

## APPENDIX

**Table A-1. Main Variables and Data Sources**

	Definition	Data Source
<b>Dependent Variable</b>		
$DEBT_{it}$	Indicator set to 1 if at least one patent awarded to startup $i$ is involved in a “security interest” agreement (i.e., used to secure a loan) in year $t$	USPTO Assignments Data
<b>Main Independent Variables</b>		
$Post\ VC_{it}$	Indicator that switches from zero to one in the year that the startup first receives VC financing	VentureSource
$Has\ Top-Tier\ VC_{it}$	1 if the startup is backed by a VC in the top 25% of the annual LJP reputation score distribution (sometimes time-invariant; see notes on output tables)	LPJ2011
$Recent\ Fund_i$	1 if the average age of the youngest funds managed by a startup’s investors in the year 2000 is less than 5 years old	PREQIN
$Patent\ Market\ Liquidity_{it}$	startup $i$ ’s combined probability (averaged across patents in its portfolio as of year $t$ ) that patents issued in the prior 8 years in its sector are traded by year $t$	USPTO Reports <sup>a</sup> ; Graham and Vishnubhakat (2013) <sup>b</sup> ; RPX Corp
$Firm-Specificity_{it}$	Proxy for degree to which the value of startup $i$ ’s patents are “firm-specific”; measured as the share of patents citing startup $i$ ’s patents within three years that are made by the focal startup (i.e., are “self-cites”). In the few instances where no patents within a startup’s portfolio are cited within three years, we set the variable to zero.	USPTO patent data
<b>Additional Startup-Level Covariates</b>		
$Patent\ Portfolio\ Size\ (citation\ weighted)_{it}$	Cumulative # successful U.S. patent applications of startup $i$ by year $t$ , weighted by the # of citations each patent receives 3-years post-grant	Delphion
$Funds\ raised\ last\ equity\ round_{it}$	Millions of US\$ raised in startup $i$ ’s last equity financing round as of year $t$ ,	VentureSource
$Profitable_{it}$	1 if the startup is profitable.	VentureSource
$Founding\ Year_i$	Year startup $i$ was founded	VentureSource
$Sector_i$	Startup $i$ ’s primary sector: medical devices, semiconductor devices, or software	VentureSource
$Year_t$	Indicates calendar year (1987-2008)	VentureSource
$Time\ Period_t$	Indicates if calendar year is in pre-boom (1987-1997), boom (1998-1999), or post-boom (2000-2008) period.	VentureSource
<b>M&amp;A Intensity Measures</b>		
$M\&A\ per\ Firm$	Annual number of M&A transactions in the industry divided by the number of active companies in the industry that year	SDC Platinum
$M\&A\ share\ of\ patents\ transacted$	Annual number of patents transacted due to M&A activity in a given year and technology sector divided by the stock of patents that could have been traded in that year	SDC Platinum

<sup>a</sup> The list of class-subclass combinations relevant for medical device inventions is available from the USPTO website at: <http://www.uspto.gov/web/offices/ac/ido/oeip/taf/meddev.htm>. A parallel list for semiconductor devices is at: <http://www.uspto.gov/web/offices/ac/ido/oeip/taf/semicon.htm>.

<sup>b</sup> The class-subclass list relevant for computer software invention, equivalently compiled by USPTO examiners, is reported in Graham and Vishnubhakat (2013) on page 75, footnote 7.

**TABLE A-2. Firm-specificity: Robustness checks**

Estimation Method Dependent Variable	1	2	3	4
	OLS Debt	OLS Debt	OLS Debt	OLS Debt
Post VC	0.028*** (0.010)	0.028*** (0.010)	0.027*** (0.010)	0.027*** (0.010)
Patent Market Liquidity	1.271*** (0.234)	1.227*** (0.233)	1.360*** (0.246)	1.560*** (0.251)
Firm Specificity	0.021 (0.044)	0.026 (0.045)		0.008 (0.043)
Firm Specificity x Patent Market Liquidity	-2.116** (0.944)	-2.625*** (0.967)		-1.868** (0.951)
High Firm Specificity			0.033* (0.020)	
High Firm Specificity x Patent Market Liquidity			-0.624* (0.374)	
Funds Raised Last Round	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Patent Portfolio Size (citation-weighted)	0.000 (0.000)		0.000 (0.000)	0.000 (0.000)
Patent Portfolio Size		0.001** (0.000)		
Patent Citations Received from Others per Patent		-0.002 (0.001)		
Profitable	-0.008 (0.016)	-0.009 (0.016)	-0.008 (0.016)	-0.008 (0.016)
Robustness Checks	Patent Portfolio Size is weighted by number of patent citations received from <i>others</i>	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 (1=High Firm Specificity if startup's firm-specificity is above the median firm-specificity of the sector; 0 otherwise)	Year x Sector Effects
Year FE	YES	YES	YES	YES
Startup FE	YES	YES	YES	YES
No. of Startups	1,519	1,519	1,519	1,519
Observations	11,298	11,298	11,298	11,298

NOTE: The unit of analysis is a startup-calendar year, with an unbalanced panel. Debt = 1 if the firm is involved in at least one security interest agreement in a calendar year. *Post VC* = Indicator that switches from zero to one in the year that the startup first receives VC financing. *Profitable* = indicates whether or not the startup 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 startup by a given year. *Firm-specificity* of patent assets is the share of citations that are self-citations. *Patent Market Liquidity* is the startup-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 startup receive from other firms. Robust standard errors, clustered at the startup level, are reported in parenthesis. Statistical significance: \* 10 percent, \*\* 5 percent, \*\*\* 1 percent.

**TABLE A-3. Patent Market Liquidity: Robustness checks**

Estimation Method	1	2	3
Dependent Variable	OLS	OLS	OLS
	Debt	Debt	Debt
Post VC	0.028*** (0.010)	0.028*** (0.010)	0.027*** (0.010)
Patent Market Liquidity	1.294*** (0.235)	1.404*** (0.236)	0.916*** (0.311)
Firm Specificity	0.019 (0.045)	0.022 (0.045)	0.005 (0.047)
Firm Specificity * Patent Market Liquidity	-2.142** (0.957)	-2.201** (0.954)	-1.830* (1.099)
Funds Raised Last Round	-0.001*** (0.000)	-0.001*** (0.004)	-0.001*** (0.000)
Patent Portfolio Size (citations-weighted)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Profitable	-0.008 (0.016)	-0.007 (0.012)	-0.008 (0.016)
Merger and Acquisition Activity	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 FE	YES	YES	YES
Year x Sector FE	NO	NO	NO
Startup FE	YES	YES	YES
Founding Year FE	NO	NO	NO
Sector FE	NO	NO	NO
No. of Startups	1,519	1,519	1,519
Observations	11,298	11,298	11,298

NOTE: The unit of analysis is a startup-calendar year, with an unbalanced panel. Debt = 1 if the firm is involved in at least one security interest agreement in a calendar year. *Post VC* = Indicator that switches from zero to one in the year that the startup first receives VC financing. *Funds Raised Last Round* (million \$) 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 startup-level patent-portfolio combined probability that a patent will be traded in a year. *Profitable* = indicates whether or not the startup is profitable as of a given calendar year. *Founding Year* is the founding year of the startups. 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 startup were obtained from the Thomson Reuters SDC Platinum database. Robust standard errors, clustered at the startup level, are reported in parenthesis. Statistical significance: \* 10 percent, \*\* 5 percent, \*\*\* 1 percent.

**TABLE A-4. The Sale of Patents of Failed Startups and Patent Market Liquidity**

	1	2	3	4
Estimation Method	OLS	OLS	Proportional Hazard Model - MLE	Proportional Hazard Model - MLE
Dependent Variable	Marginal Effect Sale	Marginal Effect Sale	Hazard Ratio Sale	Hazard Ratio Sale
Patent Market Liquidity	2.828*** (0.715)	2.929*** (0.747)	1.359*** (0.095)	1.497*** (0.136)
Has Top-Tier VC	0.050* (0.025)	0.048* (0.026)	1.337* (0.230)	1.313 (0.230)
Patent Portfolio Size (citation-weighted)	0.001*** (0.000)	0.001 (0.000)	1.003*** (0.001)	1.003*** (0.001)
Previously Received a Loan	0.062** (0.027)	0.061** (0.028)	1.403** (0.232)	1.420** (0.237)
Founding Year FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES
Year x Sector FE	NO	YES	NO	YES
No. of Startups	285	285	285	285
Observations	989	989	989	989

NOTE: The first two columns present the coefficients of linear probability models whereas the second two columns show the hazard ratios of an exponential proportional hazard model. The unit of analysis is a startup-calendar year until the year a startup sells its first patent. *Sale* is an indicator that switches from zero to one when the sells its first patent. *Patent Market Liquidity* is the startup-level patent-portfolio combined probability that a patent will be traded in a year. *Has Top-Tier VC* is an indicator that turns from 0 to 1 in the year that the startup is backed by at least one investor with a reputation score in the top quartile of the annual distribution of scores reported in Pollock et al. (2011) and remains 1 thereafter. *Founding Year* is the startup'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* = 1 if the failed startup obtained at least one loan before failure. Standard errors are reported in parenthesis. Statistical significance: \* 10 percent, \*\* 5 percent, \*\*\* 1 percent.