

Market Value Before and After the Global Financial Crisis

IPDSM 2017 - Mexico

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14.11.2017

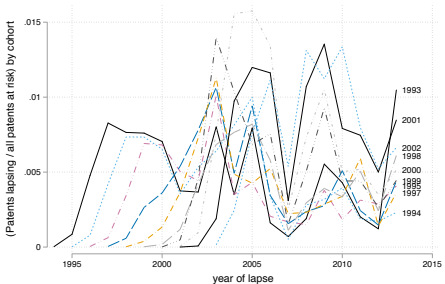


Literature - Market Value Studies

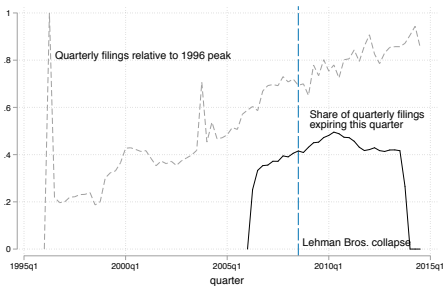
Paper	R&D	Patents	Cit.	TM	Sample	Countries	Years
Griliches (84)	YES	USPTO	NO	NO	1,091	USA	68-74
Megna and Klock (93)	YES	USPTO	NO	NO	11	USA	77-90
Hall (98)	YES	USPTO	NO	NO	5,000	USA	76-95
Blundell et al. (99)	NO	USPTO	NO	NO	340	UK	72-82
Bloom and Van Reenen (02)	NO	USPTO	YES	NO	404	UK	68-96
Toivanen et al. (02)	YES	NO	NO	NO	1,519	UK	88-95
Hall, Jaffe and Trajtenberg (05)	YES	USPTO	YES	NO	1,982	USA	79-88
Greenhalgh and Rogers (06)	YES	UK, EPO	NO	EUIPO	3,227	UK	89-02
Hall and Oriani (06)	YES	NO	NO	NO	2,156	US, UK, FR, IT, DE	89-98
Hall, Thoma and Torrisi (07)	YES	USPTO, EPO	YES	NO	7,168	Europe (21)	91-02
Sandner and Block (11)	YES	EPO	YES	EUIPO	1,216	EU	96-02
Thoma (15)	YES	USPTO, EPO	NO	USPTO	4,780	USA, Europe	91-05
This study	YES	EPO	YES	EUIPO	563	BE, CA, CH, DE, FR, IL, NL, SG, US	05-12

Did the financial crisis change use of IP?

- ▶ During crisis it was quickly apparent that applications were falling, what about renewals?



Patents lapsing



Trademarks lapsing



Sources of Data

- ▷ Firms:
 - Basis: COR&DIP (2009-2012)
 - Extended: COMPUSTAT & AMADEUS
- ▷ Patents: PATSTAT via Dietmar Harhoff
- ▷ Trademarks: Direct from EUIPO via Nathan Wajzman & Michal Kazimierczak



Constructing the data

Problems:

- 1) Matching data (IP and firm information)
- 2) Selecting the sample

What we did:

- 1) Matching partly solved by COR&DIP, but we expand this backwards using Derwent names (long do file) and manual checks.
- 2) Included all firms with at least 5 years of data on R&D and operating expenditure before 2009.



Regression model & analysis steps

- ▶ We estimate a simple Cobb-Douglas version of the market value equation based on Hall et al. (2005):

$$\ln V = \ln q + (1 - \alpha) \ln Assets + \beta_R \ln \frac{R\&D}{Assets} + \beta_P \ln \frac{Patents}{R\&D} + \beta_C \ln \frac{Citations}{Patents} + \beta_O \ln \frac{Opp.Ex.}{Assets} + \beta_M \ln \frac{Marks}{Opp.Ex.} + \epsilon \quad (1)$$

- ▶ Estimated by OLS and then IV (GMM) instrumenting $\frac{Patents}{R\&D}$ and lagging all other ratios apart from $\frac{Citations}{Patents}$.
- ▶ Instruments: Change in focus across technology areas, median age of granted patents, delay



Variables

- ▶ R&D stock, operating expenditure constructed using 15% depreciation rate
- ▶ Patent stocks (applied/granted) constructed using information on renewal payments
- ▶ Citation stocks constructed:
 - i) using 15% depreciation rate (Disc. flow)
 - ii) using only patents still upheld (Stock)

Our approach to patent and citation stocks differs from Hall et al. (2005) in that we separate applications and grants and we identify patents that are still active.

We do not depreciate active patents.



Table 1: Descriptive Statistics

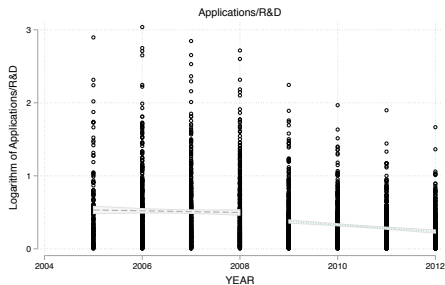
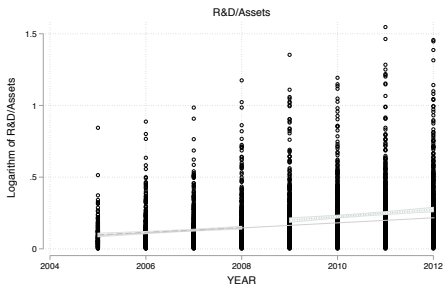
Variable	N	Mean	Median	Min.	Max.	Std. Dev.
Market value (€M)	3,945	9,292.48	1,662.19	-142.54	388,596.31	24,222.36
Book value (€M)	3,945	8,053.69	1,388.89	4.01	217,634	20,535.51
Market-to-book value	3,945	1.73	1.28	-0.38	38.92	1.69
R&D stock (€M)	3,945	928.68	165.13	-2,898.83	32,909.61	2,847.32
Op. exp. stock (€M)	3,945	17,214.10	2,961.85	28.30	705,362.81	51,560.13
Granted patents	3,139	253.47	33	1	11,876	753.50
Applied patents	3,347	333.58	61	1	11,986	916.11
Validated patents	2,859	2,265.96	182	1	135,452	8,470.82
Trademarks	3,043	67.47	19	0	1,922	139.18
D (R&D =0)	3,945	0	0	0	0	0
D (Op. exp. =0)	3,945	0	0	0	1	0.04
R&D/Assets	3,945	0.23	0.13	-1.30	3.70	0.32
Op. exp./Assets	3,945	2.79	2.26	0.17	20.93	2.12
Granted p./R&D ×1000	3,139	0.44	0.17	-0.18	18.38	0.91
Applied p./R&D ×1000	3,347	0.66	0.32	-0.23	19.84	1.22
Validated p./R&D ×1000	2,859	2.58	0.94	-2.18	106.31	5.36
Trademarks/Opp. exp. ×1000	3,043	0.01	0.00	0.00	0.56	0.02
Citations PI (EP)/Patents (app.)	3,347	0.96	0.67	0	19.27	1.05
Citations (US)/Patents (app.)	2,844	2.45	1.14	0	68.94	4.61
Citations (EP)/Patents (app.)	2,844	0.35	0.21	0	10	0.52
Citations PI (EP)/Patents (gr.)	3,139	1.64	0.56	0	73.35	4.58
Citations (US)/Patents (gr.)	2,840	6.10	2.26	0	172	11.80
Citations (EP)/Patents (gr.)	2,840	0.76	0.38	0	14.71	1.25
Citations PI (EP, app.)	3,945	267.81	28.59	0	16,063.22	906.66
Citations PI (EP, val.)	3,945	128.30	12.49	0	5,202.35	407.37
Citations (EP, app.)	2,851	60.54	20	0	655	95.34
Citations (US, app.)	2,851	319.87	124	0	6,019	498.81
Citations (EP, val.)	2,848	64.25	22	0	688	100.07
Citations (US, val.)	2,848	340.60	132	0	6,863	554.48

Descriptives - observations

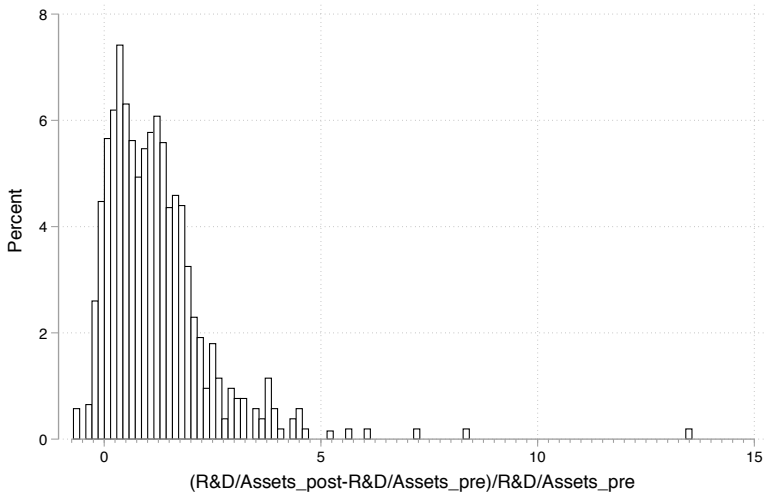
- ▶ Market-to-book value same 1.73 as Hall et al. (2005). Before 2009 1.76 and after 1.69
- ▶ $\frac{R\&Dstock}{Marketvalue}$ at mean[median] is 10%[10%] here and 19%[9%] in Hall et al. (2005).
- ▶ We observe > 500 firms between 2006 and 2012. We have “lost” 75% of the original sample due to missing datapoints - we impose requirement that firm variables are observable for at least 5 years before 2009.
- ▶ 75% of the remaining firms are from the US: due to reporting requirements and ownership type.



Sample: R&D and Applications



Distribution of Change in R&D/Assets (Book Value)



Sample: Patent Stocks and Citations to these

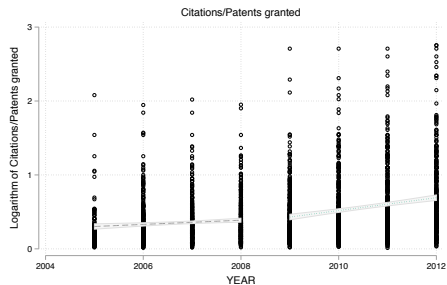
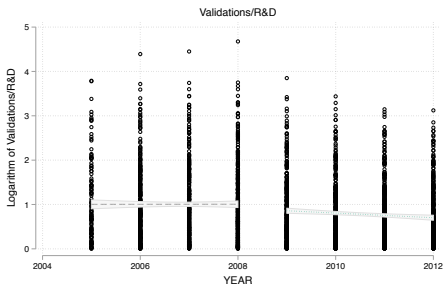


Table 2: Market Value as a function of R&D, Patents, Marks, Citations

	2005-2012		2005-2008		2009-2012	
			US cit.	EPO cit.	US cit.	EPO cit.
Assets	-0.0381*** (0.0046)	-0.0301** (0.0111)	-0.0287* (0.0113)	-0.0457*** (0.0101)	-0.0435*** (0.0104)	
R&D/Assets	0.3300*** (0.0583)	0.0956 (0.1387)	0.1296 (0.1428)	0.4548*** (0.1081)	0.4569*** (0.1083)	
Patents app./R&D	0.2075*** (0.0309)	0.2530*** (0.0576)	0.2627*** (0.0591)	0.1111 (0.0864)	0.1081 (0.0865)	
Patents val./R&D	-0.0738*** (0.0157)	-0.1044** (0.0319)	-0.1025** (0.0329)	-0.0419 (0.0358)	-0.0365 (0.0366)	
Citations app./Applied	-0.0277 (0.0380)	0.0287 (0.0411)	0.0542 (0.0908)	-0.0131 (0.0309)	-0.0804 (0.0704)	
Citations gr./Granted	0.1195*** (0.0279)	0.0451 (0.0305)	0.0900 (0.0684)	0.0513* (0.0227)	0.1339** (0.0512)	
Opp. ex. /Assets	-0.1759*** (0.0199)	-0.0952* (0.0469)	-0.0966* (0.0467)	-0.2472*** (0.0440)	-0.2450*** (0.0440)	
Marks/Opp. exp.	0.0172** (0.0060)	0.0125 (0.0137)	0.0128 (0.0139)	0.0199 (0.0137)	0.0212 (0.0138)	
Industry dummies	Yes	Yes	Yes	Yes	Yes	
Year dummies	Yes	Yes	Yes	Yes	Yes	
Country dummies	Yes	Yes	Yes	Yes	Yes	
Observations	3916	1770	1770	2146	2146	
Adjusted R ²	0.3597	0.3693	0.3640	0.3636	0.3635	

Standard errors in parentheses ⁺ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Table 3: Market Value: Comparing Citation Stock Measures (EP)

	2005-2008		2009-2012	
	Stock	Disc. flow	Stock	Disc. flow
Assets	-0.0287*	-0.0356**	-0.0435***	-0.0488***
	(0.0113)	(0.0109)	(0.0104)	(0.0102)
R&D/Assets	0.1296	0.0726	0.4569***	0.4371***
	(0.1428)	(0.1398)	(0.1083)	(0.1101)
Patents app./R&D	0.2627***	0.1858**	0.1081	0.0649
	(0.0591)	(0.0604)	(0.0865)	(0.0857)
Patents val./R&D	-0.1025**	-0.0686*	-0.0365	-0.0292
	(0.0329)	(0.0307)	(0.0366)	(0.0354)
Citations app./Applied	0.0542	0.0807	-0.0804	0.0591
	(0.0908)	(0.0515)	(0.0704)	(0.0503)
Citations gr./Granted	0.0900	0.0615	0.1339**	0.0639 ⁺
	(0.0684)	(0.0473)	(0.0512)	(0.0348)
Opp. ex. /Assets	-0.0966*	-0.0853 ⁺	-0.2450***	-0.2404***
	(0.0467)	(0.0454)	(0.0440)	(0.0437)
Marks/Opp. exp.	0.0128	0.0119	0.0212	0.0218
	(0.0139)	(0.0139)	(0.0138)	(0.0140)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Constant	1.2879***	1.3736***	1.5048***	1.5772***
	(0.1747)	(0.1678)	(0.1743)	(0.1685)
Observations	1770	1770	2146	2146
r2_a	0.3640	0.3675	0.3635	0.3631

Standard errors in parentheses

⁺ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Table 4: Market Value: Instrumental Variables - Robustness

	2005-2008			2009-2012		
	OLS	Lags	IV	OLS	Lags	IV
Assets	-0.0268* (0.0115)	-0.0233* (0.0111)	-0.0155 (0.0176)	-0.0436*** (0.0104)	-0.0434*** (0.0103)	-0.0808*** (0.0240)
R&D/Assets	0.2003 (0.1666)	0.2393 (0.1562)	0.2673 ⁺ (0.1597)	0.4618*** (0.1082)	0.4560*** (0.1052)	0.3533* (0.1384)
Patents app./R&D	0.2818*** (0.0626)	0.2934*** (0.0626)	0.5438* (0.2499)	0.1319 (0.0874)	0.1467 ⁺ (0.0870)	-0.4234 (0.4970)
Patents val./R&D	-0.1131** (0.0348)	-0.1197*** (0.0347)	-0.1827 (0.1469)	-0.0472 (0.0366)	-0.0542 (0.0368)	0.4256 (0.2663)
Citations app./Applied	0.0706 (0.0908)	0.0709 (0.0917)	0.1817 (0.1950)	-0.0756 (0.0705)	-0.0679 (0.0715)	-0.4508 ⁺ (0.2321)
Citations gr./Granted	0.0692 (0.0697)	0.0683 (0.0694)	-0.0248 (0.0912)	0.1261* (0.0523)	0.1262* (0.0530)	0.2303* (0.0965)
Opp. ex. /Assets	-0.1078* (0.0493)	-0.0409 (0.0492)	-0.0281 (0.0510)	-0.2455*** (0.0442)	-0.2011*** (0.0436)	-0.2334*** (0.0484)
Marks/Opp. exp.	0.0097 (0.0143)	0.0109 (0.0137)	0.0053 (0.0144)	0.0205 (0.0137)	0.0244 ⁺ (0.0136)	0.0212 (0.0146)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.6732*** (0.2189)	1.4925*** (0.2093)		1.2327*** (0.2127)	1.2320*** (0.2088)	
Observations	1689	1689	1689	2119	2119	2119
Likelihood	-6.9e+02	-7.0e+02	-7.3e+02	-7.3e+02	-7.5e+02	-9.9e+02
Kleibergen-Paap rk LM			41.2397			20.4725
p value			0.0000			0.0000
Kleibergen-Paap rk Wald F			16.0671			7.5281
Hansen J statistic			0.0011			1.4794
p value			0.9737			0.2239

Standard errors in parentheses ⁺ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Conclusion & Questions

Results suggest:

- ▶ The financial crisis pushed companies to reduce patent portfolios and to increase R&D investments
- ▶ The financial crisis changed how stock markets value companies - less focus on portfolio size, more on portfolio “quality”

What else can we do to test the robustness of these findings?

→ Further splitting of the data hits limits rather quickly.



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