

The Berlin Stock Exchange in Imperial Germany – a Market for New Technology?

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Online appendix

I. *Overview and descriptive statistics*

General information about the IPOs of the period from 1897 to 1913 were taken from the *Vierteljahrshefte zur Statistik des Deutschen Reichs* (see Lehmann 2014). Data about the IPOs that took place between 1892 and 1896 have been collected by Burhop (2011) using various contemporary sources. Firm specific variables were taken from the *Salinger Börsenhandbuch* and from the *Handbuch der deutschen Aktiengesellschaften* (Handbook of German joint-stock companies). Prices and dividends were taken from the *Berliner Börsenzeitung*. Our source for collecting patent data is the *Verzeichnis der im Vorjahre erteilten Patente* that was annually published by the Imperial patent office.

Table A1 provides a general overview of the data set, variables and all subsamples that were used in the analysis. The variables were calculated as follows: “*Size of the issue*” is the overall nominal share value in Mill. Mark. “*Age*” is the age of a firm in years since its incorporation, “*big four banks*” is a dummy variable that is equal to one if at least one of the four largest banks, i.e. *Deutsche Bank*, *Dresdner Bank*, *Discontogesellschaft* or *Darmstädter Bank* (see Lehmann 2014) was part of the underwriter consortium. This variable is supposed to capture the special reputation of the lead underwriter and the dominance of the large universal banks. “*Distance*” is the geographical distance between the headquarters of a firm and the Berlin stock exchange in 100 kilometers. This variable is supposed to capture potential information asymmetries. “*Trading*” is calculated as the percentage share of observed end of the year prices in the five calendar years after the IPO took place in percentage of potentially observable prices. For example, a firm that was issued in 1909 and for which we observe end of the year prices in 1909, 1910, 1911, 1912 and 1913, trading would be equal to one. If we observe only three prices, trading would be equal to 0.6. If an IPO was issued in 1912, we only need to observe the end of year price in 1912 and 1913 in order to reach the trading value one.

Table A1 shows that the subsamples are only slightly different and are clearly representative of the overall sample. Panel 1 provides the overview of the overall sample including all 474 IPOs. Panel 2 gives an overview of the sample that is used in the regressions in which the first trading price was observed within the first four weeks after the official IPO. Panel 3 shows the IPOs for which we could calculate the initial return because we know an offering price. Panel 4 presents those IPOs for which we cannot observe an offering price. Instead of publicly offering all shares before the first day of trading, banks could start issue by privately placing shares. We assume that all IPOs for which we cannot observe the offering price were preceded by private placement (see Moral 1914, p. 49). In this sample, for which we do not run separate regressions, innovative start-ups are slightly underrepresented. Panel 5 provides an overview of the IPOs which are part of the unbalanced panel (Tables A18-A20), i.e. Panel 1 minus firms that did not survive the first five years or were not traded regularly (trading below 0.5).

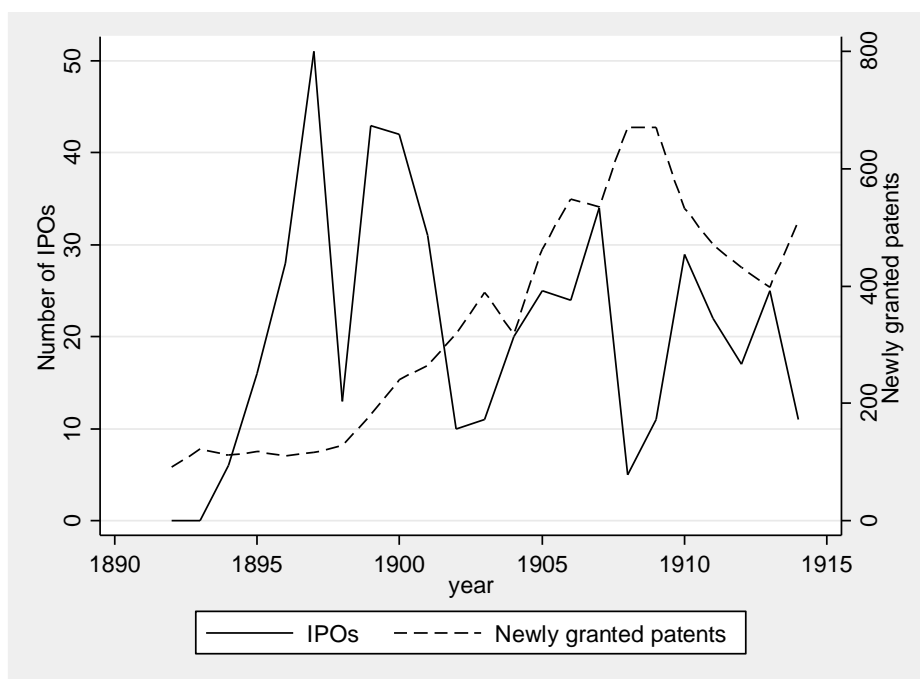
Table A1: Descriptive statistics for various subsamples of IPOs

Firm type	Number	Percent	Size of the issue	Age	Big four banks	Distance	Trading	Number of delisted firms	Percentage share of firms that survived the first 5 years after IPO
Panel 1: All IPOs									
Innovative start-ups	34	7.2	2.8	5.8	0.2	2.5	0.94	1	97.1
Buddenbrooks	67	14.1	2.9	9.2	0.3	3.0	0.93	3	95.5
Permanently innovative	70	14.8	5.2	7.2	0.3	2.7	0.90	1	98.6
Non-innovative	303	63.9	4.3	6.2	0.2	2.5	0.91	10	96.7
Total	474	100	4.2	6.7	0.3	2.6	0.91	15	96.8
Panel 2: Trading price observable within 4 weeks after IPO									
Innovative start-ups	29	6.7	2.8	6.3	0.2	2.6	0.92	1	96.6
Buddenbrooks	60	14.0	2.7	8.6	0.3	3.1	0.93	3	95.0
Permanently innovative	64	14.9	5.4	7.6	0.3	2.6	0.89	1	98.4
Non-innovative	277	64.4	4.5	6.3	0.2	2.5	0.91	10	96.4
Total	430	100	4.3	6.8	0.3	2.6	0.91	15	96.5

Table A1 continued

Firm type	Number	Percent	Size of the issue	Age	Big four banks	Distance	Trading	Number of delisted firms	Percentage share of firms that survived the first 5 years after IPO
Panel 3: With offering price (IR observable)									
Innovative start-ups	26	8.9	2.9	6.5	0.3	2.6	0.92	1	96.2
Buddenbrooks	36	12.33	3.0	6.6	0.3	3.0	0.94	0	100.0
Permanently innovative Firms without patents	42	14.38	6.6	5.8	0.3	2.5	0.86	1	97.6
Firms without patents	188	64.38	4.8	5.2	0.2	2.6	0.92	5	97.3
Total	292	100	4.7	5.6	0.3	2.7	0.91	7	97.6
Panel 4: Firms without offering price									
Innovative start-ups	3	2.1	1.9	4.7	0.0	2.6	1.00	0	100.0
Buddenbrooks	25	17.7	2.9	13.5	0.3	3.1	0.91	3	88.0
Permanently innovative Firms without patents	22	15.6	3.1	11.0	0.4	2.8	0.95	0	100.0
Firms without patents	91	64.5	3.9	8.4	0.3	2.3	0.90	5	94.5
Total	141	100.0	3.5	9.6	0.3	2.5	0.91	8	94.3
Panel 5: Excluding firms that did not survive the first 5 years or were not traded regularly (trading <0.5)									
Innovative start-ups	32	7.4	2.7	6.1	0.3	2.5	0.98	0	100.0
Buddenbrooks	59	13.7	3.0	9.2	0.3	3.0	0.98	0	100.0
Permanently innovative Firms without patents	65	15.1	5.2	7.6	0.3	2.6	0.97	0	100.0
Firms without patents	275	63.8	4.4	6.2	0.2	2.5	0.97	0	100.0
Total	431	100.0	4.2	6.8	0.3	2.6	0.97	0	100.0

Figure A1: IPOs and newly granted patents over time



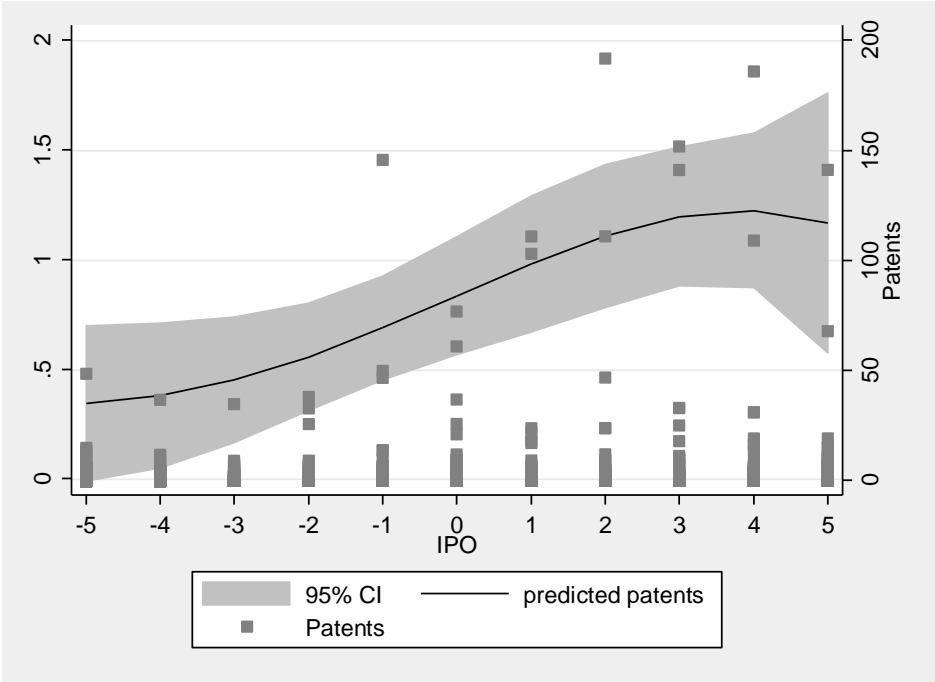
Source: see text

Table A2: Patenting activity before and after the IPO event

	all years (1877-1913)		just -5/+5 years around IPO	
	Number	Percent	Number	Percent
Firms with more patents after going public	101	21.31	88	18.57
Firms with less patents after going public	82	17.3	51	10.76
Same Number of Patents (incl. 0 Patents)	291	61.39	335	70.68
Total	474	100	474	100

Source: see text

Figure A2: Patent activity 5 years before and 5 years after the IPO event



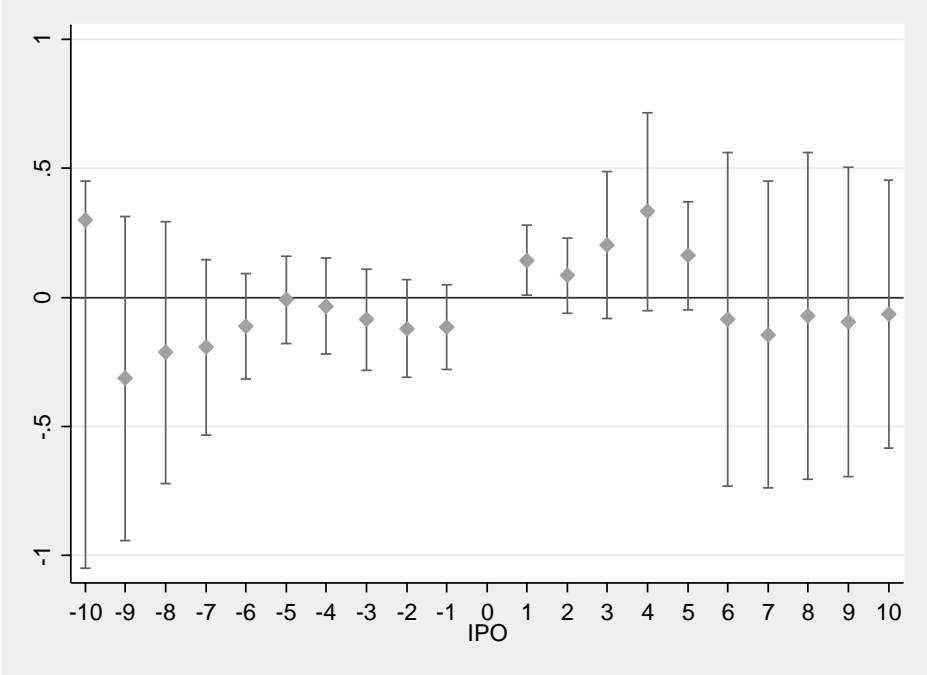
Source: see text

Table A3: Patenting patterns 10 years before and 10 years after the IPO event

Dependent variable	(1)	(2)	(3)
	Number of newly granted patents		
	Pooled	Firm fixed effects	
Sample	year of IPO<1904	just firms with patents and year of IPO<1904	
IPO-10 years	-0.317 (0.271)	-0.301 (0.382)	-0.821 (0.978)
IPO-9 years	-0.365 (0.277)	-0.315 (0.320)	-0.844 (0.818)
IPO-8 years	-0.266 (0.232)	-0.214 (0.258)	-0.588 (0.673)
IPO-7 years	-0.292 (0.206)	-0.193 (0.173)	-0.536 (0.453)
IPO-6 years	-0.232 (0.140)	-0.113 (0.104)	-0.336 (0.282)
IPO- 5 years	-0.122 (0.116)	-0.00903 (0.0859)	-0.0439 (0.226)
IPO- 4 years	-0.151 (0.158)	-0.0335 (0.0941)	-0.0910 (0.246)
IPO- 3 years	-0.177 (0.163)	-0.0869 (0.0996)	-0.227 (0.250)
IPO- 2 years	-0.196 (0.150)	-0.122 (0.0965)	-0.302 (0.236)
IPO- 1 years	-0.159 (0.117)	-0.115 (0.0832)	-0.296 (0.210)
IPO + 1 years	0.177 (0.102)	0.144 (0.0697)	0.385 (0.185)
IPO + 2 years	0.177 (0.137)	0.0846 (0.0739)	0.220 (0.189)
IPO + 3 years	0.399 (0.288)	0.203 (0.144)	0.511 (0.358)
IPO + 4 years	0.605 (0.413)	0.332 (0.195)	0.877 (0.502)
IPO + 5 years	0.502 (0.253)	0.162 (0.107)	0.433 (0.272)
IPO+6 years	0.325 (0.130)	-0.0857 (0.328)	-0.191 (0.831)
IPO+7 years	0.317 (0.130)	-0.145 (0.303)	-0.320 (0.746)
IPO+8 years	0.424 (0.159)	-0.0721 (0.321)	-0.195 (0.832)
IPO+9years	0.417 (0.190)	-0.0948 (0.305)	-0.250 (0.808)
IPO+10 years	0.476 (0.249)	-0.0648 (0.264)	-0.140 (0.666)
Year fixed effects	y	y	y
Observations	5,691	5,691	2,247
R-squared	0.003	0.012	0.031
Number of firms	271	271	107

Note: reported standard errors are clustered by firm. Clustered standard errors in parentheses

Figure A3: Newly granted patents 10 years before and 10 years after the IPO event (Beta-coefficients and 95% confidence intervals of year dummies, corresponds to Table A3, regression (2))



II. *Most innovative firms*

In Table 3 of the main paper, we run panel regressions with firm fixed effects to elaborate whether listed firms had higher patent activities. While the first columns are based on sample 1 of Table A1, column 3 relates to a reduced sample of the data set provided by Degner (2009). Table A4 provides a descriptive overview of the sample from Degner (sample 1) in comparison with our original IPO sample (sample 2). We also provide a further sample which is supposed to give an impression of differences between listed and non-listed firms for a group of firms that were not preselected as particular innovative (Sample 3). Sample 3 comprises 328 German firms that were members of the association of German machine toolmakers between 1891 and 1914 or were identified as machine toolmakers in contemporary trade journals (see Richter and Streb, 2011). Machine tool makers that went public in Berlin before the First World War had on average three times as many valuable patents than the machine toolmakers that were not listed in Berlin. This observation is again evidence for our hypothesis that innovative firms, more than other firms, strived for equity capital on the Berlin stock exchange.

Table A4. Descriptive statistics of the three firm samples

Firm type	Number	In percent of total sample	Average number of valuable patents 1877-1913	st.dv
Sample 1: Most innovative firms				
Firms that remained private	774	85.0	5.1	23.5
IPOs 1877-1913	137	15.0	19.8	72.6
Total	911	100.0		
Sample 2: All IPOs 1892-1913				
All IPOs	474	100.0	0.8	4.6
Just IPOs with more than one patent	139	29.3	2.5	8.3
Just IPOs with more than one valuable patents	43	9.1	8.2	13.4
Sample 3: Tool makers				
Firms that remained private	309	94.2	0.5	1.4
IPOs 1877-1913	19	5.8	1.7	2.7
Total	328	100.0	0.5	1.5

Source: see text

III. Signaling

As stated in the main text, we scanned all the written material the *Salinger Börsenhandbuch* provided about each of the 474 IPOs that took place in the German capital between 1892 and 1913 for explicit information about patents. Table A5 provides an overview of our findings. We found that about 50 percent of the 139 firms that had at least one patent before going public promoted their IPO with a reference to their intellectual property rights. The probability that a firm used this kind of advertisement increased with the number of patents it had already received. Whereas only 25 percent of the firms with only one patent made this information public, three quarters of the firms that patented more than ten innovations mentioned their patents at the time of their IPO. Interestingly enough, we also find 19 firms that mentioned foreign patents and/or their target to apply for patents in Germany in the years following the IPO, which did not receive any patents in our observation period.

Table A5: Signaling in Salinger Börsenhandbuch

<i>Patents before IPO</i>	<i>No signal</i>	<i>Patents as signal in Salinger</i>	<i>Total</i>
No patents	316 (94.33)	19 (5.67)	335
One patent	23 (74.19)	8 (25.81)	31
2 to 5	23 (57.5)	17 (42.5)	40
6 to 10	11 (52.38)	10 (47.62)	21
More than 10	12 (25.53)	35 (74.47)	47
Total	385 81.22	89 18.78	474

Note: percent in parentheses

In order to get a better impression of patents as signal, we further collected a random sample of issues of the “*Berliner Börsenzeitung*” and counted the appearance of announcements of IPOs and SEOs (Seasoned equity offerings) and whether patents were mentioned as a signal for quality. The random sample contains the issue of every odd-numbered Monday for the years

1896, 1899, 1902, 1905 and 1908. In this sample, we find that in 15 percent of the 80 prospects patents were mentioned in order to signal quality.

Table A6: Signaling in the Berliner Börsenzeitung

Year	Number of announced IPOs/SEOs	Patents mention in x prospects	In percent
1896	12	1	8.33
1899	39	4	10.26
1902	8	1	12.5
1905	14	5	35.71
1908	7	1	14.29
Total	80	12	15

Sample: Mondays, dates with odd numbers

IV. Shortrun performance

Table A7: Firms grouped by the number of (valuable) patents before IPO

<i>All patents</i>	<i>Patent group</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
0	0	335	70.68	70.68
1	1	31	6.54	77.22
2-5	2	40	8.44	85.65
6-10	3	21	4.43	90.08
>10	4	47	9.92	100
Total		474	100	
Valuable patents	Patent group valuable patents	Freq.	Percent	Cum.
0	0	430	90.72	90.72
1	1	10	2.11	92.83
2-5	2	19	4.01	96.84
6-10	3	6	1.27	98.1
>10	4	9	1.9	100
Total		474	100	

Source: see text

Table A8: Correlation of patent groups

		All valuable patents					
		0	1	2-5	6-10	>10	Total
All patents	0	334	0	1	0	0	335
	1	30	1	0	0	0	31
	2-5	37	1	2	0	0	40
	6-10	15	5	1	0	0	21
	>10	14	3	15	6	9	47
Total		430	10	19	6	9	474

Source: see text

Pearson correlation: 0.63

Table A9: Short run performance by patent groups

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
	Initial return			First trading price in percent of nominal share value		
1.patent group	-0.381 (1.277)		-0.428 (1.284)	4.983 (5.561)		4.908 (5.479)
2.patent group	-0.685 (0.568)		-0.855 (0.424)	1.120 (7.344)		1.152 (7.468)
3.patent group	-0.691 (1.152)		-1.428 (0.983)	5.386 (3.165)		5.594 (6.737)
4.patent group	-0.559 (0.723)		-2.770 (0.407)	31.83 (16.33)		32.61 (38.38)
1.patent group vp		0.972 (1.771)	2.193 (1.544)		11.06 (7.286)	1.566 (16.59)
2.patent group vp		0.211 (0.533)	2.186 (0.764)		5.286 (3.622)	-18.02 (29.54)
3.patent group vp		7.567 (6.222)	10.03 (6.096)		46.16 (13.26)	17.53 (46.15)
4.patent group vp		0.977 (1.741)	3.225 (1.754)		45.37 (9.564)	16.97 (41.27)
Constant	3.375 (0.507)	4.060 (3.191)	4.116 (3.188)	122.0 (1.206)	131.1 (3.311)	131.0 (3.578)
Sector and year dummies	y	y	y	y	y	y
Age, size, distance, reputation , past market return	y	y	y	y	y	y
Observations	292	292	292	430	430	430
R-squared	0.119	0.131	0.141	0.217	0.209	0.227

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

Table A10: IPOs' short-run performance by different groups of firms, Panel 3, A1

Dependent variable	(1)	(2)	(3)	(4)	(5)
			Initial return		
Innovative start-ups	-2.062 (0.600)	-2.071 (0.592)	-2.092 (0.632)	-2.141 (0.647)	-2.166 (0.662)
Buddenbrooks	-0.661 (0.711)	-0.679 (0.705)	-0.734 (0.681)	-0.716 (0.691)	-0.732 (0.710)
Permanently innovative	-1.326 (0.801)	-1.272 (0.699)	-1.256 (0.716)	-1.292 (0.715)	-1.277 (0.688)
Past market return	-4.944 (59.12)	-5.764 (59.88)	-8.816 (59.06)	-11.81 (59.07)	-11.29 (58.14)
Size of the issue		-0.0208 (0.0381)	-0.0179 (0.0394)	-0.0192 (0.0379)	-0.0243 (0.0417)
Age of the firm			0.0554 (0.0541)	0.0592 (0.0547)	0.0581 (0.0564)
Distance				-0.126 (0.0412)	-0.121 (0.0442)
Big Four banks					0.295 (0.453)
Constant	4.207 (3.329)	4.295 (3.416)	4.104 (3.377)	4.440 (3.304)	4.360 (3.191)
Sector and year of IPO dummies	y	y	y	y	y
Observations	292	292	292	292	292
R-squared	0.122	0.122	0.126	0.128	0.129

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

Table A11: IPOs' short-run performance by different groups of firms, dependent variable first trading price, Panel 2, A1

VARIABLES	(1)	(2)	(3)	(4)	(5)
Dependent variable	First trading price in percent of the nominal share value				
Innovative start-ups	19.82 (7.294)	19.32 (7.407)	19.84 (7.782)	20.16 (7.593)	19.55 (7.255)
Buddenbrooks	11.44 (7.215)	11.52 (7.057)	10.88 (7.015)	10.56 (7.089)	10.28 (6.236)
Permanently innovative	21.74 (10.28)	21.60 (11.00)	21.64 (10.97)	21.53 (11.04)	22.25 (11.09)
Past market return	-314.3 (73.14)	-311.6 (78.85)	-302.6 (93.13)	-292.6 (84.36)	-269.1 (75.49)
Size of the issue		0.0698 (0.394)	0.118 (0.394)	0.122 (0.392)	-0.217 (0.467)
Age of the firm			0.594 (0.463)	0.585 (0.455)	0.615 (0.439)
Distance				0.906 (0.959)	0.986 (0.921)
Big Four banks					16.89 (4.381)
Constant	141.6 (7.384)	141.3 (8.603)	136.9 (6.369)	135.0 (5.874)	130.5 (2.742)
Sector and year of IPO dummies	y	y	y	y	y
Observations	430	430	430	430	430
R-squared	0.171	0.171	0.182	0.184	0.206

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

We also run the above regression based on the firms for which we can observe the initial return (292). In these regressions, all firms with patents start with a significantly higher price. The start-ups, however, start with the highest prices. Thus our main results are robust to changes in sample size (see Table A12).

Table A12: IPOs' short-run performance by different groups of firms, Panel 3, A1

VARIABLES	(1)	(2)	(3)	(4)	(5)
Dependent variable	First trading price in percent of the nominal share value				
Innovative start-ups	25.04 (10.62)	25.09 (10.72)	24.71 (11.35)	24.60 (11.06)	23.59 (10.95)
Buddenbrooks	16.91 (4.550)	17.00 (4.420)	16.02 (4.907)	16.06 (5.071)	15.42 (4.515)
Permanently innovative	16.57 (6.723)	16.28 (7.047)	16.57 (7.108)	16.49 (7.192)	17.07 (7.674)
Past market return	-365.2 (258.0)	-360.9 (257.9)	-414.7 (255.0)	-421.2 (251.9)	-400.3 (221.4)
Size of the issue		0.109 (0.294)	0.159 (0.297)	0.157 (0.292)	-0.0476 (0.379)
Age of the firm			0.975 (0.666)	0.984 (0.646)	0.937 (0.633)
Distance				-0.274 (0.893)	-0.0994 (0.834)
Big Four banks					11.81 (4.416)
Constant	142.1 (14.64)	141.6 (15.05)	138.3 (12.78)	139.0 (12.58)	135.8 (11.20)
Sector and year of IPO dummies	y	y	y	y	y
Observations	292	292	292	292	292
R-squared	0.202	0.203	0.228	0.228	0.243

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

In the main document we used the following baseline definition for firm types: The dummy “*innovative start-up*” was equal to one if the respective firm received at least ten times more patents in the first five years after its IPO than during its full existence before its IPO. Conversely, the dummy “*Buddenbrooks*” was set to one if a firm’s number of patents before its IPO was at least ten times as high as in the first five years afterwards. All other innovative firms, the patents of which were more equally distributed over time, were defined as the group of *permanently innovative firms*. The group of firms without any patents served as a benchmark. In order to check the robustness of our results, table A13 and A14 show that our results are robust to other specification of firm types:

In specification 1 the dummy “*innovative start-up*” is set to one if the respective firm received no patents before the IPO, but at least one in the first five years after it went public. The dummy “*Buddenbrooks*” is set to one if a firm had patents before the IPO, but none within the first five years after the IPO.

In specification 2 the dummy “*innovative start-up*” is set to one if the respective firm received five times more patents in the first five years after its IPO than during its full existence before its IPO. Conversely, the dummy “*Buddenbrooks*” is set to one if a firm’s number of patents before its IPO was at least five times as high as in the first five years afterward. All other

innovative firms are defined as firms with patents before and after the IPO, which do not fulfil the criteria of either “*innovative start-up*” or “*Buddenbrooks*”. The group of firms without any patents serves as a benchmark in all specifications.

Table A13: Short run performance for different specification of firm types, Specification 1

Dependent variable	(1)	(2)	(3)
	Initial return	First trading price in percent of nominal share value	
Sample	Panel 3, A1	Panel 3, A1	Panel 2, A1
Innovative start-ups (Sp.1)	-2.042 (0.718)	22.81 (11.08)	19.52 (7.263)
Buddenbrooks (Sp.1)	-0.373 (1.084)	18.52 (5.459)	8.363 (7.287)
Permanently innovative (Sp.1)	-1.714 (0.455)	14.68 (6.414)	23.32 (9.079)
Past market return	-13.88 (56.74)	-407.9 (219.3)	-254.4 (92.04)
Size of the issue	-0.0198 (0.0462)	-0.0246 (0.372)	-0.238 (0.448)
Age of the firm	0.0570 (0.0557)	0.922 (0.638)	0.619 (0.443)
Distance	-0.118 (0.0477)	-0.108 (0.823)	0.976 (0.879)
Big four banks	0.287 (0.452)	11.84 (4.076)	16.64 (4.389)
Constant	4.422 (3.131)	136.2 (10.75)	130.0 (3.099)
Sector and year of IPO dummies	y	y	y
Observations	292	292	430
R-squared	0.131	0.243	0.208

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

We include all possible control variables from the main regressions. The results remain almost unchanged if we apply a stricter definition for our firm types (Table A13). *Initial returns* (regressions 1) are still significantly negative for *innovative start-ups* and not significantly different from zero for the *Buddenbrooks*. *Permanently innovative firms* now also have significantly negative *initial returns*, but this is clearly driven by firms, which had few patents before the IPO and most patents after, which were classified as start-ups in the baseline specification. The *first trading price* (market value in percent of nominal share value) also remains significantly higher for start-ups.

Table A14: Short-run performance for different specification of firm types, Specification2

	(1)	(2)	(3)
Dependent variable	Initial return	First trading price in percent of nominal share value	
Sample	Panel 3, A1	Panel 3, A1	Panel 2, A1
Innovative start-ups (Sp.2)	-2.230 (0.649)	23.08 (9.323)	18.43 (5.594)
Buddenbrooks (Sp.2)	-1.103 (0.504)	14.58 (4.524)	12.77 (5.672)
Permanently innovative (Sp.2)	-0.654 (0.659)	18.86 (8.305)	20.91 (12.87)
Past market return	-8.154 (57.90)	-398.2 (226.9)	-273.1 (74.04)
Size of the issue	-0.0298 (0.0393)	-0.0658 (0.374)	-0.196 (0.479)
Age of the firm	0.0587 (0.0574)	0.934 (0.628)	0.609 (0.443)
Distance	-0.121 (0.0483)	-0.0782 (0.785)	0.924 (0.894)
Big four banks	0.345 (0.432)	11.93 (4.456)	16.75 (4.428)
Constant	4.243 (3.172)	135.9 (11.09)	130.8 (3.028)
Sector and year of IPO dummies	y	y	y
Observations	292	292	430
R-squared	0.130	0.244	0.203

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

Specification 2 (Table A14) relaxes the definition for *innovative start-ups* by now counting firms as start-ups if the respective firm received at least five times more patents in the first five years after its IPO. It also enlarges the number of *Buddenbrooks* because now a firm is defined as *Buddenbrook* if its number of patents before its IPO was at least five times as high as in the first five years afterward. Again, *innovative start-ups* have significantly lower *initial returns*.

Buddenbrooks now also have significantly lower *initial returns*, but still higher ones than *innovative start-ups*. This is driven by firms which were categorized as *permanently innovative firms* in the other specifications.

In terms of the *first trading price*, the results for the start-ups are similar to the baseline specification. *Buddenbrooks* now also have a significantly higher price, which is again driven by firms, which were classified as *permanently innovative* before, i.e. firms that had patents within 5 years after the IPO albeit fewer than in the years before they went public.

Altogether, the results of Tables A13 and A14 confirm our interpretation from the baseline results. The stronger the definition for *innovative start-ups* and *Buddenbrooks* the clearer are the differences in the short-run performance measures. Thus investors were clearly able to distinguish between *innovative start-ups*, *permanently innovative firms* and firms, which already passed their most innovative times.

V. *Robustness checks for potentially wrongly assigned Buddenbrooks or firms without patents*

As stated in the main document, the patent data are truncated at both sides of the time bar. The introduction of the first German patent law in 1877 marks the first year in which it was possible to get a German patent. Since the Imperial patent office did not reveal the name of patent holders during wartimes, the beginning of the First World War terminates the end of the period for which firm-specific patent data are available. The latter truncation might have led to a wrong assignment of firm types for firms that went public after 1910 because we could not identify their patent activities in a five year horizon after the IPO. Table A15 provides a list of those firms, which we classified as *Buddenbrooks* or *permanently innovative*. Firms categorized as *innovative start-ups* are excluded because more patents after the IPO would just confirm the correct classification. The firms without patents are excluded for convenience. The tables shows that in most cases the truncation hardly influences our classification.

However, it is possible that we indeed miscategorised firms as *Buddenbrooks*. Some firms had few patents before the IPO and none after. If they had patents after 1914, which we cannot identify and therefore ignore, they would have to be categorized as *permanently innovative firms* and not as *Buddenbrooks*. Columns 1 and 2 of Table A16 show the results after excluding

these potentially miscategorised Buddenbrooks, i.e. all firms classified as Buddenbrooks from the IPO cohorts after 1909. Our main results are robust to the exclusion of these observations.

The firms categorized as permanently innovative are unlikely to be misclassified because more patents after 1914 would just confirm our classification, except for the cases in which firms had so many patents after the IPO that they would have to be counted as a startup. However, table A15 show that this kind of misspecification is highly unlikely. The David Richter AG, for instance held 2 patents when they went public and received two more patents within 4 years of the IPO. In order to turn this firm into an innovative start-up they would have to receive 19 patents in 1915. Some firms in the groups of firms without patents might also be misspecified, since firms which had patents in 1915, but none before should indeed be treated as innovative start-ups. Columns 3 and 4 of Table A16 present the results after also excluding potentially misclassified firms without patents, i.e. all firms classified as firms without patents from the IPO cohorts after 1909. Our main results are robust to the exclusion of these observations.

Table A15: Potentially wrongly categorized firms

Firm	Year of IPO	Number of Patents before IPO	Number of patents within the observed Years after IPO	Firm type (baseline)*
Voigtländische Tüllfabrik AG	1910	1	0	B
Ostdeutschen Holzindustrie AG	1910	4	0	B
Poppe & Wirth AG	1911	5	0	B
Brauerei Ernst Engelhardt.	1911	1	0	B
Hackethal Draht und Kabelwerke AG	1911	4	0	B
Boeddinghaus, Reimann & Co. AG	1911	4	0	B
Gevelsberger Herd und Ofenfabrik W. Krefft AG	1911	3	0	B
Carlowitz AGz	1912	51	0	B
Fabrik für Blechemballage O.F. Schaefer	1912	1	0	B
Stahlwerke Rich. Lindenberg AG	1912	2	0	B
Ernst Schiess Werkzeugmaschinenfabrik AG	1912	11	0	B
Eisenbahnsignalbauanstalt Max Jüdel & Co. AG	1912	99	8	B
Emil Köster Lederfabrik AG	1912	1	0	B
Eichener Walzwerk und VerzinkereiAG	1912	1	0	B
WerschenWeissenseller BraunkohlenAG e	1912	6	0	B
Capito & Klein AG.	1912	1	0	B
Krefelder Stahlwerks AG in Fischeln	1912	3	0	B
J. E. Reinecker AG	1913	60	1	B
David Richter AG	1910	3	2	PI
C. Lorenz AG	1910	107	143	PI
Vereinigten Schmirgel und Maschinenfabriken AG	1910	29	12	PI
Carl Berg AG	1910	9	2	PI
Carl Lindström AG	1910	6	22	PI
Gesellschaft für Lindes Eismaschinen AG	1911	47	7	PI
C. Heckmann AG i	1911	9	3	PI
R. Frister AG	1911	18	3	PI
Filter und Brautechnischen Maschinenfabrik AG	1911	74	18	PI
Franz Méguin & Co. AG	1912	26	12	PI
Maschinenfabrik Rockstroh & Schneider AG	1912	92	16	PI
C. D. Magirus AG in Ulm a.d. Donau	1913	22	14	PI
Waggonfabrik Jos. Rathgeber AG	1913	2	2	PI
Th. Goldschmidt AG	1913	34	6	PI

Note: B= Buddenbrook, PI = permanently innovative in the baseline specification

Table A16: Short-run performance excluding critical Buddenbrooks and critical firms without patents (IPO cohorts after 1910)

	(1)	(2)	(3)	(4)
	Excluding potentially wrong Buddenbrooks		Excluding potentially wrong Buddenbrooks and potentially wrong firms without patents	
	Initial return	First trading price	Initial return	First trading price
Innovative start-ups	-2.072 (0.663)	19.64 (7.799)	-2.058 (0.725)	21.79 (9.964)
Buddenbrooks	-1.045 (0.675)	8.483 (7.393)	-0.968 (0.763)	8.104 (7.259)
Permanently innovative	-1.143 (0.675)	22.15 (11.01)	-0.767 (0.394)	20.85 (10.66)
Past market return	-12.65 (57.61)	-248.3 (91.95)	33.46 (13.51)	-16.09 (172.2)
Size of the issue	-0.0259 (0.0392)	-0.258 (0.395)	-0.0249 (0.0396)	-0.140 (0.365)
Age of the firm	0.0658 (0.0627)	0.622 (0.447)	0.0569 (0.0590)	0.490 (0.501)
Distance	-0.138 (0.0616)	1.250 (0.891)	-0.134 (0.0819)	1.353 (0.959)
Big four banks	0.481 (0.378)	16.17 (3.658)	0.341 (0.594)	15.69 (3.684)
Constant	4.396 (3.151)	129.2 (3.882)	2.082 (0.251)	117.0 (7.424)
Sector and year of IPO dummies	y	y	y	y
Observations	285	413	269	374
R-squared	0.135	0.213	0.142	0.247

Note: Reported standard errors are clustered by sector (six clusters). Clustered standard errors in parentheses

VI. Long run performance

Table A17: Coefficient of variation in the first five years after the IPO for different firm types

firm types	Mean in the 5 years after the IPO						Coefficient of variation in the 5 years after the IPO					
	Prices	t-value	Annual returns	t-value	Annual excess return	t-value	Prices	t-value	Annual returns	t-value	Annual excess return	t-value
Innovative start-ups	188.15	1.1497	0.071	0.2593	0.005	-0.0078	0.151	0.838	1.08	0.412	0.275	0.264
Buddenbrooks	151.22	-0.0952	0.062	0.1883	0.017	0.1992	0.114	-0.957	1.259	0.613	0.414	0.388
permanently innovative	161.52	0.3787	0.064	0.2209	0.024	0.3502	0.159	1.629	3.728	1.123	4.959	1.123
Firms without patents	153.30		0.052		0.006		0.131		-1.779		-2.437	

Note: t-value from t-test compared to firms without patents, based on Table A1, panel 1, delisted firms were dropped and the mean just covered the last reported price, annual return or annual excess return, since we have no information about whether the shareholders received compensation.

Source: see text

Table A18: IPOs long-run performance (Panel), end of year price

Model	(1)	(2)	(3)	(4)	(5)
		Pooled OLS			FE
Innovative Start-ups	46.08	43.92			
	(19.66)	(20.41)			
Buddenbrooks	0.672	0.232			
	(11.19)	(9.995)			
Permanently innovative	27.00	23.50			
	(13.80)	(14.66)			
Age of the firms		1.211		1.215	
		(0.460)		(0.461)	
Size of the issue		0.157		0.179	
		(0.356)		(0.349)	
Distance Headquarters		-5.054		-5.172	
		(4.260)		(4.257)	
Year 2 after IPO x Innovative Start-up			46.75	43.98	6.247
			(24.51)	(25.10)	(16.99)
Year 3 after IPO x Innovative Start-up			56.97	54.67	15.89
			(25.96)	(26.41)	(19.39)
Year 4 after IPO x Innovative Start-up			41.55	39.55	5.169
			(22.16)	(22.75)	(15.11)
Year 5 after IPO x Innovative Start-up			36.40	34.48	-1.594
			(20.16)	(21.25)	(16.03)
Year 2 after IPO x Buddenbrooks			-9.543	-9.739	-12.02
			(13.08)	(12.36)	(9.833)
Year 3 after IPO x Buddenbrooks			0.243	0.431	-2.821
			(10.14)	(9.179)	(8.035)
Year 4 after IPO x Buddenbrooks			-3.403	-3.731	-2.237
			(12.31)	(10.76)	(9.438)
Year 5 after IPO x Buddenbrooks			-1.843	-1.220	1.276
			(15.11)	(12.98)	(11.74)
Year 2 after IPO x permanently innovative			20.53	17.11	-7.849
			(14.89)	(15.69)	(10.09)
Year 3 after IPO x permanently innovative			24.28	21.02	-7.954
			(12.87)	(13.40)	(8.760)
Year 4 after IPO x permanently innovative			22.24	18.70	-5.414
			(14.10)	(14.78)	(10.32)
Year 5 after IPO x permanently innovative			22.78	20.08	-4.821
Constant	220.9	225.0	228.5	232.2	159.7
	(78.29)	(79.26)	(80.85)	(81.52)	(3.357)
Sector and year of IPO dummies	y	y	y	y	n
Year after IPO dummies	y	y	y	y	y
Observations	1,903	1,903	1,903	1,903	1,903
R-squared	0.064	0.072	0.063	0.071	0.01
Number of firms	431	431	431	431	431

Note: reported standard errors are clustered by firm. Clustered standard errors in parentheses

Table A19: IPOs long run performance (Panel), annual return

Model	(1)	(2)	(3)	(4)	(5)
		Pooled OLS			FE
Innovative Start-ups	0.0319 (0.0306)	0.0289 (0.0326)			
Buddenbrooks	0.00297 (0.0205)	0.00478 (0.0184)			
Permanently innovative	0.0442 (0.0319)	0.0414 (0.0331)			
Age of the firms		0.000581 (0.000704)		0.000600 (0.000701)	
Size of the issue		-0.000299 (0.000539)		-0.000313 (0.000546)	
Distance Headquarters- Berlin		-0.00775 (0.00700)		-0.00799 (0.00705)	
Year 2 after IPO x Innovative Start-up			-0.0132 (0.0930)	-0.0172 (0.0958)	-0.152 (0.109)
Year 3 after IPO x Innovative Start-up			0.0334 (0.0460)	0.0304 (0.0470)	-0.134 (0.0946)
Year 4 after IPO x Innovative Start-up			-0.0234 (0.0403)	-0.0254 (0.0409)	-0.201 (0.113)
Year 5 after IPO x Innovative Start-up			0.00535 (0.0509)	0.00387 (0.0522)	-0.145 (0.110)
Year 2 after IPO x Buddenbrooks			-0.0776 (0.0808)	-0.0759 (0.0781)	-0.0613 (0.0871)
Year 3 after IPO x Buddenbrooks			0.0559 (0.0272)	0.0580 (0.0276)	0.0492 (0.0503)
Year 4 after IPO x Buddenbrooks			-0.00282 (0.0310)	-0.000464 (0.0310)	-0.00636 (0.0500)
Year 5 after IPO x Buddenbrooks			0.0398 (0.0321)	0.0428 (0.0320)	0.0719 (0.0477)
Year 2 after IPO x permanently innovative			0.000665 (0.0896)	-0.00208 (0.0909)	-0.0286 (0.106)
Year 3 after IPO x permanently innovative			0.0616 (0.0429)	0.0586 (0.0429)	0.0260 (0.0685)
Year 4 after IPO x permanently innovative			0.0633 (0.0445)	0.0600 (0.0450)	0.0124 (0.0681)
Year 5 after IPO x permanently innovative			0.0582 (0.0515)	0.0565 (0.0522)	0.0356 (0.0733)
Constant	0.0900 (0.0595)	0.102 (0.0598)	0.107 (0.0626)	0.118 (0.0616)	0.0539 (0.0204)
Sector and year of IPO dummies	y	y	y	y	n
Year after IPO dummies	y	y	y	y	y
Observations	1,869	1,869	1,869	1,869	1,869
R-squared	0.005	0.006	0.006	0.007	0.005
Number of firms	431	431	431	431	431

Note: reported standard errors are clustered by IPO. Clustered standard errors in parentheses

Table A20: IPOs long run performance (Panel): annual excess return

Model	(1)	(2)	(3)	(4)	(5)
		Pooled OLS			FE
Innovative Start-ups	0.0340 (0.0302)	0.0311 (0.0322)			
Buddenbrooks	0.00359 (0.0206)	0.00535 (0.0185)			
Permanently innovative	0.0412 (0.0320)	0.0381 (0.0332)			
Age of the firms		0.000620 (0.000703)		0.000669 (0.000708)	
Size of the issue		-0.000197 (0.000544)		-0.000223 (0.000546)	
Distance Headquarters- Berlin		-0.00761 (0.00700)		-0.00773 (0.00705)	
Year 2 after IPO x Innovative Start-up			0.00564 (0.0910)	0.00175 (0.0939)	-0.136 (0.107)
Year 3 after IPO x Innovative Start-up			0.0455 (0.0421)	0.0425 (0.0428)	-0.128 (0.0880)
Year 4 after IPO x Innovative Start-up			-0.0528 (0.0366)	-0.0548 (0.0370)	-0.232 (0.107)
Year 5 after IPO x Innovative Start-up			0.00453 (0.0466)	0.00299 (0.0480)	-0.149 (0.101)
Year 2 after IPO x Buddenbrooks			-0.0801 (0.0807)	-0.0785 (0.0780)	-0.101 (0.0863)
Year 3 after IPO x Buddenbrooks			0.0377 (0.0245)	0.0396 (0.0252)	-0.00736 (0.0430)
Year 4 after IPO x Buddenbrooks			-0.0177 (0.0376)	-0.0156 (0.0376)	-0.0572 (0.0555)
Year 5 after IPO x Buddenbrooks			0.0321 (0.0313)	0.0348 (0.0309)	0.0261 (0.0459)
Year 2 after IPO x permanently innovative			-0.000914 (0.0892)	-0.00385 (0.0905)	-0.0361 (0.104)
Year 3 after IPO x permanently innovative			0.0433 (0.0416)	0.0402 (0.0415)	0.000802 (0.0618)
Year 4 after IPO x permanently innovative			0.0580 (0.0479)	0.0545 (0.0482)	-0.00307 (0.0682)
Year 5 after IPO x permanently innovative			0.0525 (0.0477)	0.0505 (0.0486)	0.0200 (0.0638)
Constant	-0.0554 (0.0591)	-0.0441 (0.0595)	-0.0404 (0.0623)	-0.0296 (0.0614)	-0.00965 (0.0201)
Sector and year of IPO dummies	y	y	y	y	n
Year after IPO dummies	y	y	y	y	y
Observations	1,869	1,869	1,869	1,869	1,869
R-squared	0.012	0.012	0.012	0.013	0.007
Number of firms	431	431	431	431	431

Note: reported standard errors are clustered by IPO. Clustered standard errors in parentheses