Düsseldorf Institute for Competition Economics

DISCUSSION PAPER

No 219

Innovation, Institutional Ownership, and Financial Constraints

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April 2016

HEINRICH HEINE UNIVERSITÄT DÜSSELDORF

d|u|p düsseldorf university press

IMPRINT

DICE DISCUSSION PAPER

Published by

düsseldorf university press (dup) on behalf of
Heinrich-Heine-Universität Düsseldorf, Faculty of Economics,
Düsseldorf Institute for Competition Economics (DICE), Universitätsstraße 1,
40225 Düsseldorf, Germany
www.dice.hhu.de

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ISSN 2190-9938 (online) – ISBN 978-3-86304-218-9

Innovation, Institutional Ownership, and Financial Constraints

Jan Philip Schain and Joel Stiebale [1]

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Abstract

We analyze the relationship between institutional investors, innovation and financing constraints. Building on the empirical framework of Aghion et al. (2013), we find that the effect of institutional ownership on innovation is concentrated in industries with high dependence on external finance and among firms which are a priori likely to be financially constrained. The complementarity between institutional ownership and competition, predicted by the original paper's theory where institutional investors increase innovation through reducing career risks, disappears once this heterogeneity is taken into account. We also provide evidence that the sensitivity of R&D investment to internal funds decreases with institutional ownership.

JEL Classification: G23, G32, L25, M10, O31, O34

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1 Introduction

The importance of institutional investors has increased dramatically over the past decades. While they held less than 20% of publicly listed stocks in the US during the 1960's, this share increased to more than 60% within the United States in 2011 and to more than 80% in the UK and Japan (Çelik and Isaksson, 2014).

Publicly listed companies are responsible for a large share of research and development (R&D) expenditures and innovation. The effects of institutional owners on innovation in these companies have important policy implications since innovation is regarded as the main determinant of growth (e.g. Griliches, 1980; Aghion et al., 2013). The growing presence of institutional investors has led to a controversial policy debate. A particular concern is that institutional investors have a focus on short-term performance which is detrimental to long-run investment such as R&D and innovation and firm performance in general.[1]

In an important and widely cited paper, Aghion et al. (2013) estimate a positive causal effect of institutional ownership on innovation. They explain this effect by a career concern model, related to Holmström (1982), in which monitoring allows institutional investors to identify and reward managerial ability in risky innovation projects. The revelation of managerial ability insures good managers against unlucky innovation outcomes, which the market interprets as a negative signal of their ability, and induces them to innovate. This theory implies that institutional ownership and product market competition are complements, since competition increases the probability of imitation and hence innovation failure.[2] As argued by Aghion et al. (2013), the

[1]Examples include a project launched in 2012 by the OECD to encourage institutional investors to make long lasting investments (see `http://www.oecd.org/finance/OECD-LTI-project.pdf`,accessed January 14, 2016) and a famous speech by Germany's former vice chancellor Franz Müntefering who equated institutional investors with locusts who hollow out companies for their own benefit (see, for instance, Bertrand Benoit, "Schröder's party chairman likens investors to locusts", *Financial Times*, April 18, 2005).

[2]Luong et al. (2014), Bena et al. (2015) and Lee (2005) also find a positive effect of institutions on innovation. Overall, the results on institutional ownership and innovation are mixed. See Belloc (2012) for an overview of related literature.

channels by which institutions affect innovation have important implications. If monitoring and insider ownership are major determinants of innovation, policy measures which lead to less outside board membership and higher board representation of insiders such as institutional owners would spur innovation.

This paper analyzes the impact of institutional investors on innovation and heterogeneous effects among firms which face different degrees of credit constraints and product market competition. We test the alternative hypothesis that institutional investors induce innovation by alleviating financial constraints. This hypothesis is related to a large literature on information asymmetries in capital markets which argues that suppliers of finance are confronted with an adverse selection problem leading to the rationing of finance and underinvestment (e.g. Hubbard, 1998; Stiglitz and Weiss, 1981). Research and development (R&D) is typically associated with lower collateral value but higher riskiness and asymmetric information problems compared to tangible investment. This implies that financial constraints are particularly severe for the financing of innovation (Brown et al., 2012; Hsu et al., 2014) which has been confirmed by robust empirical evidence (see, for instance, Aghion et al., 2012; Hottenrott and Peters, 2012; Stiglitz and Weiss, 1981). We argue that institutional owners may alleviate asymmetric information problems in credit markets and improve access to finance. Firms may benefit from institutional ownership directly via lower financing costs or indirectly because institutional investors' monitoring activities and financial expertise may act as a signal for creditors that their funds are used productively (see, e.g., Boucly et al., 2011).

For our empirical analysis, we use the same data set and baseline specification as Aghion et al. (2013). We extend their analysis by estimating heterogeneous effects for firms that operate in industries with high dependence on external finance. In these industries, credit constraints are particularly important since internal funds are usually insufficient to finance investment (Rajan and Zingales, 1998).[3] Our results show that the

[3]A similar empirical strategy is chosen by Boucly et al. (2011) and Amess et al. (2015) who provide evidence that buyouts undertaken by private equity firms – a specific sub-group

positive impact of institutional investors on innovation is concentrated in these industries. Further, we find that the complementarity between competition and institutional ownership estimated by Aghion et al. (2013) and others vanishes after financial dependence, and its interaction with institutional ownership, is controlled for. Hence, we argue that a positive interaction between institutions and competition does not stem from insurance against innovation failure but from financial dependence if this factor is omitted. We investigate the relationship between competition and dependence on external finance further by estimating separate regressions across subsamples with different degrees of competition and financial dependence.

We also find that the effects of institutional investors on innovation are concentrated among firms with initially low credit ratings, arguably firms for which financial constraints typically play an important role (Carreira and Silva, 2010; Panetta et al., 2009; Rodano et al., 2016). Further, we provide evidence that the sensitivity of R&D investment to the availability of internal funds decreases with the degree of institutional ownership. Finally, we test other empirical predictions of the career concern model, a significant impact of short-term profits on CEO turnover and a lower impact of bad performance on CEO firing with more institutional owners. We find that estimates by Aghion et al. (2013) which support these predictions only hold in industries in which financial dependence is high and thus short-term profits may be needed to finance investment or service debt. Our results are robust with respect to the model specification, the measure of financial dependence, and the application of an instrumental variable (IV) estimator.

The rest of this paper is organized as follows. Section 2 provides a description of the data, section 3 describes the econometric specification. Results of the empirical analysis are presented in section 4 and section 5 concludes.

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of institutional investors – can alleviate financial constraints and thereby induce firm growth and patenting. Agca and Mozumdar (2008) find that institutional investors can reduce the sensitivity of (tangible) investment to the availability of internal funds.

2 Data and Variables

For our analysis, we exploit a rich firm-level data set from Aghion et al. (2013) which includes 6178 observations on 800 firms.[4] It contains information on institutional ownership from Compact Disclosure, patent counts weighted by forward citations from the NBER Patent Database and accounting data including capital intensity, R&D, sales, and firm value from Compustat.

For our empirical analysis, we construct a measure of industry-level financial dependence proposed by Rajan and Zingales (1998). It proxies the desired amount of investment that cannot be financed by internal cash flow. This measure is calculated as capital expenditures minus cash flow from operations divided by capital expenditures following the variable definitions in Rajan and Zingales (1998). While financial dependence is not a direct measure of credit constraints, previous evidence indicates that financial constraints are more binding for firms in industries with high dependence on external finance. In particular, it has been shown that firms in industries with high financial dependence benefit most from stock market and banking development (Amore et al., 2013; Rajan and Zingales, 1998). Hence, if institutional investors reduce financing constraints, we expect larger effects of institutional ownership in financially dependent industries. We use data on all firms available in Compustat over the pre-sample period 1980-1990 to reduce potential endogeneity problems. Industry-level financial dependence is defined as the median of the firm-specific index for each of 39 different 3-digit SIC industries.

We also use Standard & Poor's credit ratings as an additional measure to differentiate between firms that are likely to be affected by credit constraints to a different extent. We assume that, on average, firms with low or no credit rating have to pay a higher cost premium for external funds which seems to be supported by previous research (Carreira and Silva, 2010; Panetta et al., 2009; Rodano et al., 2016). Particularly, we define firms with a rating of "A-" or higher as unlikely to be financially constrained. Table A1 in the Appendix shows summary statistics for the main variables of interests. More detailed

[4] The data is available at `https://www.aeaweb.org/articles.php?doi=10.1257/aer.103.1.277`

statistics on the distribution of the credit rating variable are depicted in Table A2.

3 Empirical model

In the baseline empirical model, following Aghion et al. (2013), the conditional expectation of innovation is given by:

$$E\left(CITES_{it}|x_{it}\right) = exp\left(\alpha INSTIT_{it} + \beta \mathbf{x}_{it} + \eta_i + \tau_t\right) \tag{1}$$

The outcome variable, $CITES_{it}$, is computed from the number of granted patents filed by firm i in time period t. Patents are weighted by the number of forward citations to account for heterogeneity in the importance of patents. $INSTIT_{it}$ measures the proportion of equity owned by institutional investors, $\mathbf{x}_{it}$ contains control variables including sales, capital intensity, R&D stock and industry dummies, η_i is a firm fixed effect and τ_t are time dummies. Firm fixed effects are introduced into the model using the pre-sample mean of citation-weighted patents as suggested by Blundell et al. (1999).

To account for heterogeneous effects of institutional ownership on innovation, equation 1 is extended to allow the effect of institutional investors to vary with financial dependence:

$$E\left(CITES_{it}|x_{it}\right) = exp\left(\alpha_0 INSTIT_{it} + \alpha_1 INSTIT_{it} * FIN_{j(i)} + \beta \mathbf{x}_{it} + \eta_i + \tau_t\right) \tag{2}$$

$FIN_{j(i)}$ is the measure of financial dependence in industry j described in the previous section. A positive coefficient of the interaction term ($INSTIT_{it} * FIN_{j(i)}$) indicates that in industries that are more dependent on external funding, institutional investors have a larger effect. The effect of industry-level financial dependence independent of ownership is absorbed by industry dummies. We further extend equations 1 and 2 to analyze how the effect of institutional investors varies with competition as in Aghion et al. (2013) and to investigate how this effect changes when we introduce the interaction between institutional investors and financial dependence.

In an alternative specification, we interact institutional ownership with a dummy variable for firms with high credit rating. If institutional investors induce innovation by alleviating credit constraints, we should see a negative coefficient for this interaction term and a positive coefficient for $INSTIT_{it}$ since firms with high credit rating are less likely to face financial constraints. To reduce potential endogeneity problems, we use data on credit ratings from the pre-sample period (1988 to 1990). In this specification, we include a dummy for non-ranked firms among the control variables.[5] Following Aghion et al. (2013), the main specification is estimated as a Poisson model, but we also consider alternatives including a Negative Binomial model.

4 Results

4.1 Basic Results

Table 1 shows our baseline results. Column (1) replicates the main specification in Aghion et al. (2013) which is a Poisson model that accounts for unobserved firm heterogeneity and control variables. Institutional ownership is significantly positively associated with innovation. In columns (2) and (3), we add the interaction of institutional ownership with financial dependence. Column (3) excludes the R&D stock from the list of regressors.[6] The coefficient of institutional ownership in column (2) indicates that an increase of 1 percentage point in institutional ownership increases innovation output by

[5] For 90 observations we use ratings from the sample period to exploit as much information as possible. Excluding these observations or firms with missing credit ratings from the sample did not change our results notably.

[6] Aghion et al. (2013) argue that a specification without R&D stock identifies the combined effect of institutional investors on innovation input and output while a specification that controls for R&D stock estimates the effect on innovation productivity, i.e. output conditional on innovation input. As it is not clear whether the R&D stock accurately accounts for innovation input, as indicated by the insignificant coefficients in some specifications, we prefer a broader interpretation of institutional investors on innovation. However, we believe that financing constraints are not inconsistent with an effect of institutional investors on innovation productivity since financing constraints may prevent firms from making optimal R&D investments.

about 0.37 percent when financial dependence takes a value of zero. This corresponds to an industry where the median firm's capital expenditures is equal to its operating cash flow. The interaction term between institutional ownership and financial dependence is positive and statistically significant at the 1 percent level. This suggests that in industries that are more reliant on external finance, there is a higher association between institutional investors and innovation. Starting from a situation where financial dependence takes a value of 0, an increase in financial dependence by one standard deviation raises the predicted effect of an additional percentage point of institutional ownership from approximately 0.37% to 0.6%. Columns (4) and (5) show linear regressions with the log of the number of citation-weighted patents as the dependent variable for firm-years with non-zero patents.[7]

In column (6) and (7), we split the sample into industries with financial dependence above and below the median, respectively. In the high-dependence subsample[8], the effect of institutional ownership is more than twice as large as in the low-dependence subsample. Column (8) shows results with an interaction term between institutional ownership and $I(A)$, a dummy variable that takes value 1 for firms that are rated "A-" or higher. Following our argumentation that the impact of institutional investors is higher in more constrained firms, we would expect that they have a lower effect on firms with a high rating. This intuition is confirmed as the interaction term is negative and highly significant.

4.2 Institutional ownership, competition and financial dependence

Results in Aghion et al. (2013) indicate that institutional investors have a higher impact on innovation in more competitive sectors which is line with

[7]Following Aghion et al. (2013), the linear specifications contain industry fixed effects but not firm fixed effects. However, our conclusions do not change when we introduce firm fixed effects into the linear models.

[8]The median industry is assigned to the low-dependence subsample and the high-dependence subsample consists of all industries with larger than median financial dependence.

one of the predictions of the career concerns model. We argue that the main channel that drives this empirical observation is related to financial constraints. In competitive industries, firms have limited internal financial resources and have to rely more on external capital. Since the career concerns model predicts complementarity between institutional ownership and competition for reasons that are unrelated to financial constraints, we believe that it is important to control for financial dependence when this complementarity is investigated.

Table 2 shows results with interaction terms between institutional ownership and competition, measured as (1 - Lerner index) where Lerner index is calculated as the median gross margin at the three-digit industry level. Columns (1)-(3) replicate the results of Aghion et al. (2013) using both a time-varying measure and a time-invariant measure of competition which is computed as an average over the sample period. Columns (4)-(6) show results of analogue specifications to which we add the interaction of financial dependence and institutional ownership. Accounting for this variable, the interaction of institutional investors and competition becomes statistically insignificant and the parameter decreases from around 0.08 to 0.02. At the same time, the interaction of institutional ownership with financial dependence is almost unchanged compared to the results in Table 1 and remains statistically significant at the 5 percent level. Due to different scales, the value of the coefficients for interactions with competition and financial dependence are not directly comparable. According to the results in column (5) and descriptive statistics in Table A1, an increase in competition by one standard deviation raises the predicted effect of 1 percentage point higher institutional ownership by less than 0.06 log points. In contrast, an increase in financial dependence by one standard deviation increases the predicted effect of institutional ownership by more than 0.2 log points.

To investigate the relationship between institutional investors, financial dependence and competition further, we divide firms into four subsamples which are defined by low vs. high competition and low vs. high financial dependence. According to our financial constraints hypothesis, we expect that dependence on external finance should matter most if markups are low and hence internal finance is limited. This implies that across the two high-competition subsamples, the coefficient of institutional ownership changes more when we compare high-dependence to low-dependence industries than across the two low-competition subsamples. Similarly, we expect heterogeneity of the impact of institutions according to firms' credit rating to be more pronounced when competition is intense.

Table 3 shows the results of this sample split. In columns (1)-(4), we use the measure of financial dependence and in (5)-(8) we use the credit rating dummy to differentiate industries and firms according to the financial dimension. Across the low competition subsamples (columns 1 and 2), higher financial dependence is not associated with a stronger relationship between institutional investors and innovation. In contrast, financial dependence plays an important role when competition is intense. The coefficient of institutional investors is more than three times as large in column (4) where financial dependence is high than in column (3) where financial dependence is low. In columns (5)-(8), we see a similar pattern. In the low-competition subsamples (columns 5 and 6), the coefficient of institutional ownership does not differ much between firms with high and low credit ratings. In column (8), where credit ratings are low and competition is high, the coefficient of institutional ownership is large and statistically highly significantly, whereas in column (7), where credit ratings are high, it is insignificant and has a reversed sign.

4.3 Endogeneity of institutional ownership

It is possible that institutional investors base their investment decisions on expectations about future performance that is unobserved by the econometrician implying endogeneity of the ownership variable. To address this problem, we use the same IV for institutional ownership as Aghion et al. (2013); addition of a firm to the S&P 500 index. Aghion et al. (2013) argue that fund managers are benchmarked against the S&P 500 which induces them to invest in firms listed in this index. According to the guidelines of the S&P 500 index, it is representativeness for a firm's industry that determines addition to the index but not firm performance, innovation or investment potential.[9] The IV estimator is implemented in a control function approach where residuals from a first stage are inserted into a second stage count data regression.

Table 4 shows first and second stage results of the IV regression for the full sample in (1) and (2) and for industries with high and low financial dependence in columns (3)-(6). The instrument is highly significant in all first stage regressions. In columns (1) and (2), IV regressions of Aghion et al. (2013) are replicated showing a much higher coefficient for institutional ownership in the second stage compared to the baseline model. Second stage results in columns (4) and (6) confirm our previous results. The positive effect of institutional ownership is driven by firms in industries that are more dependent on external finance. The effect even becomes statistically insignificant for the low-dependence subsample.

The IV results show that accounting for endogenous selection increases the estimated coefficient of institutional ownership in the subsample with high financial dependence but not in the low-dependence subsample. Our hypothesis that institutional investors increase innovation by relaxing credit constraints is consistent with this result. Institutional investors may target companies that have high innovation potential but have been limited in their possibility to exploit these opportunities due to financial constraints. If we ignore endogeneity of institutional ownership, we therefore omit unobservables that are positively correlated with institutional ownership but negatively correlated with innovation in high-dependence industries. For the low-dependency subsample, financial constraints and hence selection on unobservables might be of lower importance.

4.4 Extensions and robustness checks

Another prediction of the career concern model is that CEO turnover becomes more likely after a decrease in profits but is less sensitive to changes in profitability in firms with institutional investors. To test this prediction,

[9] Guidelines can be found at `http://www.spindices.com/indices/equity/sp-500`. See Aghion et al. (2013) for further discussion of the IV.

Aghion et al. (2013) regress the probability of CEO firing on lagged changes in the profit to assets ratio (profits divided by assets), a dummy variable taking value one for firms with institutional ownership above 25 percent, and an interaction term between these two variables. Columns (1) and (4) replicate the findings of Aghion et al. (2013) for two different sample periods considered in this paper. While their results are consistent with the predictions of the career concern model, they are in line with other explanations as well. For instance, a fall in profits – and hence internal funds – might be more likely to cause severe problems and lead to lay-offs when firms are financially constrained or need internal financial resources to service debt. A lower sensitivity of managerial turnover to changes in profitability in firms with institutional ownership is therefore consistent with institutional investors alleviating financing constraints.

To investigate this relationship in more detail, we analyze whether the correlations between profitability, institutional ownership and CEO turnover are more pronounced in industries with high levels of financial dependence. The marginal effects of these regressions are depicted in columns (2)-(3) and (5)-(6) of Table 5. The correlations found for the pooled sample seem to be entirely driven by industries with high dependence on external finance. Marginal effects are statistically insignificant for the low-dependence subsample and even reverse sign for the reduced time period which overlaps with the innovation sample (and has cleaner ownership data according to Aghion et al., 2013). This indicates that the associations between profitability, CEO turnover and institutional ownership are driven by financial factors rather than the mechanisms of the career concerns model.

As an additional tests for the importance of financial constraints, we use a more direct measure; the sensitivity of R&D to cash flow. The validity of investment-cash flow sensitivities as a measure of financing constraints has been challenged (e.g. Cummins et al., 2006; Kaplan and Zingales, 1997). However, this indicator has been applied in several recent contributions which argue that it is at least a useful measure of differences in financial constraints across different groups of firms (see, for instance, Bond and Söderbom, 2013;

Brown et al., 2012; Erel et al., 2015). If institutional investors facilitate access to external finance, we expect that firms with a larger share of institutional ownership adjust their R&D to a lesser extent to increased availability of internal funds. To test this hypothesis, we estimate a dynamic model of R&D. Particularly, we relate R&D investment (scaled by a firm's capital stock) to its lagged value, institutional ownership, current and lagged values of Tobin's Q and cash flow, and interactions between institutional ownership and cash flow. We estimate the model in first differences and apply the GMM estimator proposed by Arellano and Bond (1991). As instruments, we use lagged values of all regressors except institutional ownership, a dummy variable for S&P index membership, and its interaction with lagged cash flow.

Table 6 shows the results for two alternative lag structures among the IVs. Column (1) treats all regressors except institutional ownership and its interaction terms as predetermined, column (2) treats all regressors as potentially endogenous. The R&D-cash flow sensitivities are significant which indicates the presence of financial constraints for R&D in the sample. While institutional ownership seems to induce higher R&D investment, it decreases the sensitivity of R&D to cash flow significantly. The estimated parameters imply that the cash flow sensitivity approaches zero if approximately 68 percent of shares are held by institutional investors.

We conducted several robustness checks which are closely related to those in Aghion et al. (2013). First, we control for firm value which might be an important, albeit potentially endogenous, determinant of innovation output (see Table A3 in the Appendix). Columns (1) to (3) of table A4 in the Appendix show results when we use 4-digit instead of 3-digit industry dummies. Results obtained from a Negative Binomial model are documented in columns (4) and (5). All these robustness checks do not change our conclusion regarding the interaction of institutional investors with financial dependence and credit ratings.

One might be concerned about the implicit assumption of a linear effect of financial dependence and the role of potential outliers. To address this concern, we rank industries according to the value of financial dependence in an alternative specification. The industry with the lowest value of financial dependence is assigned rank 1, and the industry with the highest financial dependence is assigned rank 39. Column (5) of table A4 shows that the interaction of institutional ownership with this ordinal scale of financial dependence is positive and statistically significant as well.

5 Conclusion

This paper builds on recent work by Aghion et al. (2013) who find a positive relationship between institutional investors and innovation. The presumed mechanism for this relationship is that monitoring by institutional investors allows them to identify and reward managerial ability in risky innovation projects. They can therefore insure managers against bad luck in the innovation process which the market might interpret as a bad signal for their ability. Our empirical analysis tests the hypothesis that institutional investors induce innovation by alleviating financial constraints.

We provide evidence that institutional investors have a higher impact in industries that are more dependent on external finance. After we control for an interaction term between financial dependence and institutional ownership, we also find that the impact of institutional investors does not significantly vary with competition which contradicts a prediction of the career concern model of Aghion et al. (2013). We argue that the previously found complementarity between institutional investors and competition is driven by financial dependence rather than a reduction of career concerns. Consistent with our argument, we find that the effect of institutional ownership on innovation is concentrated among firms with relatively low credit ratings. We also show that institutional ownership is associated with lower R&D-cash flow sensitivities.

Our results have important policy implications. Previous research has explained positive effects of institutional investors by a reduction of managers' career concerns through increased monitoring which implies that policy measures that increase board representation of blockholders relative to outsiders may spur innovation. In contrast, we argue that financial constraints are a key driver for the effects of institutional investors on innovation. We suggest that policy measures aiming to induce innovation should focus on providing firms with access to finance. Especially in industries with high dependence on external finance and low internal funds, policy measures that facilitate access to external equity by institutional investors can have a large impact on innovation activity.

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6 Tables

Table 1: Main Results with Financial Dependence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method	Poisson	Poisson	Poisson	OLS	OLS	Poisson	Poisson	Poisson
Dependent Variable	*CITES*	*CITES*	*CITES*	*ln(CITES)*	*ln(CITES)*	Pooled	*CITES*	*CITES*
Sample	Pooled	Pooled	Pooled	Pooled	Pooled	High Dep.	Low Dep.	Pooled
Shares of Institutions		0.000442***	0.000458***	0.000511**	0.000408***			
x Fin. Dep.		(0.000141)	(0.000141)	(0.000215)	(0.000138)			
Shares of Institutions	0.00737***	0.00369***	0.00349**	0.00350	0.00393*	0.00961***	0.00424***	0.00495***
	(0.00200)	(0.00138)	(0.00150)	(0.00247)	(0.00222)	(0.00133)	(0.000978)	(0.000781)
ln(R&D)	0.0150	0.0116			0.353***	-0.155***	0.0701	0.0155
	(0.0756)	(0.0741)			(0.0707)	(0.0422)	(0.0444)	(0.0705)
ln(K/L)	0.364*	0.368*	0.367*	0.400***	0.252***	0.651***	-0.0445	0.350*
	(0.219)	(0.220)	(0.213)	(0.130)	(0.0880)	(0.0679)	(0.0547)	(0.195)
ln(Sales)	0.149**	0.151**	0.153***	0.545***	0.275***	0.295***	0.116**	0.148
	(0.0728)	(0.0725)	(0.0255)	(0.0613)	(0.0702)	(0.0615)	(0.0548)	(0.0996)
I(A)								0.509**
								(0.207)
Shares of Institutions								-0.0101***
x I(A)								(0.00266)
N	6178	6178	6178	3998	3998	2706	3472	6178

Standard errors, clustered at the 3-digit industry level, in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$
Column 1 replicates the results in Aghion et al. (2013).
The dependent variable is patents weighted by future citations (log patent citations in linear models).
Fin. Dep. is an industry-level measure of financial dependence.
High Dep. (Low Dep.) are industries with a value of Fin. Dep. above (below) the median.
$I(A)$ takes a value of one (zero) if firms have a rating at least (worse than) "A-".
All regressions include time- and 3-digit industry fixed effects. Firm fixed effects are used in all regressions but the linear models.
The sample period is 1991-1999

Table 2: Competition Interactions

	(1)	(2)	(3)	(4)	(5)	(6)
Measure of Competition	Varies	Varies	Constant	Varies	Varies	Constant
Share of institutions	0.00739***	-0.0645***	-0.0683***	0.00368***	-0.0111	-0.0133
	(0.00204)	(0.0298)	(0.0280)	(0.00138)	(0.0309)	(0.0323)
Competition	0.346	-3.691		-0.164	-0.958	
	(2.334)	(3.336)		(2.140)	(3.070)	
Share of institutions		0.0821**			0.0174	
x Competition		(0.0348)			(0.0365)	
Share of institutions			0.0868***			0.0201
x Avg. Competition			(0.0330)			(0.0385)
Share of institutions				0.000443***	0.000392**	0.000371**
x Fin. Dep.				(0.000140)	(0.000178)	(0.000188)
N	6178	6178	6178	6178	6178	6178

Standard errors, clustered at the 3-digit industry level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01
The dependent variable is patents weighted by future citations.
Columns 1-3 replicate Aghion et al. (2013).
Fin. Dep. is an industry-level measure of financial dependence.
All regressions include time-, 3-digit industry-, and firm fixed effects
The sample period is 1991-1999

Table 3: Competition and Financial Dependency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Competition	Low Comp.		High Comp.		Low Comp.		High Comp.	
Fin. Dependence	Low	High	Low	High	Pooled	Pooled	Pooled	Pooled
Credit Rating Dummy	All	All	All	All	= 1	= 0	= 1	= 0
Share of Institutions	0.00432***	0.00243	0.00339***	0.0106***	0.00468	0.00435***	-0.00324	0.0103***
	(0.00145)	(0.00341)	(0.00115)	(0.000139)	(0.00352)	(0.00163)	(0.00231)	(0.000970)
ln(K/L)	-0.0740	0.652***	0.0486	0.620***	-0.0766	0.164	0.426*	0.566***
	(0.0598)	(0.231)	(0.0966)	(0.0196)	(0.0547)	(0.264)	(0.237)	(0.0768)
ln(Sales)	0.132***	0.101	0.192***	0.204***	0.392***	0.0975***	-0.0931	0.233***
	(0.0415)	(0.0792)	(0.0162)	(0.00118)	(0.119)	(0.0329)	(0.118)	(0.0135)
N	1925	1189	1547	1517	545	2569	352	2712

Standard errors, clustered at the 3-digit industry level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01
The dependent variable is patents weighted by future citations. All regressions include time-, 3-digit industry- and firm fixed effects.
The sample period is 1991-1999
Low and high competition (financial dependence in 1-4) is determined by the median.
Credit rating dummy takes a value of one (zero) if firms have a rating at least (worse than) "A-"

Table 4: IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Equation	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Method	OLS	Poisson	OLS	Poisson	OLS	Poisson
Sample	Pooled	Pooled	High Dep.	High Dep.	Low Dep.	Low Dep.
I(sp500)	8.973***		10.57***		8.010**	
	(1.990)		(1.782)		(3.231)	
Shares of Institutions		0.0258***		0.0233***		0.00494
		(0.00500)		(0.00326)		(0.0114)
ln(K/L)	-0.941	0.378*	0.182	0.603***	-1.469*	-0.0502
	(0.887)	(0.210)	(1.503)	(0.0646)	(0.786)	(0.0598)
ln(Sales)	4.557***	0.0407	4.913***	0.0817	4.277***	0.155**
	(0.677)	(0.0342)	(0.400)	(0.0538)	(0.983)	(0.0613)
1st stage residual		-0.0208***		-0.0163***		-0.00106
		(0.00506)		(0.00412)		(0.0126)
N	6178	6178	2706	2706	3472	3472

Standard errors, clustered at the 3-digit industry level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01
The dependent variable is patents weighted by future citations in (2),(4) and (6).
In the first stage regressions (column 1, 3 and 5), the dependent variable is institutional ownership.
All regressions include time-, 3-digit industry-, and firm fixed effects.
Low and high financial dependence is defined as lower and larger than median financial dependence, respectively.
The sample period is 1991-1999.

Table 5: CEO Performance and Financial Dependence

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Pooled	Low Dep.	High Dep.	Pooled	Low Dep.	High Dep.
Time period	1988–1995	1988–1995	1988–1995	1991–1995	1991–1995	1991–1995
(Share of institutions > 25%)	1.057**	0.395	1.786**	1.364*	-0.377	3.298**
x Δ(Profits/assets)$_{t-1}$	(0.456)	(0.485)	(0.724)	(0.790)	(1.020)	(1.391)
Share of institutions > 25%	-0.0332	-0.0337	-0.0278	-0.0396	-0.00727	-0.0575
	(0.0212)	(0.0261)	(0.0299)	(0.0294)	(0.0280)	(0.0520)
Δ(Profits/assets)$_{t-1}$	-1.274***	-0.570	-2.014***	-1.668**	0.00848	-3.466***
	(0.362)	(0.398)	(0.629)	(0.690)	(0.937)	(1.268)
N	1897	961	936	1178	598	580

Standard errors, clustered at the firm-level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01
The table reports marginal effects from a Probit regression.
The dependent variable takes value 1 if a manager was forced to leave and 0 otherwise.
Columns (1) and (4) replicate results in Aghion et al. (2013)

Table 6: Cash Flow Sensitivity

	(1)	(2)
RD_{t-1}	-0.00563	-0.0317
	(0.0872)	(0.0961)
Tobin's Q	-0.00324	-0.000604
	(0.00344)	(0.00499)
$(\text{Tobin's Q})_{t-1}$	-0.000856	-0.00406
	(0.00223)	(0.00294)
Cash l	0.257***	0.304**
	(0.0702)	(0.125)
$(\text{Cash Flow})_{t-1}$	0.290***	0.317***
	(0.0810)	(0.0842)
Cash Flow x Shares of Institutions	-0.00361***	-0.00361**
	(0.00101)	(0.00160)
$(\text{Cash Flow x Shares of Institutions})_{t-1}$	-0.00467***	-0.00560***
	(0.00122)	(0.00136)
Shares of Institutions	0.00125***	0.00114
	(0.000327)	(0.000807)
$(\text{Shares of Institutions})_{t-1}$	0.00114	0.00166***
	(0.000885)	(0.000618)
N	2749	2749
Arellano-Bond test AR(2), p-value	0.406	0.360
Hansen test, p-value	0.213	0.370
Lags as instruments	$t-1/t-3$	$t-2/t-3$

Standard errors, clustered at the firm-level, in parentheses.

* p<0.10, ** p<0.05, *** p<0.01

The dependent variable is R&D divided by the capital stock.

Both regressions contain year fixed effects.

S&P 500 and its interactions with lags of cash flow are used as instruments in both equations.

Column (1) also uses 1 to 3-year lags of cash flow, Q and lagged R&D as instruments.

Column (2) uses 2 to 3-year lags of cash flow, Q and lagged R&D as instruments.

7 Appendix

Table A1: Descriptive Statistics

Variable	Mean	Std.
Citation weighted patents	234.21	1016.06
Shares held by institutional investors	46.59	22.96
External funding dependence	2.82	5.27
Dummy "A-,A,A+" rated firms	0.17	0.04
Log R&D Stock	4.51	2.06
Log capital intensity	4.40	0.77
Log sales	6.49	1.92
Tobin's Q	3.00	4.18
Dummy S&P500 inclusion	0.31	0.46
1-Lerner Index	0.86	0.03
Pre sample mean citations	4.77	2.41

Table A2: Descriptive Statistics Credit Rating

S&P Rating	Freq.	Percent	Cum.
A	318	5.15	5.15
A+	212	3.43	8.58
A-	367	5.94	14.52
B	828	13.40	27.92
B+	646	10.46	38.38
B-	772	12.50	50.87
C	503	8.14	59.02
D	220	3.56	62.58
Missing	2,312	37.42	100.00
Total	6,178	100.00	

Table A3: Controlling for Firm Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable	*CITES*	*CITES*	*CITES*	*INST*	*CITES*	*INST*	*CITES*	*INST*	*CITES*
Sample	Pooled	High Dep.	Low Dep.	Pooled	Pooled	High Dep.	High Dep.	Low Dep.	Low Dep.
Shares of Institutions	0.000356***								
x Fin. Dep.	(0.0000981)								
Shares of Institutions	0.00391***	0.00853***	0.00394***		0.0279***		0.0276***		-0.00670
	(0.00113)	(0.00110)	(0.000981)		(0.00605)		(0.00500)		(0.01000)
Tobin's Q	0.0635***	0.0670***	0.0279	0.665***	0.0487***	0.823***	0.0499***	0.390	0.0145
	(0.00740)	(0.00450)	(0.0210)	(0.169)	(0.00552)	(0.221)	(0.00128)	(0.251)	(0.0296)
S&P500				8.060***		9.444***		7.553**	
				(2.264)		(2.010)		(3.294)	
Control function	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
N	6178	2706	3472	6178	6178	2706	2706	3472	3472

Standard errors, clustered at the 3-digit industry-level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01

The dependent variable is future citation weighted patents in (1)-(3),(5),(7) and (9).

Models (4), (6) and (8) are first stage regressions with institutional ownerships as dependent variable of the models (5),(7) and (9), respectively.

All regressions contain time-, 3-digit industry-, and firm fixed effects.

Table A4: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
Method	Poisson	Poisson	Poisson	Negative Binomial	Negative Binomial	Poisson
Measure of Fin. Dep.	Continuous	Continuous	-	Continuous	-	Ordinal
Shares of Institutions	0.000556***	0.000451**		0.000337**		0.000157**
x Fin. Dep.	(0.000131)	(0.000189)		(0.000131)		(0.0000708)
Shares of Institutions	0.00286**	-0.0268	0.00514***	0.00370**	0.00519***	0.00204
	(0.00124)	(0.0328)	(0.000905)	(0.00152)	(0.00127)	(0.00225)
Shares of Institutions		0.0349				
x Competition		(0.0390)				
I(A)			0.438*		0.435	
			(0.243)		(0.314)	
Shares of Institutions			-0.00765**		-0.00653*	
x I(A)			(0.00357)		(0.00371)	
Industry dummies	4-digit	4-digit	4-digit	3-digit	3-digit	3-digit
N	6178	6178	6178	6178	6178	6178

Standard errors, clustered at the 3-digit industry level, in parentheses. * p<0.10, ** p<0.05, *** p<0.01

The dependent variable is future citation weighted patents. All regressions contain time- and firm fixed effects.

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ISSN 2190-9938 (online)
ISBN 978-3-86304-218-9