



## **Online-Appendix zu**

# „Private Equity Transactions: Value Creation through Operational Engineering – Evidence from Europe”

Victor Heinrich

Technische Universität München

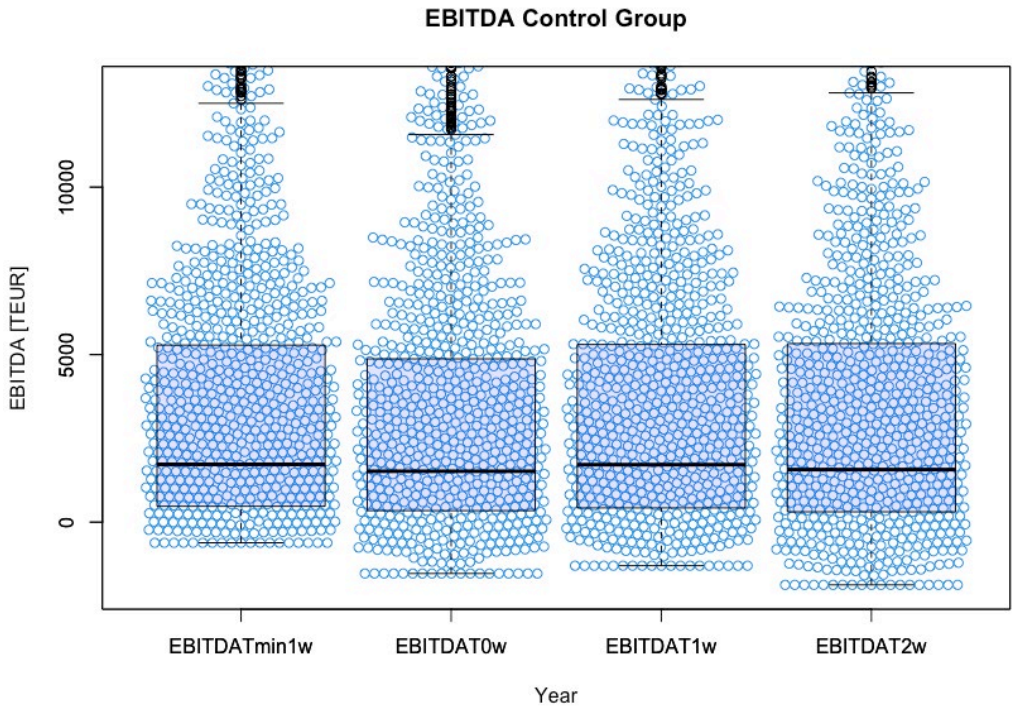
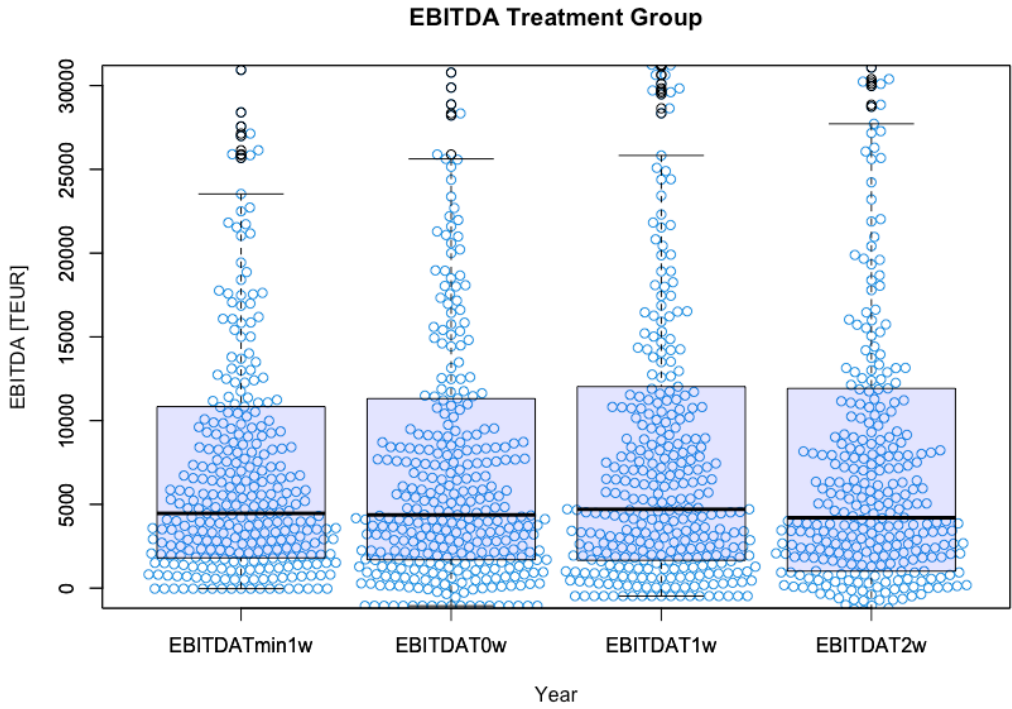
Junior Management Science 8(3) (2023) 634-657

## Appendix

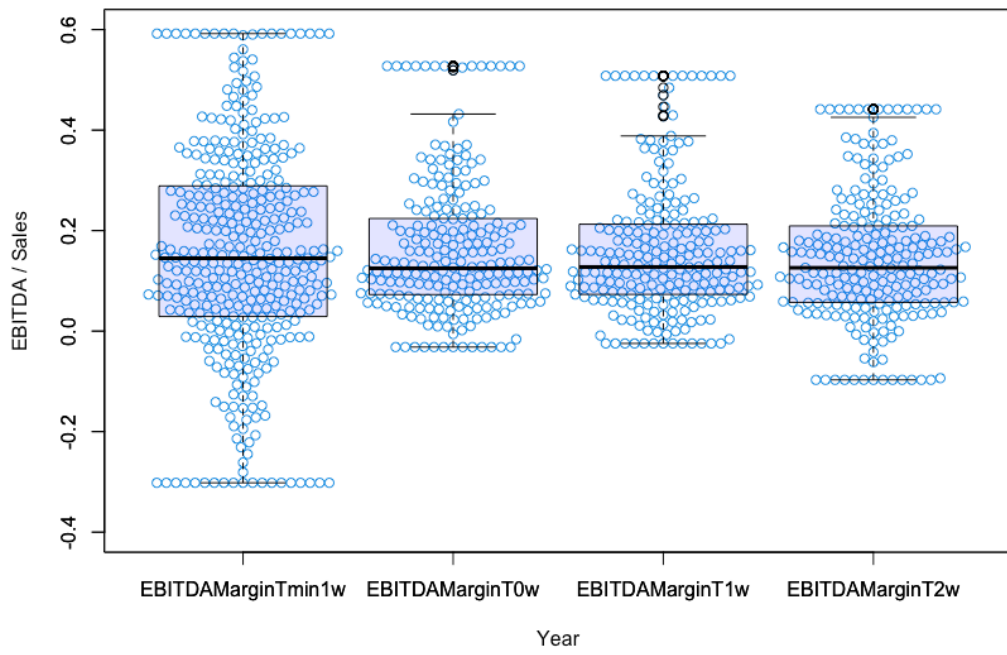
### Appendix 1: Variable Definition

CapEx	$\Delta \text{fixed Assets} + \text{Depreciation}$
EBITDA	$\text{Operating Profit} + \text{Depreciation} + \text{Audit Fee}$
EBITDA Margin	$\frac{\text{EBITDA}}{\text{Sales}}$
Free Cash Flow	$\text{EBITDA} + \Delta \text{Net Working Capital} - \text{CapEx}$
FCF Margin	$\frac{\text{FCF}}{\text{Sales}}$
$\Delta \text{fixed Assets}$	$\text{fixed Assets}_{t1} - \text{fixed Assets}_{t0}$
Gearing Ratio	$\frac{\text{short term loans} + \text{long term liabilities}}{\text{Shareholder's Equity}}$
Net Working Capital	$\text{Current Assets} - \text{Current Liabilities}$
$\Delta \text{Net Working Capital}$	$\text{Net Working Capital}_{t1} - \text{Net Working Capital}_{t0}$
Shareholder's Equity	$\text{Issued Capital} + \text{Total Reserves}$

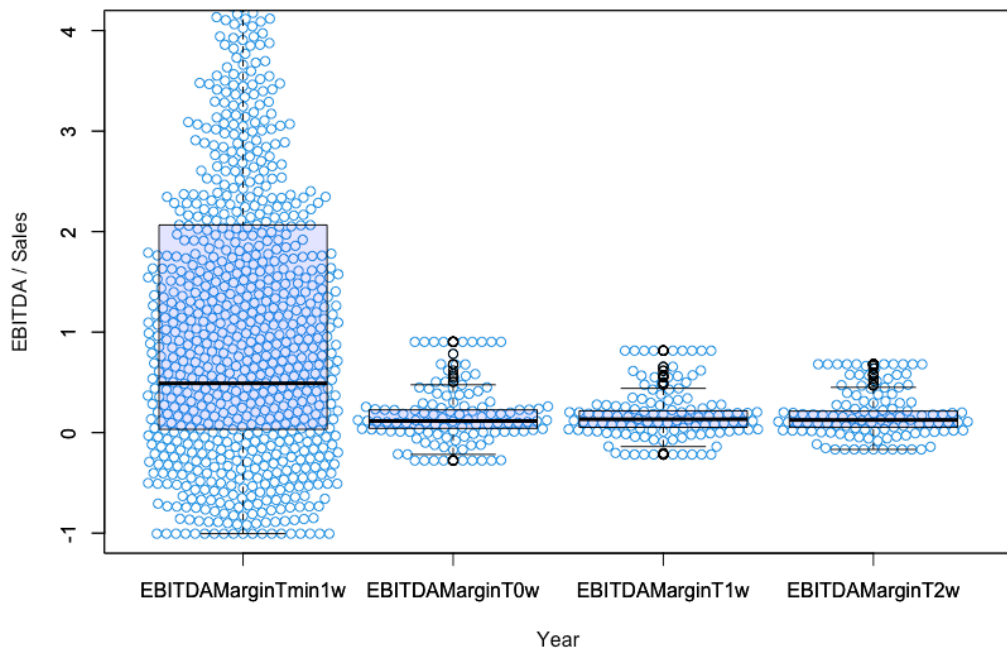
**Appendix 2:** Graphical Representation of KPI differences between Treatment and Control Group at Buyout



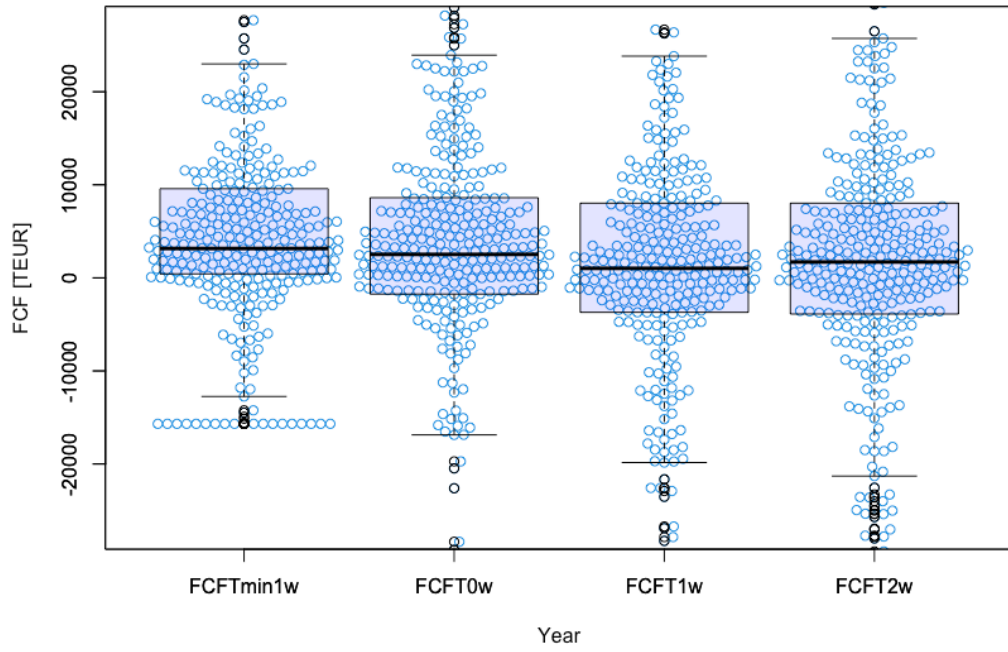
**EBITDA Margin Treatment Group**



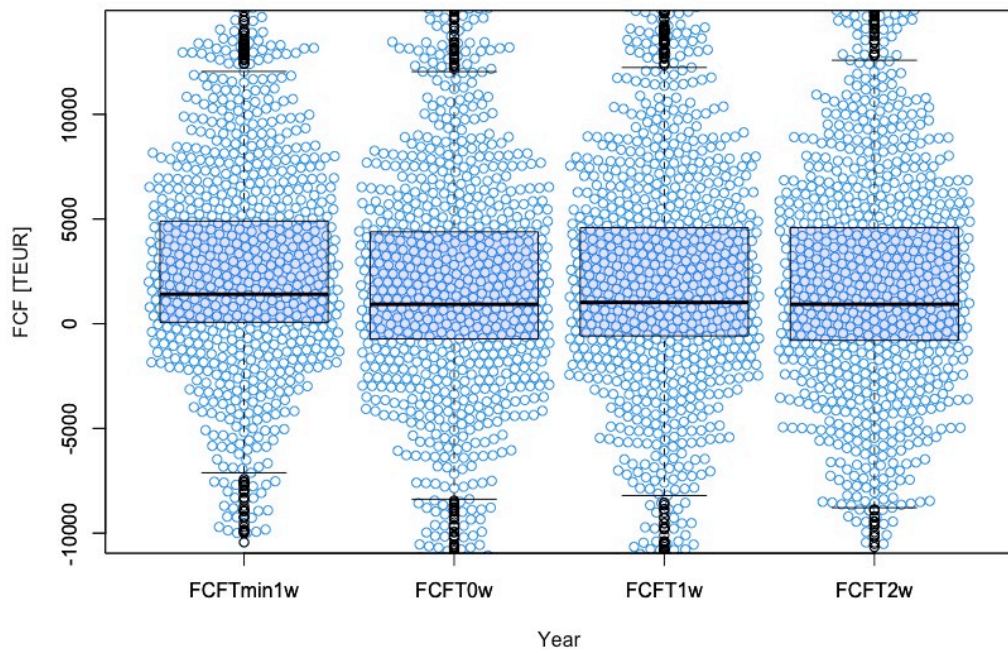
**EBITDA Margin Control Group**



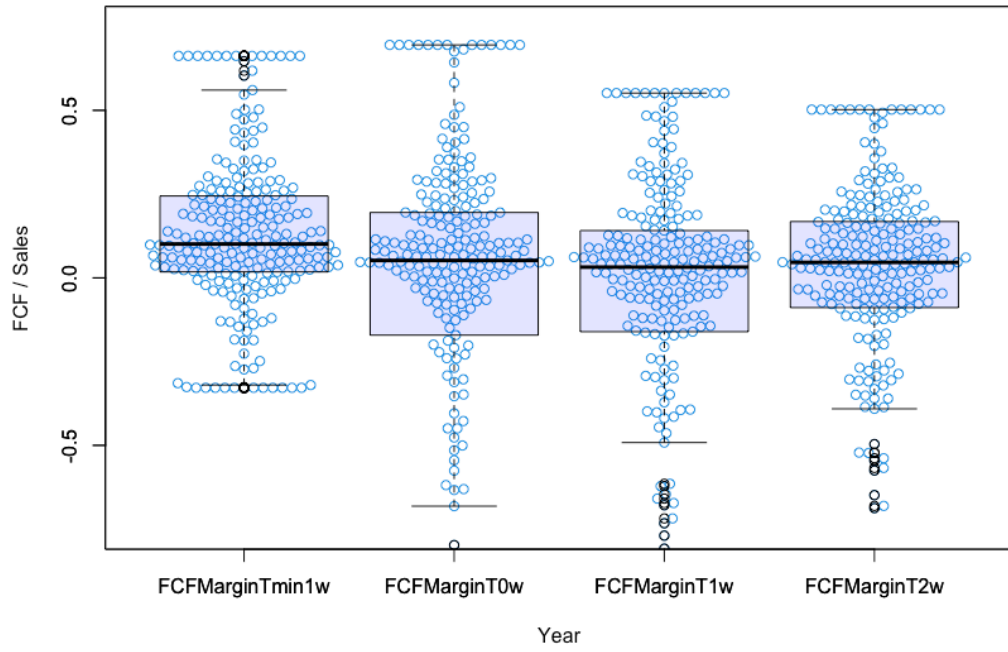
**FCF Treatment Group**



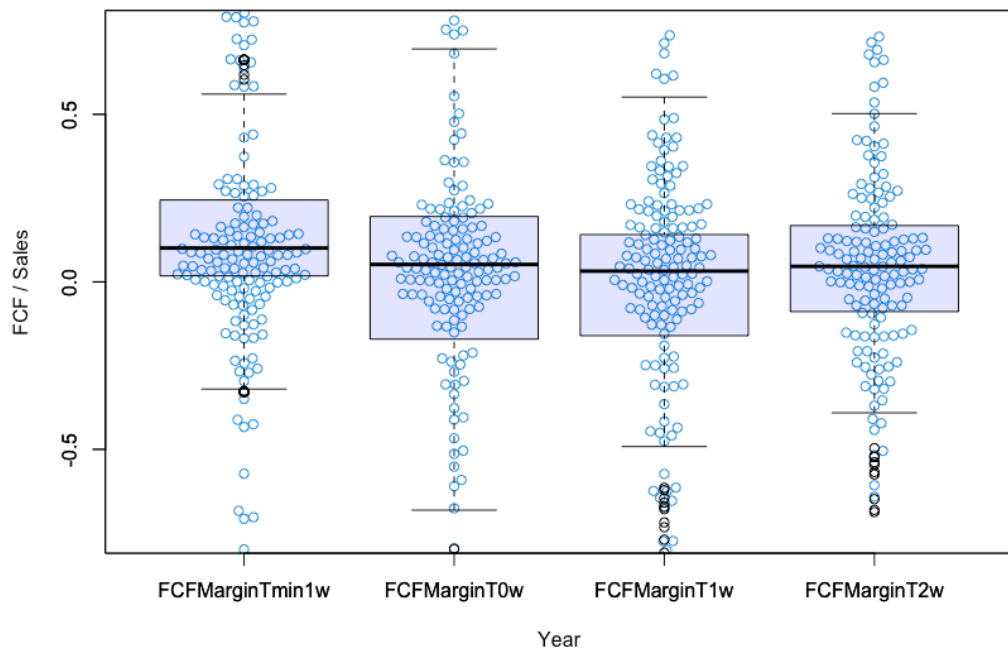
**FCF Control Group**



**FCF Margin Treatment Group**

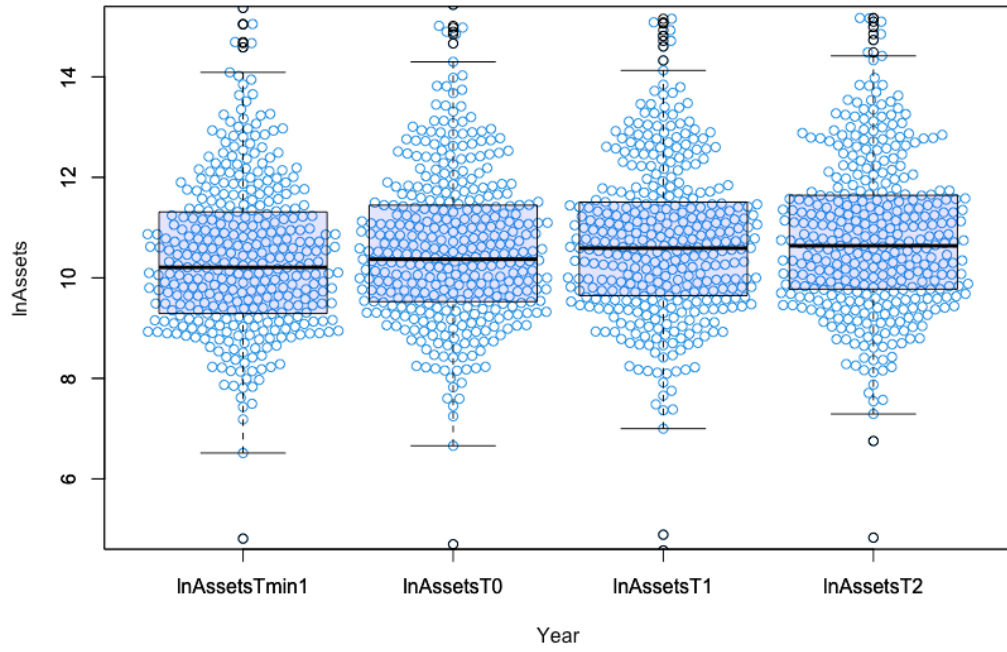


**FCF Margin Control Group**

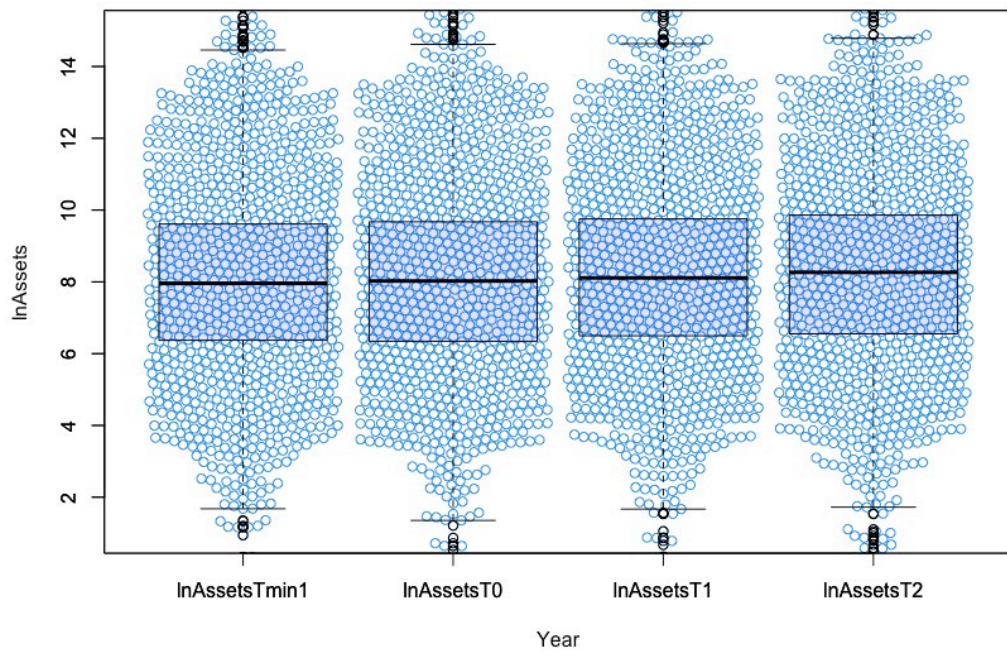




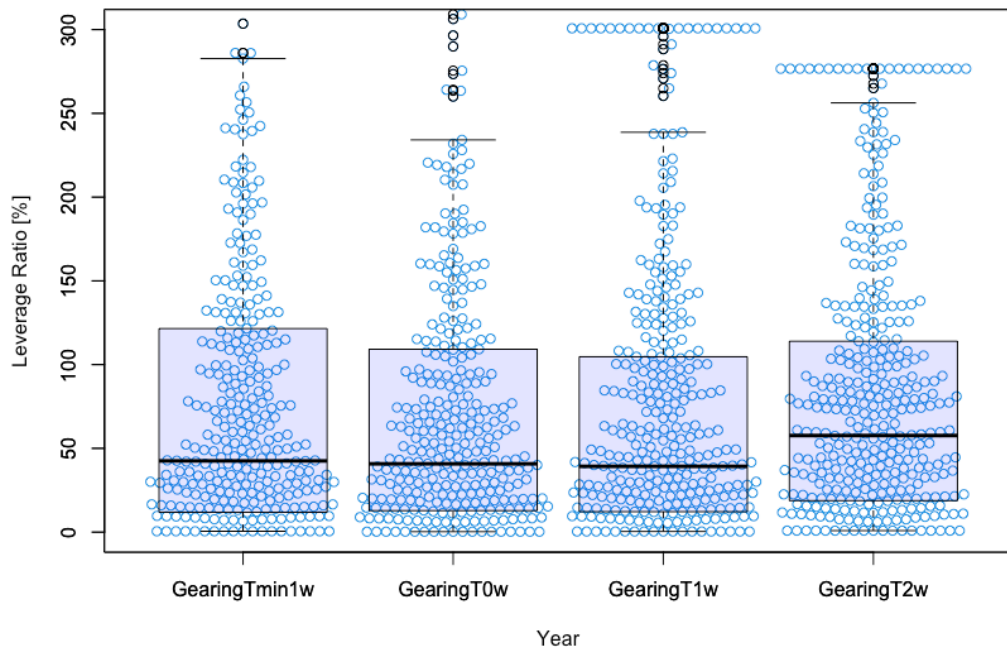
**InAssets Treatment Group**



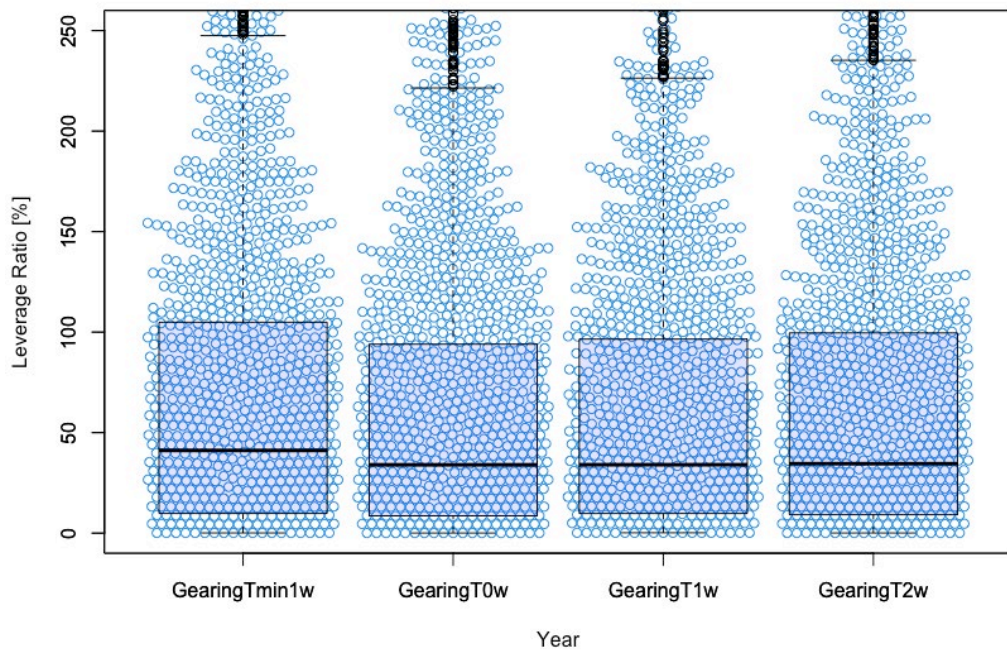
**InAssets Control Group**



### Leverage Treatment Group



### Leverage Control Group





**Appendix 3: Descriptive Statistics of Treatment and Control Group before, during, and after buyout**

**TABLE A-1**

Representing the KPIs of interest (with **(A)** EBITDA in TEUR, **(B)** EBIDTA margin in %, **(C)** FCF in TEUR, **(D)** FCF margin in %, **(E)** sales in TEUR, **(F)** lnAssets, and **(G)** leverage in %) for both Treatment and Control Group for the observation period T-1 until T+2 for comparison and get and overview of the datasets retrieved from Orbis. In addition, t tests on means and Wilcoxon Signed Rank test on medians for differences between both groups. Significant difference between groups is denoted with an asterisk (\*).

		Treatment Group				Control Group			
		T-1	T0	T+1	T+2	T-1	T0	T+1	T+2
<b>A</b>	Mean	10,455.35*	10,039.81*	11,146.99*	10,715.49*	6,370.89*	6,249.13*	7,063.82*	6,680.91*
	Median	4,428.27*	4,291.80*	4,660.52*	4,051.80*	1,614.38*	1,417.40*	1,594.68*	1,468.07*
	SDev	15,093.96	14,193.02	15,892.03	16,335.17	12,762.59	13,060.57	15,002.00	13,935.71
	Min	-33.34	-1,055.89	-472.61	-2,994.96	-617.68	-1,533.62	-1,301.20	-1,873.18
	Max	58,292.40	54,124.35	60,504.96	60,718.07	53,279.49	54,293.47	63,133.33	57,978.47
<b>B</b>	Mean	15.44%*	16.38%	16.11%	14.38%	24.75%*	16.63%	17.62%	16.68%
	Median	14.57%*	12.51%	12.76%	12.60%	49.37%*	11.59%	13.29%	12.57%
	SDev	21.80%	13.64%	13.43%	13.12%	49.35%	26.66%	23.29%	20.83%
	Min	-30.18%	-3.18%	-2.46%	-9.70%	-100.57%	-27.76%	-21.77%	-16.39%
	Max	59.20%	52.75%	60.50%	60.72%	189.31%	90.32%	81.55%	68.05%
<b>C</b>	Mean	7,282.83*	-191.75*	1,373.56	1,439.07	4,985.03*	2,522.40*	2,668.15	3,030.41
	Median	3,129.98*	2,477.78*	998.54	1,552.34	1,304.26*	848.09*	974.63	875.45
	SDev	15,679.67	24,248.43	19,650.44	17,037.18	13,560.04	13,788.34	13,439.68	13,431.45
	Min	-15,684.82	-70,585.17	-43,312.09	-38,943.03	-13,416.74	-29,917.13	-28,620.04	-22,649.27
	Max	56,221.79	43,324.02	47,574.30	44,147.72	53,402.29	41,645.90	41,891.51	45,082.85
<b>D</b>	Mean	12.78%	-11.11%	-11.90%	0.00%*	-0.84%	-22.84%	-12.01%	14.81%*
	Median	10.10%	5.19%	3.21%	4.62%	6.75%	3.55%	2.98%	4.78%
	SDev	23.18%	61.05%	55.92%	30.64%	97.89%	107.09%	82.07%	93.35%
	Min	-32.82%	-191.15%	-193.78%	-83.57%	-298.76%	-377.37%	-261.88%	-176.25%
	Max	66.26%	69.53%	55.17%	50.23%	188.63%	108.70%	140.18%	279.77%
<b>E</b>	Mean	63,668.38*	66,716.39*	72,726.14*	77,451.70*	653,022.60*	734,552.90*	713,526.95*	716,360.10*
	Median	30,729.79*	30,491.58*	35,442.04*	37,038.34*	92,170.00*	93,601.00*	101,229.30*	98,746.00*
	SDev	85,145.19	92,518.30	98,248.62	106,023.90	1,417,055.00	1,578,865.00	1,505,218.00	1,510,000.00
	Min	2,907.96	2,703.25	2,376.20	3,926.79	6,764.25	4,518.12	6,344.50	6,978.72

	Max	344,118.10	381,238.10	382,932.50	423,991.30	6,018,063.00	6,305,791.00	6,028,817.00	6,186,093.00
		<b>Treatment Group</b>				<b>Control Group</b>			
		T-1	T0	T+1	T+2	T-1	T0	T+1	T+2
<b>F</b>	Mean	10.40*	10.56*	10.68*	10.79*	8.05*	8.05*	8.15*	8.21*
	Median	10.19*	10.34*	10.57*	10.60*	7.91*	7.96*	8.06*	8.21*
	SDev	1.51	1.51	1.55	1.53	2.57	2.60	2.60	2.65
	Min	4.81	4.70	4.58	4.83	-3.49	-2.43	-0.17	-1.04
	Max	15.67	15.81	15.95	16.24	19.21	19.28	19.35	19.38
<b>G</b>	Mean	88.16%	79.44%*	72.84%	80.55%	77.54%	68.48%*	69.44%	72.31%
	Median	41.42%	40.86%*	38.80%	57.46%*	41.21%	33.87%*	33.60%	33.14%*
	SDev	108.08%	96.08%	83.89%	77.98%	93.66%	84.25%	86.19%	91.23%
	Min	0.52%	0.27%	0.38%	0.89%	0.10%	0.05%	0.17%	0.08%
	Max	397.89%	357.63%	300.77%	276.65%	340.25%	306.08%	312.01%	333.60%

#### **Appendix 4: Fama-French five industries classification based on SIC codes**

**FF1** Consumer Durables, Nondurables, Wholesale, Retail, some Services  
(Laundries, Repair Shops)

SIC 0100-0999	SIC 2000-2399	SIC 2700-2749
SIC 2770-2799	SIC 3100-3199	SIC 3940-3989
SIC 2500-2519	SIC 2590-2599	SIC 3630-3659
SIC 3710-3711	SIC 3714-3714	SIC 3716-3716
SIC 3750-3751	SIC 3792-3792	SIC 3900-3939
SIC 3990-3999	SIC 5000-5999	SIC 7200-7299
SIC 7600-7699		

**FF2** Manufacturing, Energy, and Utilities

SIC 2520-2589	SIC 2600-2699	SIC 2750-2769
SIC 2800-2829	SIC 2840-2899	SIC 3000-3099
SIC 3200-3569	SIC 3580-3629	SIC 3700-3709
SIC 3712-3713	SIC 3715-3715	SIC 3717-3749
SIC 3752-3791	SIC 3793-3799	SIC 3830-3839
SIC 3860-3899	SIC 1200-1399	SIC 2900-2999
SIC 4900-4949		

**FF3** High-tech, Business Equipment, Telephone and Television Transmission

SIC 3570-3579	SIC 3622-3622	SIC 3660-3692
SIC 3694-3699	SIC 3810-3839	SIC 7370-7372
SIC 7373-7373	SIC 7374-7374	SIC 7375-7375
SIC 7376-7376	SIC 7377-7377	SIC 7378-7378
SIC 7379-7379	SIC 7391-7391	SIC 8730-8734
SIC 4800-4899		

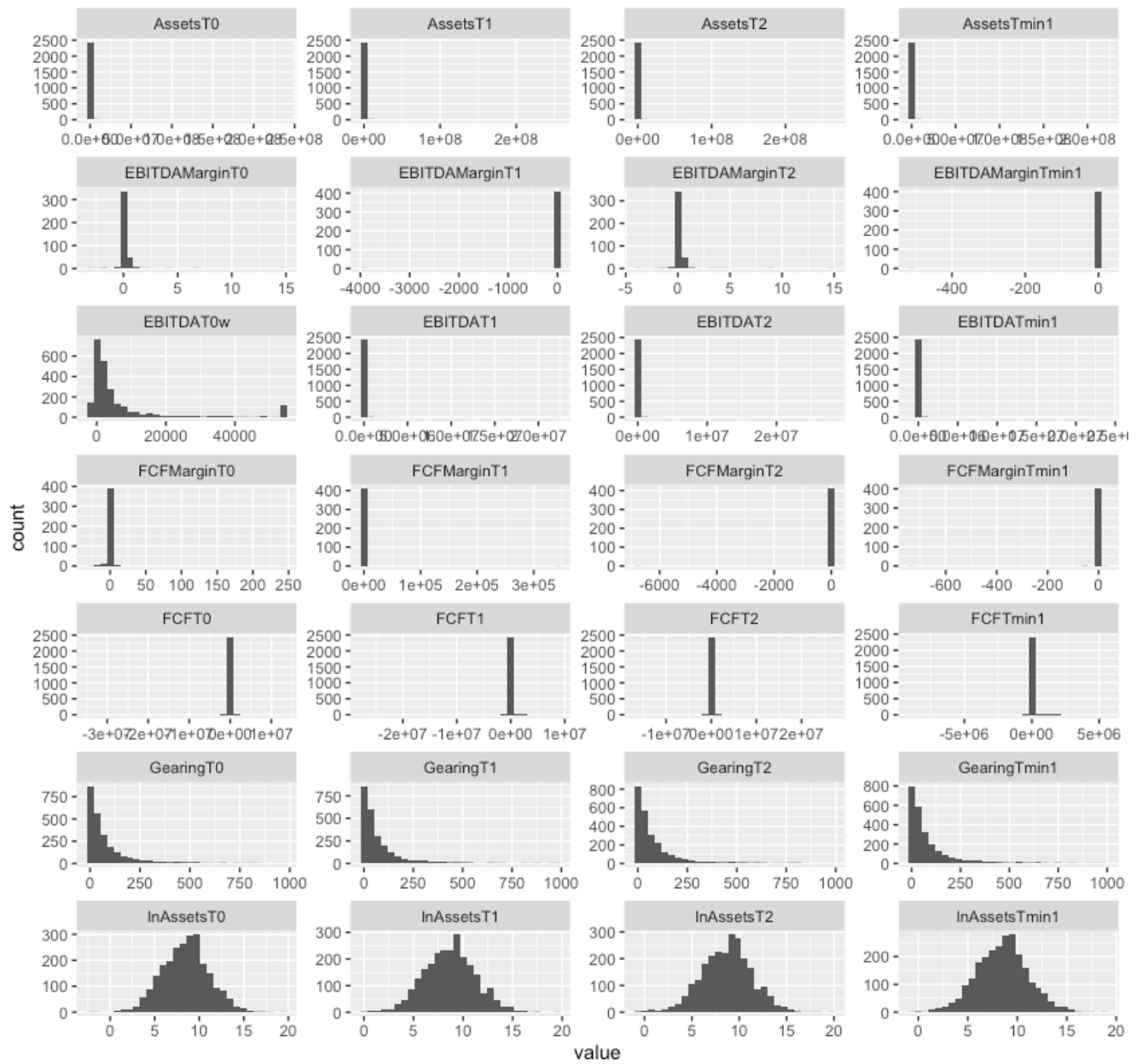
**FF4** Healthcare, Medical Equipment, and Drugs

SIC 2830-2839	SIC 3693-3693	SIC 3840-3859
SIC 8000-8099		

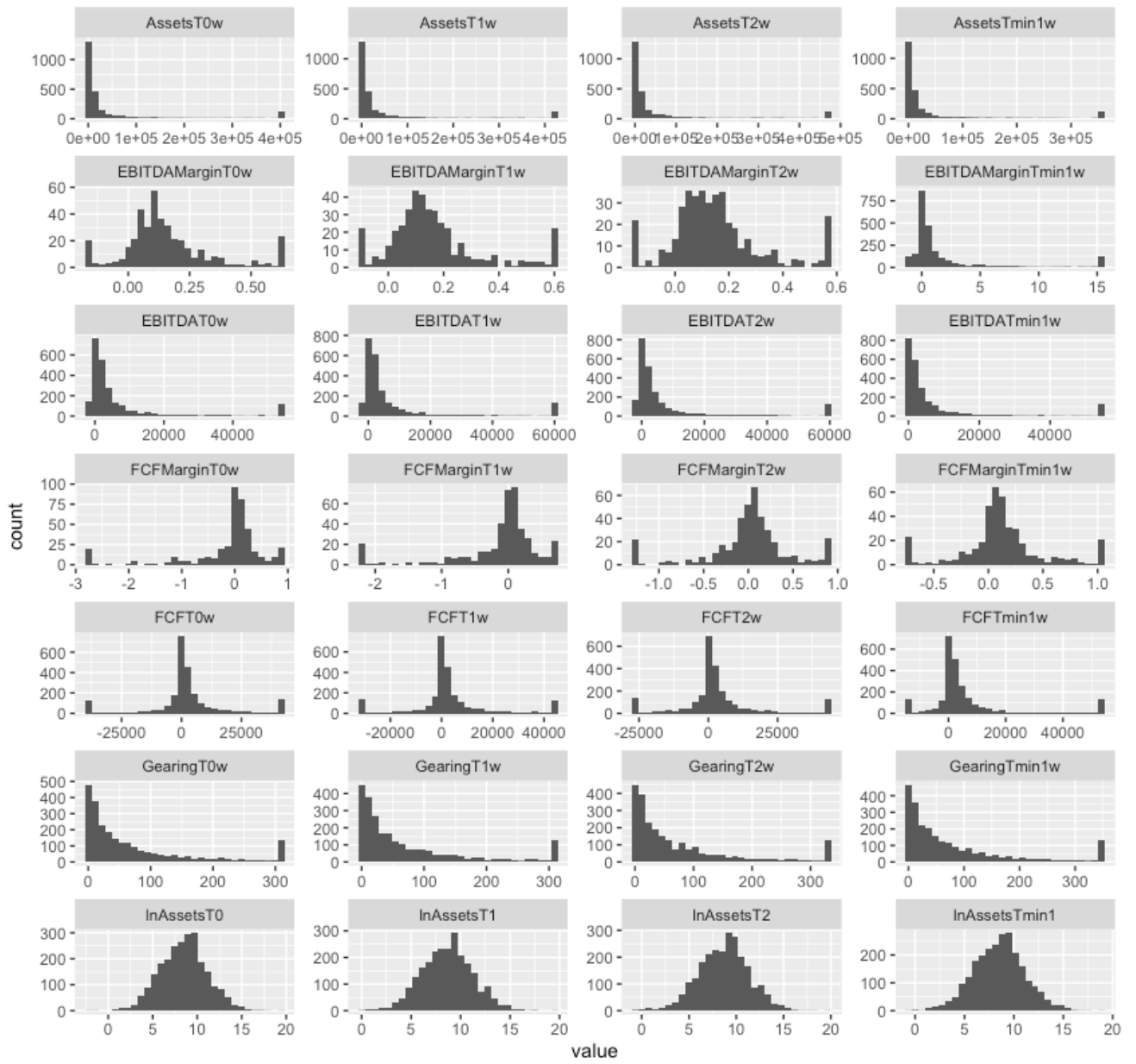
**FF5** Other (Mines, Construction, Building Management, Transportation, Hotels, Business Services, Entertainment, Finance)

## Appendix 5: Data Distribution - Effect of Winsorization

Unwinsorized data



# Winsorized data





**Appendix 6: Tests on absolute size quartile development between treatment and control group pre- and post-buyout**

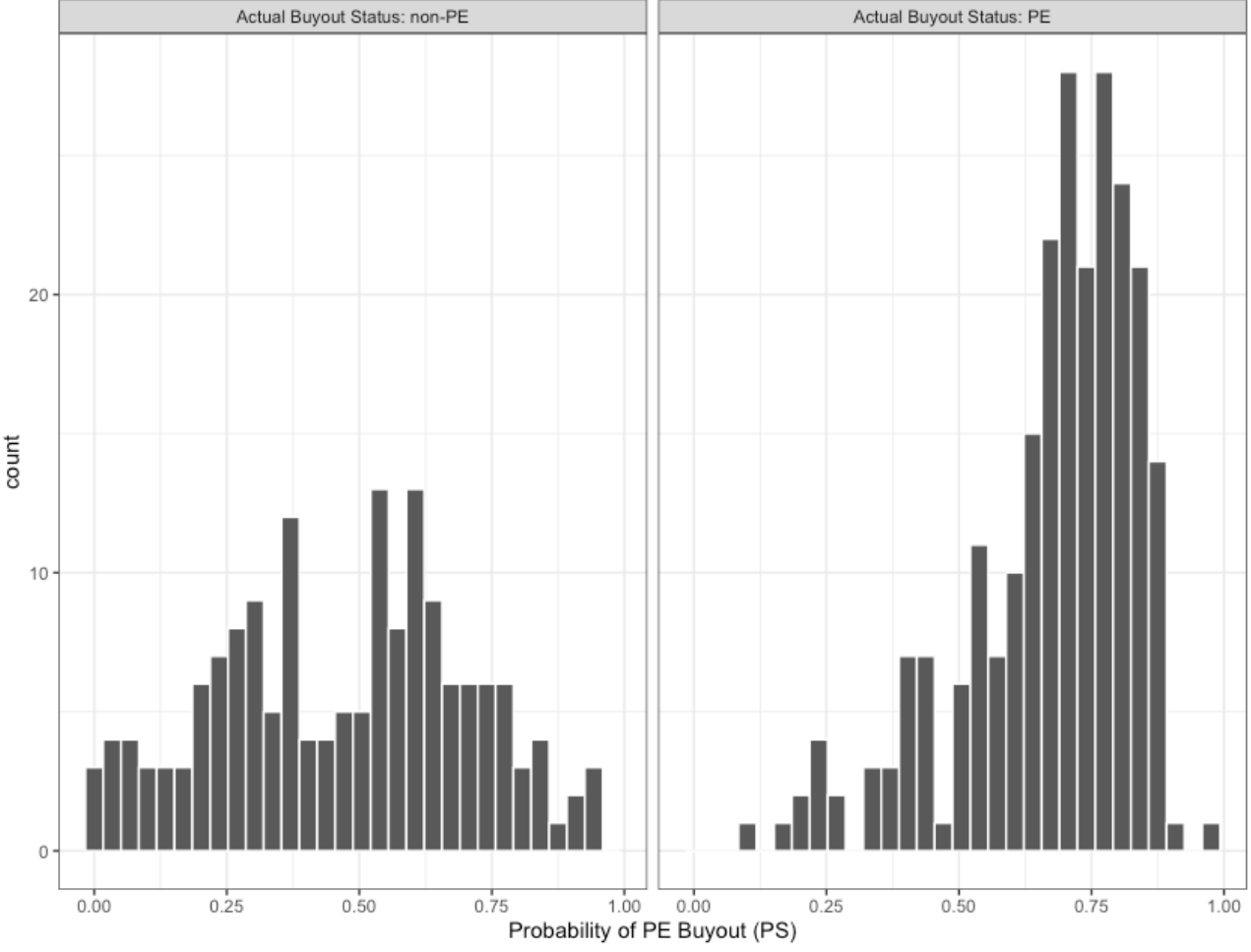
**TABLE A-2**

Quartile Comparison: Control Group in parentheses, T+2 in *italics*. Figures stated in TEUR unless denoted otherwise (except for lnAssets). Statistically significant difference in means, as tested by t test on a 5% significance level, is denoted by an asterisk (\*).

KPI	T Tests on KPI Quartiles			
	Q1	Q2	Q3	Q4
EBITDA	705.54 (-29.00) *	3,015.44 (1,034.54) *	7,190.01 (3,031.53) *	31,562.54 (22,580.03) *
	<i>364.77</i> (-128.67) *	<i>2,507.78</i> (865.64) *	<i>7,250.06</i> (2,928.00) *	<i>33,328.02</i> (22,749.05) *
EBITDA Margin	-11.57% (-42.58%) *	8.82% (22.61%) *	21.04% (107.01%) *	43.67% (889.85%) *
	<i>-8.98%</i> (-39.35%) *	<i>8.94%</i> (9.25%)	<i>16.15%</i> (16.65%)	<i>37.14%</i> (406.20%) *
FCF	-6,010.35 (-4,518.57) *	1,743.85 (650.86) *	5,834.24 (2,856.50) *	28,061.79 (21,973.50) *
	<i>-12,157.68</i> (-7,050.19) *	<i>83.68</i> (229.24)	<i>4,269.15</i> (2,381.09) *	<i>25,560.38</i> (21,025.66) *
FCF Margin	-12.78% (-64.98%) *	8.30% (15.10%) *	21.78% (114.13%) *	49.37% (93.18%) *
	<i>-24.76%</i> (-149.37%) *	<i>0.00%</i> (4.40%) *	<i>10.18%</i> (58.62%) *	<i>36.01%</i> (187.82%) *
Sales	6,542.61 (13,868.29) *	18,827.90 (54,594.44) *	49,065.87 (196,074.00) *	180,237.10 (236,418.00) **
	<i>7,978.80</i> (13,184.95) *	<i>24,270.85</i> (54,328.54) *	<i>57,114.31</i> (208,264.40) *	<i>198,205.40</i> (245,473.00)
lnAssets	8.71 (4.93) *	9.76 (7.21) *	10.75 (8.80) *	12.46 (11.40) *
	<i>8.99</i> (5.09) *	<i>10.18</i> (7.42) *	<i>11.05</i> (9.02) *	<i>12.66</i> (11.62) *
Leverage	3.78% (3.25%)	26.66% (23.69%) *	77.75% (67.50%) *	247.34% (216.20%) *
	<i>6.54%</i> (3.07%) *	<i>36.17%</i> (20.57%) *	<i>84.59%</i> (60.89%) *	<i>237.90%</i> (209.98%) *

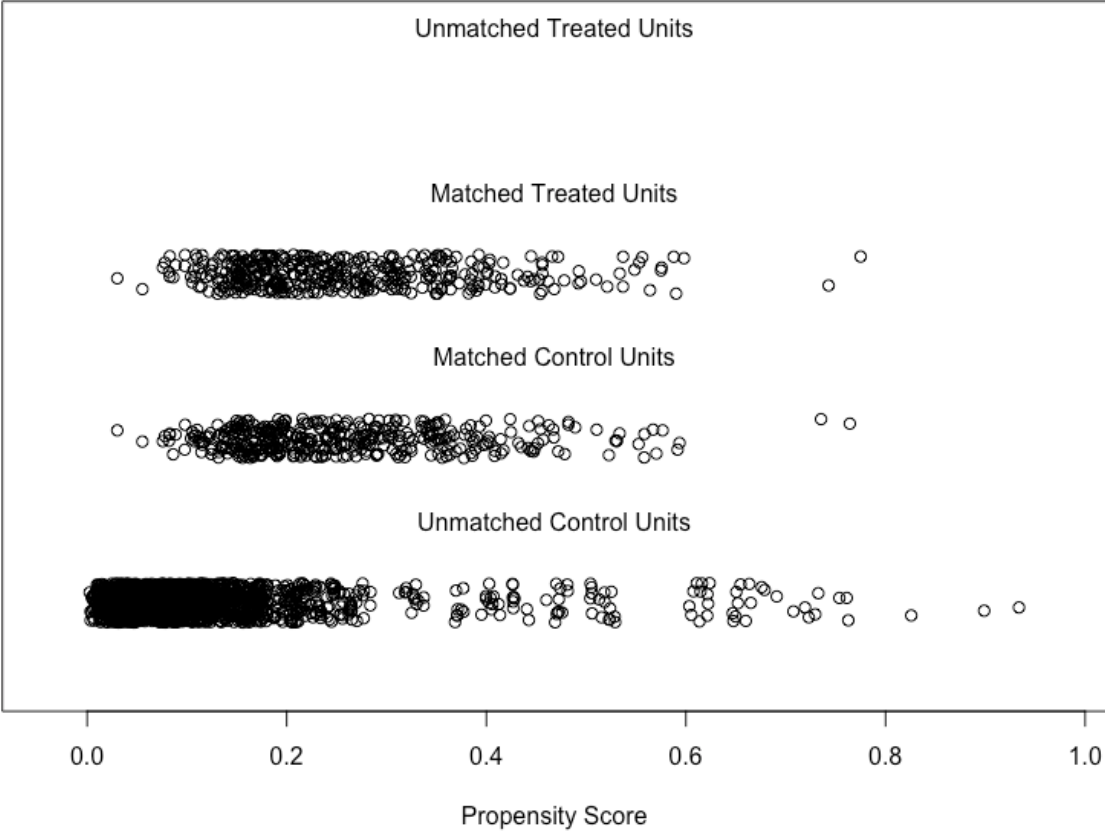


**Appendix 7: Propensity Score Matching Area of Common Support of Treatment and Control Group**

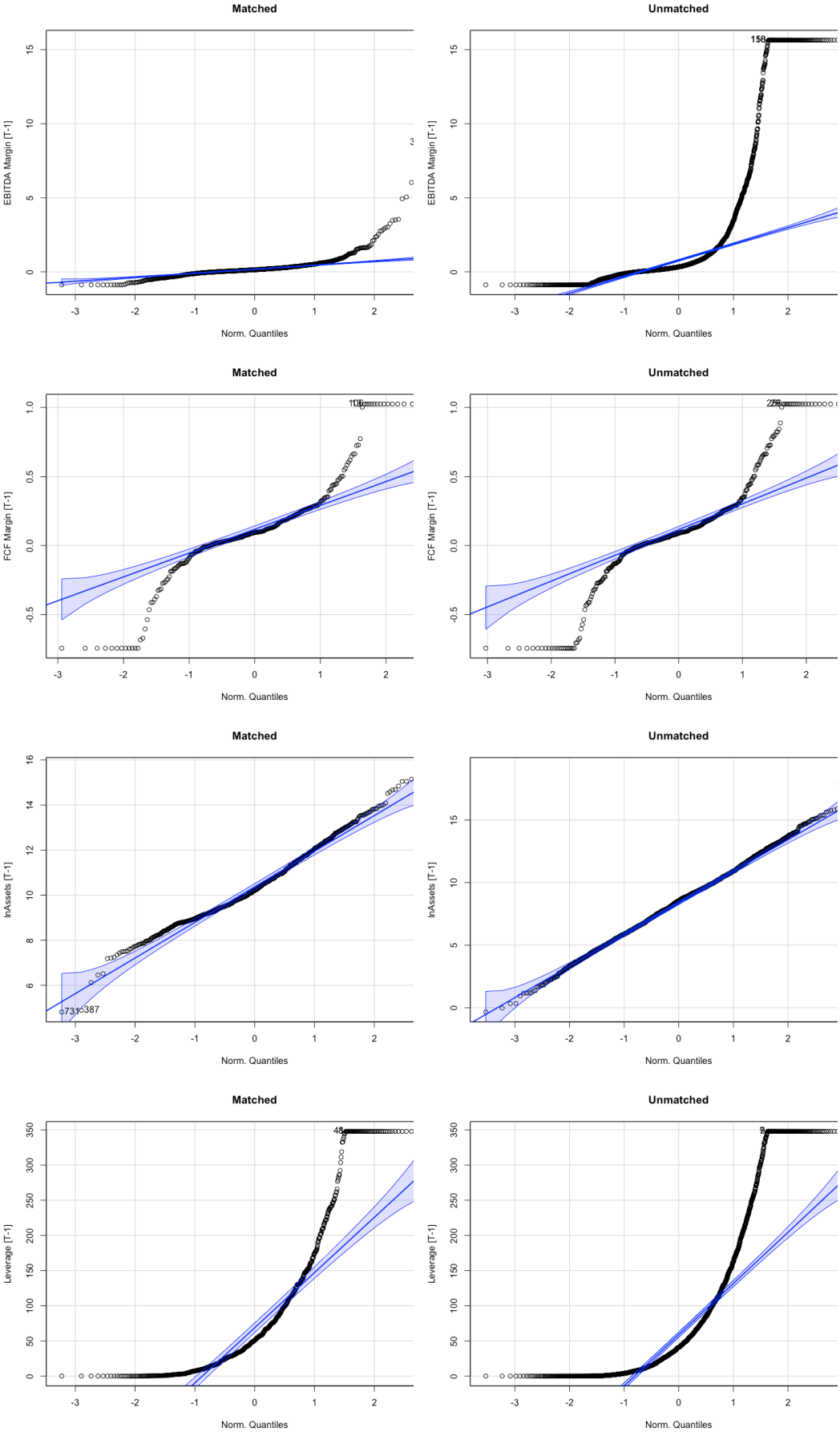


**Appendix 8:** Visual Assessment of PSM Quality with Group Distribution Balance

**Distribution of Propensity Scores**



# Appendix 9: PSM Covariate Balance Inspection





## Appendix 10: Regression Model Equations

Logistic regression models used for propensity score matching - PS estimation

$$PS = \beta_0 + \beta_1 * (EBITDA\ Margin_{T-1}) + \beta_2 * (FCF\ Margin_{T-1}) + \beta_3 * (lnAssets_{T-1}) + \beta_4 * (Leverage_{T-1})$$

(A1)

In this model, I have simultaneously controlled for year-, country-, industry-, and firm-fixed effects

Logistic regression models used in *Table 4*:

Models (A2) and (A3) estimate the probability  $P$  of a PE buyout given, i.e., under the stochastic condition, of a set of certain KPI levels to be considered in each model. In all cases it holds true that  $P(PE\ Buyout | x) \in \{0, 1\} \forall i \wedge t \in \{2013, 2019\}$ .

Model (A2) displayed as model I:

$$P(PE\ Buyout | EBITDA\ Margin\ Quartile_{T-1}, FCF\ Margin\ Quartile_{T-1}) = 1 - (1 + \exp(\beta_1 * EBITDA\ Margin\ Quartile_{T-1} + \beta_2 * FCF\ Margin\ Quartile_{T-1} + \varepsilon))^{-1} \quad (A2)$$

Model (A3) displayed as model II, only including  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$ , and model II including all coefficients:

$$P(PE\ Buyout | EBITDA\ Margin_{T-1}, EBITDA\ Margin\ Quartile_{T-1}, EBITDA\ Quartile_{T-1}, lnAssets\ Quartile_{T-1}, Leverage\ Quartile_{T-1}, Sales\ Quartile_{T-1}) = 1 - (1 + \exp(\beta_1 * EBITDA\ Margin_{T-1} + \beta_2 * EBITDA\ Margin\ Quartile_{T-1} + \beta_3 * EBITDA\ Quartile_{T-1} + \beta_4 * lnAssets\ Quartile_{T-1} + \beta_5 * Leverage\ Quartile_{T-1} + \beta_6 * Sales\ Quartile_{T-1} + \varepsilon))^{-1}$$

(A3)

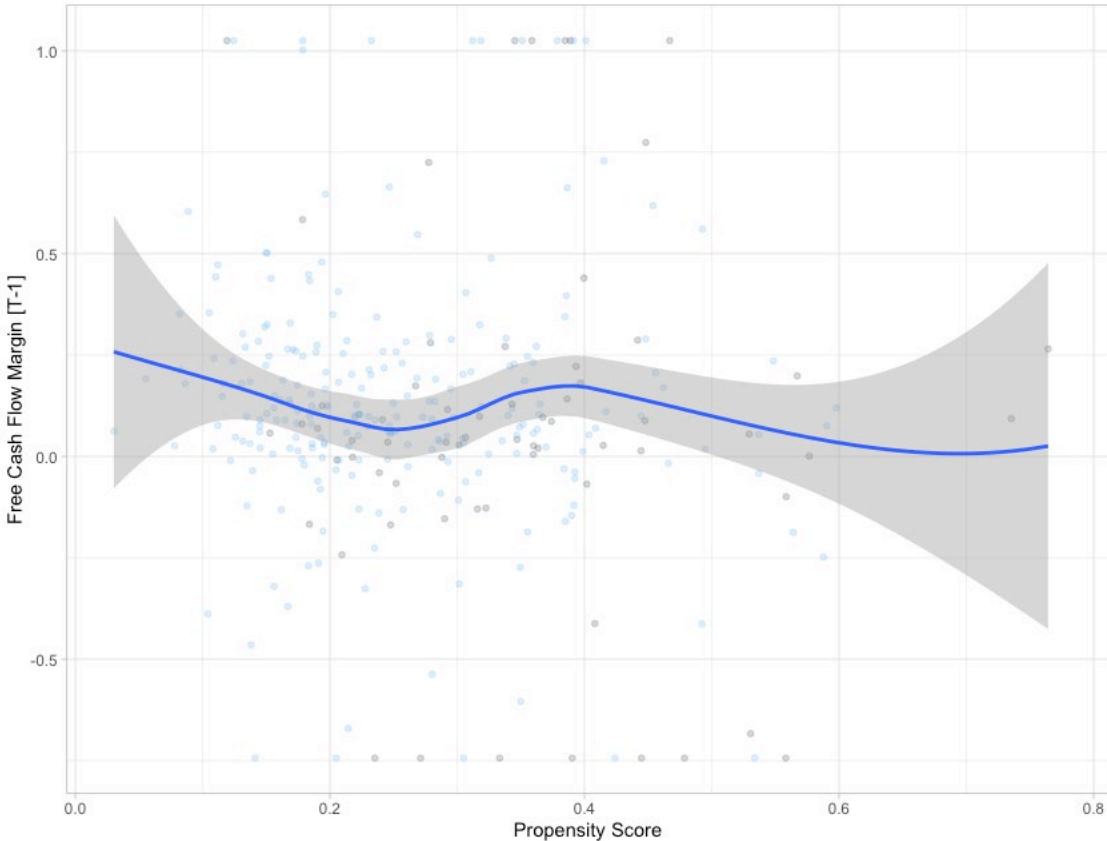
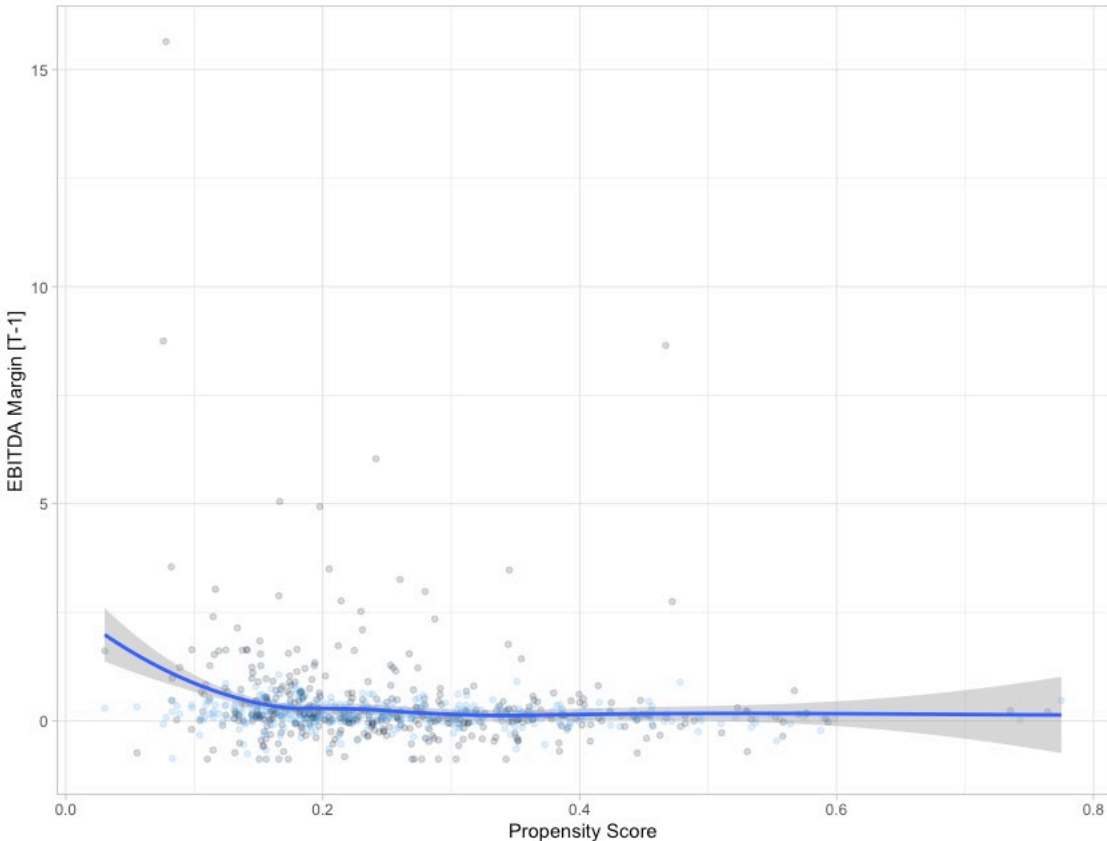
Model (A4) displayed as model IV, only including  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$ , and model V including all coefficients.

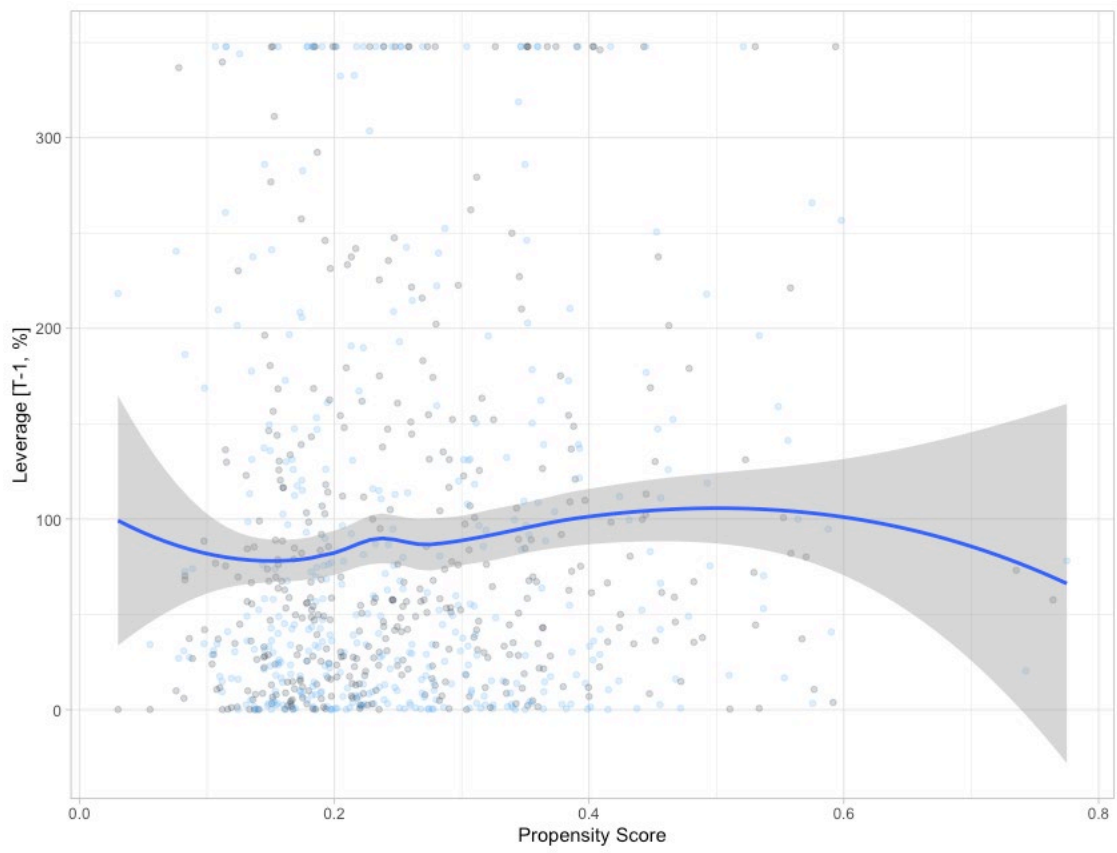
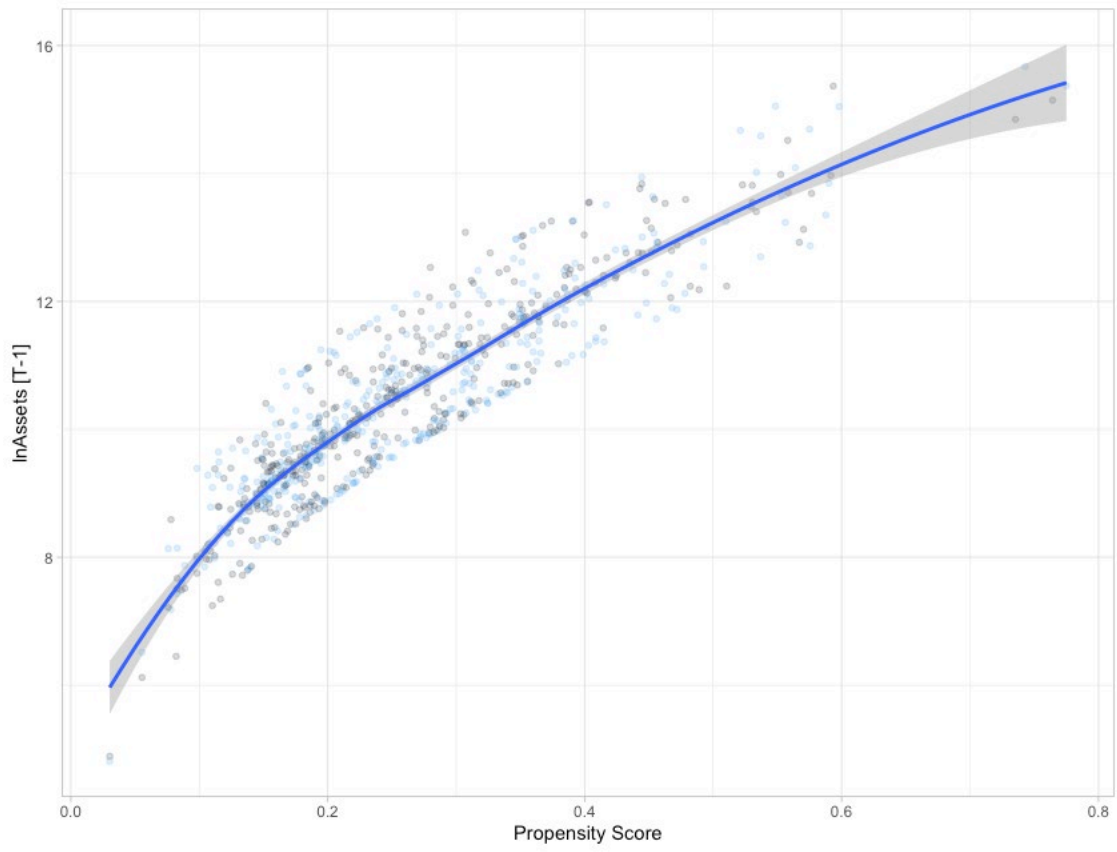
$$P(PE\ Buyout | FCF\ Margin_{T-1}, FCF\ Margin\ Quartile_{T-1}, FCF\ Quartile_{T-1},$$

$$\begin{aligned}
& \ln \text{Assets Quartile}_{T-1}, \text{Leverage Quartile}_{T-1}, \text{Sales Quartile}_{T-1}) \\
& = 1 - (1 + \exp(\beta_1 * \text{FCF Margin}_{T-1} + \beta_2 * \text{FCF Margin Quartile}_{T-1} + \\
& \beta_3 * \text{FCF Quartile}_{T-1} + \beta_4 * \ln \text{Assets Quartile}_{T-1} \\
& \quad + \beta_5 * \text{Leverage Quartile}_{T-1} + \\
& \beta_6 * \text{Sales Quartile}_{T-1} + \varepsilon))^{-1} \\
& \quad \quad \quad (\text{A4})
\end{aligned}$$

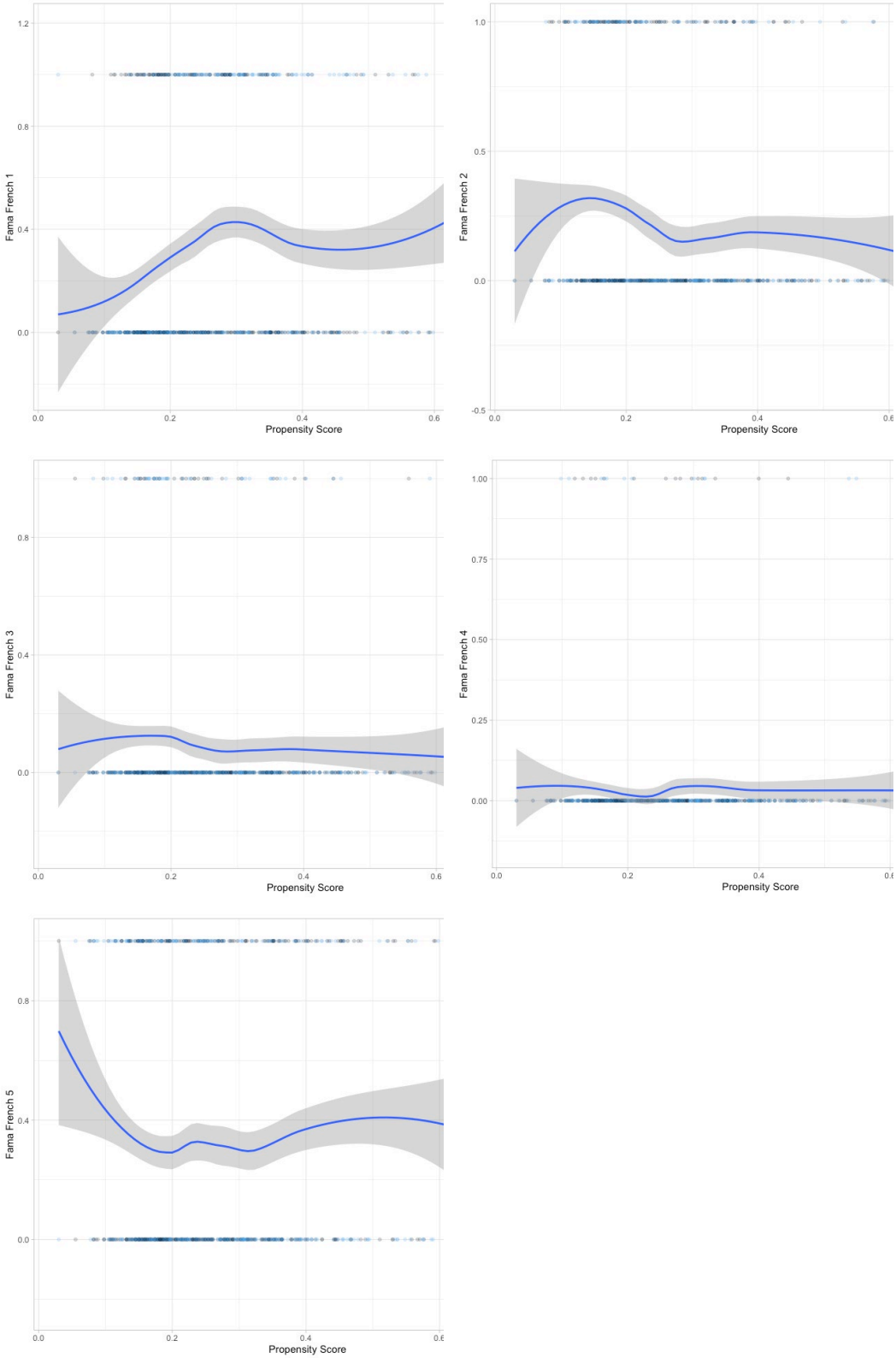
For model VI in *Table 4*, both equations (A3) and (A4) are combined, accounting for both EBITDA and FCF effects being reflected in buyout likelihood.

**Appendix 11: Propensity Score Distribution on Buyout Probability**



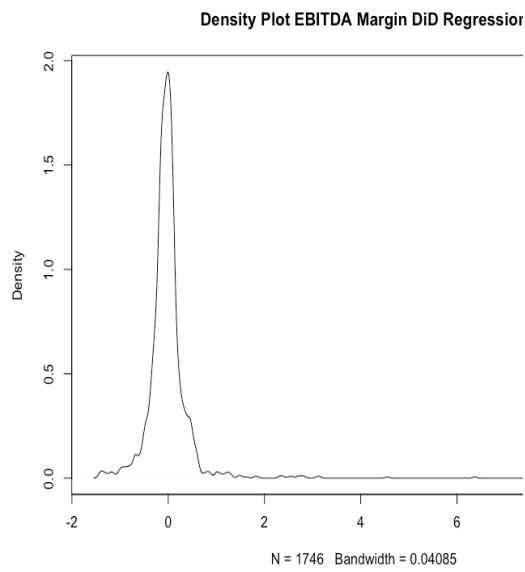
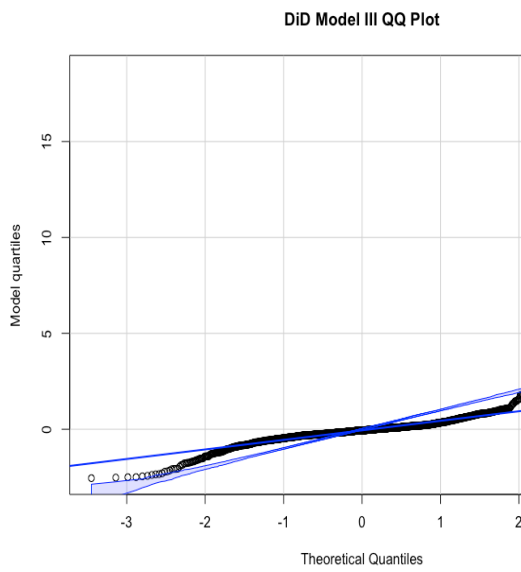
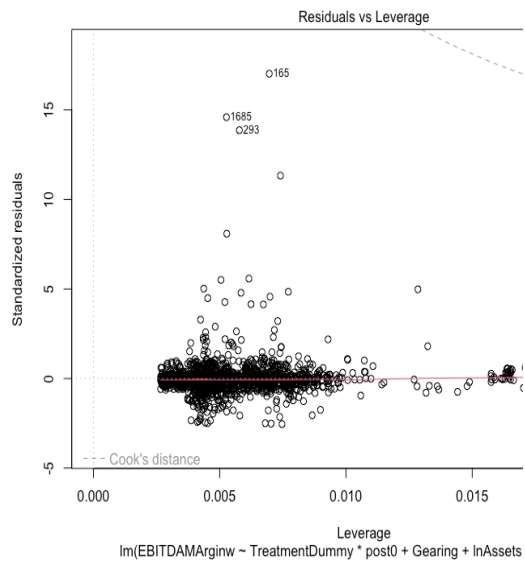
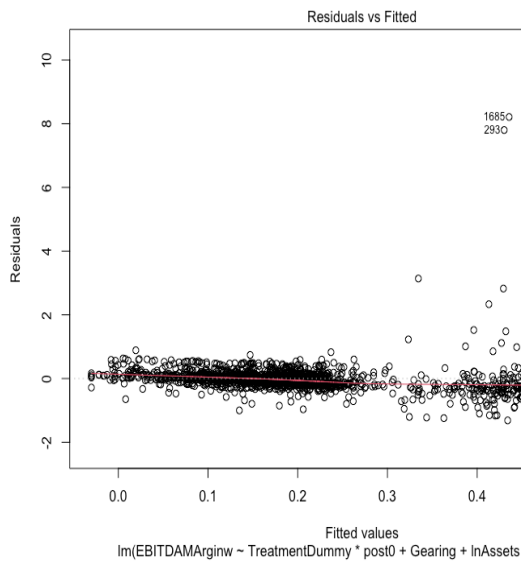


# Appendix 12: PSM Estimation on Fama French Industry Classification

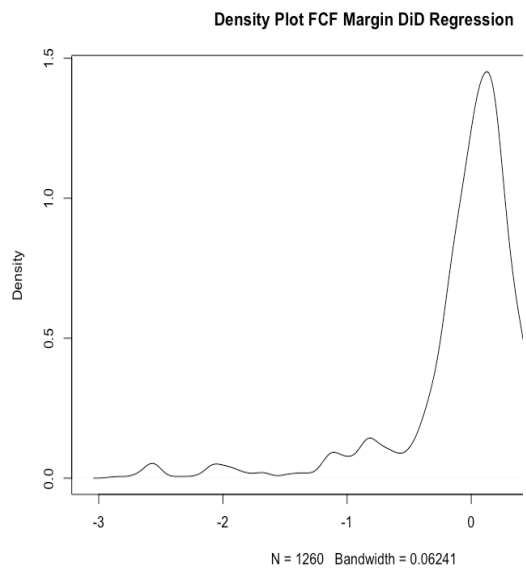
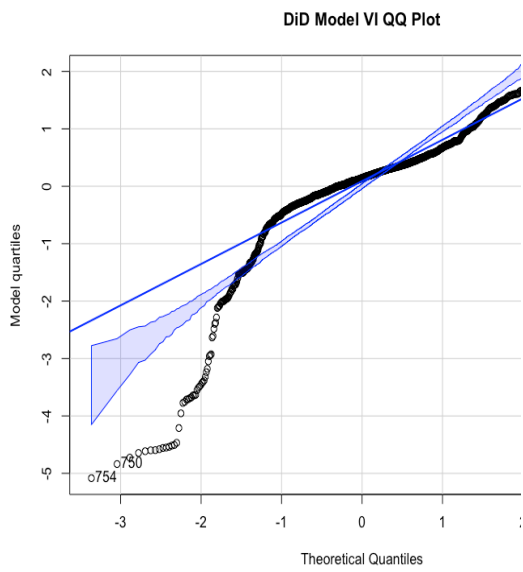
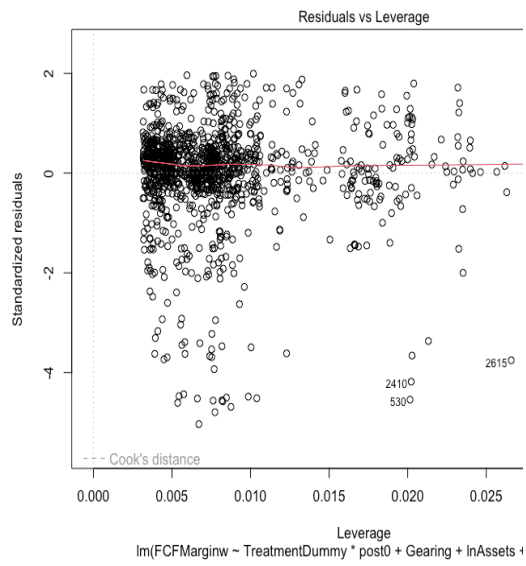
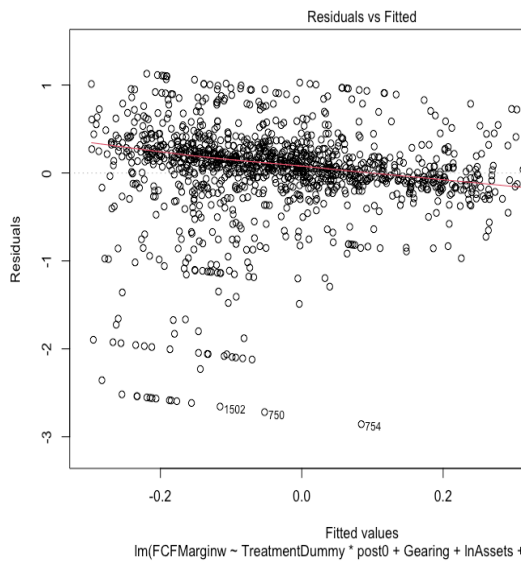




# Appendix 13: Tests on Robustness and Sensitivity Analysis: EBITDA Margin DiD Regression Residuals



# Appendix 14: Tests on Robustness and Sensitivity Analysis: FCF Margin DiD Regression Residuals



## Appendix 15: Country-level Sensitivity Analysis on DiD Regression Models

**TABLE A-5**

DiD regression sensitivity analysis through **country level cross validation**. Every model excludes transactions from one country. On each subset the same DiD model is performed. Model I excludes AT, model II DE, model III FR, model IV UK, and model V IT. The regression is performed with EBITDA margin and FCF margin as the dependent variables, regression output for FCF margin is represented in *italics*.

The level of significance is represented by an asterix where the explanatory variables are statistically significant at a 0.1% (\*\*\*), 1% (\*\*), 5% (\*), or 10% (x) confidence interval.

KPI	DiD Im Regression Models: Sensitivity Analysis				
	I	II	III	IV	V
Treatment	-0.20***	-0.30***	-0.30***	-0.27***	-0.28***
	<i>-0.10</i>	<i>-0.13</i>	<i>-0.05</i>	<i>-0.06</i>	<i>-0.12</i>
Post Buyout	-0.26***	-0.24***	-0.28***	-0.23***	-0.26***
	<i>-0.25**</i>	<i>-0.30***</i>	<i>-0.18<sup>x</sup></i>	<i>-0.23**</i>	<i>-0.25**</i>
Post Buyout Treatment	0.28***	0.26***	0.30***	0.26***	0.24**
	<i>0.05</i>	<i>0.09</i>	<i>-0.08</i>	<i>0.02</i>	<i>0.15</i>
Leverage	0.00**	0.00***	0.00*	0.00*	0.00
	<i>0.00</i>	<i>0.00</i>	<i>0.00*</i>	<i>0.00</i>	<i>0.00</i>
lnAssets	-0.02*	-0.01	-0.02	-0.02**	-0.04**
	<i>-0.07***</i>	<i>-0.07***</i>	<i>-0.06***</i>	<i>-0.07***</i>	<i>-0.05**</i>
R <sup>2</sup>	5.62%	5.21%	4.93%	5.99%	5.74%
	<i>5.48%</i>	<i>6.22%</i>	<i>6.06%</i>	<i>5.61%</i>	<i>4.41%</i>
RSME	0.57	0.56	0.63	0.47	0.59
	<i>0.57</i>	<i>0.58</i>	<i>0.56</i>	<i>0.56</i>	<i>0.54</i>
n	785	691	605	551	556

## Appendix 16: Industry-level Sensitivity Analysis on DiD Regression Models

**TABLE A-5**

DiD regression sensitivity analysis through **industry level cross validation**. Every model excludes transactions from one industry. On each subset the same DiD model is performed. Model I excludes FF1, model II FF2, model III FF3, model IV FF4, and model V FF5. The regression is performed with EBITDA margin and FCF margin as the dependent variables, regression output for FCF margin is represented in *italics*. For all models, I also controlling for Fama French industry classification, buyout year, and country.

The level of significance is represented by an asterix where the explanatory variables are statistically significant at a 0.1% (\*\*\*), 1% (\*\*), 5% (\*), or 10% (x) confidence interval.

KPI	DiD Im Regression Models: Sensitivity Analysis				
	I	II	III	IV	V
Treatment	-0.23***	-0.31***	-0.26***	-0.31***	-0.40***
	<i>-0.03</i>	<i>-0.03</i>	<i>-0.07</i>	<i>-0.08</i>	<i>-0.07</i>
Post Buyout	-0.16***	-0.27***	-0.19***	-0.26***	-0.35***
	<i>-0.02**</i>	<i>-0.26**</i>	<i>-0.24**</i>	<i>-0.26***</i>	<i>-25**</i>
Post Buyout Treatment	0.24***	0.32***	0.23***	0.30***	0.37***
	<i>0.03</i>	<i>0.04</i>	<i>0.04</i>	<i>0.07</i>	<i>0.06</i>
Leverage	0.00**	0.00*	0.00**	0.00**	0.00**
	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>
lnAssets	-0.01	-0.03*	-0.02 <sup>x</sup>	-0.03**	-0.03*
	<i>-0.06***</i>	<i>-0.07***</i>	<i>-0.07***</i>	<i>-0.07***</i>	<i>-0.06***</i>
R <sup>2</sup>	5.19%	6.43%	6.02%	6.96%	9.75%
	<i>6.11%</i>	<i>7.18%</i>	<i>7.48%</i>	<i>7.02%</i>	<i>6.49%</i>
RSME	0.57	0.60	0.52	0.67	0.58
	<i>0.61</i>	<i>0.60</i>	<i>0.56</i>	<i>0.55</i>	<i>0.52</i>
n	563	622	703	771	529