

Patent Collateral, Investor Commitment, and the Market for Venture Lending

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Online Appendix

Table OA1

Firm-specificity: robustness checks

This table tests the robustness of the collateral channel for venture lending firm-specificity results using alternative controls for patent "quality". All columns present OLS regression estimates of the annual likelihood a start-up receives a loan. The unit of analysis is a start-up–calendar year, with an unbalanced panel. Column 1 replaces the time-varying control for portfolio quality, *Patent Portfolio Size (citation-weighted)*, with a more restricted version based solely on the number of patent citations received from other entities. Column 2 replaces the *Patent Portfolio Size (citations-weighted)* variable with its un-weighted counterpart and controls separately for the average number of patent citations that the start-up receives from others. Column 3 re-defines *Firm-Specificity of Patent Assets* as an indicator set to one for start-ups with firm-specificity above the sector median, else zero. Column 4 adds calendar-year*sector fixed effects. In all regressions the dependent variable, *Debt*, is equal to one if the firm is involved in at least one security interest agreement in a calendar year, and zero otherwise. *Post VC* is an indicator that switches from zero to one in the year that the start-up first receives venture capital (VC) financing. *Profitable* indicates whether or not the start-up is profitable as of a given calendar year. *Patent Portfolio Size (citation-weighted)* is the cumulative number of patent citations received within three years of each patent being granted. *Patent Portfolio Size* is the cumulative number of patents applied for and granted to the start-up by a given year. *Firm-Specificity of Patent Assets* is the share of citations that are self-citations. *Patent Market Liquidity* is the start-up level patent-portfolio combined probability that a patent will be traded in a year. *Patent Citations Received from Others per Patent* is the number of patent citations received that the patents of the portfolio of a start-up receive from other firms. Robust standard errors, clustered at the start-up level, are reported in parentheses. Statistical significance is denoted *=10%, **=5%, ***=1%.

Variable	OLS <i>Debt</i> (1)	OLS <i>Debt</i> (2)	OLS <i>Debt</i> (3)	OLS <i>Debt</i> (4)
<i>Post VC</i>	0.028*** (0.010)	0.028*** (0.010)	0.027*** (0.010)	0.027*** (0.010)
<i>Patent Market Liquidity</i>	1.271*** (0.234)	1.227*** (0.233)	1.360*** (0.246)	1.560*** (0.251)
<i>Firm Specificity</i>	0.021 (0.044)	0.026 (0.045)		0.008 (0.043)
<i>Firm Specificity x Patent Market Liquidity</i>	-2.116** (0.944)	-2.625*** (0.967)		-1.868** (0.951)
<i>High Firm Specificity</i>			0.033* (0.020)	
<i>High Firm Specificity x Patent Market Liquidity</i>			-0.624* (0.374)	
<i>Funds Raised Last Round</i>	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
<i>Patent Portfolio Size (citation-weighted)</i>	0.000 (0.000)		0.000 (0.000)	0.000 (0.000)
<i>Patent Portfolio Size</i>		0.001** (0.000)		
<i>Patent Citations Received from Others per Patent</i>		-0.002 (0.001)		
<i>Profitable</i>	-0.008 (0.016)	-0.009 (0.016)	-0.008 (0.016)	-0.008 (0.016)
Year fixed-effects	Y	Y	Y	Y
Startup fixed-effects	Y	Y	Y	Y
Robustness Checks	Patent Portfolio Size is weighted by number of patent citations received from others	Patent Portfolio Size is unweighted and Patent portfolio quality is based on the average number of patent citations that the patents in portfolio received from <i>others</i>	Firm-Specificity is an indicator (High Firm Specificity equals one if startup's firm-specificity is above the median firm-specificity of the sector; zero otherwise)	Year x Sector Effects
Number of start-ups	1,519	1,519	1,519	1,519
Number of observations	11,298	11,298	11,298	11,298

Table OA2

Patent market liquidity: robustness checks

This table tests the robustness of the collateral channel for venture lending patent market liquidity results using alternative controls for mergers and acquisitions (M&A) activity. All columns present OLS regression estimates of the annual likelihood a start-up receives a loan. The unit of analysis is a start-up–calendar year, with an unbalanced panel. In Column 1, M&A activity is based on the annual number of transactions in the sector divided by the number of active companies in the sector that year (*M&A per Firm*). Column 2 uses an alternative measure, *M&A Share of Patents Transacted*, based on the annual number of M&A-driven patent sales in the sector divided by the stock of patents in the sector available for trading that year. Column 3 replicates our original estimation but removes patents sold via M&A from the *Patent Market Liquidity* variable. The dependent variables, *Debt*, is equal to one if the start-up is involved in at least one security interest agreement in a calendar year, and zero otherwise. *Post VC* is an indicator that switches from zero to one in the year that the start-up first receives venture capital (VC) financing. *Funds Raised Last Round* (millions of dollars) is the total amount of venture capital raised in the latest financial round. *Patent Portfolio Size (citation-weighted)* is the cumulative number of patent citations received within three years of each patent being granted. *Firm-Specificity of Patent Assets* is the share of citations that are self-citations. *Patent Market Liquidity* is the start-up level patent-portfolio combined probability that a patent will be traded in a year. *Profitable* indicates whether or not the start-up is profitable as of a given calendar year. *Founding Year* is the founding year of the start-ups. Venture capital round data are from VentureOne. Merger and acquisition bids and actual transactions involving companies in a given year and in the same technology sector of the focal start-up are from the Thomson Reuters SDC Platinum database. Robust standard errors, clustered at the start-up level, are reported in parentheses. Statistical significance is denoted *=10%, **=5%, ***=1%.

Variable	OLS <i>Debt</i> (1)	OLS <i>Debt</i> (2)	OLS <i>Debt</i> (3)
<i>Post VC</i>	0.028*** (0.010)	0.028*** (0.010)	0.027*** (0.010)
<i>Patent Market Liquidity</i>	1.294*** (0.235)	1.404*** (0.236)	0.916*** (0.311)
<i>Firm Specificity</i>	0.019 (0.045)	0.022 (0.045)	0.005 (0.047)
<i>Firm Specificity * Patent Market Liquidity</i>	-2.142** (0.957)	-2.201** (0.954)	-1.830* (1.099)
<i>Funds Raised Last Round</i>	-0.001*** (0.000)	-0.001*** (0.004)	-0.001*** (0.000)
<i>Patent Portfolio Size (citations-weighted)</i>	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
<i>Profitable</i>	-0.008 (0.016)	-0.007 (0.012)	-0.008 (0.016)
<i>Merger and Acquisition Activity</i>	0.002 (0.027)	-2.091* (1.136)	
Robustness Checks	Merger and Acquisition Activity based on number of merger and acquisition bids per firm	Merger and Acquisition Activity based on patents transacted due to merger and acquisitions	Patent Market Liquidity measure computed excluding patents transacted due to mergers and acquisitions
Year fixed-effects	Y	Y	Y
Year x sector fixed-effects	N	N	N
Startup fixed-effects	Y	Y	Y
Founding year fixed-effects	N	N	N
Sector fixed-effects	N	N	N
Number of start-ups	1,519	1,519	1,519
Number of observations	11,298	11,298	11,298

Table OA3

The sale of patents of failed startups and patent market liquidity

This table presents estimates of the relationship between the decision that a failed start-up sells a patent and patent-market trading in the overall patent market. The unit of analysis is a start-up–calendar year until the year a start-up sells its first patent. Columns 1 and 2 present the coefficients of linear probability models. Columns 3 and 4 show the hazard ratios of an exponential proportional hazard model. The dependent variable in Column 1 and 2, *Sale*, is an indicator that switches from zero to one when the start-up sells its first patent. *Patent Market Liquidity* is the start-up level patent-portfolio combined probability that a patent will be sold in a year in the broader patent market. *Has Top-Tier VC* is an indicator that turns from zero to one in the year that the start-up is backed by at least one investor with a reputation score in the top quartile of the annual distribution of scores reported in Lee, Pollock, and Jin (2011) and remains one thereafter. *Founding Year* is the start-up's founding year. *Patent Portfolio Size (citation-weighted)* is the cumulative number of patent citations received within three years of each patent being granted. *Previously Received a Loan* is equal to one if the failed start-up obtained at least one loan before failure. Standard errors are reported in parentheses. Statistical significance is denoted *=10%, **=5%, ***=1%.

Variable	OLS	OLS	Proportional Hazard Model - MLE	Proportional Hazard Model - MLE
	Marginal Effect Sale (1)	Marginal Effect Sale (2)	Hazard Ratio Sale (3)	Hazard Ratio Sale (4)
<i>Patent Market Liquidity</i>	2.828*** (0.715)	2.929*** (0.747)	1.359*** (0.095)	1.497*** (0.136)
<i>Has Top-Tier VC</i>	0.050* (0.025)	0.048* (0.026)	1.337* (0.230)	1.313 (0.230)
<i>Patent Portfolio Size (citation-weighted)</i>	0.001*** (0.000)	0.001*** (0.000)	1.003*** (0.001)	1.003*** (0.001)
<i>Previously Received a Loan</i>	0.062** (0.027)	0.061** (0.028)	1.403** (0.232)	1.420** (0.237)
Founding Year fixed-effects	Y	Y	Y	Y
Year fixed-effects	Y	Y	Y	Y
Sector fixed-effects	Y	Y	Y	Y
Year x Sector fixed-effects	N	Y	N	Y
Number of startups	285	285	285	285
Number of observations	989	989	989	989