PATENTS AND THE COMPETITIVE ADVANTAGE OF FIRMS - AN ANALYSIS BASED ON STOCK MARKET DATA

Peter Neuhaeusler, Rainer Frietsch, Torben Schubert, Knut Blind

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Contact at Fraunhofer ISI

Peter Neuhäusler
Phone +49 721 6809-335
peter.neuhaeusler@isi.fraunhofer.de

Dr. Rainer Frietsch
Phone +49 721 6809-197
rainer.frietsch@isi.fraunhofer.de

Prof. Dr. Torben Schubert
Phone +49 721 6809-357
torben.schubert@isi.fraunhofer.de

Competence Center "Policy and Regions"
Fraunhofer Institute for Systems and
Innovation Research ISI
Breslauer Strasse 48
76139 Karlsruhe, Germany

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Overview

- **Examination of the linkage** between technological and economic performance at the firm level

- **Research Question**
  - How far can property rights (patents), as an output indicator for innovation, influence a firms' success represented by its
    - stock market value?
    - returns on investment?
  - Does patent quality matter?

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Theory & Literature Review

- Innovation research highlights **innovative capacity as a key driving force** for competitive advantage and therefore companies' success

- **(one) argument:** innovative firms face other market participants in a technology (or quality) rather than a price competition (Utterback/Abernathy 1975)

- Stems from the **"product cycle model"** or **"technology gap model"** (Posner 1961; Vernon 1966; 1979; Krugman 1979, Dosi & Soete 1983; 1991)
  - new or advanced products integrating superior technology will form **temporary oligopolistic markets** until the followers catch up
  - Assumption of an **imitation lag**: It will take time and costs for a follower to absorb superior technology and apply it for manufacturing processes

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Theory & Literature Review

- New products lead to the opening of new markets or enhancement of market shares, new processes mostly to cost-minimization → both make firms more capable of competing
- A firm has also be able to appropriate these benefits → an active protection of the developed intellectual property is decisive for the increase of innovative capability (Hanel 2002)
- Innovative capability → central intangible asset which serves as a differentiating factor in the innovation process (resource-based view) (Fransman 1994; Nelson/Winter 1982; Winter 1988)

- **Analysis is based** on patent portfolios of firms
  - Patents are often components of larger patent architectures or clusters that build on each other → can lead to increasing returns through positive feedback effects (Arthur 1996)
- **Basic Hypothesis**
  - Large and valuable patent portfolios therefore have a considerable influence on the market value and profit of firms

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Overview of (some) patent value indicators

- **Central Question:** How is it possible to estimate the quality or value of a patent in an early stage of the application process?

- **Examples of indicators:**

Forward citations (citations a patent receives)	Degree to which extent a patent contributes to further developing advanced technology
Backward citations (citations a patent makes)	Refer to previous patents, indicator of technological breadth
Patent grants	Value is determined by the granting process itself, application has to fulfill certain criteria
Patent oppositions	Opposing a patent means additional costs; additionally at least two parties engage in innovative activities for the same particular piece of technology
Family size	Larger number of markets is sought to be secured
Number of inventors	Research of several inventors should be more valuable than development by a single inventor

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Data & Sample

- **Panel-Dataset** based on the DTI-Scoreboard (British Department for Innovation, Universities & Skills (DIUS); Department for Business, Enterprise & Regulatory Reform (BERR)) from 1990 to 2007 comprised of 479 firms
  - Contains information on market capitalization, industry sector, number of employees etc. for the biggest international companies according to their R&D-expenditures
  - Information on EPO patent applications, patent quality indicators (citation measures, oppositions, family size etc.) are added to the dataset from the "EPO Worldwide Patent Statistical Database" (PATSTAT) → including patent information on the companies' subsidiaries
  - Data on the companies' assets and earnings were added from Standard & Poor's COMPUSTAT Global and North America databases
- **Output variables:**
  - **Market related view:** Market-to-Book Value (Tobin's Q) (Griliches 1981; Hall, Jaffe, Trajtenberg 2005; Narin, Breitzman, Thomas 2005; Deng, Lev, Narin 1999)
  - **Earnings related view:** Return on Investment

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Descriptive Results

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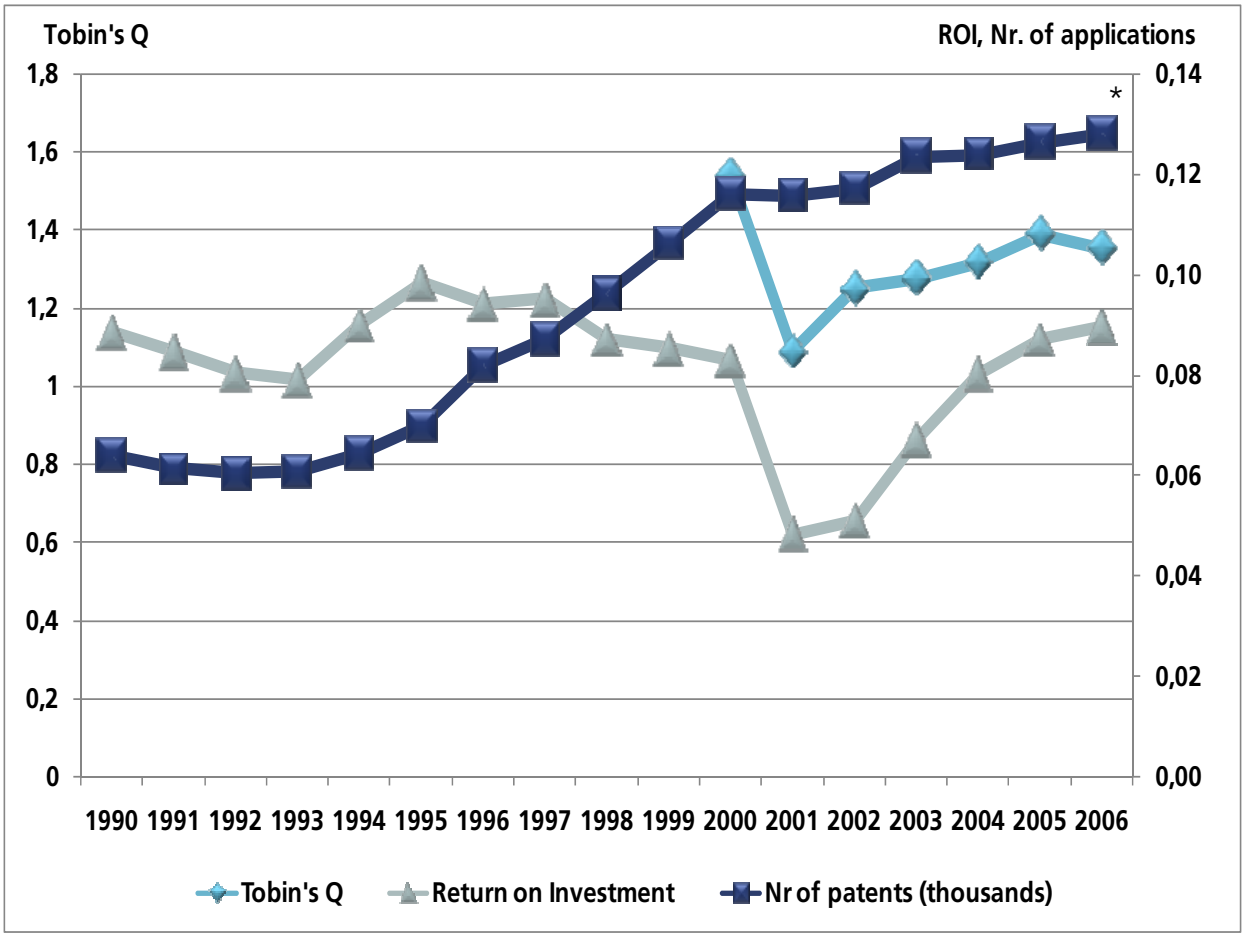
Average Tobin's Q, Return on Investment and total patent applications at the EPO, 1990-2006



*estimated

- Patent upsurge in the 1990s is not accompanied by a steep increase in Return on Investment
- ROI is most heavily affected by economic development
- BUT: All measures show a parallel growing trend from 2001 onwards
- With greater impact of the economic situation in 2001 on market value and companies' profit

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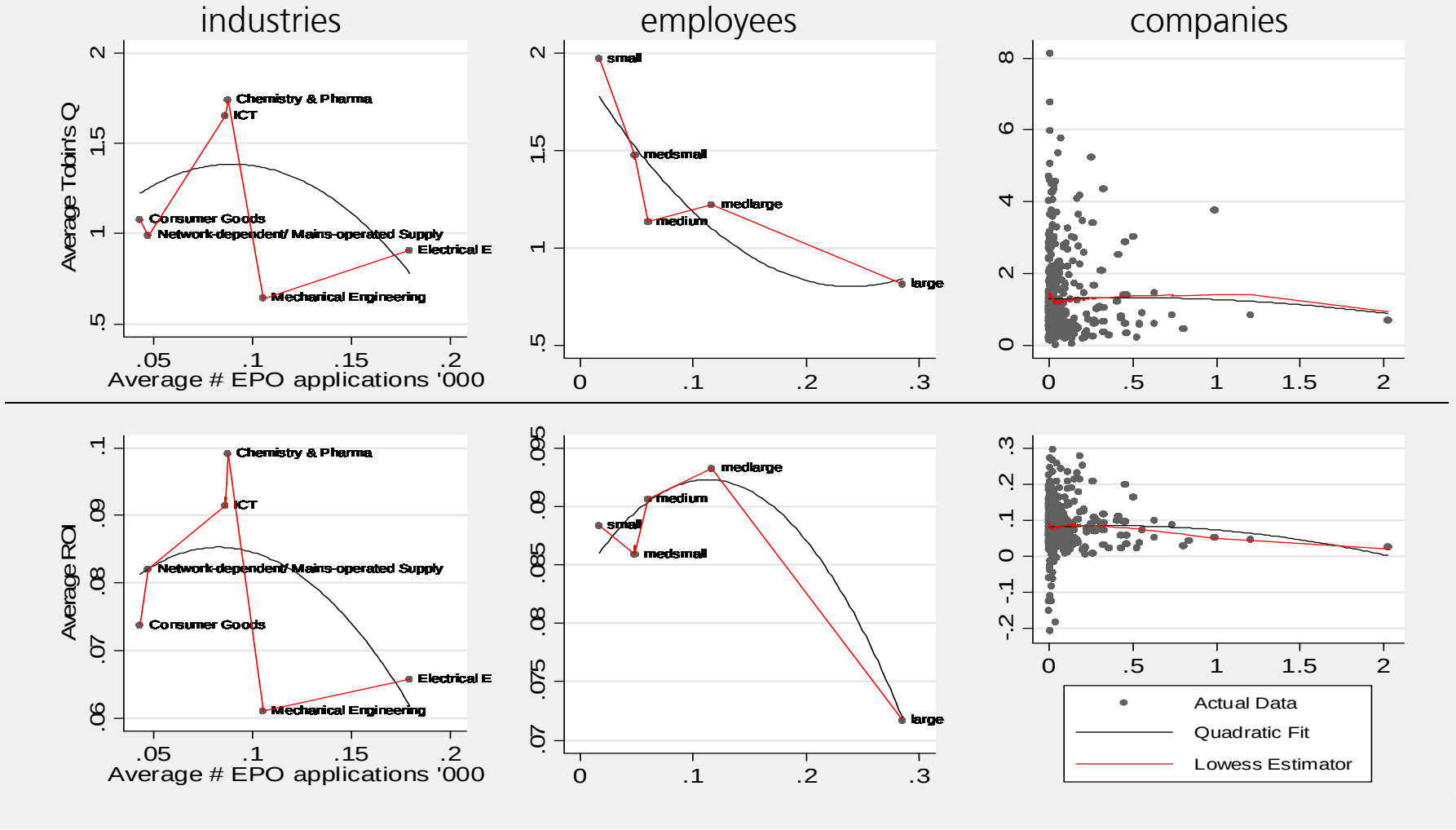
Average Tobin's Q and ROI by average number of patent applications (all available years) over industries, size and companies



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Correlations for firm performance measures and different patent (value) indicators*

	Tobin's Q	ROI	# EPO applications (in k)	Avg # FW-Citations (in k)
Tobin's Q	1.00			
ROI	0.55	1.00		
# employees (in k)	-0.19	-0.03		
R&D (in m)/Sales (in m)	0.40	-0.15		
Sales (in m)/Employees	0.20	0.14		
# EPO applications (in k)	0.01	0.00	1.00	
Patent Stock (5years) (in k)	0.00	-0.01	0.94	
Grants/Applications (lagged 5 years)	-0.18	-0.06	-0.01	
(Withdrawals+Refusals)/Applications	-0.02	-0.10	0.05	
Oppositions/Applications	-0.09	0.00	-0.05	
Avg # FW-Citations	0.19	0.01	0.00	1.00
Avg # BW-Citations	-0.11	-0.07	-0.09	0.38
Avg # XY-Citations	0.15	0.02	0.02	0.75
Avg Family Size	0.30	0.21	-0.06	0.50
Avg # Inventors	0.17	0.10	-0.03	0.24

*correlations without impact on the following analyses left out

- Nearly no bivariate association between number of EPO-applications and firm performance measures
- Large positive correlations for Forward-Citations and family size
- Dropped variables:
  - Patent stock
  - Avg # XY-Cit

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Multivariate Results

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Dynamic Panel Data Estimation

- **Econometric technique** used to estimate the effects
  - Fixed effects panel regression with clustered (robust) standard errors by company
  - Accounting for different data inherent problems like auto-correlation and heteroscedasticity

- **Problem:** Fixed-effects modeling does not allow to control for industry and firm location effects

- **Two estimations** were run on
  - Tobin's Q
  - Return on Investment

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Results of the fixed-effects model

	Tobin's Q			ROI		
	Coef.		**S.E.**	**Coef.**		**S.E.**
Firm-efficiency measures						
R&D (in m)/Sales (in m)	0.023		0.862	-0.536	***	0.093
Sales (in m)/#emp	2.929	***	1.059	0.149	***	0.057
Number of patents						
#EPO applications (in k)	-0.139		0.274	0.005		0.012
Quality measures						
grant share (lagged 5years)	0.175		0.113	-0.002		0.009
withd or refd share	0.422	**	0.214	0.006		0.018
opposed share	-1.106	**	0.485	0.107	***	0.035
avg # fw cit	0.068	***	0.022	-0.001		0.002
avg # bw cit	0.002		0.007	0.000		0.001
family size	0.104	***	0.025	0.005	***	0.002
avg # inventors	-0.077	**	0.036	-0.001		0.002
Size						
# employees (in k)	-0.006	**	0.003	0.000		0.000
Constant	0.366		0.361	0.056	***	0.021
Number of companies	388			383		
Observations	2,281			1,952		
R^2 within	0.172			0.27		

controlled for year dummies; ***p<0.01, **p<0.05, *p<0.1

- No significant effect for the mere number of applications (in both models)
- Quality indicators (forward citations and family size) show positive significant effects
- Share of withdrawn/refused patents affect Tobin's Q positively
- Opposition indicator counterintuitive at first sight

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Conclusions

- At least in this model **R&D** does neither affect market value nor Return on Investment positively → two reasons:
  - Dataset only covers highly R&D performing firms
  - Negative effect on ROI can be explained by the fact that R&D expenditures are costs

- It is **not the mere number of applications** that affect market value or the Return on Investment of firms
- But: **High quality patents** seem to influence firm performance at the market
  - highly cited patents and a large family size seem to be the most promising quality indicators in the models

- **The share of opposed patents** shows a contrary result on Tobin's Q and ROI
  - Explanation: Opposition as a negative market signal (Tobin's Q) (Häussler, Harhoff, Schirge 2009) vs. opposition as an indicator of high patent quality (ROI) (Allison, Moore, Lemley, Trunkey 2004)
- **The share of withdrawn/refused patents** influences market value positively
  - Explanation: Many withdrawn patents could be strategically valuable

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Outlook

- Controlling for strict exogeneity using a first-differencing estimator

- Construction of a second model to evaluate the technology portfolio of the firm to find out how portfolio indicators – like technology specialization measures – influence firm performance at the market
  - **Additional benefit:** allows to estimate the effect of industry related measures in a fixed-effects panel regression model

- Development of a measure of "technological value" of the firms by choosing the most promising technology strength indicators and compare it to the actual market value (Narin, Breitzman, Thomas 2005)
  - Could serve as a tool to reinforce investment decisions not solely on financial but also on technological strength of a company

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Thank you for your attention

Peter Neuhäusler
Fraunhofer ISI
Breslauer Strasse 48
76139 Karlsruhe
Germany
Peter.Neuhaeusler@isi.fraunhofer.de
0049 721 6809-335

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