Innovation and Institutional Ownership*

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Abstract

Does greater equity ownership by institutional investors improve or inhibit innovation incentives? We present a model of career concerns where institutional ownership *increases* the incentives managers have to innovate through reducing informational asymmetries. We then utilize an original panel of US firms containing information on ownership, governance, managerial characteristics and innovation. We show that higher instiutional ownership is positively associated with greater innovation, even after controling for fixed effects and endogeneity using membership of the S&P500 as an instrumental variable. An alternative to our career concern model is that institutions reduce managerial slack (the "lazy manager" story). We show that the positive effect of insitutional ownership is stronger when competition is more intense which is inconsistent with the lazy manager story, but consistent with our career concerns model.

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1. Introduction

There are large degrees of support for innovation by governments all over the world. Policy-makers frequently justify these interventions because of some sort of financial market failure that generates a socially sub-optimal degree of financing for innovation[1]. There is a large body of theoretical work on finance and innovation beginning with Kenneth Arrow (1962) which formalized the under-investment result (building on a discussion in Joseph Schumpeter, 1942). The basic problem revolves around asymmetric information: the agent who is in charge of finding or implementing the innovation project knows a lot more than the principal who is financing it. Credibly communicating this information is a non-trivial task that is hard enough for a standard investment in plant, but is particularly difficult for an intangible investment.

In recent decades, ownership of major companies has become increasingly dominated by institutions. In 1997, a year in the middle of our sample period, the median firm in the S&P 500 had 59% of its equity owned by institutions. Commentators have been sharply divided in the implications of this movement. On the one hand, there is the view that the increasing dominance of institutions will lead to excessive "short-termism" and therefore cuts in the innovation budget. On the other hand, and this will be the argument in our paper, there are several reasons for believing that institutional ownership may foster *greater* innovation. One reason for this is that institutions may be in a better position than individuals to reduce the informational asymmetry between managers and owners. Because they own a large block of equity they have incentives to do this. The corporate governance policy statements of major institutional investors certainly claim

[1] The other main economic justification for intervention are the externalities associated with knowledge spillovers (see Bloom, Schankerman and Van Reenen, 2006, for evidence that these remain substantial).

to be closely monitoring their portfolio firms. CalPERS, the Council of Institutional Investors, TIAA-CREF and others all emphasis this (e.g. TIAA-CREF Policy Statement on Corporate Governance, March 2000). Regulatory barriers have been relaxed over the last fifteen years (particularly the 1992 changes to the American Proxy Rules[2]) making it easier for different institutional owners to forge alliances, monitor CEOs and coordinate more activist policies[3].

To test these ideas we assemble a rich and original panel dataset of over a thousand US firms over the 1990s containing time-varying information on patent citations, ownership, R&D and governance. We show that there is a robust positive association between the degree of institutional ownership and innovation that is robust to controlling for fixed effects and endogeneity (through using membership of the S&P500 Index). Institutions have a weak and positive impact on R&D, but a larger effect on the productivity of R&D (as measured by future patent cites per R&D dollar).Figure 1 shows the non-parametric relationship between innovation (cite-weighted patents) and institutional ownership. We will expand on the data sources later, but this initial look at the raw data suggests a positive relationship between institutional ownership and innovation. This turns out to be robust to including many additional controls, including firm fixed effects and using an instrumental variable techniques.

We formalize this notion in a simple model of career concerns similar to Holmstrom (1982). If a CEO innovates he takes the risk that if things go wrong for

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[2]The changes permitted an unlimited number of shareholders to coordinate activist efforts and share information about governance issues in their portfolio firms provided they supplied the SEC with a brief description of any substantive discussions. Prior to the changes if a group of ten or more owners wanted to discuss firm/management performance, etc., a detailed filing had to be made to the SEC prior to the meeting.

[3]An example would be the Institutional Shareholders Services (ISS). They offer a full-service proxy voting system whereby instituions can delegate corporate governance responsibilities to ISS. This was stimulated by the Department of Labor's so-called "Avon" letter of 1987 (see Schelberg and Bitman, 1999).

purely stochastic reasons, the owners will start to think he is a bad manager and may fire him. This generates a natural risk aversion to innovation. If incentive contracts cannot fully overcome this, increased monitoring can improve incentives to innovate. Our first result is that institutional owners, which have a larger share of the firm, will therefore encourage innovation. A second result is that competition and institutional ownership are complements as higher monitoring reinforces the "escape competition" effect. This contrast our model with an alternative "lazy manager" story whereby greater institutional monitoring would simply reduce shirking and therefore also encourages great innovative managerial effort. Both stories generate the empirical prediction that institutional ownership is positive associated with innovation, albeit by different mechanisms. However they make difference predictions on the effects of competition. Under the lazy manager hypothesis, product market competition and institutional ownership are substitutes: if competition is high then there is no need for intensive monitoring as the manager is disciplined by the threat of bankruptcy to work hard. In contrast in our model, more intense competition reinforces the positive effect of institutional investment on managerial incentives. As it turns out, in our empirical analysis we find that the positive innovation-institutional ownership relationship is stronger when product market competition is more intense (or state laws less protective of incumbent CEOs), consistent with our career concerns model, but not with the "lazy manager" story.

This paper contributes to several literatures. On the theoretical side many papers have focused on the effects of financial markets on investment in general and on innovation in particular. But none look at institutional ownership through the lens of career concerns. On the empirical side there is a large literature on financial constraints and investment, but much less specifically examining the role of finance for innovation[4]. There is very little at all focusing on ownership and innovation, although exceptions include Jennifer Francis and Abbie Smith (1995) who find a positive correlation between ownership concentration (which includes institutions) and innovation also and Eng and Shackell (2001) who find a positive correlation of institutions with R&D. By contrast, Majamda and Nagarajan (1997) and Bushee (1998) found no significant effects of institutional ownership on R&D spending. We advance on the literature by (a) allowing for endogeneity of ownership, (b) identifying between different theoretical mechanisms for the innovation-ownership relationship, (c) distinguishing between R&D and innovation outputs and (d) using a much larger sample - a panel of over 1,000 US firms.

The paper is organized as follows. Section 2 presents the econometric framework, Section 3 the data, Section 4 the main results. We detail the models in Section 5 and test them in section 6. A series of extensions and robustness test are in section 7 and some concluding remarks are made in section 8.

2. Econometrics

2.1. Innovation Equations

Consider the first moment of the relationship between a count-based measure of innovation (forward cite-weighted patents), P_{it}, of firm i in period t and our measure of institutional ownership (the proportion of voting stock owned by institutions)[5]where $E(.|.)$ is the conditional expectations operator. The conditional expectation of the estimator is:

$$E(P_{it}|x_{it}) = \exp\{\alpha^p INSTIT_{it} + \beta^p x_{it} + \eta_i^p + \tau_t^p\} \tag{2.1}$$

[4]For important contributions see Kaplan and Zingales (1997) or Gomes (2000). For a survey of the theory and empirical literature see Bond and Van Reenen (2007) and Hall (2002).

[5]See Blundell, Griffith and Van Reenen (1999) and Hausman, Hall and Griliches (1984) for discussions of count data models of innovation.

where x_{it} are other control variables, η_i^p is a firm-specific idiosyncratic effect and τ_t^p is a time dummy. The vector X_{it} contains all the right hand side variables in equation (2.1). Note that we show the importance of different conditioning variables. In particular we consider specifications with and without controlling for the R&D stock. When the R&D stock is included α^p indicates whether firms with higher $INSTIT_{it}$ have a greater ability to obtain innovations from their R&D stock ("efficiency of the knowledge production function"). When we drop R&D from the right hand side α^p will reflect this effect and any effect of institutions in raising investment in R&D.

We adopt the log-link formulation because of the count-based nature of the data. Different assumptions concerning the error term will generate alternative estimators even though the first moment (2.1) is the same. The variance of the Negative Binomial under our specification is:

$$V(P_{it}) = \exp(\alpha^p INSTIT_{it} + \beta^p x_{it} + \eta_i^p + \tau_t^p) + \vartheta \exp(2(\alpha^p INSTIT_{it} + \beta^p x_{it} + \eta_i^p + \tau_t^p))$$

where the parameter, ϑ, is a measure of "over-dispersion". We also consider the Poisson model where the mean equals the variance ($\alpha = 0$). Since all models will allow the standard errors to have arbitrary heteroskedacity and autocorrelation (i.e. clustering the standard errors by firm) the exact functional form of the error distribution assumed should not be important.

We introduce firm fixed effects, η_i^p, into the count data model using the "mean scaling" method of Richard Blundell, Rachel Griffith and John Van Reenen (1999). This relaxes the strict exogeneity assumption underlying Jerry Hausman, Bronwyn Hall and Zvi Griliches (1984). Essentially, we exploit the fact that we have a long pre-sample history (of up to 27 years per firm) on patenting behavior to construct its pre-sample average. This can then be used as an initial condition to proxy for unobserved heterogeneity if the first moments of the variables are stationary.

Although there will be some finite sample bias Monte Carlo evidence shows that this pre-sample mean scaling estimator performs well compared to alternative econometric estimators for dynamic panel data models with weakly endogenous variables (see Richard Blundell, Rachel Griffith and Frank Windmeijer (2002)).

There will be censoring of the patent citation information as we approach the last year of citations data, 2002. To deal with this censoring we have done two things. First, we estimate only until 1999 allowing for a three year window. Second, we re-normalize the citations taking into account the year in which the patent was taken out (see Appendix B and Bronwyn Hall et al, 2005, for more details).

An advantage of these count data models is that we take the zeros explicitly into account. We compare the results of these models with OLS estimates on the sample of firms with non-zero patenting, i.e.

$$\ln P_{it} = \alpha^p INSTIT_{it} + \beta^p x_{it}^p + \eta_i^p + \tau_t^p + v_{it}^p \tag{2.2}$$

and with models that use the arbitrary re-scaling and substitute the dependent variable with $\ln(1 + P_{it})$.

2.2. Productivity Equations

Consider the production function. Although we consider more complex forms, the basic production function is of the R&D augmented Cobb-Douglas form:

$$\ln Y_{it} = \alpha^y INSTIT_{it} + \beta^y x_{it}^y + \eta_i^y + \tau_t^y + v_{it}^y \tag{2.3}$$

where Y is the real sales of firm i in period t.

The interpretation of α^y is somewhat different than α^p because α^y>0 indicates that institutional ownership is associated with higher TFP ("efficiency") whereas

$\alpha^p > 0$ indicates that institutional ownership is associated with higher innovation (presumably, "TFP growth")[6]. Because we do not have information on firm-specific prices, this induces measurement error. Controlling for industry sales dynamics (see Tor Klette and Zvi Griliches, 1996) and fixed effects should go a long way towards dealing with the problem of firm-specific prices.

2.3. Endogeneity

Institutional ownership may be more prevalent in successful firms biasing the coefficient on institutional ownership upwards. Alternatively, institutions may see more opportunities to turn around badly performing firms biasing the OLS coefficient towards zero. Demsetz and Lehn (1985) where one of the first to explicitly analyze the ownership structure of publicly traded firms and argue that these responded endogenously to features of the firm and industry (see also Morck, Shleifer and Vishny, 1988, 1989). Measurement error will also cause problems, if classical it will attenuate the coefficient towards zero.

We consider using membership of the S&P500 as an instrumental variable. The inclusion of a firm in the S&P500 has a large random component attached to it and seems unrelated to the fundamental performance of firms. Shleifer (1986) was the first to utilize this property in a systematic way and subsequent work has broadly speaking confirmed this (e.g. Dhillon and Johnson, 1991). Once a firm is in the S&P500 it is likely to attract the attention of institutions for at least two reasons. First, openly indexed funds are more likely to track the S&P500 so Tracker Funds will demand more of the firm's equity. Second, even in Closed Funds, managers are usually benchmarked against the S&P500 so there is an incentive for them to be over-exposed to companies in the S&P500. Thirdly,

[6] Chiara Criscuolo (2006) and Neal Dryden et al (1997) look at the effects of ownership on the level of productivity in UK panel data.

Fiduciary duty laws - such as ERISA - have been shown to influence portfolio selection through their implied endorsement of broad indexing[7].

We implement the instrumental variable estimator in two ways. First, we present the two-stage least squares results. Although this is fine for sales and for the non-zero patent count models, it is problematic for the count data models. For this reason we take a control function approach (see Blundell and Powell, 2001). Under exogeneity of $INSTIT_{it}$ we have the moment condition

$$E(\upsilon_{it}^{y}|INSTIT_{it}, x_{it}^{y}, \eta_{i}^{y}, \tau_{t}^{y}) = 1$$

This will not hold under endogeneity of $INSTIT_{it}$.We assume that the instrument z_{it} obeys the reduced form

$$INSTIT_{it} = \pi z_{it} + \beta^{o} x_{it}^{o} + \eta_{i}^{o} + \tau_{t}^{o} + \upsilon_{it}^{o}$$

with

$$E(\upsilon_{it}^{o}|x_{it}^{o}, \eta_{i}^{o}, \tau_{t}^{o}) = 1$$

so that controlling for υ_{it}^{o} in the conditional moment condition is sufficient to remove the endogeneity bias. In estimation we use the extended moment condition

$$E(P_{it}|X_{it}, \upsilon_{it}^{o}) = \exp\{\alpha^{p} INSTIT_{it} + \beta^{p} x_{it} + \eta_{i}^{p} + \tau_{t}^{p} + \rho(\upsilon_{it}^{o})\} \qquad (2.4)$$

where $\rho(\upsilon_{it}^{o})$ is a non-parametric function of υ_{it}^{o} (empirically we used a polynomial series expansion). A simple test for exogeneity is the joint significance of the residuals in equation (2.4).

[7] See Diane Del Gurcio (1996), John Wei and Stephen Pruitt (1989) or Froot, Scharfstein and Stein (1992) for supportive evidence.

3. Data

We use U.S. firm level panel data from a wide variety of sources. Our basic dataset is the Compustat database which contains balance sheet information on sales, R&D, employment, capital and other key data items for all U.S. publicly listed firms since the mid 1950s. We build on this dataset in several ways. First, for information on innovation we use the match between Compustat and the U.S. Patent and Trademark Office data in the NBER data archive. This contains detailed information on almost three million U.S. patents granted between January 1963 and December 1999 and all citations made to these patents between 1975 and 2002 (over 16 million)[8]. Second, for information on ownership we use public sources and the text files of Compact Disclosure. Ownership data includes the number of institutional owners, the number of shares issues and the percent of outstanding shares held by each institution[9]. The ownership data covers 91,808 firm-year observations between 1991 and 2004. Third, for information on managerial characteristics (such as CEO tenure) we use the S&P ExecuComp database. Fourth, for information on governance we use the *Investor Responsibility Research Center* (IRRC) which publishes detailed listings of corporate governance provisions for individual firms in Corporate Takeover Defenses (see Paul Gompers et al, 2003, for more details).

These datasets do not overlap perfectly so our baseline regressions run between 1991, the first year of ownership data, and 1998, the last year when we can re-

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[8]See Bronwyn Hall, Adam Jaffe and Manuel Trajtenberg (2001) and Adam Jaffe and Manuel Trajtenberg (2002).We used Bronwyn Hall's update of the citation files which runs through to 2002. We also constructed a cite weighted firm patent count as a quality adjusted measure of the raw patent count.

[9]All institutional organizations, companies, universities, etc. are required to file a Form 13-F with the SEC on a quarterly basis if they have greater than $100 million in equity assets under discretionary management. All common stock holdings of 10,000 or more shares or having a value of $200,000 or more must be reported. Throughout this paper an institutional owner is defined as an institution that files a 13-F.

alistically construct citation weighted patent counts. A full set of time dummies is included to control for the censoring problem with the citation series (we also consider unweighted patent counts). We also exploit the pre-sample information on the patent series beginning in 1969 as described in the econometric section below.

Appendix A provides details on all datasets. Although the exact number of observations depends on specific regression, the sample for which we run the cite-weighted patents equation contains 7,923 observations on 1,078 firms. Descriptive statistics are contained in Table 1. We see that our firms are large (2,900 employees and $472,000 in sales at the median). As is well-known the citation and patents series are very skewed. For example, the mean number of cites is fourteen per firm-year, but the median number of cites is only one.

[**Table 1 about here**]

We first take a preliminary look at the data in Figures 1 and 2. Figure 1 presents the non-parametric relationship between the log of firm citation weighted patents and the proportion of firm's equity owned by institutions (the line is the local linear regression line estimated by the lowest smoother with a bandwidth of 0.8). We do this for a year in the middle of our sample period (1995) but other years are similar. There is clearly a positive correlation between the two series which appears to be monotonic, although the positive relation does not appear until institutions own at least a quarter of the shares. Figure 2 uses raw patent counts instead of citation weighted patent counts which paints a similar picture.

We next look at "event studies" of firms who were added to the S&P500, our candidate instrumental variable for institutional ownership. We use a window of 7 years, three years prior to the year when the firm was added, the year itself and three years after the firm was added (a similar story emerges from adding or subtracting a year to the window). Figure 3 plots the change in the proportion of equity owned by institutions. The year the firm joined the index, the proportion of institutions rose by an average of 8.1 percentage points compared to a change of approximately zero or a small negative prior to the event. If we cumulate these from three years prior to joining (Figure 4), the long-run effect is an increase of about 4 percentage points. Figures 5 and 6 repeat the exercise for patent counts. There appears to be a delayed reaction of patents to S&P500 membership, the peak of the cumulative increase being reached about two years after the firm joins the index.

These graphs do not control for other confounding variables such as size or industry composition, of course. Nevertheless they are suggestive that there is a positive relationship in the data between innovation and institutional ownership in the data.

[**Figures 1-6 about here**]

4. Main Results

4.1. Innovation and Institutional Ownership

Table 2 contains the first set of results where we measure innovation by cite-weighted patent counts ("CITES"). Since we obtained quite similar results for raw patent counts we generally omit the results. Columns (1) through (3) in Table 2 are estimated by OLS where ln(CITES) is the dependent variable (so we drop observations with zero cites). Columns (4) through (11) are proper count data models where we include all the zeros and avoid arbitrary transformations[10]. Poisson regressions are contained in columns (4) through (7) of Table 2 and Negative

[10]See below in Appendix Table A3 for an alternative where we consider ln(1 + CITES) as an alternative dependent variable and obtain similar results.

Binomial ("Negbin") results are contained in columns (8) through (11)[11].

Across all the columns of Table 2 (except column (6)) the coefficient on institutional ownership lies between 0.005 and 0.013. If we are conservative and use the lower bound, a marginal effect of 0.005 implies that an increase of ten percentage points in institutional ownership (e.g. from the mean of 42% to 52%) is associated with a five percent increase in the probability of obtaining an additional cite-weighted patent (e.g. from the mean of 138 cites to 145 cites). This seems a result of economic as well as statistical significance. In our sample period between 1991 and 1999 institutional ownership for our firms rose from 37% to 46%, so ten percentage points is a reasonable change to consider.

Column (1) of Table 2 simply presents the OLS regressions of ln(CITES) on institutional ownership with controls for the ln(capital/labor) ratio, ln(sales), four-digit industry dummies and time dummies. As was suggested by Figures 1 and 2, there is a positive and significant association between innovation and the firm's share of equity owned by institutions. Column (2) include the firm's R&D stock which, as expected has a positive and significant association with patent citations (see, e.g. Bronwyn Hall et al, 2005). Conditioning on R&D slightly reduces the coefficient on institutional ownership (from 0.006 to 0.005) suggesting that the main effect of ownership is to alter quality and/or productivity of R&D rather than through stimulating more R&D. Table A4 in the Appendix also shows that institutions have a significant and positive effect on firm R&D investment (even after controlling for fixed effects) although the magnitude of this effect is small.

Columns (3) and (4) repeat the specifications of the first two columns but use a Poisson count data model. Since the zeros can now used the number of

[11] Note that Negbin is more general than Poisson as we relax the assumption than the variance is equal to the mean. However, since we allow a general error structure when clustering the standard errors (i.e. they are robust to arbitrary autocorrelation and heteroscedacity) this is not so critical (see Blundell, Griffith and Van Reenen, 1995, 1999 for a discussion).

observations almost doubles (from 4,044 to 7,923). The coefficient on institutional ownership remains significant with a larger marginal effect of 0.012. Column (5) includes the controls for fixed effects following the method of Richard Blundell et al (1999) using the pre-sample history of citations ("BGVR"). These are highly significant and reduce the marginal effect of institutions to 0.008, although the coefficient remains significant at the five percent level. Column (6) controls for fixed effects using the Jerry Hausman et al (1983) approach ("HHG") and although the institutional ownership variable remains significant, the coefficient falls to 0.001 - the lowest magnitude in Table 2. The problem with this method, as noted in the econometric section, is that the coefficients may be severely attenuated towards zero in the presence of measurement error. Additionally, the method is only valid with strictly exogenous variables.

The final four columns repeat the specifications but use the more Negative Binomial model instead of a Poisson model. The qualitative results are similar: institutional ownership has a positive and significant marginal effect. The magnitude of the coefficients are slightly larger for the more general count data model which relaxes the assumption of the equality between the variance and the mean.

[Tables 2 and 3 about here]

4.2. Instrumental Variable Estimates

We were concerned about the potential endogeneity of institutional ownership so we consider using membership of the S&P500 as an instrumental variable (as discussed above). Table 3 reports some instrumental variable results for innovation (columns (1) through (6)). The first column reproduces the basic Poisson results of Table 2 column (3) for reference. Column (2) presents the first stage where we regress institutional ownership on a dummy equal to unity if the firm was in the S&P500 (and all the other controls). As expected the instrument is positive and highly significant. Firms included in the S&P500 Index obtain on average 4.8 percentage points more institutional ownership than we would expect from their observable characteristics. The third column presents the results where we use the control function outlined in the econometric section[12]. Interestingly, the ownership variable remains significant with a coefficient that is much larger than column (1). On face value then, this suggests that we are underestimating the positive effect of ownership on innovation by treating institutions as exogenous.

The next three columns of Table 3 repeats the specifications but include fixed effects. Column (4) shows the standard result treating institutional ownership as exogenous and column (5) has the first stage. In column (6) we again use the control function approach to deal with the endogeneity of institutions. Again, the ownership variable remains positive and significant with a much higher marginal effect than column (4). This is consistent with some attenuation bias towards zero in the OLS results. Note, however, that exogeneity is rejected at the 10% level, but not the 5% level in column (6) whereas it rejects at the 1% level in column (3). This suggests that the fixed effects deal with a substantial part of the endogeneity bias.

Could inclusion in the S&P500 be associated with other "good news" about the firm's future performance thus invalidating the instrumentation strategy? We argued above that this was unlikely to be the case as exclusion/deletion in the S&P500 is largely an information-free event. Nevertheless, a way to examine this is to condition on other performance measures such as tobin's Q (a stock market based measure) or profitability. This is a very tough test as innovation will raise firm performance (see Hall et al, 2005 for direct evidence using this dataset) thus making it hard to identify an independent effect of ownership on innovation.

[12]This uses just a first order term in the polynomial for the control function.The second order term was insignificant (p-value =0.510). The coefficient on institutional ownership was 0.051 (standard error = 0.018) when both terms of the control function were included.

We do find, however, that institutional ownership remained significant even after conditoning on current and past values of these performance metrics[13]. This gives us further confidence in the robustness of the results.

[Tables 4 and 5 about here]

5. A simple model to explain the positive effect of institutions on innovation

5.1. A simple career concern model

Consider the following variant of Holmstrom (1982)'s career concerns model. There are two periods, $t = 1, 2$. The firm is run by a manager with unknown ability $\theta \in \{\underline{\theta}, \overline{\theta}\}$. The prior beliefs about θ are that:

$$\Pr(\theta = \overline{\theta}) = \Pr(\theta = \underline{\theta}) = 1/2.$$

For notational simplicity we normalize $\underline{\theta}$ at zero.

A fraction ψ of the firm is owned by an institutional investor, who, by investing monitoring effort $\frac{1}{2}s^2$, learns the manager's true ability with probability s whenever the project is informative.

At the beginning of period 1, the manager decides whether or not to innovate. We denote the innovation decision by $i \in \{0, 1\}$. If the manager does not innovate ($i = 0$), then her project is assumed to be uninformative about her ability in the sense that the revenue realization in period 1 is uncorrelated with ability. Moreover, with probability π the manager loses her job as the firm's technology is imitated by some other firm in the same sector. The parameter π is our measure of competition.

[13] For example, in column (4) the coefficient on institutional ownership was 0.006 with a standard error of 0.002 and the coefficient on ln(tobin's average q) was 0.031 with a standard error of 0.059. In column (6) the marginal effect of institutional ownership was 0.033 (standard error of 0.016).

If the manager decides to innovate ($i = 1$), then the period 1 revenue realization is equal to:

$$y_1 = \begin{cases} 1 \text{ with probability } p \\ 0 \text{ with probability } 1 - p \end{cases}$$

if the manager is of high ability (that is with $\theta = \overline{\theta}$), and to

$$y_1 = \begin{cases} 1 \text{ with probability } \alpha p \\ 0 \text{ with probability } 1 - \alpha p \end{cases},$$

where (i) $\alpha < 1$, so that a lower ability manager is less successful at innovating than a higher ability manager; and (ii)

$$p = 1 - \frac{\pi}{2}.$$

The term $\frac{\pi}{2}$ reflects the fact that more competition reduces the probability of a high income, yet the term $\frac{\pi}{2}$ instead of π the fact that an innovating firm is less subject to the competition threat than a non-innovating one. This reflects an escape competition effect: by innovating, the firm (partly) escapes the threat of being imitated and thereby driven out of the market.

Note that by innovating, the manager escapes competition and the associated risk of losing her job only partially. This in turn limits her incentive to innovate in the first place. it is here that institutional investment can play a role, namely to mitigate that risk.

The timing of moves is as follows: (i) the manager first decides whether or not to innovate; (ii) the institutional investor decides how much to invest in monitoring and may then learn about the manager's ability; (iii) the first period revenue is realized; based on that realization the market updates its assessment of the manager's ability; (iv) the manager decides whether or not to stay with the firm, based on the comparison between her expected wage in period 2 if she remains inside the firm versus what she can expects if he reallocates to another sector.

To complete our description of the model we make three assumptions:

Assumption 1: The market for managers is fully competitive, and the second period wage of a manager is equal to her expected ability conditional upon the information acquired in period 1.

This assumption is identical to that made in Holmstrom (1982).

Assumption 2: The information acquired by the institutional investor is hard, and made publicly available at no additional cost.

This implies that the manager's second period wage if the institutional investor learns about her ability and she stays in the firm or sector, is simply equal to her revealed ability.

Assumption 3: Managerial ability is sector-specific, thus what happens on her current job is uncorrelated with the manager's ability if she moves to another sector.[14] Moreover, a manager who reallocates to another sector incurs a switching cost equal to δ.

This latter assumption implies that the expected wage of a manager who reallocates to another sector, is equal to:

$$\underline{w} = \frac{1}{2}\overline{\theta} - \delta.$$

This is also the manager's reservation wage on her current job.

5.2. Equilibrium wage and innovation decision

We first consider the benchmark case where no information is acquired by the institutional investor. We solve the model by backward induction. Suppose that the manager has decided to innovate. Then, based on the revenue realization in period 1, the market updates its beliefs about managerial ability using Bayes' rule. Consequently, the manager's wage in period 2 if she remains in the firm, is given by:

$$w_2(y_1) = \Pr(\theta = \overline{\theta}/y_1)\overline{\theta}.$$

[14] Below we analyze the other extreme case where skills are fully non-specific.

If $y_1 = 1$, then

$$\Pr(\theta = \overline{\theta}/y_1 = 1) = \frac{p}{p + \alpha p} = \frac{1}{1+\alpha}.$$

We thus get:

$$w_2(y_1 = 1) = \frac{\overline{\theta}}{1+\alpha}.$$

Similarly,

$$w_2(y_1 = 0) = \Pr(\theta = \overline{\theta}/y_1 = 0)\overline{\theta} = \frac{1-p}{2-p-\alpha p}\overline{\theta}.$$

Assumption 5:

$$\frac{\overline{\theta}}{1+\alpha} > \frac{1}{2}\overline{\theta} - \delta = \underline{w} > \frac{1-p}{2-p-\alpha p}\overline{\theta}.$$

This assumption implies that the manager will leave the firm whenever her first period revenue performance is low. Note that we always have

$$\frac{1}{1+\alpha} > \frac{1}{2} > \frac{1-p}{2-p-\alpha p},$$

so that there is a non-empty set of parameters $(\alpha, \underline{w}, p)$ which satisfy this assumption.

Now, moving back to the initial stage of the game, the manager will decide to innovate if and only if:

$$U(i = 0) < U(i = 1),$$

where

$$U(i = 0) = (1-\pi)\frac{1}{2}\overline{\theta} + \pi \underline{w}$$

is the ex ante utility conditional upon not innovating (if the company is surpassed by a rival in innovation, the manager goes back to the labor market and gets his expected value, minus a relocation cost δ), and

$$U(i = 1) = (\frac{1}{2}p + \frac{1}{2}\alpha p)\frac{\overline{\theta}}{1+\alpha} + [\frac{1}{2}(1-p) + \frac{1}{2}(1-\alpha p)]\underline{w}.$$
$$= \frac{1}{2}p\overline{\theta} + \frac{1}{2}(2 - p - \alpha p)\underline{w}.$$

The first term in $U(i = 1)$ is the ex ante probability of a high revenue realization[15] times the second period wage conditional upon a high revenue realization $w_2(y_1 = 1)$. The second term is the ex ante probability of a low revenue realization times the manager's expected payoff from moving to another firm.

We now introduce the institutional investor into the analysis. We assume that the investor learns the true ability of an innovating manager with some probability s which is independent of the first period revenue realization.Anticipating this, the manager will innovate if and only if:

$$U(i = 0/s) < U(i = 1/s),$$

where

$$U(i = 0/s) = U(i = 0)$$

and

$$U(i = 1/s) = s[\frac{1}{2}\overline{\theta} + \frac{1}{2}\underline{w}] + (1-s)U(i = 1)$$

With probability s the manager's ability is learned by the institutional investor and then revealed to the market, so that the manager gets $\overline{\theta}$ if she is found out to be of high ability and $\underline{w}$ if she is found out to be of low ability; with probability $(1 - s)$ the market must rely on its observation of first period revenues to update its information about θ. Then one can establish:

[15] That is the ex ante probability of $\theta = \overline{\theta}$ (i.e $\frac{1}{2}$) times the probability of a high revenue conditional upon $\theta = \overline{\theta}$ (i.e p) times plus the probability of $\theta = \underline{\theta}$ times the probability of a high revenue conditional upon $\theta = \underline{\theta}$,

Proposition 5.1. *The manager's net gain from innovating,* $U(i = 1/s) - U(i = 0/s) = \Delta U/s$*, is increasing in* s*, and all the more so the higher* π*.*

Proof. We have:

$$\frac{d}{ds}(U(i=1/s) - U(i=0/s)) = \frac{1}{2}[(1-p)\overline{\theta} - (1-p-\alpha p)\underline{w}], \qquad (5.1)$$

which is positive since

$$\overline{\theta} > \underline{w}$$

by Assumption 5.

Next, we have:

$$\frac{d^2}{dsd\pi}(U(i=1/s) - U(i=0/s)) = \frac{1}{2}\frac{dp}{d\pi}[-\overline{\theta} + (1+\alpha)\underline{w}],$$

which is positive since

$$\frac{dp}{d\pi} = -\frac{1}{2}$$

and

$$\overline{\theta} > (1+\alpha)\underline{w}$$

again by Assumption 5. This establishes Proposition 1. ■

Thus, institutional investment stimulates managerial innovation all the more the higher the degree of competition measured by the imitation probability π. The intuition is the following: in the absence of institutional investors, innovating allows a firm manager to partly escape the competition threat; "partly" because higher competition also increases the expected cost an innovating manager is confronted with (this risk is reflected in the p factor in the expression for $U(i = 1)$. A higher intensity of institutional investment enhances the escape competition effect by insulating the innovating manager against the additional risk brought about by competition.

Now, let us compare the above analysis with what happens if managerial skills are fully non sector specific. In this case the ex ante utility of the manager conditional upon not innovating, is given by:

$$U(i=0) = (1-\pi)\frac{1}{2}\overline{\theta} + \pi\underline{\theta} = (1-\pi)\frac{1}{2}\overline{\theta}.$$

The ex ante utility conditional upon innovating and without an institutional investor, is equal to

$$U(i=1) = \frac{1}{2}p\overline{\theta} + \frac{1}{2}(2-p-\alpha p)\frac{1-p}{2-p-\alpha p}\overline{\theta} = \frac{1}{2}\overline{\theta}.$$

Whereas the ex ante utility conditional upon innovating and with an institutional investor, is equal to

$$U(i=1/s) = s[\frac{1}{2}\overline{\theta}] + (1-s)U(i=1) = \frac{1}{2}\overline{\theta} = U(i=1).$$

Thus in that case the institutional investor makes no difference to the manager's incentive to innovate.

Finally, let us compare with the case where p is constant, independent of π, in other words the manager fully escapes competition by innovating. In that case, we have

$$\frac{d}{d\pi}[U(i=1) - U(i=0)] = -\frac{d}{d\pi}U(i=0) = \frac{1}{2}\overline{\theta} > 0.$$

Moreover

$$\frac{d}{ds}[U(i=1) - U(i=0)] = \frac{1}{2}(1-p)\overline{\theta} > 0.$$

Thus, both institutional ownership and increased competition increase managerial incentives. However the interaction between the two effects disappears since

$$\frac{d^2}{d\pi ds}[U(i=1) - U(i=0)] = 0.$$

This last case looks very similar to the lazy manager story mentioned in the introduction. Namely, that monitoring by institutional investors, together with the managers' fear of losing the private benefits of remaining on the job, would force the latter to innovate if they are a priori reluctant to do so. This alternative story, inspired by Hart (1983) and Schmidt (1997), would point to competition and institutional investment being strategic substitutes.[16] However, the empirical analysis in the next section points to these factors being instead complements.

5.3. Equilibrium monitoring probability

To complete the solution of the model, we need to compute the equilibrium monitoring probability s^*. By learning the true managerial ability, the institutional investor avoids having to pay a high wage to a low ability manager who turns out to be lucky in period 1. The probability of such an event is αp, and the wage saving is equal to $w_2(y_1 = 1) - \frac{1}{2}\overline{\theta} = (\frac{1}{1+\alpha} - \frac{1}{2})\overline{\theta}$. Given that he owns a fraction ψ of the firm's shares, the institutional investor will choose the monitoring probability s to

$$\max_s \{\psi \alpha p (\frac{1}{1+\alpha} - \frac{1}{2})\overline{\theta} s - \frac{1}{2} s^2\},$$

which in turn yields

$$s^* = \psi \alpha p (\frac{1}{1+\alpha} - \frac{1}{2})\overline{\theta}.$$

This, together with Proposition 1, yields the main predictions of this model, namely:

[16] For example, suppose that the manager draws private benefit B from remaining on the job, but that innovating entails a private cost K to her. Other than that, the manager does not respond to monetary incentives, whether explicit or implicit. Finally, suppose that whether the manager has innovated or not, is verifiable with probability s, where s is the monitoring intensity of institutional investors. Then, the investor can use the firing threat to force the manager to innovate. More specifically, the manager will choose to innovate whenever:

$$B - K > B(1 - \pi)(1 - s).$$

As before, the higher s, the more likely it is that the manager will innovate. However, now, a higher imitation probability π will reduce the marginal effect of s on the manager's net gain from innovating, namely $[B - K - B(1-\pi)(1-s)]$. Thus, unlike in Proposition 1, more competition on the product market will reduce the effect of institutional investment on managerial innovation.

Proposition 5.2. *(i) The manager's incentive to innovate is an increasing function of the institutional investor's share* ψ. *(ii) Higher investor's share and competition as measured by* π, *have complementary effects on managerial innovation incentives.*

Proof. *We first have, from (5.1):*

$$\frac{d\Delta U/s}{d\psi} = (1-p)\frac{\overline{\theta}}{2}\frac{ds}{d\psi} = (1-p)\frac{\overline{\theta}}{2}\alpha p(\frac{1}{1+\alpha} - \frac{1}{2})\overline{\theta} > 0,$$

which establishes the first part of the proposition. The second part results from the fact that:

$$\frac{d^2\Delta U/s}{d\psi d\pi} = K\frac{dp(1-p)}{d\pi} = \frac{1}{2}K(1-\pi) > 0.$$

■

As we shall see in the next subsection, the latter prediction contrasts our model with an alternative theory based on the notion that investors can force managers to innovate when managers are reluctant to do so and care instead primarily about keeping their job.

6. Testing the Theoretical Mechanism

6.1. Product Market Competition and Ownership

Taking the results so far as a whole it seems that institutional ownership has a positive effect on innovation and productivity. What is the interpretation for these results? Our theoretical model suggests a role for institutions in monitoring the performance of managers and therefore encouraging them to make riskier investments (i.e. innovations) by easing informational asymmetries over managerial ability. We showed that in the context of this model that competition and institutional ownership are *complements* (i.e. the positive effect of institutions on innovations should be stronger when competition is higher). An alternative interpretation of the institutions effect is that they discipline "lazy" managers and force them to work harder at innovating. In this case competition and institutions are *substitutes* (see Neil Dryden, Stephen Nickell and Daphne Nicolitsas, 1997). In highly competitive environments there will be little managerial slack and therefore little need for greater monitoring by institutions or other mechanisms (e.g. Schmidt, 1997; Bloom and Van Reenen, 2007). This suggests a direct test between the two hypotheses: is the effect of ownership stronger or weaker when there is more competition?

Table 4 presents some evidence that is consistent with our model and inconsistent with the lazy manager story. The first column reproduces our baseline fixed effects Poisson model of citations (column (5) of Table 2) but also includes a measure of product market competition (1 - the Lerner Index in the three digit industry). Competition has a positive association with innovation, although the effect is not significant[17]. Institutional ownership remains positive and significant. Column (2) introduces an interaction term between ownership and competition which is positive and significant, consistent with our model of competition and institutional owners being complements. We then split the sample into observations with high and low competition based on the median of the Lerner Index. In column (3) where competition is high, the coefficient on institutional ownership is large, positive and significant whereas in column (4) where competition is low the coefficient in institutional ownership is small and insignificant (0.010 vs. 0.002). We illustrate the findings by plotting the implied value of patent citations at different levels of institutional ownership in Figure 3. This shows that it is only in the high competition regime that there is an important effect of institutions on

[17] As with Aghion et al (2005) there is some evidence of an inverted U relationship, although the quadratic term is only (just) significant at the 10% level.

innovation.

[Figure 3 about here]

A concern might be that we have allowed the Lerner Index to change over time, so instead we consider a time invariant measure, averaging the Lerner over our sample period. The last four columns of Table 4 repeat the specifications of the first four columns using this time invariant measure. This gives similar results. Table 5 offers some more robustness checks of the Lerner Index. In the first four columns we use patent counts (rather than patent cites) as the dependent variable. In the last four columns we correct the Lerner Index for costs of capital (as in Aghion et al, 2005 and Nickell et al, 1996). Again, we find the same pattern of results.

Taken together, Tables 4 and 5 seem inconsistent with the "lazy manager" interpretation of the empirical findings and consistent with the simple model outlined in Section 2.

6.2. CEO Entrenchment and Ownership

A further implication of the "lazy manager" hypothesis is that the benefits of institutional ownership should be felt most sharply where agency costs are likely to have more negative effects. Apart from competition there are several settings where we might think agency costs are less likely to allow managers to slack. First, where the market for corporate control though is strong (e.g. via a credible threat of a hostile takeover), this should also discipline CEOs. Many states have laws protecting firms from hostile takeovers – in these states institutional ownership may be a substitute for a hostile takeover (voice rather than exit). Second, if shareholders have more power – the low values of Gompers Index discussed above should mean that the firm is more "democratic" and the power of the CEO less entrenched. So there is less of a role for institutions.

[Tables 6 and 7 about here]

Table 6 investigates these possibilities. Panel A contains state takeover laws and Panel B contains the Gompers Index of CEO power. The first column looks at the linear effects of institutional ownership and the "agency cost" variable, the second column interacts the two and the final two columns split the sample. In the first column we see that states with laws that block hostile takeovers have a worse level of innovation but this is not significant at conventional levels. There is no evidence for interaction effects. The final columns actually suggest that ownership is more important in states that do not have laws blocking a takeover which is the opposite of the prediction of the lazy manager view.

In Panel B the first column shows that ownership is still positively correlated with innovation even when we condition on the Gompers Index. The Gompers Index is weakly negatively associated with innovation (see the next section for further analysis of this). The interaction between ownership and the Gompers Index is completely insignificant also in column (2). When we split the sample by the median value of the Index ownership looks equally important in both subsamples.

So again, this evidence is inconsistent with the lazy managers story interpretation of our results on ownership.

6.3. CEO Tenure and endogenous ownership structure

If a CEO is long tenured in a firm there is a lot of public information about the ability of the CEO and the quality of his match to the firm. Consequently there is less of a benefit to an institutional investor finding out more about the CEO's quality. To examine this idea we estimated a model with the proportion of equity owned by institutional investors as a dependent variable in Table A3 and tenure of the CEO as the variable of interest (since this is from Execucomp the sample size is much smaller than the other regressions). Column (1) regresses institutional ownership on time dummies and tenure. The coefficient on CEO tenure is negative and significant. This implies that institutional ownership is more prevalent among firms that have younger CEOs. Column (2) includes controls for four digit industry dummies, size and membership of the S&P500. These variables are significant and they bring the magnitude of the coefficient on tenure towards zero, but it remains negative and significant at the 5% level. The third column includes a full set of firm fixed effects. The coefficient on tenure remains negative but is not significant at conventional levels.

So this is weak evidence in line with our theory as the OLS results do suggest a significantly negative correlation with tenure and ownership. The magnitudes of the effect is not large though. An increase in tenure by ten years increases the proportion of equity owned by institutions by only two percentage points (according to column (1)) and under one percentage point according to column (3)).

7. Further Extensions and Robustness Tests

In this section we investigate some further results. First, we look at productive efficiency (as measured by TFP) rather than dynamic efficiency (as was measured by innovation). Then we look at corporate governance touched upon above in more detail. Finally, we examine an implication of our model for the endogenous determination of institutional ownership as a function of management characteristics, such as tenure.

7.1. Productivity and institutional ownership

We have focused on innovation as our outcome, but institutional ownership could more generally raise the level of efficiency in the firm. To investigate this we estimated production functions where the coefficient on institutional ownership should reflect the conditional correlation of ownership with Total Factor Productivity (TFP).

To be precise, we include the percentage of institutional ownership into the production function conditioning on other factor inputs[18]. Full results are reported in Table A1. In column (1) we control for only labor (as well as four digit industry dummies and time dummies). There is a positive and significant association between productivity and institutional ownership. The second column also controls for capital and the third column also controls for R&D stocks. The coefficient on the factor inputs are sensible, being close to their factor shares and suggesting constant returns to scale. More importantly, the coefficient on institutional ownership is positive and significant in all specifications. Using the estimates in column (3) a ten percentage point increase in institutional ownership is associated with a 3% increase in (total factor) productivity, which is substantial. The fourth column includes a full set of firm dummies. The coefficient on labor and capital both fall as is typical in within groups estimates of production functions, although it is surprising that the labor coefficient falls by much more than the coefficient on capital. The R&D coefficient is basically unchanged[19]. The magnitude of the coefficient on institutional ownership falls substantially in column (4) from 0.033 to 0.007, although it remains significant at the 5% level. Using the estimates in column (4) a ten percentage point increase in institutional ownership is associated with a 1% increase in productivity. The final column shows the IV results. The broad pattern is the same as before: treating ownership as exogenous leads to an

[18] More accurately this should be termed a sales equation as we do not have firm specific prices.

[19] As with the innovation equation, conditioning on R&D only makes a small difference to the coefficient on ownership (it falls from 0.034 in column (2) without R&D to 0.033 in column (3) with R&D). So again this suggests that ownership affects the quality rather than the quantity of R&D.

under-estimate of the marginal effect, although the standard errors are quite large in column (6) and we cannot formally reject that ownership is exogenous.

7.2. Corporate Governance, Innovation and Productivity

In this sub-section we consider whether the greater the power of the CEO (relative to the shareholders), the poorer is the innovative performance of the firm. There is some suggestive evidence in favor of this hypothesis, but it is not robust. Table A2 shows some results which are identical in structure to Table 2. Note that an OLS regression of citation on the usual controls except the capital-labor ratio gives a significant negative coefficient on the Gompers et al (2003) index of CEO power of -0.042 with a standard error of 0.025. However, when we control for the capital-labor ratio in column (1) of Table A2 (and the R&D stock in column(2)), the index becomes insignificant. The results are strongest for the Poisson regressions of columns (3) and (4) where the governance index is negative and significant at the 5% level. When we control for fixed effects in column (5), however, the coefficient almost halves and is significant at only the 10% level. Also when we control for fixed effects using Hausman et al (1984) the ownership variable switches sign and becomes positive. Additionally, all the Negbin results are insignificant (columns (7) through (10)). We could find no effect of the power Index on productivity. In conclusion, although there is a hint of a negative effect of CEO dictatorship on innovation, the evidence is not robust.

7.3. Other robustness checks

One interpretational issue is whether it is institutions that matter per se, or whether it is simply that firms with more institutional owners simply have more concentrated ownership and this improves the monitoring of the CEO. To look at this explicitly we included various measures of ownership concentration and included measures in our baseline regressions. For example, we constructed a variable measuring the proportion of equity held by the top five shareholders. This ownership concentration measure enters positively and (weakly) significantly into naive innovation equations, but is driven to zero when we condition on the institutional ownership variable[20]. This suggests that existing findings of positive effects of ownership concentration may be due to the failure to distinguish between institutional and non-institutional ownership.

A second concern is that we are using data from the 1990s when there was a tech boom towards the end of decade, which ended in a big shakeout. Could this contaminate our findings? Since our sample is based on older firms we do not have the dot-com start-ups, so it is unlikely to be a major problem. Nevertheless, to check for this problem we allowed the coefficient on ownership to be different in the latter part of the sample. We could not reject the stability of the coefficient as the interaction was insignificant (and actually negative)[21]. We also split the sample into industries with high and low R&D intensities, but found similar coefficients in both sub-samples.

A third concern is that the instrumentation strategy is weak because the treatment group (those who joined the S&P500) is not well matched with the rest of the sample (the implicit control group). To examine this we used a propensity score matching technique. We estimate the propensity to join the S&P500 as a function of the exogenous firm characteristics (including fixed effects). Examination of the propensity score shows that there are very firms who are members of

[20]For example, In Table 2, column (5) the coefficient (standard error) on the concentration measure was 0.005 (0.004) and the institutional ownership variable remained positive and significant (coefficient of 0.005 with a standard error of 0.002). If we drop institutions and salese from the regression, however, the coefficient (standard error) on ownership concentration rises to 0.006(0.003), which is significant at the 10% level.

[21]For example, in the baseline specification of column (5) Table 2 adding an interaction of a post 1995 dummy and instiutional owners gave a coefficient of -0.002 (standard error=0.002).

the S&P500 who have a probability of below 0.24 (roughly the sample median). We trim the sample below this thresholds so that treatment and control have common support and re-estimate the IV results on this sub-sample. The results are similar: a treatment effect of 0.044 (standard error = 0.015) on this sub-sample of 3998 observations compared to 0.045 (standard error=0.015) on the full sample of 7,908.

8. Conclusions

In this paper we have theoretically and empirically investigated the effect of institutional ownership on firm innovation. We presented a simple model where institutional ownership can increase the incentives of risk-averse managers to engage in innovation for reasons of career concern. The greater monitoring of managers performed by institutions makes it less likely a manager will lose his job if gets an unlucky draw when trying to innovate. This effect is stronger when product market competition is greater, a prediction that is the opposite of the alternative "lazy manager" theory (where monitoring by institutional owners can substitute for lower product market competition). We presented panel data evidence from over a thousand US firms that was consistent with the two main predictions of our model: institutional ownership is positive correlated with innovation and this relationship is stronger when product market competition is more intense.

These results are interesting as they contradict the popular view that institutions take an entirely short-termist approach an inhibit investment in intangible assets like R&D which have long-run returns. Institutional ownership appears to be beneficial for innovation and efficiency. Consequently, barriers to greater ownership of equity by institutions, as exist in many countries, are not to be encouraged.

References

Aghion, Philippe, Bloom, Nick, Blundell, Richard,Griffith, Rachel and Howitt, Peter (2005) "Competition and Innovation: An Inverted U Relationship?" *Quarterly Journal of Economics,* 120(2), pp. 701-728

Arrow, Kenneth (1962) "Economic Welfare and the Allocation of Resources for Innovation", in Richard Nelson (ed.), *The Rate and Direction of Inventive Activity.* Chicago: Chicago University Press

Bartelsman, Erik, Becker, Randy and Gray, Wayne (2000) *NBER Productivity Database*, available at www.nber.org

Bloom, Nick, Schankerman, Mark and Van Reenen, John (2006) "Technology Spillovers and Product Market rivalry" NBER Working Paper No. 13060

Bloom, Nick and Van Reenen, John "Measuring and Explaining Management Practices across firms and countries", *Quarterly Journal of Economics,* 122(4), 1351–1408

Blundell, Richard and Powell, James (2004) "Endogeneity in Semiparametric Binary Response Models" *Review of Economic Studies* 71(3) pp. 655-679

Blundell, Richard and Bond, Stephen (1998) "Initial Conditions and moment restrictions in dynamic panel data models" *Journal of Econometrics*, 87, pp.115-143

Blundell, Richard, Griffith, Rachel and Van Reenen, John (1995) "Dynamic Count Data Models of Technological Innovation", *The Economic Journal*, 105, pp. 333-344

Blundell, Richard, Griffith, Rachel and Van Reenen, John (1999) "Market Shares, Market Value and Innovation in a Panel of British Manufacturing Firms" *Review of Economic Studies*, 66, pp. 529-554

Blundell, Richard, Griffith, Rachel and Windmeijer, Frank (2002) "Individual Effects and Dynamic Feedback in Count Data Models" *Journal of Econometrics*, 108, pp. 113-131

Bond, Stephen and Van Reenen, John (2007) "Micro-econometric models of investment and employment" in Jim Heckman and Ed Leamer (eds) *Handbook of Econometrics Volume VI,* Amsterdam: Kluwer

Bushee (1998)

Clay, Darin (2001) "Institutional Ownership, CEO Incentives and Firm Value" University of Chicago PhD Dissertation

Del Guercio, Diane (1996) "The distorting effect of the prudent man law of institutional equity investments" *Journal of Financial Economics*, 40, pp. 31-62

Demsetz, Harold and Lehn, Kenneth (1985) "The structure of corporate ownership: Causes and consequences" *Journal of Political Economy*, 93, pp. 1155-1177

Criscuolo, Chiara (2006) "Does ownership structure effect productivity: Evidence from the UK", mimeo University College London

Dilhon, Upinder and Johnson, Herb (1991) "Changes in the Standard and Poor's 500 List" *Journal of Business*, 64(1), pp.75-85

Dryden, Neil, Nickell, Stephen and Nicolitsas, Daphne (1997) "What makes firms perform well?", *European Economic Review*, 41, pp.783-96.

Eng, Li and Shackell, Margaret (2001) "The impact of long-run performance plans and institutional ownership for firms Research and Development Expenditures" *Journal of Accounting, Auditing and Finance*, 16(2), 1177-149

Fisman, Ray, Khurana, Rakesh and Rhodes-Kropf, Matthew (2005) "Governance and CEO turnover: Do something or do the right thing?" University of Columbia mimeo

Froot, K., Scharfstein, and Stein, Jeremy (1992) "Herd on the street: Informational inefficiencies in a market with short-term speculation", *Journal of Finance*, 47, pp. 1461-1484

Gompers, Paul, Ishi, Joy and Metrick, Andrew (2003), "Corporate Governance and Equity Prices" *Quarterly Journal of Economics,* 118, pp. 107-155

Gomes, Joao "Financing Investment" *American Economic Review* 91(5), pp. 1263-1285

Hall, Bronwyn (2002) "The Financing of Innovation" NBER Working Paper ***

Hall, Bronwyn, Jaffe, Adam and Trajtenberg, Manuel (2001) "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools". NBER Working Paper 8498.

Hall, Bronwyn, Jaffe, Adam and Trajtenberg, Manuel (2005), "Market Value and Patent Citations: A First Look", *RAND Journal of Economics,* 36, pp.16-38

Hart, Oliver (1983)

Hausman, Jerry, Hall, Bronwyn and Griliches, Zvi (1984) "Econometric Models for Count Data and an Application to the Patents-R&D Relationship" *Econometrica*, 52, pp. 909-938

Holstrom, Berngt (1982) "Managerial Incentive Problems - A Dynamic Perspective" in *Essays in Economics and Management in honor of Lars Wahlbeck,* Helsinki: Swedish School of Economics

Jaffe, Adam and Trajtenberg, Manuel (2002), *Citations and Innovations: A Window on the Knowledge Economy,* Cambridge: MIT Press

Kaplan, Stephen and Zingales, Luigi "Do Investment-cash flow sensitivities provide useful measures of financial constraints?" *Quarterly Journal of Economics*, 112(1), 169-215

Klette, Tor and Griliches, Zvi (1996), "The Inconsistency of Common Scale Estimators when Output Prices are Unobserved and Endogenous," *Journal of Applied Econometrics*, 11, pp. 343-361

Majamda and Nagarajan (1997)

Morck, Randall, Schleifer, Andrei and Vishny, Robert (1988) "Management ownership and market valuation: An empirical analysis" *Journal of Financial Economics*, 20, pp. 293-315

Morck, Randall, Schleifer, Andrei and Vishny, Robert (1989) "Alternative mechanisms for corporate control" *American Economic Review*, 79, 842-852

Nickell, Stephen (1981) "Biases in Dynamics Models with Fixed Effects", *Econometrica,* 49, pp. 1417-1426.

Nickell, Stephen (1996) "Competition and Corporate Performance" *Journal of Political Economy*, 104, pp. 724-746

Schumpeter, Joseph (1942) *Capitalism, Socialism and Democracy,* New York: Harper and Brothers

Schelberg, Neil and Bitman, Craig (1999) "Corporate governance under ERISA: The power to influence corporations" *Employee Benefits Journal*, 24, 21-28

Schleifer, Andrei (1986) "Do Demand Curves for stocks slope down?" *Journal of Finance*, 41(3), pp. 579-590

Schmidt, Klaus (1997), "Managerial Incentives and Product Market Competition", *Review of Economic Studies*, LXIV (2), 191-213.

Tirole, Jean (1994), *The Theory of Industrial Organization* (Cambridge, MIT Press).

Wei, K. C. John and Pruitt, Stephen W. (1989) "Institutional Ownership and Changes in the S&P 500", *Journal of Finance*, 14(2), 509-513

Appendices

A. Data

We combine several firm level panel datasets. Because we are using cite-weighted patents as our key measure of innovation, we rely on the NBER's matching of the USPTO with Compustat (see Bronwyn Hall et al (2001) and Jaffe and Trajtenberg (2002) for details). The matching was performed based on the ownership structure in 1989, so our sample is of a cohort of firms who were alive in 1989 that we follow through the 1990s (including those who subsequently died). We use the updated version containing cites through to 2002. All patents granted between 1963 and 1999 are included (just under 3 million) and citation information is available from 1975 to 2002 (over 17 million). We condition on the sample of Compustat firms who were granted at least one patent between 1969 and 1999 and our regression period ends in 1999 so that we have at least 3 future years to construct cite-weighted patents (the year dummies in the regressions should control for truncation). The need to have some patent data is the main reason why our sample is smaller than the full Compustat sample.

The second dataset we draw on is the text files from Compact Disclosure. This is an electronic version of the 13-F forms that all institutional organizations are obliged to lodge at the SEC on a quarterly basis if they have at least $100m in equity assets under discretionary management. The data includes the numbers of institutional owners, the number of share issues and the percentage of outstanding shares held by each institution (our key measure of institutional ownership). This dataset is time consuming to put together and not wholly consistent pre 1990, so we use ownership data from 1991 onwards. The ownership data covers almost all the firms in the NBER USPTO match (we lose a couple of observations due to ownership changes in 1990), so the merging of the two datasets is straightforward.

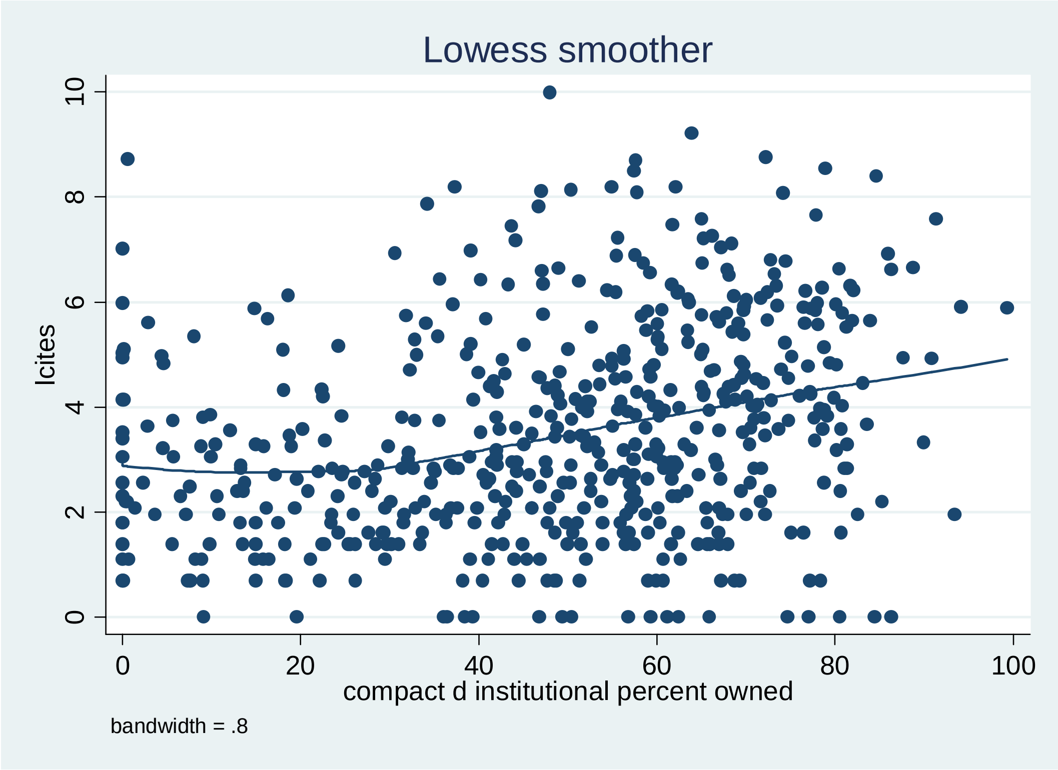
The merged dataset consists of 1,078 firms and 7923 observations between 1991 and 1999.We are able to use lags of patent information back to 1969, however, so our patent stock variables include all this past information. Descriptive statistics are in Table 1.

In the robustness tests we also use other datasets. For information on managerial characteristics (such as CEO tenure) we use the S&P ExecuComp database. For information on governance we use the *Investor Responsibility Research Center* (IRRC) which publishes detailed listings of corporate governance provisions for individual firms in Corporate Takeover Defenses (see Paul Gompers et al, 2003, for more details). These datasets cover sub-samples of the larger firms in Compustat, so this is the reason why the number of observations in smaller in these regressions.

B. Additional Results

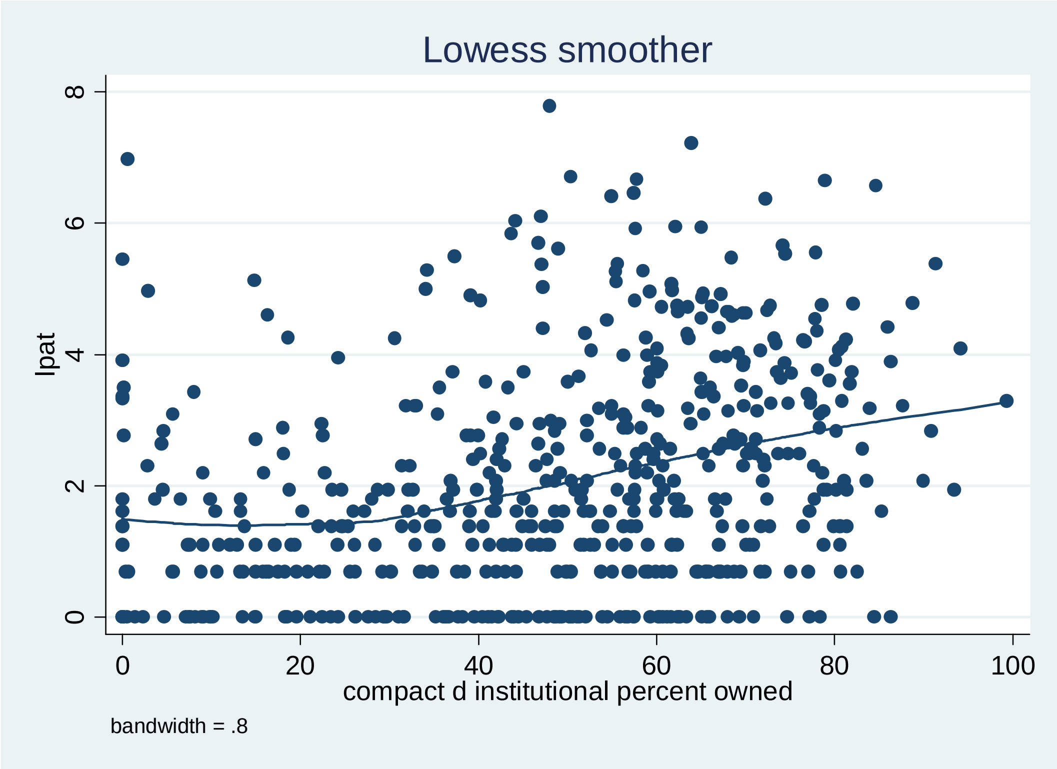
Table A1 through A3 present some further tests of the hypotheses and are discussed in the text.

Figure 1: Nonparametric Regression of log(Patent Citations) and Percentage Institutional Ownership



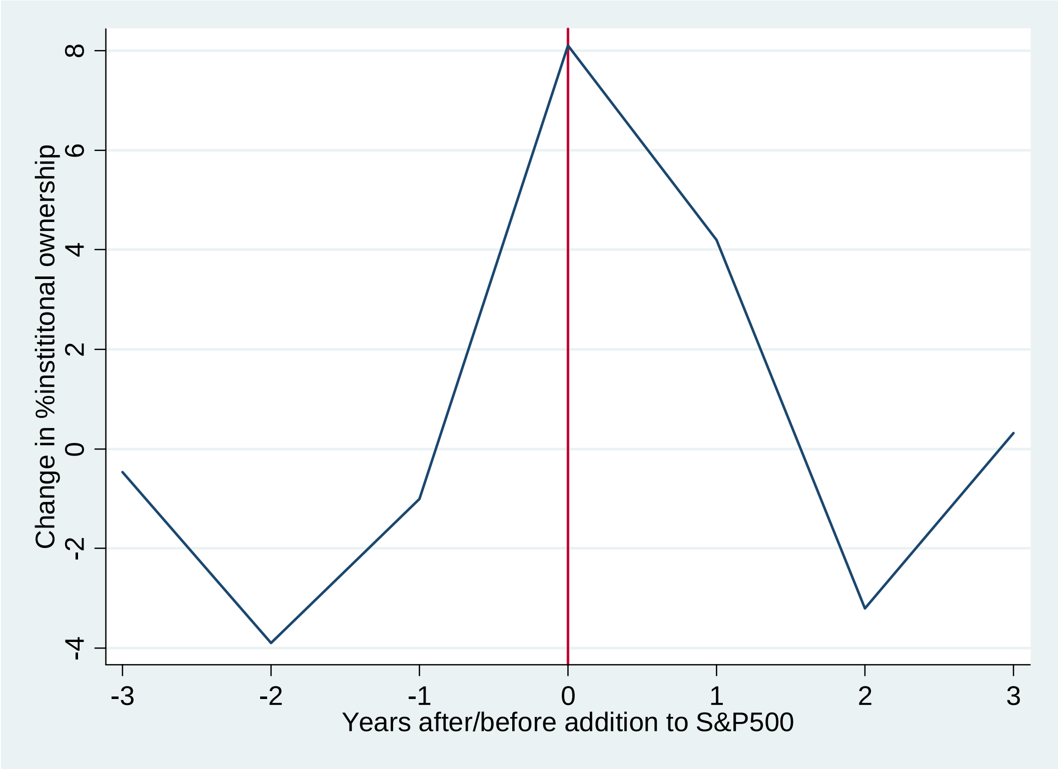
NOTES: This Figure presents the non-parametric (local linear) regression of the firm citations and the proportion of equity owned by institutions (the graph is from 1995 in the middle of our sample period)

Figure 2: Nonparametric Regression of log(Patent Counts) and Percentage Institutional Ownership



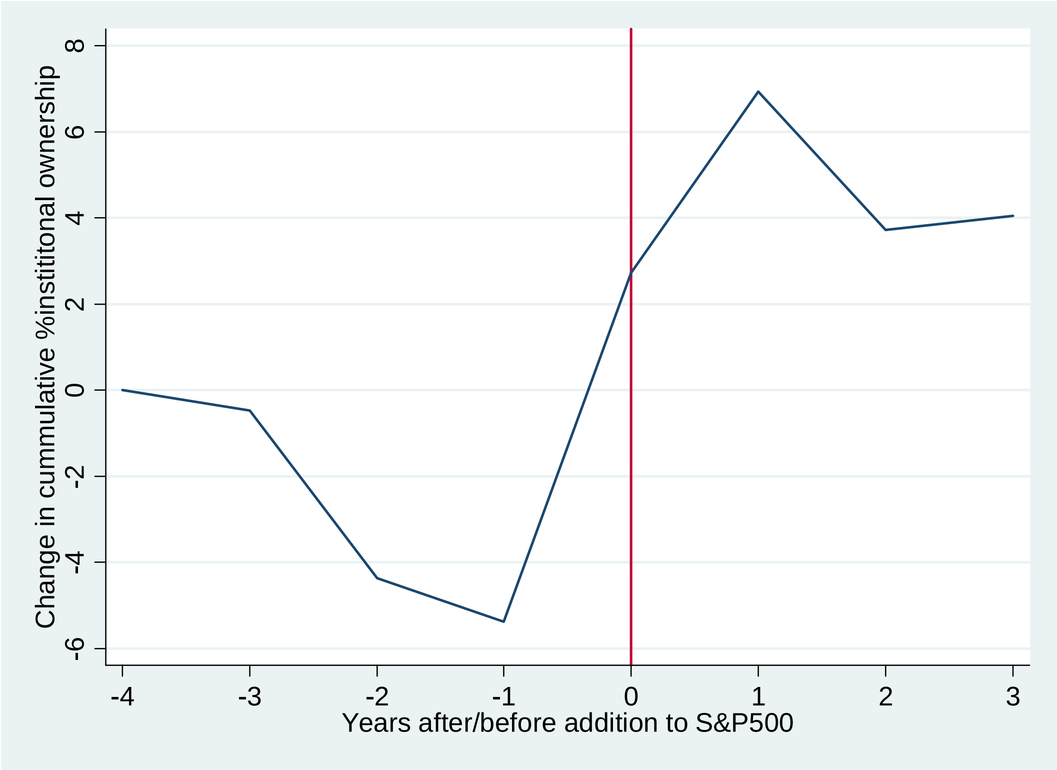
NOTES: This Figure presents the non-parametric (local linear) regression of the firm patent counts and the proportion of equity owned by institutions (the graph is from 1995 in the middle of our sample period)

Figure 3: Change in the proportion of institutional ownership before and after a firm becomes added to the S&P500 (7 year window)



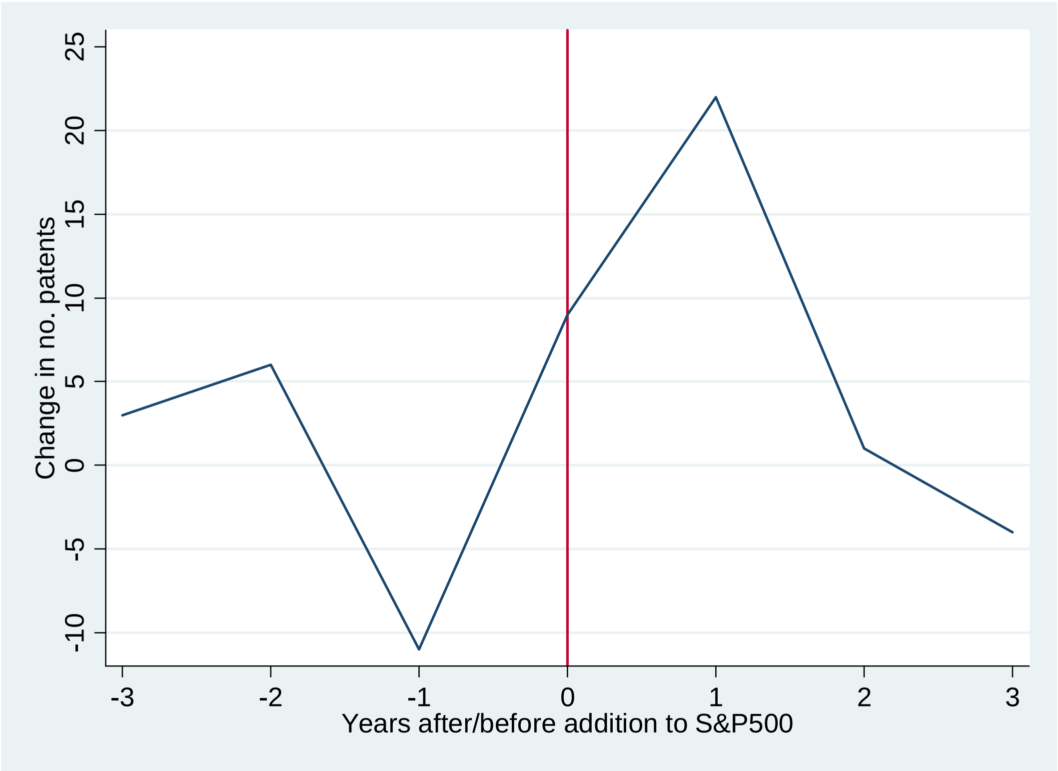
NOTES: The graph shows the mean change in the proportion of equity owned by institutions up to three years before and three years after a firm becomes a member of the S&P 500 Index (year 0 is the year the firm was added). For example, in the year a firm joined the S&P 500 8.1 percentage points more of its stock became owned by institutions. The following year institutional owners increased this proportion by 4.2 percentage points, and so on.

Figure 4: Cumulative change in the proportion of institutional ownership before and after a firm becomes added to the S&P500 (7 year window)



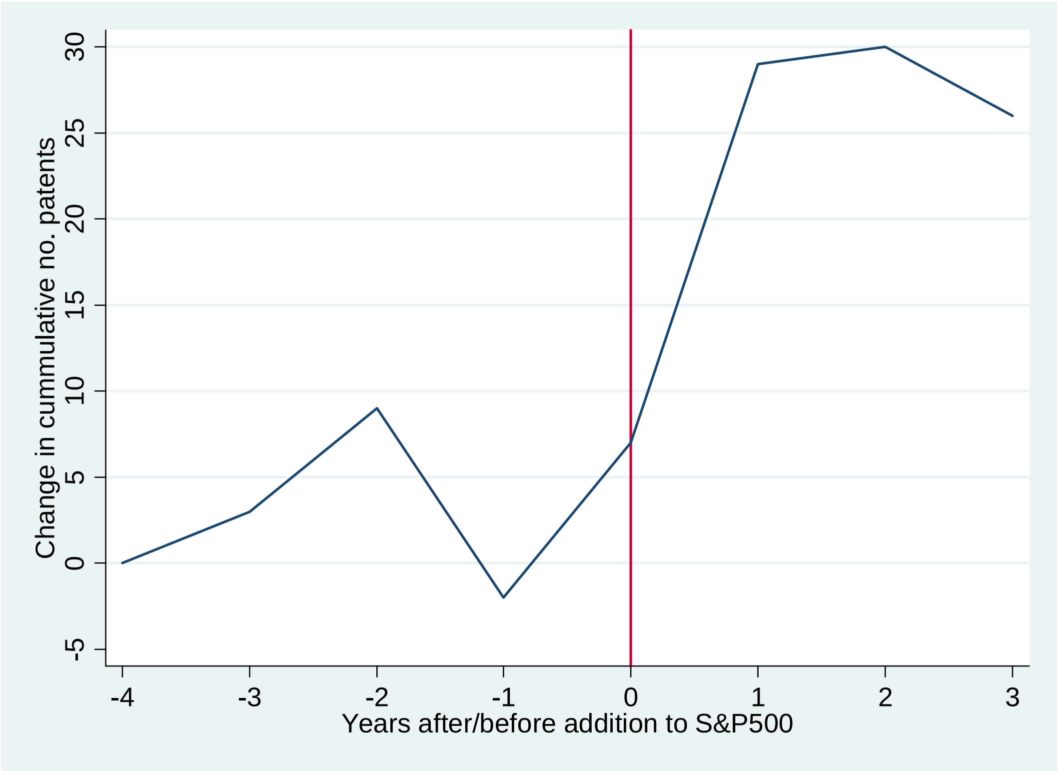
NOTES: The graph shows the cumulative increase in the proportion of equity owned by institutions up to three years before and three years after a firm becomes a member of the S&P 500 Index (time t-4 is normalized to zero). For example, looking over the three years prior to joining the cumulative increase in the proportion of equity owned by institutions was -4%. One year after joining this figure was 6%.

Figure 5: Change in the number of patents before and after a firm becomes added to the S&P500 (7 year window)



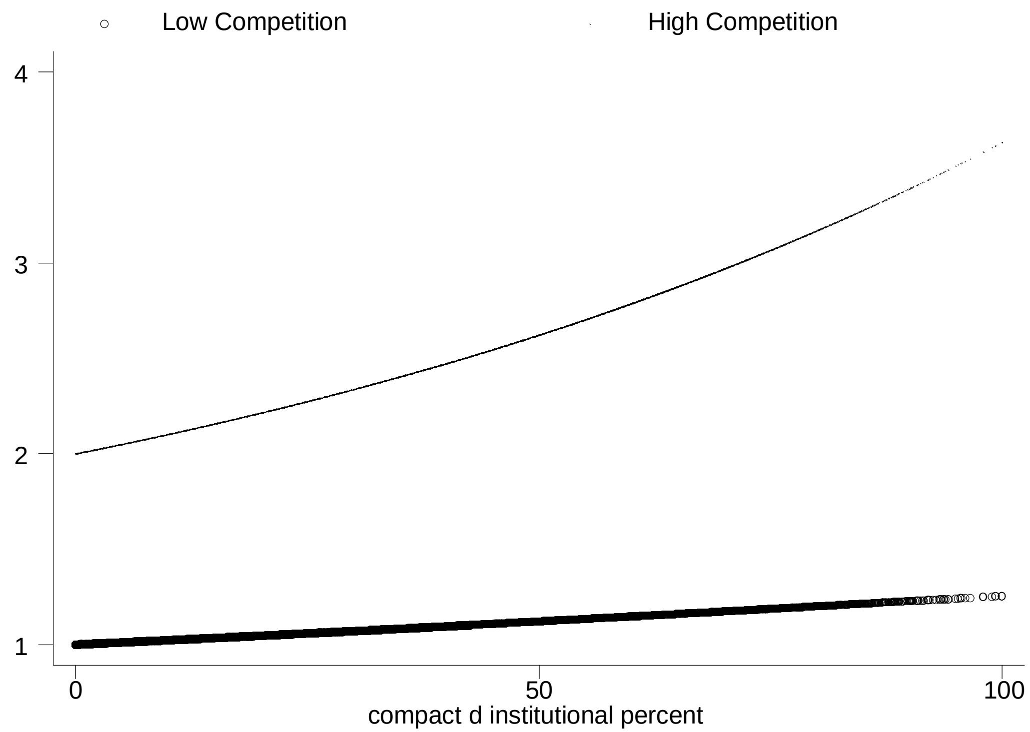
NOTES: The graph shows the mean change in the number of patents up to three years before and three years after a firm becomes a member of the S&P 500 Index (year 0 is the year the firm was added). For example, in the year a firm joined the S&P 500 the average firm applied for an additional 9 subsequently granted) patents. This rose to 22 in the following year.

Figure 6: Cumulative change in the number of patents before and after a firm becomes added to the S&P500 (7 year window)



NOTES: The graph shows the cumulative increase in the change in the number of patents up to three years before and three years after a firm becomes a member of the S&P 500 Index (time t-4 is normalized to zero). For example, looking over the three years prior to joining the cumulative increase in the proportion of equity owned by institutions was -1. Three years after joining this figure was 26.

Figure 7: Predicted relationship between number of cites and percentage of institutional ownership



NOTES: This Figure presents the predicted number of cites as a function of the proportion of equity owned by institutions for firms in high competition industries (upper line) and lower competition (lower line). The estimates are taken from the Poisson model of columns (3) and (4) of Table 7.

TABLE 1: DESCRIPTIVE STATISTICS

VARIABLE	Mean	Standard deviation	Median	Min	Max	Source	Observations
Cites	138	829	1	0	23,121	USPTO	7923
Patents	19	94	1	0	2405	USPTO	7923
% Institutional Ownership	42.4	24.1	44.6	0	100	SEC	7923
1-Lerner Index	0.861	0.046	0.871	0.488	1.012	Compustat	7923
Employment (1000s)	14.8	46.8	2.9	0.042	757.4	Compustat	7923
Sales ($1000s)	3036	9855	472	0.019	174,694	Compustat	7923
R&D ($1000s)	104	479	4.325	0	8900	Compustat	7923
CEO Power Index	9.7	2.8	10	2	18	IRRC and Gompers et al (2003)	1587

NOTES: Data is taken from the sample of 7,923 observations used for the regression of citations/patents sample unless otherwise stated.

TABLE 2: OWNERSHIP AND INNOVATION (CITE-WEIGHTED PATENTS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Estimation Method	**OLS**	**OLS**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Negative Binomial**	**Negative Binomial**	**Negative Binomial**	**Negative Binomial**
Dependent variable	**Ln (CITES) citation weighted patent counts**	**Ln (CITES) citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**
Share of Equity owned by institutions	0.006*** (0.002)	0.005** (0.002)	0.012*** (0.003)	0.012*** (0.003)	0.008** (0.002)	0.0009*** (0.0001)	0.015*** (0.002)	0.012*** (0.002)	0.009*** (0.002)	0.005*** (0.001)
ln (R&D Stock)		0.599*** (0.048)		0.525*** (0.124)	-0.032 (0.146)	0.540*** (0.008)		0.735*** (0.062)	0.259** (0.049)	0.356*** (0.020)
Fixed Effects controls (method)	No	No	No	No	Yes (BGVR)	Yes (HHG)	No	No	Yes (BGVR)	Yes (HHG)
Standard Errors clustered by firm?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Observations	4044	4044	7923	7923	7923	6208	7923	7923	7923	6208
Firms	822	822	1078	1078	1078	803	1078	1078	1078	803

NOTES: All regressions control for ln(sales), ln(capital/sales) ratio), and a full set of four digit industry dummies and time dummies. Estimation period 1991-1999 (citations up to 2002); ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. HHG = Hausman, Hall and Griliches (1983); BGVR = Blundell, Griffith, Van Reenen (1999) initial stock mean scaling estimator. Firm level panel data, 1991-1999.

TABLE 3: OWNERSHIP AND INNOVATION, INSTRUMENTAL VARIABLE REGRESSIONS

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**Poisson**	**OLS (First Stage)**	**Poisson and control function**	**Poisson**	**OLS (First Stage)**	**Poisson and control function**
Dependent variable	**CITES citation weighted patent counts**	**Share of Equity owned by institutions**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**Share of Equity owned by institutions**	**CITES citation weighted patent counts**
Share of Equity owned by institutions	0.012** (0.003)		0.057** (0.015)	0.008** (0.002)		0.048** (0.022)
S&P500		4.822*** (1.658)			5.730*** (1.660)	
Exogeneity test (p-value)			0.003			0.092
FE controls	No	No	No	Yes	Yes	Yes
Observations	7923	7923	7923	7923	7923	7923
Firms	1078	1078	1078	1078	1078	1078

NOTES: Columns (1)-(6) control for ln(sales), ln(capital/employment), 4-digit industry dummies and time dummies. Estimation period 1991 -1999. S&P500 is a dummy variable equal to unity if the firm is a member of the S&P 500 Index. ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. FE controls use the Blundell et al (1999) method in columns (4)-(6) and within groups in (7)-(9). Exogeneity test is a Hausman test.

TABLE 4:
ALLOWING THE INSTITUTIONAL OWNERSHIP EFFECT TO VARY WITH PRODUCT MARKET COMPETITION

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Poisson	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**
Dependent variable	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**
Measure of Competition	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time constant 1-Industry Lerner	Time constant 1-Industry Lerner	Time constant 1-Industry Lerner	Time constant 1-Industry Lerner
Sample	Pooled	Pooled	High Product Market Competition (1-Lerner) > 0.871)	Low Product Market Competition (1-Lerner) < 0.871)	Pooled	Pooled	High Product Market Competition (1-Lerner) > 0.871)	Low Product Market Competition (1-Lerner) < 0.871)
(Share of Equity owned by institutions) * (Intensity of Product market Competition)		0.081** (0.034)				0.085** (0.033)		
Share of Equity owned by institutions	0.008* (0.002)	-0.063** (0.029)	0.010** (0.002)	0.002 (0.003)	0.008*** (0.002)	-0.067** (0.028)	0.010*** (0.001)	0.002 (0.001)
Intensity of Product market Competition	0.399 (2.357)	-3.587 (3.350)	4.742 (3.971)	1.355 (4.930)				
Observations	7923	7923	3991	3932	7923	7923	3991	3932

NOTES:- These are all cite-weighted patent regressions. Each column from each Panel is a separate Poisson regression (with standard errors clustered at the three digit industry level); ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. Product market competition constructed as (1 - Lerner Index) where Lerner is calculated as the median gross margin from the entire Compustat database in the firm's three digit industry. In columns (1)-(4) this measure is time-varying and in columns (5)-(8) it is averaged over the sample. All regressions control for four digit industry dummies, year dummies, log(sales), log(capital/labor) ratio and log(R&D stock).

TABLE 5: ALLOWING THE INSTITUTIONAL OWNERSHIP EFFECT TO VARY WITH PRODUCT MARKET COMPETITION, ROBUSTNESS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Poisson	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Poisson**
Dependent variable	**PATENTS patent counts**	**PATENTS patent counts**	**PATENTS patent counts**	**PATENTS patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**
Sample	Pooled	Pooled	High Product Market Competition (1-L) > 0.871)	Low Product Market Competition (1-L) < 0.871)	Pooled	Pooled	High Product Market Competition (1-L) > 0.991)	High Product Market Competition (1-L) < 0.871)
Measure of Competition	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner	Time varying 1-Industry Lerner (K adjusted)	Time varying 1-Industry Lerner (K adjusted)	Time varying 1-Industry Lerner (K adjusted)	Time varying 1-Industry Lerner (K adjusted)
(Share of Equity owned by institutions) * (Intensity of Product market Competition)		0.093** (0.021)				0.103** (0.043)		
Share of Equity owned by institutions	0.004* (0.002)	-0.077** (0.018)	0.006** (0.002)	0.001 (0.002)	0.008*** (0.002)	-0.088** (0.039)	0.009*** (0.002)	0.003 (0.003)
Intensity of Product market Competition	0.400 (2.537)	-3.621 (3.907)	6.869* (4.804)	-0.818 (4.487)	-2.778 (2.533)	-7.914* (4.102)	4.205 (2.709)	-2.179 (8.1965)
Observations	7923	7923	3991	3932	7923	7923	3991	3932

NOTES:- These are all cite-weighted patent regressions. Each column from each Panel is a separate Poisson regression (with standard errors clustered at the three digit industry level); ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. Product market competition constructed as (1 - Lerner Index) where Lerner is calculated as the median gross margin from the entire Compustat database in the firm's three digit industry. In columns (1)-(4) this measure is time-varying and in columns (5)-(8) it is averaged over the sample. All regressions control for four digit industry dummies, year dummies, log(sales), log(capital/labor) ratio and log(R&D stock).

TABLE 6: ALLOWING THE INSTITUTIONAL OWNERSHIP EFFECT TO VARY WITH STATE TAKEOVER LAWS AND CEO DICTATORSHIP INDEX

Panel A: State Laws Protecting CEO Against Hostile Takeoves

	(1)	(2)	(3)	(4)
Estimation Method	**OLS**	**OLS**	**OLS**	**OLS**
Dependent variable	**Ln (CITES)**	**Ln (CITES)**	**Ln (CITES)**	**Ln (CITES)**
Sample	Pooled	Pooled	Many State Laws block takeovers (index>.167)	Few Laws block takeovers (Index<.167)
(Share of Equity owned by institutions) X (State Laws Blocking Hostile Takeover)		-0.012 (0.011)		
Share of Equity owned by institutions	0.005** (0.003)	0.008** (0.004)	-0.003 (0.004)	0.011*** (0.003)
State Laws Blocking Hostile Takeovers	-0.090 (0.251)	0.562 (0.664)		
Observations	2866	2866	1144	1722
Firms	514	514	206	313

Panel B: Gompers Index of CEO Power over Shareholders

	(1)	(2)	(3)	(4)
Estimation Method	**OLS**	**OLS**	**OLS**	**OLS**
Dependent variable	**Ln (CITES)**	**Ln (CITES)**	**Ln (CITES)**	**Ln (CITES)**
Sample	Pooled	Pooled	CEO Dictator (Gompers Index>10 High	CEO Democrat (Gompers Index<10 Low)
(Share of Equity owned by institutions) X (Gompers Index of CEO Power)		-0.001 (0.001)		
Share of Equity owned by institutions	0.005** (0.003)	0.012 (0.008)	0.003 (0.004)	0.005 (0.003)
Gompers Index of CEO Power	-0.032 (0.019)	0.028 (0.043)		
Observations	2866	2866	1513	1353
Firms	514	514	296	277

NOTES:- These are all cite-weighted patent regressions. Each column from each Panel is a separate OLS regression (with standard errors clustered by firm in parentheses); ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. Gompers Index described in text (data from IRRC in 1990, 1993, 1995, 1998 and interpelated in between years). State Takeover law index is an average of 6 different state laws that make it harder to launch a hostile takeover bid (data from IRRC in 1990, 1993, 1995, 1998 and interpelated in between yearsAll regressions control for 4 digit industry dummies, year dummies, log(Sales), log(capital/labor) ratio and log(R&D stock).

TABLE A1: PRODUCTIVITY AND OWNERSHIP

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**OLS**	**OLS**	**OLS**	**OLS**	**OLS (First Stage)**	**IV**
Dependent variable	**Ln(Sales)**	**Ln(Sales)**	**Ln(Sales)**	**Ln(Sales)**	**Share of Equity owned by institutions**	**Ln(Sales)**
Share of Equity owned by institutions	0.0042*** (0.0006)	0.0034*** (0.0005)	0.0033*** (0.0005)	0.0007** (0.0004)	2.107* (1.167)	0.026 (0.019)
R&D stock	-	-	0.0496*** (0.0140)	0.0557* (0.0219)	-1.127*** (0.348)	0.052** (0.023)
Labor	1.0095*** (0.0127)	0.6077*** (0.0382)	0.6049*** (0.0380)	0.3464*** (0.0478)	4.186*** (0.577)	0.383*** (0.081)
Capital		0.3913*** (0.0331)	0.3559*** (0.0342)	0.3594*** (0.0373)	0.004 (0.614)	0.356*** (0.071)
Fixed Effect	No	No	No	Yes (Within Groups)	Yes	Yes
Observations	7923	7923	7923	7923	7923	7923
Firms	1078	1078	1078	1078	1078	1078

NOTES: Controls for ln(capital), ln(employment), 4-digit industry dummies, time dummies, standard errors clustered by firm. Estimation period 1991-2004 ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level.

TABLE A2: INNOVATION AND GOVERNANCE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Estimation Method	**OLS**	**OLS**	**Poisson**	**Poisson**	**Poisson**	**Poisson**	**Negative Binomial**	**Negative Binomial**	**Negative Binomial**	**Negative Binomial**
Dependent variable	**Ln (CITES) citation weighted patent counts**	**Ln (CITES) citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**	**CITES citation weighted patent counts**
Governance Index1=democratic, 18=dictatorship; mean=9.58, sd=2.85	-0.042*	-0.005	-0.066**	-0.061**	-0.036*	0.071***	-0.018	-0.005	-0.003	-0.000
	(0.025)	(0.016)	(0.021)	(0.022)	(0.021)	(0.007)	(0.021)	(0.018)	(0.015)	(0.013)
ln (R&D Stock)		0.596***		0.526***	-0.081	0.607***		0.593***	0.181**	0.310***
		(0.066)		(0.130)	(0.091)	(0.032)		(0.070)	(0.050)	(0.042)
Fixed Effects controls (method)	No	No	No	No	Yes (BGVR)	Yes (HHG)	No	No	Yes (BGVR)	Yes (HHG)
Standard Errors clustered by firm?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Control for capital-labor ratio	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1395	1381	2119	2119	2094	1659	2119	2119	2094	1659
Firms	511	503	654	654	647	461	654	654	647	461

NOTES: Controls for capital-employment ratio, ln(sales), 4 digit industry dummies, time dummies, standard errors clustered by firm. Estimation periods 1990, 1993, 1995, 1998 (forward citations up to 2002).; ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. HHG = Hausman, Hall and Griliches (1983); BGVR = Blundell, Griffith, Van Reenen (1999) initial stock mean scaling estimator. Firm level panel data. Governance is measured using the Gompers et al (2003) index.

TABLE A3: OWNERSHIP AND INNOVATION INSTRUMENTAL VARIABLE REGRESSIONS; ALTERNATIVE TRANSFORMATION OF DEPENDENT VARIABLE

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**OLS**	**OLS (First Stage)**	**IV**	**OLS**	**OLS (First Stage)**	**IV**
Dependent variable	**Ln (1+CITES) citation weighted patent counts**	**Share of Equity owned by institutions**	**Ln (1+CITES) citation weighted patent counts**	**Ln (1+PATENTS) citation weighted patent counts**	**Share of Equity owned by institutions**	**Ln (1+PATENTS) citation weighted patent counts**
Share of Equity owned by institutions (mean=58.6, sd=109)	0.009** (0.002)		0.122** (0.035)	0.010** (0.002)		0.096** (0.027)
S&P500		7.8254*** (0.724)			8.056*** (0.730)	
Observations	7932	7932	7932	7932	7932	7932
Firms	1078	1078	1078	1078	1078	1078

NOTES: Columns control for ln(sales), ln(capital/employment), ln(R&D stock/employment), 4-digit industry dummies and time dummies. All standard errors clustered by firm. Estimation period 1992-1999. S&P500 is a dummy variable equal to unity if the firm is a member of the S&P 500 Index. ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level.

TABLE A4: INSTITUTIONAL OWNERSHIP LESS LIKELY WITH LONGER TENURED CEOs

	(1)	(2)	(3)	(4)	(5)
Dependent variable	**Share of Equity owned by institutions**	**Share of Equity owned by institutions**	**Share of Equity owned by institutions**	**Share of Equity owned by institutions**	**Share of Equity owned by institutions**
Tenure of CEO	-0.199***	-0.150**	-0.064	-0.170**	-0.074
	(0.078)	(0.071)	(0.043)	(0.074)	(0.048)
First year of new CEO				-1.780*	-0.501
				(1.022)	(0.576)
Controls		S&P500, ln(employment), four digit industry dummies	S&P500, ln(employment), four digit industry dummies	S&P500, ln(employment), four digit industry dummies	S&P500, ln(employment), four digit industry dummies
Fixed Effects	no	no	yes	no	yes
Observations	2,908	2,908	2,908	2,908	2,908

NOTES: All columns control for a full set of time dummies. All standard errors clustered by firm. Estimation period 1992-1999. ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level. Estimation by OLS (standard errors in parantheses)..

TABLE A5: R&D AND INSTITUTIONS

	(1)	(2)	(3)	(4)
Estimation Method	**Poisson**	**Poisson**	**NBREG**	**NBREG**
Dependent variable	**Ln (R&D Expenditure)**	**Ln (R&D Expenditure)**	**Ln (R&D Expenditure)**	**Ln (R&D Expenditure)**
Share of Equity owned by institutions	0.043** (0.003)	0.010** (0.002)	0.007*** (0.001)	0.002** (0.001)
controls		Ln(capital-labor ratio)	Ln(capital-labor ratio), 4 digit industry dummies	Ln(capital-labor ratio), fixed effects
Observations	5686	5686	5686	5686
Firms	795	795	795	795

NOTES: Columns control for ln(sales) and time dummies. All standard errors clustered by firm. Estimation period 1992-1999. S&P500 is a dummy variable equal to unity if the firm is a member of the S&P 500 Index. ***=significant at the 1% level, **=significant at the 5% level, *=significant at the 10% level.