Corporate Investment and Innovation in the Presence of Competitor Constraints

Internet Appendix

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A Additional Empirical Analysis

In this Internet Appendix, we outline supplemental analyses that test the robustness of our findings from the main text. We start by illustrating the parallel trends from our quasi-experimental design from Section 6 of the main text. Then we demonstrate that our results on investment levels are robust to an alternative approach to defining competitors. Specifically, in Table IA1, we reestimate the specifications from Table 2 of the main text using a clustering procedure outlined in Jaffe (1986) to define competitors according to technology classes, rather than patent citations.

In Table IA2, we estimate our specifications from Table 2 of the main text with $Industry \times Year$ fixed effects instead of $Year$ dummies, according to the Fama-French 48 industry classifications. The $Industry \times Year$ fixed effects account for time-varying industry shocks to investment behavior and financial constraints. In Table IA3, we estimate Equation (1) (Panel B of Table 2 in the main text) with 2- and 7-year competitor relationships instead of the 5-year assumption in our general analysis.

In Section A.2 we provide detailed definitions of the financial constraint measures used throughout our analysis. In Tables IA4 and IA5, we repeat our analysis of Tables 2 and 3 of the main text separately for equity- and debt-based constraint measures developed by Hoberg and Maksimovic (2015).

In Table IA6, we perform a subsample analysis of Table 3 from the main text according to patent intensity. In Table IA7, we demonstrate the robustness of our patent portfolio distance results (Table 3 in the main text) using an alternative construction of the Mahalanobis distance. In Table IA8 we explore measures of distance that treat patent technology classes as orthogonal (Euclidean distance and Pairwise correlation). In Table IA9 (IA10), we perform a matched sample of our AJCA (junk bond) analysis from Table 4 of the main text. Then Tables IA11–IA13 explore the robustness of our opportunistic hiring and inventor departure results and interactions with noncompete enforceability.

Finally, we allow for nonlinear specifications of our analysis in Table 2 of the main text, as well as in our opportunistic hiring and inventor departure analysis from Tables 7 and 8. Specifically, in Table IA14, we estimate a Poisson specification of Panel B from Table 2; and in Tables IA15 and IA16, we estimate logit specifications of Equations 3 and 4 (Tables 7 and 8). Overall, the results from our robustness analysis are consistent with the analysis presented in the main text. While it is likely that our analysis includes problems that we have not accounted for, the consistency of our results increases our confidence that we have documented a first-order relationship between competitor financing constraints and investment behavior.

A.1 K-means technology clusters

We implement an alternative to our citation-based method of defining competitors from the main text. In particular, we employ a clustering procedure outlined in Jaffe (1986) and implemented in Jaffe (1989). First, we create a vector that represents each company's total patent portfolio from 1980 to 2006 across the 37 technology classes as defined by HJT (2001). Then we normalize each firm's patent portfolio to have a distance of 1 from the origin. This normalization alleviates the concern that clusters are overly dependent on patent portfolio size. Second, using these vectors, we generate 21 firm clusters following Jaffe

(1989). Jaffe (1989) finds that 21 clusters minimize the patent portfolio distance without being too restrictive. Specifically, we implement K-means clustering – an iterative procedure in which clusters are formed, distances to the cluster average are calculated, and firms are resorted until the algorithm converges and the firm clusters no longer change.

Results are reported in Table IA1. Overall, the results are consistent with those of the main text. The competitor constraint variable (*Comp const.*) is statistically significant in Columns 1–5, but it is insignificant at conventional levels in Column 6. Note that the sample size is larger than that for Table 2 of the main text, because 21 clusters are much broader classifications than our citation-based approach. Thus, the five competitor per firm restriction is not binding for any of the 21 clusters whereas several firms have fewer than five competitors according to the citation-based approach.

The economic magnitudes are smaller than the estimates from our citation-based competitors. This is likely due the broader grouping from the 21 clusters. That is, more firms will be considered related under this approach, while the average strength of relationship will be much weaker. A citation-based network mitigates this issue by only linking related firms that are actively aware of each other's recent innovations (as evidenced by the citations). However, we cannot assume that firms are aware of all patents in a given technology class. Furthermore, it is not always evident that firms in the same technological classes work on similar technologies. For instance, Jaffe (1986) points to an example motivated by Jacob Schmookler in which patents for both toothpaste and for a manure spreader are classified into the same patent subclass relating to "dispensing of solids." Because patent technology classes are fairly broad (21 clusters for 4,717 firms in our sample), many similar examples are likely present in the data.

A.2 Financial constraint measures

For measures of financial constraints, we use three standard empirical proxies from recent literature. First, we use the Whited-Wu (*WW*) financial constraint index developed in Whited and Wu (2006), who provide structural estimates of an investment Euler equation. Parameter estimates from the structural equation are used to calculate a constraint index from commonly used accounting variables:

$$\begin{aligned} WW_{it} &= -0.091CF_{it} - 0.062DIVPOS_{it} + 0.021TLTD_{it} - 0.044LNTA_{it} \\ &\quad +0.102ISG_{it} - 0.035SG_{it}, \end{aligned}$$

where *CF* is a firm's cash flow, *DIVPOS* is a dummy variable indicating whether a firm pays cash dividends, *TLTD* is the ratio of long-term debt to total assets, *LNTA* is the log of total assets, *ISG* is the 3-digit SIC industry sales growth, and *SG* is firm-level sales growth.

Second, we use the the Size-Age (*SA*) index developed by Hadlock and Pierce (2010), who calculate the *SA* index as

$$SA_{it} = -0.737LNTA_{it} + 0.043LNTA_{it}^2 - 0.040AGE_{it},$$

where *AGE* is a firm's age and *LNTA* is the natural log of total assets. While there are potential drawbacks to *SA* as a measure of constraints, the main benefit of this index is that it can be easily constructed for all firms.

As our final measure, we use the Delayed Investment (*Delay*) constraint index developed by Hoberg and Maksimovic (2015). Similar to Hadlock and Pierce (2010), Hoberg and Maksimovic (2015) gather information on constraints from 10-Ks. Specifically, Hoberg and Maksimovic (2015) create a *Delay* index according to the extent to which firms mention curtailing, abandoning, or postponing investment. By automating the textual analysis of firm 10-Ks, Hoberg and Maksimovic (2015) can measure the *Delay* index directly for a large set of firms, rather than extrapolating values from accounting information. Note, however, that the *Delay* index is available from 1996 to 2013, whereas the other measures can be computed for any year in which data are available in Compustat. For this reason, our samples are generally smaller when using the *Delay* index as our measure of financial constraints.

We define a competitor's financial constraints as the average of the *WW* (*SA*, *Delay*) constraint index for a firm's competitors in year t:

$$Comp\,const_{i,t} = \frac{\sum_{j \in C_{it}} FC_{j,t}}{num(C_{it})},$$

where C_{it} is the set of firms competing with firm i, and $num(C_{it})$ is the number of firms in C_{it}, defined for the text-based and citation-based networks, respectively. Firm i is excluded from C_{it}. We winsorize (1% each tail) and then normalize these financial constraint variables to have a mean of 0 and a standard deviation of 1 to aid in the interpretation of the results.

A.2.1 Equity- and debt-based financial constraints

In addition to their delayed investment constraint index (*Delay*), Hoberg and Maksimovic (2015) develop separate measures of constraints depending on whether firms report equity or debt related financing issues in their 10-K. For instance, Hoberg and Maksimovic (2015) define a firm as equity constrained if they describe postponing or abandoning investment in conjunction with issues related to equity financing, such as "seek equity investments" or "access equity markets."

We run additional empirical tests for our analysis in Tables 2 and 3 of the main text separately for each of the constraint indices developed in Hoberg and Maksimovic (2015). In Table IA4, we report OLS regression estimates for the relationship between corporate investment and competitor financing constraints. The set up follows that of Table 2 in the main text except that competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) are calculated according to the unconditional *Delay* index (Columns 1 and 2), the equity-based delay index *Equity delay* index (Columns 3 and 4), and the debt-based delay index *Debt delay* (Columns 5 and 6). Similarly, in Table IA5, we report OLS regression estimates for the relationship between investment composition similarity and competitor financing constraints with the competitor-pair-year is the unit of observation. The set up follows that of Table 3 in the main text except that competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) are calculated according to the unconditional *Delay* index (Columns 1–3), the *Equity delay* index (Columns 4–6), and the *Debt delay* index (Columns 7–9).

In Table IA4, equity based competitor constraints (*Equity delay*) exhibit a stronger effect

than debt based competitor constraints on R&D, patents, and citations. The effect on capital expenditures is similar across all three measures of constraints. A similar but less distinct pattern is also present in Table IA5. In particular, all three measures of competitor constraints exhibit a very similar effect on product market similarity, whereas equity based competitor constraints exhibit a stronger effect on patent portfolio distances (MD) than debt based competitor constraints.

These results are consistent with interpretation outlined in Hoberg and Maksimovic (2015) that equity constraints are associated with growth opportunities and informational asymmetries. A large literature highlights that financing innovation with debt is challenging because of the payoff convexity of innovative projects and the low collateral value of patents (see Hall and Lerner (2010) for a survey). Thus, we should expect equity constraints to strongly affect a firm's innovative investments and potentially open the door to aggressive investment by competitors.

A.3 Patent portfolio distance, financial constraints, and patent intensity

We implement subsample analyses by splitting firms based on total patent activity (innovative intensity). One reason that we might expect a stronger effect for firms with above median (unscaled) patent activity is that our results for patent portfolio distance could be capturing differences in firms' innovative intensity. Additionally, it could be the case that larger firms have more internal capital that our control variables do not perfectly capture. The easier access to capital may allow large firms to more easily deploy resources in order to respond to competitor constraints. Alternatively, we may expect a stronger effect for firms with below median (unscaled) patent activity because smaller firms face less internal bureaucracy, which affords them a better opportunity to respond to changes in competitors' financial conditions. Existing research also suggests that larger firms are more likely to acquire innovation rather than develop their own (KPS). This stylized fact could result in disproportionately more new patent activity for small firms that are less likely to acquire innovation as an alternative. Ultimately, whether larger or smaller firms respond more aggressively to competitor constraints is an empirical question.

We split our sample above and below the cross sectional median number of (unscaled) patents each year and re-estimate our specifications from Table 3 for each subsample. The results of this procedure are presented in Table IA6. In both panels, we find that firms shift their patent portfolio to compete more aggressively (i.e., by reducing their distance) with constrained competitors. This suggests that the competitive effects that we document exist in both subsamples and that any potential confounding effects related to innovative intensity do not overpower the competitive channel that we have posited. Comparing the coefficient estimates across subsamples, we find that, on average, the patent portfolios of firms with below median (unscaled) patent activity are more responsive to competitor constraints than those of firms with above median (unscaled) patent activity. Indeed, the coefficient estimates for the small firm sample are, on average, more than twice as large (in magnitude) as the coefficient estimates for the large firm subsample. In unreported results, we split the sample by firm sales and market capitalization and obtain very similar results.

Overall, our subsample analysis suggests that smaller firms shift their patent portfolios to a greater extent than large firms in response to competitor financial constraints. While differences in internal bureaucracy or acquisition behavior could explain the larger effect

exhibited by small firms, we cannot distinguish between these potential effects, as well as other potential explanations, given the data that we have available. In any case, it does not appear that our primary findings are driven by large patent portfolio distances of firms with high patent intensity.

A.4 Alternative definitions of patent portfolio distance

In this section, we explore alternatives to our definitions of patent portfolio distance. First, we implement a "pseudo" first-difference version of Mahalanobis distance in which we compare the 3-year window of ex post distance with a 3-year window of ex ante distance. Specifically, we define the ex post Mahalanobis distance between normalized patent portfolios of firms i and j as

$$MD_{i,j,t}^{ex\,post} = \sqrt{(\mathbf{P_{i,t,t+2}} - \mathbf{P_{j,t-3,t-1}})\Omega(\mathbf{P_{i,t,t+2}} - \mathbf{P_{j,t-3,t-1}})},$$

where $\mathbf{P_{i,t,t+2}}$ is a 37×1 vector representing the normalized portion of firm i's patents in each ordered subcategory from year t to $t+2$, and $\mathbf{P_{j,t-3,t-1}}$ is a 37×1 vector representing the normalized portion of firm j's patents in each ordered subcategory from year $t-3$ to $t-1$, and Ω is the weighting matrix with the diagonal elements equal to 1 and the off-diagonal elements equal to the uncentered correlations between technology classes.[35] Thus, the *ex post* MD is the same MD that we calculate in the main text. Similarly, we define the ex ante Mahalanobis Distance between normalized patent portfolios of firms i and j as:

$$MD_{i,j,t}^{ex\,ante} = \sqrt{(\mathbf{P_{i,t-3,t-1}} - \mathbf{P_{j,t-3,t-1}})\Omega(\mathbf{P_{i,t-3,t-1}} - \mathbf{P_{j,t-3,t-1}})}$$

where $\mathbf{P_{i,t-3,t-1}}$ is a 37×1 vector representing the normalized portion of firm i's patents in each ordered subcategory from year $t-3$ to $t-1$, and $\mathbf{P_{j,t-3,t-1}}$ is a 37×1 vector representing the normalized portion of firm j's patents in each ordered subcategory from year $t-3$ to $t-1$. Thus, the ex ante MD measures the distance between the normalized patent portfolios of firm i and firm j over the same 3-year window (3 years before year t). Then we take the difference in these two versions of MD and define

$$MD_{i,j,t}^{PsuedoFD} = MD_{i,j,t}^{ex\,post} - MD_{i,j,t}^{ex\,ante}$$

We calculate the $MD_{i,j,t}^{PsuedoFD}$ to help isolate movements by firm i, holding the patent portfolio of firm j constant. With this difference, we can study whether firm i's new patent portfolio has more or less overlap with that of firm j from the recent past. The average, median, and standard deviation of $MD_{i,j,t}^{PsuedoFD}$ in the sample are 0.0142, 0.0087, and 0.1618, respectively. Following our analysis in Section 5.2 of the main text, we estimate the following equation:

$$\begin{aligned} MD_{i,j,t}^{PsuedoFD} &= \alpha_{i,t} + \gamma_1 Comp\,const_{j,t-1} + \gamma_2 Own\,const_{i,t-1} \\ &\quad + \beta Controls_{i,j,t-1} + \epsilon_{i,t}. \end{aligned} \tag{5}$$

Table IA7 presents estimates of Equation (5). We use the *WW* index (Columns 1–3), the *SA* index (Columns 4–6), and the *Delay* index (Columns 7–9) to construct our

[35] We calculate cross category correlations in Ω after collapsing patents to the firm level, so that each firm represents one observation in the full sample.

constraint variables. Specifications in Columns 1, 4, and 7 include firm and year fixed effects, specifications in Columns 2, 3, 5, 6, 8, and 9 include $Firm \times Year$ fixed effects, and specifications in Columns 3, 6, and 9 also include competitor-pair fixed effects. We cluster standard errors at the firm level or the competitor-pair level to account for the overlap of $MD_{i,j,t}^{PsuedoFD}$ across time.

Overall, the estimates are generally consistent with those of Table 3 from the main text. Specifically, a 1-standard-deviation tightening of competitor constraints results in a 13.3%–27.4% decrease in $MD_{i,j,t}^{PsuedoFD}$. This suggests that firm i shifts investment spending toward that of competitor j as competitor j experiences a tightening of constraints. Note, that the coefficient on competitor constraints is insignificant in all three specifications that include competitor-pair fixed effects (Columns 3, 6, and 9). This is likely due to an over-differencing of the data, since $MD_{i,j,t}^{PsuedoFD}$ is already a difference in distance for a given competitor pair.

A.5 Nonlinear specifications

A.5.1 Patent variables

As with most studies using patents, the dependent patent variable is highly skewed and has a large mass of observations at zero patents (and citations). Typically, to address these concerns, patent variables are transformed by taking the natural log of the patent variable (plus 1). As a robustness exercise, we implement count variable specifications that are less driven by skewness. Specifically, we implement a Poisson regression, in which the events measured are assumed to be independent. Since we adjust patents and citations, our dependent variables of interest are not traditional count variables. However, we can still implement Poisson regressions to mitigate the effects of skewness.

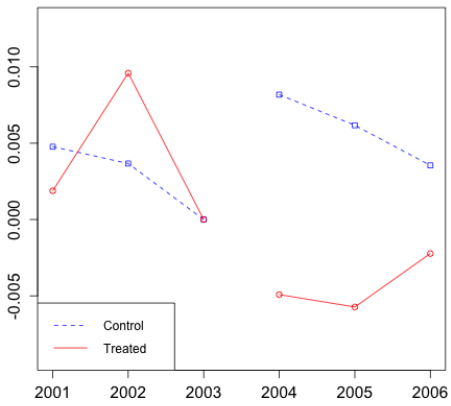
In Table IA14, we present the exponentiated coefficient estimates (odds ratios) from our Poisson fixed effects regressions. Coefficients greater than 1 mean that an increase in the variables is associated with an increase in the rate of patenting (citations). The effect of a 1-standard-deviation increase in WW_cited (SA_cited) is a 157%–402% increase in the rate of patenting and a 139%–341% increase in the number of citations. This is consistent with the specification presented in the main text. For the median firm in our sample, which has 0.328 adjusted patents, a 400% increase in patenting would bring the total to 1.28. This change would move a firm from the median to about the 73rd percentile in the distribution of patenting firms.

A.5.2 Opportunistic hiring of inventors

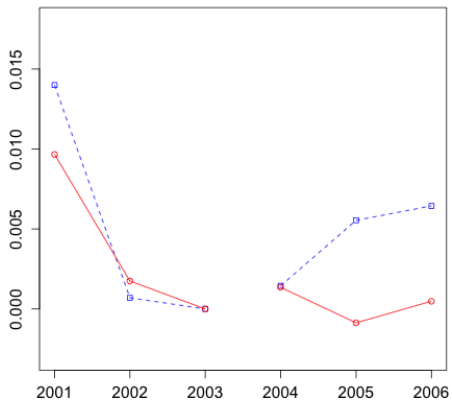
In addition, we estimate logit specifications of our inventor analysis from Tables 7 and 8 in the main text. We report the log odds coefficients for estimates of opportunistic hiring and inventor departures in Tables IA15 and IA16, respectively.

Figure IA1: AJCA parallel trends

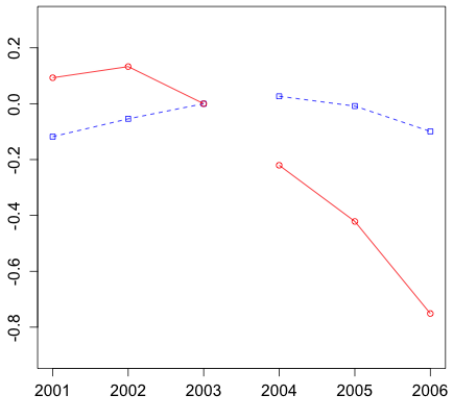
(A) RDS



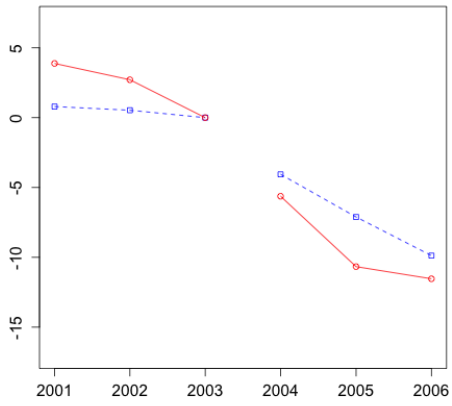
(B) INV



(C) Adj patent



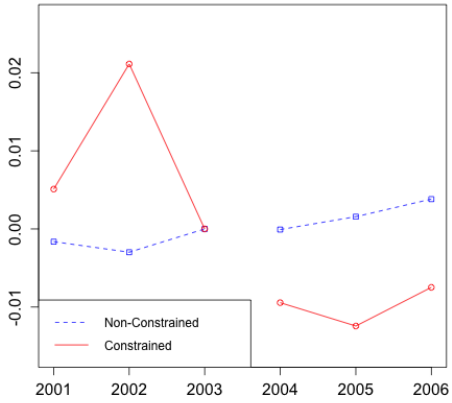
(D) Adj cites



This figure plots the parallel trends for the treatment and control groups in the AJCA quasi-natural experiment. We use 3 years of data both before and after the 2004 AJCA tax holiday for the sample period 2001 to 2006. The dependent variables include capital expenditures scaled by lagged assets (*Capx/asset*), R&D expenses scaled by sales (R&D/sale), the natural log of truncation adjusted patents (plus 1) applied for in year t (*Adj pat*), and the natural log of adjusted citations (plus 1) for patents applied for in year t (*Adj cite*). We define treated firms as those with competitors that averaged at least 33% of pretax income from abroad from 2001 to 2003. We match each treated firm with the nearest untreated firm that has the most similar ex ante predicted likelihood of receiving treatment based on pretreatment controls (*log(sales), Market-to-book, EBITDA/assets, PP&E/assets*).

Figure IA2: AJCA parallel trends for treated firms

(A) RDS



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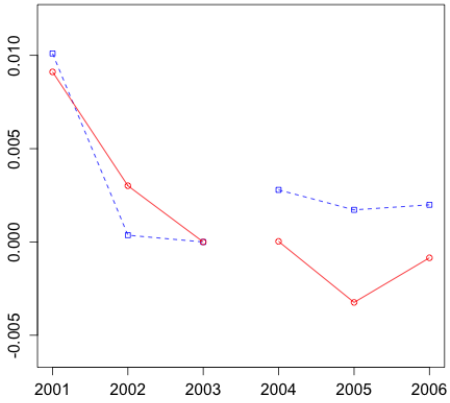
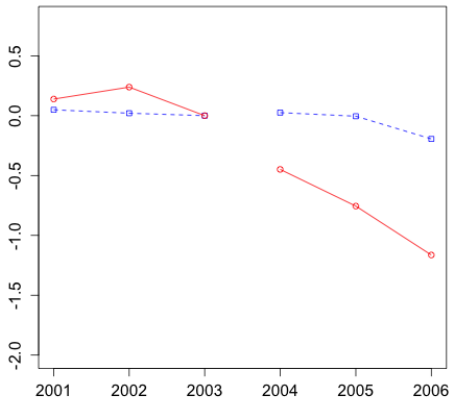
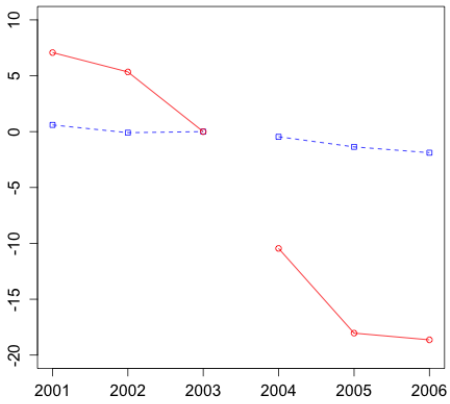


(C) Adj patent



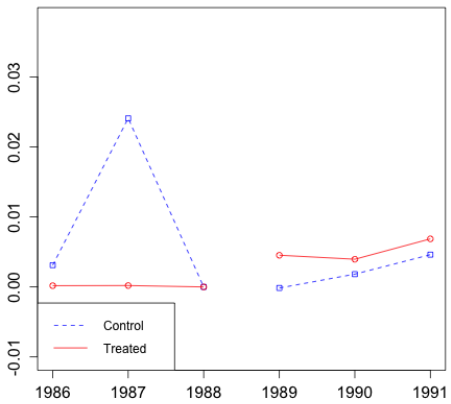
(D) Adj cites



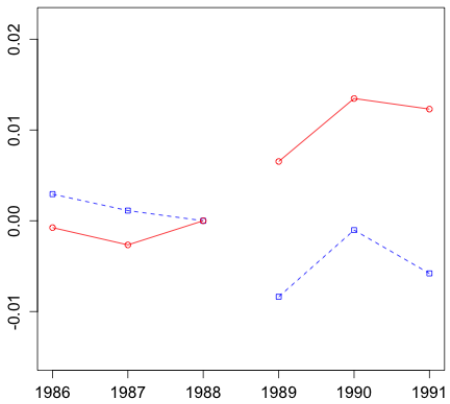
This figure plots the parallel trends of constrained and unconstrained firms in the treatment group of the AJCA quasi-natural experiment (only treated firms' outcomes are plotted in the figure). We use 3 years of data both before and after the 2004 AJCA tax holiday for the sample period 2001 to 2006. The dependent variables include capital expenditures scaled by lagged assets (*Capx/asset*), R&D expenses scaled by sales (R&D/sale), the natural log of truncation adjusted patents (plus 1) applied for in year t (*Adj pat*), and the natural log of adjusted citations (plus 1) for patents applied for in year t (*Adj cite*). We define treated firms as those with competitors that averaged at least 33% of pre-tax income from abroad during 2001 to 2003. We define a treated firm as being constrained in this analysis if the firm is above the 2003 full sample (cross-sectional) median measure of financial constraints according to the WW index.

Figure IA3: Junk bond crisis parallel trends

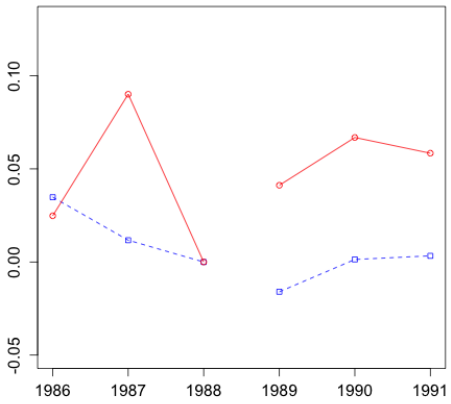
(A) RDS



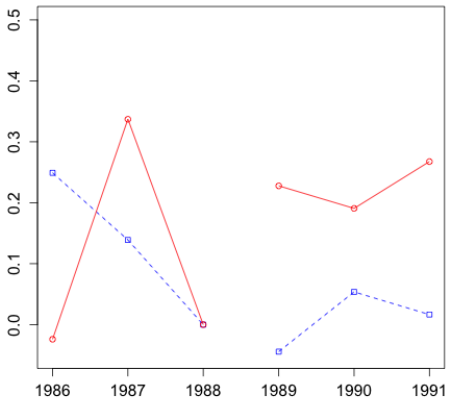
(B) INV



(C) Adj patent



(D) Adj cites



This figure plots the parallel trends for the treatment and control groups in the Junk Bond quasi-natural experiment. We use 3 years of data both before and after the junk bond crisis for the sample period 1987 to 1992. The dependent variables include capital expenditures scaled by lagged assets (*Capx/asset*), R&D expenses scaled by sales (R&D/sale), the natural log of truncation adjusted patents (plus 1) applied for in year t (*Adj pat*), and the natural log of adjusted citations (plus 1) for patents applied for in year t (*Adj cite*), . We define treatedt firms as those with competitors that have at least 15% of their competitors have a junk-debt rating. We match each treated firm with the nearest untreated firm that has the most similar ex ante predicted likelihood of receiving treatment based on pre-treatment controls (*log(sales), Market-to-book, EBITDA/assets, PP&E/assets*).

Table IA1: Corporate investment and competitor constraints using tech clusters

OLS regression estimates are reported for the relationship between corporate investment and competitor financing constraints using technology clusters to define competitors (implemented in Jaffe, 1989). The firm-year is the unit of observation in this analysis. The dependent variables include the natural log of truncation-adjusted patents (plus 1) applied for in year t (*Adj pat*), the natural log of adjusted citations (plus 1) for patents applied for in t (*Adj cite*), capital expenditures scaled by lagged assets (*Capx/asset*), and R&D expenses scaled by sales (R&D/sale). We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). We include *log(sales), Market-to-book, EBITDA/assets, PP&E/assets*, and analogous competitor averages, (all lagged one period) as control variables. All specifications include firm and year fixed effects. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	0.0339***	0.0769***	0.0176**	0.0509**	0.0328***	0.0184
	(0.0114)	(0.0283)	(0.0080)	(0.0202)	(0.0094)	(0.0223)
Own const.	-0.0107	-0.0575***	-0.4040***	-0.8097***	0.0004	0.0146
	(0.0071)	(0.0208)	(0.0396)	(0.0796)	(0.0060)	(0.0148)
R-squared	.6453	.6474	.6600	.6563	.6277	.6348
Observations	26,863	26,863	26,863	26,863	19,011	19,011
Firm FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓

Table IA2: Main result with industy *times* year FE

OLS regression estimates are reported for the relationship between corporate investment and competitor financing constraints. The firm-year is the unit of observation in this analysis. The dependent variables include the natural log of truncation adjusted patents (plus 1) applied for in year t (*Adj pat*), the natural log of adjusted citations (plus 1) for patents applied for in t (*Adj cite*), capital expenditures scaled by lagged assets (*Capx/asset*), and R&D expenses scaled by sales (R&D/sale). We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). We include *log(sales), Market-to-book, EBITDA/assets, PP&E/assets*, and analogous competitor averages (all lagged one period) as control variables. All specifications include firm fixed effects transformations and industry×year (Fama-French 48) dummies. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
Panel A: Text-based network						
	Capx/asset	R&D/sales	Capx/asset	R&D/sales	Capx/asset	R&D/sales
Comp const.	0.0129**	0.0184***	0.0069**	0.0009*	0.0055***	0.0042
	(0.0064)	(0.0059)	(0.0035)	(0.0005)	(0.0015)	(0.0041)
Own const.	-0.0175***	-0.0564***	-0.0277***	-0.3226***	0.0009	0.0051
	(0.0030)	(0.0141)	(0.0058)	(0.0303)	(0.0014)	(0.0041)
R-squared	.5760	.7850	.5757	.7888	.5888	.8652
Observations	50,865	50,865	50,865	50,865	36,615	36,615
Panel B: Citation-based network (1980-2006)						
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	0.1425***	0.3050***	0.1515***	0.3457***	0.0273***	0.0242
	(0.0129)	(0.0255)	(0.014)	(0.0267)	(0.0054)	(0.0149)
Own const.	-0.4433***	-0.0163***	-0.2835***	-0.5043***	-0.0567	-0.0378
	(0.1116)	-0.00265	(0.0556)	(0.0943)	(0.1073)	(0.2286)
R-squared	.8631	.8130	.8641	.8140	.8572	.8216
Observations	17,226	17,226	17,226	17,226	11,016	11,016
Firm FE	✓	✓	✓	✓	✓	✓
Ind × Year FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓

Table IA3: Corporate innovation and competitor constraints: 2- and 7-year patent citation links

This table reports OLS results for a robustness analysis of Table 2 in the main text. In the odd-numbered columns, the dependent variable *Adj pat* is the natural log of adjusted patents (plus 1) in the following year. In the even-numbered columns, *Adj cite* is the natural log of adjusted citations (plus 1) for patents applied for in the following year. We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). We assume that a firm is related to its competitor for 2 years (Panel A) and 7 years (Panel B) after the firm cites a competitor's patent. This is meant to serve as a robustness analysis for the 5-year duration we assume throughout the main text. We include *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets*, and analogous competitor averages (all lagged one period) as control variables. Columns 1–4 include firm and year fixed effects and Columns 5–8 include industry×year fixed effects. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level.

	WW		SA		WW		SA	
Panel A: Citation-based network with 2-year links								
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	0.123***	0.235***	0.160***	0.316***	0.115***	0.219***	0.148***	0.294***
	(0.0127)	(0.0221)	(0.0163)	(0.0276)	(0.0119)	(0.0218)	(0.0154)	(0.0273)
Own const.	-0.150***	-0.284***	-0.418***	-0.752***	-0.130***	-0.257***	-0.366***	-0.687***
	(0.0181)	(0.0346)	(0.0413)	(0.0854)	(0.0168)	(0.0333)	(0.0399)	(0.0826)
R-squared	.849	.798	.852	.801	.859	.807	.861	.809
Observations	16,545	16,545	16,545	16,545	16,545	16,545	16,545	16,545
Panel B: Citation-based network with 7-year links								
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	0.087***	0.172***	0.139***	0.265***	0.088***	0.166***	0.135***	0.252***
	(0.0115)	(0.0215)	(0.0163)	(0.0296)	(0.0115)	(0.0218)	(0.0162)	(0.0301)
Own const.	-0.119***	-0.250***	-0.330***	-0.642***	-0.106***	-0.232***	-0.293***	-0.592***
	(0.0141)	(0.0284)	(0.0328)	(0.0713)	(0.0133)	(0.0277)	(0.0316)	(0.0683)
R-squared	.843	.792	.846	.795	.852	.800	.854	.802
Observations	22,002	22,002	22,002	22,002	22,002	22,002	22,002	22,002
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓				
Ind x Year FE					✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓

Table IA4: Corporate investment and competitor constraints

(with debt and equity delay measures of constraints)

OLS regression estimates are reported for the relationship between corporate investment and competitor financing constraints. The firm-year is the unit of observation in this analysis. The dependent variables include the natural log of truncation-adjusted patents (plus 1) applied for in year t (*Adj pat*), the natural log of adjusted citations (plus 1) for patents applied for in t (*Adj cite*), capital expenditures scaled by lagged assets (*Capx/asset*), and R&D expenses scaled by sales (R&D/sale). We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the unconditional *Delay* index (Columns 1 and 2), the *Equity delay* index (Columns 3 and 4), and the *Debt delay* index (Columns 5 and 6) defined in Hoberg and Maksimovic (2015). We include *log(sales), Market-to-book, EBITDA/assets, PP&E/assets*, and analogous competitor averages, (all lagged one period) as control variables. All specifications include firm and year fixed effects. Results for specifications with firm and industry×year (Fama-French 48) fixed effects are reported in Table IA2 of the Internet Appendix. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	Delay		Equity delay		Debt delay	
Panel A: Text-based network (1996-2012)						
	Capx/asset	R&D/sale	Capx/asset	R&D/sale	Capx/asset	R&D/sale
Comp const.	0.0019***	0.0114***	0.0023***	0.0095***	0.0019***	0.0015
	(0.0005)	(0.0031)	(0.0006)	(0.0034)	(0.0005)	(0.0028)
Own const.	-0.0001	0.0117***	0.0000	0.0122**	0.0001	0.0129**
	(0.0005)	(0.0044)	(0.0005)	(0.0043)	(0.0005)	(0.0045)
R-squared	.6846	.7610	.6711	.7519	.6809	.7655
Observations	36,615	36,615	36,615	36,615	36,615	36,615
Panel B: Citation-based network (1980-2006)						
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	0.0436***	0.1396***	0.0378***	0.1483***	-0.0076	-0.0178
	(0.0056)	(0.0145)	(0.0052)	(0.0468)	(0.0052)	(0.0141)
Own const.	-0.0415	-0.0717	-0.0488	0.0101	-0.0299	-0.0591
	(0.1095)	(0.2283)	(0.0913)	(0.1805)	(0.0881)	(0.2384)
R-squared	.8498	.8164	.8322	.8098	.8296	.7987
Observations	12,016	12,016	12,016	12,016	12,016	12,016
Firm FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓

Table IA5: Investment similarity and competitor constraints

(with debt and equity delay measures of constraints)

OLS regression estimates are reported for the relationship between investment composition similarity and competitor financing constraints. The competitor-pair-year is the unit of observation in this analysis. The dependent variable in Panel A is the pairwise cosine similarity in product market descriptions (*Prod similarity*) between two firms according to the text-based network of competitors developed by Hoberg and Phillips (2016) from 1996-2012. A higher *Prod similarity* indicates a greater similarity between two firms' 10-K product descriptions. The dependent variable in Panel B is the Mahalanobis distance (*MD*) between a firm's normalized patent portfolio from years t to $t+2$ and that of its competitor from years $t-3$ to $t-1$, according to our citation-based network of competitors from 1980 to 2006. A lower value represents patent portfolios that are closer in correlation-weighted distance, or are more similar. We calculate competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the unconditional *Delay* index (Columns 1–3), the *Equity delay* index (Columns 4–6), and the *Debt delay* index (Columns 7–9) defined in Hoberg and Maksimovic (2015). We include *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* for a firm and its competitors (all lagged one period) as control variables. Specifications include firm and year fixed effects in Columns 1, 4, and 7; competitor-pair fixed effects in Columns 3, 6, and 9; and firm×year fixed effects in Columns 2,3, 5, 6, 8, and 9. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	Delay			Equity delay			Debt delay		
Panel A: Text-based product market similarity - text-based network									
Comp const.	0.0031***	0.0033***	0.0017***	0.0039***	0.0035***	0.0021***	0.0027***	0.0028***	0.0011***
	(0.0008)	(0.0009)	(0.0005)	(0.0008)	(0.0008)	(0.0006)	(0.0007)	(0.0008)	(0.0006)
Own const.	0.0014			-0.0022			0.0058		
	(0.0015)			-0.0031			-0.0075		
R-squared	.2409	.2721	.8176	.0242	.2802	.8199	.0238	.2700	.8105
Observations	1,850,473	1,850,473	1,850,473	1,850,473	1,850,473	1,850,473	1,850,473	1,850,473	1,850,473
Panel B: Patent portfolio distance (mahalanobis distance) - citation-based network									
Comp const.	-0.0429***	-0.0461***	-0.0061***	-0.0536***	-0.0411***	-0.0053***	-0.0020***	-0.0021***	-0.0017**
	(0.0080)	(0.0082)	(0.0009)	(0.0104)	(0.0078)	(0.0014)	(0.0006)	(0.0006)	(0.0009)
Own const.	-0.0006			0.0012*			-0.0005		
	(0.0010)			(0.0009)			(0.0055)		
R-squared	.2014	.2426	.6661	.1846	.2280	.6280	.1544	.2047	.5981
Observations	161,073	161,073	161,073	161,073	161,073	161,073	161,073	161,073	161,073
Firm & Year	✓			✓			✓		
Firm × Year		✓	✓		✓	✓		✓	✓
Competitor Pair			✓			✓			✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table IA6: Patent portfolio distance and competitor constraints (subsample analysis cased on patent intensity)

OLS regression estimates are reported for the relationship between patent portfolio distance and competitor financing constraints. The competitor-pair-year is the unit of observation in this analysis. We split our analysis into subsamples of firms with patenting activity above the full sample median (Panel A) and patenting activity below the full sample median (Panel B). In both panels the dependent variable is the Mahalanobis distance (*MD*) between a firm's normalized patent portfolio from years t to $t+2$ and that of its competitor from years $t-3$ to $t-1$, according to our citation-based network of competitors from 1980 to 2006. A lower value represents patent portfolios that are closer in correlation-weighted distance, or are more similar. We calculate competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1–3), the *SA* index (Columns 4–6), and the *Delay* index (Columns 7–9). We include *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* for a firm and its competitors (all lagged one period) as control variables. Specifications include firm and year fixed effects in Columns 1, 4, and 7; competitor-pair fixed effects in Columns 3, 6, and 9; and firm×year fixed effects in Columns 2, 3, 5, 6, 8, and 9. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW			SA			Delay		
Panel A: Firms with above median patent activity									
Comp const.	-0.0171***	-0.0170***	-0.0117***	-0.0177***	-0.0176***	-0.0097***	-0.0154***	-0.0154***	-0.0010**
	(0.0032)	(0.0032)	(0.0016)	(0.0032)	(0.0032)	(0.0041)	(0.0053)	(0.0048)	(0.0005)
Own const.	0.0013			-0.0206			-0.0005		
	(0.0073)			(0.0153)			(0.0014)		
R-squared	.1385	.1632	.8939	.1398	.1642	.8940	.1495	.1631	.9199
Observations	176,354	176,354	176,354	176,354	176,354	176,354	82,866	82,866	82,866
Panel B: Firms with below median patent activity									
Comp const.	-0.0465***	-0.0462***	-0.0251***	-0.0494***	-0.0491***	-0.0296**	-0.0412*	-0.0481***	-0.0091**
	(0.0018)	(0.0017)	(0.0055)	(0.0018)	(0.0017)	(0.0149)	(0.0226)	(0.0101)	(0.0045)
Own const.	0.0082			-0.0139**			0.0009		
	(0.0054)			(0.0067)			(0.0013)		
R-squared	.2567	.3173	.8954	.2579	.3183	.8954	.2365	.2909	.9049
Observations	171,566	171,566	171,566	171,566	171,566	171,566	78,408	78,408	78,408
Firm & Year	✓			✓			✓		
Firm × Year		✓	✓		✓	✓		✓	✓
Competitor Pair			✓			✓			✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table IA7: Alternative mahalanobis distance and competitor constraints

OLS regression estimates are reported for the relationship between patent portfolio distance and competitor financing constraints. The competitor-pair-year is the unit of observation in this analysis. The dependent variable ($MD_{i,j,t}^{PsuedoFD}$) is the difference in Mahalanobis distance between firm i's normalized patent portfolio from years t to $t+2$ and firm j's normalized patent portfolio from years $t-3$ to $t-1$, and the distance between firm i's normalized patent portfolio from years $t-3$ to $t-1$ and firm j's normalized patent portfolio from years $t-3$ to $t-1$. We calculate $MD_{i,j,t}^{PsuedoFD}$ according to our citation-based network of competitors from 1980 to 2006. A negative value indicates a decrease in correlation-weighted distance (i.e., patent portfolios have become more similar). We calculate competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1–3), the *SA* index (Columns 4–6), and the *Delay* index (Columns 7-9). We include *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* for a firm and its competitors (all lagged one period) as control variables. Specifications include firm and year fixed effects in Columns 1, 4, and 7; competitor-pair fixed effects in Columns 3, 6, and 9; and firm×year fixed effects in Columns 2, 3, 5, 6, 8, and 9. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW			SA			Delay		
	Patent portfolio distance (pseudo differenced MD) - citation-based network								
Comp const.	-0.0033**	-0.0029**	0.0001	-0.0039***	0.0017	0.0017	0.0025***	0.0019***	0.0007
	(0.0014)	(0.0013)	(0.0015)	(0.0006)	(0.0011)	(0.0015)	(0.0005)	(0.0005)	(0.0005)
Own const.	0.0074**			0.0016			0.0034**		
	(0.0037)			(0.0014)			(0.0017)		
R-squared	.1184	.3565	.5970	.1196	.3565	.3565	.1581	.3595	.6450
Observations	282,014	282,014	282,014	282,014	282,014	282,014	125,550	125,550	125,550
Firm & Year	✓			✓			✓		
Firm × Year		✓	✓		✓	✓		✓	✓
Competitor Pair			✓			✓			✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table IA8: Patent portfolio distance: alternative measures

This table reports OLS regression estimates of alternative definitions of patent portfolio distance on competitor constraints. This is the same specification of Table 4 using different measures of similarity. As in Table 4, the unit of analysis is the competitor level. In Columns 1–4, we use the Euclidian distance (ED) between patent portfolios as our measure of similarity. A smaller ED between two firms means that their patent portfolios are more similar. In Columns 5–8, we use the Pairwise Correlation (PC) between competitors patent portfolios as a measure of similarity. The higher the correlation, the greater the similarity between two firm's patent portfolios. In the odd-numbered columns, we include firm and year fixed effects. In the even-numbered columns, we include firm × year fixed effects. Standard errors clustered at the firm level are included in parentheses below coefficient estimates. All variables are winsorized at the 1% level.

	Euclidean distance				Pairwise correlation			
	WW		SA		WW		SA	
Comp const.	-12.86***	-13.01***	-6.575***	-6.774***	0.0328***	0.0328***	0.0472***	0.0470***
	(0.552)	(0.531)	(0.346)	(0.302)	(0.0028)	(0.0028)	(0.0030)	(0.0030)
Own const.	-1.732**		(0.599)		-0.0044		(-0.0101)	
	(0.780)		(1.136)		(0.0035)		(0.0096)	
R-squared	.391	.457	.275	.342	.151	.179	.156	.184
Observations	747,423	747,423	747,423	747,423	703,465	703,465	703,465	703,465
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Firm FE	✓		✓		✓		✓	
Year FE	✓		✓		✓		✓	
Firm x Year FE		✓		✓		✓		✓

Table IA9: AJCA tax holiday matched sample

Estimates are reported for difference-in-differences and triple-differences specifications using the 2004 AJCA tax holiday as a treatment event. The firm-year is the unit of observation in this analysis. We use two years of data both before and after the event for the sample period 2001 to 2006. The dependent variables include the natural log of truncation adjusted patents (plus one) applied for in year t (*Adj pat*), the natural log of adjusted citations (plus one) for patents applied for in year t (*Adj cite*), capital expenditures scaled by lagged assets (*Capx/asset*), and R&D expenses scaled by sales (R&D/sale). We define *Treated* firms as those with competitors that averaged at least 33% of pre-tax income from abroad during 2001 to 2003. For the specifications reported in this table, we exclude firms with any foreign profits themselves from the treatment and control groups. We define *Comp Pre-const.* as an indicator variable equal to 1 if a firm's pre-treatment average competitor constraints from 2001 to 2003 rank above the full sample median for the same period according to the *WW* index (Columns 3 and 4), the *SA* index (Columns 5 and 6), and the *Delay* index (Columns 7 and 8). All specifications include firm and year fixed effects, which subsume the *Post, Treated, Comp pre-const., and Treated*×*Comp pre-const.* variables. For expositional convenience, we do not report the coefficient for *Post*×*Comp pre-const.*. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

			WW		SA		Delay	
			Panel A: Text-based network					
	Capx/asset	R&D/sale	Capx/asset	R&D/sale	Capx/asset	R&D/sale	Capx/asset	R&D/sale
Treated×*Post*	-0.0155**	-0.0038**	-0.0040	-0.0004	0.0033	-0.0015	0.0069	-0.0131**
	(0.0068)	(0.0018)	(0.0062)	(0.0027)	(0.0023)	(0.0023)	(0.0043)	(0.0052)
Treated×*Post*×			-0.0222*	-0.0065*	-0.0380***	-0.0046	-0.0286***	0.0113**
Comp Pre-const.			(0.0129)	(0.0037)	(0.0136)	(0.0037)	(0.0093)	(0.0055)
Post×			-0.0016	0.0013	0.0126	-0.0010	0.0055	-0.0106**
Comp Pre-const.			(0.0112)	(0.0029)	(0.0120)	(0.0028)	(0.0074)	(0.0050)
R-squared	.882	.741	.883	.741	.883	.741	.882	.742
Observations	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936
			Panel B: Citation-based network					
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Treated×*Post*	-0.0727**	-0.2971***	-0.0025	-0.0966	-0.0335	-0.2153	-0.0483	-0.3254
	(0.0315)	(0.1013)	(0.0303)	(0.1161)	(0.0421)	(0.1382)	(0.0383)	(0.2292)
Treated×*Post*×			-0.1330**	-0.3700*	-0.0722	-0.1474	-0.0319	0.0356
Comp Pre-const.			(0.0602)	(0.1940)	(0.0622)	(0.2001)	(0.0551)	(0.2551)
Post×			-0.0282	-0.1610	0.0162	-0.0449	0.0065	-0.0929
Comp Pre-const.			(0.0237)	(0.1083)	(0.0229)	(0.1071)	(0.0252)	(0.1171)
R-squared	.891	.828	.895	.834	.891	.829	.891	.828
Observations	712	712	712	712	712	712	712	712
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

Table IA10: Junk bond crisis matched sample

Estimates are reported for difference-in-differences specifications using the junk bond crisis as a treatment event. We use 3 years of data both before and after the event for the sample period 1987 to 1992. The dependent variables include the natural log of truncation-adjusted patents (plus 1) applied for in year t (*Adj pat*), the natural log of adjusted citations (plus 1) for patents applied for in year t (*Adj cite*), capital expenditures scaled by lagged assets (*Capx/asset*), and R&D expenses scaled by sales (R&D/sale). We define treated firms as those with at least 15% of their competitors having a junk-debt rating. We match each treated firm with the nearest untreated firm that has the most similar ex ante predicted likelihood of receiving treatment based on pretreatment controls (*log(sales), Market-to-book, EBITDA/assets, and PP&E/assets*). Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	R&D/sale	Capx/asset	Adj pat	Adj cite
Treated×*Post*	0.0131***	0.0145**	0.0318	0.1390
	(0.0041)	(0.0067)	(0.0274)	(0.1370)
R-squared	.919	.657	.795	.694
Observations	461	461	461	461
Firm FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

Table IA11: Opportunistic hiring (NEI interaction)

Linear probability model estimates are reported for the relationship between the opportunistic hiring of inventors and competitor constraints. The firm-year is the unit of observation in this analysis. The dependent variable $Hire_{i,t+1,t+5}$ is a binary variable equal to 1 if firm i hires an inventor during the years *t+1* to *t+5* that appeared on a competitor's patent in year t, and 0 otherwise. Competitors are defined according to our citation-based network of competitors from 1980 to 2006. Data on individual inventors come from the Harvard Patent Database inventor file (see (Lai et al., 2014)). We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). The control variables *log(sales), Market-to-book, EBITDA/assets, PP&E/assets*, and analogous competitor averages, are measured at time t. The specifications in all columns include firm, year, and NEI fixed effects. NEI stands for the Noncompetition Enforcement index developed in Garmaise (2009). A higher NEI indicates stronger enforcement of noncompete agreements. The variable $Compconst. \times NEI$ is the interaction between the noncompete enforcement index and the average constraints of a firm's competitors at time t. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
	Opportunistic hiring					
Comp const.	0.0476***	0.0634***	0.0644***	0.0762***	0.0042	0.0076*
	(0.0098)	(0.0108)	(0.0101)	(0.0111)	(0.0043)	(0.0044)
Own const.	-0.0292***	-0.0190***	-0.0708***	-0.0493***	-0.0043	-0.0029
	(0.0052)	(0.0048)	(0.0092)	(0.0101)	(0.0041)	(0.0041)
Comp const.×NEI	-0.0047**	-0.0046**	-0.0056***	-0.0057***	0.0009	0.0003
	(0.0022)	(0.0021)	(0.0021)	(0.0021)	(0.0010)	(0.0010)
log(sales)		0.0254***		0.0172***		0.0171***
		(0.0046)		(0.0050)		(0.0058)
Market-to-book		0.0098***		0.0099***		0.0110***
		(0.0020)		(0.0020)		(0.0023)
EBITDA/assets		-0.0001		0.0004		0.0096
		(0.0162)		(0.0160)		(0.0200)
PP&E/assets		0.0621*		0.0601*		0.1422***
		(0.0338)		(0.0338)		(0.0467)
Comp.		0.0083		0.0021		0.0021
Market-to-book		(0.0071)		(0.0070)		(0.0075)
Comp.		0.0219**		0.0159*		0.0349***
log(sales)		(0.0094)		(0.0083)		(0.0107)
Comp.		0.2125***		0.2534***		-0.0987
EBITDA/assets		(0.0804)		(0.0813)		(0.0953)
Comp.		-0.1557**		-0.0608		-0.0867
PP&E/assets		(0.0701)		(0.0707)		(0.1121)
R-squared	.4021	.4063	.4053	.4083	.4220	.4274
Observations	16,982	16,982	16,982	16,982	11,063	11,063
Inventor	✓	✓	✓	✓	✓	✓
NEI	✓	✓	✓	✓	✓	✓
Year	✓	✓	✓	✓	✓	✓

Table IA12: Inventor departures for competitor (NEI interaction)

Linear probability model estimates are reported for the relationship between a firm's financial constraints and inventor departures for competitors. The inventor-year is the unit of observation in this analysis. The dependent variable $Departure_{i,t+1,t+5}$ is a binary variable equal to 1 if inventor k moves to a competitor during years *t+1* to *t+5* and equal to 0 if inventor k patents for the same firm or for a noncompetitor during years *t+1* to *t+5*. We omit an observation if the inventor does not patent during the years *t+1* to *t+5*. Competitors are defined according to our citation-based network of competitors from 1980 to 2006. Data on individual inventors come from the Harvard Patent Database inventor file (see (Lai et al., 2014)). The variable $Current\ employer\ const_{j,t}$ measures the financial constraints of the firm j that inventor k patents for in year t, according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). The control variables *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* are measured at time *t*. The specifications in all columns include inventor, year, and NEI fixed effects. NEI stands for the Noncompetition Enforcement index developed in Garmaise (2009). A higher NEI indicates stronger enforcement of noncompete agreements. The variable $Current\ employer\ const \times NEI$ is the interaction between the noncompete enforcement index and the constraints of an inventor's employer at time *t*. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
	Inventor departures for competitor					
Current employer const.	0.0205***	0.0188***	0.0196***	-0.0001	0.0044***	0.0044***
	(0.0026)	(0.0034)	(0.0032)	(0.0045)	(0.0013)	(0.0014)
Current employer const.	-0.0083**	-0.0110***	-0.0131**	-0.0145**	-0.0292***	-0.0460***
× NEI	(0.0037)	(0.0040)	(0.0051)	(0.0058)	(0.0109)	(0.0132)
log(sales)		-0.0019		-0.0103***		-0.0070*
		(0.0018)		(0.0018)		(0.0037)
Market-to-book		-0.0046***		-0.0046***		-0.0057***
		(0.0005)		(0.0004)		(0.0008)
EBITDA/assets		-0.0542***		-0.0545***		-0.0395***
		(0.0061)		(0.0063)		(0.0101)
PP&E/assets		0.0373***		0.0376***		-0.0234
		(0.0107)		(0.0106)		(0.0228)
R-squared	.3409	.3437	.3406	.3436	.4492	.4505
Observations	377,923	377,923	377,923	377,923	134,722	134,722
Inventor	✓	✓	✓	✓	✓	✓
NEI	✓	✓	✓	✓	✓	✓
Year	✓	✓	✓	✓	✓	✓

Table IA13: Inventor departures for competitor (fewer than 6 inventor departures)

Linear probability model estimates are reported for the relationship between a firm's financial constraints and inventor departures for competitors. The inventor-year is the unit of observation in this analysis. The dependent variable $Departure_{i,t+1,t+5}$ is a binary variable equal to 1 if inventor k moves to a competitor during years *t+1* to *t+5* and equal to 0 if inventor k patents for the same firm or for a noncompetitor during years *t+1* to *t+5*. We omit an observation if the inventor does not patent during the years *t+1* to *t+5*. Competitors are defined according to our citation-based network of competitors from 1980 to 2006. The sample in this analysis excludes firms with more than 5 inventors departing in a given year. Data on individual inventors come from the Harvard Patent Database inventor file (see (Lai et al., 2014)). The variable $Current\ employer\ const_{j,t}$ measures the financial constraints of the firm j that inventor k patents for in year t, according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). The control variables *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* are measured at time t. The specifications in all columns include inventor, year, and NEI fixed effects. NEI stands for the Noncompetition Enforcement index developed in Garmaise (2009). Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
Inventor departures (fewer than 6 departures from employer)						
Current employer const	0.0151***	0.0126***	0.0150***	0.0160***	0.0015	0.0022**
	(0.0025)	(0.0035)	(0.0035)	(0.0054)	(0.0011)	(0.0009)
log(sales)		0.0201***		-0.0031		0.0077**
		(0.0022)		(0.0021)		(0.0034)
Market-to-book		-0.0063***		-0.0054***		-0.0049***
		(0.0005)		(0.0005)		(0.0007)
EBITDA/assets		-0.0326***		-0.0295***		0.0015
		(0.0069)		(0.0074)		(0.0091)
PP&E/assets		0.0573***		0.0434***		0.0032
		(0.0122)		(0.0118)		(0.0211)
R-squared	.3789	.3835	.3811	.3849	.4527	.4559
Observations	369,223	369,223	369,223	369,223	129,141	129,141
Inventor	✓	✓	✓	✓	✓	✓
NEI	✓	✓	✓	✓	✓	✓
Year	✓	✓	✓	✓	✓	✓

Table IA14: Poisson specification

This table reports results for Poisson regressions. The coefficients reported are the incidence-rate ratios (the exponentiated coefficients). The dependent variable are adjusted patents in Columns 1 and 3 and adjusted citations in Columns 2 and 4. The variable *FC_cited* is the average WW index (SA index) among peers cited by a firm within the last 5 years. MTB, R&D, profit, cash holdings, and tangibility are control variables. All regressions are run with Firm and Year fixed effects. T-statistics, calculated from robust standard errors, are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level.

	WW		SA		Delay	
	Adj pat	Adj cite	Adj pat	Adj cite	Adj pat	Adj cite
Comp const.	4.0289***	2.9586***	1.5760***	1.3903***	0.6046	3.4140***
	(0.3284)	(0.2071)	(0.1548)	(0.1342)	(0.7098)	(0.6191)
Own const.	-1.2718***	-0.4848***	-0.1003***	0.0573**	-0.6525**	-0.8258***
	(0.2246)	(0.1489)	(0.0377)	(0.0247)	(0.2649)	(0.2013)
Observations	13,925	13,897	13,925	13,897	7,883	7,855
Number of firms	1,682	1,682	1,682	1,682	1,318	1,318
Controls	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓

Table IA15: Opportunistic hiring and competitor constraints (log odds)

The logarithm of the odds are reported for logit model estimates of the relationship between the opportunistic hiring of inventors and competitor constraints. The firm-year is the unit of observation in this analysis. The dependent variable $Hire_{i,t+1,t+5}$ is a binary variable equal to 1 if firm i hires an inventor during the years *t+1* to *t+5* that appeared on a competitor's patent in year t, and 0 otherwise. Competitors are defined according to our citation-based network of competitors from 1980-2006. Data on individual inventors come from the Harvard Patent Database inventor file (see (Lai et al., 2014)). We calculate average competitor constraints (*Comp const.*) and a firm's own constraints (*Own const.*) according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). The control variables *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets*, and analogous competitor averages, are measured at time *t*. The specifications in all columns include firm, year, and NEI fixed effects. NEI stands for the Noncompetition Enforcement index developed in Garmaise (2009). A higher NEI indicates stronger enforcement of noncompete agreements. Bootstrapped standard errors are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
	Opportunistic hiring					
Comp. const.	1.7270***	1.4830**	1.2196***	1.9517***	0.8020***	0.4649
	(0.1876)	(0.6312)	(0.1802)	(0.4056)	(0.2742)	(0.3443)
Own const.	-0.9653***	-0.7812***	-1.1659***	-1.8513***	0.1330	-0.0074
	(0.0860)	(0.1531)	(0.0966)	(0.2531)	(0.0810)	(0.0761)
log(sales)		0.2701***		-0.0393		-0.0343
		(0.0809)		(0.0921)		(0.1160)
Market-to-book		0.1123***		0.1318***		0.0887**
		(0.0410)		(0.0382)		(0.0428)
EBITDA/assets		-0.2762		0.2892		0.8868*
		(0.4115)		(0.3343)		(0.5127)
PP&E/assets		0.8166		0.6865		2.1763*
		(0.5639)		(0.6513)		(1.2105)
Comp. Market-to-book		2.2051***		2.0332***		1.8947***
		(0.1207)		(0.1151)		(0.1722)
Comp. log(sales)		-1.8841***		-2.1214***		-1.2354***
		(0.3639)		(0.2356)		(0.3860)
Comp.		-12.2389***		-9.4336***		-14.8843***
EBITDA/assets		(1.8067)		(1.5574)		(2.9560)
Comp.		10.0290***		12.8641***		28.6556***
PP&E/assets		(1.1384)		(1.3681)		(3.6368)
Observations	13,768	12,771	13,768	12,771	4,104	3,786
Firm	✓	✓	✓	✓	✓	✓
NEI	✓	✓	✓	✓	✓	✓
Year	✓	✓	✓	✓	✓	✓

Table IA16: Inventor departures for competitor (log odds)

The logarithm of the odds are reported for logit model estimates of the relationship between the inventor departures for competitors and employer constraints. The inventor-year is the unit of observation in this analysis. The dependent variable $Departure_{i,t+1,t+5}$ is a binary variable equal to 1 if inventor k moves to a competitor during years *t+1* to *t+5* and equal to 0 if inventor k patents for the same firm or for a noncompetitor during years *t+1* to *t+5*. We omit the observation if the inventor does not patent during the years *t+1* to *t+5*. Competitors are defined according to our citation-based network of competitors from 1980 to 2006. Data on individual inventors come from the Harvard Patent Database inventor file (see (Lai et al., 2014)). The variable $Current\ employer\ const_{j,t}$ measures the financial constraints of the firm j that inventor k patents for in year t, according to the *WW* index (Columns 1 and 2), the *SA* index (Columns 3 and 4), and the *Delay* index (Columns 5 and 6). The control variables *log(sales), Market-to-book, EBITDA/assets, and PP&E/assets* are measured at time *t*. The specifications in all columns include inventor, year, and NEI fixed effects. NEI stands for the Noncompetition Enforcement index developed in Garmaise (2009). A higher NEI indicates stronger enforcement of noncompete agreements. Standard errors clustered at the firm level are reported in parentheses below coefficient estimates. All variables are winsorized at the 1% level (1% in each tail).

	WW		SA		Delay	
	Opportunistic hiring					
Current employer const.	1.1592***	1.3268***	1.1889***	1.2851***	0.9646***	0.9807***
	(0.1460)	(0.3676)	(0.2375)	(0.3367)	(0.2799)	(0.3208)
log(sales)		0.3274***		0.5536**		0.5271***
		(0.0839)		(0.1515)		-0.0993
Market-to-book		0.0518***		0.0616***		0.0164
		(0.0072)		(0.0110)		(0.0143)
EBITDA/assets		-0.0857		-0.2541**		-0.0296
		(0.1200)		(0.1176)		(0.1607)
PP&E/assets		1.3707***		1.4503***		1.4576***
		(0.1319)		(0.1427)		(0.2476)
Observations	49,041	38,934	49,041	38,934	13,046	11,046
Firm	✓	✓	✓	✓	✓	✓
NEI	✓	✓	✓	✓	✓	✓
Year	✓	✓	✓	✓	✓	✓

Table IA14: Variable definitions

In the chart below we provide the definitions of all of our variables using Compustat/CRSP/Execucomp variable names. The prefix "l." indicates a one year lag. So, for example, "l.at" indicates the lagged value of the at (total assets) variable from Compustat. All variables are inflation adjusted to 1971 dollars before entering these formulas.

- $log(assets)$ - log(at)
- $Capx/assets$ - capx/l.at
- $R\&D/sale$ - xrd/l.sale where xrd equals zero if missing
- $PP\&E/asset$ - ppent/at
- $Market-to-book$ - (at+(prccf×csho)-ceq)/at
- $Bookleverage$ - (dltt+dlc)/at
- $Ebitda/assets$ - ebitda/l.at
- WW - the Whited-Wu financial constraint index developed by Whited and Wu (2006), standardized to have a mean of 0 and a standard deviation of 1
- SA - the Size-Age financial constraint index developed by Hadlock and Pierce (2010), standardized to have a mean of 0 and a standard deviation of 1
- $Delay$ - the delayed investment constraint index developed by Hoberg and Maksimovic (2015), standardized to have a mean of 0 and a standard deviation of 1
- $AdjustedPatents$ - the natural log (plus 1) of the total number of patents applied for in year t, adjusted according to the method described in Hall et al. (2001)
- $AdjustedCitations$ - the natural log (plus 1) of the total number of citations received on patents applied for in year t, adjusted according to the method described in Hall et al. (2001)
- $Productsimilarity$ - the pairwise cosine similarities between two firms' product descriptions from their 10-Ks, as developed by Hoberg and Phillips (2016)
- MD - the Mahalanobis distance between a firm's normalized patent portfolio from years t to $t+2$ and that of its competitor from years $t-3$ to $t-1$, according to our citation-based network of competitors from 1980 to 2006