ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

FAKULTÄT FÜR BETRIEBSWIRTSCHAFT
MUNICH SCHOOL OF MANAGEMENT

To Be Financed or Not - The Role of Patents for Venture Capital Financing

Carolin Häussler (INNO-tec, LMU Munich),
Dietmar Harhoff (INNO-tec, LMU Munich) and
Elisabeth Müller (ZEW Mannheim)

9th Annual Bank of Finland/CEPR Conference

Helsinki - October 16-17, 2008

Point of Departure I

- The challenge of new ventures is to turn promising ideas into products
- New ventures often require considerable amount of capital
- VCs are an important source of financing for high-technology firms (e.g., Gompers and Lerner, 2004) and, thus, a dominant source of selection (e.g., Baum and Silverman, 2004)

Point of Departure II

- VCs need to identify promising startups, however selection process is challenging: High-tech firms have uncertain prospects and a short-track record, difficult to evaluate their business ideas

- "Scouts" have to appraise the firms based on observable attributes (e.g., Stuart et al., 1999)

Point of Departure III

- Prior studies have investigated various mechanisms used to judge new ventures
  - Affiliations with reputable third parties (e.g., Gulati and Higgins, 2003; Hsu, 2006; Stuart et al., 1999, Carter et al., 1998)
  - Background of founders (e.g., Eisenhardt and Schoonhoven, 1990; Burton et al., 2002)

- Little attention has been attributed to patents as quality signals for new firms
  - Patents as signals (Spence, 1973):
    - are observable
    - patents are costly to obtain and have to undergo a fully controlled examination process
    - are perceived to be linked to the value of the technology (Harhoff et al., 1999; Lanjouw and Schankerman, 2004; Hall et al., 2006)

Previous Studies

- Patents have a positive impact on the amount of VC financing:
  - Baum and Silverman (2004) - 204 VC financed biotechnology startups in the US: pos. association of patent stock on amount of VC financing
  - Mann and Sager (2007) - 877 VC financed software firms in the US: pos. correlation between patents and number of VC rounds, investment size, receipt of late stage financing
- Patents have a positive impact on firm valuation:
  - Lerner (1994) - 173 VC financed biotechnology firms in the US: pos. effect of patent scope on firm valuation
  - Hsu and Ziedonis (2007) - 370 VC financed semiconductor start-ups in the US: pos. effect of patents on investor estimates of firm value; signaling value is greater in earlier financing rounds

Hypotheses

Base:

- H1: Once startups file patent applications, the likelihood of obtaining VC finance increases.

Anticipated Quality:

- H2: The higher the anticipated quality of a startup's patent application, the more likely the startup is to receive VC financing.

Revealed Quality:

- H3a: The more favorable the evaluation of the startup's patents as indicated by references in the search report, the more likely it receives VC financing.
- H3b: Startups with *granted patents* more likely receive VC financing.
- H3c: Startups with *opposed patents* more likely receive VC financing.

Contribution

- The relation between VC financing and patents has been analyzed only rarely, especially no study exists that looks at the impact of patents on the likelihood of obtaining VC financing (time to VC)
- We examine the ability of VCs to recognize valuable patents
- Various patent metrics are used to examine the role of patents as quality signal
- Econometric analysis is complemented with interview evidence

Biotechnology Industry as Field of Study

- Large capital need – VCs are typically viewed as the most critical form of financing source (e.g., Shepherd et al., 2000)
- Unique role of patents in biotechnology:
  - Appropriability regime is strong, patented compounds are difficult to circumvent (Lerner, 1995; Heller and Eisenberg, 1998)
  - Biotechnology firms compete in patent races (Reynolds 2000)
  - Patents obtained by small firms are important for licensing research results to larger firms (e.g., Gans et al., 2002; Häussler, 2007)

Data

- Sample based on Anglo-German Biotech Observatory
  - Biotechnology companies in UK and Germany
  - Firms active in
    - the human biotechnology sector (OECD 2005)
    - with own research lab (no pure service or supplier firms)
    - subsidiaries or firms that are not originally from either country are excluded
  - 346 German and 343 British firms fulfilled criteria in 2005
- Method
  - personal interviews in 2006 with 162 German and 118 British companies (response rate: 47% resp. 33%)
- Sample for this study
  - 116 German and 74 British firms that received VC or did apply for VC
- Patent data from European Patent Office matched

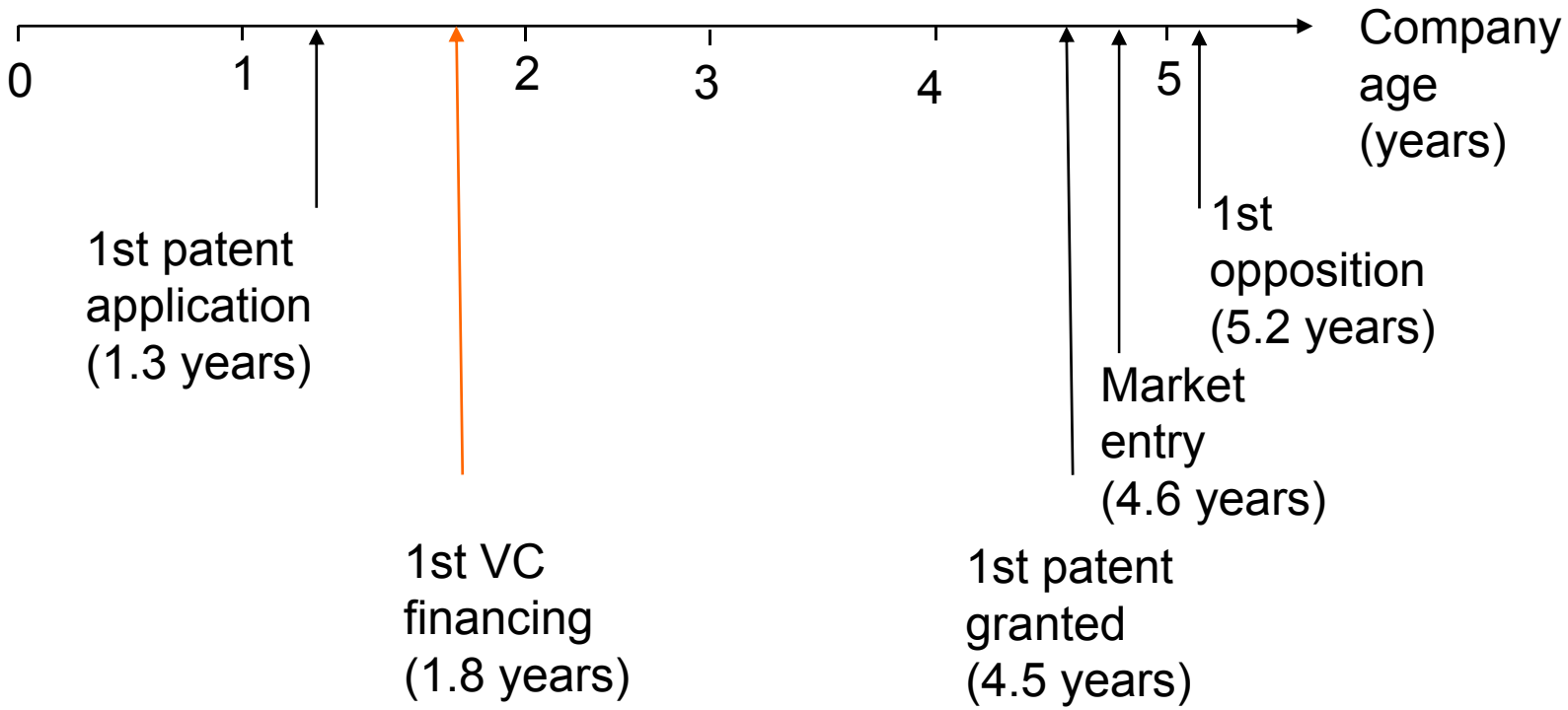
Control Variables I

- Technical capabilities
  - Skill set of employees
  - Number of biotechnical methods firm is working with at firm founding, e.g., DNA, proteins and molecules (up to nine)
- Years to market entry
  - Demand for external financing
- Number of early stage VC financings
  - Supply conditions in the market for VC financing
  - Includes seed and start-up financings
  - Information for Germany from the German Private Equity and Venture Capital Association (BVK)
  - Information for the UK from the British Private Equity and Venture Capital Association (BVCA)

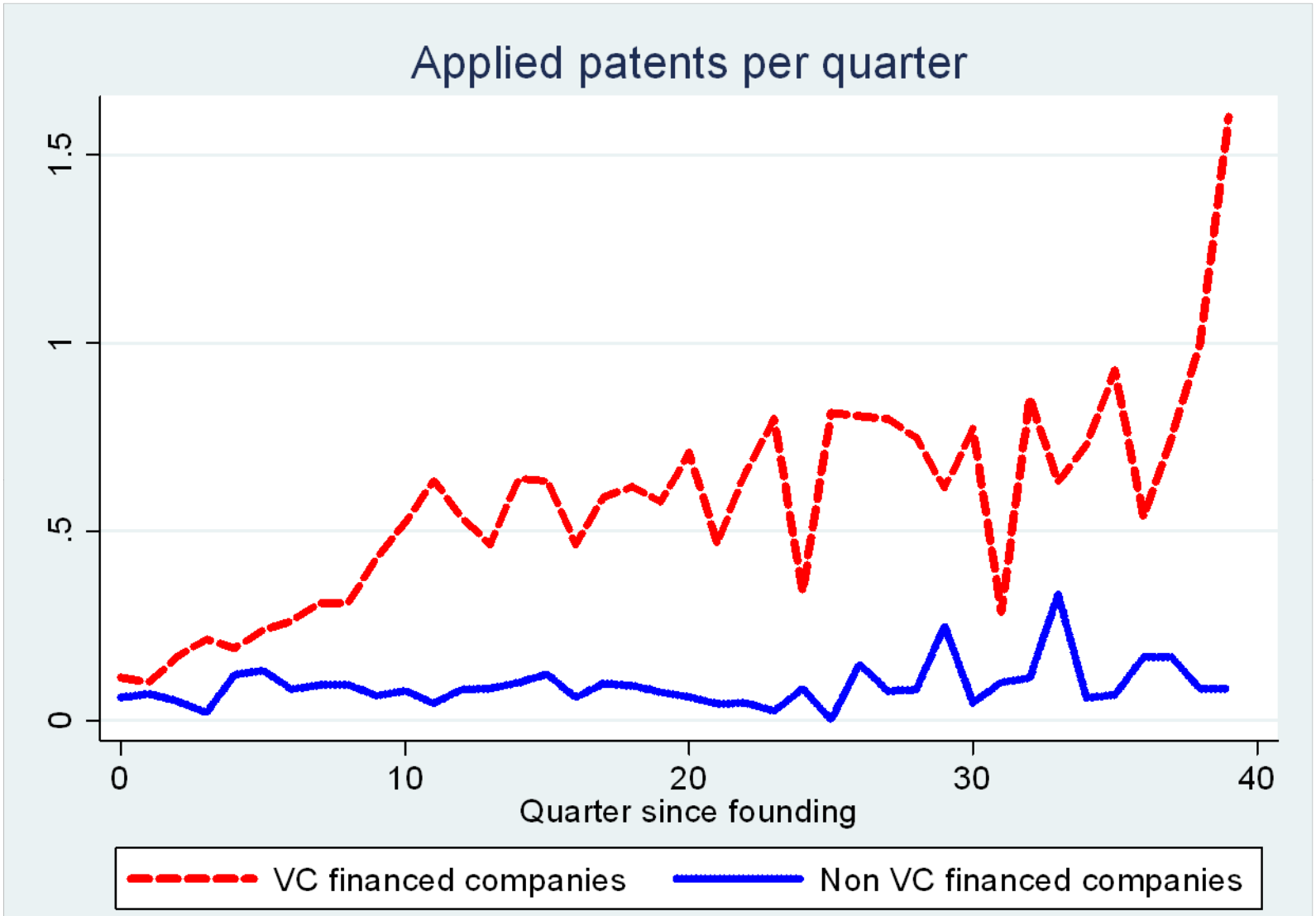
Control Variables II

- Type of founding
  - Spin-out science, spin-out private company, base category is independently founded
- Founding period
  - Dummies for founding period 1990-1995, 1996-1999 and 2003-2005, base category is 2000-2002
- Country control
  - Dummy for German company, base category is UK company

Timing of Events



Note: Average number of years given in brackets.


Applied patents per quarter
0
.5
1
1.5
0
10
20
30
40
Quarter since founding
VC financed companies
Non VC financed companies

Characteristics of Firms at Time of First VC Financing

- 61% of firms have at least applied for one patent
- Among the firms that have at least applied for one patent, the average number of patent applications is 7.3 (median 3)

- 13% of firms have at least one granted patent
- Among the firms that have at least one granted patent, the average number of granted patents is 4.4 (median 2)

Note: N=87 VC financed firms

Empirical Model

- Cox proportional hazard model with time-varying covariates
- Hazard: obtaining VC finance in a specific quarter
- All time-varying covariates are updated every calendar quarter

Examples Data Structure

Company 1						
Analysis time (quarters)	1	2	3	4	5	
Calender time (quarters)	I/02	II/02	III/02	IV/02	I/03	
VC financing	0	0	0	0	1	
Years to market entry	4	4	4	4	4	
Dummy application	0	1	1	1	1	
Application stock	0	1	2	2	3	
Company 2						
Analysis time (quarters)	1	2	3	4	5	6
Calender time (quarters)	III/04	IV/04	I/05	II/05	III/05	IV/05
VC financing	0	0	0	0	0	0
Years to market entry	2	2	2	2	2	2
Dummy application	0	0	0	0	0	0
Application stock	0	0	0	0	0	0

Descriptive Statistics Patent Variables

	VC financed firms			Non VC financed firms		
Variable	Obs	Mean	St. Dev.	Obs	Mean	St. Dev.
Dummy application	1411	0.69		1595	0.37	
Dummy grant	1411	0.09		1595	0.05	
Application stock #	976	5.12	6.65	584	3.32	3.45
Grant stock #	976	0.23	0.77	584	0.22	0.87
Share grant	976	0.04	0.15	584	0.04	0.14
Av. citations, incl. self #	976	1.54	3.33	584	0.87	0.92
Av. citations, excl. self #	976	1.38	3.16	584	0.81	0.85
Share x-type refs #	976	0.91	1.07	584	1.33	1.40
X-type references/claims #	976	0.06	0.08	584	0.08	0.10
Impact factor scientific lit. #	976	1.71	3.26	584	0.54	1.50
Share opposition #	976	0.01	0.05	584	0.001	0.01

Note: The statistics refer to the first 16 quarters after founding. Statistics with # are calculated for firms with at least one patent.

Descriptive Statistics Time-invariant Variables

	VC financed firms			Non VC financed firms		
Variable	Obs	Mean	St. Dev.	Obs	Mean	St. Dev.
Years to market entry	87	5.37	3.88	103	3.96	3.568
Technological capabilities	87	2.16	1.31	103	1.69	1.04
Spin-out science	87	0.61		103	0.53	
Spin-out company	87	0.06		103	0.12	
Independently founded	87	0.33		103	0.35	
German company	87	0.63		103	0.59	
Founded ‘90 - ’95	87	0.09		103	0.14	
Founded ‘96 - ‘99	87	0.39		103	0.23	
Founded ‘00 - ’02	87	0.46		103	0.49	
Founded ‘03 - ‘05	87	0.06		103	0.14	

Hazard Models – Patents as Signals

	1	2	3	4
Model	Cox	Cox	Cox	Log-logistic
Dummy application		0.677***		-0.777**
Ln application stock			0.441**	
Technical capabilities	0.232***	0.213**	0.182*	-0.465***
Years to market entry	0.053*	0.043*	0.046**	-0.077*
Early stage financings	0.001**	0.001**	0.001**	-0.002**
Observations	3001	3001	3001	3001
Pseudo R-squared	0.03	0.04	0.04	
Log likelihood	-412	-408	-406	-238

Note: Dependent variable is first quarter of obtaining VC finance. Coefficients not hazard ratios reported.
Gamma for log-logistic: 1.10

Cox Hazard Models – Anticipated and Revealed Quality

	1	2	3	4	5
Ln application stock	0.414***	0.415***	0.535***	0.498***	0.429***
Av. citations, incl. self	0.047**				
Av. citations, excl. self		0.043**			
Share x-type refs			-0.252+		
X-type refs/claims				-2.343	
Impact factor scientific lit.					0.021
Technical capabilities	0.187**	0.187**	0.184*	0.177*	0.183**
Years to market entry	0.047*	0.047*	0.047*	0.046*	0.044
Early stage financings	0.001**	0.001**	0.001**	0.001**	0.001**
Observations	3001	3001	3001	3001	3001
Pseudo R-squared	0.04	0.04	0.04	0.04	0.04
Log likelihood	-405	-405	-405	-406	-406

Note: + significance level 11%

Cox Hazard Models – Revealed Quality

	1	2	3	4
Dummy application no grant	0.617**			
Dummy grant	1.016***			
Ln stock application no grant		0.378***		
Ln grant stock		0.351		
Ln application stock			0.430***	0.431***
Share grant			0.333	
Share opposition				8.452**
Technical capabilities	0.204**	0.186**	0.181**	0.164*
Years to market entry	0.044	0.046	0.045	0.045
Early stage financings	0.001**	0.001**	0.001**	0.001**
Observations	3001	3001	3001	3001
Pseudo R-squared	0.04	0.04	0.04	0.05
Log likelihood	-407	-406	-406	-404

Further Results

US grants

- US grants often earlier than EPO grants
- Robustness check with earliest grant date for patents applied both at EPO and USPTO
- Grant variable has larger coefficient but not higher significance level

Second data source

- Robustness check with additional data set for German companies only. Data also includes companies going out of business but fewer company characteristics. Same results for patent applications found.

Interview Evidence (I)

- Five in-depth interviews with VCs in Germany and the UK

1. Future protection and signaling are both important aspects of patent applications
   - "There must be clear water for a patent. If not, they [the venture team] are out. Very simple."; "Without a patent, there is no prospect of high growth."
   - "It signals that homework has been done."; "It is a barrier of entry."
2. Patent applications reduce uncertainty of the investment decision, no cost reduction for due dilligence
   - "We look at the patent document, search report and do a web search. That is the intelligence of our company."
   - "Search report is useful to see what examiner thinks. From the prior art we learn who is also working in this area."

Interview Evidence (II)

3. Grants are preferred but not a condition
   - "Grant is preferable, but not important for the investment decision. We do seed investments. There is often no grant at this stage."
   - "We do not require a grant. We are able to decide on whether there is something valuable based on the patent document."
4. Opposition can be positive or negative for investment decision
   - "If the patent sustains – a positive investment signal for us."
   - "My reaction to an opposition depends. I want to understand why this firm is opposing."
   - "The opposition signals interest in the technology! Great. We might license the technology to the opponent."

Conclusions

- VCs take patent applications into account when evaluating the future prospects of firms
- VCs are able to evaluate technology, able to recognize valuable patents as indicated by received citations
- References to underlying prior art which call in question the inventive step and novelty of the patent application's claims show a negative but not significant effect
- No independent influence of grants. Due to long grant lag, patents are often not granted when firms need VC
- Opposition has positive influence

Implications

- Patents are quality signals
  - Managers can use patents to overcome the 'liability of newness'
  - Patents helpful for acquisition of outside resources
- Need for external financial resources impacts the disclosure strategy of a company
  - Trade-off between early discosure to obtain financing and late disclosure to benefit from secrecy and have longer protection period while product is in the market
- VCs should invest into patent reading ability, analysis of patent documents is expensive but can be worthwhile
- 'Pro-competitive' role of patents, patents allow market entry through securing of financing

Thank you for your attention!

Backup slides

Size of Effects

Cox model

- Having at least one patent application increases the hazard of obtaining VC financing by 97%
- An increase of the application stock by one standard deviation increases the hazard of obtaining VC financing by 50%

Log-logistic model

- Companies with at least one patent application receive VC financing 78% faster than companies without patent applications

Robustness Check Selection

- AGBO does not include firms going out of business before 2005. A startup that fails leaves the sample without the effect of patents on VC financing represented in the data
- Robustness check with different data source
- Data on all German biotechnology companies founded since 1991
- Information from Creditreform (Germany's largest credit rating agency)
- VC investment identified through ownership information
- Restriction to human biotechnology and to producers (as opposed to service companies or suppliers)
- Match with patent data from the EPO

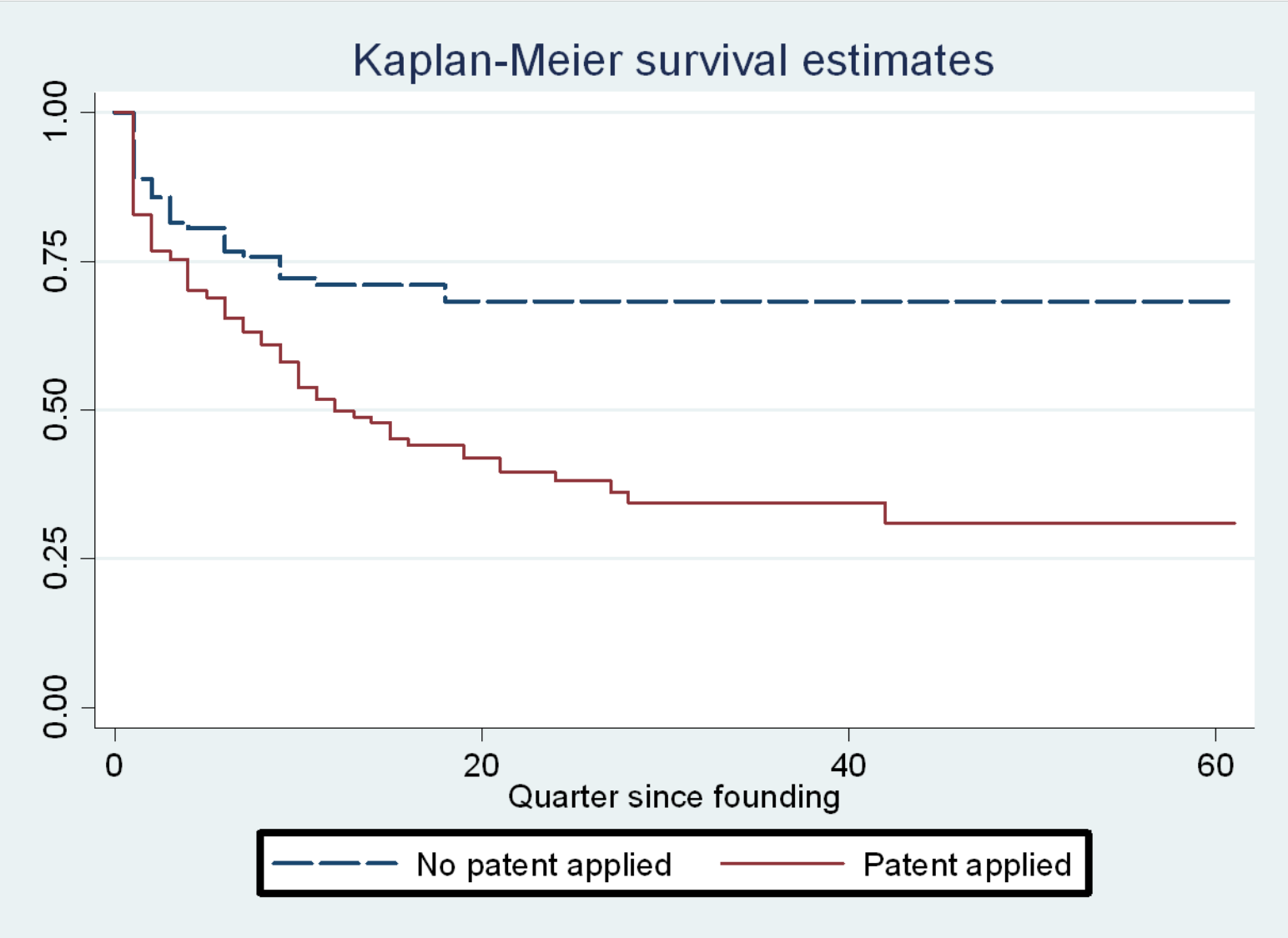
Sample Information

- 543 firms covered
- 401 firms still alive, 142 firms already out of business
- 112 firms received VC financing
  - 61% of those have applied for at least one patent at the time of financing
  - Companies with applications have on average applied for 4.3 patents (median 3) at the time of financing
- Mean size at founding is 8.9 employees (median 2)

Cox Hazard Models – Alternative Data Source

	1 alive	2 dead	3 alive	4 dead
Dummy application	1.810***	1.208***		
Ln application stock			0.771***	1.162***
Ln employees at founding	0.053	0.032	-0.023	-0.011
Early stage financings	0.002***	0.003***	0.003***	0.003***
Founded ‘90 - ‘95	-0.763	-1.619*	-0.68	-1.451*
Founded ‘00 - ‘04	-0.098	0.396	0.051	0.328
Observations	4744	1409	4744	1409
Pseudo R-squared	0.11	0.13	0.09	0.16
Log likelihood	-372	-148	-381	-143

Note: Dependent variable is first quarter of obtaining VC finance. Coefficients not hazard ratios reported.


Kaplan-Meier survival estimates
1.00
0.75
0.50
0.25
0.00
0
20
40
60
Quarter since founding
No patent applied
Patent applied