Innovation in Founder-run Firms: Evidence from S&P 500[1]

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Abstract

One important element of a firm's organizational environment that may influence innovation is whether the CEO of the firm is its founder. Popular perception is that the inherent venturous spirit of the founders creates an environment that fosters innovation. This study investigates whether founder-CEOs are more innovative than non-founder CEOs. Using a sample of S&P 500 firms from 1995-2005 and the NBER patent database for measuring innovation output, the study's baseline results suggest that founder-CEOs are actually associated with fewer patents (quantity of innovation) and fewer citations (quality of innovations), a finding that is contrary to popular perception. However, to reveal the true picture of the innovativeness of founders, evaluating the effect of innovation output on overall firm valuation is necessary. Thus, the study considers the effect of innovation output on firm valuation and suggests that founder-CEOs add more value by innovation. The market greets the innovation output of founder-run firms more favorably than the innovation output of non-founder-run firms. This value addition holds even after controlling for strategic investments such as R&D. This finding helps to identify a probable channel-innovation that bridges, at least partially, the gap in the literature that shows that there is a 'founder-premium'

Keywords: *Founder-CEO, Innovation, Patents, Citations, R&D*

JEL classification: *G32,G34,O31,O32,O34*

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ABSTRACT

One important element of a firm's organizational environment that may influence innovation is whether the CEO of the firm is its founder. Popular perception is that the inherent venturous spirit of the founders creates an environment that fosters innovation. This study investigates whether founder-CEOs are more innovative than non-founder CEOs. Using a sample of S&P 500 firms from 1995-2005 and the NBER patent database for measuring innovation output, the study's baseline results suggest that founder-CEOs are actually associated with fewer patents (quantity of innovation) and fewer citations (quality of innovations), a finding that is contrary to popular perception. However, to reveal the true picture of the innovativeness of founders, evaluating the effect of innovation output on overall firm valuation is necessary. Thus, the study considers the effect of innovation output on firm valuation and suggests that founder-CEOs add more value by innovation. The market greets the innovation output of founder-run firms more favorably than the innovation output of non-founder-run firms. This value addition holds even after controlling for strategic investments such as R&D. This finding helps to identify a probable channel-innovation that bridges, at least partially, the gap in the literature that shows that there is a 'founder-premium'.

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1. Introduction

The separation of ownership and control in public companies and the resultant tension of monitoring the delegated managers are highlighted in the seminal contributions of Berle and Means (1932), and Jensen and Meckling (1976). This agency problem is mitigated to some extent in founder-run firms though other forms of agency issues arise in such settings (see, e.g., Demsetz and Lehn, 1985). Extant literature on the effect of founder-CEOs on operating performance and market valuation produces mixed findings, with relatively recent studies documenting a 'founder premium'. Though different in terms of identification strategy, Adams et al. (2009), Fahlenbrach (2009), Palia et al. (2003), and Villalonga and Amit (2006) all show that founder-run firms average better market valuation and operating performance. However, other studies such as those of Morck et al. (1988), Claessens et al. (2002), Morck et al. (1998) and Cronqvist and Nilsson (2003), document that family-run businesses underperform relative to non-family firms. Although there is a rich segment of the literature linking family-management of firms to firm performance, the probable avenues by which such value creation (destruction) occur are under-identified. In this study, I address the issue of value creation (or destruction) empirically by analyzing the effect of founder-CEOs on firm performance by a specific channel: innovation.

Innovation is one of the key drivers of business performance and value creation. Innovation provides the necessary competitive edge that a successful organization requires to stay ahead in business, and it paves the way to leadership in the hyper-competitive world. Successful innovation largely determines a firm's future

profitability and competitive edge (Scherer, 1984; Ettlie, 1998). Innovation involves a long process that is full of uncertainties and greater chances of failure (Holmstrom, 1989) and is not a routine task such as mass production or marketing. Many firms do not meet with innovation success given the risks associated with innovation, which are triggered by the higher probability of failure when exploring untested ideas and actions, nor do all firms have the appropriate type of organizational environment to foster innovation.

One important element of a firm's organizational environment that may influence innovation is whether the CEO of the firm is its founder. The inherent venturous spirit of founders may engender an environment that nurtures innovation. However, the organization of a founder-run firm may also dampen innovation because of the occasional entrenchment, less risk-taking, and 'familism' by founders.[3] On balance, are these founder-run firms really more innovative?

I develop my testable hypothesis based on two strands in the empirical literature that document contradictory findings regarding the effects of founder-CEOs on firm performance. The literature discussed above that views founder-CEOs positively suggests that founder-CEOs, on average, may have a lower degree of short-termism because of their 'patient capital' focus on long-term performance and also because of the families' desire to pass on the fortune to the next generations.[4] Bertrand and Schoar (2006) argue that professional managers in widely held firms may

[3] Barnett (1960) defines 'familism' as "narrow kinship networks in making hiring decisions".
[4] Bertrand and Schoar (2006) argue that the bonding of current generation with the future ones provide firms with stable capital base.

often be associated with myopic investment decisions. For the venturous and enterprising attitude of founders, it is generally perceived that founder-run firms average more innovations than their counterparts managed by non-founders or hired managers. Borrowing on the innovation literature that broadly documents that innovation, on average, enhances a firm's value, I refer to this as the '**value creation hypothesis'** or **'patient capital hypothesis'**. The strand of the literature that views founder-control negatively suggests that founders are entrenched and thus invest sub-optimally in non-routine, less certain but value creating projects such as R&D. I refer to this as the '**founder-entrenchment hypothesis'.** In addition, because of the restricted labor market for these firms (family firms tend to hire from within), family businesses may develop a culture of 'familism' that may impede creativity, assuming that entrepreneurial talent is not necessarily genetically transferrable.

In the milieu of this unsettled view on innovation in founder-run businesses, in this study, I test the above two hypotheses by examining two broad research questions. The first question is whether founder-run firms differ from non-founder run firms in terms of innovation. I use the number of patents granted to a firm and the number of citations received by the patents as a measure of corporate innovation outputs. In addition to this measure of innovation output, I also examine whether founder-run firms have more innovation inputs in the form of higher strategic investments such as in R&D. The second is the effect of innovations on market valuation and also whether the market valuation differs based on whether the firm is run by a founder-CEO.

My primary sample comprises data on S&P 500 firms from 1995-2005, excluding financial firms and regulated utilities. Using the NBER patent database for measuring innovation output, the baseline results suggest that founder-run firms are less innovative. Contrary to popular perception, I observe that founder-run firms are associated with fewer patents (quantity of innovations) and fewer citations (quality of innovations). Then, adhering to guidelines from the literature, I consider the endogenous nature of the *founder-dummy* seriously. I run two-stage-least-square (2SLS) regressions instrumenting the potentially endogenous *founder-dummy* by two instruments, namely, *Number of founders* and *Dead founder dummy.* These two instruments are originally proposed by Adams et al. (2009), who convincingly argue about the validity of these two instruments in the context of performance regressions. Instrumental variable (IV) regressions produce even stronger results, both economically and statistically, suggesting that according to count-based measure founder-run produce fewer innovation outputs. My baseline results are robust to alternative samples, econometric models and alternative measures of innovations output.

Although the baseline results suggest that founder-run firms have lower innovation output, for the hypothesis concerning innovation input, I identify evidence suggesting that founder-run firms spend more on risky strategic investments (R&D). This result regarding R&D spending suggests that founder-CEOs are not necessarily entrenched or are not 'enjoying the quiet life' and are investing more in risky projects. This, at the same time, does not necessarily indicate that they create value through R&D investments because R&D investments may not necessarily be value-enhancing.

This may be because of the founder-CEOs' susceptibility to overinvestment problems or perhaps because they meet less resistance when investing in poor projects because of their dominant position within the organization (see, e.g., Fahlenbrach, 2009).

Initially, these two apparently contrasting findings, that founders are less innovative based on count-based measures of innovation output and that they spend more on R&D investments, suggest that R&D investments may be a potential vehicle for aggrandizing self-belief in creativity by founder-CEOs by labelling personal projects as R&D investments. It is also plausible that founder-CEOs are camouflaging various amenities as R&D investments, which may have value implications for shareholders. Alternatively, increased R&D investments could also indicate that the firm's research efficiency is less than is generally perceived. Finally, I examine whether innovation outputs of founder-run firms are valued differently by the market, splitting the sample into a founder-CEO sample and non-founder-CEO sample and identify evidence that the market greets the innovation outputs of founder-run firms more favorably than the innovation outputs of non-founder-run firms.

My analysis suggests that using only count-based measure of innovations such as number of patents or citations may not truly identify the effect of founder-CEOs on firm-level innovations. To reveal the true innovativeness of founders, evaluating the effect that innovations outputs may have on overall firm valuation may help shed some light. After considering the innovation input and the effect that innovation outputs have on firm valuation, I observe that founder-CEOs add more value by innovation. This value addition holds even after controlling for strategic investment

levels such as R&D investments. This finding helps identify a probable channel, innovation, that bridges, at least partially, the gap in the literature that shows that there is a 'founder-premium'.

The rest of the study is organized as follows: Chapter 2 discusses the related literature, Chapter 3 describes the sample selection, data and methodology and chapter 4 reports the main empirical findings. Chapter 5 concludes the study.

2. Literature review

2.1 Founder-CEO and firm performance:

Given the prevalence of family businesses around the world, the proliferation of academic literature in this regard is certainly conceivable. The literature on the effect of founder-CEOs on firm performance may broadly be partitioned into two strands: one that identifies a positive founder premium and the other that documents value destruction by founders. Morck et al. (1988) document that in older firms, founding families are associated with a negative effect on market valuation; however, the opposite is true for younger firms when one of the top two executives is supplied by the families. Morck et al. (1998) also observe while studying Canadian firms that heir management is negatively related to firm performance. Pérez-González (2006) and Bennedsen et al. (2007) supplement the findings of Morck et al. (1998): inherited control by a family member is associated with a decline in firm performance. Johnson et al. (1985) observe that following the sudden deaths of the founders, stock prices increase significantly, indicating probable entrenchment by the founders. Holderness

and Sheehan (1988) document that family firms have lower Tobin's Q than non-family firms.

The strand that views family control or founder control positively documents opposite findings. Anderson and Reeb (2003) provide evidence that family firms not only have higher market valuations but also better accounting performances than non-family firms. Villalonga and Amit (2006) argue that making a distinction between family ownership and family control is important and observe that family ownership creates value only when the founder serves as the CEO of the family firm or as chairman with a hired CEO. Unlike earlier studies, Adams et al. (2009) and Fahlenbrach (2009) consider the endogenous nature of the founder-CEO status. Deploying instrumental variable regressions, Adams et al. (2009) document causal relationship between founder-CEOs and firm performance and show that causation is running from founder-CEOs to performance. They use two convincing instruments: *number of founders* and *dead founder dummy* to instrument *founder-CEO.* Fahlenbrach (2009) use *CEO personal name* and *early incorporation* to instrument *founder-CEO status* and document that in addition to enjoying higher market valuation, founder-run firms also demonstrate better stock market performance.

More recently, Li and Srinivasan (2011) report an insignificant coefficient on the f*ounder-CEO* variable and argue that the positive relation documented in earlier literature between the presence of the founder-CEO and firm valuation is because of using fewer control variables and that using a larger set of control variables reduces the founder-premium effectively to zero (even negative). They find that f*ounder-*

director as opposed to *founder-CEO* is positively associated with firm valuation. They also recognize the lack of a clean instrument to identify the causal effect of founder-directors on firm policy.

The literature discussed above does not provide convincing explanations for why founder-run firms may have higher (or lower) valuation compared to non-founder-run firms. Fahlenbrach (2009) attempts to identify whether founder-run firms have better M&A performances but does not provide any conclusive evidence. In addition, he shows that founder-run firms have higher strategic investments but notes that higher strategic investments are not necessarily value-increasing because investments are input only and not an outcome variable and thus invites further investigation.

2.2 Innovation and firm performance: input of innovation perspective

R&D investments are essential in enhancing technological know-how and thus to remain innovative and obtain competitive advantages. Although R&D investment has been used as a proxy measure for innovation in earlier studies, more recently, R&D is considered only as input for innovation. The important characteristic that distinguishes R&D investment from other investments is the highly uncertain and skewed returns of R&D investments because of the time-consuming and failure-intensive outcomes (see, e.g. Scherer, 1998; Scherer and Harhoff, 2000). Risk-taking and non-myopic long-term-oriented attitudes are required when making risky investments such as R&D. *Asymmetric information* with regard to the probable success of R&D investments may trigger *agency problems* between owners and managers when these two entities are substantially distinct (Akerlof, 1970; Brealey et al., 1977;

Myers and Majluf, 1984; Thakor, 1990). Managers, being the insiders, have better information to assess the likelihood of success of R&D investments and the value that may be generated from such risky ventures. Managers with short-term focus may fear the long-term uncertainty of R&D investments and prefer short-term projects with more certain payoffs, thereby inducing the *moral hazard* (see, e.g., Campbell and Marino, 1994; Hirshleifer and Thakor, 1992; Narayanan, 1985). Sub-optimal strategic investments may be the consequence of these *asymmetric information* and *moral hazard* problems. It possible that firms may under-invest in R&D. It is also plausible that over-investment is a possibility when managers try to support their "pet projects" or aggrandize their creativity by exploiting shareholders' wealth (Jensen (1986)).

In a family firm or founder-controlled setting, these types of problems may manifest themselves differently depending on the agency perspective. Founders, because they have stayed with the firms since the beginning, have a thorough understanding of the business models, may embody less information asymmetry. In addition, because of the large portion of ownership of founders, the interests of managers and owners are more tightly aligned, which may help to reduce agency costs. However, there are other avenues by which founders, seeking the private benefit of control, may aggravate the sub-optimality of strategic investments. Kim and Lu (2011) show that CEO ownership exhibits a humped-shaped relation with R&D investments if external governance is weak but no relation when the external governance is strong.

Founders are by nature innovative, venturous and enterprising. One would expect founder-run firms to invest more in research and development because founders embody fewer agency problems. In addition, founders have a relatively long-term investment point of view compared with hired CEOs. They suffer less from investment myopia. Executive survey findings in Graham et al. (2005) indicate that managerial myopia is consistent with the evidence of Bushee (1998), who argues that managers feel pressure to cut R&D to manage earnings. However, for firms in which the current CEO is one of the founders, agency problems of these types should be less pronounced because of the owners' sizable financial and emotional stake in the business. Innovation decisions generally require substantial firm-specific knowledge (Coles et al., 2008). As one of the spearhead idea generators still active in the operation of the firm, a founder CEO with considerable firm-specific knowledge is a natural candidate to invest more in R&D than the hired-CEOs.

2.3 Innovation and firm performance: output of innovation perspective

Holmstrom (1989) argues that performance measures for innovative activities are noisier. In a similar vein, Aghion and Tirole (1994) argue that because of the unpredictable nature of the outcome of innovative activities, contracting *ex-ante* is difficult. Earlier literature commonly uses R&D expenditures as a measure of innovation. However, the problem with such coarse measure is that it potentially sheds light on the input for innovation rather than the output, the expected innovation productivity or innovation efficiency. More recent literature in this area uses the number of patents (quantity) and the citations received by the patents (quality) as the

measure of innovation, which are better justified because these are measures of the output of innovation.

The innovation literature shows that innovation significantly contributes to firm value.[5] Kang et al. (2013) investigate some plausible sources of CEO power and observe that some of the sources of power are positively related to innovative productivity whereas others are negatively related. Using the social-connectedness of CEOs and outside directors to asses friendly boards, Kang et al. (2013) argue that friendly boards perform better in innovation activities both in terms of the quantity and the quality of the patents created. In addition, in firms with extensive advisory needs such as high R&D-intensity firms and those with multiple segments, the positive effect of a friendly board is more pronounced. Hirshleifer and Thakor (1992) argue that powerful and entrenched CEOs may have a greater ability to appoint their friends to the board and also have more discretion in making value-enhancing, risky investments.

Fracassi and Tate (2012) argue that it is possible that powerful CEOs are less likely to face performance pressures or career concerns and thus are more likely to be able to take on more risky investments, including innovations. Manso (2011) also argues that in the context of managerial compensation, the optimal innovation-motivating incentive schemes can be implemented by a combination of stock options with long vesting periods, option repricing, golden parachutes, and managerial entrenchment. Manso (2011) argues that to nurture the innovative culture in

[5] See Hall et al. (2005), who document a significant effect of innovation outputs on market valuation. They show that one extra citation per patent boosts market value by 3%.

organizations, early failure should be rewarded rather than punished and that long-term performance should be prioritized over short-term performance.

Regarding organizational setting, innovation requires information sharing between the appropriate stakeholders such as managers and directors, which helps create a friendly atmosphere. In such an innovation-inducing setting, more emphasis is placed on advising rather on monitoring and restriction. Faleye et al. (2011) find that intense monitoring by boards reduces advising quality, thereby leading to worse acquisition outcomes and less innovation. Less monitoring reduces CEO career concerns and increases CEOs' incentives to invest in value-increasing but risky projects. (see, e.g., Manso, 2011; Chemannur and Tian, 2012; Hirshleifer and Thakor, 1992). Founders, a special type of powerful CEO, may exhibit less career concern than non-founders and thus may be more interested in pursuing more value-enhancing risky projects such as innovations.

Adams et al. (2005) argue that firms with more powerful CEOs exhibit more volatile performance than their counterparts with less powerful CEOs. They argue that in firms in which CEOs are more powerful and make the most relevant decisions, the risks arising from judgmental errors are not well diversified.[6] In terms of performance, Adams et al. (2005) present evidence that firms with powerful CEOs are not only those with the worst performances but are also those with the best performances. Consistent with management literature (Finkelstein, 1992; Donaldson and Lorch,

[6] Focusing on the power of CEOs over the board and other top executives as a consequence of formal position and titles (status as a founder, status as a sole insider in the board, CEO-chair duality), they convincingly argue that measures of CEO power are positively associated with stock return variability.

1983), CEOs who are one of the founders can be reasonably assured of being more powerful. In the similar vein of the firm performance, I argue that as the CEOs provide much of the leadership for pioneering innovation, firms with more powerful CEOs such as founder CEOs should experience different innovation productivity and efficiency.

3. Data and variables

3.1 Data on firm level innovation:

My sample comprises all publicly traded firms in the 2004 S&P 500 from 1995-2005. I exclude regulated financial firms and utilities because of their relatively very low rate of innovation input and output compared with non-financial and non-regulated utility firms. The financial and regulated utility firms are regulated differently and on average, have negligible R&D investments (only 0.1% of total assets). My final sample includes 361 firms.

Following Adams et al.(2009), I choose the S&P 500 firms in the year 2004 and follow them back in time, to minimize survivorship bias. In my analysis, selected firms do not exit the sample even if they do not belong to the S&P 500 in any other years. The downside of this sample selection methodology may be the introduction of another type of selection bias. Andersen and Reeb (2003) choose firms in 1992 and follow them until 1999. However, Andersen and Reeb's (2003) sample selection methodology overweights those firms that have survived as public companies throughout their sample period. My sample selection procedure overweights those firms that have grown larger (or remained in the S&P 500) during our sample period.

To construct my sample, I first require that firms be listed in the NBER 2006 edition patent database (Hall et al., 2001). The NBER patent database covers more than 3.2 million patent grants and 23.6 million citations from 1976-2006. The dataset provides information on the names of the assignees, the number of patents, the number of citations received by the each patent, etc., on each patent filed with the U.S. Patent and Trademark Office (USPTO). I use the patent application date instead of the patent grant date because the patent application date is more meaningful in my set up in capturing the relevant date of the innovation although the patents appear in the database only after they are granted. In this regard, I follow guidelines from the innovation literature and consider dating the patents by the year of their application (Hall et al., 1986). This also ensures that anomalies caused by the time lag between the applications and the grant date of a patent are addressed. I restrict my sample to patents applications before 2006 considering that patents applied for after 2005 may not appear in the dataset because of the time lag in granting patents.

3.2 Data on Founder-dummy and firm performance:

I hand-collect all the data related to names and number of founders of each firm, founding year, year of death of the original founders, etc., from several sources including 10-K filings of the firms with the SEC available in Electronic Data-Gathering, Analysis, and Retrieval (EDGAR), the Funding Universe website, company websites, and other Internet resources including Wikipedia, Forbes pages, Bloomberg's Business Week website, etc. Majority of the financial data are from Compustat's fundamentals annual data and ExecuComp. CEO-specific data are collected from ExecuComp and Risk Metrics. RiskMetrics provides data to capture board specific features and corporate

governance variables. The final dataset includes 3737 firm-year observations on 361 different firms for which data are available on S&P ExecuComp.

3.3 Construction of main variables of interest:

3.3.1 Measure of innovation activities:

Hirshleifer et al. (2012) use two variables to measure corporate innovation activity- number of patents and forward citations received by these patents. Following the recent adoption of the innovation measure, I use *number of patents* applied for (and subsequently granted) as the measurement proxy for quantity of innovations. To distinguish major technological breakthroughs from incremental technological improvements, I also use the *number of citations* received by these patents to measure quality of innovation.[7]

One potential problem in the patent dataset is the truncation bias caused by the finite duration of the sample period. Citations accumulate over many years after a patent is first granted. Presumably, patents granted in the latter part of the sample period would have less time to accumulate citations compared with those granted in the earlier part. To address this issue, consistent with literature, I adjust the patent citations count by multiplying the unadjusted or raw citations by the weighting index by Hall et al. (2005), which is also provided in the NBER patent database. This adjusted citation count is labelled *HJT-Weighted citation*. Using a quasi-structural approach, this weighting index is constructed that econometrically estimates the shape of the

[7] Studies employing these two variables to measure innovation performance include among others Hirshleifer et al. (2012), Seru (2012), Tian and Wang (2012), He and Tian (2013), Hsu et al. (2013) Fang, Tian and Tice (2013), Chemannur and Tian (2013), Bereskin and Hsu (2013), Kang et al. (2013).

citation-lag distribution. I also construct *Citations per patent* or *average citation* by scaling the *number of citations* in a year by the *number of patents* granted in a year.

One of the limitations of the study that may have implications for the interpretation of the findings is the measure of innovation output that I use. The NBER patent and citations database, although the standard dataset used in the innovation literature, is reflective only of successful innovations. Firms having a strong commitment to research and development but filing fewer patents are not necessarily less innovative or less creative. Generally, however, one may expect more innovative firms to file for more patents grants. To the extent that patent and citations data capture the innovation output of the firms, this study should enable the identification of innovation productivity and efficiency of founder-run firms. I also use R&D/Assets to measure innovation input defined as R&D expenditures to total assets of the firm.

3.3.2 Founder dummy:

'Founder-Dummy' in a given year is a dummy variable that equals one if any sources explicitly mention that the current CEO is one of the original founders of the firm or was a main executive at the time the company was founded. When instrumenting *Founder Dummy*, I follow Adams et al. (2009) and use a similar definition to construct *Number of founders* and *Dead founder dummy*. *Dead founder dummy* is a straightforward per-firm average of the dummy indicating whether the founder(s) died prior to 1995 and then continuously updating the information up to 2005 for deaths occurring during the sample period. This continuous updating ensures that the instrument reflects the true status of the proportion of deaths throughout the

sample period, not just at the beginning of the sample period. The *Number of founders* variable is the number of original founders for each firm.

3.3.3. Market valuation measure:

Later in the analysis, I use natural log of Tobin's Q, *log (Tobin's Q* to measure the market valuation of the firms. Tobin's Q is estimated as firm's market value to the book value where market value is calculated as the book value of assets minus the book value of equity plus the market value of equity.

Among the control variables, *Firm size* is defined as the natural log of book value of total assets of the firm.[8] I also control for other strategic investments such as capital expenditure scaled by assets. The appendix-1 provides definitions of all the variables used in the study.

3.4 Summary statistics:

Table 1 reports the summary statistics for the sample firms. Panel A shows the summary statistics for the Non-founder-CEO sample whereas Panel B (Panel C) shows summary statistics for the Founder-CEO sample (Full sample). In the sample, 111 different firms were run by their founders at some point in time. Several observations are noteworthy. Founder-run firms have higher levels of R&D intensity (4.8% compared to 3.2% for non-founder-run firms) in which missing values of R&D investments are coded with zero[9]. These numbers are broadly consistent with those of Fahlenbrach (2009), who reports similar statistics. Founder-run firms, on average, are

[8] Chemmanur and Tian (2013) and Sapra et al. (2013), among others, use natural log of assets to measure firm size. Hirshleifer et al. (2012) and Kang et al. (2013), among others, use natural log of sales to measure firm size. My results are robust using alternative measurements of firm size.

[9] The difference is more pronounced when missing R&D is NOT coded with zero. Approximately 29.64% of the firm-year observations have missing R&D values. The results do not change if these observations with missing R&D values are excluded from analysis.

smaller, and have a higher market valuation, more volatility, more sales growth and higher stock return. Compared to Adams et al. (2009), volatility level has increased for both the founder-CEO sample and the non-founder-CEO sample. Founder-run firms utilize a significantly lower percentage of debt capital. Column (6) reports the difference-of-means test for the Founder-CEO sample and the Non-founder CEO sample.

<<<Insert Table 1 about here>>>

In terms of CEO characteristics, founder-run firms are characterized by significantly higher CEO stock ownership (4.05% compared with 0.57%) and longer CEO tenure. These numbers are broadly consistent with those in Adams et al. (2009) and indicate that founders have a significant stake in the firms both in the form of sizable shareholdings and longer career orientation. In terms of governance features, founder-run firms have a higher incidence of issuing Dual-Class stocks, indicating their intention to control the firms, assuming that founders own these shares. This is consistent with Villalonga and Amit (2006).[10]

In terms of innovations output, founder-run firms have, on average, 52 patents as opposed to 73 for non-founder-run firms. The difference-of-means test indicates that this difference is statistically significant. However, founder-run firms have more citations, both unadjusted and HJT-weighted, than the non-founder-run firms although these differences are not statistically significantly different as indicated by the *t*-

[10] Villalonga and Amit (2006) find that family firms use disproportionately higher percentage of Dual class stock issuance. For their sample, Family vote holding in excess of shares owned averages 17% for all family firms.

statistics in column (6). More notably, the *Citations per patent* are significantly higher for the founder-CEO sample with each patent receiving an average of 3.96 citations compared to only 2.45 citations for the non-founder-CEO sample. Combined, these statistics on innovation-related measures indicate that founder-run firms file, on average, fewer but higher quality patents with potential for being groundbreaking discoveries. The average non-founder-CEO-run firm has a higher percentage of dead founders and fewer original founders than the average founder-run firm.

4. Empirical analysis

4.1 Effect of Founder-CEO status on firm innovation output: quantity of innovation and quality of innovations

In this section, I start in examining the effect of founder-CEO status on firm innovation outputs by estimating the following empirical model in the baseline OLS regressions:

$$\text{Innovations}_{i,t} = \alpha + \beta\ \text{Founder Dummy}_{i,t} + \gamma\ \text{Vector of controls of firm characteristics}_{i,t} + \text{Industry dummies} + \text{Time dummies} + \varepsilon \quad (1)$$

in which *i* indexes firms, *t* indexes time, $Innovations_{i,t}$ is the dependent variable at time *t* and can be any of the following measures: the natural logarithm of (1+number of patents) labelled as ***log (1+Patents)***, the natural logarithm of (1+ total unadjusted citations) labelled as ***log (1+Citations)***, the natural logarithm of (1+ HJT-weighted citations) labelled as ***log (1+HJT-weighted citation)***, the average citations labelled as ***Citations per patent*** estimated as total citations in a year scaled by the total number of

patents in a year; $\boldsymbol{\gamma}$ is the vector of firm characteristics that may potentially affect firm's innovation productivity.

It is reasonable to assume that the performance of all S&P 500 firms would in part be driven by the same unobserved factors in a particular year. As such, I incorporate year-fixed effects in my models but do not use firm-fixed effects in my baseline analysis. My main explanatory variable of interest, *Founder Dummy,* changes little over time for any given firm. Adams et al. (2005), noting a similar condition in their data, posit the following:

> *"…we do not use firm fixed effects in our specification, because our measures of CEO power vary little over time for a given firm…. In addition, we expect differences in variability to be more systematically related to industry, for which we control."*

In another influential paper, Adams et al. (2009) posit that when the main explanatory variable varies little over time for a given firm, firm fixed effects should not be used. They argue the following:

> *"We do not use firm fixed-effects in our specification because our main explanatory variable (founderCEO) varies little over time for a given firm. To calculate all t-statistics, we use heteroskedasticity-corrected standard errors."*

On a similar note, Zhou (2001) further argues,

> *"…managerial ownership, while substantially different across firms, typically changes slowly from year to year within a company...By relying on*

within variation, fixed effects estimators may not detect an effect of ownership on performance even if one exists."

As such, following guidelines from Adams et al. (2005) and Zhou (2001), I do not use firm-fixed effects in baseline specifications. In addition, following Adams et al. (2005), I expect differences in variability to be more systematically related to industry; thus, I use industry-fixed effects. I cluster standard errors at the firm level.

Table 2 reports the baseline results. The estimates of univariate regressions are reported in column (1) through column (4) of Table 2. The coefficients of *Founder-Dummy* are negative and significant at the 1% level for all measures of innovations except for *Citations per patent,* for which the coefficient is positive but statistically indistinguishable from zero. These coefficient estimates suggest that founder-run firms have, on average, both fewer patents and fewer citations, both unadjusted and HJT-weighted. Then, I run the baseline multi-variate regression and report the estimates in columns (5) through (8). The coefficient estimates of *Founder Dummy* are negative for all measures of innovation output except *citations per patent*. The economic effect of founder-CEOs on firm innovation outputs is extensive, with founder-run firms producing approximately 28.6% fewer patents than non-founder-run firms. For the citations-based measure of innovation outputs, founder-run firms have, on average, 37.4% and 45.1% less innovation output in which unadjusted citations and HJT-weighted adjusted citations are used, respectively, as measures of innovation output.

<<<Insert Table 2 about here>>>

In the baseline regressions, I control for a reasonable set of firm characteristics that may potentially affect firms' innovation outputs. These results are robust even after controlling for R&D investments I which R&D investments are scaled by assets. Firms with higher R&D intensity average higher innovation outputs. R&D investments, the only observable innovation inputs, have very large coefficients, which are statistically highly significant. This is consistent with Hirshleifer et al. (2012), Chemmanur and Tian (2013), Bereskin and Hsu (2013), and Kang et al. (2013) who also document economically meaningful and statistically significant coefficients on R&D investments. The coefficients of *Firm size* are also large and statistically significant at the 1% level in all regressions. This is broadly consistent with the findings of the innovation literature, which documents that larger firms average greater innovation output.[11] Firms with higher Tobin's Q have more innovation outputs. Kang et al. (2013) and Chemmanur and Tian (2013) also note a positive coefficient on Tobin's Q.

4.2. Robustness tests:

In addition to solving the potential endogeneity problem by using the instrumental variable approach and including potentially omitted CEO characteristics, firm characteristics and governance feature in the baseline regressions in later sections, I also run a rich set of robustness tests for the baseline specification. I briefly summarize the results of these tests which are reported in Table 3.

<<<Insert Table 3 about here>>>

[11] See Chemmanur and Tian (2013), Hirshleifer et al. (2012), and Bersekin and Hsu (2013), who also report positive and significant effect of firm size on innovation outputs.

4.2.1 Alternative econometric specifications: Firm fixed effects

The baseline regressions utilize both year-fixed effects and industry-fixed effects (in which industry is defined at two-digit SIC code) and cluster standard errors at the firm level. In Table 3, I also use *firm fixed effects* instead of industry fixed effects considering that my sample consists of a relatively longer (11 years) panel. Use of firm-fixed effects controls for time-invariant, unobservable firm characteristics that may jointly determine both the founder-CEO status and innovation output. Because my objective is to examine whether founder-CEOs are stifling or stimulating firm innovation, inclusion of the firm-fixed effects would allow me to examine whether and how the variation of founder-CEO status within a firm explains the firm's contemporaneous as well as subsequent variations in innovation output assuming that there is reasonable variation in the *Founder Dummy*. The results are reported in columns (1) and (2). I observe similar coefficients for *Founder Dummy* for both patents and citation based measures of innovations compared to the baseline results. For patents (HJT-weighted citations), *Founder Dummy* is associated with 19.5% (34.55%) less innovation output. This alleviates the concern that time-invariant, unobservable firm characteristics drive the relation observed thus far between *Founder Dummy* and innovations output.

4.2.2 Alternative econometric specifications: CEO level clustering

In the baseline and subsequent specifications, I adjust standard errors for clustering at the firm level consistent with Adams et al. (2009) and Fahlenbrach (2009), among others. In addition, Petersen (2008) provides similar guidelines for using firm-level clustering in the presence of significant *firm* effect as opposed to *time* effect.

However, I also cluster standard errors at the CEO level. The statistical significance of the baseline results are unaltered and are reported in columns (3) and (4).

4.2.3 Innovation in subsequent year, Innovation$_{(t+1)}$:

Since it is possible that innovation process generally takes longer time than one year, I examine the impact of *Founder-dummy* on firm innovation activities in the subsequent year, year$_{(t+1)}$. The results are reported in columns (5) and (6). The coefficients are qualitatively quite unchanged in terms of economic significance but statistical significant has dropped to 10% level. In untabulated regressions, I also try innovation outputs in year$_{(t+2)}$ as the dependent variables and find similar results.

4.2.4 Deleting observations of the last year:

I restrict my sample period up to year 2005 to address the possible truncation bias in the NBER patent database from which I obtain patent and citations-related data. Patents are included in the NBER database only if they are eventually granted and there is, on average, approximately a two-year lag between patent application and patent grant (Hall et al. (2001)). Since 2006 is the latest year in the NBER database, patents that are applied for after 2004 may not appear in the database. Therefore, I delete firm-year observations of year 2005 and re-estimate the baseline regressions in columns (7) and (8). The results continue to hold.

4.3 Concern for endogeneity- Omitted CEO characteristics, firm characteristics and corporate governance features

My main variable of interest, *Founder Dummy*, is highly unlikely to be a random occurrence. If innovation activity and the founder's occupying the CEO position are jointly determined by some other unobservable CEO characteristics, firm characteristics or governance features, my baseline regression results may be subject

to omitted variable problems. In addition, it could be the case that direction of causality runs from innovation output to founder-CEO status. In this section, I try to address the endogeneity problem by adding some plausibly omitted CEO-characteristics, firm characteristics and some governance features to the baseline regression. In a later section, I use Two-Stage-Least-Square (2SLS) Instrumental Variable (IV) regressions to address the potentially endogenous nature of the *Founder-Dummy.*

Because it is plausible that the *Founder Dummy* correlates with CEO characteristics, these baseline results could reflect a spurious correlation between *Founder Dummy* and innovation output caused by omitted CEO characteristics. It is possible that CEOs who are more powerful, because they hold multiple titles, may be better able to influence strategic investment choices and thus may overcome resistance from other important, influential decision-makers. In other words, the CEO's holding multiple titles is indicative of fewer remaining important decision-makers other than the CEO. The fact that the CEO holds multiple titles also indicates that the CEO does not have to face the bureaucratic decision-making process, which presumably stifles innovation. Adams et al. (2005) observe that powerful CEOs, because they hold multiple titles, have founder-status and are the only insider on the board, may significantly affect corporate policies. More seasoned CEOs may also be more influential in making strategic decisions by virtue of their experience or seniority. Founders may also hold a disproportionately large portion of firm's equity and CEOs with reasonable ownership may exercise stronger opinions in making strategic investment choices. Adams et al. (2009) observe that CEO compensation that is based

on equity may be correlated with *Founder-Dummy* because of the differing pay-for-performance incentives for founders. Giving CEOs more equity-based pay may also be an important determinant of innovation output because of a compensation package tightly linked to firm values.

Thus, I include the variable *CEO-Chair dummy,* (e.g., Goyal and Park, 2002), *CEO age, CEO equity pay* (Adams et al., 2009) and *CEO ownership* (Adams et al., 2009) to determine whether baseline results are driven by these omitted CEO characteristics. Table 4 reports the results of this section. The results continue to hold, and the coefficients are even more significant, both economically and statistically. This confirms that my findings are not driven by omitted CEO characteristics. These results are reported in columns (1) and (5). In unreported regressions, I use the *CEO-title concentration dummy* (which takes the value one if the CEO is also the chairman of the board and holds the title of CFO, COO, President, or Chief scientist or takes the value zero otherwise) instead of the *CEO-Chair dummy* variable and observe that the results are robust. The *Founder Dummy* continues to negatively affect firm innovation output. The *CEO-chair* dummy has a positive relation with firm innovation output. A plausible argument for the positive effect of the *CEO-Chair* dummy may be the less bureaucratic decision-making process that ensues when the CEO also holds important titles, thereby reducing friction in terms of making smooth strategic decisions such as R&D investments. Thomson (1965) examines the relation between bureaucratic structure and innovative behavior by comparing the conditions within the bureaucratic structure with the conditions observed by psychologists to be most conducive to individual

creativity and observe that the conditions within a bureaucracy are determined by a drive for productivity and control and as such are not conducive to creativity.

<<<Insert Table 4 about here>>>

I then include *Stock return, Leverage, Volatility, ROA* and *Sales growth* as omitted firm characteristics. Firms' strategic investments may be a function of *stock returns* in previous years and stock returns may also affect the founder-CEO status. Again, *leverage* may be an important determinant of firms' strategic investments, and the summary statistics (Table 1) indicate that founder-run firms have disproportionately low levels of leverage. In addition, the summary statistics (Table 1) indicate that founder-run firms have disproportionately higher levels of volatility. Firms' *volatility* may affect innovations input such as R&D investments as well as innovation output. Apart from controlling firm performance (annual buy-and-hold-stock return), I also control for *ROA* because it is also possible that more profitable firms can raise funds at relatively cheap rate because of their having better access to external capital markets. I also control for firm growth opportunity with *sales growth*.

The results of the regressions including these omitted firm characteristics are reported in columns (2) and (6). The results still continue to hold and are qualitatively unchanged, thus alleviating the concern of omitted firm characteristics' driving the results. Firm *leverage* appears to have a negative relation with innovation output, which is consistent with the findings of Chemmanur and Tian (2013), Kang et al. (2013), and Fang et al. (2012). This suggests that firms may not utilize debt financing for risky, strategic investments such as R&D investments, the pay-offs for which are highly

uncertain and skewed. *Volatility* also has a positive and significant effect on innovation output.

It is also plausible that firms' governance features may also drive the baseline results. If the firms embed mechanisms in the corporate charter to shield the CEO from a hostile takeover or weaken the disciplining mechanism from the market for corporate control, the incentives to innovate and remain competitive may be affected.[12] One such mechanism is the classified or staggered board. Bebchuk et al. (2002) show that in the five-year period from 1996 to 2000, no firm with an effective staggered board was successfully acquired in a hostile takeover. In addition, Low (2009) shows that in response to an exogenous increase in takeover protection, managers in Delaware firms with staggered boards have significantly reduced risk and that this risk reduction is value-destroying for these companies. Chemmanur and Tian (2013) show that firms with more anti-takeover-protections (ATPs) have better innovations. Meulbroek et al. (1990) document a negative correlation between R&D intensity in firms and the adoption of firm-level anti-takeover provisions. In addition, to the extent that founder-CEOs value control and retain their voices in important corporate decisions such as R&D investments, it is plausible for founder-run firms have more incidents of issuing dual-class stock. Villalonga and Amit (2006) document that family-firms use dual class shares more heavily to have voting rights in excess of their cash-flow rights.

[12] Shleifer and Summers (1988) argue that incumbent managers have less bargaining power over shareholders at the time of higher takeover threats, which leads them to have less incentive to invest effort and human capital in areas that potentially have long-run payoffs-such as innovation. This is in part due to the Incumbent managers' apprehension of a hostile bidder dismissing them after the takeover (when the innovation meets with success) and thus denying them the opportunity to enjoy the profits resulting from the innovation.

Therefore, I include *classified board* and *Dual class stock* as possibly omitted governance characteristics. Columns (3) and (7) report the results of the regressions for number of patents and number of HJT-weighted citations. My results continue to hold and remain robust to these plausible omitted governance features. Moreover, columns (4) and (8) include all of the potentially omitted variables, showing that the baseline results are unaltered and that even more pronounced effects are envisioned. For the patents (HJT-weighted citations), the coefficients of *Founder-Dummy* are -0.33 (-0.498) and are statistically significant at the 5% level.

4.4. Effect of founder-CEO status on firm innovation outputs- different sample

I repeat these regressions on a broader sample of firms including financials (SIC code: 6000-6999) and regulated utilities (4800 and 4900) along with the original sample of the study. The financial and regulated utility firms are regulated differently and average a much lower innovation output. In addition, innovation input is negligible.[13] For the non-financial and non-regulated utilities firms, the average number of patents (citations) is approximately 69 (369) compared with approximately 5 (30) for the financial firms and regulated utilities. In untabulated regressions, *Founder Dummy* continues to have a negative effect on firm innovation output; however, the effects are a bit less pronounced and less significant statistically. Founder-run firms have approximately 23.2% fewer patents and 33.4% fewer HJT-weighted citations compared with non-founder-run firms. Importantly, this extended sample includes the financials and the regulated utilities firms for which innovation is

[13] Average R&D investments of only 0.1% of total assets compared to 3.5% for the sample excluding these firms.

less significant in remaining competitive in the marketplace than for the firms in the original sample, which excludes both these types of firms.

4.5 Effect of Founder-CEO status on firm innovation output: Instrumental Variable (IV) approach

In this section, to address the possible endogeneity more convincingly, I use a Two-Stage-Least-Square (2SLS) Instrumental Variable approach. I use two instruments, *Number of founder* and *Dead founder dummy,* originally proposed by Adams et al. (2009). Adams et al. (2009) present a detailed discussion of the validity of these instruments. For the *Number of founders* instrument, it is arguable that the greater the number of founders, the greater the likelihood of the current CEO's being one of the founders, thus satisfying the relevance requirement of the instruments. Also the *Number of founders* is unlikely to directly affect firm innovation output long after the founding event. However, one could also argue that when the number of founders involved in a firm is large and as such more involved decision-making process may ensue. This could potentially influence the innovation in the firms. For the *Dead founder dummy* instrument, the explanation is fairly straight-forward. Dead founders cannot be CEOs and thus satisfy the relevance requirement. The death of a founder should also be a fairly exogenous event without any direct effect on innovation, except when the founder happens to be in control (Adams et al., 2009). Thus, this instrument also satisfies the requirements for a valid instrument.

Table 5 reports the results of the instrumental variable regressions. Columns (1) through (3) report the 1st stage regression results, using OLS regressions to estimate

the likelihood of having a *Founder-Dummy.* In column (1) *Number of founders* is the instrument. In column (2), *Dead founder dummy* is the instrument. column (3) includes use both the instruments. As expected, *Number of founders* is positively related to the likelihood of having one of the founders as the CEO and *Dead founder dummy* is negatively related to the likelihood of having one of the founders as the current CEO. The *F*-statistics for the 1st stage regressions in all three specifications are above 10, indicating the relevancy of the instruments (see, e.g., Staiger and Stock, 1997).

<<<Insert Table 5 about here>>>

Columns (4)-(6) and (7)-(9) report the results from 2nd stage regressions that I use the ***log (1+Patents)***, and ***log (1+HJT-weighted citation)*** as dependent variables, respectively, and the instrumented *Founder-Dummy* and other control variables used in Table 4 as the independent variables. The coefficient estimates in columns (4)((7)) and (5)((8)) show that the instrumented *Founder Dummy* is negative and significant at the 1% level. The coefficients in columns (6) ((9)) are also negative and significant at the 1% (5%) level. Interesting observations include the much larger coefficients for *Founder Dummy* compared to the OLS estimates. Volatility becomes significant in nearly all 2nd stage regressions. CEO characteristics such as *CEO age* and *CEO-Chair dummy* are also significant in some of the specifications.

Overall, the results so far suggest that founder-run firms average lower innovation productivity, both in terms of quantity of innovations (number of patents) and quality of innovations (number of forward citations received). These findings are robust to employing alternative samples, endogeneity caused by omitted CEO

characteristics, firm characteristics and governance features, and econometric specifications.

4.6 Effect of Founder-CEO status on firm innovation inputs- R&D investments

Contrary to the popular perception, the results of the previous section suggesting that founder-run firms have lower average innovation outputs than their non-founder-run counterparts renders it interesting to investigate the pattern of R&D investments in these firms. It is also arguable that founders, because of their positions in the firm by virtue of their founder-status, titles and inherent venturous spirit, may suffer from overinvestment problems regarding strategic investments. It is plausible that founder-CEOs are investing disproportionately high amounts on risky strategic investments such as R&D and failing to recoup their investments. The difference-of-means test for R&D investments in summary statistics (Table 1) shows that founder-run firms have higher R&D investments. I also scale this variable by total assets.

Taking the endogenous nature of the founder dummy, I estimate the following empirical model to examine the innovation inputs of founder-run firms:

$$(\text{R\&D}/\text{Assets})_{i,t} = \alpha + \beta\ \text{Founder Dummy}_{i,t} + \gamma\ \text{Vector of controls of firm characteristics}_{i,t} + \text{Industry dummies} + \text{Time dummies} + \varepsilon \quad (2)$$

in which *Founder-Dummy* is instrumented by the *Number of founders* and *Dead founder dummy.*

The results of the 2nd stage regressions of the 2SLS procedures are reported in Table 6. While estimating this empirical model, I also consider that a significant

percentage of the R&D data are missing. Columns (1) - (3) ((4)-(6)) show the results of regressions in which missing R&D data are (NOT) coded with zeros. In columns (1) and (4), I use *Number of founders* as the instrument for *Founder Dummy* but *Dead founder dummy* as the instrument for *Founder Dummy* in columns (2) and (5). Columns (3) and (6) report results instrumenting *Founder Dummy* by both these instruments. The coefficient estimates for the *Founder Dummy* are positive and significant in all specifications. Using both instruments demonstrates that founder-run firms are associated with approximately 2.5% (2.8%) more investment in R&D than non-founder-run firms when missing R&D values are (NOT) coded with zeros. This is consistent with Fahlenbrach (2009), who also reports similar coefficients. Relative to the sample mean of 3.5% (5%), this translates to 71% (56%) more spending on R&D in founder-run firms when missing R&D data are (NOT) coded with zeros.

<<<Insert Table 6 about here>>>

Overall, the results of this section suggest that founder-CEOs are associated with higher average levels of strategic investments compared with their non-founder-CEO counterparts. The coefficient estimates show that firms with founder-CEOs are investing more in risky projects and thus are not necessarily 'enjoying the quiet life'. This finding, when considered in conjunction with the findings of innovation outputs of founder-run firms of the previous section, raises questions regarding the research efficiency of the founder-run firms in general and value implications for shareholders in particular, whom I turn to next.

4.7 Effect of Founder-CEO status on firm value through innovations

4.7.1 Founder-CEO and firm valuation:

Extant literature, as discussed in the literature review section (Chapter-2), documents mixed findings regarding the effect of founder-control on firm performance. Adams et al. (2009), using data on Fortune 500 firms (excluding financials and regulated utilities) for the period 1992-1999, show that founder-run firms have 18.5 % more market valuation, on average, using OLS estimates, and even higher founder-premiums utilizing the instrumental variable approach. Using a similar approach, Fahlenbrach (2009) estimates an approximately 25.9% higher market valuation for founder-CEO firms using a sample of 2327 publicly listed U.S. firms for the period 1992-2001. My sample (S&P 500), includes 361 different firms for the period 1995-2005 (compared to 321 different firms in Adams et al., 2009), and my sample firms are broadly similar to the sample firms of Adams et al. (2009) in terms of firm characteristics and CEO characteristics. Thus, employing similar specifications as in Adams et al. (2009), I try to replicate their findings in Table 7. Column (1) shows the results of the regression of firm valuation with the proxy of *log (Tobin's Q)* using the baseline specification of Adams et al. (2009). Column (2) shows the results of the specifications that include more firm-specific controls. The coefficients of *Founder Dummy* are quite similar to those of Adams et al. (2009). In the baseline specifications of Adams et al. (2009), founder-run firms are, on average, associated with 15.1% more market valuation. This confirms that findings in the earlier section are not driven by sample selection.

<<<Insert Table 7 about here>>>

4.7.2 Innovation and firm-valuation:

Innovation literature shows that firm value is a positive function of innovation output- both patents and citations. Hall et al. (2005) show that an extra citation per patent boosts market values by 3% for the period 1963-1995 for 4864 publicly traded firms. Because my sample period largely differs from their sample, I attempt to replicate the results of Hall et al. (2005) in Table 8. Columns (1)-(3) show the baseline results of Hall et al. (2005) by running the univariate regressions. Hall et al. (2005) do not cluster standard errors at any level; rather they report heteroskedasticity-consistent standard errors only. Following their specifications, columns (1)-(3) report heteroskedasticity-consistent standard errors only although in later specifications, I cluster standard errors at the firm level in columns (7)-(14). Hall et al. (2005) also include only six different industry dummies in a later section of their analysis. I include industry dummies at two-digit SIC level.

The coefficient estimates show that my findings are broadly consistent with findings of Hall et al. (2005) although coefficient estimates are different. Notably, among the innovation outputs, the coefficient of *Citations/patents* (*average citation)* is positive and significant even after using industry-fixed effects and firm-level clustering in column (14). Although in the baseline replication in columns (1)-(3), the coefficients of all proxies for firm knowledge stock are positive and significant, results indicate that *average citations* (citations/patents) is an important determinant of firms' market value alongside R&D investments.

<<<Insert Table 8 about here>>>

The replication of Adams et al. (2009) in my sample shows that founder-run firms are valued more highly by the market than non-founder-run firms. Again, the replication of Hall et al. (2005) shows that firms' innovations are valued, on average, positively by the market. However, my baseline results document that founder-run firms average less innovation measured by the number of patents filings and forward citations received by these patents. They also spend disproportionately highly on R&D investments compared with their non-founder-run counterparts. This leads to the intriguing question of - why less innovative founder-run firms are valued highly by the market. Potential alternative answers may include the following:

1. Patent and citations level data may not fully capture or reflect the firm innovation productivity and innovation efficiency especially because patent level data are only reflective of successful innovations, and / or
2. The higher valuation of founder-run firms derives from non-innovation-related factors such as, value-enhancing mergers and acquisitions, and / or
3. Innovations of founder-run firms are appreciated more heavily by the market than innovations of non-founder-run firms. Although founder-run firms have lower levels of innovation output, the market values these innovation outputs disproportionately higher than the market values the innovations of non-founder-run firms, and thus, on balance, founder-run firms enjoy higher valuation from innovation outputs.

Among the above-mentioned plausible answers to this puzzle, the first one is not directly testable. The patent database of NBER is thus far the most utilized dataset for innovation outputs. As noted by Griliches ((1998), PP. 336)

"*In spite of all the difficulties, patent statistics remain a unique resource for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and the potential industrial, organizational and technological detail*."

Regarding the second possible answer, Fahlenbrach (2009) makes an attempt but does not provide any conclusive evidence that founder-run firms are better acquirers and suggests further investigation into the issue.

In my setup, the third possibility is directly testable. I split the entire sample into two subsamples: the founder-CEO sample and non-founder-CEO sample. For both sub-samples, I run the regressions of *log (Tobin's Q)* on innovation output measures-*patents, average citation, and HJT-adjusted citations* with other relevant controls that have been used in the literature for market value (Q) regressions. I also control for innovation inputs: R&D intensity. Table 9 reports the results of this section, the regressions of firm valuation *Log (Tobin's Q)* on the different measures of knowledge stocks. Columns (1)-(3) show the regressions for the founder-CEO sample and columns (4)-(6) show the results for the non-founder-CEO sample.

<<<Insert Table 9 about here>>>

In the founder-CEO sample, the coefficients of *log (1+Patents)* show that a 1% change in patents leads to an average increase in Tobin's Q of 0.056% compared with a 0.04% increase in Tobin's Q in the non-founder-CEO sample. However, the effect of the *log (1+ Average citation)* measure is remarkably different on firms' market valuation. The coefficient estimates suggests that a 1% change in *Citations per patent* or *average citations* boosts market valuation by 0.139% for the founder-CEO sample but only 0.042% for market valuation in the non-founder-CEO sample. This pattern is similar when using adjusted citations as the measure of a firm's innovations although the magnitude is much less pronounced.

Although the magnitude of these different effects of innovation outputs on firms' market valuation suggests that founder-run firms have higher market valuation than non-founder-run firms because of innovation output, these point estimates may be misleading. To achieve a more valid and direct comparison, I use interactions of *Founder Dummy* with each measure of innovation outputs on firm valuation and report the results in Table 10. Columns (1)-(3) report the results of the regressions of the firm valuation on each measure of innovation output for the full sample. Column (4) shows the results of the regression involving the interaction of *Founder Dummy* with the patents. The coefficient of the interaction term is not significant, both economically and statistically, suggesting that founder-CEOs are not creating value by *number of patents*.

<<<Insert Table 10 about here>>>

However, the result of the regression in column (5) shows that the interaction term (*founder-dummy*log (1+ Average citations))* is highly significant and that the magnitude is economically meaningful. Founder-run firms are enjoying greater market valuation than non-founder-run firms because of the *average citation variable,* which has also been observed to be the most important measure of innovation output for explaining a firm's market valuation (Hall et al., 2005). For founder-run firms, a 1% change in *average citations* increases Tobin's Q by 0.103%[14], which is economically meaningful and statistically significant.

The coefficient of *log (1+ Average citation)* has subsumed all of the valuation effect of innovation output. For the founder-run firms, the coefficient also suggests that patenting activity, by itself, may not create value if the patents are not groundbreaking discoveries as opposed to incremental technological improvements. Market value increases if firms file patents that accumulate higher average forward citations, indicative of the groundbreaking nature of these discoveries.

As a robustness check, I have re-run these regressions in the extended sample that includes the financial firms and the regulated utilities. Untabulated regressions show pattern quite similar to the coefficients of Table 10 although the coefficients are a bit less pronounced. The coefficient estimate of interaction term *(founder-dummy*log (1+ Average citation)* is both economically and statistically significant.

[14] The mean value of *log (1+ average citation)* is 0.7244.

A plausible reason why patents of firms with founder-CEOs are more valuable could be that founder-CEOs are more prudent with regard to patent applications. The number of patents granted to a firm may be considered an objective measure of value creation of that firm and thus a firm may consider patent generation an end in itself. I argue that this is more applicable for firms with non-founder-CEOs, for whom information asymmetry may be more relevant. Non-founder-CEOs may also find patent generation more useful as an objective indicator of their own performance with regard to bargaining their compensation packages.

However, founder-CEOs have relatively less career concerns than hired managers. They may decide to file patents only when they believe that their ideas must be protected because of the real potential of this innovation to add value to the firm. Furthermore, a close affinity of the founders with their firms because of their long tenure as CEOs (since founding) may help them distinguish groundbreaking discoveries that require patenting from mere technological improvements. They may gauge the differential technological effects that patents may engender more accurately and thus file only those patents that have the potential to be value-enhancing. However, hired or professional managers, because of their career concerns or short-termism, may view patent filings as an intermediate indicator of performance. This may encourage them to patent anything indiscriminately.

Conclusion

In this study, I examine the effect of founder-CEOs on firm innovations from the perspective of both input and output. From the innovation output perspective, the results of the study indicate that using count-based measures of innovations such as number of patent filings and subsequent forward citations received by the patents lead to founder-run firms' showing low innovation productivity and efficiency, a finding that is contrary to the popular perception of the creativity of the founder-CEOs. From an input perspective, founder-run firms appear to be putting more resources into innovation, the return of which is inherently highly skewed, indicating that founder-CEOs are not 'enjoying the quiet life' or that they are not inexorably entrenched. Divergence in findings regarding these two perspectives has potential value implications for shareholders, because founder-CEOs may be aggrandizing their self-notion of creativity by expropriating shareholders' wealth.

Testing the value creation (or destruction) of founder-CEOs by innovation indicates that founder-CEOs are creating value for the shareholders by innovation. The market greets the innovations of founder-run firms more favorably than the innovations of non-founder run firms, perhaps because of the less-pronounced agency issues in founder-run firms. In addition, the incremental valuation in founder-run firms stem from an *average citation* variable, which the innovation literature considers to be more value-enhancing.

This finding helps to identify a probable channel-innovation that may bridge the gap, at least partially, in the founder-CEO literature that documents a positive founder premium.

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Appendix-1: Definitions of variables

Variable	Definition
Capital expenditure/Asset	Capital expenditure scaled by Asset.
CEO age	Age of CEO in years.
CEO-Chair dummy	Dummy equal to one if CEO is also the Chairman of the board.
CEO Equity pay	Value of annual option pay divided by the sum of salary, bonus and annual option pay.
CEO ownership	Ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding.
CEO Tenure	Tenure of CEO measured in years.
Citation	Total number of citation counts of all patents applied for during the year.
Citations per patent	Total citations in year / total patents in a year.
Classified board	Dummy variable taking the value one when the firm has a classified board.
Dead founder dummy	Average of an indicator variable that takes the value of 1 if a given founder is dead as of 2005 and zero otherwise.
Dual class stock	Dummy variable taking the value one if the firm has issued a dual class voting stock.
Firm Size	Natural log of book value of Asset of the firm.
Founder Dummy	Equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm.
HJT-weighted Citation	number of citations earned by each patent is multiplied by the weighting index
Leverage	(Long-term debt+ Short-term debt)/Total assets.
Log (1+Avg citations)	Log (1+ (total citations in a year / Total patents in a year)).
Log (Tobin's Q)	Natural log of Q defined as (book value of assets-book value of equity +market value of equity) /book value of assets.
Number of founders	Number of original founders of the firms.
Patent	Number of patents applied for during the year.
Patents/R&D	Number of patents/ R&D expenditure

R&D/Asset	Research and development expenditures scaled by total assets.
ROA	Ratio of net income before extraordinary items and discontinued operations to book value of assets.
Sales growth	One year growth rate of sales.
Stock return	Compounded monthly stock returns over the fiscal year.
Tobin's Q	(Book value of assets-book value of equity +market value of equity) /book value of assets
Volatility	Black–Scholes volatility as reported in ExecuComp.

Table-1: Summary statistics- firm characteristics, CEO characteristics, governance variables & innovation outputs

The Initial sample consists of S&P 500 firms from the year 1995 to 2005. To be included in the final sample, firms are required to have financial and stock price data from Compustat and CRSP, respectively, and patent data from the NBER patent dataset. This table presents the summary statistics on firm characteristics, CEO characteristics and innovation. All statistics are firm-level averages. Panel-A presents statistics on Non-founder CEO sample which includes 250 different firms (based on different GVKEY). Panel B presents summary statistics on the Founder CEO sample which includes 111 different firms where founder(s) has (have) been the CEO in any of the sample years. Panel C presents the same for Full sample which include 361 different firms. The patent data is from the NBER patent dataset, Edition 2006. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted Citation*. *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the natural log of book value of Asset of the firm. *Tobin's Q* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *Leverage* is defined as (long-term debt+ Short-term debt) /Total assets. *Sales growth* is one year growth rate of sales. *Stock return* is the compounded monthly stock returns over the fiscal year. *Capital expenditure/Asset* is Capital expenditure scaled by Asset. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO ownership* is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. *CEO-Chair dummy* is a dummy equal to one if CEO is also the Chairman of the board. *CEO Tenure* is the tenure of CEO measured in years. *CEO age* is the age of CEO in years. *Classified board* is a dummy variable taking the value one when the firm has a classified board. *Dual class stock* is a dummy variable taking the value one if the firm has issued a dual class voting stock. *Citations per patent* is (total citations in year / total patents in a year). *Number of founders* is the number of original founders of the firms. *Dead founder dummy* is the average of an indicator variable that takes the value of 1 if a given founder is dead as of 2005 and zero otherwise.

	Mean	Median	SD	Min	Max	t-test diff
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel-A: Non-Founder CEO sample						
R&D/Assets	0.032	0.011	0.048	0.000	0.605	
R&D/Assets(Missing values are Not coded with zero)	0.045	0.028	0.052	0.000	0.605	
Firm size	14.763	5.257	42.331	0.037	750.507	
Tobin's Q	2.482	1.929	1.962	0.513	37.772	
Volatility	0.352	0.315	0.156	0.119	1.266	
Leverage	0.191	0.178	0.137	0.000	1.596	
Sales growth	11.546	7.988	33.319	-77.473	865.339	
Stock return	18.003	12.801	49.924	-89.973	1304.094	
Capital Expenditure/Asset	0.056	0.046	0.040	0.000	0.380	
CEO ownership	0.569	0.097	1.953	0.000	24.308	
CEO Equity pay	0.255	0.000	0.338	0.000	1.000	
CEO-Chair dummy	0.307	0.000	0.461	0.000	1.000	
CEO tenure	5.453	4.000	5.766	0.000	38.000	
CEO age	55.180	55.000	6.542	35.000	83.000	
Classified Board	0.573	1.000	0.495	0.000	1.000	
Dual class stock	0.079	0.000	0.270	0.000	1.000	
Patents	72.677	3.000	252.824	0.000	4302.867	
Raw citations	365.380	1.000	1926.881	0.000	45559.000	
HJT-weighted citations	1600.460	168.374	5874.302	0.000	104907.200	
Citations per patent	2.457	0.113	5.004	0.000	68.000	
Number of founders	1.333	1.000	1.020	0.000	8.000	
Dead founder dummy	0.621	1.000	0.476	0.000	1.000	

Panel-B: Founder CEO sample						
R&D/Assets	0.048	0.018	0.065	0.000	0.472	-7.34
R&D/Assets(Missing values are NOT coded with zero)	0.070	0.055	0.068	0.000	0.472	-9.02
Firm size	5.429	2.878	9.831	0.045	208.504	5.92

Table-1 (Continued….)

Variables	Mean	Median	SD	Min	Max	t-test diff
	(1)	(2)	(3)	(4)	(5)	(6)
Tobin's Q	3.948	2.570	6.040	0.732	105.090	-11.08
Volatility	0.473	0.424	0.192	0.190	1.198	-17.36
Leverage	0.133	0.109	0.130	0.000	0.758	10.17
Sales growth	32.760	18.400	74.629	-66.029	1299.340	-11.52
Stock return	43.068	22.613	102.497	-89.572	867.347	-9.46
Capital Expenditure/Asset	0.066	0.048	0.058	0.000	0.429	-5.60
CEO ownership	4.057	0.611	7.945	0.000	53.507	-21.55
CEO Equity pay	0.261	0.000	0.384	0.000	1.000	-0.38
CEO-Chair dummy	0.296	0.000	0.457	0.000	1.000	0.55
CEO tenure	15.380	13.500	11.346	0.000	64.000	-33.42
CEO age	55.406	56.000	8.973	30.000	83.000	-0.77
Classified Board	0.555	1.000	0.497	0.000	1.000	0.90
Dual class stock	0.117	0.000	0.322	0.000	1.000	-3.34
Patents	51.581	1.000	150.504	0.000	1200.333	2.17
Raw citations	386.250	0.000	1464.064	0.000	12745.000	-0.27
HJT-weighted citations	1907.631	219.468	4584.432	0.000	26728.660	-0.98
Citations per patent	3.962	0.000	9.239	0.000	88.000	-6.01
Number of founders	1.697	2.000	1.572	0.000	9.000	-7.68
Dead founder dummy	0.170	0.000	0.348	0.000	1.000	24.12
Panel-C: Full sample (361 different firms)						
Founder Dummy	0.196	0.000	0.397	0.000	1.000	
R&D/Assets	0.035	0.012	0.052	0.000	0.605	
R&D/Assets(Missing values are NOT coded with zero)	0.050	0.031	0.056	0.000	0.605	
Firm size	12.930	4.611	38.373	0.037	750.507	
Tobin's Q	2.771	2.000	3.255	0.513	105.090	
Volatility	0.375	0.332	0.170	0.119	1.266	
Leverage	0.179	0.168	0.137	0.000	1.596	
Sales growth	15.707	9.212	45.326	-77.473	1299.340	
Stock return	22.848	14.391	64.317	-89.973	1304.094	
Capital Expenditure/Asset	0.058	0.046	0.045	0.000	0.429	
CEO ownership	1.252	0.115	4.163	0.000	53.507	
CEO Equity pay	0.257	0.000	0.347	0.000	1.000	
CEO-Chair dummy	0.305	0.000	0.460	0.000	1.000	
CEO tenure	7.398	5.000	8.213	0.000	64.000	
CEO age	55.224	56.000	7.083	30.000	83.000	
Classified Board	0.569	1.000	0.495	0.000	1.000	
Dual class stock	0.086	0.000	0.281	0.000	1.000	
Patents	68.545	3.000	236.428	0.000	4302.867	
Raw citations	369.468	1.000	1845.229	0.000	45559.000	
HJT-weighted citations	1654.028	175.923	5670.808	0.000	104907.200	
Citations per patent	2.752	0.070	6.099	0.000	88.000	
Number of founders	1.404	1	1.157	0	9	
Dead founder dummy	.532	1	.487	0	1	

Table-2: Effect of Founder-CEO status on firm innovation outputs

The table presents results of regressing quantity and quality of firm innovation on *Founder Dummy*. The patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted citation* variable. *Citations per patent* is defined as (Total citations in a year / Total patents in a year). *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is the natural log of Q defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Capital expenditure/Asset* is Capital expenditure scaled by Asset. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-stats are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Dependent variables							
	log (1+Patents)	log (1+Citations)	log (1+HJT-weighted citation)	Citations per patent	log (1+Patents)	log (1+Citations)	log (1+HJT-weighted citation)	Citations per patent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Founder Dummy	-0.540***	-0.593***	-0.700***	0.501	-0.286**	-0.374**	-0.451**	0.228
	(-3.04)	(-2.83)	(-2.79)	(1.14)	(-2.08)	(-2.21)	(-2.20)	(0.57)
R&D/Asset					8.222***	9.640***	11.541***	14.741***
					(4.87)	(4.69)	(4.61)	(3.39)
Firm Size					0.918***	0.951***	1.117***	0.304***
					(14.15)	(13.47)	(12.84)	(2.82)
Log (Tobin's Q)					0.305***	0.483***	0.625***	1.341***
					(3.07)	(4.18)	(4.50)	(4.73)
Capital Expenditure/Asset					1.026	0.857	-0.225	-0.543
					(0.59)	(0.39)	(-0.09)	(-0.12)
Constant	0.378***	1.591***	1.451***	5.580***	-1.143***	-0.063	-0.416	4.405***
	(2.70)	(7.86)	(4.23)	(9.64)	(-5.85)	(-0.25)	(-1.14)	(7.00)
Year-Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Number of Obs.	3737	3737	3737	3737	3712	3712	3712	3712
Adjusted R^2	0.483	0.501	0.495	0.277	0.649	0.617	0.612	0.304

Table-3: Effect of Founder-CEO status on firm innovation outputs- other robustness tests

The table presents results of regressing quantity and quality of firm innovation on *Founder Dummy*. The patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted citation* variable. *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is the natural log of Q defined as (book value of assets-book value of equity +market value of equity) /book value of assets *Capital expenditure/Asset* is Capital expenditure scaled by Asset. Column (1) and (2) show the results of regressions using firm-fixed effects. Column (3) and (4) show results of regressions using CEO level clustering of standard error. Column (5) and (6) show results of regressions of lagging the independent variables for one year. Column (7) and (8) show the results of regressions without firm-year observations of year 2005. All regressions include year, industry (based on two digit SIC code) and firm-fixed effects as indicated. Standard errors are clustered at the indicated level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable							
	log (1+Patents)	**log (1+HJT-weighted citation)**	**log (1+Patents)**	**log (1+HJT-weighted citation)**	**log (1+Patents)$_{t+1}$**	**log (1+HJT-weighted citation)$_{t+1}$**	**log (1+Patents)**	**log (1+HJT-weighted citation)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Founder Dummy	-0.195**	-0.345*	-0.286**	-0.451**	-0.237*	-0.378*	-0.255*	-0.416*
	(-2.39)	(-1.73)	(-2.00)	(-2.17)	(-1.72)	(-1.87)	(-1.79)	(-1.93)
R&D/Asset	1.865*	4.004*	8.222***	11.541***	7.777***	11.258***	8.338***	12.094***
	(-1.92)	(-1.7)	(4.87)	(4.61)	(-4.56)	(-4.55)	(-4.77)	(-4.52)
Firm Size	0.493***	0.845***	0.918***	1.117***	0.920***	1.108***	0.955***	1.183***
	(-5.46)	(-4.97)	(14.15)	(12.84)	(-13.95)	(-12.74)	(-14.2)	(-12.74)
Log (Tobin's Q)	0.072	0.406***	0.305***	0.625***	0.358***	0.611***	0.319***	0.658***
	(-1.28)	(-3.54)	(3.07)	(4.50)	(-3.61)	(-4.53)	(-3.11)	(-4.49)
Capital Expenditure/Asset	0.479	0.708	1.026	-0.225	0.684	-0.529	1.014	-0.406
	(-0.75)	(-0.52)	(0.59)	(-0.09)	(-0.39)	(-0.21)	(-0.57)	(-0.15)
Constant	3.270***	5.939***	-1.143***	-0.416	-1.145***	-0.361	-1.265***	-0.678
	(-21.96)	(-18.28)	(-5.85)	(-1.14)	(-5.66)	(-1.03)	(-5.94)	(-1.62)
Year-Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	N	N	Y	Y	Y	Y	Y	Y
Firm-Fixed effects	Y	Y	N	N	N	N	N	N
Clustering-level	Firm	Firm	CEO	CEO	Firm	Firm	Firm	Firm
Number of Obs.	3712	3712	3712	3712	3367	3367	3370	3370
Adjusted R^2	0.904	0.813	0.649	0.612	0.645	0.606	0.654	0.62

Table-4: Effect of Founder-CEO status on firm innovation output: omitted CEO characteristics, firm characteristics and corporate governance variables

The table presents results of regressions of firm innovation on *Founder Dummy*. Patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted citation* variable. *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Capital expenditure/Asset* is Capital expenditure scaled by Asset. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *Leverage* is defined as (long-term debt+ Short-term debt) /Total assets. *Sales growth* is one year growth rate of sales. *Stock return* is the compounded monthly stock returns over the fiscal year. *ROA* is the ratio of net income before extraordinary items and discontinued operations to book value of assets. *CEO-Chair dummy* is a dummy equal to one if CEO is also the Chairman of the board. *CEO age* is the age of CEO in years. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO ownership* is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. *Classified board* is a dummy variable taking the value one when the firm has a classified board. *Dual class stock* is a dummy variable taking the value one if the firm has issued a dual class voting stock. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Independent variables							
	log (1+Patents)				**log (1+HJT-weighted citation)**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Founder Dummy	-0.354**	-0.283*	-0.277**	-0.330**	-0.522**	-0.466**	-0.433**	-0.498**
	(-2.43)	(-1.96)	(-2.00)	(-2.15)	(-2.39)	(-2.21)	(-2.10)	(-2.21)
R&D/Asset	8.409***	6.831***	8.067***	6.746***	11.635***	9.360***	11.275***	9.091***
	(4.97)	(3.82)	(4.76)	(3.76)	(4.64)	(3.54)	(4.50)	(3.43)
Firm Size	0.913***	0.942***	0.912***	0.932***	1.109***	1.152***	1.107***	1.133***
	(13.89)	(14.61)	(14.02)	(14.34)	(12.57)	(13.35)	(12.64)	(12.91)
Log (Tobin's Q)	0.305***	0.372***	0.296***	0.377***	0.596***	0.673***	0.609***	0.651***
	(3.10)	(3.12)	(3.00)	(3.18)	(4.36)	(3.99)	(4.42)	(3.92)
Capital Expenditure/Asset	0.921	0.970	1.089	0.964	-0.382	-0.255	-0.118	-0.263
	(0.53)	(0.54)	(0.63)	(0.55)	(-0.15)	(-0.10)	(-0.05)	(-0.10)
CEO-Chair dummy	0.170*			0.205**	0.173			0.226*
	(1.86)			(2.16)	(1.30)			(1.65)
CEO age	0.000			-0.001	-0.003			-0.003
	(0.07)			(-0.08)	(-0.26)			(-0.30)
CEO Equity pay	0.013			0.015	0.128			0.118
	(0.13)			(0.15)	(0.84)			(0.80)
CEO ownership	0.016			0.011	0.019			0.012
	(1.19)			(0.93)	(0.96)			(0.63)
Stock return		-0.001*		-0.001**		-0.001		-0.001

Table-4 (continued…)

	log (1+Patents)				log (1+HJT-weighted citation)			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
		(-1.92)		(-2.07)		(-1.15)		(-1.26)
leverage		-0.741*		-0.728*		-1.102*		-1.080*
		(-1.83)		(-1.83)		(-1.83)		(-1.82)
Volatility		0.891**		0.935**		1.403**		1.417**
		(2.09)		(2.16)		(2.27)		(2.28)
ROA		0.001		0.001		0.002		0.001
		(0.39)		(0.31)		(0.35)		(0.28)
Sales Growth		-0.005***		-0.005***		-0.006***		-0.006***
		(-5.52)		(-5.46)		(-4.25)		(-4.26)
Classified Board			-0.165	-0.146			-0.274	-0.254
			(-1.34)	(-1.20)			(-1.58)	(-1.48)
Dual class stock			-0.078	-0.123			-0.172	-0.202
			(-0.47)	(-0.74)			(-0.66)	(-0.78)
Constant	-1.320***	-1.149***	-1.047***	-1.208**	-0.389	-0.460	-0.240	-0.279
	(-3.00)	(-3.56)	(-4.65)	(-2.26)	(-0.55)	(-0.91)	(-0.69)	(-0.37)
Year-Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Number of Obs.	3712	3568	3712	3568	3712	3568	3712	3568
Adjusted R^2	0.651	0.660	0.650	0.662	0.612	0.620	0.613	0.622

Table-5: Effect of Founder-CEO status on firm innovation output: Two stage least squares (2SLS) Instrumental Variable (IV) approach

The table presents results of Instrumental variable regressions of firm innovation on *Founder Dummy* instrumented by *Number of founders* and *Dead founder dummy*. *Number of founders* is the number of original founders of the firms. *Dead founder dummy* is the average of an indicator variable that takes the value of 1 if a given founder is dead as of 2005 and zero otherwise. The patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database. *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Capital expenditure/Asset* is Capital expenditure scaled by Asset. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *Leverage* is defined as (long-term debt+ Short-term debt) /Total assets. *Sales growth* is one year growth rate of sales. *Stock return* is the compounded monthly stock returns over the fiscal year. *ROA* is the ratio of net income before extraordinary items and discontinued operations to book value of assets. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO-Chair dummy* is a dummy equal to one if CEO is also the Chairman of the board. *CEO age* is the age of CEO in years. *Classified board* is a dummy variable taking the value one when the firm has a classified board. *Dual class stock* is a dummy variable taking the value one if the firm has issued a dual class voting stock. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	1st Stage			2nd stage					
	Founder Dummy			Log (1+Patents)			log (1+HJT-weighted citation)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Founder Dummy: Instrumented by Number of founders	-	-	-	-1.997***	-	-	-3.287***	-	-
				(-2.64)			(-2.88)		
Founder Dummy: Instrumented by Dead founder dummy	-	-	-	-	-2.126***	-	-	-2.873***	-
					(-7.90)			(-6.88)	
Founder Dummy: Instrumented by both Number of founders and Dead founder dummy	-	-	-	-	-	-1.371***	-	-	-1.696**
						(-2.59)			(-2.43)
Number of founders	0.034**	-	0.055***	-	-	-	-	-	-
	(2.16)		(3.72)						
Dead founder dummy		-0.226***	-0.253***	-	-	-	-	-	-
		(-5.85)	(-6.40)						
R&D/Asset	-0.473	-0.523	-0.623	7.615***	5.910***	6.207***	10.561***	8.013***	8.500***
	(-1.16)	(-1.24)	(-1.55)	(6.99)	(5.94)	(3.34)	(6.06)	(5.14)	(3.17)
Firm Size	-0.034**	-0.021	-0.024*	1.004***	0.874***	0.901***	1.251***	1.056***	1.093***
	(-2.31)	(-1.56)	(-1.76)	(25.05)	(30.12)	(13.41)	(20.29)	(24.22)	(12.37)

Table-5 (continued……)

	1st Stage			2nd stage					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Log (Tobin's Q)	0.090**	0.078**	0.054	0.169*	0.561***	0.456***	0.305**	0.890***	0.779***
	(2.52)	(2.24)	(1.59)	(1.72)	(7.78)	(3.30)	(1.98)	(7.99)	(4.11)
Capital Expenditure/Asset	0.511	0.709*	0.568	-0.458	2.129**	1.743	-2.598*	1.266	0.528
	(1.44)	(1.93)	(1.64)	(-0.46)	(2.48)	(1.01)	(-1.66)	(0.94)	(0.21)
Stock return	0.000	0.000	0.000	-0.001**	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.94)	(0.99)	(1.58)	(-2.00)	(-1.38)	(-1.48)	(-1.33)	(-0.80)	(-1.09)
leverage	-0.164	-0.122	-0.104	-0.381	-1.053***	-0.895**	-0.496	-1.501***	-1.309**
	(-1.56)	(-1.25)	(-1.08)	(-1.42)	(-4.88)	(-2.20)	(-1.14)	(-4.32)	(-2.17)
CEO Equity pay	-0.061**	-0.056**	-0.055**	0.135	-0.095	-0.031	0.319**	-0.024	0.041
	(-2.40)	(-2.20)	(-2.31)	(1.46)	(-1.23)	(-0.28)	(2.19)	(-0.21)	(0.26)
CEO-Chair dummy	0.101***	0.115***	-0.003	-0.020	0.400***	0.048	-0.148	0.480***	0.360**
	(2.93)	(3.34)	(-0.11)	(-0.22)	(6.45)	(0.49)	(-1.00)	(5.05)	(2.30)
CEO age	0.005**	0.006**	0.007***	-0.012**	0.009**	0.008	-0.022**	0.009	0.003
	(2.01)	(2.52)	(3.05)	(-2.06)	(2.15)	(0.98)	(-2.42)	(1.39)	(0.24)
Volatility	0.702***	0.482***	0.446***	-0.632	2.216***	1.619***	-1.157	3.099***	2.286***
	(4.94)	(3.38)	(3.17)	(-1.09)	(6.79)	(2.90)	(-1.30)	(6.29)	(2.92)
ROA	-0.001	-0.001	-0.001	0.003	-0.001	-0.000	0.004	-0.001	0.000
	(-1.10)	(-1.10)	(-1.27)	(1.54)	(-0.24)	(-0.07)	(1.49)	(-0.14)	(0.08)
Sales Growth	0.002***	0.001***	0.001***	-0.008***	-0.002**	-0.003***	-0.012***	-0.002	-0.004***
	(4.22)	(3.73)	(3.75)	(-4.71)	(-2.06)	(-3.13)	(-4.40)	(-1.45)	(-2.64)
Classified Board	0.044	0.043	0.050	-0.243***	-0.075	-0.104	-0.411***	-0.159*	-0.207
	(1.32)	(1.30)	(1.53)	(-3.84)	(-1.36)	(-0.79)	(-3.99)	(-1.88)	(-1.15)
Dual class stock	0.080	0.069	0.072	-0.283***	0.039	-0.013	-0.475***	0.006	-0.086
	(1.43)	(1.27)	(1.28)	(-2.62)	(0.43)	(-0.07)	(-2.76)	(0.04)	(-0.31)
Constant	-0.659***	-0.555***	-0.497***	-0.519	-2.963***	-1.608***	0.168	-3.483***	-1.318
	(-4.20)	(-3.09)	(-2.78)	(-0.95)	(-8.89)	(-2.64)	(0.20)	(-6.87)	(-1.52)
Year-Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of Obs.	3568	3568	3568	3568	3568	3568	3568	3568	3568
Adjusted R^2	0.247	0.303	0.311	0.524	0.575	0.628	0.464	0.557	0.605
F statistic for the 1st stage	31.88	231.17	21.63	-	-	-	-	-	-
Partial R^2	0.0118	0.0711	0.0951	-	-	-	-	-	-

Table-6: Innovation input- R&D investments on Founder-CEO status

The table presents results of regressions of firm Research inputs on instrumented *Founder Dummy*. Columns (1) and (4) use *Number of founder* as the instrument. Columns (2) and (5) use *Dead founder dummy* as the instrument. Columns (3) and (6) use both the instruments. *Number of founders* is the number of original founders of the firms. *Dead Founder dummy is* the average of an indicator variable that takes the value of 1 if a given founder is dead as of 2005 and zero otherwise. *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are (NOT) coded with zero in columns (1)-(3)((4)-(6)). *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Capital expenditure/Asset* is Capital expenditure scaled by Asset. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *Leverage* is defined as (long-term debt+ Short-term debt) /Total assets. *Sales growth* is one year growth rate of sales. *Stock return* is the compounded monthly stock returns over the fiscal year. *ROA* is the ratio of net income before extraordinary items and discontinued operations to book value of assets. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO-Chair dummy* is a dummy equal to one if CEO is also the Chairman of the board. *CEO age* is the age of CEO in years. *Classified board* is a dummy variable taking the value one when the firm has a classified board. *Dual class stock* is a dummy variable taking the value one if the firm has issued a dual class voting stock. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variables= R&D/Assets					
	Missing R&D coded with zero			**Missing R&D NOT coded with zero**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Founder Dummy: Instrumented by Number of Founder	0.059***			0.043***		
	(3.07)			(2.80)		
Founder Dummy: Instrumented by Dead Founder dummy		0.018***			0.020**	
		(2.63)			(2.14)	
Founder Dummy: Instrumented by both Number of Founder and Dead Founder dummy			0.025*			0.028*
			(1.75)			(1.68)
Firm Size	0.003**	0.001*	0.001	0.000	-0.000	-0.000
	(2.44)	(1.77)	(0.86)	(0.14)	(-0.39)	(-0.08)
Tobin's Q	0.020***	0.023***	0.023***	0.019***	0.022***	0.021***
	(5.99)	(9.04)	(4.85)	(4.95)	(7.18)	(3.65)
Capital Expenditure/Asset	0.005	0.031	0.026	0.087**	0.095***	0.092
	(0.20)	(1.53)	(0.67)	(2.56)	(3.07)	(1.61)
Stock return	-0.000***	-0.000***	-0.000***	-0.000**	-0.000**	-0.000**
	(-3.56)	(-3.50)	(-3.54)	(-2.31)	(-2.54)	(-2.46)
leverage	-0.034***	-0.040***	-0.039***	-0.051***	-0.052***	-0.052***
	(-4.93)	(-6.77)	(-3.51)	(-5.79)	(-6.04)	(-3.50)
CEO Equity pay	0.011***	0.008***	0.009**	0.011***	0.009***	0.010**
	(3.96)	(3.54)	(2.54)	(3.43)	(3.12)	(2.29)
CEO-Chair dummy	-0.005**	-0.001	-0.002	-0.005	-0.002	-0.003
	(-1.99)	(-0.73)	(-0.63)	(-1.62)	(-0.95)	(-0.75)
CEO age	-0.001***	-0.001***	-0.001**	-0.001***	-0.001***	-0.001**
	(-4.58)	(-4.05)	(-2.26)	(-4.41)	(-3.78)	(-2.35)
Volatility	0.057***	0.085***	0.079***	0.062***	0.074***	0.070***
	(3.82)	(8.53)	(4.51)	(4.72)	(6.17)	(3.50)
ROA	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-1.38)	(-1.57)	(-1.15)	(-1.46)	(-1.58)	(-1.13)
Sales Growth	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(-3.79)	(-3.85)	(-3.20)	(-5.81)	(-5.35)	(-4.38)
Classified Board	-0.008***	-0.006***	-0.007*	-0.006***	-0.005**	-0.005
	(-4.12)	(-3.94)	(-1.71)	(-2.64)	(-2.39)	(-1.14)
Dual class stock	-0.011***	-0.008***	-0.008	0.001	0.004	0.003
	(-3.43)	(-3.08)	(-1.34)	(0.39)	(1.05)	(0.41)
Constant	0.027*	0.009	0.013	0.030**	0.020	0.024
	(1.86)	(0.87)	**(0.71)**	(2.04)	(1.37)	(1.03)

Table-6 (continued……)

	Dependent Variables= R&D/Assets					
	Missing R&D coded with zero			Missing R&D NOT coded with zero		
	(1)	(2)	(3)	(4)	(5)	(6)
Year-Fixed effect	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y
Number of Obs.	3568	3568	3568	2531	2531	2531
Adjusted R^2	0.333	0.488	0.471	0.417	0.476	0.460

Table-7: Replication of Adams et al. (2009) - firm valuation on Founder-CEO status

The table replicates the results of regressing Log (Tobin's Q) on *Founder Dummy* and other firm and CEO characteristics as in Adams et al. (2009). *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *Firm Size* is the natural log of book value of Asset of the firm. *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. . *Capital expenditure/Asset* is Capital expenditure scaled by Asset. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO ownership* is defined as the ratio of the number of shares owned by the CEO after adjusting for stock splits to total shares outstanding. *CEO Tenure* is the tenure of CEO measured in years. Column (1) shows the baseline replication and column (2) shows replication with some additional controls. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable = Log (Tobin's Q)		
	(1)	(2)
Founder Dummy	0.151**	0.100*
	(2.55)	(1.85)
Firm size	-0.126***	-0.117***
	(-5.60)	(-5.66)
Volatility	-0.266*	-0.639***
	(-1.78)	(-4.35)
CEO ownership	0.017***	0.017***
	(3.32)	(3.90)
CEO Tenure	-0.003	-0.002
	(-1.54)	(-1.00)
CEO Equity pay	0.440***	0.346***
	(12.60)	(10.60)
Capital Expenditure/Asset	-	1.078**
		(2.56)
Sales Growth	-	0.003***
		(4.11)
R&D/Asset	-	3.187***
		(7.11)
Constant	0.812***	0.762***
	(7.41)	(7.73)
Year-Fixed effect	Y	Y
Industry- Fixed effect	Y	Y
Number of Obs.	3593	3593
Adjusted R^2	0.381	0.456

Table-8: Replication of Hall et al. (2005)- firm valuation on different measures of firm knowledge stock

The table replicates the results of Hall et al. (2005). The patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are coded with zero. *Patents/R&D* is defined as (#of patents/ R&D expenditure)). *Citations/Patent* is defined as (total citations in a year / Total patents in a year). *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) / book value of assets. All regressions include year and industry (based on two digit SIC code) fixed effects as specified. Clustering of standard errors is as indicated. Robust *t*-stats are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Dependent variables= Log (Tobin's Q)													
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
R&D/Asset	4.223***	-	-	3.409***	-	-	4.223***	-	-	3.409***	-	-	4.031***	3.173***
	(19.47)			(13.39)			(10.85)			(7.71)			(10.93)	(7.36)
Patents/R&D	-	0.003	-	-	-0.048*	-	-	0.003	-	-	-0.048	-	-0.112**	-0.054
		(0.12)			(-1.93)			(0.06)			(-1.06)		(-2.20)	(-1.17)
Citations/Patent	-	-	0.019***	-	-	0.015***	-	-	0.019***	-	-	0.015***	0.010***	0.011***
			(7.20)			(5.98)			(5.81)			(5.31)	(3.64)	(4.29)
Constant	0.614***	0.769***	0.627***	0.593***	0.609***	0.521***	0.614***	0.769***	0.627***	0.593***	0.609***	0.521***	0.573***	0.535***
	(22.89)	(25.95)	(18.53)	(8.20)	(8.29)	(7.17)	(21.03)	(23.52)	(16.53)	(22.71)	(23.19)	(17.38)	(15.70)	(18.57)
Year-Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry-Fixed effect	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y	N	Y
Firm-level Clustering	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Number of Obs.	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712
Adjusted R2	0.184	0.037	0.069	0.322	0.261	0.277	0.184	0.037	0.069	0.322	0.261	0.277	0.194	0.332

Table-9: Regression of Tobin's Q innovation outputs- sub-sample analysis

The table presents results of regressions of market valuation on firms' innovation outputs. Patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted citation* variable. *Log (1+Avg citations)* is defined as log (1+ (total citations in a year / Total patents in a year)). *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the book value of Asset of the firm. *Log (Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO Tenure* is the tenure of CEO measured by years. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Dependent variable= Log (Tobin's Q)					
	Founder-CEO sample			**Non-founder-CEO sample**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
log (1+Patents)	0.056*	-	-	0.040***	-	-
	(1.71)			(3.27)		
log (1+Average citations)	-	0.139***	-	-	0.042**	-
		(4.40)			(2.27)	
log (1+HJT-weighted citation)	-	-	0.051***	-	-	0.024***
			(3.33)			(3.59)
R&D/Asset	1.121	1.283*	0.965	3.115***	3.354***	3.174***
	(1.31)	(1.78)	(1.21)	(5.47)	(5.85)	(5.60)
Firm Size	-0.219***	-0.192***	-0.223***	-0.128***	-0.102***	-0.120***
	(-4.78)	(-3.98)	(-4.84)	(-6.37)	(-5.52)	(-6.30)
Volatility	-0.572	-0.479	-0.567	-0.706***	-0.690***	-0.710***
	(-1.60)	(-1.36)	(-1.63)	(-3.89)	(-3.78)	(-3.94)
CEO Equity pay	0.323***	0.319***	0.309***	0.383***	0.382***	0.380***
	(3.67)	(3.77)	(3.61)	(11.47)	(11.35)	(11.33)
CEO Tenure	-0.002	-0.001	-0.002	0.002	0.001	0.002
	(-0.39)	(-0.32)	(-0.40)	(0.62)	(0.57)	(0.65)
Constant	2.269***	1.922***	2.257***	1.782***	1.535***	1.696***
	(5.84)	(4.45)	(5.61)	(9.14)	(8.25)	(9.12)
Year-Fixed effect	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y
Number of Obs.	681	681	681	2912	2912	2912
Adjusted R^2	0.448	0.465	0.462	0.428	0.422	0.428

Table-10: Regression of Tobin's Q on innovation outputs-full sample: Interaction of Founder dummy and innovation outputs

The table presents results of regressions of incremental impact of founder CEO status on market valuation of firms through innovations. Patent data is from the NBER patent dataset. Patent is the number of patents applied for during the year. Citation is the total number of citation counts of all patents applied for during the year. To take into account the truncation bias due to the finite length of the sample period, the number of citations earned by each patent is multiplied by the weighting index (Hall et al. (2001)) provided in the NBER patent database to construct the *HJT-weighted citation* variable. *Log (1+Avg citations)* is defined as log (1+ (total citations in a year / Total patents in a year)). *Founder Dummy* is equal to one if the CEO is a founder of the firm or CEO since the founding year of the firm. *R&D/Asset* is Research and development expenditures scaled by total assets. Missing values are coded with zero. *Firm Size* is the book value of Asset of the firm. *Log* (*Tobin's Q)* is defined as (book value of assets-book value of equity +market value of equity) /book value of assets. *Volatility* is the Black–Scholes volatility as reported in ExecuComp. *CEO Equity pay* is calculated by the value of annual option pay divided by the sum of salary, bonus and annual option pay. *CEO Tenure* is the tenure of CEO measured by years. All regressions include year and industry (based on two digit SIC code) fixed effects. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Independent variable= Log (Tobin's Q)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Founder Dummy	-	-	-	0.190***	0.118**	0.152**
				(2.96)	(2.13)	(2.51)
log (1+Patents)	0.045***	-	-	0.039***	-	-
	(3.71)			(3.23)		
Founder Dummy*log (1+Patents)	-	-	-	0.001	-	-
				(0.02)		
log (1+Average citations)	-	0.071***	-	-	0.045**	-
		(4.24)			(2.41)	
Founder Dummy*log (1+Average citations)	-	-	-	-	0.080**	-
					(2.30)	
log (1+HJT-weighted citation)	-	-	0.031***	-	-	0.025***
			(4.63)			(3.74)
Founder Dummy*log (1+HJT-weighted citation)	-	-	-	-	-	0.014
						(0.83)
R&D/Asset	2.552***	2.761***	2.571***	2.741***	2.849***	2.703***
	(5.21)	(5.70)	(5.33)	(5.82)	(6.24)	(5.88)
Firm Size	-0.150***	-0.122***	-0.144***	-0.155***	-0.125***	-0.149***
	(-8.07)	(-6.97)	(-8.13)	(-6.85)	(-5.84)	(-6.85)
Volatility	-0.516***	-0.495***	-0.518***	-0.576***	-0.550***	-0.581***
	(-3.26)	(-3.14)	(-3.30)	(-3.62)	(-3.49)	(-3.70)
CEO Equity pay	0.372***	0.369***	0.367***	0.375***	0.374***	0.370***
	(10.58)	(10.47)	(10.47)	(10.72)	(10.92)	(10.70)

Table-10 (continued…….)

	Independent variable= Log (Tobin's Q)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
CEO Tenure	0.004*	0.004*	0.004*	-0.001	-0.000	-0.000
	(1.70)	(1.75)	(1.79)	(-0.24)	(-0.08)	(-0.16)
Constant	1.888***	1.600***	1.812***	0.945***	0.851***	0.915***
	(10.28)	(8.93)	(10.28)	(9.33)	(8.34)	(9.33)
Year-Fixed effect	Y	Y	Y	Y	Y	Y
Industry- Fixed effect	Y	Y	Y	Y	Y	Y
Number of Obs.	3593	3593	3593	3593	3593	3593
Adjusted R^2	0.425	0.422	0.427	0.423	0.425	0.427