Insider CEOs: Lucky or Good?[1]

Andrew Capron
University of North Carolina at Chapel Hill

Barton H. Hamilton
Olin Business School, Washington University in St. Louis

Andrés Hincapié
University of North Carolina at Chapel Hill

Noah Lyman
Warwick Business School, University of Warwick

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ABSTRACT: Why do firms tend to hire CEOs from within rather than externally? And why do external hires increase when firm performance is poor? We answer these questions using a dynamic selection model of CEO hiring and turnover, weighing the relative importance of various mechanisms suggested in the literature including differences in average quality, uncertainty about CEO quality, costs of firing, preference for internal hires, and preference for "rocking the boat" (external hires) during times of crisis. Firm performance is persistent and boards learn about CEO quality over time, facing different levels of uncertainty when hiring internally or externally. We estimate the model using a matched CEO-firm panel from 1995-2019 of all publicly-traded North American firms. We find that the main mechanism answering these questions is information. Our estimates indicate that boards' uncertainty over insider candidates is roughly half that of outsiders, which causes insider CEOs to become better selected and generates a significant difference in quality ex-post despite there being little ex-ante difference in quality between the two candidate pools. Long-tenured insider CEOs thus tend to be "good" while outsiders tend to be "lucky." Finally, the higher variation in quality faced by firms when hiring externally increases firms' willingness to hire outsiders when performance is poor, in hopes of drawing an exceptional outsider from the right tail of the distribution.

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[1]Capron: Department of Economics, University of North Carolina at Chapel Hill (email: acapron@unc.edu); Hamilton: Olin Business School, Washington University in St. Louis (email: hamiltonb@wustl.edu); Hincapié: Department of Economics, University of North Carolina at Chapel Hill (email: andres.hincapie@unc.edu); Lyman: Warwick Business School, University of Warwick (email: Noah.Lyman@wbs.ac.uk). First version: April 16, 2024. This version: January 24, 2025. We thank the participants of seminars at the University of North Carolina at Chapel Hill and the Southern Economic Association for their valuable feedback and comments, and Simone Hanna for her expert research assistance.

1 Introduction

When appointing a new CEO, why do firms tend to promote from within rather than hiring externally? And why do external hires increase when firm performance is low? Given the importance of CEOs as a determinant of firm performance,[2] a substantial literature examines the mechanisms underlying the Board of Director's decision to hire *Insiders* versus *Outsiders* and their subsequent impact on firm performance. Classic labor market theories emphasize the role of firm-specific human capital (Becker, 1975), while other studies argue that Boards can more effectively screen insiders (Greenwald, 1979; Hermalin, 2005). Conversely, job matching models (Miller, 1984; Hincapié, 2020) emphasize the upside option value of hiring from the more uncertain pool of candidates (e.g. outsiders), noting that poor matches can be terminated. Finally, many authors point to Board preferences that are unrelated to performance, such as non-pecuniary preferences for executives with prior ties to the firm, or a desire to "shake up management" by hiring externally during periods of poor performance (Parrino, 1997; Agrawal et al., 2006; He and Schroth, 2024). Empirically, weighing the relative importance of these explanations for the prevalence and performance of internal hires is complicated by selection. Insiders tend to inherit control of relatively healthy firms, while outsiders are more often hired in times of crisis. Hence, it is imperative we address selection bias to understand Boards' hiring behavior and identify the causal impact of internal and external hires on firm performance.

In this paper we address the selection concerns that limit our understanding of the relative strengths of internal and external hires. We estimate a dynamic selection model of CEO hiring and turnover that uncovers the mechanisms underlying the observed gap in performance between insider and outsider CEOs, and the tendency to hire externally in times of poor firm performance. Boards learn about the match quality of their CEO over time and make hiring and termination decisions based upon their beliefs. Replacing a CEO entails both pecuniary and non-pecuniary costs, the latter reflecting CEO entrenchment.[3] Upon the departure of a CEO, boards can hire a replacement from within the company (an insider) or outside the company (an outsider). Insider and outsider candidates differ in their firm-specific match quality, and boards may face more uncertainty when hiring externally (Hermalin, 2005). Boards have a non-pecuniary preference for hiring from within, and the strength of this preference is allowed to vary with prior firm performance.[4] Given the difficulty to uncover and weigh the main differences between internal and external hires

[2] See for example: Hayes and Schaefer (1999), Bertrand and Schoar (2003), Peréz-González (2006), Pan (2017), Black (2019), Jenter et al. (2023).

[3] Prior literature often models CEO entrenchment as a utility cost incurred by the board upon firing a CEO (Taylor, 2010; Ferraro, 2021; Hamilton et al., 2023; Lyman, 2024).

[4] This is motivated by previous empirical results establishing that the likelihood of outside successions decreases with prior firm performance. See for example: Weisbach (1988), Boeker and Goodstein (1993), Datta and Guthrie (1994), Parrino (1997), Chen and Hambrick (2012).

due to selection at both the entry and exit margins, our main contribution to the literature is a framework free of selection bias that allows us to determine empirically the main sources explaining the prevalence of internal hires and their impact on profitability, and the increase in external hires in low performing years.

Using a matched CEO-firm panel spanning from 1995 to 2019, we estimate the model using the Simulated Method of Moments. Firm-level information comes from Compustat, which covers the universe of publicly-traded North American firms. CEO-level information comes from Execucomp, which contains data on executives' prior firm experience allowing us to classify CEOs as either insiders or outsiders. We define an insider CEO as one which has more than one year of experience within the firm prior to their CEO appointment (or is a founding executive).[5] All other CEOs are classified as outsiders. Consistent with prior literature, summary statistics show the employment of insider CEOs is associated with significantly higher firm performance, measured as the firm's return on assets (ROA). In addition, employment of outsider CEOs is associated with higher variance in firm performance. Despite this, firms' proclivity to hire outsider CEOs is persistent; roughly a third of CEO successions observed in the sample result in an external hire, with outsiders more likely to be hired when the firm is performing poorly.[6] These empirical patterns suggest that considerations beyond pure expected profit maximization are given weight in board hiring decisions.

Our structural estimates show that the difference in average match quality of insider and outsider CEO candidates is minimal, suggesting that firm-specific human capital plays only a small role in explaining the superior performance of internal candidates who become CEOs. This is consistent with prior literature arguing that in the context of matching between CEOs and firms, the importance of firm-specific skills is dwarfed by general human capital (Murphy and Zabojnik, 2004, 2006; Custódio et al., 2013). What then explains the observed superior performance of insider CEOs? We find that the gap is explained partly by differences in information quality between the two CEO types. Our estimates imply that Boards' uncertainty over insider candidates is roughly half that of outsiders. Insider CEOs are therefore better selected which, despite there being little ex-ante difference in quality between the two candidate pools, generates a significant difference in quality ex-post. For example, the initial match quality of insiders, conditional upon being hired, is 78% higher than the initial match quality of outsiders. Furthermore, our simulation results suggest that for the median sized firm in our sample, the additional prior information on internal candidates is worth approximately $38.3 million dollars in the net present value of profits, holding other factors constant.

[5] We show in Appendix A.2.4 that our results are robust to other definitions of insider status.

[6] Cziraki and Jenter (2021) finds that within the S&P 500, 28% of CEOs are hired externally. Our figure of 35% is slightly higher as we examine the S&P 1500, and the likelihood of external hires generally decreases with firm size.

The ability of the Board to screen internal candidates has important implications for the dynamics of CEO quality and retention. In our model, the Board observes firm performance and must disentangle signals of CEO quality from idiosyncratic firm-specific factors such as demand shocks. The Board's learning process is complicated by the fact that firm performance is persistent, implying that current shocks (positive or negative) have a continued impact in future periods. Because there is less initial uncertainty regarding insider match quality, the Board can more easily distinguish between the roles of CEO ability and luck (i.e., the idiosyncratic firm shocks) in driving performance. Our results therefore indicate that insiders are strongly positively selected over time, where the average match quality of an internally promoted CEO with 10 years of experience is almost two times as large as that of a newly hired insider. In the case of outsiders, we find much less dynamic selection. Because there is greater uncertainty regarding the initial match quality of outsiders, it is more difficult for the Board to infer CEO ability from observed firm performance (Bushman et al., 2010; Jenter and Lewellen, 2020). Consequently, outsider CEOs who survive for long tenures tend to be only marginally better than a CEO candidate chosen at random. In other words, successful long-tenured outsider CEOs tend to be lucky (the firm has experienced a sequence of positive shocks during their tenure) while successful long-tenured insider CEOs tend to be good (have high match quality).

We next investigate the role that Board preferences for internal candidates plays in CEO hiring and retention (Agrawal et al., 2006; He and Schroth, 2024). Like many prior studies, we find that the likelihood of hiring outsiders decreases with prior firm performance.[7] To assess the role of Board preferences, we specify a non-pecuniary hiring cost any time a firm undergoes an external succession, and allow this cost to vary with prior performance. We estimate this cost to be negative and significant, suggesting a notable degree of preference for promoting from within. For instance, the median firm is willing to sacrifice approximately $20.5 million dollars in profits to hire an insider. This cost, however, does not vary significantly with prior performance. Thus, the increase in the likelihood of external successions when prior performance is poor cannot be explained by a non-pecuniary desire to "rock the boat."

As discussed above, we find that the match quality of outside CEO candidates is more uncertain than that of insiders. The literature on job matching (e.g., Miller, 1984) implies that outsiders may then have greater option value and are thus more attractive to the Board. However, Lazear (1995) and Chan (1996) argue that a firm's ability to benefit from the upside risk of hiring externally depends on the cost of termination. For example, if termination is costless, the firm can easily fire a poorly performing CEO and replace them with someone new. Consistent with prior results in the literature (Taylor, 2010), we estimate substantial pecuniary and non-pecuniary costs of terminating

[7] See for example: Boeker and Goodstein (1993), Datta and Guthrie (1994), Borokhovich et al. (1996), Parrino (1997), Huson et al. (2001), Agrawal et al. (2006), DeVaro and Morita (2013), Cziraki and Jenter (2021)

the CEO, limiting the Board's ability to realize the option value associated with hiring an outsider. However, our counterfactual simulations indicate that the difference in expected termination costs associated with hiring an outsider versus an insider are smaller when the firm is performing poorly,[8] which increases the likelihood of hiring an external CEO in times of crisis in the hope of achieving a drastic turnaround by drawing an exceptional outsider. We emphasize that in most cases, the screening value and non-pecuniary benefits of hiring insiders generally outweigh the option value of outside candidates.

Our paper makes several contributions to the growing literature using structural models to analyze CEO employment dynamics. We expand previous work by Taylor (2010) to allow for both internal and external CEO successions, utilizing the information structure proposed by Hermalin (2005) to assess disparities in Boards' information quality over the two CEO types. We show that, as hypothesized by Cziraki and Jenter (2021), this asymmetry in information quality has an immense impact on Boards' propensity to favor internal CEO successors over external candidates. Additionally, as discussed by Cvijanović et al. (2023), existing empirical studies on CEO employment dynamics focus predominately on Boards role as an *ex-post* monitor of CEO quality (Taylor, 2010, 2013; Lyman, 2024). Our results underscore the importance of Boards' screening capabilities as a catalyst of high-quality matching *ex-ante*. Furthermore, we show that such screening behavior at the hiring stage has long-lasting effects on the dynamics of CEO quality and turnover. In particular, our estimates imply a markedly lower rate of dynamic selection for externally-hired CEOs relative to internal hires. Adding this margin of ex-ante selection, which accounts for Boards' beliefs about incoming CEOs and future firm performance, allows us to disentangle underlying quality differences from higher screening capabilities, uncovering the main mechanisms generating the observed gap in performance between insider and outsider CEOs. Finally, consistent with recent work by He and Schroth (2024), our estimates highlight the importance of Boards' non-pecuniary preferences for internal candidates in the succession process, suggesting that factors beyond pure profit maximization are given considerable weight when making CEO succession decisions.

The remainder of this paper is structured as follows. Section 2 summarizes the data and key empirical facts motivating the model. Section 3 outlines the structural model with which we analyze Boards' CEO succession decisions and decompose the subsequent gap in insider and outsider CEO performance. Section 4 summarizes our model estimation and identification strategy and Section 5 presents the model estimates. Section 6 discusses the determinants of Boards' choice between internal and external CEOs and Section 7 analyzes insider and outsider CEO performance, paying special attention to the influence of non-random selection at the hiring stage. Section 8 concludes.

[8]Expected termination costs can be thought of as the cost of termination multiplied by the probability of being fired.

2 Data

We construct a panel of more than twenty years of data from all publicly traded firms in the United States and Canada from 1995 to 2019. We use three sources of information: Execucomp, Compustat, and supplementary turnover data from Peters and Wagner (2014) and Jenter and Kanaan (2015). Execucomp provides information on firm CEOs including compensation, firm-specific tenure, demographics, and turnover. Compustat North America provides information on firm fundamentals including balance sheet and income statement items. Notably, we employ operational income before depreciation and total assets to construct the industry-adjusted operational return on assets (IA-ROA), our measure of firm performance.[9] Lastly, the supplementary turnover data allow us to classify cases of CEO turnover as either forced (being fired) or voluntary (retiring).[10]

Our final sample consists of 38,974 observations with 3,278 distinct firms and 6,715 CEO spells.[11] We classify CEOs as *outsiders* or *insiders* using their prior tenure with the firm at the time of appointment: outsiders are CEOs who are not founders of the firm and who have one year of prior experience at the firm or less, insiders are CEOs who are founders or who have more than one year of prior experience at the firm. This threshold of prior experience at the firm to define outsider type follows Parrino (1997). In Appendix A.2.4 we use different thresholds (more and less strict) and show that our estimates are robust to this definition. Panel A of Table 1 shows that outsider spells are slightly less common (39%, 2,588 spells) and outsider-led firms are on average smaller in both total revenue and assets.[12] There are 3,859 instances of turnover in our final sample, 25% of which are forced and the remaining 75% voluntary.

Three main stylized facts in our sample motivate our research question and modeling approach: on average outsider CEOs are outperformed by insiders but the variance in outsider performance is higher; firms that have performed poorly in the recent past are more likely to hire outsiders; and insider type and executive performance are associated with forced separation but not with voluntary departures. We elaborate on these regularities below.

[9] IA-ROA for firm i in year t is defined as $IA\text{-}ROA_{it} = \frac{2*oibd_{it}}{at_{it}+at_{it-1}} - \alpha_{it}^{ind}$, where $oibd_{it}$ is firm operating income before depreciation, at_{it} is firm total assets, and α_{it}^{ind} captures an industry-specific time trend. See Hamilton et al. (2023) for additional details on the construction of IA-ROA using Compustat data.

[10] Peters and Wagner (2014) and Jenter and Kanaan (2015) follow the methodology outlined in Parrino (1997). Data from 1993-2000 comes from Jenter and Kanaan (2015), while data from 2001-2019 come from Peters and Wagner (2014). See Hamilton et al. (2023) for additional details on the forced turnover database.

[11] We follow Peréz-González (2006) in dropping from the sample CEOs with only one year of tenure at the time of turnover as these are likely to be interim employment spells. A total of 312 CEO-year observations were dropped, six of those observations were founder CEOs.

[12] When restricted to CEO hires made within the sample period, we find the percentage of outsider CEO appointments is similar at 35%. Moreover, the percentage of outsider CEO hires is consistent over the sample period. Other studies in the literature have found comparable shares of external appointments with no observable trends in recent years, including 39% in Zhang and Rajagopalan (2010), 28% in Cziraki and Jenter (2021), and 30% in Cremers and Grinstein (2014).

TABLE 1: Summary Statistics

Panel A: Descriptives for Firm-Year Observations

	Outsiders		Insiders		
	Mean	SD	Mean	SD	Difference
Return on assets (ROA)	11.2	(13.1)	13.2	(11.1)	1.93***
Industry-adjusted return on assets (IA-ROA)	-1.37	(12.8)	0.74	(10.4)	2.11***
Assets ($ billions)	11.7	(83.9)	22.9	(129.8)	11.2***
Total revenue ($ billions)	3.64	(10.2)	7.49	(22.7)	3.84***
Observations (firm-year)	13,640		25,334		

Panel B: Descriptives for Firm-CEO Pairs

	Outsiders		Insiders		Difference
	Mean	SD	Mean	SD	
Performance statistics					
Average residual performance ($\tilde{\theta}_{ij}$)	-0.437	(4.77)	-0.043	(3.71)	0.394***
Average residual performance ($\tilde{\theta}_{ij}$), small firms	-0.537	(5.87)	-0.101	(5.09)	0.436**
Average residual performance ($\tilde{\theta}_{ij}$), large firms	-0.275	(3.14)	0.005	(2.38)	0.280***
Observations (firm-CEO)	2,407		3,900		
Turnover statistics					
Voluntary retirement conditional on turnover	0.701		0.782		0.081***
Observations (firm-CEO)	1,409		2,450		

Notes: Standard deviations (SD) are shown in parentheses. Difference is the mean of insiders minus the mean of outsiders. Large (small) firms are those with above (below) median assets. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Assets and revenues are in real billion U.S. dollars indexed to 2016.

Outsider executives exhibit lower average performance and higher variance. Panel A in Table 1 shows that outsider-led firms are outperformed on average by insider-led firms even after adjusting for industry-specific trends. In addition, the standard deviation of ROA and industry-adjusted ROA is larger for firms led by outsiders. These statistics are consistent with the conjectures in Parrino (1997), Hermalin (2005), and Chen and Hambrick (2012) suggesting that outsider executives may be "risky" because their quality is likely to be more variable than the quality of the already known insiders.

To provide motivating evidence regarding CEO quality before controlling for dynamic selection using our structural model, we follow Hamilton et al. (2023) and create a reduced-form descriptive

proxy for CEO quality using residualized performance. We first regress firm performance (IA-ROA) on its lag and a vector of firm and CEO characteristics. Then we compute the average of fitted residuals from this regression for each firm-CEO spell ij. Concretely, we first estimate the regression

$$IA\text{-}ROA_{ijt} = \delta_1 \cdot IA\text{-}ROA_{ijt-1} + \delta_2 \cdot X_{ijt} + \varepsilon_{ijt} \tag{1}$$

where δ_1 and δ_2 are coefficients, and X_{ijt} is a vector of firm and CEO characteristics including total firm assets, CEO tenure and gender, and CEO total compensation. Then, denoting $\hat{\varepsilon}_{ijt}$ as the fitted residuals from estimating equation (1), we compute the within-spell average residual performance as

$$\tilde{\theta}_{ij} = \frac{\sum_t \hat{\varepsilon}_{ij't} \cdot \mathbf{1}\{ij' = ij\}}{\sum_t \mathbf{1}\{ij' = ij\}} \tag{2}$$

The measure $\tilde{\theta}_{ij}$ aims to capture variation in firm performance generated during the spell between firm i and CEO j that is not explained by performance persistence, CEO and firm observables, and industry trends. We use this residual performance measure as a reduced-form descriptive proxy of CEO quality for the exploratory results of this section.[13]

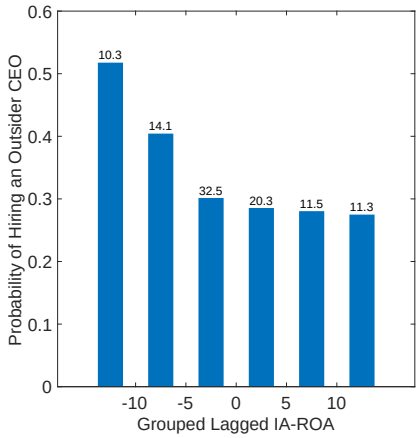
Consistent with results in Hamilton et al. (2023), Panel B of Table 1 shows that for outsider executives the average of residual performance $\tilde{\theta}_{ij}$ computed across firm-CEO pairs is lower but the variance is higher. Since outsiders tend to be employed at smaller firms we also include the average residual performance by firm size in Panel B of Table 1. The results are qualitatively equivalent. While the gap between insiders and outsiders diminishes at larger firms, there remains a substantial difference in residual performance after controlling for firm assets, which suggest that the difference in residual performance between insiders and outsiders is not an artifact of larger, better performing firms hiring insiders. Keeping in mind that our descriptive results are affected by dynamic selection, our reduced-form proxy for CEO quality is consistent with the conjecture that outsider executives offer both lower expected returns to the firm but also a greater upside via their higher variance in executive quality.

Firms that have performed poorly in the recent past are more likely to hire outsiders. Our data reveal that conditional on turnover, the probability that a firm appoints an outsider as CEO decreases with lagged performance. To show this we first group all instances of turnover into six bins determined by the firm's performance (IA-ROA) the year before turnover. Then, we calculate the share of outsider hires within each bin and plot them in Figure 1. At the lowest levels of prior performance (the bar furthest to the left), which account for 10.3% percent of all turnover instances, firms are almost as likely to hire insiders as outsiders. However, as prior performance increases, the

[13] In the rest of the paper, we control for dynamic selection using our structural model and estimate the unbiased distribution of CEO quality by type.

probability of hiring outsiders declines substantially to under one third. This relationship between prior firm performance and the likelihood of hiring externally is consistent with findings in Boeker and Goodstein (1993) and Parrino (1997). Paired with the higher variance in outsider residual performance showed above, this pattern suggests that firms are likely to take higher-variance gambles in periods of low performance hoping to draw exceptional executives from the upper-tail of the "riskier" outsider candidate pool.[14]

FIGURE 1: Outsider CEO Hire Probability Conditional on Turnover and Lagged Performance



Notes: To construct this figure all turnover instances are first grouped into discrete bins using firm performance (IA-ROA) in the year before turnover. The bins, in billion U.S. dollars, are: ≤ -10, $(-10,-5]$, $(-5,0]$, $(0,5]$, $(5,10]$, > 10. The height of each bar represents the probability of hiring an outsider CEO conditional on turnover within each bin. The labels atop each bar represent the share of turnover instances captured by each bin.

Insider type and residual performance are associated with firing but not with voluntary departures. Panel B in Table 1 shows that conditional on turnover, outsider CEOs are less likely to step down voluntarily and hence more likely to be forced out than insider CEOs. To further explore the association between CEO type and turnover we run a descriptive multinomial logit regression of turnover next period (forced, voluntary, no turnover) as a function of current CEO type (insider, outsider), the *current* proxy of CEO quality, CEO tenure, age, and gender, and total firm assets. The current proxy of CEO quality, indexed by t and denoted $\tilde{\theta}_{ijt}$, is the average of residual performance within spell ij up to period t (not over the entire ij spell, as in equation (2)), and it is a descriptive proxy for the assessment of CEO quality at period t.[15] Results in Table 2 indicate that while insider type does not have a significant association with voluntary separation, insider CEOs are 1.7 percentage points less likely to be forced out at any given period than outsiders, holding

[14] Chen and Hambrick (2012) argue that outsider CEO successions provide the highest probability of performance improvements following periods of poor firm performance.

[15] Formally, $\tilde{\theta}_{ijt} = \frac{\sum_{r=0}^{t} \hat{\varepsilon}_{ij'r} \cdot \mathbf{1}\{ij'=ij\}}{\sum_{r=0}^{t} \mathbf{1}\{ij'=ij\}}$.

fixed the current proxy for CEO quality. In addition, Table 2 reveals that the current proxy for CEO quality affects forced turnover but does not have a significant association with voluntary turnover (Warner et al., 1988; Hazarika et al., 2012). A one standard deviation increase in the current proxy for CEO quality is associated with a 0.83 $(\approx 4.15 * 0.199)$ percentage point decrease in the likelihood of forced turnover at any given period. Instead, voluntary turnover seems to be driven by age, tenure and gender (though only 3% of CEOs in the sample are women).[16]

TABLE 2: Marginals of Forced and Voluntary Turnover

	Forced		Voluntary	
	Baseline: 2.9%		*Baseline*: 8.5%	
	$\frac{\partial p}{\partial x}(\%)$	SE	$\frac{\partial p}{\partial x}(\%)$	SE
Current Average				
Residual performance, $\tilde{\theta}_{ijt}$	-0.199***	(0.042)	0.031	(0.032)
CEO characteristics				
Insider	-1.71***	(0.394)	0.033	(0.245)
Tenure	-0.229***	(0.045)	-0.109***	(0.021)
Age	-0.156***	(0.035)	0.542***	(0.076)
Male	-2.07***	(0.802)	1.63**	(0.817)
Total compensation	$8.8e^{-6}$	$(1.4e^{-5})$	$-2.9e^{-6}$	$(1.3e^{-5})$
Firm Characteristics				
Total assets	$3.3e^{-6}$***	$(9.6e^{-7})$	$-5.3e^{-7}$	$(9.7e^{-7})$
Observations	29,001		29,001	

Notes: Marginal effects from multinomial logit regression of forced and voluntary turnover; no turnover is the base outcome. Columns: $\partial p/\partial x(\%)$ are the marginal changes in probability in percentage points; SE are the standard errors of the marginal effects; *, **, and *** denote significance at the 10% level, 5% level, and 1% level, respectively. Rows: Current average residual performance is the average of residual performance (from equation (2)) within spell ij up to period t, it is a descriptive proxy for the current assessment of CEO quality; the base category for CEO type is outsider. The baseline point at which the derivatives are evaluated is the mean of the continuous variables and zeros for all binary variables. The value of the derivative for binary variables is the change in probability from a unit change. Baseline are the probabilities of forced and voluntary turnover evaluated at the baseline point.

While the descriptive results throughout this section suggest a close relation between firms' turnover decisions and CEO type, perceived CEO quality and prior performance, our descriptive proxy for CEO quality in this section is subject to selection concerns at both the entry and exit (survival) margins. In the remaining of the paper we write and estimate an economic model of CEO turnover that endogenizes (and hence controls for) selection on ability and captures the effect of firm performance around the time of hire on firms' hiring choices. We then use the model to

[16] A potential caveat to this result could be the kind of turnover misclassification discussed in Jenter and Lewellen (2020), who argue that the method of Parrino (1997) may classify as voluntary turnover some instances that would be better classified as "performance-induced", and hence closer to forced turnover.

answer two questions through counterfactual decompositions: Why are outsiders outperformed by insiders? Why do firms hire outsiders in bad times?

3 A Dynamic Model of CEO Turnover

Our aim is to weigh the relative importance of various explanations for the prevalence and performance of internal versus external hires, and to disentangle whether the increase in the likelihood of external hires among low-performing firms is due to non-pecuniary preferences unrelated to firm value (e.g. bringing someone new or shaking things up), or due to the option value of high-variance external candidates. We capture these mechanisms and address the selection problem by providing an economic framework that accounts for both selection on unobserved and time-varying beliefs about CEO ability, and selection on prior firm performance. In the model, turnover decisions are made by the firm's board of directors. Each infinitely-lived firm employs a single CEO endowed with time-invariant match quality which is not known with certainty. The Board forms beliefs about their CEO's match quality based on observed firm performance (Engel et al., 2003). Using these beliefs, their expectation over future firm performance, and weighing their preferences for different CEO types (insiders or outsiders), the Board decides each period whether to fire or retain their current CEO. Turnover can also be triggered by exogenous CEO retirements. Upon executive turnover, Boards hire a replacement either from inside or outside the firm. Boards have prior information about the quality of insider candidates.[17] Throughout this section, we index firms (and their Boards) by i, CEOs by j, and years by t.

Firms and CEOs. Each firm employs a single CEO characterized by the set $\{m_{ij}, \theta_{ij}, a_{ijt}, \tau_{ijt}\}$ where $m_{ij} \in \{I, O\}$ is a time-invariant type indicating whether the CEO was hired from within (I) or outside (O) of the company; $\theta_{ij} \in \mathbb{R}$ is a firm-specific, time-invariant match quality that affects firm profitability; $a_{ijt} \in \mathbb{Z}_+$ is the age of the executive; and $\tau_{ijt} \in \mathbb{Z}_+$ is the CEO tenure of executive j in firm i at time t. The hiring age of executives is drawn from the distribution F_a.[18] The quality of CEO candidates is normally distributed with type-specific mean μ_{θ_m} and common variance σ^2_θ. The type-specific mean allows for firm-specific human capital accumulated at lower ranks within the firm to affect the average quality of insider candidates.

CEOs can depart voluntarily or they can be fired. Let v_{it}, $d^f_{it} \in \{0, 1\}$ denote the respective indicators for whether the CEO of firm i retires or is fired. At the beginning of each period voluntary separation is realized. If the CEO retires ($v_{it} = 1$) the firm must hire a replacement. If the CEO does not retire ($v_{it} = 0$) the firm has the option to retain ($d^f_{it} = 0$) or fire ($d^f_{it} = 1$) their CEO. Upon

[17] This assumption captures the information gap that boards face when considering insider and outsider candidates.

[18] F_a is the non-parametric empirical distribution of hiring age (Appendix Figure A.3).

turnover, there are always executive candidates available from both within and outside the firm.

Profitability and information structure. Firm profits are the product of firm profitability Y_{ijt} and book value of assets b_{it}. Firm profitability is given by:

$$Y_{ijt} = \iota_{it} + y_{ijt} - c(v_{it} + d_{it}^{f}) \tag{3}$$

where ι_{it} is an exogenous industry trend, y_{ijt} is the firm-specific component of profitability, and c is the monetary cost of CEO turnover. Firm-specific profitability y_{ijt} follows the mean-reverting process:

$$y_{ijt} = y_{it-1} + \rho(\theta_{ij} - y_{it-1}) + \eta_{ijt} \tag{4}$$

where its mean is given by the match quality θ_{ij} of the current CEO, y_{it-1} is last period's profitability (not indexed by j as the CEO might have been different), $(1-\rho)$ captures persistence in firm performance (thereby affecting the expectations over future performance), and η_{ijt} is an idiosyncratic profitability shock with distribution $N(0, \sigma_{\eta}^2)$. Through its dependence on prior profitability, current profitability y_{ijt} is affected by CEO quality and idiosyncratic shocks from prior periods. Thus, holding the quality of the current CEO constant, firms where the new CEO succeeds a high-quality CEO will on average enjoy higher performance. Upon turnover, whether forced or voluntary, the firm incurs monetary cost c, capturing the financial cost of executive search, severance payouts, and structural disruptions to the firm that occur during managerial transitions. For tractability we avoid modeling the evolution of assets b_{it} and follow Taylor (2010) and Hamilton et al. (2023) assuming that profits are paid out as dividends every period, which ensures that b_{it} remains constant.

Upon turnover, Boards weigh an insider candidate against an outsider competitor. Boards know that the population distribution of candidate quality is $N(\mu_{\theta_O}, \sigma_{\theta}^2)$ but hold no additional information regarding the outsider candidate prior to hiring. Boards have rational expectations so their priors about the match quality of the outsider candidate coincide with the population distribution. For the insider candidate, Boards have knowledge of the candidate's population distribution $N(\mu_{\theta_I}, \sigma_{\theta}^2)$, and observe an additional signal $s_{it} \sim N(\theta_{Iit}, \sigma_s^2)$ about the quality of the insider candidate. The signal is centered on the true match quality of the insider candidate available for firm i at time t, and its variance measures the precision of the signal. The gap between the prior information Boards possess about insider and outsider candidates, which is determined by the signal variance σ_s^2, captures the extent to which fitness for the CEO position is further revealed through experience in lower ranks within the firm. Using Bayes' rule, the board's prior belief regarding the quality of

the insider candidate at t is:

$$\theta_{Iit} \sim N\left(\frac{\sigma_s^2\mu_{\theta_I} + \sigma_\theta^2 s_{it}}{\sigma_s^2+\sigma_\theta^2}, \frac{\sigma_s^2\sigma_\theta^2}{\sigma_s^2+\sigma_\theta^2}\right) \tag{5}$$

where the variance of the prior belief for the insider candidate is smaller than that of the outsider candidate ($\frac{\sigma_s^2\sigma_\theta^2}{\sigma_s^2+\sigma_\theta^2} < \sigma_\theta^2$). Hence, the level of uncertainty about CEO quality that Boards face when hiring from within is at most as large as the uncertainty they face when hiring from outside.

Firm profitability is affected by prior firm performance and by the match quality of the CEO selected for hire. While firms trivially observe prior firm performance, they do not separately observe CEO match quality from idiosyncratic shocks to profitability. Hence, realizations of profitability, as governed by (4), generate a noisy signal of match quality given by $\xi_{ijt} \equiv \theta_{ij} + \frac{\eta_{ijt}}{\rho}$. In response to this signal, Boards use Bayes' rule to update their beliefs $N(\tilde{\theta}_{ijt+1}, \tilde{\sigma}^2_{ijt+1})$ according to:

$$\tilde{\theta}_{ijt+1} = \frac{\sigma_\eta^2\tilde{\theta}_{ijt} + \tilde{\sigma}^2_{ijt}\xi_{ijt}}{\sigma_\eta^2+\tilde{\sigma}^2_{ijt}}; \qquad \tilde{\sigma}^2_{ijt+1} = \frac{\sigma_\eta^2\tilde{\sigma}^2_{ijt}}{\sigma_\eta^2+\tilde{\sigma}^2_{ijt}} \tag{6}$$

Let $B_{ijt} \equiv [\tilde{\theta}_{ijt}, \tilde{\sigma}_{ijt}]$ denote the set of sufficient statistics describing the Board's beliefs about its current CEO. Note that upon turnover, the Board's prior beliefs about outsider and insider executive candidates are $B^0_{Oit} = [\mu_{\theta_O}, \sigma^2_\theta]$ and $B^0_{Iit} = \left[\frac{\sigma_s^2\mu_{\theta_I}+\sigma_\theta^2 s_{it}}{\sigma_s^2+\sigma_\theta^2}, \frac{\sigma_s^2\sigma_\theta^2}{\sigma_s^2+\sigma_\theta^2}\right]$, respectively.

Firm preferences and CEO turnover. The Board of Directors is risk-neutral and forward-looking with discount factor β. It draws flow utility from a combination of firm profits and CEO turnover according to:[19]

$$u_{ijt} = b_{it}\left(Y_{ijt} - \pi d^f_{it} + (\gamma_1 + \gamma_2 y_{ijt-1})\cdot(d^f_{it} + v_{it})\mathbf{1}\{m_{ij} = O\}\right) \tag{7}$$

The flow utility in (7) incorporates the two main economic forces influencing Boards' turnover decisions. In concordance with the financial interests of the firm, the Board draws direct utility from profits. Additionally, the Board's utility is also affected by their turnover decisions. First, the Board incurs a non-pecuniary cost π from firing its CEO, which measures the level of CEO entrenchment (Taylor, 2010; Lyman, 2024).[20] Second, it has preferences for (or against) hiring a replacement from outside the firm which we allow to vary with the firm's prior performance as

[19] An important implication here of extending the standard assumption of firm risk-neutrality to their Boards is that the exogenous industry component of profitability ι_{ijt} has no effect on decision making as it does not affect marginal utility in (7).

[20] Board composition has been found to be highly persistent (Graham et al., 2020). Hence, we assume the non-pecuniary cost of firing a CEO to also remain stable over time. See Appendix A.1.3 for further discussion.

measured by its lagged firm-specific profitability y_{it-1}.[21] Parameter γ_1 measures Boards' "baseline" preference for hiring externally, while γ_2 measures the extent to which these preferences vary with prior firm performance. These features of the model allow us to assess the relative importance of non-pecuniary motives for hiring from outside versus profit-driven option-value incentives.

Following our descriptive results in Table 2, voluntary departures ($v_{it} = 1$) do not depend on beliefs about CEO quality. They are exogenous and occur with probability $g(a_{ijt}, \tau_{ijt}, m_{ij})$.[22] If voluntary turnover occurs, the Board must hire a replacement. If it does not occur, the Board first makes a decision over whether to fire or retain the current CEO. Given state $x_{it} = (m_{ij}, B_{ijt}, a_{ijt}, y_{it-1})$, the Board decides whether to fire or retain by solving:

$$\max_{r \in \{0,1\}} \{V_r(x_{it}) + \nu^1_{rit}\} \tag{8}$$

where $V_0(x_{it})$ and $V_1(x_{it})$ denote the respective values of retaining and firing the current CEO, and ν^1_{rit} are independent Gumbel-distributed preference shocks associated with each alternative. The value of firing the CEO is impacted by the non-pecuniary cost of firing and the expected value of hiring a successor:

$$V_1(x_{it}) = -d^f_{it}\pi + \mathbb{E}\left[\max_{m \in \{I,O\}} \{V_0(x^m_{it}) + \nu^2_{mit}\} \,\middle|\, x_{it} \right] \tag{9}$$

where x^m_{it} denotes the initial state conditional on hiring a CEO of type m, and ν^2_{mit} are independent Gumbel-distributed preference shocks associated with each alternative. Note that the monetary impact of forced turnover (the cost c) is implicit in the second term in (9), as the conditional value functions incorporate the impact of CEO departure on profits. Expectations are computed over future firm performance, the prior signal of insider quality s_{it} (which determines initial beliefs), over the age of CEO candidates, and over the preference shocks.

The value of retaining a CEO is composed of flow profits, the possibility of future voluntary departures, and the future value of the firing/retention decision:

$$V_0(x_{it}) = \mathbb{E}\left[Y_{ijt} + \beta \left(v_{it+1} V_1(x_{it+1}) + (1 - v_{it+1}) \max_{r \in \{0,1\}} \{V_r(x_{it+1}) + \nu^1_{rit+1}\} \right) \,\middle|\, x_{it} \right] \tag{10}$$

where v_{it+1} is the indicator of whether the current CEO will departure voluntarily at the beginning of next period. Note that our assumption of constant firm assets allows b_{it} to be dropped from the

[21] Alternatively, prior performance could be measured by overall profitability Y_{ijt}. We opt for using the firm-specific component of profitability y_{it-1} as it nets out industry trends that individual executives likely take as given. Hence, we assume that the pressure Boards may face to "clean house" and hire from outside when doing poorly comes from their performance net of industry trends. Our descriptive results in Figure 1 are consistent with this modeling choice. A similar approach is used by He and Schroth (2024).

[22] In practice, $g(z) = (1 + exp(-z))^{-1}$ where z represents an index function of tenure, age, and type indicators. See Appendix A.2.2 for more details.

decision problem. Expectations are computed over profitability (using current beliefs), over the future state, and over future preference shocks. The optimal firing and hiring decisions characterized in this section capture both the effect of prior performance on current beliefs as well as the expectations Boards have regarding future firm performance, the latter affected by CEO quality, profitability persistence, and additional idiosyncratic variation.

4 Identification and Estimation

We estimate the model using the Simulated Method of Moments (SMM). The model has four sets of parameters to identify and estimate: voluntary turnover, CEO ability, firm profitability, and board utility. The parameters of the index function $\tilde{g}$ are identified off of variation in voluntary turnover rates across CEO age, type, and tenure. Following our results in Table 2, our exclusion restriction is that boards' beliefs do not directly affect voluntary turnover.

Next, we argue how we disentangle the scale parameters σ_θ, σ_ε, and σ_s. As discussed in Taylor (2010) and Lyman (2024), σ_ε is identified off of within-spell variation in firm ROA while σ_θ is identified off of across-spell variation in firm ROA. The precision of the insider signal, determined by σ_s, affects the ex-post distribution of insider match quality. As the precision of the signal increases, board selectivity over insider match quality increases, which will concentrate the distribution of insider match quality among higher values. Our identifying restriction is that there is no such pre-hire selection mechanism available for outsiders. Thus, the difference in residual performance variation across insider and outsider CEO spells helps identify σ_s. Define $\hat{\varepsilon}_{ijt}$ as the persistence-adjusted IA-ROA generated by match ij at t; concretely, $\hat{\varepsilon}_{ijt}$ is the estimated residual from regressing the IA-ROA (y_{ijt}) on its lag (y_{ijt-1}). To pin down σ_θ and σ_ε, we compute the following measures for each CEO-firm match using the persistence-adjusted IA-ROA:

$$\bar{\varepsilon}_{ij} \equiv \mathbb{E}_{ij}[\hat{\varepsilon}_{ijt}]; \qquad \bar{\sigma}_{ij} \equiv Var_{ij}(\hat{\varepsilon}_{ijt}) \tag{11}$$

where $\bar{\varepsilon}_{ij}$ and $\bar{\sigma}_{ij}$ are the within-spell average and variance, respectively, of $\hat{\varepsilon}_{ijt}$ over CEO i's employment with firm j. To disentangle σ_θ, σ_ε, and σ_s, our targeted moments include: the within-spell variance of $\hat{\varepsilon}_{ijt}$ averaged across all CEO-firm matches $\mathbb{E}[\bar{\sigma}_{ij}]$, the sample counterpart of σ_ε; the variance of $\bar{\varepsilon}_{ij}$ across all employment spells $Var(\bar{\varepsilon}_{ij})$, which carries information about the population standard deviation of match quality σ_θ^2; and the variance of $\bar{\varepsilon}_{ij}$ across all insider spells $Var_I(\bar{\varepsilon}_{ij})$. The difference between $Var(\bar{\varepsilon}_{ij})$ and $Var_I(\bar{\varepsilon}_{ij})$ carries information about the variance of the insider signal σ_s^2.

The means of the distributions of candidate quality (μ_{θ_O}, μ_{θ_I}) along with the persistence ρ and the turnover monetary cost c from the firm profitability process are identified off of variation in

firm IA-ROA across time, CEO type, and around turnover events. To aid identification of these parameters, we target the coefficients of the following regression of IA-ROA on its lag, an insider indicator, and indicators for CEO turnover:

$$y_{ijt} = \delta_0^y + \delta_1^y \, insider_{ijt} + \delta_2^y \, y_{ijt-1} + \sum_{s=-1}^{1} \delta^s (d_{i,t+s}^f + v_{it+s}) + \varepsilon_{ijt}^y \tag{12}$$

Coefficients δ_0^y and δ_1^y carry information about μ_{θ_O} and μ_{θ_I}, respectively. Coefficient δ_2^y, measuring the empirical rate of persistence, carries information about ρ. Coefficients δ^s capture the effect of recent turnover, these are most informative about the turnover cost c. Because hiring and forced turnover are endogenous, the identification of μ_{θ_O}, μ_{θ_I}, and c critically depends on our modeling of the hiring and firing decisions which takes into account time-varying unobservable beliefs and firm performance persistence.

Next, we discuss identification of the preference parameters π measuring the non pecuniary cost of firing, and (γ_1,γ_2) measuring preference for, or against, outsider transitions. Conditional on the previous parameters determining profitability and belief formation, π is identified off of the empirical rate of CEO termination. We target the coefficients of the following forced turnover regression:

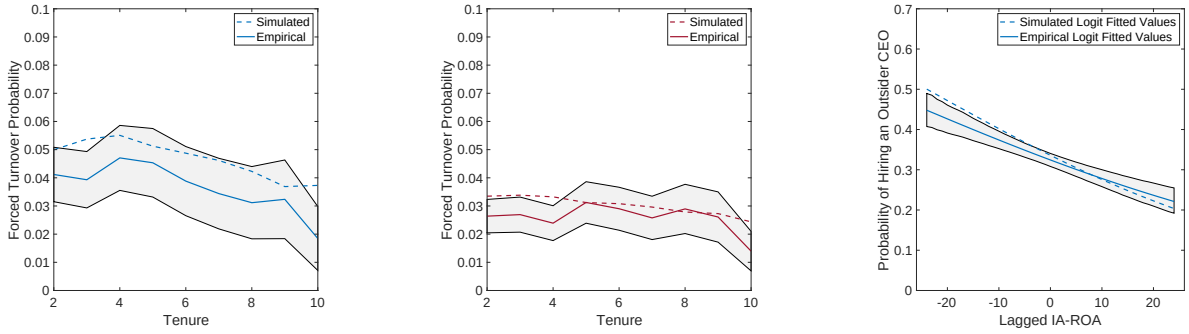
$$d_{ijt}^f = \sum_{s=1}^{4} (\delta_{0,s}^d + \delta_{1,s}^d insider_{ijt}) \cdot \tau_{ijt}^s + \varepsilon_{ijt}^d \tag{13}$$

where τ_{ijt}^s are indicators for four tenure bins $\{(1,2),(3,4),(5,7),(8,\infty)\}$. While the coefficients $\delta_{0,s}^d$ carry information regarding π, the differential rates of forced termination captured by $\delta_{1,s}^d$ carry additional information regarding the insider signal variance σ_s. This is because boards in the model are ex-ante more informed about insider quality relative to outsiders, which will then be reflected in differential rates of forced termination. Finally, the outsider hiring gradient by prior performance illustrated in Figure 1 helps identify the preference parameters γ_1 and γ_2. Here we target the coefficients of a logistic regression of the type of CEO hired on prior performance.

We jointly estimate all parameters and match a total of 27 moments.[23] At the firing margin, Panels (a) and (b) of Figure 2 compare the empirical and simulated forced turnover rates for outsiders and insiders, respectively. The model replicates well the low rates of forced turnover with the simulated hazards for both types of CEOs. The simulated hazards fall within the 95 percent confidence interval of their empirical counterparts for almost all levels of CEO tenure, remaining very close to the confidence interval otherwise. At the hiring margin, the model's simulations closely match the empirical gradient of outsider hiring across the distribution of prior firm performance,

[23] See Appendix A.2.3 for more details on the moments, estimation routine, and model fit.

FIGURE 2: Model Fit



(a) Outsider Hazard (b) Insider Hazard (c) Hire Probability

Notes: The shaded gray region indicates 95% confidence intervals around the empirical forced turnover rates and hiring probabilities.

as illustrated in Panel (c) of Figure 2.

5 Structural Estimates

We find that once we control for selection using our model, there is only a minor difference in average quality between outsider and insider CEO candidates in the population. Our structural estimates in Table 3 indicate a slight gap between the mean quality of outsider and insider CEO candidates, μ_{θ_O} and μ_{θ_I}, respectively.[24] This is consistent with the view that firm-specific human capital accumulated within the firm provides only a small benefit for internal CEO candidates. At first glance, this finding is puzzling because our descriptive statistics in Table 1 show a substantial advantage in average firm performance for firms led by insiders. However, these descriptives do not account for selection at both the hiring and firing margins. Our analysis highlights two key explanations for the puzzle. First, as illustrated in Figure 2, insiders are disproportionately likely to be hired by firms that have been performing well. This endogenous hiring bias is exacerbated by the high persistence in firm performance, estimated to be 0.794 $(1-\rho)$. Hence, holding CEO quality constant, observed firm performance will on average be persistently higher following the appointment of an insider CEO versus an outsider. This is one of the reasons why insiders appear to be of much higher quality in descriptive statistics that do not account for selection.

A second reason explaning the puzzle is that insider candidates are substantially better screened than outsiders. The estimates of σ_θ^2 and σ_s^2 together imply that the variance of Boards' beliefs over the quality of an insider candidate is roughly half that of an outsider candidate.[25] In other words, Boards face roughly half the uncertainty when hiring internally than when hiring externally. Our

[24] Recall that since our measure of profitability is the IA-ROA, the parameters in Table 3 are expressed in terms of a percentage of firm assets.

[25] This comes directly from the belief updating rule (5): $\frac{\sigma_s^2\sigma_\theta^2}{\sigma_s^2+\sigma_\theta^2} = 0.429$

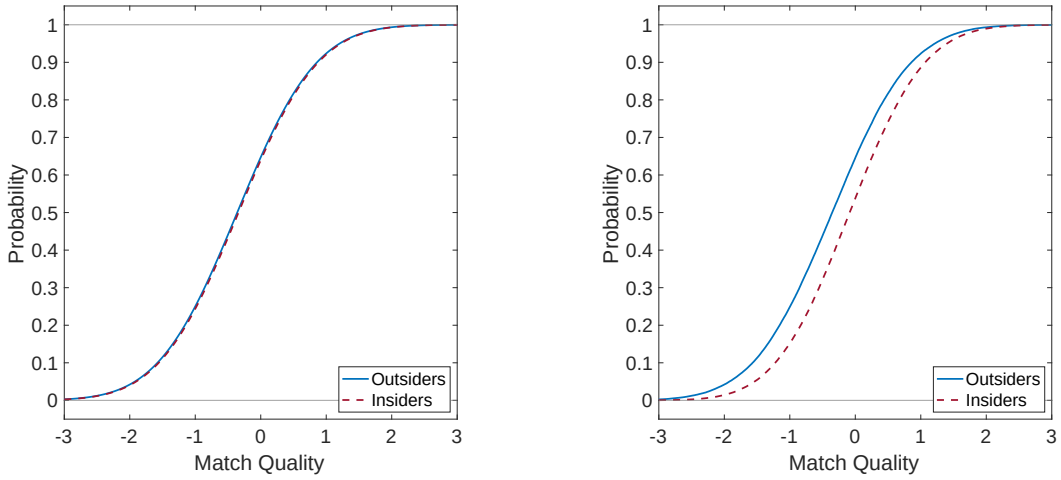
TABLE 3: Structural Estimates

CEO Ability and Insider Signal				*Profitability*			*Preferences*		
μ_{θ_O}	μ_{θ_I}	σ^2_θ	σ^2_s	σ^2_η	ρ	c	π	γ_1	γ_2
-0.359	-0.340	0.904	0.816	44.32	0.206	0.688	3.919	-0.886	-0.023
(0.089)	(0.029)	(0.043)	(0.134)	(0.305)	(0.007)	(0.282)	(0.301)	(0.100)	(0.022)

Notes: Standard errors are shown in parentheses. Since our measure of profitability is the IA-ROA, the parameters are expressed in terms of a percentage of firm assets. We relegate estimates of our voluntary turnover model to Table A.3 in Appendix A.2.2. We note that as in Table 2, CEO age is by far the strongest predictor of voluntary departures. Furthermore, we confirm the reduced-form finding that CEO type has no significant impact on voluntary turnover.

estimates in Table 3 imply that insider and outsider CEO candidates share very similar (ex-ante) distributions of match quality (Figure 4(a)). However, conditional on being hired, the (ex-post) distribution of insider match quality stochastically dominates that of outsiders (Figure 4(b)). Thus, despite coming from virtually the same population distribution, the Boards' superior screening capabilities regarding internal candidates enables the hiring of insider CEOs that will on average exhibit higher levels of performance over their careers than outsider CEOs.

FIGURE 3: Distribution of Match Quality Among CEO Candidates and Hired CEOs

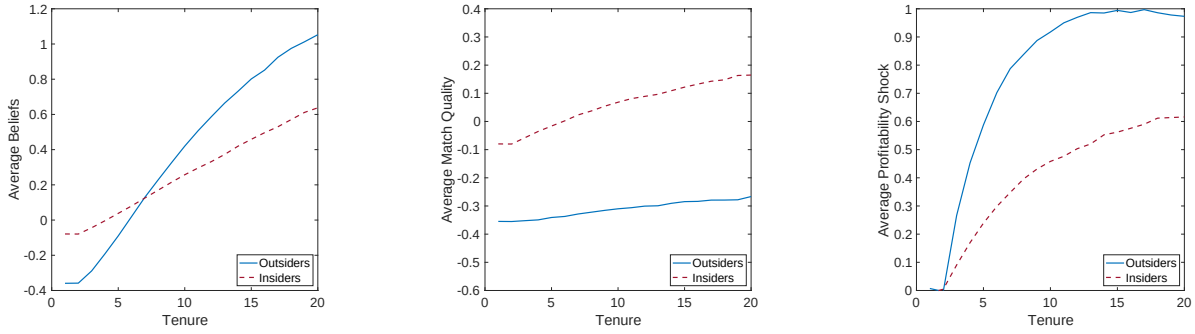


(a) CEO Candidates (Ex-Ante) (b) Hired CEOs (Ex-Post)

Notes: Panel (a) plots the CDFs of the estimated population match quality distributions $N(\mu_{\theta_O}, \sigma^2_\theta)$ and $N(\mu_{\theta_I}, \sigma^2_\theta)$. Panel (b) plots the CDFs of match quality conditional on being selected for hire.

The greater ability to screen internal executive candidates has long-lasting effects on the dynamic selection of internally and externally-hired CEOs. For instance, the resulting posterior variance of boards' beliefs is relatively higher for outsiders and therefore more sensitive to additional signals of CEO quality. These signals (Equation (6)) contain CEO quality but also firm idiosyncratic variation; in other words, luck. The two components are harder to disentangle when firms

FIGURE 4: Selection, Luck, and Belief Dynamics



(a) Average Beliefs $\tilde{\theta}_{ijt}$ (b) Average Match Quality θ_i (c) Average Cumulative η_{ijt}

Notes: Panel (a) plots the trajectory of firms' average beliefs regarding CEO-firm match quality over tenure by CEO type. The next two panels decompose beliefs into its composite parts; Panel (b) plots average match quality across tenure by CEO type, while Panel (c) plots the cumulative average residual from the profitability process over tenure by CEO type. The decomposition reveals that while there is dynamic selection in the quality of insiders, luck (captured in Panel (c)) plays a larger role in the retention of outsiders as tenure progresses.

hire outsiders. Consider the trajectory of average beliefs over tenure for insiders and outsiders (Figure 5(a)). Dynamic selection results in a positive gradient of average beliefs over tenure for both types of CEOs as executives of perceived low quality are filtered out.

The factors underlying the positive gradient of average beliefs over tenure observed in Figure 5(a) differ greatly by CEO type. We decompose the trajectory of average beliefs into its two components: CEO match quality (Figure 5(b)) and firm-specific shocks, i.e., luck (Figure 5(c)). First, while there is dynamic selection in the match quality of insider CEOs, this process is muted in the case of outsider CEOs. On average, Figure 5(b) shows that outsider CEOs who survive into late years of tenure are only marginally better than a CEO candidate chosen at random. Second, to measure luck among surviving CEOs we compute the cumulative average of idiosyncratic variation (η_{ijt}) over a given CEO's employment spell. Figure 5(c) shows that for both outsiders and to a considerably lesser extent insiders, the measure of cumulative luck increases with tenure, suggesting that a portion of CEOs are retained primarily as a result of luck. Thus, while firms can be more certain that long-tenured insiders are of relatively high quality, the same cannot be said of outsiders. The positive beliefs keeping long-tenured outsider CEOs from being fired are almost entirely explained by luck.

The higher level of uncertainty associated with external hires is costly because CEO replacement is very expensive, slowing the speed at which firms move on from low-performing executives (Jenter and Lewellen, 2020). The cost of CEO replacement has a monetary and a non-pecuniary component. The monetary cost of turnover (c) is estimated to be .688% of total assets, equivalent to roughly $15.6 million for the median-sized firm. This cost reflects a variety of expenses such as severance, executive search fees, or other general disruptions to firm operations upon CEO re-

placement. The non-pecuniary cost of turnover (π), incurred only if the CEO is fired, is substantial. The estimated value of π is 3.9% of total assets or roughly \$90.1 million for the median-sized firm, suggesting that the level of CEO entrenchment is high (Taylor, 2010; Lyman, 2024). Putting these pieces together, the effective cost of firing an incumbent CEO (monetary plus non-pecuniary) is \$105.9 million for the median-sized firm.[26] Entrenchment, captured by π, effectively raises the cost of forced CEO replacement by a factor of 6.7.

In addition to beliefs regarding CEO quality and the anticipation of future turnover costs, the Boards' hiring decisions are influenced by non-pecuniary preferences against outsider candidates (negative and significant γ_1). This result can be explained by a number of factors, including the prevalence of firm personnel with familial ties to board members (Hamilton et al., 2023), burdensome search efforts associated with external hires (Geelen and Hajda, 2024), and adverse incentive and morale effects on lower-ranked executives following external appointments (Parrino, 1997). For the median sized firm, our estimate of γ_1 implies that the Board is willing to sacrifice approximately \$20.5 million in firm profits to hire an insider. The Board's preference against outsiders only weakly varies with prior performance. While we find that boards' preference against outsiders shrinks when prior firm performance has been weak (negative γ_2), this gradient is very small and statistically insignificant. Therefore, the negative relationship between prior performance and external hires illustrated in Figure 1 cannot be explained by non-pecuniary preferences alone. Rather, we show in the next sections that this relationship is explained largely by the disparity in information over internal and external candidates. When prior performance is low, firms are more willing to roll the dice with a risky outsider in hopes of a sharp turnaround. Conversely, Boards are more likely to play it safe with internal hires, which they prefer, following periods of good firm performance.

Sensitivity analysis. Before using our estimates for counterfactual exercises, we assess their sensitivity to the definition of outsider in the data, and to various changes to the structure of the baseline model. Extended results are presented in Appendix A.2.4. Our main estimates are robust to most of the changes. Our first sensitivity test is around the definition of outsider (Parrino, 1997). For this we reestimate the model using either a stricter or more lax definition of outsider.[27] Both sets of estimates yield similar results that do not qualitatively change our findings.

Second, since part of the literature has raised concerns regarding the predictive power of the standard Bayesian learning model in the context of CEO turnover (Jenter and Lewellen, 2020),

[26] The median-sized firm has roughly \$2.3 billion in assets.

[27] The definition in Parrino (1997) categorizes as outsider CEOs those with one or fewer years of prior experience at the firm at the time of hire. We estimate the baseline model changing the outsider cutoff of prior experience at the firm to either zero years of prior experience (stricter definition) or two or fewer years of prior experience (looser definition).

we assess the sensitivity of our estimates to changes to the learning structure. We estimate two types of models, memory decay and limited recall, that allow firms to more heavily rely on recent information when updating their beliefs about CEO quality. In the memory decay model, firms use all prior information but place more weight on recent signals. In the limited recall model, a starker change, firms only use information received in recent periods, "forgetting" any prior information outside a specific time window.[28] Estimates from the memory decay model indicate that our results are robust to levels of memory decay used in the literature. Estimates from the limited recall model yield the most differences relative to our baseline but also seem to offer the poorest fit (Appendix Figure A.6). The limited recall model yields a less informative pre-hire signal of insider quality, loading the observed difference in profitability between insider and outsider-led firms to large differences in the average quality of insider and outsider candidates, which is inconsistent with other findings in the literature (Jenter and Kanaan, 2015). This model also yields a very high level of persistence in profitability ($1-\rho = 0.986$), which contradicts prior results in the literature (Taylor, 2010) and greatly minimizes the contribution of CEO quality to firm profitability.

Finally, given the nonlinearity of the relation between outsider hiring and prior firm performance (Figure 1), it is possible that our parsimonious linear gradient of preferences conditional on prior performance (the linearity of γ_2) may not fully capture firms' preference for hiring externally during bad times. We test the sensitivity of our results to this specification by estimating alternative models that allow the non-pecuniary preference for outsiders to be a non-linear function of prior firm performance. Our results are robust to such nonlinear specifications.

6 Why Do Firms Hire Outsiders in Bad Times?

We first use our model to decompose the main drivers of Board hiring decisions and to understand the association between prior firm performance and outsider hiring. Various mechanisms influence firm hiring decisions in the model: differences in the quality of insider and outsider candidates, non-pecuniary preferences over internal hires, the anticipation of future turnover costs, and differences in option value associated with insider and outsider hires. We sequentially shut off these mechanisms in counterfactual experiments to isolate their effect on the realized rate of external hiring and on its gradient over prior firm performance. We find that preference for internal candidates have a large impact of the level difference in hiring probabilities between CEO types. However, non-pecuniary preferences for outsiders in times of poor firm performance cannot explain the gradient between the probability of outsider hiring and prior firm performance.

[28] In the memory decay model, we set the decay weight to 0.9, a common benchmark used in such models (Malmendier and Nagel, 2015). For the starker recency bias in the limited recall model, we implement a memory cutoff of 5 years which approximates the near zero weight that a memory decay model with decay parameter of 0.5 would place on any information received more than five years ago.

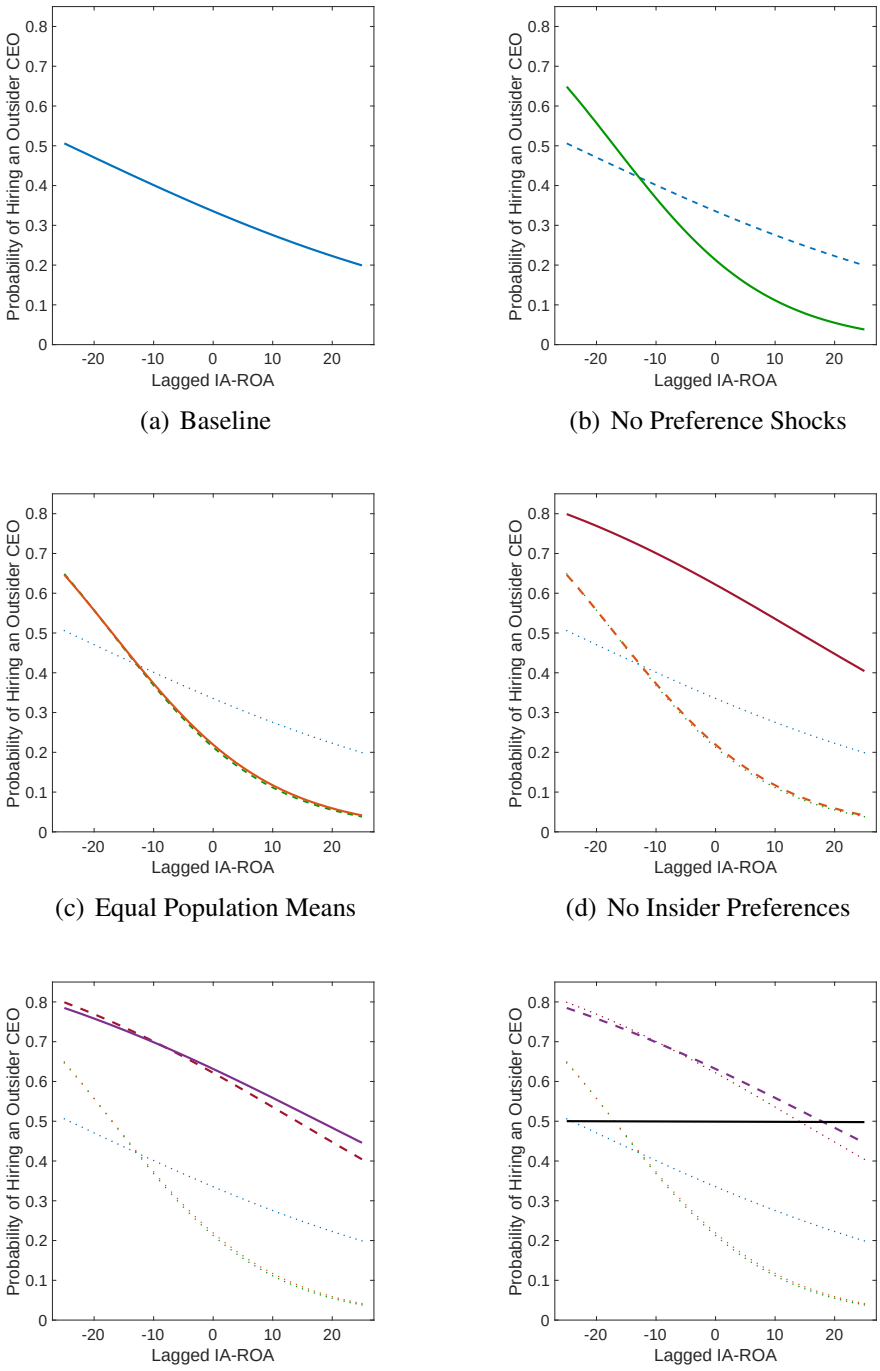
This gradient is explained by boards' superior information regarding the match quality of insider candidates, which provides incentives for firms to increase riskier external hiring in times of crisis.

To perform our counterfactual analyses, we fix the number of years and firms in each simulation to match that of the sample used in estimation. To minimize simulation error each scenario is run independently twenty times and results are averaged across iterations. Starting from our baseline, Panel (a) of Figure 5 plots the simulated probability of hiring an outsider CEO (conditional on turnover) by prior firm performance before any mechanism is shut off. To help clarify the exposition of the economic mechanisms we first remove in Panel (b) the preference shocks. Unsurprisingly, idiosyncratic preferences for CEO types, which add randomness to firm choices, attenuate the systematic association between prior firm performance and the hiring rate of outsiders. The next step in Panel (c) equalizes the means of the distributions of CEO candidate quality (μ_{θ_O} and μ_{θ_I}) at the estimated value for outsiders, effectively decreasing the average quality of insider candidates. Within our framework, this step is akin to eliminating any relative advantage in performance stemming from prior human capital acquired within the firm. Because the estimated difference in means is minuscule (Table 3), this change leaves both the hiring rate and its gradient virtually unchanged, suggesting that differences in average quality between internal and external candidates do not explain the difference in hiring rates between both candidate pools.

Next, we assess the importance of Boards' systematic non-pecuniary preferences for outsider candidates by setting the parameters capturing these preferences (γ_1 and γ_2) to zero. Since we estimated a sizable preference in favor of internal candidates (the large and negative γ_1 in Table 3), Panel (d) shows that eliminating this preference substantially increases the probability of outsider hiring. Additionally, Panel (d) shows a slight attenuation of the hiring profile over prior firm performance. The attenuation towards a more horizontal profile follows from the fact that the estimated value of γ_2 is negative. Hence, by setting γ_2 to zero, the counterfactual exercise eliminates the marginal increase in the non-pecuniary preference for outsiders in bad times. However, since the estimated magnitude of this preference gradient is rather small, Panel (d) shows that the attenuation that occurs is fairly moderate. Therefore, while preferences for internal candidates play a large role in the level difference in hiring probabilities between CEO types, these preferences play a much smaller role explaining the higher rate of outsider hires in times of poor firm performance.

From here, we assess the impact of turnover costs by setting to zero the estimated monetary and non-pecuniary costs of turnover (c and π). Panel (e) shows a moderate attenuation of the hiring gradient with slightly more outsiders being now hired during times of high firm performance. Since the estimated costs of turnover are positive, dropping these costs decreases the relative degree of risk associated with experimenting with CEO candidates. This effect is relatively stronger for outsider candidates, who have a higher probability of future turnover (Figure 2). In the presence of turnover costs, boards are more willing to gamble with outsider hires when prior performance

FIGURE 5: Counterfactual Outsider Hiring Probabilities



(a) Baseline

(b) No Preference Shocks

(c) Equal Population Means

(d) No Insider Preferences

(e) No Turnover Costs

(f) Insider Information and Hiring Parity

Notes: Figure 5 sequentially decomposes the simulated hiring profile in five steps. Starting with the baseline case (Panel (a)), we remove the Gumbel preference shocks v^1_{rit} and v^2_{mit} from the model and show the change in Panel (b). The solid line indicates the new hiring profile, while the dashed line indicates the hiring profile in the previous step of the decomposition, and is included for reference. In Panel (c) we set μ_{θ_I} equal to μ_{θ_O} and plot the resulting change. In Panel (d) we set both $\gamma_1 = \gamma_2 = 0$. In Panel (e), we set both $\pi = c = 0$. Finally, our last counterfactual in Panel (f) removes the insider signal s_{it} from the model; at this point insiders and outsiders are ex-ante identical. The results of this decomposition illustrate that while non-pecuniary preferences explain most of the low level of external hires, insider information explains the majority of the slope.

is poor. Removing these costs decreases the disparity in risk associated with hiring insiders and outsiders, lessening the sensitivity of board hiring decisions to prior performance.

The final step of our decomposition exercise removes the asymmetry in the prior information firms have about insider versus outsider candidates. This exercise is akin to eliminating the information value of prior interactions between internal candidates and the Board of Directors. The equalized and flattened probability of hiring for insider and outsider candidates in Panel (f) shows that at this point in the sequence of counterfactual experiments both types of CEO candidates are ex-ante identical, and the hiring decision becomes independent of prior performance. The magnitude of the change in slope between the previous step of the decomposition and the last step removing the asymmetry in prior information is the largest. This reveals that Boards' superior information over insider candidates explains most of the gradient between the probability of outsider hiring and prior firm performance. As discussed previously, Boards' prior information over insider quality reduces the risk of hiring these candidates. Outsider candidates, who are relatively more risky, are more preferable when prior firm performance is low and Boards are more willing to take risks hoping for a severe turnaround. Equating the relative levels of risk associated with both CEO types makes prior firm performance effectively irrelevant when deciding who to appoint as a successor CEO. Hence, the observed gradient in Figure 1, a source of selection bias when assessing the quality of outsider CEOs is simple descriptives, is driven primarily by differences in prior information between candidate types and the resulting option value associated with hiring externally, not by differences in non-pecuniary preferences for bringing fresh candidates from outside during times of poor firm performance.

7 Why Do Insiders Outperform Outsiders?

In the previous section we showed that the observed gradient between the probability of hiring outsiders and prior firm performance is mostly driven by the larger amount of prior information firms have about their internal candidates. However, this higher, endogenous, probability of hiring outsiders in bad times begs a question: Is the main reason why insiders seem to outperform outsiders on average (Table 1) that outsiders are endogenously more likely to be hired in bad times? The answer to this question is not trivial because dynamic selection, which works fairly differently for outsider and insider CEOs (Figure 4), could also explain the difference in observed performance. Our analysis confirms that the endogenous relation between prior firm performance and the likelihood of hiring and outsider is the main culprit behind the gap observed in Table 1. Consistent with our results in Section 6, the main model mechanisms generating the gap are the differences in prior information regarding insider and outsider candidates, and systematic differences in non-pecuniary preferences for CEO types.

To answer the question of why insiders outperform outsiders, we first isolate the impact of prior performance by allowing for firms to hire and fire their CEOs optimally but then counterfactually randomize the initial condition of prior performance *after* the optimal hiring decision has been made, using the empirical distribution of prior performance conditional on turnover. This approach holds fixed the initial condition while still allowing firms to optimally hire and fire their CEOs based on the economic mechanisms of the model. We measure performance as annual profits, where we scale firm-year ROA by the total assets of the median-sized firm in our sample.

The first row of Panel A of Table 4 shows a baseline profitability gap of roughly $24 million in favor of insiders. However, the second row indicates that the gap disappears when the initial condition is randomized after the optimal hiring decision has been made. Consistent with prior literature (Allen et al., 1979; Shen and Cannella, 2002; Quigley et al., 2019), our results confirm that prior performance at the time of hire is a main driver of the observed gap in firm performance observed between insider and outsider-led firms. Since the higher rate of external hiring among firms with low prior performance is endogenous, we now use the structure of the model to study how the gap changes as we shut off the various mechanism driving the dynamic selection of CEOs. Following the same sequence from the previous section, we counterfactually decompose the overall performance gap starting with the baseline case and ending with the extreme case in which insiders and outsiders are ex-ante identical. Panel B of Table 4 reports the results of this exercise. In addition to expected annual profits, the Panel also reports the difference in the ex post average match quality of insider and outsider CEOs at the time of hire. Comparison of the difference in CEO match quality with the performance gap under each counterfactual simulation indicates the potential impacts of selection and the state of the firm at the time the CEO is hired.

As shown in the previous section (Figure 5, Panel (b)), idiosyncratic preferences for CEO types add substantial randomness to firm choices. Hence, removing the preference shocks (Table 4, Panel B, row (2)) sizably increases the performance gap as decisions are now more driven by the systematic components of firms' objective functions. Next, we equalize the mean of the distributions of candidate quality $\mu_{\theta_I} = \mu_{\theta_O}$ (Panel B, row (3)) and eliminate the preference parameters γ_1 and γ_2 (Panel B, row (4)). Given the small advantage in average candidate quality in favor of insiders, equalizing the means of the distributions contributes minimally to closing the gap. A much larger reduction in the gap is obtained when we then set the preference parameters γ_1 and γ_2 to equal zero. This generates two effects: First, in the absence of non-pecuniary preferences, the Board is much more selective when hiring insider candidates: the second column of Panel B shows that difference in match quality between insider and outsider at the time of hire more than doubles. Second, despite the impact on CEO quality, the last column of row (4) shows that the performance gap narrows. According to Panel (d) in Figure 5, this paradoxical result follows from a heterogenous effect of non-pecuniary preferences for CEO types along the support of prior performance at the

TABLE 4: Gap in Firm Performance from Model Decomposition ($ Millions)

Panel A: Gap in Firm Performance Conditional on Prior Performance Initial Condition

	$\mathbb{E}[Y_t\|I]$	$\mathbb{E}[Y_t\|O]$	$\mathbb{E}[Y_t\|I] - \mathbb{E}[Y_t\|O]$
Baseline	297.8	273.9	23.94
Randomized prior firm performance upon hire	317.7	321.5	-3.80

Panel B: Gap in Firm Performance as Model Mechanisms Are Shut Off

	$\mathbb{E}[\theta_I] - \mathbb{E}[\theta_O]$	$\mathbb{E}[Y_t\|I]$	$\mathbb{E}[Y_t\|O]$	$\mathbb{E}[Y_t\|I] - \mathbb{E}[Y_t\|O]$
(1): Baseline	0.277	297.8	273.9	23.94
(2): No preference shocks	0.277	306.8	242.2	64.61
(3): (2) and $\mu_{\theta_I} = \mu_{\theta_O}$	0.264	305.6	244.0	61.60
(4): (3) and $\gamma_1 = \gamma_2 = 0$	0.645	310.2	277.8	32.38
(5): (4) and $\pi = c = 0$	0.707	315.6	277.2	38.36
(6): (5) and no insider signal	-0.002	286.8	286.3	0.50

Notes: Table 4 reports the gap in average firm performance between insider and outsider-led firms as model mechanisms are sequentially shut off, using the same sequence of steps as in Figure 5. We fix the number of years and firms in each simulation to match that of the estimation sample. Flow profitability Y_{ijt} follows Equation (3). Industry trends ι_{it}, the year t average of ROA within the industry of firm i, are drawn directly from the data. We convert units of profitability to dollars by scaling results by the total assets of the median-sized firm. The first row in *Panel A* is a counterfactual exercise in which firms are allowed to hire and fire their CEOs optimally but their prior-performance initial condition is randomized *after* the optimal hiring decision has been made, using the overall distribution of prior performance conditional on turnover.

time of hire. Eliminating the preference parameters increases the likelihood of hiring externally overall, but the increase is much larger during good times than during bad ones. The resulting average effect is dominated by the higher impact on external hiring during good times.

Setting both pecuniary and non-pecuniary turnover costs (π, c) to zero slightly increases the gap as it increases average insider performance (Panel B, row (5)). As discussed in prior literature (Taylor, 2010; Hamilton et al., 2023; Lyman, 2024), eliminating turnover costs increases the rate at which low-quality CEOs are filtered out. However, as shown in Figure 4, Boards are more able to dynamically select insiders of good quality due to their superior prior information regarding internal candidates combined with the high level of idiosyncratic variation in firm performance. Thus, removing turnover costs enhances average insider performance through improved selection.

Lastly, eliminating differences in prior information, which renders insider and outsider CEOs ex-ante identical, eliminates the last systematic difference between firms lead by insiders and outsiders, thereby erasing the remaining performance gap (Panel B, row (6) of Table 4). Without prior information on the quality of insider candidates, Boards' screening ability is identical for both types of candidates so any outstanding systematic difference in quality at the time of hire between firms lead by insiders and outsiders disappears (column (2)), as well as any outstanding

difference in dynamic selection over tenure. Notably, neutralizing the insider signal yields the largest change in the gap between insiders and outsiders. Consistent with our results in Panel (e) of Figure 5, our model suggests that the disparity in Boards' information quality over insider and outsider CEO candidates is the primary determinant of the observed gap in performance. This follows from the fact that differences in prior information about internal and external candidates is the main mechanism behind the relationship between low prior performance and the likelihood of hiring externally.

8 Conclusion

Empirically, firms that hire CEOs internally tend to perform better than those who hire externally. Such regularity would seem to reflect differences in the quality or firm-specific human capital of insider and outsider CEO candidates, which could then explain firms' tendency to promote from within. However, assessing the quality of internal and external talent pools is complicated by selection as insiders tend to inherit control of relatively healthy firms, while the likelihood of hiring outsiders increases in times of crisis. Consequently, it is not clear why firms tend to promote executives from within, rather than hiring externally, and why external hires increase when firm performance is low. We contribute to the literature by answering these questions while addressing selection concerns with a dynamic selection model of CEO hiring and turnover. The estimated model allows us to weigh the relative importance of various mechanisms suggested in the literature including differences in average quality, uncertainty about CEO quality, costs of firing, non-pecuniary preferences for internal hires, and non-pecuniary preferences for "rocking the boat" (external hires) during times of crisis.

Our main findings indicate that selection bias greatly contributes to the observed gap in firm performance between insider and outsider CEOs. Outsiders, who are more often appointed in bad times, under perform insiders partly as a result of these poor and endogenous initial conditions coupled with the high persistence of firm profitability. But that is not the whole story. Insiders exhibit higher levels of performance even after adjusting for persistence. This results from Boards' superior information over internal CEO candidates as opposed to systemic differences in match quality among insider and outsider candidate pools. Boards are able to screen insider CEO candidates more proficiently than outsiders, generating a sizable gap in ex-post match quality even when virtually none exists ex-ante. Our estimates imply that a considerable degree of dynamic selection on match quality takes place for internally-hired CEOs, while virtually none occurs for externally-hired CEOs. Hence, insiders generally survive termination because they are high quality, while outsider survival is largely the consequence of luck. Finally, it is that same uncertainty associated to the outsider candidate pool that increases their likelihood to be hired in times of cri-

sis. Firms performing poorly are willing to take a chance with an external candidate, not because of a non-pecuniary desire to "rock the boat," but rather because Boards hope to benefit from the option value of a good draw from the right tail of the high-variance, external candidate pool.

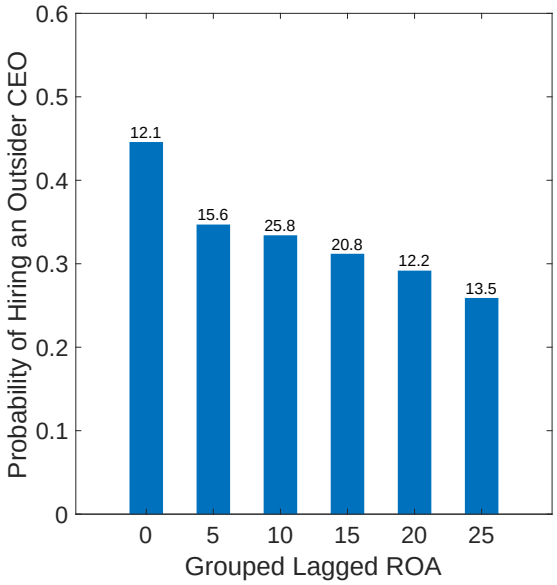
A Appendix

A.1 Data Appendix

A.1.1 Firm Profitability

Consistent with the literature, throughout this paper we use industry-adjusted operational return on assets (IA-ROA) as our primary measure of firm performance. However, Figure A.1 shows that the same empirical pattern that we observe when using IA-ROA occurs when we use unadjusted operational return on assets. Thus, the tendency for firms to more often hire an outsider CEO when in the left-tail of the lagged performance distribution is not an artifact of the industry adjustment, but is rather a result that is robust to multiple measures of firm performance.

FIGURE A.1: Outsider CEO Hire Probability Conditional on Turnover and Lagged Performance



Notes: To construct this figure all turnover instances are first grouped into discrete bins using firm performance (non-industry-adjusted ROA) in the year before turnover. The bins, in billion U.S. dollars, are: ≤ 2.5, $(2.5, 7.5]$, $(7.5, 12.5]$, $(12.5, 17.5]$, $(17.5, 22.5]$, > 22.5. The height of each bar represents the probability of hiring an outsider CEO conditional on turnover within each bin. The labels atop each bar represent the share of turnover instances captured by each bin.

A.1.2 CEO Tenure and Firm Performance

TABLE A.1: Industry-Adjusted Return on Assets Regressions

	Outsiders		Insiders	
	Coefficient	SE	Coefficient	SE
Lagged IA-ROA	0.795***	(0.003)	0.431***	(0.005)
Tenure	-0.006	(0.005)	0.103	(0.141)
CEO Age	0.012**	(0.005)	0.155	(0.145)
CEO Type (Outsider)	-0.325***	(0.070)	-1.791	(6.812)
CEO Gender (Male)	0.006	(0.193)	-1.839	(6.483)
CEO Compensation	$2.4e^{-5}$***	($3.6e^{-6}$)	$2.0e^{-5}$***	($4.6e^{-6}$)
Firm Assets	$-7.6e^{-7}$***	($2.8e^{-7}$)	$6.6e^{-7}$	($1.4e^{-6}$)
Constant	-0.802**	(0.368)	-8.629	(8.470)
Observations (firm-CEO)	35,264		35,264	

Notes: The dependent variable in both columns is IA-ROA. The first two columns estimate the model with year fixed effects while the last two columns also include fixed effects for each CEO-firm match. *, **, and *** denote significance at the 10% level, 5% level, and 1% level, respectively. Both sets of columns suggest that firm performance is insignificantly dependent upon CEO tenure.

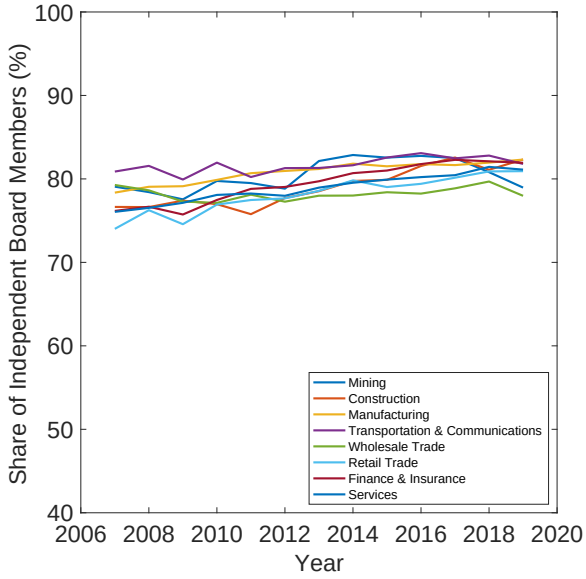
In Table A.1, we present the results from two regressions of IA-ROA on lagged performance and a vector of CEO and firm characteristics, with and without CEO-firm fixed effects. In both instances, the coefficient on CEO tenure is not statistically distinguishable from zero. We conclude that such a pattern is inconsistent with tenure dependent CEO ability.

A.1.3 Board Composition

Institutional Shareholder Services (ISS) Data (formerly "Riskmetrics"). We obtain data on firm governance and director affiliation from Institutional Shareholder Services, an investment management firm that provides corporate governance and investment solutions to North American firms. The ISS sample spans from 2007 to 2019, and maps to the Execucomp and Compustat datasets using each firm's unique *cusip* ID (i.e., "Committee on Uniform Securities Identification Procedures" (CUSIP) number). The dataset provides information on director demographics, such as gender, race, and age, along with firm-specific information such as tenure, firm share holdings, committee membership, and board affiliation. We utilize this latter variable to identify whether

a board member should be classified as an "insider" director, or as an "independent" director. The field *classification* takes the values "E" (employee/insider), "I" (independent), "L" (linked), or "NA" (not ascertained). We remove directors who are missing the affiliation classification and group "E" and "L" directors together as affiliated board members (or insiders). Figure A.2 plots the share of independent directors by SIC industry classification. We observe that this trend is stable and flat across both time and industry. This provides us with additional confidence in our decision to abstract away from board composition in our model framework, as the share of independent board members appears to be independent of firm hiring patterns and endogenizing board composition poses a significant modeling and data challenge that is outside the scope of this paper.

FIGURE A.2: Share of Independent Directors By Industry

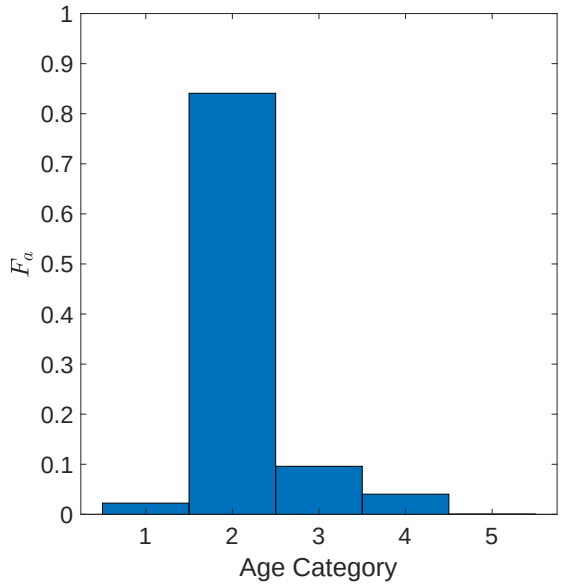


A.2 Model Appendix

A.2.1 CEO Age

We discretize CEO age a_{ijt} into five categories in order to estimate the model. When hiring an executive, each new CEO has an age category $\bar{a}_{ijt}$ which is drawn from the empirical distribution of executive age conditional on turnover, denoted by F_a in Figure A.3. The categories for $\bar{a}_{ijt}$ are as follows:

FIGURE A.3: Empirical Distribution of Executive Age at Hiring



$$\bar{a}_{ijt} = \begin{cases} 1 & \text{if } a_{ijt} < 40 \\ 2 & \text{if } a_{ijt} \in [40,59] \\ 3 & \text{if } a_{ijt} \in [60,64] \\ 4 & \text{if } a_{ijt} \in [65,80] \\ 5 & \text{if } a_{ijt} > 80 \end{cases} \tag{A.1}$$

Given CEO age is categorical in the empirical specification of our model, we use our sample to compute the transition probabilities that govern the stochastic evolution of $\bar{a}_{ijt}$ that we use in estimation:

TABLE A.2: Empirical Distribution of Age Transition Probabilities

	Age Group (T+1)				
Age Group (T)	< 40	[40,59]	[60,64]	[65,80]	> 80
<40	0.686	0.314	0	0	0
$[40,59]$	0	0.926	0.074	0	0
$[60,64]$	0	0	0.877	0.123	0
$[65,80]$	0	0	0	0.988	0.012
> 80	0	0	0	0	1

A.2.2 Voluntary Turnover

As noted in Section 3, we consider voluntary turnover as an exogenous process that is a function of CEO tenure at the firm, age, and type. Thus, the we model the probability of voluntary turnover as follows:

$$\mathbb{P}(v_{ijt} = 1) = g(\tau_{ijt}, a_{ijt}, m_{ij}) = \frac{\tilde{g}(\tau_{ijt}, a_{ijt}, m_{ijt})}{1 + \tilde{g}(\tau_{ijt}, a_{ijt}, m_{ijt})} \tag{A.2}$$

where we make the parametric assumption for identification that:

$$\tilde{g}(\tau_{ijt}, a_{ijt}, m_{ijt}) = \omega_0 + \omega_1 \tau_{ijt} + \omega_2 \tau_{ijt}^2 + \alpha_a + \iota \mathbf{1}[m_{ijt} = I] \tag{A.3}$$

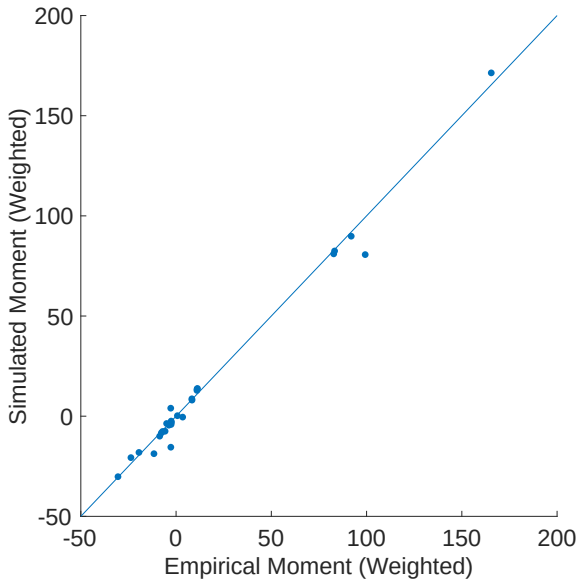
where α_a are fixed effects for CEO age category and the indicator function captures fixed effects by CEO type. Note that we impose mandatory voluntary turnover (i.e., retirement) when a CEO exceeds age 80 (i.e., age category 5), as this age closely reflects the cutoff we observe empirically in our sample. The omitted category from the remaining age category fixed effects is category 4. Parameter estimates are reported in Table A.3.

TABLE A.3: Voluntary Turnover Estimates

Constant	*Tenure*		*CEO Age*			*Insider*
ω_0	ω_1	ω_2	α_1	α_2	α_3	ι
-1.352	0.083	-0.004	-1.651	-1.854	-0.637	0.161
(0.089)	(0.014)	($5.4e^{-4}$)	(0.356)	(0.070)	(0.069)	(0.189)

Notes: Standard errors are shown in parentheses.

FIGURE A.4: Model Fit: Empirical and Simulated Moments Difference



A.2.3 Model Fit

TABLE A.4: Summary of Model Fit

	Empirical Coefficient	Simulated Coefficient	Standard Error	t-stat
Voluntary Turnover Regression				
ω_0	-1.794	-1.565	(0.075)	3.017
ω_1	0.078	0.075	(0.009)	-.3397
ω_2	-0.002	-0.003	$(3.2e^{-4})$	-0.621
α_1	-1.895	-2.041	(0.267)	-0.545
α_2	-1.759	-1.741	(0.057)	0.299
α_3	-0.473	-0.548	(0.055)	-1.369
ι	0.029	0.010	(0.041)	-0.456
Profitability Regression				
δ_0	-0.177	0.252	(0.063)	6.794
δ_1	0.794	0.776	(0.008)	-2.086
δ_2	0.258	-0.034	(0.074)	-3.922
$\Delta^{(-1)}$	-0.716	-4.031	(0.260)	-12.73
$\Delta^{(0)}$	-2.864	-4.619	(0.246)	-7.115
$\Delta^{(1)}$	-1.370	-1.007	(0.276)	1.315
Hazard Regression				
λ_1	0.023	0.024	(0.002)	0.387
λ_2	0.044	0.054	(0.003)	2.574
λ_3	0.041	0.049	(0.003)	1.925
λ_4	0.022	0.027	(0.002)	2.617
λ_5	-0.009	-0.008	(0.003)	0.135
λ_6	-0.018	-0.021	(0.004)	-0.685
λ_7	-0.012	-0.018	(0.004)	-1.509
λ_8	-0.006	-0.007	(0.002)	-0.665
Residual Profitability				
$\mathbb{E}[\bar{\sigma_{ij}}]$	39.45	40.87	(0.238)	5.936
$Var(\bar{\varepsilon_{ij}})$	17.30	14.05	(0.174)	-18.61
$Var_1(\bar{\varepsilon_{ij}})$	13.81	13.53	(0.166)	-1.713
Hiring Probability				
$\mathbb{P}$(Insider Hire)	0.649	0.643	(0.007)	-0.737
κ_0	-0.734	-0.682	(0.037)	1.393
κ_1	-0.022	-0.028	(0.003)	-1.735

Notes: t-statistics are reported as a measure of fit quality. They are computed as the difference in the empirical moment from the simulated moment divided by the standard error of the empirical moment.

A.2.4 Sensitivity Analysis

In this section, we present model estimates from a number of variations in data definitions and model structure in order to assess the sensitivity of our results. The variations we estimate are:

↪ *Model A1: Stricter definition of outsider.* Instead of our baseline definition of outsider (executives with one or fewer years of prior experience at the firm at the time of hire as CEO), which follows Parrino (1997), we define outsider CEOs as those with zero years of prior experience at the firm at the time of hire as CEO.

↪ *Model A2: Looser definition of outsider.* Instead of our baseline definition of outsider, we define outsider CEOs as those with two or fewer years of prior experience at the firm at the time of hire as CEO.

↪ *Model A3: Memory decay.* We let firms to gradually lose memory of older information, and therefore place more weight on recent signals when updating their beliefs. Formally, the firm's prior belief is weighted by a decay factor $\in (0,1)$ which exponentially reduces the impact of prior beliefs on future beliefs over time. We set the decay weight to 0.9, a common benchmark used in such models (Malmendier and Nagel, 2015).

↪ *Model A4: Limited recall.* We let firms face a memory constraint that limits their ability to recall previous periods beyond a discrete cutoff. The firm only considers periods within the "recall window" when updating beliefs. For this starker recency bias we implement a memory cutoff of five years which approximates the near zero weight that a memory decay model with decay parameter of 0.5 would place on any information received more than five years ago.

↪ *Model A5: Non-linear preference for outsiders in bad times.* We redefine firm preferences for hiring a replacement from outside the firm as function of prior performance (see equation (7)) as follows: $\gamma(y_{ijt-1}) = \gamma_1 + \gamma_2 \mathbf{1}[y_{ijt-1} \in Q_1]$, where the indicator function captures when prior firm performance was in the bottom quartile (Q_1) of the distribution of lagged IA-ROA. This specification captures the fact that firm preferences for hiring outsider CEOs may be non-linear across the prior performance distribution (as Figure 1 suggests).

The parameter estimates from each of these sensitivity specifications detailed above, their assessment of fit, as well as the baseline estimates and fit included for reference, can be found in Table A.5 and Figures A.5 and A.6. Models A1 and A2 yield similar estimates to our baseline model for all parameters except for the population average match qualities and the insider signal variance. Specifically, we find that outsider average quality exceeds that of insiders. This is likely

due to the reclassification of outsiders (who have lower average quality) into the insider category in Model A1. In Model A2, while some insiders are reclassified as outsiders, the change is minimal and the large reduction in the magnitude of the insider signal variance indicates that match quality is particularly noisy for insider CEOs with minimal prior firm-specific experience (two years or fewer). In both instances, the population average match qualities of insider and outsider candidates are still statistically indistinguishable from one another, indicating that a baseline difference in match quality between insider and outsider CEO candidates is not the primary mechanism driving the observed difference in hiring rates. This aligns with our findings in Section 5.

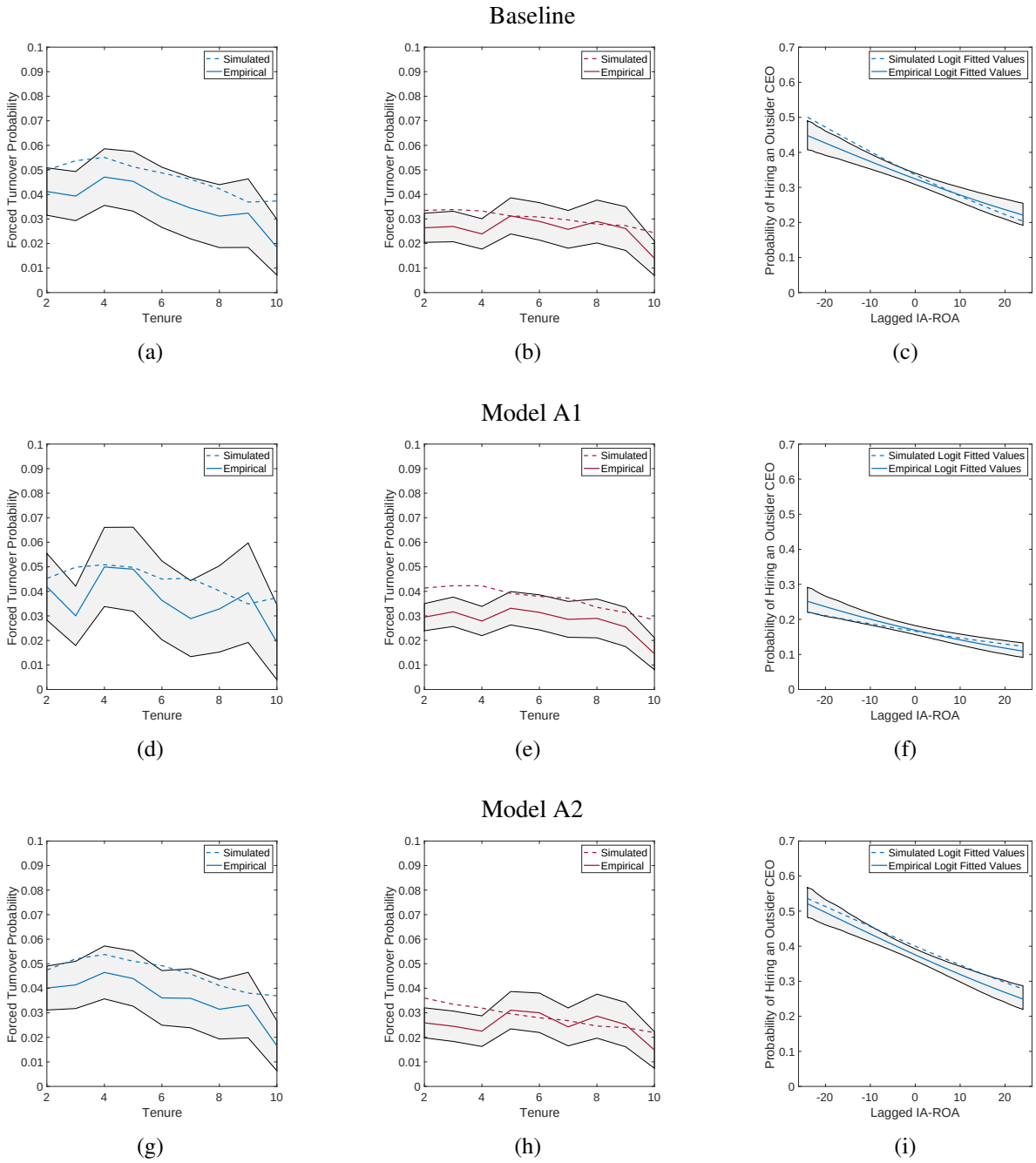
Model A3 yields estimates that are most similar to our baseline specification, indicating that our model is robust to the levels of fading memory used in the literature. Estimates from the limited recall model (Model A4) yield the most differences relative to our baseline but it is also the one that offers the poorest fit (Figure A.6). The limited recall model yields a large differences in the average quality of insider and outsider candidates and a very high level of persistence in profitability, both results contradict prior findings in the literature (Jenter and Kanaan, 2015; Taylor, 2010). Finally, in Model A5, the estimate of γ_2 remains negative and both statistically and economically insignificant. Given this specification more precisely targets the spike in outsider hiring that we observe in the left-tail of the lagged performance distribution (Figure 1), we have confidence in our baseline result that board preferences play a limited role explaining the gradient between the rate of outsider hiring and prior firm performance.

TABLE A.5: Structural Estimates from Sensitivity Analysis

CEO Ability				*Profitability*			*Utility*		
μ_{θ_O}	μ_{θ_I}	σ^2_θ	σ^2_s	σ^2_η	ρ	c	π	γ_1	γ_2
Baseline model									
-0.359	-0.340	0.904	0.816	44.32	0.206	0.688	3.919	-0.886	-0.023
(0.089)	(0.029)	(0.043)	(0.134)	(0.305)	(0.007)	(0.282)	(0.301)	(0.100)	(0.022)
Model A1: Stricter definition of outsider									
-0.131	-0.207	1.023	1.703	45.01	0.212	0.645	3.905	-1.734	-0.006
(0.084)	(0.040)	(0.064)	(0.217)	(0.260)	(0.007)	(0.301)	(0.220)	(0.207)	(0.005)
Model A2: Looser definition of outsider									
-0.343	-0.498	0.953	0.374	44.55	0.213	0.704	3.681	-1.001	$3.0e^{-4}$
(0.109)	(0.057)	(0.140)	(0.103)	(0.307)	(0.007)	(0.155)	(0.212)	(0.252)	(0.001)
Model A3: Memory decay (decay parameter: 0.9)									
-0.360	-0.361	0.950	0.742	44.47	0.216	0.725	3.500	-0.986	-0.013
(0.103)	(0.040)	(0.083)	(0.196)	(0.269)	(0.007)	(0.203)	(0.216)	(0.154)	(0.007)
Model A4: Limited recall (recall window: 5 years)									
-4.111	1.909	1.157	14.65	44.50	0.014	$1.4e^{-7}$	5.800	0.001	-0.072
(2.213)	(0.823)	(0.213)	(9.708)	(0.280)	(0.001)	(0.325)	(0.267)	(0.039)	(0.009)
Model A5: Non-linear preference for outsiders in bad times									
-0.488	-0.405	0.879	1.010	44.28	0.199	0.870	3.759	-0.968	-0.094
(0.100)	(0.053)	(0.046)	(0.129)	(0.393)	(0.007)	(0.205)	(0.207)	(0.157)	(0.114)

Notes: Standard errors are shown in parentheses. "Baseline" corresponds to the estimated parameters from the baseline model (Table 3). "Model A1" corresponds to the stricter definition of outsider CEO (zero years of prior experience with the firm at the time of hire). "Model A2" corresponds to the looser definition of outsider CEO (two or fewer years of prior experience with the firm at the time of hire). "Model A3" corresponds to the Bayesian learning model with memory decay (using a decay parameter of $\alpha = 0.9$). "Model A4" corresponds to the Bayesian learning model with limited recall (using a recall window of 5 years). "Model A5" corresponds to the specification with non-linear preference for outsiders in bad times.

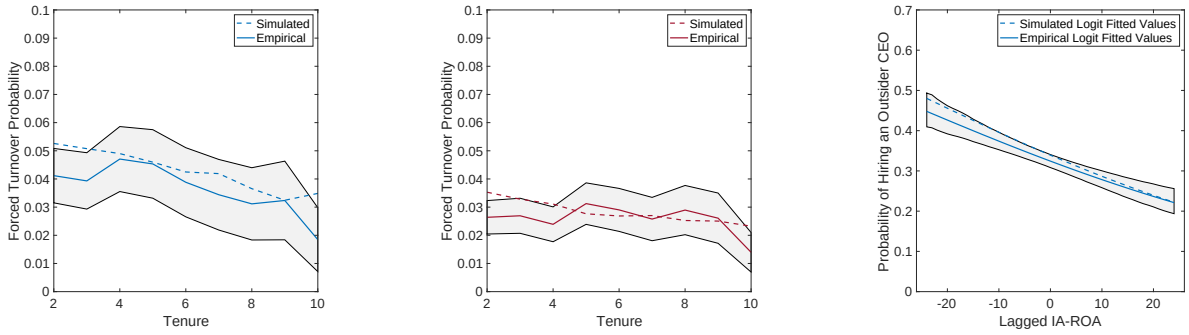
FIGURE A.5: Model Fit for Robustness Specifications



Notes: The shaded gray region indicates 95% confidence intervals around the empirical forced turnover rates and hiring probabilities. Panels (a), (d), and (g) show the outsider forced hazard rates, while Panels (b), (e), and (h) capture the insider forced hazard rates. The remaining figures (Panels (c), (f), and (i)) illustrate the probability of hiring an outsider across the lagged performance distribution. "Baseline" corresponds to the model fit from the baseline model (Figure 2). "Model A1" corresponds to the stricter definition of outsider CEO (zero years of prior experience with the firm at the time of hire). "Model A2" corresponds to the looser definition of outsider CEO (two or fewer years of prior experience with the firm at the time of hire).

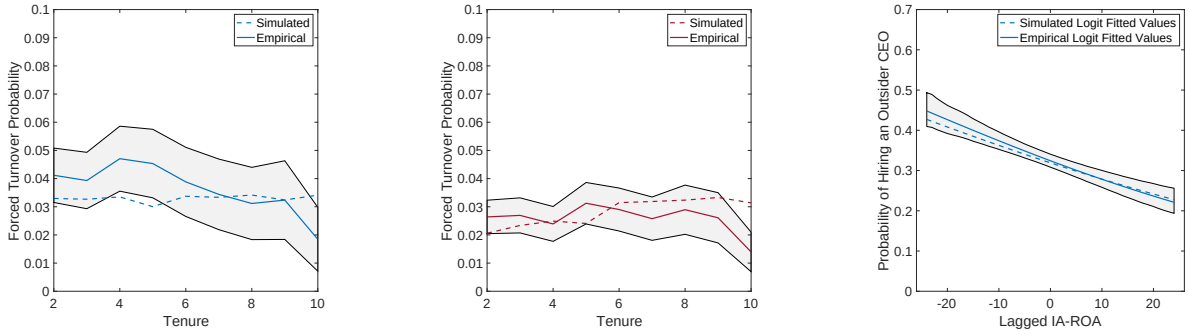
FIGURE A.6: Model Fit for Robustness Specifications (Continued)

Model A3



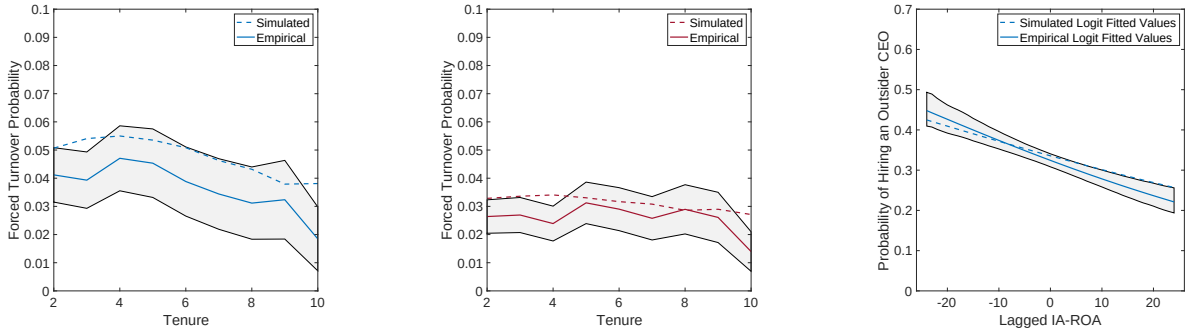
(a) (b) (c)

Model A4



(d) (e) (f)

Model A5



(g) (h) (i)

Notes: The shaded gray region indicates 95% confidence intervals around the empirical forced turnover rates and hiring probabilities. Panels (a), (d), and (g) show the outsider forced hazard rates, while Panels (b), (e), and (h) capture the insider forced hazard rates. The remaining figures (Panels (c), (f), and (i)) illustrate the probability of hiring an outsider across the lagged performance distribution. "Model A3" corresponds to the Bayesian learning model with memory decay (using a decay parameter of $\alpha = 0.9$). "Model A4" corresponds to the Bayesian learning model with limited recall (using a recall window of 5 years). "Model A5" corresponds to the specification with non-linear preference for outsiders in bad times.

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