Do Outside CEOs Change Firm Strategy More (or Less) Than Inside CEOs? The Case of Technology Redeployment

Leonardo Kluppel, Jay Anand, and Patel Gbedjemaiho

The Ohio State University

ABSTRACT

Do outside CEOs change firm strategy more (or less) than inside CEOs? This study aims to investigate how and under what conditions outside versus inside CEOs impact innovative strategic change. We begin by observing the fact that there is a commonly held belief in both popular press and research that outside CEOs act as change agents and drive new strategies in firms. Yet, the literature does not offer clear empirical results to support this belief. To close this gap, we compared the change in innovation direction observed in firms lead by outside CEOs versus inside CEOs. We measured the change in R&D direction by calculating the angle between vectors representing the yearly patent portfolio in the technology space. This measure allows us to separate the amount of innovation from the innovation direction. Results from panel data on publicly traded firms in the United States from 1992 to 2017 suggest that outside CEOs are associated with fewer changes in firms' R&D strategic orientations than inside CEOs. These results show that strategic decision-making is context-specific and that it takes some time for outside CEOs to converge to inside CEOs' levels of innovative strategic change.

Keywords:

Change in R&D direction; inside vs. outside CEOs; innovation; technology redeployment

INTRODUCTION

[The initial foundation of the research questions]

Does the executives' successor origin matter in explaining the changes in R&D direction? This is a pressing issue since the share of CEOs hired from outside the organization has increased from 1980 to 2000 by more than 100% (Cummings & Knott, 2018). The literature has recognized the importance of the manager's characteristics on the firm's strategic direction (Hambrick & Mason, 1984; Hambrick D. , 2007), highlighting the influence of CEOs' past experiences (Crossland, Zyung, Hiller, & Hambrick, 2014). More specifically, several studies linked CEO origin with innovation outcomes, generally finding that CEOs hired from outside the firm are associated with less innovative behavior (Balsmeier & Buchwald, 2015) and lower R&D productivity (Cummings & Knott, 2018). Despite finding differences in innovation output, the literature does not show what external CEOs are doing differently than internal hires. This paper aims to fill this gap by looking at the impact of CEO origin on the change in the firm's R&D direction. The results show that external CEOs keep the direction of innovation steadier than inside CEOs. We also show that this effect lasts only in the early years of the CEO stint, suggesting that outside CEOs operate the "innovation rudder" like an insider after a couple of learning years.

[Why this study's research questions are important/interesting and why CEOs matter]

For instance, one interesting argument for why, in general, CEOs should matter in defining new strategic orientations can be drawn from (Cummings & Knott, 2018), which argues the following: "… if CEOs don't matter, then (a) in equilibrium, firms wouldn't have them; or (b) CEOs wouldn't enjoy their 262% wage premium over the next four most highly paid executives in their firm as shown in an unreported analysis of Execucomp salary data." More importantly,

CEOs would matter because they play a critical economic and financial role due to the important discretion that is conferred to them by the separation of ownership and control (Berle & Means, 1932; Williamson, 1964; Jensen & Meckling, 1976; Balsmeier & Buchwald, 2015). For example, Schepker, et al., (2017) note that "… outside CEOs often prefer to bring their own executive teams with whom they have past relationships. These 'change teams' in the upper echelons further strengthen the relationship between outside succession and strategic change." As this discretional power can allow them to directly change the strategic direction of the firm (Schepker, Youngsang, Pankaj, Sherry, & Michael, 2017), untangling the causes and consequences of CEOs' successor origin on certain innovation outcomes, such as the changes in R&D direction, grants a great deal of interest/importance to this study's research questions.

[What gaps is this study's trying to fill?]

Several studies recognized the origin of CEOs as one of the most important top management attributes that determine certain subsequent firm-level outcomes in terms of innovation, performance, and strategic changes (Hambrick D. , 2007; Carpenter, Marta, & Wm, 2004; Balsmeier & Buchwald, 2015; Cummings & Knott, 2018). In their critical review of leader succession, Giambatista, et al., (2005) observed that there is no general theory of the causes and consequences of executives' succession on performance or strategy change. In this respect, they argue that future research should investigate conditions under which different theoretical mechanisms are applicable. Thus, as little is known about how and under what conditions the origin of CEOs' successors (i.e., inside versus outside CEOs) influences the change in their firm's innovation direction, this study's research attempts to fill that gap in the literature.

[Anecdotal evidence: Part 1]

Arguably, CEOs' ability to redefine the R&D orientation can be amplified by the fact that "…outside CEOs often prefer to bring their own executive teams with whom they have past relationships." (Schepker, Youngsang, Pankaj, Sherry, & Michael, 2017). Indeed, some anecdotal evidence supports the assumption that external CEOs affect the firm's R&D direction. For instance, in the early 1990s, IBM was experiencing a tremendous financial hardship and was on the brink of bankruptcy when Lou Gerstner, an outside CEO, was appointed. To save the company from an imminent failure, Gerstner implemented important cuts in the expenses and redeployed resources especially by selling assets Part of IBM's problem was its lack of dynamic capability to reallocate assets and make the organizational changes required to neutralize its threats and take advantage of the opportunities available in its environment (Harreld, Charles, & Michael, 2007). Accordingly, under Gerstner's leadership, the Corporate Investment Fund was established to redeploy resources from existing business units to new initiatives, where Gerstner observed: "We worked very hard at the process of starving the losers and investing in the big bets…" (Harreld, Charles, & Michael, 2007).

[Anecdotal evidence: Part 2]

Moreover, in early February of 2021, Intel ousts its CEO, Robert Swan, over investors' pressure, in part because Intel lost its leadership in producing fast chips. Swan, who was an outsider when he joined Intel in 2016, was replaced by an insider, Patrick Gelsinger, a tech specialist, who has 30 years of work experience at Intel. According to a news report (Don & Steve, 2021), Intel's board likely fired Swan because of its detrimental impact on the firm innovation direction that resulted in significant manufacturing problems which ultimately led to a deterioration of the company's technological competitive advantage. For instance, (Don & Steve, 2021) observed the

following “Mr. Swan, 60, is credited with helping to ease internal squabbling at the company, and spearhead changes aimed at taking Intel into other markets, such as gear for cellular base stations. He also shed ailing businesses, selling a unit that designed wireless chips to Apple and another making a variety of memory chips to SK Hynix.” The board estimated that replacing an outsider with an insider would result in a leadership change that would reverse the detrimental changes that occurred in the innovation direction under Swan’s leadership. Although these two examples are anecdotal facts, they, however, appear to grant support for the leading mechanism conjectured in this study that posits that outside CEOs can directly implement significant changes in the innovation direction of their firms.

[Main contributions of this study]

Even though the core of the design of this investigation is phenomenon-based and primarily empirical, we undertake this study with the hope to contribute to both theory and management practice. To achieve this goal, we combine data from the Compustat, Execucomp, and USPTO databases on 580 U.S. firms from 1992 to 2017. Our results show that compared to inside CEOs, outside CEOs are associated with fewer changes in the innovation direction, all else equal. We extend this baseline result in several ways. We investigate under what conditions one might expect outside CEOs to have a lower influence in defining new strategic orientations for the firm R&D. Our findings suggests that factors such as the lack of in-depth firm-specific R&D knowledge and managerial power may play a role in weakening outside CEOs’ propensity toward innovative strategic change. Other factors such as inventor turnover or the degree of the previous change in strategy were not found to play a significant role in explaining the observed results. Finally, R&D centralization seems to mitigate outside CEOs’ lack of innovative behavior toward change in

strategy. Overall, we found evidence that innovative strategic change is context-specific and it takes some time for outside CEOs to impact firms' R&D orientation.

[Announcing the structure of the paper]

The rest of the paper is organized as follows: In the background section, we cover the literature review, use insight from some previous research to make conjectures about how one might expect CEO successor origin to influence the change in R&D direction. The method section mainly describes the structure of the data that we used and how we constructed the dependent variable of interest. The empirical approach section presents the different estimation techniques that we applied and includes the baseline as well as the extended results. The last section concludes the paper.

BACKGROUND: THE RELATIONSHIP BETWEEN CEOS' SUCCESSOR ORIGIN AND THE CHANGE IN INNOVATION DIRECTION

[Literature review: What explain the difference in CEO successor origin]

Evidence from previous studies suggests that CEOs' successor origin influences firm performance (Bailey & Helfat, 2003; Huson, Malatesta, & Parrino, 2004), and CEO attributes and governance have a strong bearing on innovation (Dechow & Sloan, 1991; Lerner & Wulf, 2007; Gormley, Matsa, & Milbourn, 2013). Indeed, Zhang & Rajagopalan, (2010) argue that "The origin of the CEOs hence can affect their ability to formulate and implement strategic changes, and therefore to influence the relationship between the level of strategic change and firm performance." Evidence from (Crossland, Zyung, Hiller, & Hambrick, 2014) suggests that CEOs with a high

level of career variety are associated with more experimentation and strategic changes than CEO with low-level career variety. The paper describes "CEO career variety" as "… the array of distinct professional and institutional experiences and executive has had before becoming CEO." Additionally, Datta & Guthrie, (1994) suggest that because outside CEOs are believed to have broader perspectives, they are hired when changes are expected (Zhang & Rajagopalan, 2010), and found evidence that the choice of outside CEOs appears to be more likely in light of low firm performance and high growth.

[Extant Research showed how some CEO attributes influence certain R&D outcomes]

Moreover, several previous research investigated the relationship between certain attributes of top managers and R&D. For instance, Barker III & Mueller, (2002) examined the importance of CEO characteristics on R&D spending and found that young CEOs with greater wealth and significant career experience in marketing and/or engineering/R&D are associated with higher R&D spending. Additionally, Talke, et al., (2010) investigated the influence of corporate governance issues, such as top management diversity, on innovation outcomes (i.e., new product portfolio innovativeness) and performance. The empirical results suggest that idiosyncrasies of top managers, measured by task-related top management teams' diversity have a strong bearing on strategic choices in the innovation context, proxied by a firm's focus on innovation fields. Furthermore, a few other studies provide evidence that overconfident CEOs are associated with better innovation outcomes such as investments in R&D, patents and patent citations, and innovative success (Galasso & Simcoe, 2011; Hirshleifer, Low, & Teoh, 2012). For example, Galasso & Simcoe, (2011) studied the relationship between CEOs' revealed beliefs about future performance and standard measures of corporate innovation. The evidence indicates that

overconfident CEOs are associated with higher citation-weighted patents counts, meaning that overconfident CEOs are more likely to change their firm R&D direction.

[Literature review: A nonlinear explanation of how CEO successor origin's influence on strategic change impact performance]

Furthermore, Zhang & Rajagopalan, (2010) analyzed how the relationship between the level of strategic change in the pattern of resource allocation and firm performance differs between outside and inside CEOs. On the one hand, the results suggest that the level of strategic change exhibits an inverted U-shaped relationship with firm performance. On the other hand, both the positive and negative effect of strategic change on firm performance is more important for outside CEOs than for inside CEOs. These later results appear to indicate that compared to inside CEOs, outside CEOs' propensity to implement relatively higher strategic changes has a greater negative impact on firm performance.

[Literature review: A linear explanation of how CEO successor origin's influence on strategic change explains performance]

Additionally, Schepker, et al., (2017) examined the relationship between CEO succession and firm performance from a disruption and adaptation perspective. The study hypothesized ".. inside CEO succession will lead to less strategic change and be more positively related to both short-and-long-term performance, while outside succession will lead to greater strategic change and poorer short-and-long-term performance" and note that "Outside CEOs bring fresh strategic perspectives and new ties to the environment." The evidence from a meta-analysis suggests that CEOs succession is negatively associated with short-run performance and has no impact on long-run performance. However, long-run performance is influenced through strategic change and CEO

successor origin. Results from the study also indicate that compared to inside CEOs, outside CEOs have a negative bearing on long-run performance and are associated with more strategic changes.

[How CEO successor origin is likely to influence the change in R&D direction]

Thus, considering Datta & Guthrie, (1994), and Crossland, et al., (2014) we assume that CEOs' successor origin can be correlated with CEO career variety in the sense that outside CEOs will tend to exhibit higher career variety whereas inside CEOs may exhibit low career verity. Indeed, Zhang & Rajagopalan, (2010) posit the following: "Relative to inside CEOs, outside CEOS can amplify the adaptive effect of strategic change…" and argues that this is because outside CEOs are appointed when changes are expected and also because they come with new insights and skills. Accordingly, consistent with Schepker et al., (2017), we argue that outside CEOs will be associated with more experimentation and strategic changes in the R&D direction of the firm than inside CEOs. Additionally, as outside CEOs may have a broader range of experiences and domains of expertise and are hired when changes are expected (Zhang & Rajagopalan, 2010; Balsmeier & Buchwald, 2015; Crossland, Zyung, Hiller, & Hambrick, 2014; Schepker, Youngsang, Pankaj, Sherry, & Michael, 2017), we assume that they may also be appointed when changes are expected in domains other than innovation (e.g., revenue, advertising, and sale expenses). Thus, we may also expect outside CEOs to be associated with more changes in these areas than inside CEOs.

[Preliminary conclusion/summary]

Overall, we conjecture that compared to inside CEOs, outside CEOs will have a stronger bearing on technology redeployment by changing the strategic orientation of the firm's R&D, all else equal. The most implication of this view is that executive turnover may offer an opportunity for firms to reposition their innovative strategy under certain conditions.

METHODS

Data and Sample

[Describing the sources of the data]

We use data from Execucomp, Compustat, and the USPTO database from 1992 to 2017. To identify CEO origin, we used the Execucomp database to identify CEOs' career histories and individual characteristics. We cross-checked-checked that data with data on the CEO dismissal database made available by Gentry, et al., (Gentry, Harrison, Quigley, & Boivie, 2021) excluding entries classified as mistakes. Furthermore, we performed manual checks on the dataset to ensure its integrity. The final sample includes 944 CEOs and 580 firms.

Measures

Dependent variable

The dependent variable is the change in the firm's yearly innovation direction. To calculate that, we matched USPTO patent applications to firms, we used the link provided by Kogan, et al., (Kogan, Papanikolaou, Seru, & Stoffman, 2017). We then constructed a vector of technology by aggregating the technology classifications in the firm's patents each year. We use the Cooperative Patent Classification technology classification at the subclass level, yielding 638 possible technological classifications.

The change in innovation direction is measured as the soft cosine (Sidorov, Gelbukh, Gómez-Adorno, & Pinto, 2014) between the yearly technology vectors. The soft cosine measure

calculates the angle between vectors[1], aligning with the intuition behind the idea of change in direction. By using this measure, we disentangle the change in innovation intensity (the number of patents) from the directionality of the patent portfolio within each year. Figure 1 illustrates the idea behind our measure. In that figure, there are only two possible technology classifications and two years: T and T+1. The cosine measure captures the cosine of angle α in that figure. Note that the measure is the same if the firm perfectly duplicates its patents on year T+1 (i.e., having a vector (6,6) instead of (3,3) as shown in Figure 1). The soft cosine measure is a cosine measure that accounts for the fact that some technological classifications are closer than others. Thus, the soft cosine measure gives more weight for changes in technologies that are less likely to be observed. More specifically, the soft cosine measure between vectors $\vec{A}$ and $\vec{B}$ is defined as equation (1).

$$Distance(\vec{A},\vec{B}) = 1 - \frac{\sum_{i,j}^{N} s_{i,j} A_i B_j}{\sqrt{\sum_{i,j}^{N} s_{i,j} A_i A_j}\sqrt{\sum_{i,j}^{N} s_{i,j} B_i B_j}} \qquad (1)$$

Where, $s_{i,j}$ is the similarity between technologies *i* and *j*. That similarity is using the proportion of patents including technology classifications *i* that also contain patents with technology classifications *j*, $p_{i,j}$. To make the similarity measure symmetric (i.e., to have $s_{i,j} = s_{j,i}$), we took the average between $p_{i,j}$ and $p_{j,i}$ so that $\frac{p_{i,j}+p_{j,i}}{2} = s_{i,j} = s_{j,i}$.

Following, (Sidorov, Gelbukh, Gómez-Adorno, & Pinto, 2014), $s_{i,j}$ is the "soft similarity" that captures the similarity between features of texts that goes beyond the perfect overlap in spellings. This similarity is identified independently from the Vector Space Model that is traditionally used to find the similarity between two objects displayed as vectors. For instance, in the paper, the

[1] It calculated the angles' cosine but, since the vectors are positive, we can interpret increases in cosine as increases in angle between the vectors.

authors use a simple example of two texts: (1) play, game, (2) player, gamer, where, if a and b are the vectors representing these two texts, these two vectors will be such that $a = [1,0,1,0]$ and $b = [0,1,0,1]$. In this case, the traditional similarity will be zero. However, as the paper argues, these two texts are quite similar.

$\vec{A}, \vec{B}$ are respectively the vectors of technology classifications in years t and t+1. For example, in the technology classification of a given hypothetical firm, if we have:

$A_{2001} = (\text{Tech}_{\text{ClassA01B}} = 20, \text{Tech}_{\text{ClassA01C}} = 5, \text{Tech}_{\text{ClassA01D}} = 30, \dots, \text{Tech}_{\text{ClassY10T}} = 0)$,

$B_{2000} = (\text{Tech}_{\text{ClassA01B}} = 8, \text{Tech}_{\text{ClassA01C}} = 50, \text{Tech}_{\text{ClassA01D}} = 35, \dots, \text{Tech}_{\text{ClassY10T}} = 10)$,

these will be represented by the vectors:

$\vec{A}_{2001} = (20,\ 5, 30, \dots, 0)$,

$\vec{B}_{2000} = (8, 50, 35, \dots, 10)$

where the coordinates represent the frequencies of the technology classifications $\text{Tech}_{\text{ClassA01B}}$, $\text{Tech}_{\text{ClassA01C}}$, $\text{Tech}_{\text{ClassA01D}}$, …, $\text{Tech}_{\text{ClassY10T}}$ of each firm and A_j and B_j are respectively the transposed of the matrices A_i and B_i.

Given that $-1 \leq \text{cosine}(\alpha_{x,y}) \leq 1$, and because the observations on the technology classification are all nonnegative integers, the soft cosine distance measure used in this study will be such that $0 \leq Soft\ Cosine\ distance(\vec{A}, \vec{B}) \leq 1$. We then scale this measure so that 100 is the maximum distance between two vectors.

Insert Figure 1 about here

[The dependent variable's construct validity]

To assess the validity of the dependent variable at the construct level, we estimate the following model $Distance_{it} = \beta_0 + \beta_1 Knowledge\_Stock_{it} + \beta_2 HHI\_Yr_{it} + \beta_3 Low\_Patent\_Count_{it} + \beta_3 LogR\&D_{i(t-1)} + \beta_4 Growth_{i(t-1)} + Firm\_age_{it} + \alpha_i + \gamma_t + \mu_{it}$, where α_i and γ_t are respectively firm fixed effects and time fixed effects and $Firm\_age_{it}$ is a fixed effect for firm age. Results from Table 1 show that distance is negatively related to firms' knowledge stock and growth, positively related to low patent counts, and positively related to R&D expenditure. This implies that firms with high levels of knowledge stock and growth tend to exhibit fewer changes in innovation direction, whereas firms with fewer patents and high R&D expenditure tend to exhibit more changes in innovation direction. The firm age fixed effects (plotted in Figure 2) show that as the firms in our sample age, they tend to exhibit fewer changes in R&D.

Insert Table 1 about here

Insert Figure 2 about here

Independent variable of interest

The main independent variable, *Outside CEO*, is equal to one whenever the CEOs used to be in a different firm at least two years within their appointment to the focal firm, and zero otherwise. Our final sample includes 944 different CEOs, 287 of whom are outside CEOs. This implies that in our sample, from 1992 to 2017, approximately 30% of the new CEOs' appointments

involved outside CEOs. This is consistent with coding from extant research which found that out of the new CEOs appointed, outside CEOs represent between 23% and 32.4% (Murphy & Zabojnik, 2007; Balsmeier & Buchwald, 2015; Cummings & Knott, 2018; Keil, Lavie, & Pavićević, 2021).

Control variables

We use data from the Compustat and USPTO databases to generate controls for Knowledge stock (as measured by the cumulative number of patent citations), low patent counts (dummy equal to one if the firm has less than 5 patents), R&D expenditures, and revenue growth. We also use information from the CEO dismissal data made available by Gentry et al. (Gentry et al., 2021.) to control for reasons for CEO departure, allowing us to proxy for the quality of the match between CEO and firm. The CEO dismissal database provides us with useful information to control for the following reasons for CEO departure: death; illness; dismissed for job performance; dismissed for personal issues; retirement; new opportunity; and other.

The degree of R&D centralization, HHI_Yr_{it}, is based on the inventors' locations as shown on patents' applications. For each patent, the location of all its inventors is plotted on a map. Then, we apply a Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) to calculate the inventor's clusters. The inventors that are classified as noise are deleted from the database. Then, we assigned patents to clusters by calculating the cluster containing the most inventors. In the case of a tie, the cluster of the first inventor was used. Finally, we calculated the yearly Herfindahl index by summing the square of patent shares produced in

each cluster. Thus, higher HHI_Yr_{it} are associated with more centralized patent production each year.

[Description of the final sample]

The final panel data are unbalanced and span over the years 1992-2017 and include 580 U.S. firms and 944 CEOs, 287 of which are outside CEOs. Thus, the sample contains approximately 30% of outside CEOs. As mentioned in the IV section above, the proportion of outside CEOs in our sample is consistent with findings from previous research (Murphy & Zabojnik, 2007; Balsmeier & Buchwald, 2015; Cummings & Knott, 2018; Keil, Lavie, & Pavićević, 2021). The summary statistics of these data are presented in Table 2.

Insert Table 2 about here

EMPIRICAL APPROACH

Results

[Baseline Results]

The baseline results from the fixed effects estimator presented in Table 3 suggest that on average, outside CEOs are associated with *fewer* changes in the R&D direction than inside CEOs, all else equal. The coefficient of the outside CEO variable in the full model is negative (-0.02) and significant. This means that outside CEOs change innovation direction less than CEOs hired from within the firm. If we include in this regression the CEO years of experience in the firm, we can

calculate the change in innovation direction for insiders and outsiders during each year of their tenure. The marginal analysis of this regression is shown in Figure 3. This figure shows that outside CEOs tend to change the innovation direction less than insiders, but that the difference is greater between the years 3 and 7. This should be expected during the earlier years of their terms because CEOs may spend some time establishing new routines and policies to institute a new administration. In the later years, outsiders may become insiders, and thus they should exhibit similar innovative behavior.

Insert Table 3 about here

Insert Figure 3 about here

[Alternative Explanations: Firm Experience and Long Term Impact]

Another way to look at the impact of outside CEOs over time is to divide the CEO tenure into periods and compare how CEOs' origins differ in explaining the change in R&D direction. We chose to divide the tenure into blocks of five years because that is the median firm experience in the sample. In the first period, we excluded the first year of the CEO's tenure to take out the period where CEOs should have little ability to direct innovation. The result of the regression including the blocks of five years periods instead of every year is captured in Figure 4, and it shows that the difference between outsiders and insiders gradually became less important between the fifth and tenth years, and insignificant between the tenth and fifteenth years. This appears to show

that outside CEOs' innovative behavior tends to converge to inside CEOs' within ten to fifteen years.

Insert Figure 4 about here

[Resolving Endogeneity Concerns]

It is known that the choice of CEO is not random, raising endogeneity concerns. To mitigate this issue, we used a propensity score matching estimator, as it is commonly used in literature (Cummings & Knott, 2018). Using the propensity score matching (PSM) model allows us to estimate the average treatment effect of executives who share the same propensity toward exposure to treatment (i.e., Outside CEO) conditional on the observed covariates or control variables. The result for the full model is in Table 4, while the result for the first five-year period is in Table 5. The full model and the first period indicate that the average treatment effect (ATE) of outside CEO is negative (-0.02 and -0.04, respectively) and significant. The other periods show non-significant average treatment effects. These results seem to not only grant support to the baseline results but also, appear to indicate that the difference in executive innovative behavior is slightly higher in the first five years following the turnover (i.e., ATE = -0.04) than the overall difference considering the entire firm experience distribution in the sample (i.e., ATE = -0.02.)

Insert Table 4 about here

Insert Table 5 about here

[Alternative Explanations:: Inventor Quitting]

Many reasons can cause outside CEOs to change innovation direction less than insiders. One possibility is the change in the composition of the R&D teams. Perhaps some inventors are quitting to move to another company given the hiring of an outsider. To investigate this, we created a proxy for the number of inventors that stopped collaborating within a particular firm each year. For each inventor *i* listed in a patent belonging to the firm *f*, we tracked their last patent and compared the year of their last patent y_i with the year of their latest patent that belongs to the firm *f*, y_{if}. We classify inventor *i* as quitting collaboration with firm *f* in year y_{if} if they show up in a later patent that does not belong to the firm, i.e., $y_i > y_{if}$. Once we have the number of inventors quitting, we regress it on outside CEO and the usual control variables. The results of the marginal comparison between outsider and insider CEO are depicted in Figure 5. Although the point estimation for the first period indicates that outside CEOs see more inventors quitting (around five in the first period), the coefficient is not precise. Thus, there is no evidence that the outside CEOs are associated with a decrease in inventors' collaboration over time.

Insert Figure 5 about here

[Alternative Explanations: Tech Expertise]

Another possible mechanism underlying the observed effect of outside CEO and innovation direction is the lack of domain of expertise. Cummings & Knott, (2018) speculate that outside CEOs may lack in-depth firm-specific knowledge. Thus, we conjecture that this may

weaken their ability to set an optimal innovation direction. One response to this uncertainty is to keep the innovation orientation stable by maintaining the status quo (Samuelson & Zeckhauser, 1988). To test that, we use the current CEOs' historical titles from Execucomp and classify them as having tech expertise if they had a title with "tech" on it. We then regress Distance on tech expertise per firm experience and the other control variables. The marginal impact on the innovative strategic change stemming from being an outsider vs insider is displayed in Figure 6. These results show that compared to inside CEOs with no tech expertise, outside CEOs with no tech expertise are slower to implement changes in firms' R&D orientation. However, compared to inside CEOs with tech expertise, outside CEOs with tech expertise are much quicker to exhibit stronger changes in innovation orientation. More specifically, we observe that among the executives with no tech expertise, outside CEOs seem to converge to inside CEOs' level strategic change within fifteen years, whereas among the executives with tech expertise, outside CEOs tend to converge to inside CEOs' level of strategic change within ten years and then implement subsequently stronger and increasing changes in innovation orientation. Overall, these results lend credibility to the idea that the lack of innovative strategic change is due to a lack of R&D expertise.

Insert Figure 6 about here

[Alternative Explanations: Board Membership]

The low level of innovative strategic change associated with outside CEOs can also be explained by their managerial ability to implement new strategies. To investigate this issue, we identified which CEOs were also appointed as board chairman at some point in their career within the focal firm. Such a board membership may carry some political power which may grant more

managerial wherewithal to CEOs seeking to redefine the innovative strategic orientation of the firm. The marginal impact of being a chairman is depicted in Figure 7 (again, the usual control variables are included in the underlying regression). On the one hand, compared to inside CEOs without a chairman position, outside CEOs without a chairman position seem to be less capable of implementing changes in strategy and never converge to inside CEOs' level of strategic change over time. On the other hand, outside CEOs with a chairman position tend to converge to inside CEOs with a chairman position's level of R&D behavior within fifteen years. This evidence suggests that one plausible reason for the lack of innovative strategic change could be the low level of managerial power conferred outside CEOs.

Insert Figure 7 about here

[Additional Explanations: R&D Centralization]

Another corroborating evidence for the link between the decrease in the change in innovation direction and lack of power could be the impact of R&D centralization. Figure 8 shows that the difference between the outside and inside CEOs' innovative strategic change effect is less important in firms with a centralized R&D structure. This result is expected because it should be easier to redefine innovation direction when inventors are co-located. Thus, results from Figure 8 reinforce the results from Figure 7.

Insert Figure 8 about here

[Alternative Explanations: Course Correction]

Another plausible explanation for the lack of strategic change is that too many changes were made just before the new CEO appointment, and therefore, the observed results are just evidence of course correction. To test for that, we computed the average rate of change during three years before the CEO turnover (*Prev_MeanLast3*). The results from that regression are shown in Table 6, showing that the coefficient of the interaction between inside and outside CEOs and the previous change in direction is not significant. Thus, we conclude that there is no evidence that outside CEOs are correcting for large swings in innovation direction made before their terms.

Insert Table 6 about here

[Additional Explanations:: Tech abandonment]

Moreover, from Figures 9.a and 9.b, we observe that the marginal change in innovation direction as a result of an increase in tech abandonment is lower for outside CEOs than for inside CEOs. On the one hand, we note that although inside CEOs' R&D behavior seems to be more important, it is relatively constant over time when it comes to using the increase in tech abandonment as a mechanism for changing innovation orientation. On the other hand, there is more variance in outside CEOs' impact on firms' innovation orientation stemming from an increase in tech abandonment, even though the marginal effect remains largely minimal over time. Overall, these findings appear to suggest that the two types of CEOs appear to use the increase in tech abandonment mechanism very differently to redefine their firms' R&D orientation.

Insert Figures 9 about here

[Additional Explanations: How Does Executives' Focus on Other Strategic Dimensions Differ?]

Considering (Crossland, Zyung, Hiller, & Hambrick, 2014), one can establish that a firm's strategic profile includes the following distinct dimensions: (1) advertising intensity (advertising

expenditure/sales); (2) R&D intensity (R&D expenditure/sales); (3) overhead efficiency (selling, general, and administrative expenses/sales); (4) capital intensity (fixed assets/total employees); (5) plant and equipment newness (net plant and equipment/gross plant and equipment); (6) financial leverage (total debt/shareholder's equity); and (7) corporate strategic change as the year-on-year change in diversification. Indeed, Finkelstein, and Hambrick, (1990) posits the following about the first six strategic dimensions "These dimensions were chosen because (a) they are potentially controllable by top managers; (b) they may have an important effect on firm performance; (c) they are complementary, each focusing on an important but specific aspect of the firm's strategic profile; and (d) they are amenable to data collection and have relatively reliable comparability across firms within and industry" At the conceptual level, these dimensions represent patterns in firms' resource reallocation choices (Crossland et al., 2014.) Additionally, considering Wiersema, and Bantel, (1992), we include the corporate diversification strategy dimension of strategic change that captures changes in firms' diversification positions induced by top management choices (Jacquemin, and Berry, 1979; Palepu, 1985.) The measure of diversification was calculated by applying the entropy measure (Palepu, 1985), which reflects the number, importance, and relatedness of a firm's business units.

We speculate that the observed lack of change in innovation direction may be explained by the fact that outside CEOs' strategic change behavior is more tilted toward these other key dimensions of strategic change. To investigate this alternative explanation, we replicated the aforementioned dimensions of strategic change using the individual dimensions as dependent variables instead of the composite index. Results from these analyses are presented in Tables 7 through 12. Overall, our findings reveal that compared to inside CEOs, as their firm experience increase, outside CEOs tend to make more significant changes in advertising intensity in Time T+6 (Table 7), R&D intensity in Time T, T+1, and T+2 (Table 8), and firms' corporate strategies within seven years of the turnover, i.e., Time T+7 (Table 12.) The results on the other strategic dimensions appear to suggest that outside CEOs still exhibit fewer changes when it comes to inventory levels in Time T+1 and T+3 (Table 11), while the effects on the remaining strategic dimensions, i.e., overhead efficiency (Table 9) and financial leverage (Table 10) are not significant.

Insert Table 7 through 12 about here

[Robuness Check]

Considering the counterintuitive nature of our baseline results, we conducted various robustness checks. First, we examine whether the observed effects will differ between CEOs with short-term tenure (i.e., less than six years) and long-term tenure (i.e., greater than five years.) Results from Figures 10 and 11 suggest that outside CEOs who stayed in office for less than 5 years exhibit significantly more changes than inside CEOs, especially in their fifth year, whereas outside CEOs who stayed for more than five years tend to make fewer changes than inside CEOs. Second, we conducted the same analyses using the other strategic dimensions and except for the R&D intensity and overhead efficiency dimensions, our findings show the same patterns, i.e., short-term outside CEOs are associated with more changes, whereas long-term outside CEOs are associated with inertia (Figures 11 through 20.) Third, we also examine the long-term effect of the changes that occur over time as compared to the first-year level of strategic change in the other dimensions. Our results (not pesented here, but, available upon request) are generally consistent with the results presented in the previous paragraph and support the idea that outside CEOs tend to focus more on making changes in advertising intensity and corporate strategy in Time T+6.

Insert Figures 11 through 20 about here

CONCLUSION

In this study, we examined how CEOs' successor origin explains the change in the R&D direction. From the baseline result, we were able to improve our understanding of how CEOs' successor origin influences innovative strategic orientations in the firm. Inconsistent with previous

theoretical arguments, our results indicate that on average, compared to inside CEOs, outside CEOs tend to make fewer strategic changes in the innovation direction of the firm, all else equal. Meanwhile, consistent with previous research (Argyres & Silverman, 2004; Argyres, Rios, & Silverman, 2020), we find evidence that firms with centralized R&D organizations exhibit more innovative behavior.

Due to the lack of a comprehensive theory on the relationship between CEOs' successor origin and strategic change (Giambatista, W, & Suhaib, 2005), we investigate the conditions under which this finding may be justified. Overall, our findings reveal that change in firm innovative strategy is context-specific and it takes time for outside CEOs to impact firm innovative strategy at the level of inside CEOs. In particular, our findings are consistent with the idea that the lack of in-depth firm-specific R&D knowledge may weaken outside CEOs' ability to redefine the R&D strategic orientations. Additionally, we found evidence that the lack of managerial power could also be one of the reasons why outside CEOs may exhibit lower innovative behavior. Finally, as expected, our results suggest that centralized R&D organizations tend to mitigate the negative effect of outside CEOs on change in strategy.

DISCUSSION

Considering the findings from the multiarmed bandit model of exploration and exploitation (Posen & Levinthal, 2012), Posen & Levinthal argued the following: "… under some conditions, the appropriate response to environmental change is a renewed focus on exploiting existing knowledge and opportunities." Arguably, balancing exploitation and exploration is critical for firm

performance. However, findings from their bandit model of organizational choice suggest that the appropriate response to environmental change is not necessarily a change in strategy toward exploration, but instead, under certain conditions, a change toward exploitation is the best course of action. According, considering the baseline findings from our study, we speculate that the outside CEOs' lack of in-depth firm-specific R&D knowledge combined with the lack of managerial power and potentially other unobserved factors may lead outside CEOs to engage in the exploitation of existing innovation opportunities rather than exploring new opportunities and markets through experimentation or radical shift in strategic orientation.

Moreover, the seminal work by (Penrose, 1959) on the theory of the growth of the firm established the idea that managerial experience represents one of the key determinants of the rate of firm growth. Indeed, Penrose explains that managerial level factors such as their heterogeneity, subjective perception, and learning effect can influence firms' growth strategies. First, from her view of managerial heterogeneity, Penrose observed the following: "there are many examples of firms with vigorous and creative management which have substantially altered their range of products… but there are also many examples of other firms which have not been able to make the required adjustments. In such cases, failure to grow is often incorrectly attributed to demand conditions rather than to the limited nature of entrepreneurial resources." Second, the managerial subjective perception is also believed to play a role in influencing firms' growth strategies. Penrose (1959) suggests that such a subjective perception can influence firm growth and exploration of market opportunities that follow a dynamic process and therefore require a certain sense of managerial imagination and interpretation which can be subjective.

Third, according to the managerial learning effect, Penrose posits firm-specific experiences as critical for identifying growth opportunities as well as implementing growth projects. As a result, she views the process of decision-making and coordination as an outcome of a managerial firm-specific experience. As such, due to the complexity of codifying such a process for newly appointed managers for them to implement, managerial learning is considered "the best way of doing things" dependent on the context (Kor, Mahoney, Siemsen, & Tan, 2016). For example, Kor, et al., (Kor, Mahoney, Siemsen, & Tan, 2016) notes the following: "Executive growth projects also require the knowledge of team members at various management levels (top executives, middle-management, and front-line managers), which are the champions and/or implementers of growth initiatives. Managers with such knowledge can better match employee skills to projects and employees to each other in team settings." This view is consistent with our results which suggest that as outside CEOs' firm-experience increases, so does their impact on advertising intensity, R&D intensity, and corporate strategic change. More importantly, this view also supports one of our main findings which indicates that outside CEOs' ability to make significant changes in innovation direction is greater when they have firm-specific R&D experience.

Furthermore, the notion of time compression diseconomies derived from the theory of capital investment also appears to support our conclusion that firm-specific experience is vital for significant strategic changes to occur. For instance, Dierickx & Cool (Dierickx, & Cool, 1989), observed the following: "... MBA students may not accumulate the same stock of knowledge in a one-year program as in a two-year program, even if all inputs other than time are doubled. In the case of R&D, the presence of time compression diseconomies implies that maintaining a given

rate of R&D spending over a particular time interval produces a larger increment to the stock of R&D know-how than maintaining twice this rate of R&D spending over half the time interval." Accordingly, we posit that the conditions under which outside CEOs are capable of making significant changes in firms' innovation orientation not only depends on R&D specific knowledge and the circumstances in which they are working, but also on Penrose's (1959) managerial level factors (i.e., heterogeneity, subjective perception, and learning effect.)

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TABLE 1
Dependent Variable Construct Validity Test

Change in innovation direction

	(1) Distance
Knowledge_stock	-0.05***
	(0.01)
R&D centralization	0.02
	(0.02)
Less than 5 patents	0.12***
	(0.02)
L.log_xrd	0.02**
	(0.01)
L.growth	-0.0005***
	(0.0001)
_cons	0.39***
	(0.06)
Obs.	4376
R-squared	0.60
Firm FE	YES
Firm age FE	YES

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

TABLE 2
Summary Statistics

	N	Mean	SD	Min	Max
Distance	4854	.20	.24	0	1
OutsideCEO	4854	.27	.44	0	1
departure code	4854	4.62	1.13	1	7
Knowledge stock cit	4854	7.60	2.05	0	13.55
R&D centralization	4854	.67	.42	0	1
Less than 5 patents	4854	.18	.38	0	1
log xrd	4854	4.50	1.87	-4.61	9.41
Growth	4854	.20	4.95	-1	343.32

TABLE 3

Fixed Effect Estimation

Change in Innovation Direction

	(1) Distance	(2) Distance
Departure Code		
Death	Ref Group	Ref Group
Illness	-0.06*	-0.06*
	(0.03)	(0.04)
Performance	-0.03	-0.02
	(0.03)	(0.03)
Personal	0.04	0.04
	(0.04)	(0.04)
Retired	-0.02	-0.02
	(0.03)	(0.03)
New Opportunity	-0.01	-0.0027
	(0.03)	(0.04)
Other	-0.01	-0.0013
	(0.04)	(0.04)
L.log_xrd	0.02*	0.02*
	(0.01)	(0.0094)
L.growth	-0.0001	-0.0001
	(0.0001)	(0.0001)
Executive's Age	0.0015*	0.0015*
	(0.0008)	(0.0008)
Knowledge_sto~t	-0.04***	-0.04***
	(0.01)	(0.01)
R&D centralization	0.03	0.03
	(0.02)	(0.02)
Less than 5 patents	0.11***	0.11***
	(0.02)	(0.02)
OutsideCEO		-0.02*
		(0.01)
_cons	0.32***	0.33***
	(0.07)	(0.07)
Obs.	3873	3873
R-squared	0.61	0.61
Firm FE	YES	YES
Year FE	YES	YES

Standard errors are in parenthesis ***p<0.01, **p<0.05, *p<0.1

TABLE 4

Propensity Score Matching, Full Model

OutsideCEO	Coefficient	Std. err.	z	P>z	[95% conf. interval]	
Departure_code						
Death	Ref Group	0				
Illness	0.02	0.16	.62	0.54	-0.21	0.41

Performance	0.14	0.10	1.52	0.13	-0.04	0.32
Personal	0.13	0.14	.94	0.35	-0.14	0.39
Retired	-0.23	0.08	-2.72	0.01	-0.39	-0.06
New Opportunity	0.46	0.16	2.77	0.01	0.13	0.78
Log_revt	-0.24	0.01	-16.03	0.00	-0.26	-0.21
HHI_Yr	0.10	0.05	1.94	0.05	-0.0013	0.21
Log_xrd	0.10	0.02	6.23	0.00	0.07	0.14
Growth	-0.01	0.03	-0.38	0.70	-0.08	0.05
_cons	0.72	0.12	5.76	0.00	0.48	0.97

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
Unmatched	0.19	0.21	-0.02	0.01	-2.04
ATT	0.19	0.18	0.01	0.01	.77
ATU	0.21	0.17	-0.04	0.01	-3.13
ATE			-0.02	0.01	-2.40

	Off support	On support	Total
Untreated	53	3,433	3,486
Treated	0	1,287	1,287
Total	53	4,720	4,773

TABLE 5

Propensity Score Matching, First Five Years as a CEO

OutsideCEO	Coefficient	Std. err.	z	P>z	[95% conf.	interval]
Departure_code						
Death	Ref Group	0				
Illness	0.05	0.28	.17	0.86	-0.50	0.59
Performance	0.24	0.16	1.52	0.13	-0.07	0.54
Personal	0.0048	0.23	.02	0.98	-0.45	0.46
Retired	-0.18	0.15	-1.26	0.21	-0.47	0.10
New Opportunity	0.34	0.24	1.44	0.15	-0.12	0.81
Log_revt	-0.26	0.02	-11.06	0.00	-0.31	-0.22
HHI_Yr	0.21	0.08	2.48	0.01	0.04	0.38
Log_xrd	0.11	0.03	4.09	0.00	0.06	0.16
Growth	-0.07	0.07	-1.11	0.27	-0.21	0.06
_cons	0.95	0.21	4.43	0.00	0.53	1.37

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
Unmatched	0.18	0.21	-0.03	0.01	-2.17
ATT	0.18	0.20	-0.02	0.02	-1.32
ATU	0.21	0.16	-0.05	0.02	-2.98
ATE			-0.04	0.01	-2.84

	Off support	On support	Total
Untreated	24	1,203	1,227
Treated	0	565	565
Total	24	1,768	1,792

TABLE 6

Course Correction

Variable	Model 1	Model 2
OutsideCEO	-0.026	
Previous innovation ch~e	0.13	0.22
Departure Code		
Death		
Illness	-0.08**	-0.07*
Performance	-0.05**	-0.05***
Personal	-0.09**	-0.09**
Retired	-0.04**	-0.04**
New opportunity	-0.04	-0.07*
Other	-0.03	-0.04
Executive's Age	0.00	0.00
Knowledge_stock_cit	-0.042***	-0.04***
R&D centralization	0.03	0.03
Less than 5 patents	0.12***	0.12***
L1.	0.01	0.01
Growth		
L1.	-0.01	-0.01
Outsider	0.01	
OutsideCEO#		
c.Prev_MeanLast3		
Outsider	-0.20	
Constant	0.40***	0.37***

Legend: * p<.1; ** p<.05; *** p<.01

TABLE 7

Advertising Intensity

	(1) advint_adj	(2) F.advint_adj	(3) F2.advint_adj	(4) F3.advint_adj	(5) F4.advint_adj	(6) F5.advint_adj	(7) F6.advint_adj
0.OutsideCEO	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO	0.000866	-0.00228	0.00188	-0.000496	-0.00119	-0.0123	-0.0235***
	(0.00150)	(0.00343)	(0.00236)	(0.00222)	(0.00431)	(0.00766)	(0.00444)
Firm_experience	-0.0000309	0.0000137	-0.000186	-0.0000796	0.000220	-0.000953	-0.00144**
	(0.0000878)	(0.000136)	(0.000253)	(0.000128)	(0.000144)	(0.000619)	(0.000522)
0.OutsideCEO#c.Firm_experience	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO#c.Firm_experience	-0.000104	0.000198	-0.0000544	-0.000293	-0.0000785	-0.000365	0.00104**
	(0.000165)	(0.000557)	(0.000349)	(0.000471)	(0.000441)	(0.000936)	(0.000469)
growth	0.00107**	0.000900***	-0.00199	0.00574*	-0.00820	-0.00207	0.00227
	(0.000461)	(0.000307)	(0.00316)	(0.00329)	(0.00493)	(0.0103)	(0.00853)
Ownership	-0.00000758	0.0000173	0.000370*	0.000000531	-0.0000953	-0.000365	0.000341
	(0.000233)	(0.000147)	(0.000215)	(0.000379)	(0.000457)	(0.000608)	(0.000866)
age	0.0000156	0.0000572	0.000126	0.000355**	-0.000300	0.00198	0.00328***
	(0.000101)	(0.0000783)	(0.000156)	(0.000150)	(0.000322)	(0.00123)	(0.00108)
salary	-0.00000577*	0.00000981	-0.00000607	0.00000346	-0.0000130	0.0000186	-0.00000973
	(0.00000346)	(0.00000896)	(0.00000449)	(0.00000798)	(0.0000115)	(0.0000185)	(0.0000142)
tdc1	-0.000427	-0.000433	0.000515*	-0.000402	0.000528	-0.000252	0.000346
	(0.000317)	(0.000481)	(0.000304)	(0.000423)	(0.000449)	(0.000485)	(0.000530)
tdc2	0.000712**	-0.000398	0.000199	-0.000199	0.00000286	-0.00109	0.000286
	(0.000288)	(0.000413)	(0.000271)	(0.000399)	(0.000537)	(0.000724)	(0.000455)
log_emp	0.00162	-0.000205	0.00161	0.00363	0.00672	-0.0000647	0.00871
	(0.00121)	(0.00239)	(0.00221)	(0.00301)	(0.00467)	(0.00533)	(0.00536)
_cons	0.00363	0.000955	-0.00508	-0.0177*	0.0155	-0.0915	-0.167***
	(0.00510)	(0.00422)	(0.00794)	(0.00909)	(0.0209)	(0.0625)	(0.0534)
N	417	340	257	182	131	88	54
R^2	0.667	0.702	0.632	0.653	0.628	0.685	0.768

TABLE 8

R&D Intensity

	(1) RDint_adj	(2) F.RDint_adj	(3) F2.RDint_adj	(4) F3.RDint_adj	(5) F4.RDint_adj	(6) F5.RDint_adj	(7) F6.RDint_adj
0.OutsideCEO	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
1.OutsideCEO	-0.0841**	-0.0251	-0.0276**	-0.000442	-0.00596	0.00401	0.00131
	(0.0358)	(0.0170)	(0.0130)	(0.0122)	(0.00865)	(0.0135)	(0.0133)
Firm_experience	-0.00387*	-0.00283*	-0.00279**	-0.000265	-0.000715	-0.00107	0.000159
	(0.00230)	(0.00160)	(0.00122)	(0.000916)	(0.000674)	(0.000797)	(0.000981)
0.OutsideCEO#c.Firm_experience	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
1.OutsideCEO#c.Firm_experience	0.00840*	0.00542*	0.00545**	0.00206	0.00161	-0.000731	-0.00133
	(0.00433)	(0.00301)	(0.00262)	(0.00251)	(0.00172)	(0.00127)	(0.00155)
1.departure_code	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
2.departure_code	-0.0524	-0.0115	-0.0129	-0.0209	-0.0106	-0.0167	-0.0157
	(0.0484)	(0.0236)	(0.0238)	(0.0183)	(0.0166)	(0.0162)	(0.0169)
3.departure_code	-0.0338	-0.0191	-0.0237	-0.0327***	-0.00750	-0.0133	-0.0154
	(0.0352)	(0.0221)	(0.0220)	(0.0104)	(0.00867)	(0.0129)	(0.0130)
4.departure_code	-0.0502	0.000385	-0.0169	-0.00193	0.00554	0.000963	-0.00428
	(0.0407)	(0.0213)	(0.0203)	(0.0147)	(0.0133)	(0.0180)	(0.0157)
5.departure_code	-0.0532	-0.0282	-0.0395***	-0.0309***	-0.0113	-0.0104	-0.0146
	(0.0325)	(0.0174)	(0.0147)	(0.00987)	(0.00717)	(0.0111)	(0.0114)
6.departure_code	-0.132	-0.0913*	-0.0670*	-0.0393**	-0.0270*	-0.0295	-0.0319*
	(0.168)	(0.0518)	(0.0344)	(0.0179)	(0.0160)	(0.0185)	(0.0190)
7.departure_code	-0.0263	-0.0311	-0.0459**	-0.0289**	-0.0378	-0.0557	-0.0775
	(0.0453)	(0.0220)	(0.0193)	(0.0145)	(0.0273)	(0.0421)	(0.0526)
8.departure_code	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
growth	0.214**	-0.0388	0.0169	-0.0140	0.00458	-0.00833	0.00131
	(0.0841)	(0.0401)	(0.0244)	(0.0153)	(0.00569)	(0.00930)	(0.00719)
age	-0.00128	-0.000777	0.000361	0.000299	0.00128*	0.00166*	0.000160
	(0.00195)	(0.00136)	(0.00107)	(0.000604)	(0.000683)	(0.000890)	(0.000832)
salary	0.0000871	0.0000251	0.000000431	-0.0000468	-0.0000414*	-0.0000322	-0.0000265*
	(0.0000829)	(0.0000503)	(0.0000365)	(0.0000403)	(0.0000242)	(0.0000200)	(0.0000151)
tdc1	-0.0119	-0.00423	0.00957	0.000831	-0.00169	-0.000371	-0.00407
	(0.00972)	(0.00464)	(0.00593)	(0.00321)	(0.00251)	(0.00205)	(0.00441)

TABLE 9

Overhead Efficiency

	(1) OverhEff_adj	(2) F.OverhEff_adj	(3) F2.OverhEff_adj	(4) F3.OverhEff_adj	(5) F4.OverhEff_adj	(6) F5.OverhEff_adj	(7) F6.OverhEff_adj
0.OutsideCEO	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO	-0.278	-0.0400	-0.0188	0.0137	0.0000636	-0.0357	0.00242
	(0.230)	(0.0278)	(0.0355)	(0.0729)	(0.0157)	(0.0319)	(0.0198)
Firm_experience	-0.00588	-0.00134	-0.00378	0.0105	-0.000259	-0.00127	-0.00149
	(0.00406)	(0.00299)	(0.00448)	(0.0113)	(0.00106)	(0.00223)	(0.00160)
0.OutsideCEO#c.Firm_experience	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO#c.Firm_experience	0.0151	0.00229	0.00330	-0.00773	-0.00193	0.000339	-0.00107
	(0.0104)	(0.00218)	(0.00324)	(0.00867)	(0.00170)	(0.00323)	(0.00197)
growth	0.153	-0.110**	-0.0689*	0.0425	-0.0214	0.0774**	-0.0118*
	(0.127)	(0.0520)	(0.0381)	(0.0368)	(0.0219)	(0.0388)	(0.00653)
Ownership	0.00169	-0.0197**	0.00964	-0.00611	-0.0000205	0.00519	0.00293
	(0.00573)	(0.00798)	(0.0102)	(0.0150)	(0.00325)	(0.00586)	(0.00242)
age	0.000203	-0.000268	0.00400	-0.00932	0.00208*	-0.00283	0.000195
	(0.00257)	(0.00386)	(0.00310)	(0.00691)	(0.00122)	(0.00174)	(0.00229)
salary	0.000314	0.0000241	0.0000376	-0.000218	-0.0000213	-0.00000244	0.0000282
	(0.000238)	(0.000119)	(0.0000853)	(0.000164)	(0.0000995)	(0.0000626)	(0.0000504)
tdc1	-0.00694	0.0126	-0.0138	0.0189	-0.00448	0.0175	0.00150
	(0.00740)	(0.0244)	(0.0187)	(0.0192)	(0.00826)	(0.0178)	(0.00190)
tdc2	-0.000445	-0.00726	0.0104	0.00383	0.00147	-0.00162	-0.00240
	(0.00428)	(0.00653)	(0.0120)	(0.00622)	(0.00401)	(0.00552)	(0.00373)
log_emp	-0.102	0.0137	0.0110	-0.0318	-0.0100	-0.0687	-0.00662
	(0.0640)	(0.0240)	(0.0140)	(0.0213)	(0.0117)	(0.0421)	(0.0133)
_cons	0.107	0.0474	-0.163	0.576	0.0141	0.183	0.0287
	(0.158)	(0.165)	(0.179)	(0.402)	(0.0856)	(0.114)	(0.113)
N	1177	965	744	556	407	275	174
R^2	0.657	0.533	0.546	0.641	0.694	0.531	0.541

TABLE 10

Financial Leverage

	(1) DER_adj	(2) F.DER_adj	(3) F2.DER_adj	(4) F3.DER_adj	(5) F4.DER_adj	(6) F5.DER_adj	(7) F6.DER_adj
0.OutsideCEO	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO	0.183	-43.55	-73.05	12.40	7.594	25.34	16.93
	(20.67)	(42.42)	(61.70)	(34.31)	(21.01)	(18.35)	(13.18)
Firm_experience	0.0614	0.740	0.329	0.777	-0.666	2.608	-0.177
	(1.465)	(1.768)	(1.025)	(2.237)	(1.373)	(1.917)	(0.976)
0.OutsideCEO#c.Firm_experience	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO#c.Firm_experience	1.593	-1.360	-4.148	-6.636	-3.921	1.270	1.881
	(3.675)	(2.373)	(4.276)	(6.446)	(5.900)	(1.873)	(1.284)
growth	-0.0941	-2.618	1.002	-1.154	-7.236	-5.868	-6.711
	(3.313)	(5.664)	(7.049)	(8.302)	(7.268)	(3.824)	(5.313)
Ownership	-4.401	-13.76	-10.68	-24.76	-3.474	3.652*	1.512
	(9.056)	(29.89)	(14.29)	(24.90)	(6.726)	(2.117)	(1.858)
age	0.631	-1.028	-1.719	2.721	1.734	-4.457	0.621
	(0.849)	(1.844)	(2.634)	(1.683)	(1.804)	(3.230)	(1.382)
salary	-0.00819	-0.0164	-0.0241	0.0106	0.0418	-0.0326	-0.0192
	(0.0302)	(0.0445)	(0.0769)	(0.0331)	(0.0968)	(0.0198)	(0.0207)
tdc1	14.02	11.19	1.036	-9.479	-4.468	1.392	2.057
	(9.734)	(10.89)	(2.439)	(10.57)	(8.433)	(2.834)	(3.311)
tdc2	7.535	0.877	-3.052	-7.002	-6.464	-3.047	-2.439**
	(17.22)	(6.672)	(6.230)	(7.957)	(6.537)	(2.137)	(1.199)
log_emp	20.54	-1.067	-13.19	5.794	18.84	18.26**	21.71**
	(25.64)	(24.16)	(14.71)	(13.08)	(16.15)	(7.454)	(10.74)
_cons	-202.6	42.46	238.0	43.60	-24.55	237.1	-43.82
	(164.5)	(208.8)	(220.2)	(131.0)	(100.3)	(159.9)	(74.69)
N	1208	988	748	554	403	272	172
R^2	0.423	0.500	0.623	0.740	0.536	0.696	0.584

TABLE 11

Inventory Levels

	(1) inventory_adj	(2) F.inventory_adj	(3) F2.inventory_adj	(4) F3.inventory_adj	(5) F4.inventory_adj	(6) F5.inventory_adj	(7) F6.inventory_adj
0.OutsideCEO	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO	0.0267	0.00882	-0.00355	0.000243	0.00466	-0.00511	0.00463
	(0.0211)	(0.00752)	(0.00623)	(0.00689)	(0.00798)	(0.00949)	(0.00592)
Firm_experience	-0.000529	-0.000593	-0.000608	0.0000460	0.000429	0.00136***	-0.000678
	(0.000434)	(0.000395)	(0.000452)	(0.000474)	(0.000396)	(0.000462)	(0.000594)
0.OutsideCEO#c.Firm_experience	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO#c.Firm_experience	-0.00131	-0.00157*	-0.00111	-0.00164*	-0.00167	-0.000285	-0.000261
	(0.00103)	(0.000867)	(0.000976)	(0.000956)	(0.00114)	(0.00117)	(0.000821)
growth	0.0104*	0.00422*	-0.00568	-0.00248	0.00820	0.00154	-0.00735
	(0.00576)	(0.00241)	(0.00620)	(0.00344)	(0.0108)	(0.00425)	(0.00575)
Ownership	0.000178	-0.000284	0.000486	-0.00125	-0.000108	-0.000711	-0.00110
	(0.000575)	(0.00102)	(0.00120)	(0.000967)	(0.00147)	(0.00130)	(0.00140)
age	0.00129**	0.000841*	0.00134*	0.000767	0.000232	-0.00110*	0.00202**
	(0.000591)	(0.000492)	(0.000693)	(0.000625)	(0.000446)	(0.000555)	(0.000852)
salary	-0.0000223	-0.0000190**	-0.00000170	-0.0000103	0.0000123	0.00000296	-0.0000419**
	(0.0000164)	(0.00000751)	(0.0000106)	(0.0000135)	(0.0000147)	(0.0000144)	(0.0000176)
tdc1	-0.00277	0.000186	-0.00131	-0.000786	-0.000876	0.000869	-0.000187
	(0.00177)	(0.00113)	(0.00103)	(0.00145)	(0.00127)	(0.00111)	(0.00107)
tdc2	0.000348	-0.000326	0.00145*	0.00101	-0.00151	-0.00201	0.00140
	(0.000824)	(0.000945)	(0.000838)	(0.00111)	(0.000954)	(0.00133)	(0.00117)
log_emp	0.0126*	0.00635*	-0.00570	-0.00458	0.00415	0.0123*	0.00828
	(0.00758)	(0.00344)	(0.00428)	(0.00432)	(0.00469)	(0.00693)	(0.00621)
_cons	-0.0373	-0.0154	-0.0370	-0.000582	0.0112	0.0627**	-0.0703*
	(0.0326)	(0.0251)	(0.0382)	(0.0330)	(0.0250)	(0.0301)	(0.0403)
N	1202	981	741	549	401	270	170
R^2	0.567	0.621	0.706	0.716	0.748	0.616	0.625

TABEL 12

Corporate Strategic Change

	(1) CorpStrChang	(2) F.CorpStrChang	(3) F2.CorpStrChang	(4) F3.CorpStrChang	(5) F4.CorpStrChang	(6) F5.CorpStrChang	(7) F7.CorpStrChang
0.OutsideCEO	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO	-0.130	0.185	0.199	0.337	-0.0583	-0.330	-1.205
	(0.127)	(0.181)	(0.188)	(0.216)	(0.253)	(0.289)	(0.813)
Firm_experience	-0.00592	0.0131	0.0106	0.0189*	-0.0197	-0.00469	-0.105
	(0.00794)	(0.00897)	(0.0111)	(0.0103)	(0.0133)	(0.0176)	(0.0867)
0.OutsideCEO#c.Firm_experience	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
1.OutsideCEO#c.Firm_experience	-0.0110	-0.0374	-0.0145	-0.0200	0.00860	0.0308	0.187**
	(0.0210)	(0.0228)	(0.0258)	(0.0314)	(0.0368)	(0.0404)	(0.0847)
growth	0.0706***	-0.176***	-0.0193	-0.0101	0.164	0.150	-0.252
	(0.0228)	(0.0482)	(0.0409)	(0.0961)	(0.123)	(0.135)	(0.362)
Ownership	-0.0170	-0.0125	-0.00419	-0.0323	-0.0181	-0.0575*	0.0121
	(0.0159)	(0.0163)	(0.0171)	(0.0253)	(0.0242)	(0.0308)	(0.0711)
age	0.0217**	-0.00591	-0.0104	-0.00320	-0.00461	-0.0239	0.0524
	(0.0105)	(0.0115)	(0.0193)	(0.0166)	(0.0193)	(0.0333)	(0.104)
salary	-0.000315*	-0.000341*	0.000325	-0.000385	0.000881**	0.000480	0.00121
	(0.000173)	(0.000193)	(0.000278)	(0.000305)	(0.000342)	(0.000493)	(0.00113)
tdc1	-0.0382	-0.0237	-0.0390	0.0536	-0.00784	-0.0853	-0.0318
	(0.0384)	(0.0439)	(0.0375)	(0.0427)	(0.0643)	(0.0611)	(0.0649)
tdc2	0.0288	-0.0140	0.0301	0.0129	-0.0393	-0.0702	-0.104
	(0.0310)	(0.0376)	(0.0369)	(0.0356)	(0.0523)	(0.0530)	(0.0995)
log_emp	0.0153	0.212**	-0.0145	-0.139	-0.471***	-0.174	0.937
	(0.0989)	(0.107)	(0.127)	(0.170)	(0.181)	(0.177)	(0.626)
_cons	-0.962	0.267	0.0860	-0.0877	0.794	2.448	-3.974
	(0.618)	(0.721)	(1.167)	(1.011)	(1.078)	(1.780)	(5.931)
N	16727	13999	11167	8590	6492	4615	1896
R^2	0.367	0.365	0.398	0.408	0.516	0.558	0.674

FIGURE 1

Change in Innovation Vector Direction

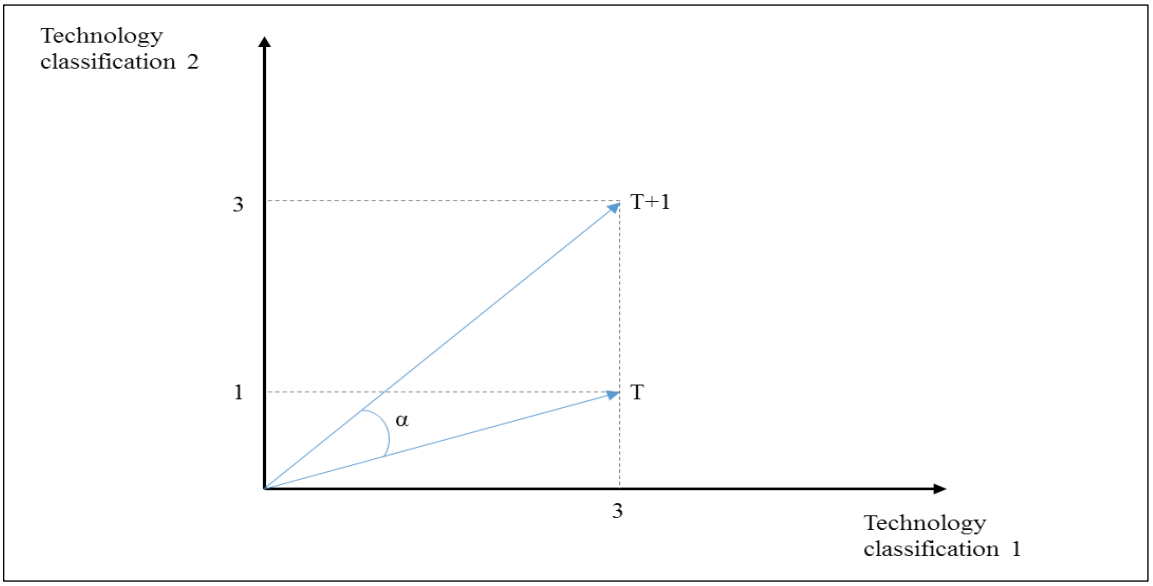


FIGURE 2

The Effect of Firm Age

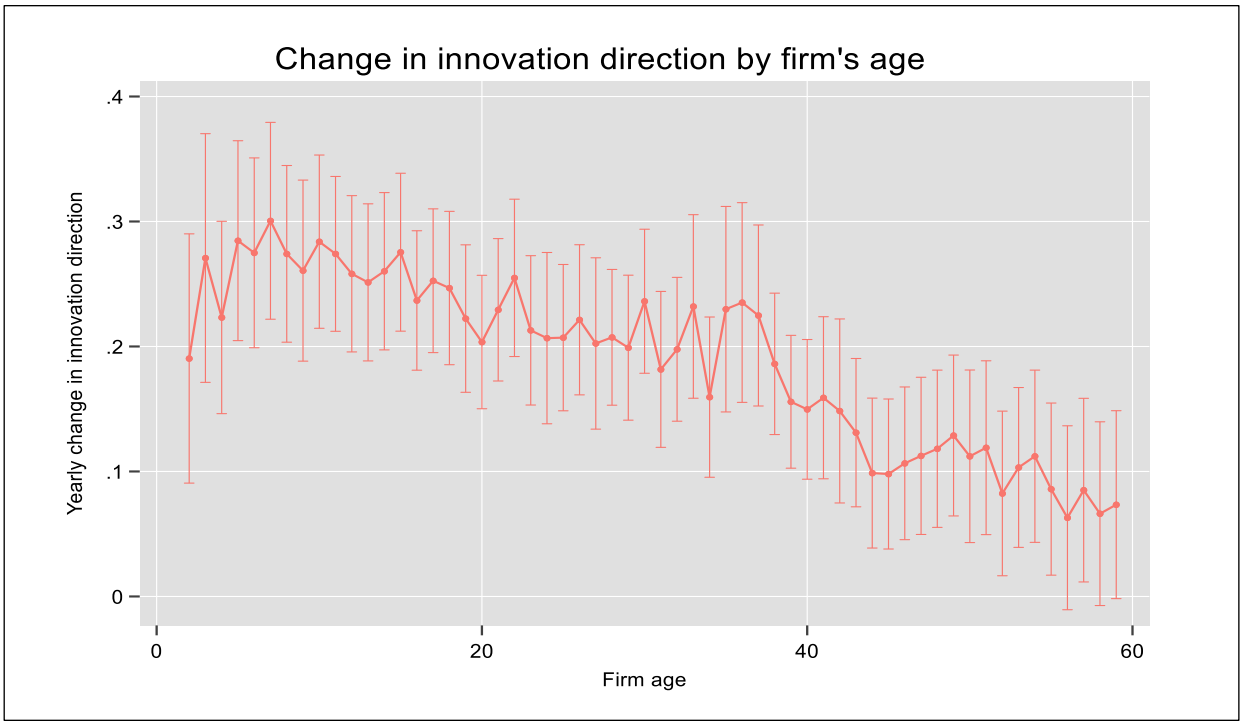


FIGURE 3

Marginal Innovation Change per Year

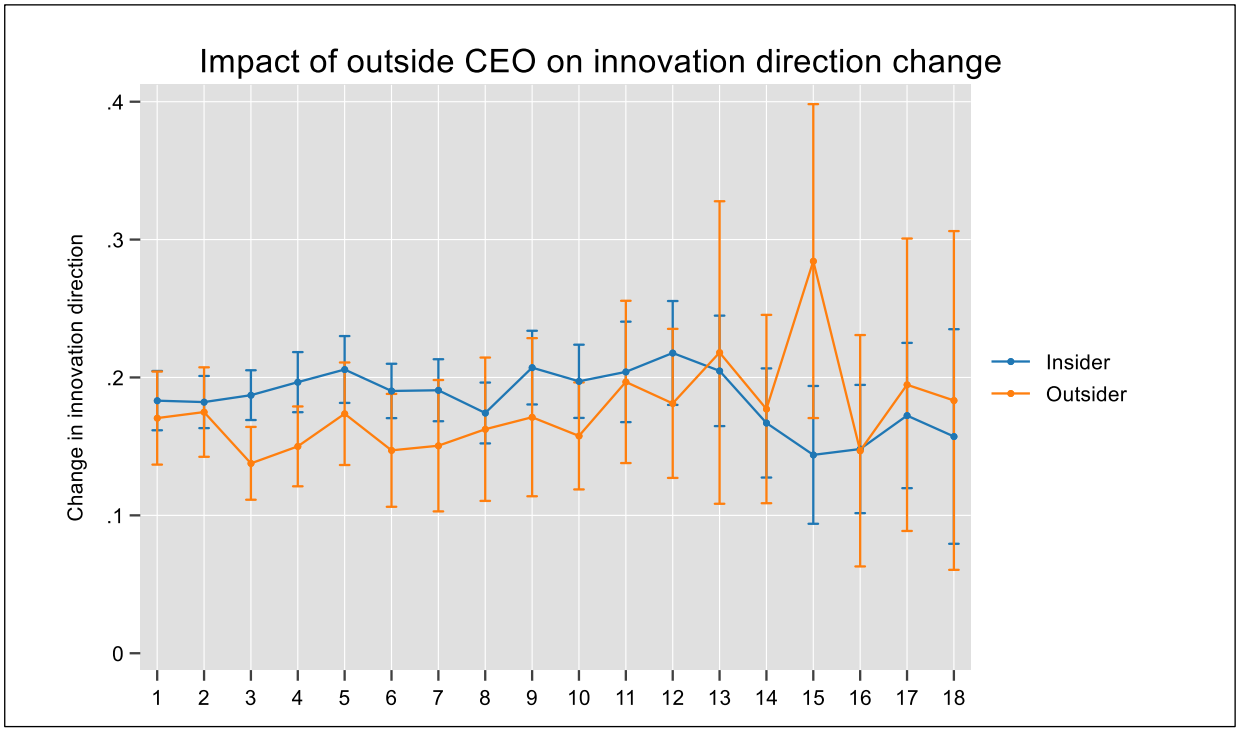


FIGURE 4

Marginal Innovation Change per Year

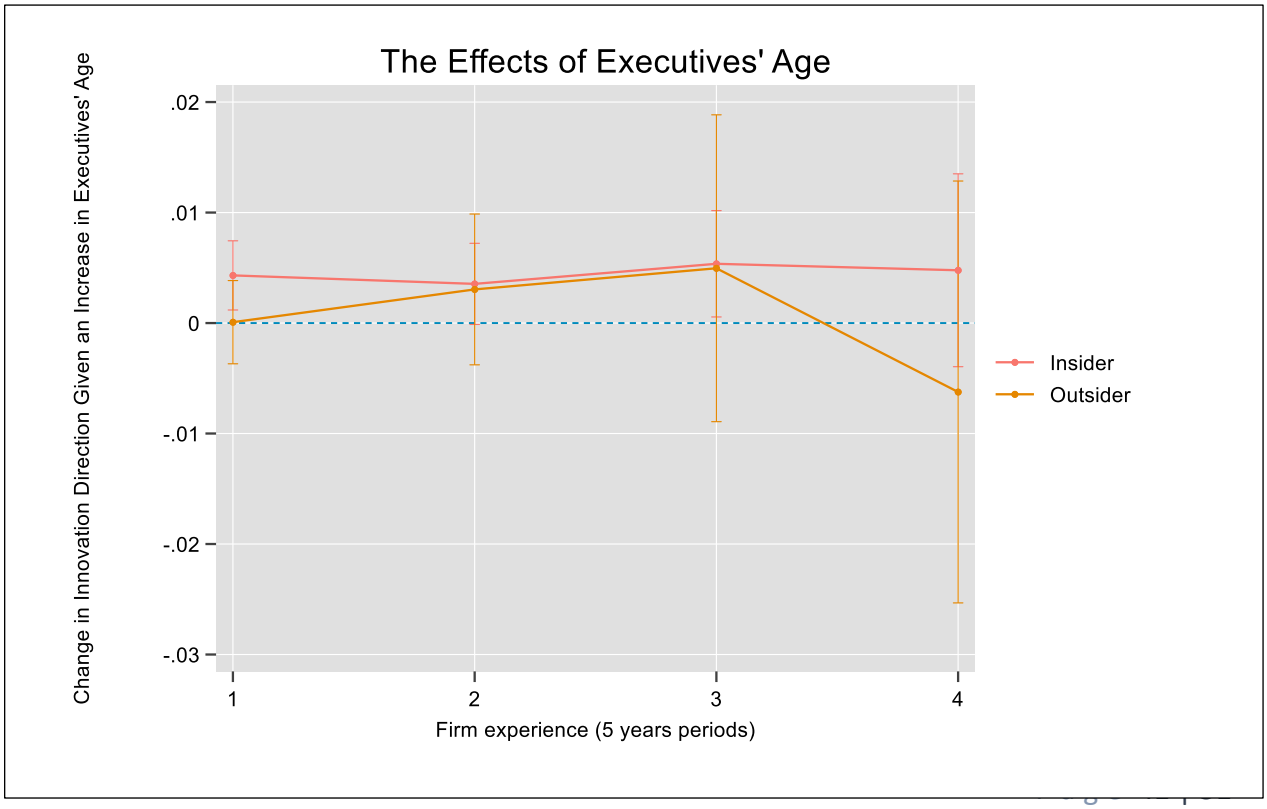


FIGURE 5

Inventors Do Not Stop Collaborating More Often Under Outside CEOs

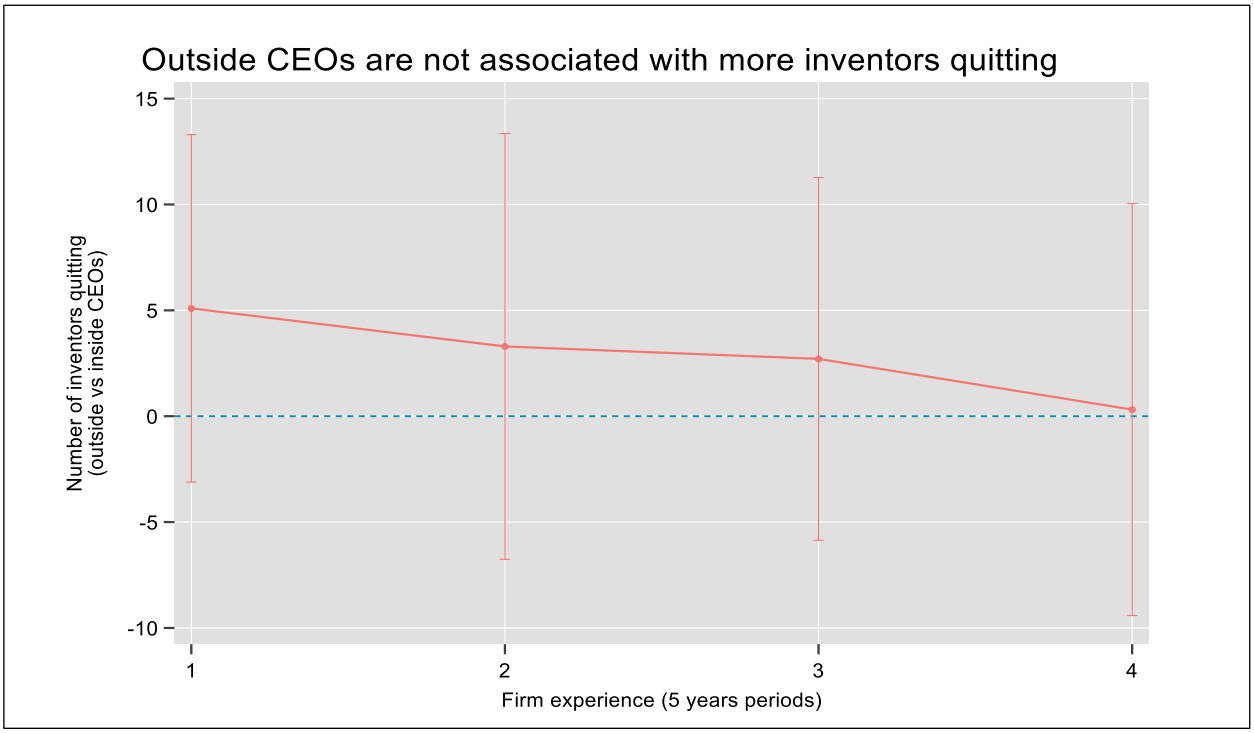


FIGURE 6

Tech Expertise and Innovation Direction

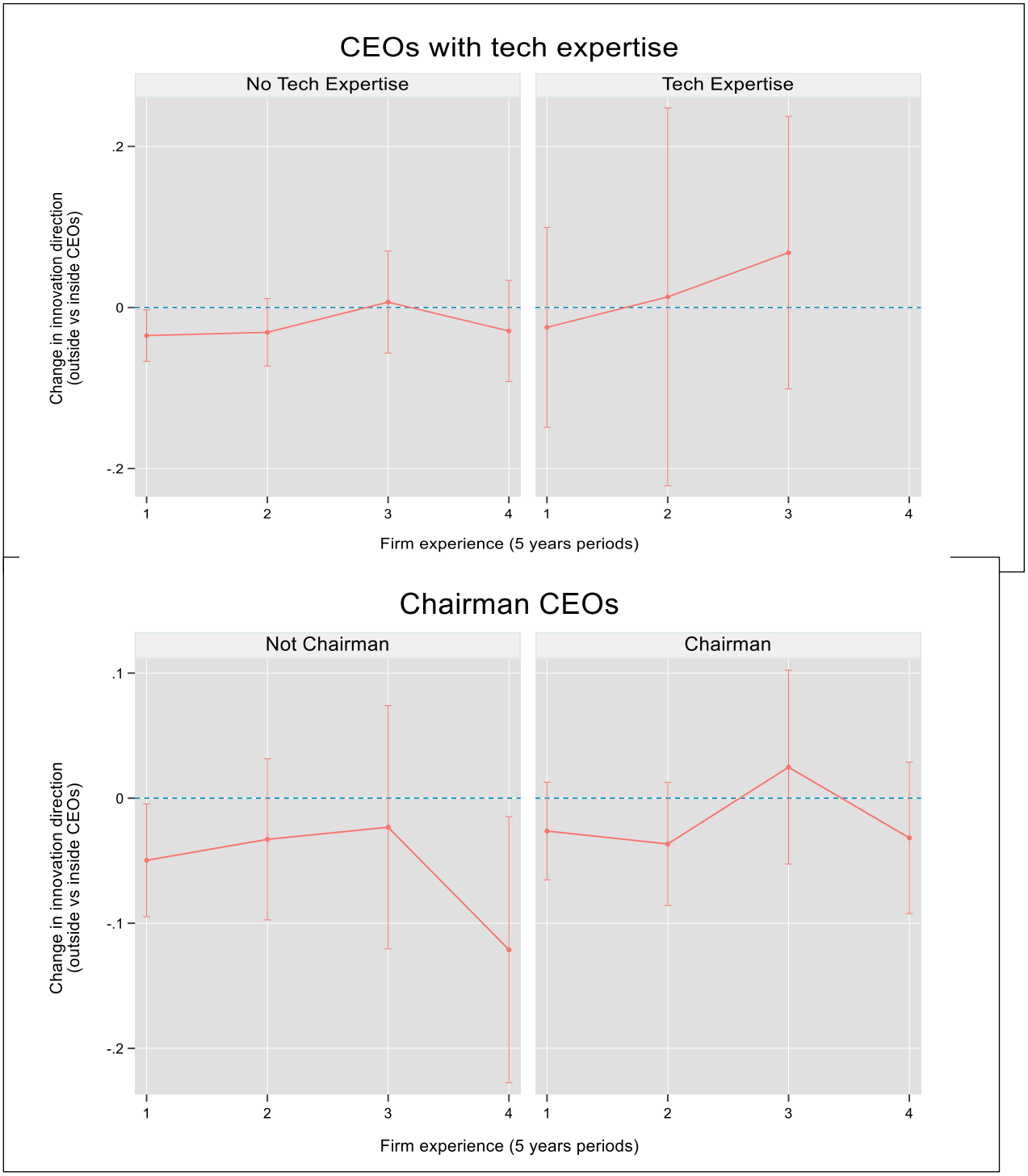
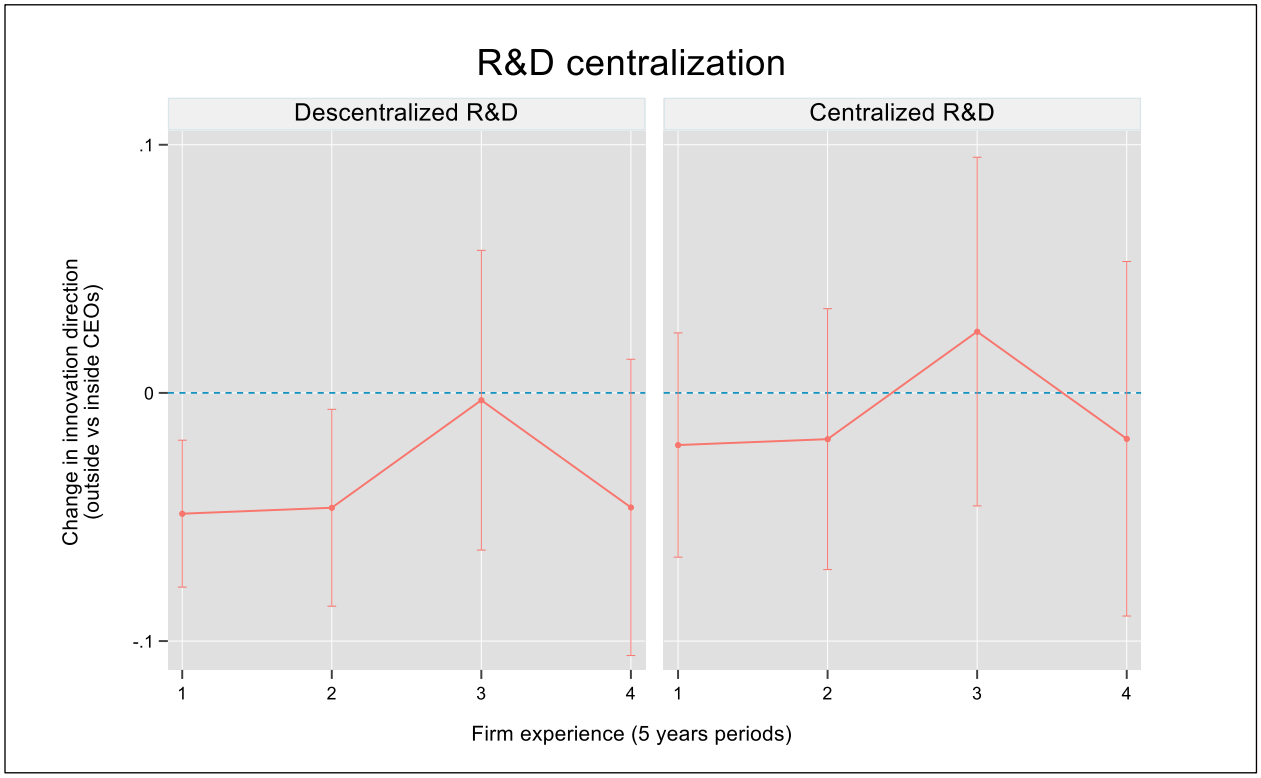


FIGURE 8

R&D Centralization and Innovation Direction



FIGURES 9

Marginal Innovation Change Stemming from Tech Abandonment

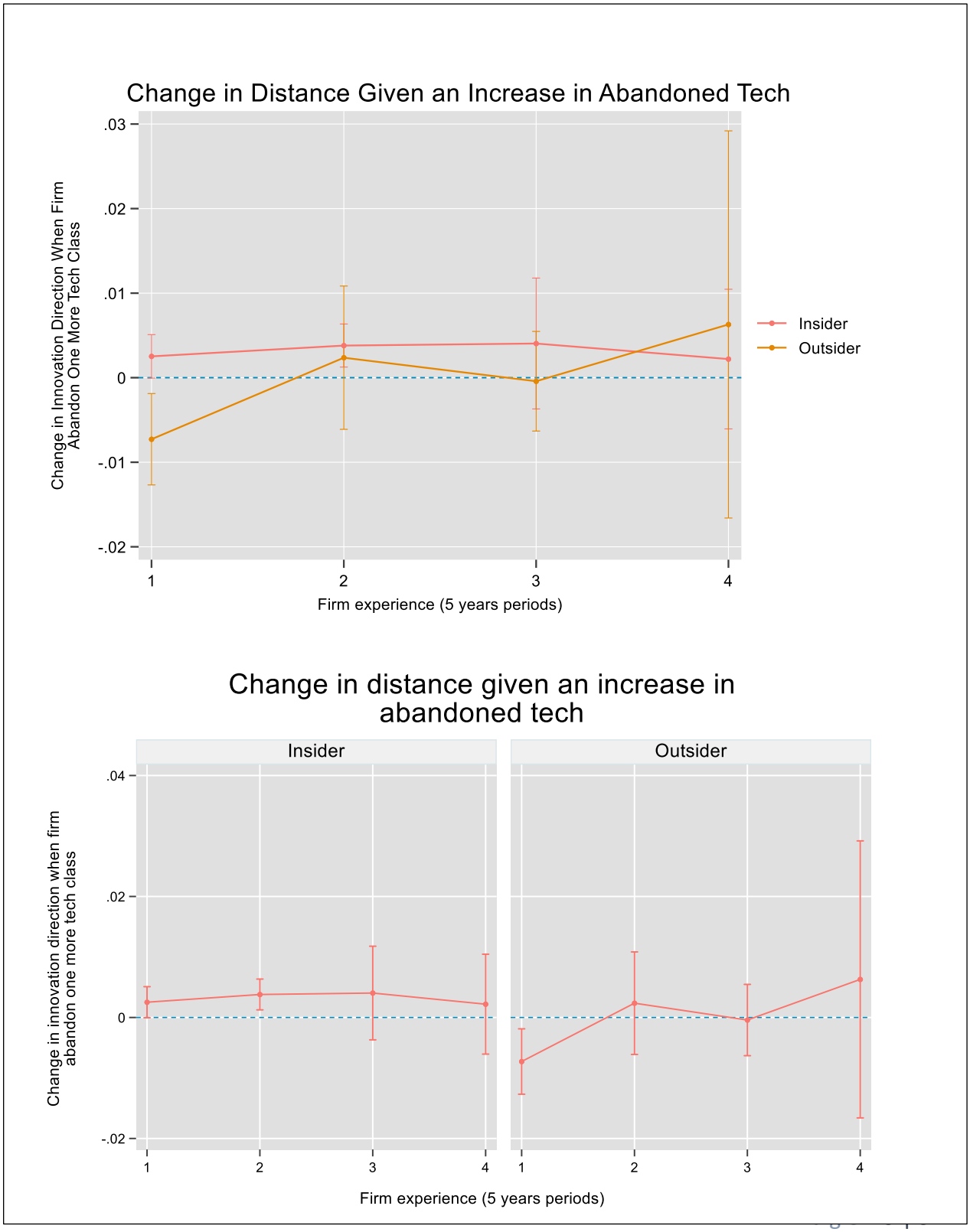


FIGURE 10

The Effect of Short-Term CEOs on Innovation Direction

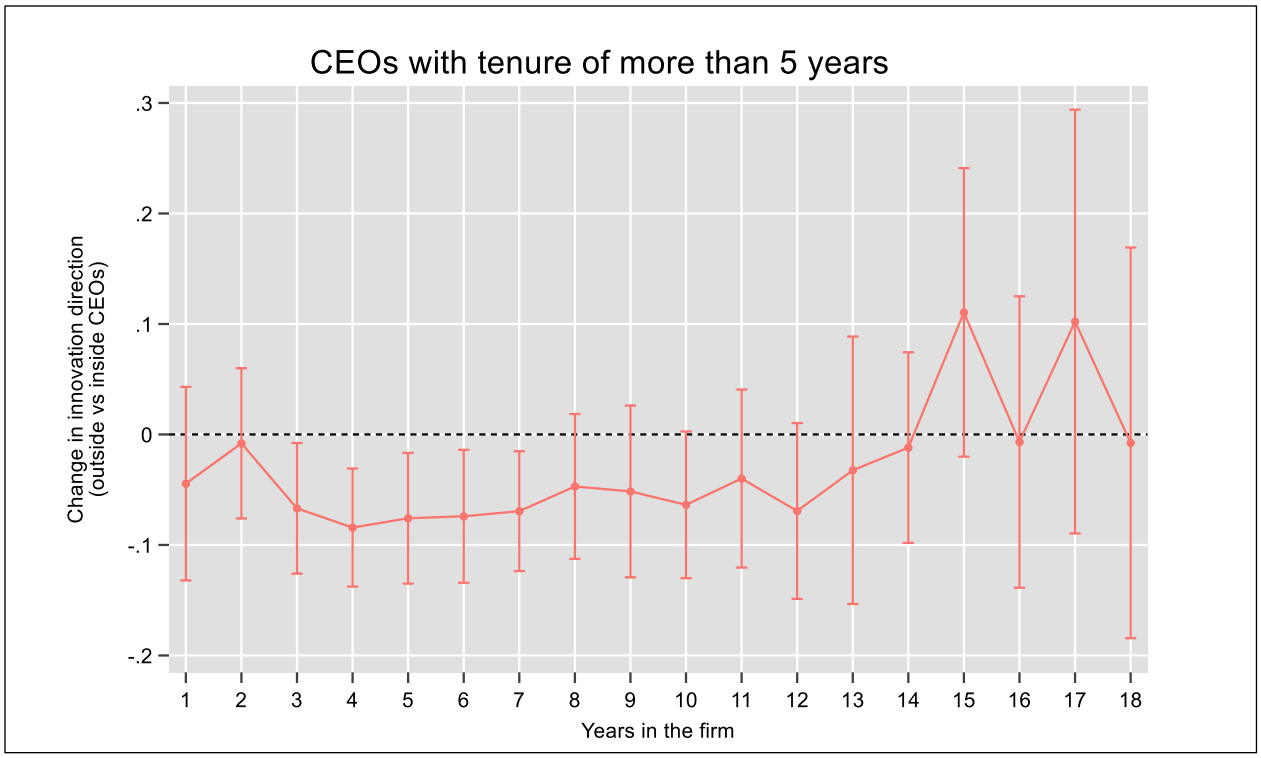


FIGURE 11

The Effect of Long-Term CEOs on Innovation Direction

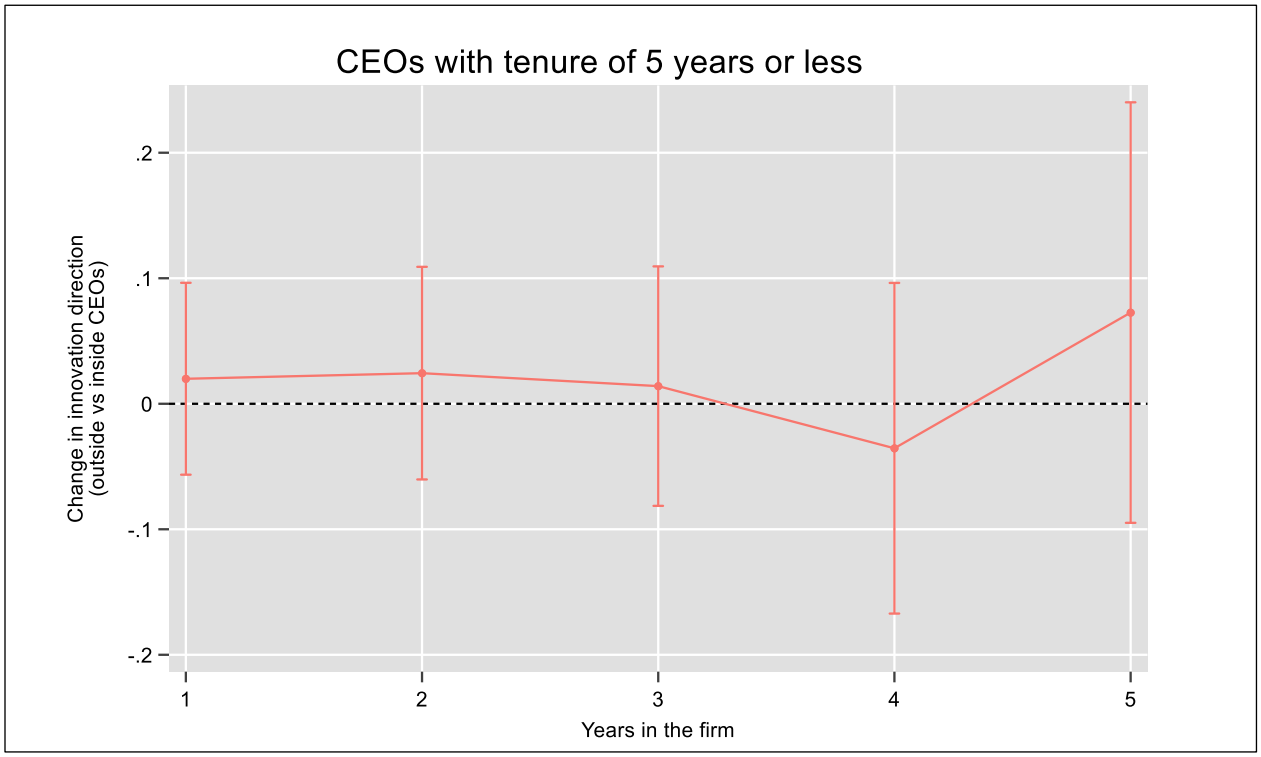


FIGURE 11

The Effect of Short-Term CEOs on Advertising Intensity

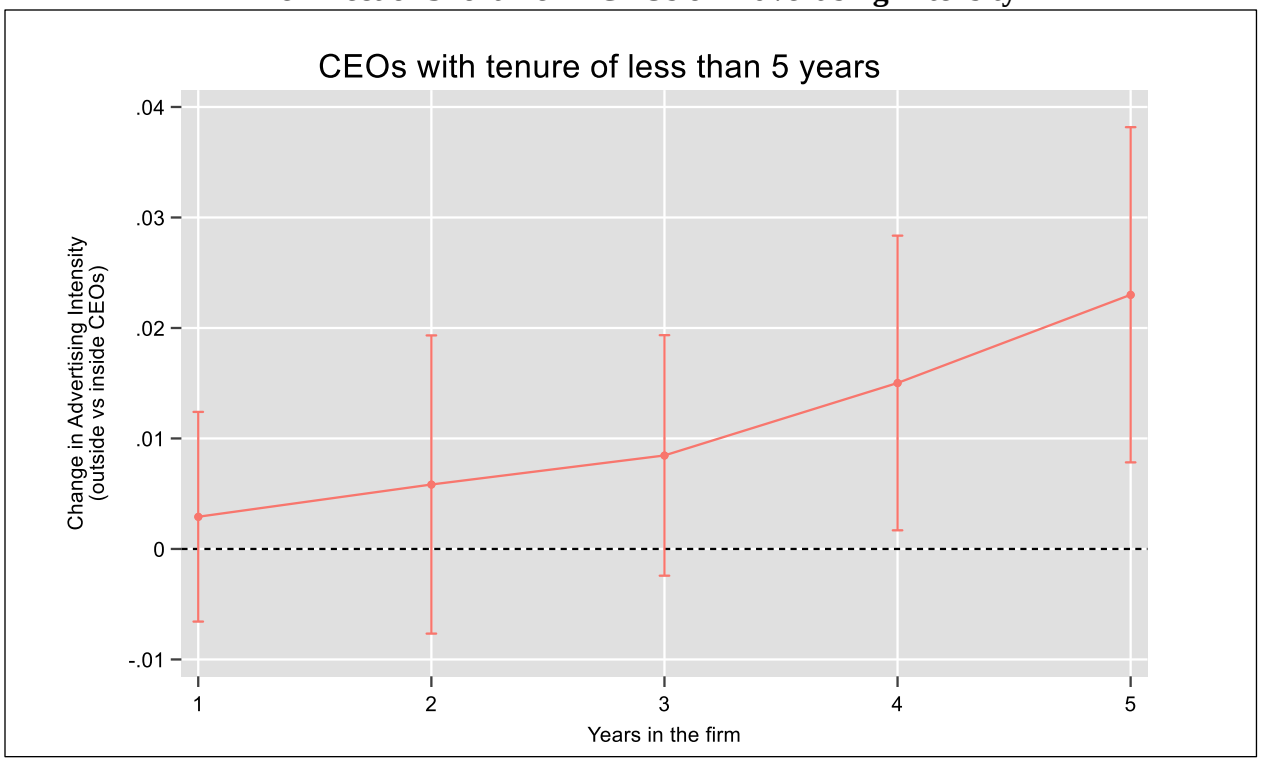


FIGURE 12

The Effect of Long-Term CEOs on Advertising Intensity

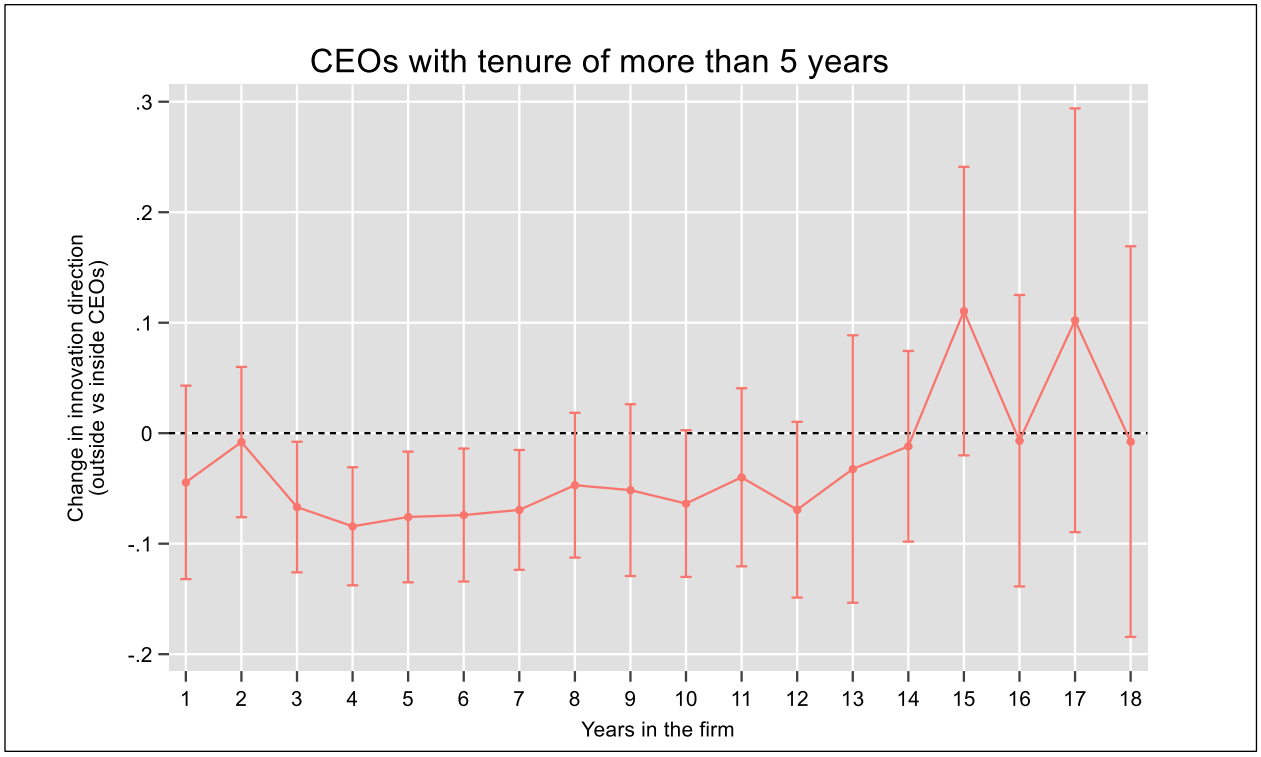


FIGURE 13

The Effect of Short-Term CEOs on R&D Intensity

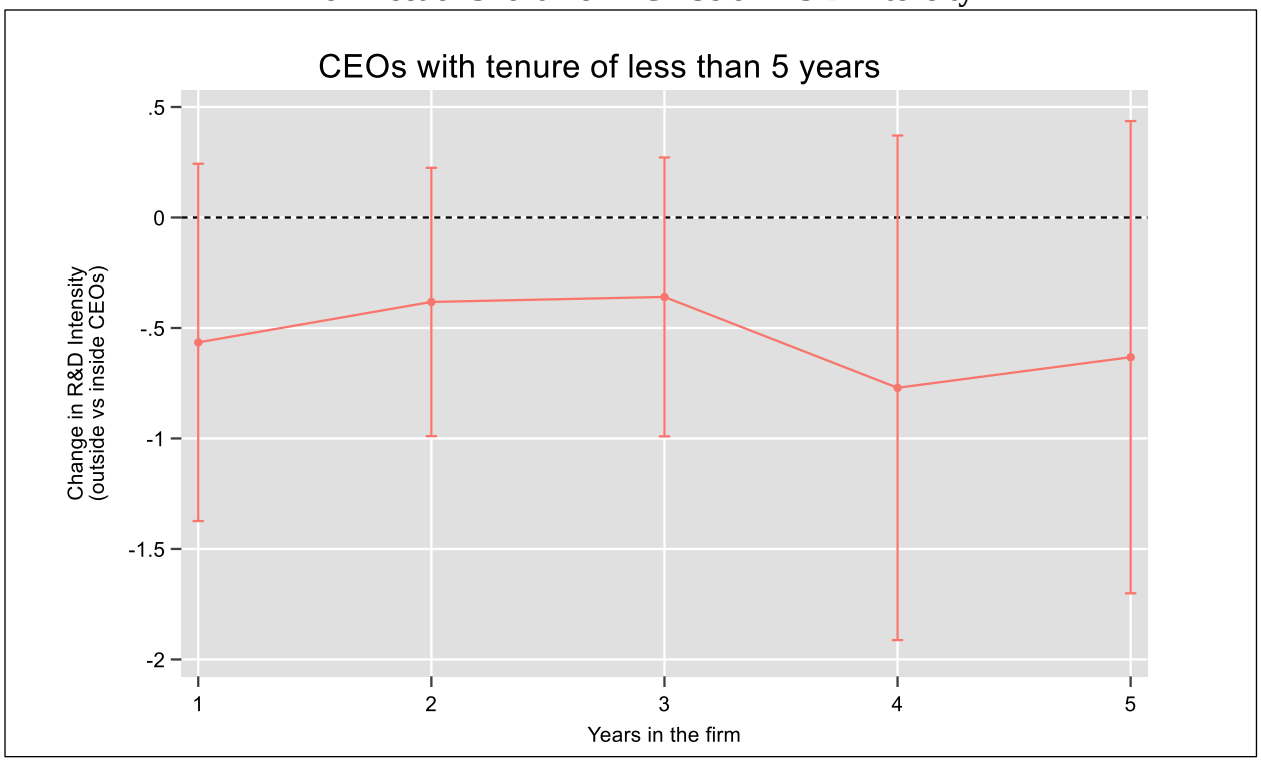


FIGURE 14

The Effect of Long-Term CEOs on R&D Intensity

FIGURE 15

The Effect of Short-Term CEOs on Overhead Efficiency

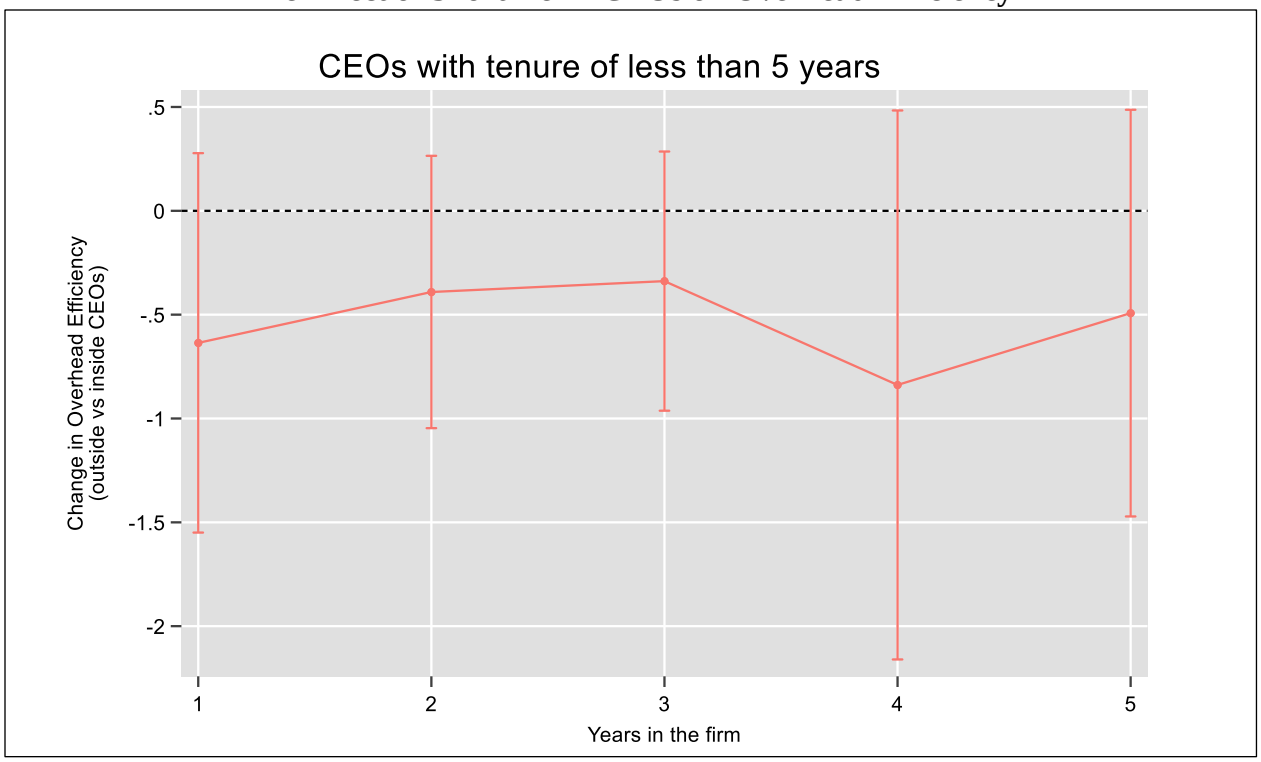


FIGURE 16

The Effect of Long-Term CEOs on Overhead Efficiency

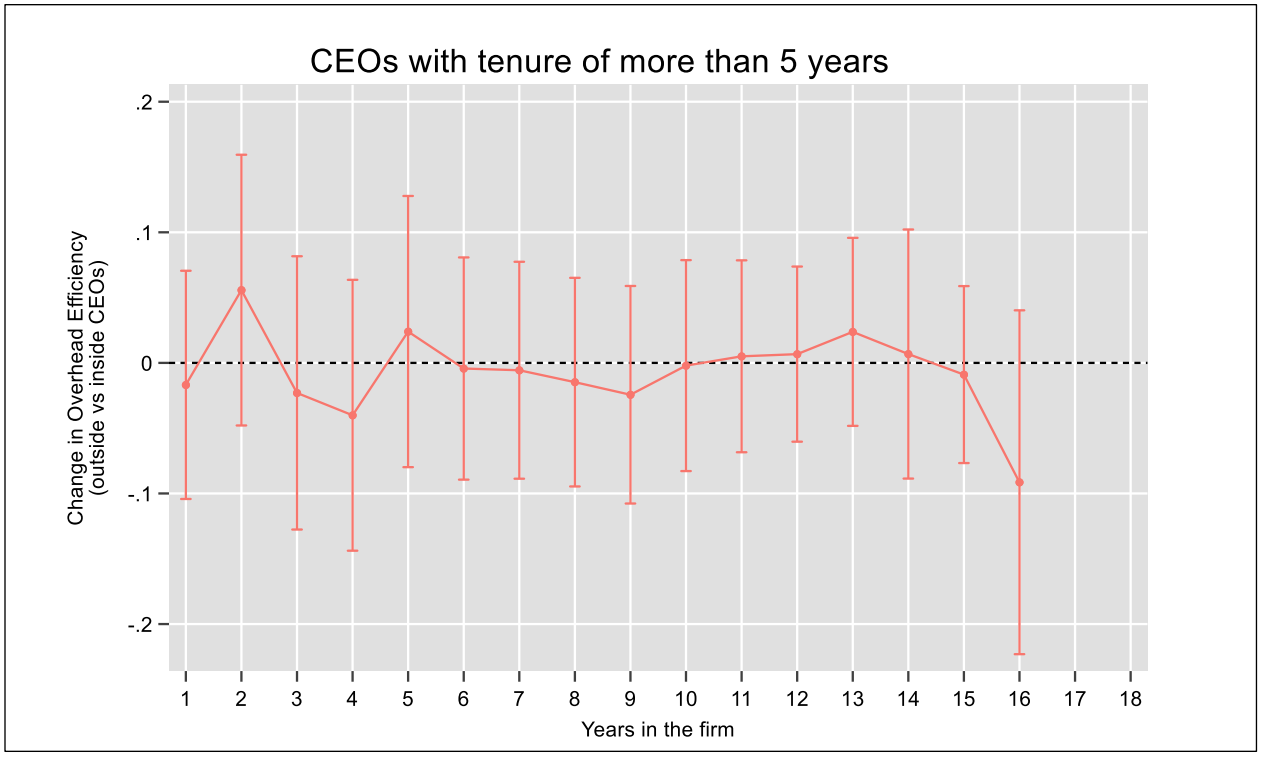


FIGURE 17

The Effect of Short-Term CEOs on Overhead Efficiency

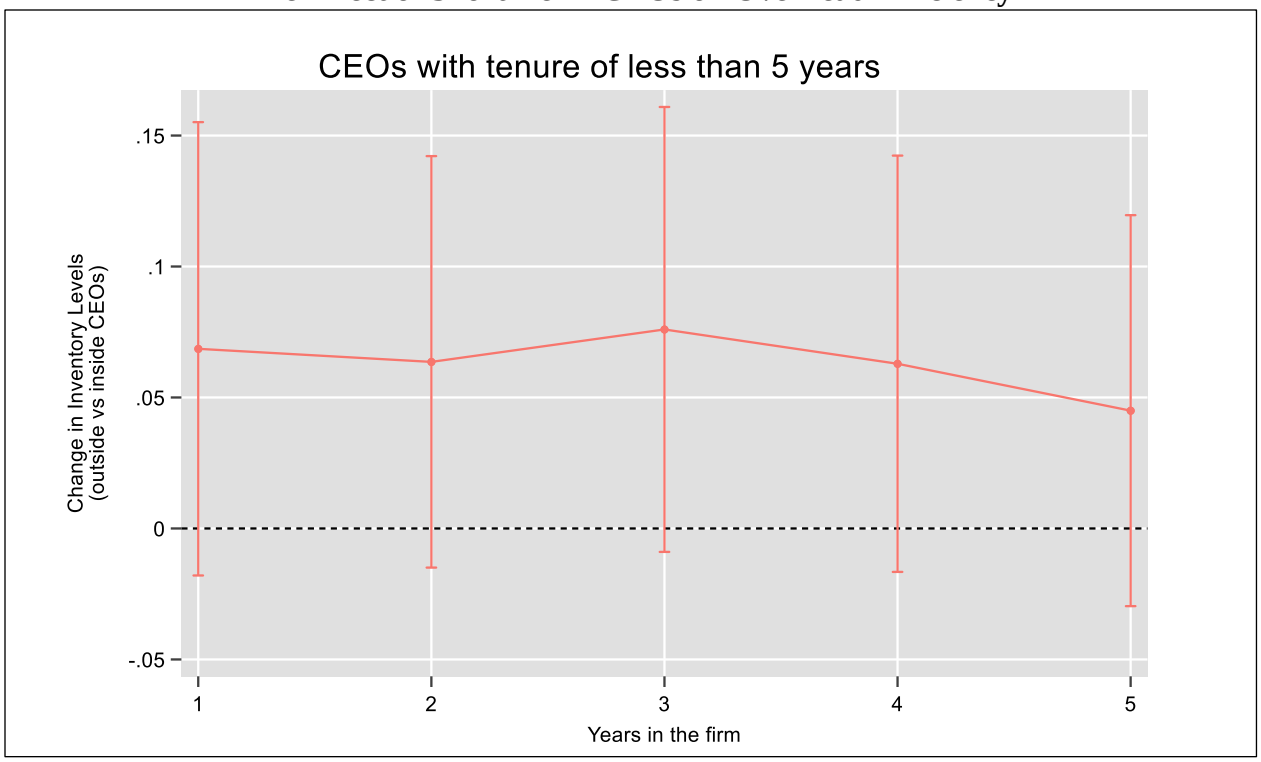


FIGURE 18

The Effect of Long-Term CEOs on Overhead Efficiency

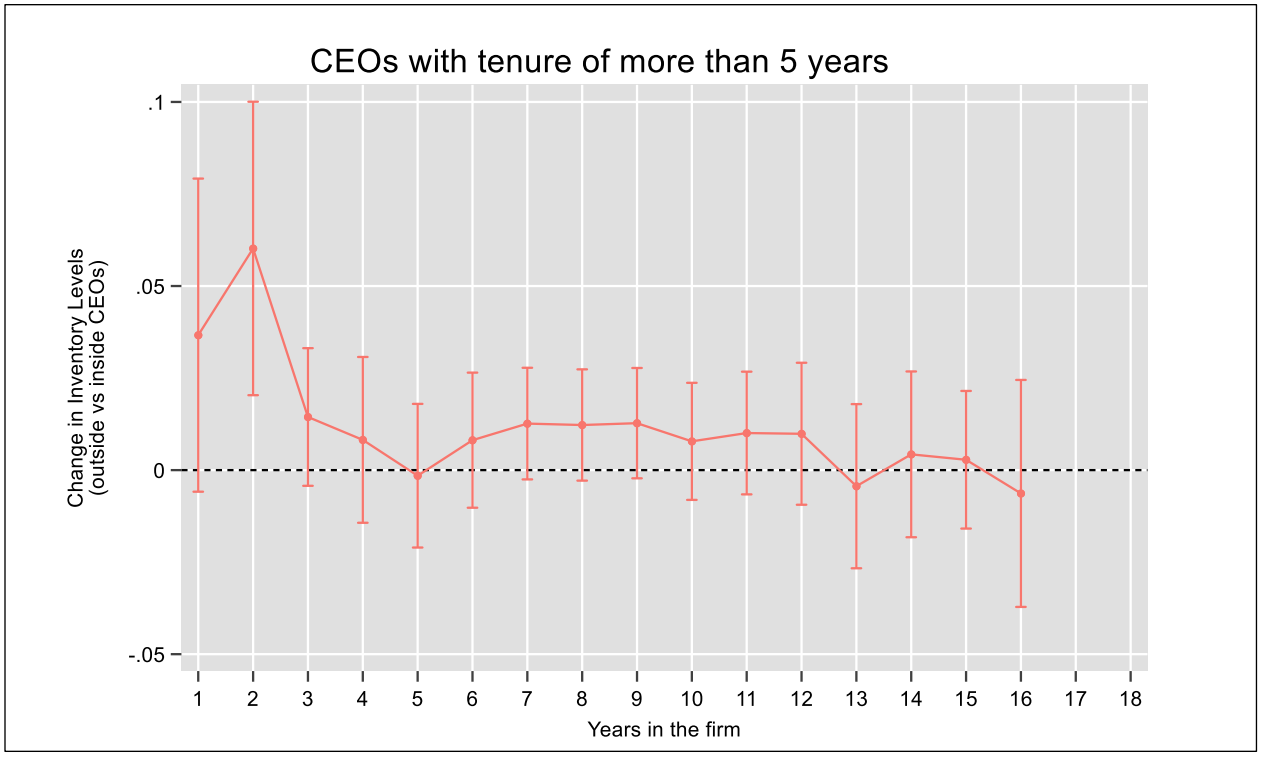


FIGURE 19

The Effect of Short-Term CEOs on Corporate Strategic Change

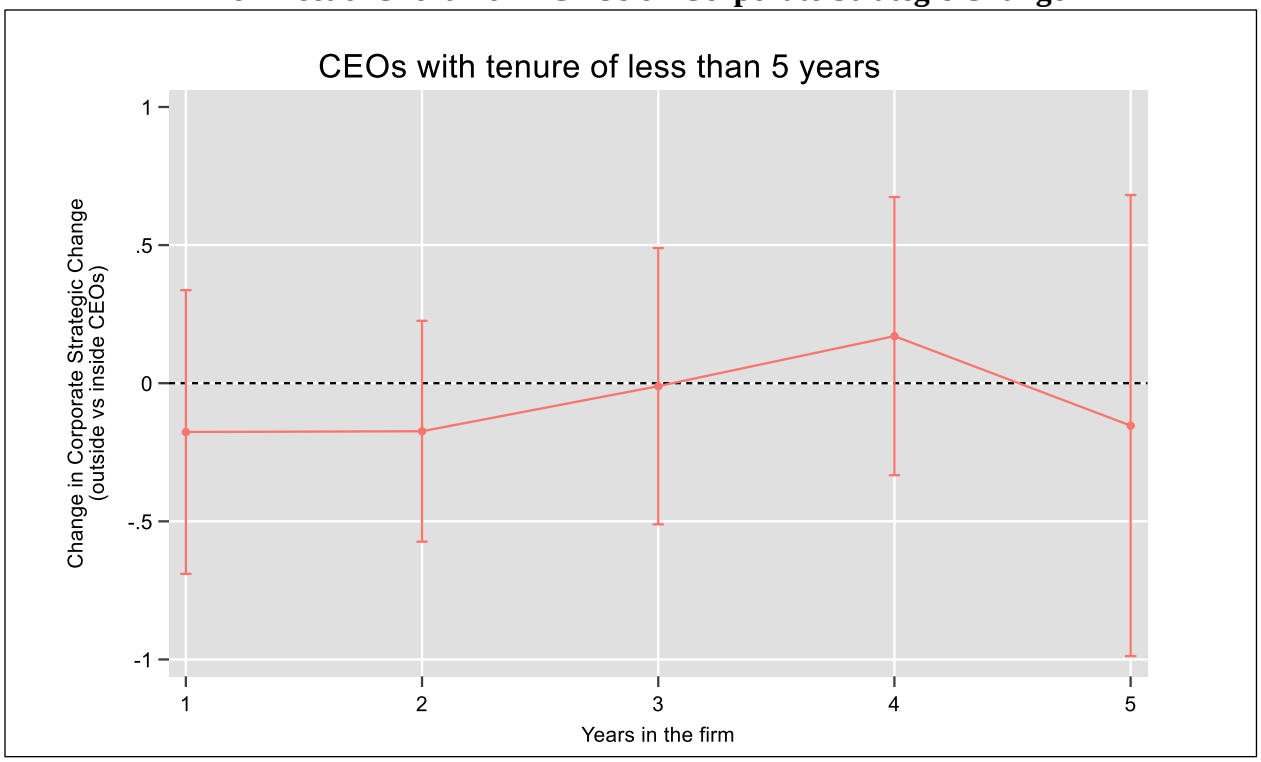


FIGURE 20

The Effect of Long-Term CEOs on Corporate Strategic Change