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INNOVATION IN FOUNDER AND FIRMS: ENTREPRENEURIAL VERSUS NURTURER IDENTITIES OF OWNERS

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ABSTRACT

We argue that the identities of owners and owner-managers of public companies can influence innovation and thus performance. We distinguish between innovation input, innovation output and innovation quality. We show that lone founder owners and owner-managers, who we argue embrace entrepreneurial identities, achieve superior innovation output and quality when compared to other firms, even controlling for innovation input. By contrast family owners and managers, who we argue adopt family nurturer identities, spend less on innovation input and also obtain less output and quality, again, controlling for innovation input.

INTRODUCTION

Although various industry, market, organizational, and cultural drivers of innovation have been studied (e.g., Baysinger, Kosnik and Turk, 1991; Cohen and Levinthal, 1990), a potentially critical underlying influence on innovation has been neglected: namely that of corporate governance – specifically, who are the major owners of the company and what are their personal and strategic priorities. We shall argue that the identity of those owners and their consequent priorities may engender significant owner-owner agency conflicts that manifest in inferior corporate innovation strategies under certain types of ownership.

By their very nature, the processes and outcomes of innovation are highly uncertain (Scherer, 1998; Scherer and Harhoff, 2000). Innovation poses investment risk for a firm’s owners and managers. Indeed, the financing of innovation versus more self-serving projects may be fraught with owner-manager agency conflicts of moral hazard and adverse selection (Block, in press; Leland and Pyle, 1977; Hall, 2002; Myers and Majluf, 1984). For example, a manager whose rewards depend on short-term performance may avoid innovation, favoring instead projects with short-term payoffs (Campbell and Marino, 1994; Hirshleifer and Thakor, 1992).

We shall argue that owner-owner agency costs also may arise, especially in family firms because family owners embrace identities of family nurturers more than responsible agents for non-family shareholders. In so doing they may pursue private benefits of control such as conserving resources for the family rather than investing them in productive innovation initiatives. We shall argue that this type of owner-owner agency cost is less likely to be significant in firms where lone founders are major owners. We will argue that the latter take on an entrepreneurial rather than a family identity, and pursue strategies of shareholder wealth creation, often via a robust program of innovation.
By their very nature, the processes and outcomes of innovation are highly uncertain (Scherer, 1998; Scherer and Harhoff, 2000). Innovation poses investment risk for a firm’s owners and managers. Indeed, the financing of innovation versus more self-serving projects may be fraught with owner-manager agency conflicts of moral hazard and adverse selection (Block, in press; Leland and Pyle, 1977; Hall, 2002; Myers and Majluf, 1984). For example, a manager whose rewards depend on short-term performance may avoid innovation, favoring instead projects with short-term payoffs (Campbell and Marino, 1994; Hirshleifer and Thakor, 1992). We shall argue that owner-owner agency costs also may arise, especially in family firms because family owners embrace identities of family nurturers more than responsible agents for non-family shareholders. In so doing they may pursue private benefits of control such as conserving resources for the family rather than investing them in productive innovation initiatives. We shall argue that this type of owner-owner agency cost is less likely to be significant in firms where lone founders are major owners. We will argue that the latter take on an entrepreneurial rather than a family identity, and pursue strategies of shareholder wealth creation, often via a robust program of innovation.

**Theory**

**Governance, Agency and Identity**

Proponents of agency theory argue that where ownership is dispersed, managerial agents are able to appropriate or misuse firm resources in ways that erode shareholder value (Jensen and Meckling, 1976). However, there may also arise owner-owner agency problems whereby major owners appropriate resources for their own or their family’s benefit, again at the expense of shareholder returns (Shleifer and Vishny, 1997). Unfortunately, agency theory has not taken into account the disparate motives of different types of major owners or owner-managers.

Indeed, not all major owners have the same motivations or purposes, nor are they subject to the same agency conflicts. The social context of owners as well as their identities can have an important impact on the agendas they adopt as major principals and/or executives (Miller et al., 2011). Entrepreneurs who are lone founders or part of a team of unrelated founders are said to follow growth-oriented agendas that benefit all shareholders, while family owners and executives have been argued to follow conservation strategies that cater to family needs.

We believe that the identity of major owners or owner-managers also can also have a vital impact on the degree to which a firm is innovative and on its innovation quality. When ownership resides with powerful owners or owner-managers, then the identities and social contexts of those parties can shape their loyalties and personal agendas. Those in turn can influence both the investment in and the level and quality of innovation within their firms – with significant consequences for shareholder returns.

Based on identity theory (Burke, 1991; Stryker, 1987) and social identity theory (Tajfel and Turner, 1979) we shall argue that lone founders, given their roles, aspirations, and salient social constituencies, will embrace identities of entrepreneurs and pursue aggressive programs of innovation. By contrast, family owners, given their close associations with family members in the business, may take on identities of family nurturers and thus divide their loyalties between the family and the business (Miller et al., 2011). This will constrain firm financial and knowledge resources and risk taking, and therefore reduce the scope and quality of innovation. That constraint may represent an owner-owner agency cost (Bertrand and Schoar, 2006; Bloom and Van Reenen, 2007).
Two Theories of Identity

Theories of human identity represent attempts to relate social structure to human behavior. Identification with particular social groups and the taking on of a related set of roles can influence loyalties, values and behavioral priorities. Both identity theory and social identity theory concern the ways in which a socially constructed self-mediates between social structure and behavior (Hogg and Terry, 2001). Identity theory is primarily based on role identification, whereas social identity theory is concerned with identification with a particular group (Ashforth and Mael, 1989).

Role identity manifests as role expectations are fulfilled when interacting with significant social partners or constituencies (Stryker, 1980). For example, a person takes on the role of a physician in interacting with colleagues and patients who make legitimate demands upon him, expect certain behaviors from him, and provide symbolic or real rewards in return.

Social identity is embraced when one aspires to or presumes membership in a valued social group – whether or not there is direct interaction with that group (Ashforth and Mael, 1989; Tajfel and Turner, 1979). Part of that definition of group membership is based on distinguishing attributes between the target group and other contrasting groups. For example, a person may, due to preferences, aspirations, or perceived commonalities consider her- or himself to be a Democrat – a group with certain identifiable characteristics relating to attitude and behavior. Those characteristics are typically taken as contrasts with a defined “other” group, such as Republicans. Under the logic of both identity and social identity theory, the taking on of a particular identity is held fundamentally to shape attitudes and behavior.

Lone Founder Identities and Innovation Behavior

As noted, social identity theory suggests that people define themselves according to the salient groups that they see themselves as being members of (Hogg and Terry, 2001; Tajfel and Turner, 1979). Identification arises out of an aspiration to be a member of a valued group based on similarities of objectives, values, or even occupations. Thus firm founders or entrepreneurs may see themselves as being part of a group of peers – as being quite different from a contrasting group of mere administrators.

Lone founders have created a significant enterprise (at least in our study of public firms). As such, they are unusual individuals – people characterized in the literature as significant “entrepreneurs”. Previous research has found these individuals to have an internal locus of control – a sense that they control their own destiny (Boone et al., 2007). They also demonstrate a high need for achievement (McClelland, 1961) and are shown to be persistent and confident (Kirzner, 1979).

Thus, following social identity theory, many such lone founders will see themselves as members of a special group – one quite distinct from the more conservative managers (Kirzner, 1979). That entrepreneurial group, and the way in which it is celebrated in the popular literature, especially prizes both growth and innovation (Lumpkin and Dess, 1996; Miller, 1983). The celebration in America of an innovative entrepreneurial culture can be seen from the many technology and new venture prizes offered entrepreneurs and the laudatory cover stories on successful entrepreneurs in major business publications. These are especially common in knowledge intensive industries. Identification by founders with such a celebrated group may well reinforce their enterprising characteristics.

There are, however, additional sources of entrepreneurial identity, and these are to be found in the social interactions of a typical lone founder. Identity theory, as noted, has a different emphasis.
than social identity theory (Stets and Burke, 2000). It suggests that it is not simply aspirations but social relationships and roles that determine identity and the attitudes and preferences that arise from that identity (Burke and Reitzes, 1981; Stryker, 1987; Stryker and Serpe, 1982). Thus for entrepreneurs, the parties with whom they interact on a regular basis – venture capitalists, investors, bankers, suppliers, managers, customers, all help to shape their identities through the cognitive, social and political influence they exert.

For example, the pressures exerted by investors in an enterprise typically are for increasing share value, which in turn often comes from growth and the innovation strategies that support growth. Similar pressure for growth is apt to come from suppliers and employees – the first wish to expand their business and secure the credit-worthiness of their customers, the second want to have opportunities for career advancement in a growing enterprise. These stakeholders – investors, suppliers, and key employees – all may constitute important partners in any innovation effort as they supply the key resources of capital, knowledge and skill.

The continued presence of a founder in a firm that has grown to significant scale in a dynamic, research intensive industry suggests that he or she bears a good deal of responsibility for that growth. Within such industries, a major source of growth is effective innovation – the creation of new products or processes which are demonstrably original and relevant to users who are willing to use the fruits of the innovation (Thornhill, 2006). It is not simply investment in R&D, but also the wish to see consequential innovation projects through to fruition that distinguishes entrepreneurs (Kirzner, 1979) and results in what Schumpeter (1942) called “creative destruction.” Only successful and consistent innovation can translate into the kind of growth and performance that founding firm stakeholders most value (Hall et al., 2005). Again, this involves not only research and development expenditures but the productive output of those investments as measured by realized patents on innovations and also by innovation quality as attested by the citations those patents garner.

**H1a:** Lone founder owned firms will perform more research and development than other firms;

**H1b** Given their level of research and development, lone founder owned firms will receive more patents and patent citations.

Where a founder also serves as CEO and/ or chairman, the opportunities for innovation may be even greater than when the founder is merely an owner. Presence in the top management of a firm puts a founder in direct communication with those who must collaborate to produce important inventions and commercialize them. There is thus an immediacy in which the energy, motivation and expertise of the founder are brought to bear day-to-day in innovative endeavors. An entrepreneur’s involvement in top management also avoids all owner-manager agency costs which might otherwise draw resources away from the innovative effort.

**H2a:** Lone founder managed firms will perform more research and development than other firms;

**H2b** Given their level of research and development, lone founder managed firms will receive more patents and patent citations than other firms.
Familial Identities and Innovation Behavior

In family firms, at least one family member – other than the founder – is present in top management and/or has sizeable firm ownership. Thus a founder has decided to pass on ownership and/or management positions to at least one other family member.

Social identity theory may inform how family firm owners and executives view their identities and shape their priorities. The family is the core primary social group. A nuclear family has clear social boundaries, as, in many cultures, does an extended family (Nisbet, 1970). It is common for loyalties and privileges to be extended to family members that would never be extended towards outsiders (Homans, 1950). Thus assuming the identity of a family member can stimulate conformity to the norms and values of the family, and loyalty towards it (Haslam, 2001).

Identity theory, which focuses on role identities, is also relevant to family behavior. The role of a father, for example, implies a host of socially institutionalized values, responsibilities and behaviors. Where a family member serves as a major owner or manager of an enterprise in which his or her kin are involved in similar capacities, the family role can become quite salient. There may occur among such parties divided loyalties – to the family and to the business (Miller et al., 2011). Instincts of family altruism requited and otherwise, therefore may be much in evidence (Schulze et al., 2003; Lubatkin et al., 2005).

Loyalties and responsibilities to the family may also be reinforced through direct interaction with family members (Bloch, 1973). For example, demands may be made by relatives for financial rewards from the business in the form of dividends or compensation, and for careers in the firm (Perez-Gonzalez, 2006). There is also, frequently, a desire to keep the business within the family to provide wealth, prestige or security for later generations (Stewart, 2003). Thus resource restrictions and conservatism are the norm in many family firms, and that can constrain the research endeavor as well as its effectiveness. Instead of investing in R&D and generating innovations, family owners might decide to deploy resources to fulfill parochial family interests, thus suggesting an owner-owner agency conflict. These arguments are elaborated below for our subsequent hypotheses.

H3a: Family owned firms will perform less research and development than other firms;

H3b: Given their level of research and development, family owned firms will receive fewer patents and patent citations than other firms.

The above-mentioned family priorities will be particularly detrimental to innovation if family members are actively running the firm as CEOs and/or chairmen. Family priorities can constrain, in a number of ways, the financial and knowledge resources available for innovation, as well as the level and quality of innovation. First, where cash flows from the firm to the family, it is not available for innovative efforts. Second, innovation requires both talent and risk taking. Where family managers are in charge of a firm, especially in later generations, expertise may be inadequate to ensure a high level and quality of innovation (Perez-Gonzalez, 2006). Issues of nepotism, entrenchment of mediocre family executives, and altruism towards undeserving family members using business resources, all come to the fore (Bertrand and Schoar, 2006; Bloom and Van Reenen, 2007; Schulze et al., 2003). This can lead to incompetent management, which may hamper the innovative effort and its outcomes. So might the conservatism typical of family managers, and the tendency of such individuals to appropriate funds from the business to divert to parochial family purposes (Villalonga and Amit, 2006). The desire to keep the firm for later generations tends to
compound risk aversion – which is anathema to innovation. Indeed, such conservatism and a
dearth of capital may constrain investment in significant innovation projects. That conservatism,
coupled with a scarcity of knowledge or talent, also may limit the ability to follow through on
innovation projects, and constrain their scope and impact (Morck and Yeung, 2003). These chal-
lenges may apply mostly to later generation family management as the first generation family
CEOs and/or chairmen have already demonstrated the capability to create a significant enterprise,
have assumed some risk to do so, and typically do not occupy their positions as a result of nepo-
tism. These individuals may have much in common with lone founders (Miller et al., 2007).

\[H4a: \text{Family managed firms will perform less research and development than other firms;}\]

\[H4b: \text{Given their level of research and development, family managed firms will receive fewer patents and patent citations than other firms.}\]

**Data and Methods**

**Sample and Data Sources**

Our sample included firms in the Standard & Poor’s 500 index (S&P 500) as of July 31, 2003
that competed within research intensive industries.\(^1\) For those firms, we collected accounting, pat-
ent and ownership data for the years 1994-2003. Based on average R&D intensity per firm and
related prior findings (Hansen and Hill, 1991; Himmelberg and Petersen, 1994), we limited our
dataset to the following industries: “chemicals and allied products” (SIC 28), “industrial machin-
ery and equipment” (SIC 35), “electronic and other electrical equipment” (SIC 36), “transporta-
tion equipment” (SIC 37), “instruments and related products” (SIC 38), and “communications”
(SIC 48)\(^2\). However, as we show in our robustness checks, using a larger set of industries from the
S&P 500 sample does not change our results in any substantial way.

**Patent data** were obtained from the patent data project of the National Bureau of Economic
Research (NBER) (Hall et al., 2001)\(^3\), which builds on information from the US Patent and
Trademark Office (USPTO). The NBER dataset includes all granted patents in the US in the years
from 1976 to 2006. This dataset takes into account that a patent might have been applied for by a
mother company or any of its subsidiaries. Mergers and acquisitions were also taken into account
to accumulate patents appropriately. We employed the European Patent Office (EPO) Worldwide
Patent Statistical Database (PATSTAT) to construct a patent citations variable\(^4\). PATSTAT was cre-
ated by EPO on behalf of the OECD Taskforce on Patent Statistics and provides comprehensive
information on patent applications in 80 countries (including the US, Japan and Europe).

Data on a firm’s **ownership and management** were collected manually from corporate proxy
statements submitted to the US Securities and Exchange Commissions (SEC). In most cases, we
used the SEC Form DEF 14A, in which a company provides ownership information about offi-
cers, directors, and five-percent owners. The Securities Exchange Act of 1934 requires firms to
provide this information annually. Proxy statements have been shown to be the most accurate
source of such ownership information (Anderson and Lee, 1997; Dlugosz et al., 2006). To resolve
any ambiguous information, we complemented data from the Proxy statements with that from
Hoover’s Handbook of American Business or company websites (see the note in Appendix A1 for
a list of the sources used).
Accounting and financial data were obtained from the COMPSTAT North America and CRSP databases (Center for Research on Security Prices, University of Chicago). After excluding observations with missing values, we were left with an unbalanced panel data set consisting of 854 observations from 116 firms.

Variables

**Dependent variables.** Both R&D expenditures and patent data were used to analyze innovativeness in order to reflect both input and output indicators of innovation (Hall et al., 2005; Trajtenberg, 1990). Thus our analysis is based on three measures: (1) To gauge innovation input, we measure R&D expenditures as a percentage of total assets. (2) The *patent count* variable refers to a firm’s number of granted patents by application year. It is constructed by summing the single patents for each firm using the NBER dataset assignee number (Hall et al., 2001). (3) The *patent citations* variable measures the number of citations a firm receives for its patents by application year. Citations are calculated as the number of times a patent is cited by other patents within the first five years after its publication. Self-citations are included in this variable, but as we show in the robustness section, deleting these does not influence our results. Our three innovation measures reflect different aspects of innovation: patent counts gauges the quantity of innovation output, whereas patent citations reflects the quality of those patents as patents with a high number of citations are apt to be especially important to technological progress (Hall et al., 2005; Trajtenberg, 1990). Patent applications must include all “prior art” such as previous patents related to the invention. This information is evaluated by a patent examiner who decides whether the patent application is acceptable or not. In some industries, R&D expenditures may be a more reliable measure of innovation than patent data because patents are avoided as they are easily circumvented. There, secrecy may be a more effective mechanism than patents to appropriate rents from innovation (Arundel, 2001).

**Independent variables.** Our main independent variables are those of management and ownership. The involvement of families or founders in a firm is assessed by their share of ownership and their presence in top management. The variable *ownership by lone founder* refers to the founder’s or the founding team’s percentage of common equity above 5%; no relatives of the founder(s) are involved as major shareholders. The variable *ownership by family* constitutes the percentage of common equity of founding family members where relatives of a founder act as major (>5%) owners. Ownership by family and ownership by lone founder variables are mutually exclusive. That is, a family firm is not a founder firm, and vice versa. Our management variables are constructed similarly: The variable *management by lone founder* indicates a founder being active as CEO and/or chairman. The variable *management by family* indicates that a member of the founding family other than the founder serves as CEO and/or chairman. Note that lone founder variables refer exclusively to first generation firms, whereas family variables include both first and later generation family firms. Unfortunately, we have too few first generation family firms to run separate analyses on this group (N=6 firms). To distinguish the effects of family and founder ownership from that of institutional investors (Kochhar and David, 1996), we calculate the ownership share of investment funds, private equity firms as well as large banks and insurance companies. To control for investors that pursue mostly private benefits of control (Morck and Yeung, 2003; Villalonga and Amit, 2006), we included the variable *supershares* which indicates whether the firm has distributed shares that gives its owners disproportional voting power (e.g., dual class stock). Finally, to assure that the effects of family and founder ownership/management are not due to the age of the firm, we include the variable *firm age.*
We include a number of other control variables that are found to have an effect on innovation. Previous research has shown that a strong relationship exists between innovation expenses and innovation output (Hagedoorn and Cloodt, 2003). There may exist substantial economies of scale in the innovation process (Acs and Audretsch, 1988), which is why it is necessary to correct for firm size. As a proxy for firm size, we employ total assets. As this variable is skewed, we use its natural logarithm. Prior research has also suggested a negative relationship between debt levels and innovation (Baysinger and Hoskisson, 1989). Thus, debt to assets (debt/assets) taken as a control, again logged to reduce skewness. To take into account differences in investment opportunities, we incorporate lagged Tobin’s q (market-to-book value). To control for market specifics, we included a measure for market risk, which is calculated as the firm’s daily return regressed against the returns of the S&P 500 index (market risk). To take into account industry effects we used two-digit SIC industry dummies. Finally, to control for business cycle effects on innovation we include year dummies.

**Results**

Tables 2 and 3 show fixed-effects negative binomial regressions for patent counts and patent citations. For the patent regressions, Models I and II show the effect of ownership variables on innovation; Models III and IV show the effect of the management variables on innovation; Models V and VI incorporate both management and ownership variables. Due to the high correlation between the ownership and management variables (r=0.31 in case of lone founder firms or r=0.65 in case of family firms, Table 1), the latter models exhibit multicollinearity, which lowers the significance levels of the respective coefficients. Overall, the regression results show a clear trend: family ownership and management are associated with a lower level of innovation, whereas lone founder ownership and management have a positive influence on innovation. Moreover, results are stronger for innovation output and innovation quality than for innovation input.

When using innovation output as dependent variable (patent count), we find strong support for our hypotheses. For example, Model IV in Table 1 shows a positive effect of management by lone founder (H2b, $\beta=0.30, p<0.05$) and a negative effect of management by family (H4b, $\beta=-0.54, p<0.01$) on the number of successful patent applications (patent count). The ownership variables have similar effects. Model II in Table 1 shows a negative effect of ownership by family (H3b, $\beta=-0.80, p<0.10$); Ownership by lone founder has a positive but non-significant effect on the number of successful patent applications (H1b, $\beta=0.44, p>0.10$).

We also find support for our hypotheses when using innovation quality and thus patent citations as dependent variable. Family and founder variables show similar effects on patent citations. For example, Model II in Table 2 shows a negative effect of ownership by family on patent citations (H3a, $\beta=-1.04, p<0.01$); management by lone founder shows a positive effect (H2b, $\beta=0.35, p<0.01$). Hypotheses 1b, 2b, 3b and 4b do receive considerable support.

In summary, all indicators of innovation related negatively to family firms; and all but R&D expenditures related positively to lone founder firms.

The control variables have the expected effects. R&D spending and firm size show positive influences on innovation. Debt is inversely related to patent applications and patent citations. Firm age has a strong positive effect on innovation, perhaps because firm size and age are closely linked.
Discussion

Our results serve to condition the precepts of agency theory. Whereas the unity of ownership and control mitigates owner-manager agency conflicts, it can also give rise to so called owner-owner conflicts in which majority owners exploit their weaker counterparts (Villalonga and Amit, 2006). To date, however, agency research has not explained which types of personal major owners benefit or harm firm value in the context of innovation. This paper argues that not all types of major owners or executives have the same motivations, and hence might incur very different levels of agency costs. We drew on social identity and identity theory to understand which types of major owners (lone founder or family owners) would enhance or diminish shareholder value, particularly value based on innovation. Whereas lone founder owners and managers were expected to assume identities of entrepreneurs wishing to innovate and grow their firms, family owners and managers were expected to see themselves as family nurturers, pursuing conservative and more stagnant strategies to serve parochial family needs (Miller et al., 2011). We substantiated these notions in the context of the propensity and ability of these different types of owners and managers to create effective innovations.

Innovations have been shown to be critical to firm performance and economic prosperity (Aghion and Howitt, 1992; Schumpeter, 1942). Unfortunately, innovation research to date has neglected the effects of governance on the output and quality of innovations (i.e., patents and patent citations). Most of it has merely provided evidence that ownership concentration relates positively to R&D expenses which mirrors innovation input (Block, in press; Lee and O’Neill, 2003). Little research has been conducted, however, on how the identities of major owners relate to innovation, in particular innovation output and quality. This study has attempted to fill that gap.

We showed that lone founder firms do not under-invest in R&D. More importantly, when controlling for those expenses, lone founders firms displayed significantly higher innovation output and higher innovation quality than other firms. This effect was enhanced when founders also served as CEOs or chairpersons. For family firms we found opposite results. Family ownership was negatively related to R&D expenses, and they showed significantly fewer innovative outcomes (patents) and lower innovative quality (patent citations), even when controlling for R&D expenses. The presence of a family member in top management worsened the negative effect on number of patents and patent citations. These findings supported our hypotheses and suggest an important distinction between lone founder and family firms, a distinction that may be explained at least in part by identity theory.

Conclusion

In this paper, we introduced social identity and identity theory perspectives to explain how major owner governance differences may affect a firm’s innovativeness. In contrast with previous research, we examined three aspects of the innovation process to assess both innovation inputs and outputs: namely, innovation spending, innovation output, and the quality of innovation output. Our results indicate that when controlling for R&D expenditures, lone founder firms generate more patents and a larger number of patent citations. In contrast, we find the opposite to hold true for family firms, which also invest less in R&D. These results condition agency theoretic predictions because it is not simply ownership concentration, but the actual identity of major firm owners that affects firm innovation efforts, outcomes and quality – all indicators of reduced agency costs. Our findings are also consistent with Schumpeterian perspectives arguing that the locus of innovation...
resides within the entrepreneur, and advocating the importance of such innovation not simply for technological advancement but actual firm performance. Finally, our findings indicate that family firms, while held up by some anecdotal reports as founts of innovation, in fact may be challenged in both the quantity and quality of their innovative output, especially when family executives are in charge. It is especially significant that this last point holds true even in very large knowledge and research intensive businesses that are publicly traded in a highly developed economy.

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NOTES
1. We choose the year 2003 and not a more recent year as a starting point since we use patent citation data. Patent citations only occur some years after the firm has successfully applied for a patent.
2. We excluded software firms falling into the SIC 48 category, since patents are not a meaningful indicator for software firms (Bessen and Hunt, 2007).
3. We used Bronwyn Hall's update of the patent data files from 29th Dec 2008, which runs through 2006.
5. Note that if a patent is granted several years after it was applied for, it is still attached to the application year.
6. Past research has shown that most citations are made within the first five years after the publication of a patent (Hall, Jaffe and Trajtenberg, 2005).
7. Proxy statements do not report shareholders with less than 5% unless they are also members of the board of directors.
8. Clearly, the use of three-digit SIC industry dummies would be preferable. However, due to our low sample size, this is not possible.

REFERENCES


Table 1: Fixed-effects negative binomial regressions on *patent count*

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Model I</th>
<th>Model II</th>
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<td>N obs. (firms)</td>
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<td>Obs. per firm: min., mean, max.</td>
<td>2; 7.4; 10</td>
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<td>-3,105.88</td>
<td>-3,102.02</td>
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Notes: two sided tests: *** p<0.01, ** p<0.05, * p<0.1; Coeff=regression coefficients; SE=standard errors

1 reference category: year 2002
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