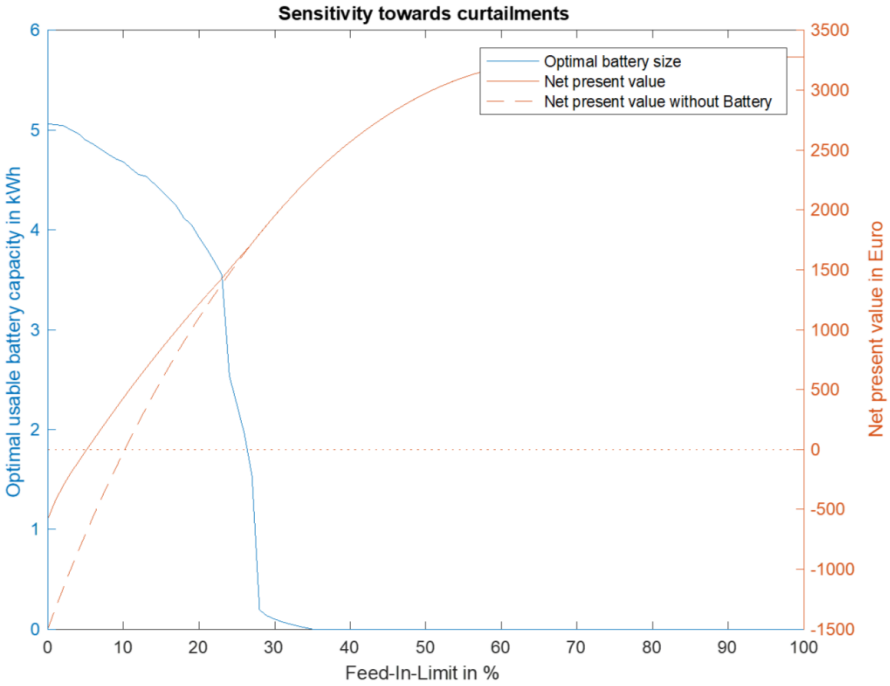


Figure 18: Return-maximizing battery sizes at different feed-in limit regulations.

applied towards photovoltaic installations would have to decrease from 70% by 44% to incentivize battery storage installations.

4.5. Simulation of a likely future scenario

By now, I determined the optimal battery sizes for different battery costs, electricity prices, feed-in tariffs and curtailment regulations. Every parameter includes values, at which it could incentivize a battery storage installation. However, none of the parameters shows an imminent investment opportunity if it is changed alone without adjusting also other parameters. It might be not possible for any parameter to change as much as needed to create a financially lucrative investment in battery storages while the other parameters stay constant. Thus, I simulate a possible future scenario for the year 2020 changing multiple parameters. In contrast to the simulation of investor B in chapter 4.3, this is a speculative scenario changing multiple parameters according to previous historic movements. The changes in rates of remuneration are assumed to continue linearly over the next three years until 2020. The rates of remuneration decreased from 12.95 Cents/kWh in January 2015 to 12.30 Cents/kWh in January 2017 leading to a yearly decline of approximately 0.325 Cents/kWh.[254] I assume a similar decrease until 2020, therefore using a feed-in tariff of 11.325 Cents/kWh. The simulation works with constant electricity retail rates over 20 years. Therefore, the chosen price should be an average value for the years 2020 until 2040. Looking at the electricity costs since 1998, total electricity costs increased by 68% until 2016 whereas taxes, fees and levies increased by 281% and the retail rates are still expected to rise.[255] [256] Even if the prices might currently not be rising in a constant linear manner, I assume an increase in the electricity retail rates in the next years and calculate with an electricity price of 31 Cents/kWh. Curtailment regulations did not change in the last years and are still set to the current rate of 70%.[257] Thus, I keep this and all other parameters as they were already applied in the previous simulations. The estimations for future battery costs vary widely. Some experts expect the total costs to sink to very low levels of 100$/kWh.[258] Thus, I take the initial investment costs of the battery system for the x-axis and calculate the optimal battery sizes with the new parameters and battery costs between 100-600 € /kWh.

Figure 19 shows a slowly decreasing curve of the optimal battery size. In the range between 100-600 € /kWh battery system costs, the optimal battery size is always positive and higher than 2.78 kWh. The NPV is always positive and decreasing with increasing battery costs. Thus, assuming the bespoken parameters, there could be a clear financially lucrative investment opportunity in battery storage systems in 2020.

[254] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

[255] Bundesverband der Energie- und Wasserwirtschaft e.V. (2016a) p. 33.

[256] International Renewable Energy Agency (2015) p. 35.

[257] Bundestag (2012) Gesetz für den Vorrang Erneuerbarer Energien (EEG 2012).

[258] Fehrenbacher (2015) This startup is looking to revolutionize lithium ion batteries.

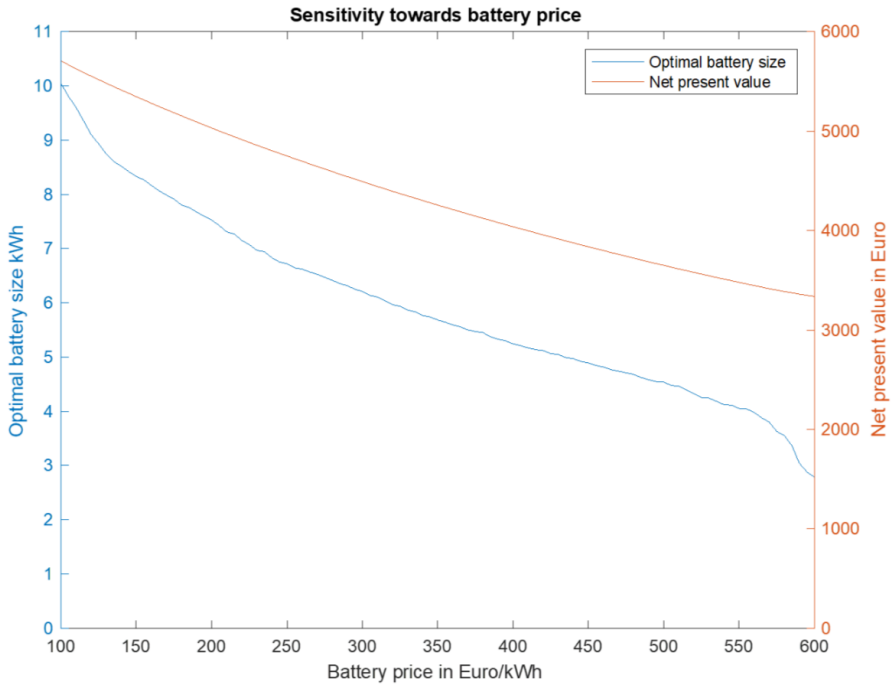


Figure 19: Return-maximizing battery sizes in a "2020 scenario".

5. Summary and further research

This thesis determines the net present value-maximizing battery sizes in different market scenarios and varying political regulations for a German photovoltaic owner. By comparing the production profile of a residential photovoltaic rooftop facility with an average household's energy demand in hourly steps, I simulated energy shifts with a battery storage system to compute the financial value of residential storage applications. This thesis identifies boundaries in political and market driven parameters that have a crucial influence on the financial value of the battery storage system. This is done by varying initial costs of the battery storage system, electricity retail prices and rates of remuneration as well as feed-in limiting regulations.

Investment costs of a battery system above 510€ /kWh lead to a steep drop in the net present value-optimizing battery size. Subsidies could help overcome the high initial investment costs of a battery installation. However, current subsidy regulations do not provide profitable opportunities for every photovoltaic owner. Rising electricity retail rates or lower rates of remuneration could have a similar effect on the profitability of battery storage systems ceteris paribus. The higher the price of electricity, the higher the incentive to increase the self-consumption to avoid paying for the expensive energy. Electricity costs below 31.6 Cents/kWh lead to a decrease in the optimal battery size so that a storage system would not be profitable. Thus, taxes, fees and levies like the EEG-charges that are influencing the electricity retail rate could have a high influence on the profitability of battery storage systems. If the compensation of selling energy to the grid is low, photovoltaic owners will try to increase their self-consumption with a battery system. Rates of remuneration above 9.6 Cents/kWh diminish the calculative revenues of self-consumption such that battery systems become unprofitable. The current rates of remuneration are at 12.30 Cents/kWh.[259] Thus, the compensation is too high to allow a battery storage system (that is operated for increasing self-consumption) to be financially lucrative. For the 20-year-period the EEG-contracts guarantee these rates of remuneration, photovoltaic installations that have already been built will not have financial opportunities in retrofitting storage systems under the assumption of constant electricity retail prices. Regulations that limit the power that can be sold to the grid could deliver a similar incentive for self-consumption. Current regulations regarding feed-in limitations on photovoltaic facilities however do not show any impact on the optimal battery size. To incentivize battery installations via feed-in curtailments, every residential photovoltaic owner would have to be forced to cut feed-in power above 26% of the installed capacity.

The one-dimensional simulations of every influencing parameter have revealed that at the currently assumed market situations no parameter could solely financially justify the high investment costs of a battery installation. The only scenario where a battery storage system shows immediate profitability is for photovoltaic owners that are fading out of the fixed EEG-compensations. These investors could be facing rates of remuneration at around 3 Cents/kWh. However,

[259] Bundesnetzagentur für Elektrizität Gas Telekommunikation Post und Eisenbahnen (2017) Photovoltaikanlagen - Datenmeldungen und EEG-Vergütungssätze.

battery installations on new residential photovoltaic systems might be profitable in the near future. The experimental simulation with presumable parameters for the year 2020 already shows financial opportunity in battery storage systems.

Finally, it should be critically highlighted that all simulations using this linearized approach are based on multiple assumptions and therefore not meant to be used on calculations regarding a specific business case. The optimal battery sizes calculated in this thesis are usually not available at the market. The results depend on the assumed parameters and are not suitable to draw conclusions about an optimal investment for a specific household's consumption pattern. Every household faces different solar radiation and has an individual consumption behavior, causing big deviations from the results of this study. The simulations of this paper instead focus on the general connections and impacts of various political- and market-driven parameters on the profitability of residential storage. The key results of this paper are heavily based on the input values and can thus be improved by using more accurate data or more precise parameter values. Production and consumption profiles in a frequency resolution higher than the current hourly pattern can improve the accuracy. In addition, there is plenty of room for further research in similar variations for different application purposes.

Since these one-dimensional simulations assume multiple fixed parameters, for example the size of the photovoltaic system, future research could focus on optimizing the system setup in a multidimensional approach in order to calculate political boundaries and necessary subsidies. As increasing photovoltaic self-consumption is only one way to operate battery storage systems, follow-up studies could integrate additional operation modes into the net present value calculations and clarify how political regulations and market design influence the profitability of investments in stacked battery storage systems. As Gährs et al. (2015) already mentioned, it is complex to operate residential storage that is usually used for storing photovoltaic rooftop power, in peak-shaving applications or use it for balancing the grid. If battery capacity is used for auxiliary services, the available capacity for self-consumption is lowered, which could lead to economic losses.[260] Further work on this topic could develop a storing and capacity partitioning mechanism that works in a revenue optimizing way. Similar to the algorithm of this paper, an advanced optimization algorithm could continuously switch to the currently most profitable application. This paper focuses on residential usage of battery storage systems in combination with a rooftop photovoltaic facility. By switching the perspectives, similar simulations on an aggregated level could determine critical boundaries for the grid operators. Since multiple storage installations affect the energy flows in the grid, a simulation of energy streams could compare the results of changing profitability of residential storage with alternative costs for peak-shaving facilities on grid-side at different market and regulatory environments.

Battery storage systems in combination with residential solar plants might be one of the key elements to path the way for a transition towards a fully renewable energy supply. The boundaries of a supporting political environment are only one small part of a complex energy system. There are many open questions that can be important for the valuation of battery storage systems and for the identification of necessary political measures towards a greener future.

[260] Gährs et al. (2015) pp. 29-30.

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