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 internally promoted CEOs outperform external hires? We answer this question using a dynamic selection model of CEO hiring and turnover. Firm performance is persistent and boards gradually learn about CEO quality, facing different uncertainty when hiring internally or externally. We estimate the model using a matched CEO-firm panel (1995-2019) of S&P 1500 firms. After accounting for endogenous turnover, performance, and hiring decisions, the key mechanism generating the performance gap is information. Boards' uncertainty over insider candidates is roughly half that of outsiders, resulting in better selected insider CEOs and a significant difference in executive quality ex-post, despite little ex-ante difference between insiders and outsider candidates. Hence, long-tenured insider CEOs tend to be "good" while outsiders tend to be "lucky." Overall, our results show that information, not innate ability, explains insiders' superior performance, and that firm size magnifies this informational advantage.

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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: July 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. We address these selection concerns to understand boards' hiring behavior and to identify the impact of internal and external hires on firm performance.

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 average firm-specific match quality, and boards may face more uncertainty when hiring externally (Hermalin, 2005). We demonstrate that the interplay between match quality uncertainty and termination costs in our model reduces the expected net financial benefit of hiring risky, external candidates, especially when the firm is performing well.[4] Boards have a non-pecuniary preference (positive or negative) for hiring externally, and the strength of this preference is allowed to vary with prior

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

[3] Related 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; Celentano and Mello, 2024).

[4] This is consistent with 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).

firm performance. This framework thus allows us to address selection concerns, contributing to the literature an empirical quantification of the main sources explaining the prevalence of internal hires, their impact on profitability, and the increase in external hiring in low performing years; for example, we assess the role of initial conditions at the time of hire (prior firm performance), and prior knowledge about internal candidates.

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 for S&P 1500 firms 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 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, roughly a third of CEO successions observed in the sample result in an external hire,[6] with even more external hires occurring when the firm is performing poorly.[7]

Our structural estimates reveal that the difference in average match quality between insider and outsider CEO candidates is minimal.[8] However, we find that boards face roughly half the amount of uncertainty regarding the quality of insider CEO candidates relative to outsiders. Insiders are therefore far better selected, generating significant ex-post differences in quality despite little ex-ante differences in average quality between the two candidate types. Boards' superior ability 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 shocks. Because there is less initial uncertainty regarding insider match quality, the board of an insider-led firm can more easily discern the roles of CEO ability and luck (i.e. idiosyncratic firm shocks) in driving firm performance. Our results therefore indicate strong positive selection of insiders over tenure, where the average match quality of an internally promoted CEO with 10 years of experience is almost twice as large as that of a newly hired insider.

[5] We show in Appendix B.5 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.

[7] This is consistent with prior studies including 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), and Cziraki and Jenter (2021).

[8] This is in line 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; Barry et al., 2024).

In the case of outsiders, we find much less dynamic selection. Because there is greater uncertainty regarding the initial match quality of outsiders, boards face more difficulty inferring 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 the average external CEO candidate. 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).

Our estimates shine light on the role that board preferences for internal candidates plays in CEO hiring and retention (Agrawal et al., 2006; He and Schroth, 2024). Board preferences in our model are captured by the non-pecuniary cost (positive or negative) the board faces when hiring externally, which varies with prior firm performance. We estimate this cost to be negative and significant, revealing a sizable preference for promoting from within. For instance, in the median firm the board is willing to sacrifice approximately $19.1 million dollars in profits to hire an insider. Additionally, we find that this cost does not vary significantly with prior firm 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." These findings remain robust across numerous sensitivity analyses, including alternative definitions of insider/outsider status, alterations to the functional form of non-pecuniary preferences, and variations in the assumptions regarding board learning and information structure.

We next explore heterogeneity in hiring practices and information structure across firms, focusing in particular on the role of firm size. Many key features of the CEO succession landscape have been shown to vary with firm size, including the prevalence of formal CEO succession planning (Cvijanović et al., 2023), scale of internal information systems (Rajan and Wulf, 2006), and non-pecuniary value for continuity in corporate culture (Cannella and Shen, 2001, 2002). Thus, informational structures and managerial hiring processes may systematically differ across firms depending on their scale. To analyze the role of firm size, we estimate our model separately for small and large firms, ultimately revealing that insiders' informational advantage scales substantially with firm size. Boards in larger firms have considerably more precise information about internal candidates, leading to far more accurate assessments of their match quality relative to smaller firms. Specifically, our estimates indicate that insiders' informational advantage in large firms is close to three times that of insiders in small firms, likely a reflection of superior internal information systems and richer data environments in large organizations (Baker et al., 1994). Conversely, smaller firms, facing greater uncertainty when evaluating insider candidates, find insiders less clearly advantageous ex-post. Furthermore, the variance of idiosyncratic performance shocks for small firms is roughly four times that of large firms, exacerbating small firms' difficulty in making precise inference about CEO ability. Additionally, we find that large firms exhibit signifi-

cantly stronger non-pecuniary preferences for insider candidates. Intrinsic board preferences thus play a more pronounced role in large firms relative to smaller firms, whose hiring practices appear to rely more heavily on direct shareholder value considerations. This heterogeneity underscores how organizational scale shapes boards' capabilities and incentives to screen managerial talent effectively, amplifying the value of internal promotion pathways in larger enterprises.

We rigorously decompose both the insider/outsider performance gap and the external hiring gradient, the pattern whereby boards disproportionately appoint outsiders following poor performance. We carefully highlight the nuanced relationship between these two phenomena, emphasizing how both are jointly driven by the same economic primitives. Starting with our decomposition of the external hiring gradient, we conduct a series of counterfactual exercises designed to sequentially isolate and quantify each contributing factor. Specifically, we sequentially remove: (a) differences in average candidate quality; (b) turnover costs: (c) non-pecuniary preferences; and (d) asymmetric information about candidate quality, assessing their impact on the likelihood of external hires at each step. Crucially, the external hiring gradient persists across all counterfactual scenarios until we eliminate insiders' informational advantage. Only upon stripping insiders of their informational edge does the gradient completely disappear. This result highlights how the board's superior information about internal candidates significantly alters the perceived risks and returns of internal versus external hires. Stronger prior performance increases the relative attractiveness of insiders due to their reduced downside risk, while weaker prior performance encourages risk-taking by making the higher uncertainty of external hires, and thus their potential upside, more appealing. Critically, the fact that internal CEO successions tend to be preceded by strong firm performance enhances the observed performance of insider CEOs relative to outsiders, underscoring the importance of asymmetric information and (endogenous) initial conditions when assessing the merits of internal CEO appointments.

Turning to the performance gap between insider and outsider CEOs, our counterfactual analyses emphasize that insiders' informational advantage and favorable initial conditions go hand in hand when explaining insiders' superior performance. We similarly decompose this performance gap, finding that it persists through all but the last step of the decomposition, disappearing only after eliminating the informational asymmetry between internal and external candidates. Our decomposition clearly establishes information as the dominant factor underpinning insiders' superior performance. However, as discussed above, insiders' informational advantage simultaneously enhances their ex-post quality and their initial conditions at time of hire. To isolate the role of initial conditions, we run an additional experiment in which we randomize prior performance at time of hire for both insider and outsider CEOs, eliminating any systematic difference between the initial conditions faced by the two. Strikingly, randomizing initial conditions completely eliminates the insider CEO's performance advantage, even resulting in a slight underperformance due to boards'

inherent non-pecuniary bias. Collectively, these counterfactual exercises underscore our central finding: informational advantages drive both the insider/outsider performance gap and the external hiring gradient with respect to prior performance, while non-pecuniary factors and turnover costs play smaller, complementary roles.

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 Taylor (2010), we estimate substantial pecuniary and non-pecuniary costs of terminating the CEO, limiting the board's ability to realize the option value associated with hiring an outsider.

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. As discussed by Cvijanović et al. (2023), existing empirical studies on CEO employment dynamics focus predominately on boards' role as *ex-post* monitors 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 dimension 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. Section 5 presents the model estimates, subsample analysis by firm size, and sensitivity results using

estimates from alternative versions of the model. 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.

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 B.5 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% are voluntary.

[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.

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.

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 conjec-

tures 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]

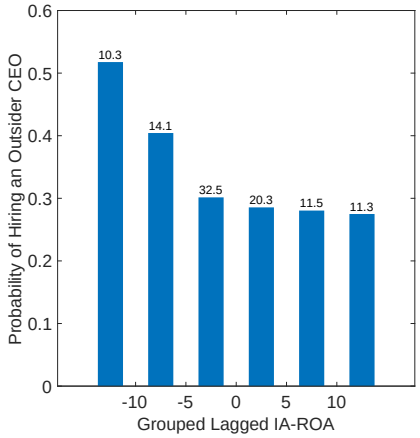
Panel B of Table 1 shows that the average of residual performance $\tilde{\theta}_{ij}$ computed across firm-CEO pairs is lower for outsider executives but the variance is higher. Since outsiders tend to be employed at smaller firms we also include the average residual performance by firm size in Panel B of Table 1. Small and large firms are those with assets below and above median.[14] The results are qualitatively equivalent across firm sizes. While the gap between insiders and outsiders is about 60% larger at small firms, there remains a substantial difference in residual performance after controlling for firm assets in large firms. Hence, the performance gap is likely not an artifact of larger, better performing firms hiring insiders. Keeping in mind that these descriptive results are affected by dynamic selection, our reduced-form proxy for CEO quality supports 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.

[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.

[14] We categorize firms into constant size types (as small or large) by computing each firm's average annual total assets during the sample period and then comparing it against the median average total assets across all firms. This yields an equal number of small and large firms in our subsample analyses.

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 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).[15] Since outsiders have higher variance in residual performance, this pattern suggests that during periods of low performance firms are more willing to hire candidates from the pool with higher performance variance.

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

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

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 belief about CEO quality at period t.[16] 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 fixed the proxy for the current belief about CEO quality. In addition, Table 2 reveals that this proxy 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 proxy for the current belief about 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).[17]

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

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

[17] 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.

proxy for CEO quality in this section is subject to dynamic selection concerns at both the entry and exit (survival) margins. In the remainder of the paper we write and estimate an economic model of CEO turnover that endogenizes (and hence controls for) selection on beliefs about ability and captures the effect of firm performance around the time of hire on firms' hiring choices.

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 in someone new or shaking things up), or due to the option value of high-variance external candidates. We capture these mechanisms in an economic framework that accounts explicitly 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, and have additional prior information about the quality of insider candidates. 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

[18] F_a is the non-parametric empirical distribution of hiring age (Appendix Figure B.1).

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 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:

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

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 $N(0, \sigma^2_\eta)$. 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.

Boards have knowledge of the population distributions of both insider candidates, $N(\mu_{\theta_I}, \sigma^2_\theta)$, and outsider candidates, $N(\mu_{\theta_O}, \sigma^2_\theta)$. Furthermore, at the beginning of each period, before deciding whether to replace the incumbent CEO, boards observe an additional signal $s_{it} \sim N(\theta_{Iit}, \sigma^2_s)$ about the quality of their "next-in-line" insider.[19] The signal is centered on the true match quality of the insider candidate available for firm i at time t, and its variance σ^2_s measures the precision of the signal. Using Bayes' rule, the board's prior belief regarding the quality of the insider candidate at

[19]The true match quality of the internal candidate θ_{Iit} is independently redrawn each period. In other words, we rule out multi-period learning about potential successors and assume that the "next-in-line" insider is different each year. This is in line with Celentano and Mello (2024) and preserves tractability. In Table B.4 of Appendix B.5, we report estimates of an alternative version of the model in which the insider signal s_{it} is not observed until *after* the termination decision. This choice of timing has minimal effect on parameter estimates.

t is:

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

Regarding outsider candidates, boards hold no additional information prior to hiring. Boards have rational expectations, so their priors about the match quality of the outsider candidate coincide with the population distribution. Thanks to their prior information about the insider candidate, the variance of the prior belief for the insider candidate is smaller than that of the outsider candidate ($\frac{\sigma_s^2\sigma_\theta^2}{\sigma_s^2+\sigma_\theta^2} < \sigma_\theta^2$). The gap between the prior information boards possess about insider and outsider candidates, which is determined by the signal variance, captures the extent to which fitness for the CEO position is further revealed through experience in lower ranks within the firm.

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 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:[20]

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

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).[21] Second, it has preferences for (or against) hiring

[20] 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).

[21] 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.3 for further discussion.

a replacement from outside the firm which we allow to vary with the firm's prior performance as measured by its lagged firm-specific profitability y_{it-1}.[22] 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 $g(a_{ijt}, \tau_{ijt}, m_{ij})$.[23] If voluntary turnover occurs, the board must hire a replacement. If it does not occur, the board first decides whether to fire or retain the incumbent CEO. Given state $x_{it} = (m_{ij}, B_{ijt}, a_{ijt}, y_{it-1}, s_{it})$, which includes the beliefs about the incumbent CEO and the signal about the quality of the internal candidate, 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 age of CEO candidates, and 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

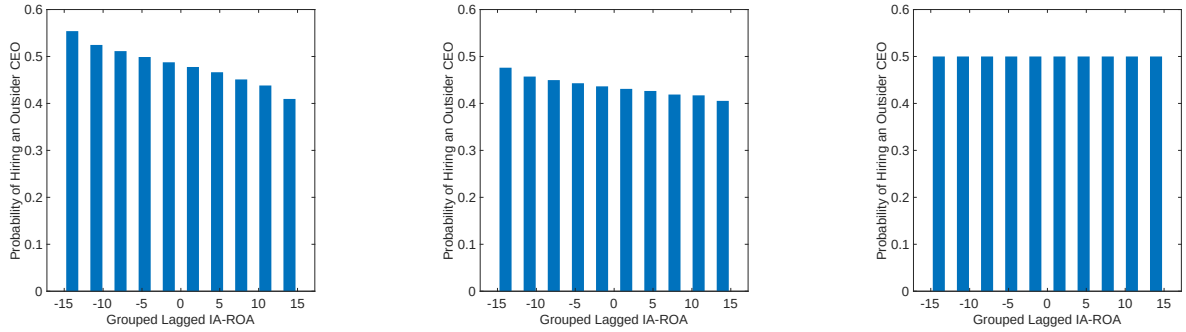
[22] Alternatively, prior performance could be measured by overall profitability Y_{ijt}. We opt for using the firm-specific component of profitability y_{it-1} as it nets out industry trends that individual executives likely take as given. Hence, we assume that the pressure boards may face to "clean 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).

[23] In practice, $g(z) = (1 + exp(-z))^{-1}$ where z represents an index function of tenure, age, and type indicators. See Appendix B.2 for more details.

of next period. Note that our assumption of constant firm assets allows b_{it} to be dropped from the 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.

An illustration of the role of information on boards' decision problem. In order to display the information mechanism of the model, for an arbitrary set of parameters Figure 2 plots the conditional choice probabilities of hiring an outsider implied by the model. Specifically, Figure 2 shows the implied probability of hiring externally conditional on CEO turnover at different levels of prior performance y_{it-1} when the board has more precise (Panel (a)), less precise (Panel (b)) or no (Panel (c)) prior information on the insider signal s_{it}. For ease of exposition, we assume here both CEO types have equal population means ($\mu_{\theta_I} = \mu_{\theta_O}$) and non-pecuniary hiring preferences are absent ($\gamma_1 = \gamma_2 = 0$). In this case, insiders and outsiders are ex-ante heterogeneous only via the insider signal s_{it}.

FIGURE 2: Conditional Choice Probabilities



(a) Low Signal Variance (b) High Signal Variance (c) No Insider Signal

Notes: Conditional on turnover ($d_{it}^f = 1$), the model-implied probability of hiring an outsider is given by: $P(x_{it}) = \frac{exp(V_0(x_{it}^O))}{exp(V_0(x_{it}^O)+exp(V_0(x_{it}^I)}$. We integrate these choice probabilities over the insider signal distribution and plot them across the distribution of lagged prior performance (y_{it-1}). We repeat this exercise with three separate cases: low signal variance, $\sigma_s^2 = 3$ (Panel (a)), high signal variance $\sigma_s^2 = 30$ (Panel (b)), and no insider signal (Panel (c)).

Boards' additional prior information about insider candidates shapes and sharpens their beliefs about their internal candidate. Notably, Figure 2 shows that the extent to which boards then proceed to hire CEOs from their internal pool depends on prior firm performance. With healthy prior performance, the downside of hiring externally looms large; a bad hire would squander an already good situation and risk turnover costs in the near future. In such cases, boards prioritize their greater confidence in their internal candidate beliefs over the higher variance, and therefore

greater uncertainty, of external candidates. In contrast, when recent performance has been poor, the potential upside of taking a chance on the more uncertain external candidates becomes relatively more appealing, as there is less downside in risking a change. This dynamic results in a downward-sloping hiring gradient, with insiders preferred in good times and outsiders in bad ones.

Crucially, this gradient is pinned down by the precision of boards' information. Figure 2 shows that as the variance of insider signals σ_s^2 increases, insiders' informational advantage dissipates. In the limiting case with no insider signal ($\sigma_s^2 \to \infty$), the two pools of executive talent are ex-ante identical. Hence, our framework nests more restrictive models with a single talent pool such as Taylor (2010). Given higher prior information about internal candidates ($\sigma_s^2 < \infty$), the resulting endogenous hiring gradient implies a negative correlation between the likelihood of hiring externally and firm performance. This helps to explain why, empirically, failing to control for this information asymmetry may exaggerate outsiders' under-performance.

4 Identification and Estimation

Formal identification. We first discuss formally the identification of the parameters of the distributions of candidate quality, the quality of pre-hire internal signals, and the persistence in firm profitability. After this formal discussion we provide a heuristic argument for the identification of all the model parameters. For our formal discussion we rely on a simplified version of the model in which boards are profit maximizers (no non-pecuniary motivations), and there is no voluntary separation.

Assumption 1. *Interim CEOs*. No CEOs are removed at tenure $\tau = 1$ based on beliefs.

The *Interim CEOs* assumption states that CEOs who leave the firm after just one year with the firm are interim and not fired based on beliefs. This assumption is consistent with the common practice in the literature, including in this paper, of dropping the observations of interim CEOs (those with only one year of tenure at the time of turnover) from the estimation sample (Peréz-González, 2006; Hamilton et al., 2023; He and Schroth, 2024).

Proposition 1. *If the Interim CEOs assumption holds, ρ, μ_{θ_O}, σ_θ^2, and σ_η^2 are identified.*

PROOF: *See Appendix B.3.1.*

Using first differences in profitability, the proof of Proposition 1 in Appendix B.3.1 leverages the *Interim CEOs* assumption, the shape of the profitability equation in (4), and the fact that at the time of hire firms only have additional information about internal CEO candidates, to deliver

identification of the persistence parameter ρ, the mean of the distribution of outsider candidates μ_{θ_O}, the variance of the distribution of candidate quality σ^2_θ, and the variance of the idiosyncratic shocks to profitability σ^2_η.

Proposition 2. *If the Interim CEOs assumption holds, and ρ, μ_{θ_O}, σ^2_θ, and σ^2_η are identified, then μ_{θ_I} and σ^2_s are identified.*

PROOF: *See Appendix B.3.2.*

The proof of Proposition 2 in Appendix B.3.2 focuses on variation in profitability generated by internal CEOs and it uses not only the shape of the profitability equation but also the selection rule imposed by the structure of the model, which endogenizes the various mechanisms explaining selection at the hiring and firing margins.

Estimation and heuristic identification. Next we provide a heuristic argument for the identification of all model parameters without relying on the Interim CEOs assumptions. 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 $\tilde{g}$ in the voluntary separation process 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.

We disentangle the scale parameters σ_θ, σ_η, and σ_s using various moments of firm performance. As discussed in Taylor (2010) and Lyman (2024), σ_η is identified off of within-spell variation in firm ROA while σ_θ is identified off of across-spell variation in firm ROA. Regarding the precision of the insider signal, Figure 2 showed that σ_s is directly related to the gradient between prior firm performance and the likelihood of hiring outsiders. Moreover, 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 concentrates the distribution of insider match quality among higher values. Thus, since firms only receive prior signals about the quality of insider candidates, the difference in residual performance variation across insider and outsider CEO spells also 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_η, for each CEO-firm match we compute the within-spell average and variance of the the persistence-adjusted IA-ROA $\hat{\varepsilon}_{ijt}$:

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

To disentangle σ_θ, σ_η, 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_η; 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.

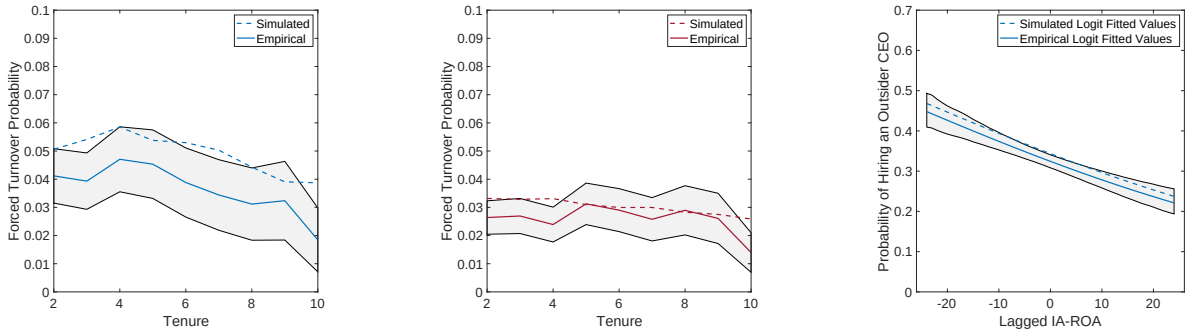
Next, we discuss identification of the preference parameters π measuring the non-pecuniary cost of firing, and (γ_1,γ_2) measuring preference for, or against, outsider hires. Conditional on the previous parameters determining profitability and belief formation, π is identified off of the empirical rate 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. We target the coefficients of a logistic regression of the type of CEO hired on prior performance. Since this

gradient also carries information about σ_s, the additional moments we include to identify σ^s are crucial to separate how much variation in the gradient corresponds to preferences and how much to signal quality.

We jointly estimate all model parameters using the Simulated Method of Moments (SMM), matching a total of 27 moments.[24] At the firing margin, Panels (a) and (b) of Figure 3 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, as illustrated in Figure 3(c).



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

FIGURE 3: Model Fit

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

5 Structural Estimates

Accounting for selection using our model reveals only a minor difference in average quality between outsider and insider CEO candidates in the population, with a slight edge in favor of outsiders. Our structural estimates in Table 3 indicate a minor gap between the mean quality of outsider and insider CEO candidates (μ_{θ_O} and μ_{θ_I}).[25] This is consistent with the pool of outsider candidates being composed of the best higher-ranked executives (Fee and Hadlock, 2003), and the pool of internal candidates containing more mid-career managers who have not undergone as many rounds of selection. While our estimates indicate that outsider candidates have higher match quality on average ($\mu_{\theta_O} > \mu_{\theta_I}$), our descriptive statistics in Table 1 show that firms led by insiders

[24] See Appendix B.4 for more details on the moments, estimation routine, and model fit.

[25] 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.

displayed higher average performance. We provide two explanations for this seeming discrepancy between raw descriptives and model estimates; these explanations underscore the importance of accounting for dynamic selection at both the hiring and firing margins. First, as illustrated in Figure 3, 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 ($1-\rho$), estimated to be 0.797. 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.

TABLE 3: Structural Estimates

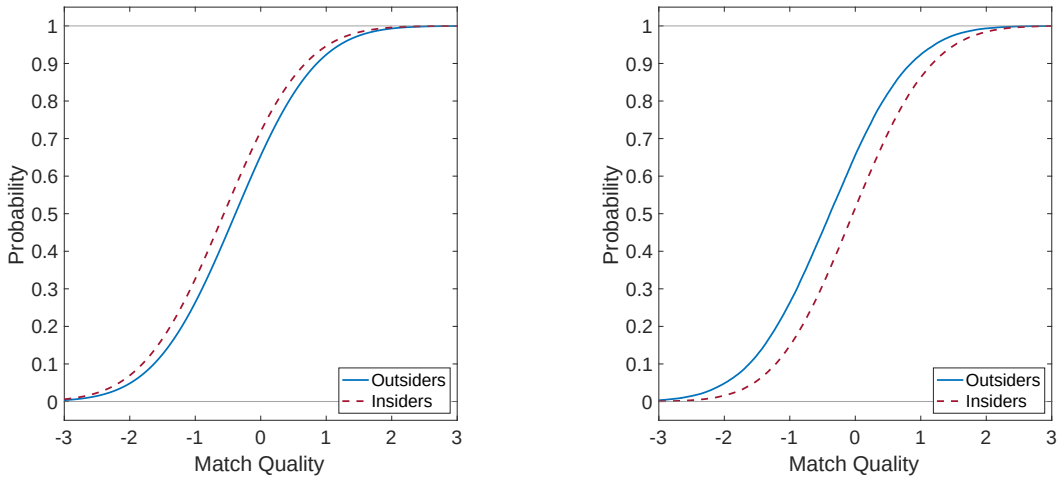
CEO Ability and Insider Signal				*Profitability*			*Preferences*		
μ_{θ_O}	μ_{θ_I}	σ^2_θ	σ^2_s	σ^2_η	ρ	c	π	γ_1	γ_2
-0.387	-0.563	0.943	0.712	44.25	0.203	0.775	4.689	-1.032	-0.030
(0.086)	(0.058)	(0.086)	(0.080)	(0.261)	(0.007)	(0.179)	(0.253)	(0.137)	(0.011)

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 B.2 in Appendix B.2.

A second reason is that insider candidates are substantially better screened than outsiders thanks to the boards' prior information on internal personnel. The estimates of σ^2_θ and σ^2_s imply that the variance of boards' beliefs over the quality of an insider candidate is roughly 40% that of an outsider candidate.[26] In other words, boards face less than half the uncertainty when hiring internally than when hiring externally. Our 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 being drawn from similar populations, the boards' additional prior information about internal candidates enables the hiring of insider CEOs that will on average exhibit higher levels of performance than outsider CEOs.

The greater ability to screen internal candidates has durable 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 is therefore more sensitive to new information about CEO quality generated through performance. These signals (Equation (6)) contain both information about CEO quality and firm idiosyncratic variation, in other words, luck. CEO quality and luck are harder to disentangle when firms hire outsiders. Consider the trajectory of average beliefs over tenure for insiders and outsiders (Figure 5(a)). Dynamic selection results in a positive gradient

[26] This comes directly from the belief updating rule (5): $\frac{\sigma^2_s\sigma^2_\theta}{\sigma^2_s+\sigma^2_\theta} = 0.406$



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

FIGURE 4: Distribution of Match Quality Among CEO Candidates and Hired CEOs

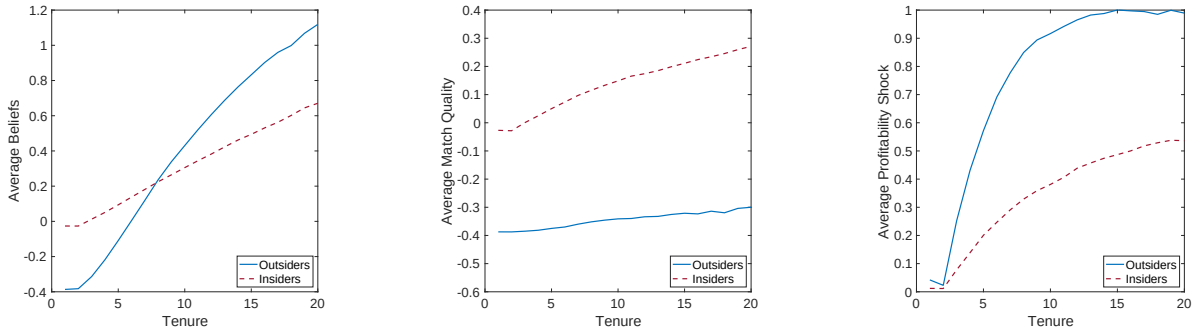
Notes: Panel (a) plots the CDFs of the estimated population match quality distributions $N(\mu_{\theta_O}, \sigma^2_\theta)$ and $N(\mu_{\theta_I}, \sigma^2_\theta)$. Panel (b) plots the CDFs of match quality conditional on being selected for hire.

of average beliefs over tenure for both types of CEOs as executives of perceived low quality are filtered out.

The factors underlying this positive gradient differ greatly by CEO type. We decompose the trajectory of average beliefs into its two components: CEO match quality and firm-specific shocks. 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 the measure of cumulative luck increases with tenure for both outsiders and (to a lesser extent) insiders, 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 largely driven 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 0.78% of total assets, equivalent to roughly \$14.4 million for the median-sized firm.[27] This cost reflects a variety of expenses including severance payments, executive search fees, or other general disruptions to firm operations

[27]The median-sized firm has roughly \$1.86 billion in assets.



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

FIGURE 5: Selection, Luck, and Belief Dynamics

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.

upon CEO replacement. The non-pecuniary cost of turnover (π), incurred only if the CEO is fired, is substantial. The estimated value of π is 4.7% of total assets or roughly \$87.0 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 \$101.4 million for the median-sized firm.

In addition to beliefs regarding CEO quality and the anticipation of future turnover costs, we estimate that 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 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 \$19.1 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 quite small in comparison with the intercept γ_1. Therefore, non-pecuniary preferences are unlikely to be the main force behind the negative relationship between prior performance and external hires illustrated in Figure 1. Rather, we show in Section 6 that this relationship emerges endogenously from the disparity in information over internal and external candidates.

5.1 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 B.5. Our main estimates are robust to most of the changes. Our first sensitivity test is around the definition of outsider (Parrino, 1997). We re-estimate the model using both a stricter and a looser definition of outsider status.[28] 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), 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.[29] 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 largest differences relative to our baseline but also seem to deliver the poorest fit (Appendix Figure B.4). The limited recall model yields a considerably less informative pre-hire signal of insider quality, larger quality dispersion, and substantially greater firing costs. This model also yields a high level of persistence in profitability ($1-\rho = 0.883$), which greatly minimizes the contribution of CEO quality to firm profitability. All of these estimates are inconsistent with prior results in the literature (Taylor, 2010).

Further, 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. Finally, we assess the sensitivity of our estimates to the assumption that insider signals are observed prior to CEO departures. To this end, we estimate a version of the model in which the signal s_{it} is not observed by boards until after the departure of the incumbent CEO. Our estimates and inferences are qualitatively unchanged.

[28] 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).

[29] 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.

5.2 Firm-Size Subsample Analysis

To explore the relationship between insider performance, information, and firm size, we estimate the model separately in the subsamples of small and large firms.[30] The estimates in Table 4 show that many key informational features are amplified by firm size. First, the variance of the insider signal is much larger for small firms (1.441) than large firms (0.233), implying that the latter observe the quality of internal CEO candidates far more precisely. Together with the values of the variance of candidate quality, our estimates indicate that insiders' informational advantage at the time of hire in large firms is close to three times that in small firms.[31] This result can be explained by information gains from scale. Large, complex enterprises generate and archive vast quantities of internal data on cash-flow composition, project milestones and individual manager scorecards. Prior research demonstrates that boards in such firms routinely track promotion-eligible executives across dozens of performance metrics, yielding finely-grained signals of executive ability (Baker et al., 1994; Rajan and Wulf, 2006). In contrast, smaller listed companies disclose less and draw thinner analyst coverage, leaving boards to work with markedly noisier information when evaluating internal candidates. Furthermore, in line with prior research (Campbell et al., 2001), the variance of idiosyncratic performance shocks is more than four times larger in the small-firm subsample (77.6 versus 18.2). This reinforces the informational gap: even post-hire, small firms are less able to make precise inferences about CEO match quality due to the idiosyncratic volatility of small-firm performance.

TABLE 4: Subsample 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
Large Firms:	-0.252	-1.269	1.004	0.233	18.16	0.173	0.692	5.800	-4.592	-0.093
	(0.100)	(0.142)	(0.112)	(0.044)	(0.140)	(0.008)	(0.182)	(0.318)	(0.560)	(0.038)
Small Firms:	-0.158	-0.628	1.454	1.441	77.61	0.224	0.994	3.758	-0.506	-0.039
	(0.132)	(0.111)	(0.180)	(0.237)	(0.835)	(0.010)	(0.355)	(0.393)	(0.243)	(0.010)

Notes: Standard errors are shown in parentheses. Small and large firms are those below and above median assets as described in Section 2.

The gap in candidate quality found across all firms is wider in large companies. Table 4 shows that the distance between μ_{θ_O} and μ_{θ_I} in large firms is more than twice that in small firms. Two forces may be pushing apart these candidate quality means in large firms. First, supply-side sorting:

[30] Small and large firms as defined in Section 2, i.e. those with assets below and above median.

[31] Insiders' informational advantage is given by the ratio of prior variance of insider candidates, given by $\frac{\sigma^2_s\sigma^2_\theta}{\sigma^2_s+\sigma^2_\theta}$, to the prior variance of outsider candidates, given by σ^2_θ. In large firms, this ratio equals $\frac{0.233}{0.233+1.004} = 0.19$, while in small firms it equals $\frac{1.441}{1.441+1.454} = 0.50$.

when the board of a large firm launches an external search, it can attract a narrow set of "superstar" managers Fee and Hadlock (2003), shifting the distribution of external talent up relative to the firm's own c-suite. Second, the internal pipeline of large, multi-division firms likely contains many specialists whose skills do not necessarily scale to the top job. Hence, while large firm boards observe many insiders, the *average* fitness for the CEO position of these candidates is likely unexceptional. In sum, our results reveal a sharper trade off between information and ability in large firms; these firms have much better information, and consequently greater certainty, about their insiders, but outsiders promise higher average match quality in large firms.

Our results also suggest that hiring practices in large firms are more influenced by non-pecuniary factors. The baseline taste parameter (γ_1) is strongly negative in large firms (-4.59) but only mildly so in small firms (-0.51). Similarly, the slope parameter (γ_2) is larger in magnitude for large firms (-0.09) than small firms (-0.04). This sizable premium for keeping things in-house is consistent with large firms more frequently weaving succession planning into their governance processes (Cvijanović et al., 2023) and with internal promotions being perceived as lower-risk cultural fits (Cannella and Shen, 2001, 2002; Zhang and Rajagopalan, 2004). Small-firm boards appear to rely more on shareholder value considerations when choosing successors as opposed to intrinsic preferences for internal CEOs.

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, the anticipation of future turnover costs, non-pecuniary preferences over internal hires, 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 (Figure 6). In our counterfactuals we fix the number of years and firms in each simulation to match the sample used in estimation, and we minimize simulation error by running each scenario independently twenty times and averaging results across iterations. We find that preference for internal candidates has a large impact on the *level* of the probability of insider hiring, and hence on the hiring gap between insiders and outsiders. Instead, the *gradient* between the probability of outsider hiring and prior firm performance is primarily explained by boards' superior information regarding the match quality of insider candidates.

Starting from our baseline, Panel (a) of Figure 6 plots the simulated probability of hiring an outsider CEO (conditional on turnover) by prior firm performance before any mechanism is shut off. The next step in Panel (b) equalizes the means of the distributions of CEO candidate quality

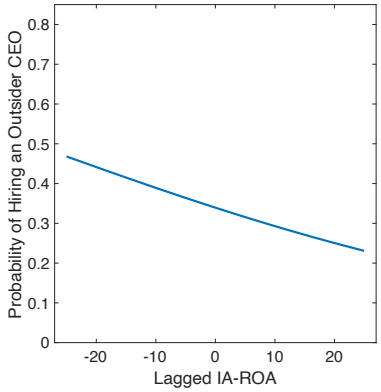
(μ_{θ_O} and μ_{θ_I}) at the estimated value for insiders, effectively decreasing the average quality of external candidates. Within our framework, this step is akin to eliminating any relative human capital advantages between the two candidate pools. As the estimated difference in means is modest (Table 3), this change induces only a moderate downward shift in the level of external appointments, suggesting that differences in average quality between internal and external candidates have limited power to explain differences in hiring rates between the two candidate pools.

Next, we assess the impact of turnover costs by setting to zero the estimated monetary and non-pecuniary costs of turnover (c and π). Panel (c) shows a moderate amplification of the hiring gradient with slightly more outsiders being hired during times of low firm performance. Eliminating turnover costs fundamentally increases boards' flexibility. With no penalty for replacing low-quality executives, boards can afford to experiment with high-variance outsiders when recent profits are poor, because any mismatch can eventually be replaced at zero cost. This added option value has the effect of magnifying the hiring gradient.

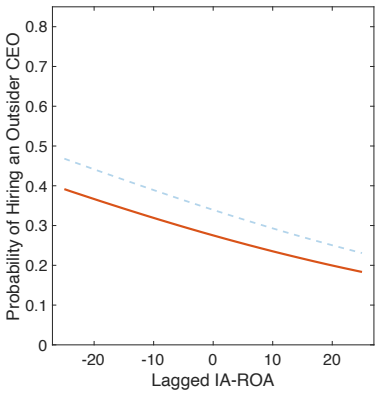
From here, we assess the importance of boards' systematic non-pecuniary preferences for outsider candidates by setting to zero the preference parameters γ_1 and γ_2. Since we estimated a sizable preference in favor of internal candidates (the large and negative γ_1 in Table 3), Panel (d) shows that eliminating this preference substantially increases the probability of external 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, we eliminate the marginal increase in the non-pecuniary preference for outsiders in bad times. However, since the estimated magnitude of γ_2 is small, Panel (d) shows only a modest attenuation of the gradient. Therefore, while preferences for internal candidates play a large role in the level difference in hiring probabilities between CEO types, non-pecuniary preferences play a much smaller role explaining the higher rate of outsider hires in times of poor firm 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. At this point in the sequence of counterfactuals both types of CEO candidates are ex-ante identical and the hiring decision becomes independent of prior performance. Consequently, the probability of hiring outsiders is flattened at 0.5. 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

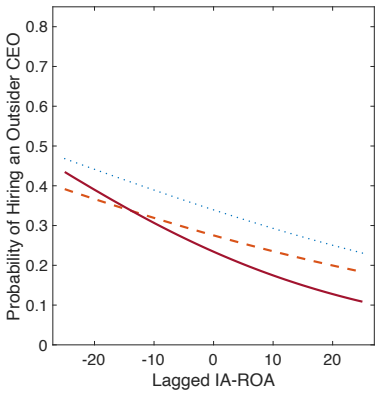
FIGURE 6: Counterfactual Outsider Hiring Probabilities



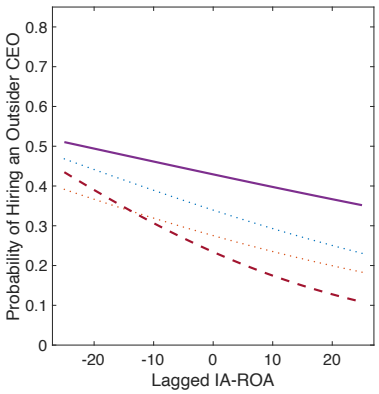
(a) Baseline



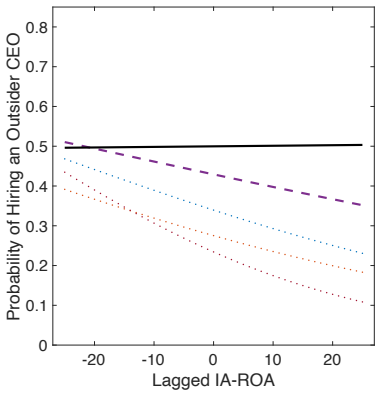
(b) Equal Population Means



(c) No Turnover Costs



(d) No Insider Preferences



(e) No Insider Information

Notes: Figure 6 sequentially decomposes the simulated hiring profile in five steps. 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. Panel (a) is the baseline case with no changes. Panel (b) sets μ_{θ_O} equal to μ_{θ_I}. Panel (c) eliminates turnover costs by setting both $\pi = c = 0$. Panel (d) sets both $\gamma_1 = \gamma_2 = 0$. Finally, Panel (e) 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.

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 what type of candidate to appoint as CEO. Hence, the observed gradient in Figure 1, a source of selection bias when assessing the quality of outsider CEOs in 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 driven largely by the superior 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) simply that outsiders are endogenously more likely to be hired in bad times? Or is the gap in observed performance a product of the different dynamic selection of insider and outsider CEOs evidenced in Figure 5? We find that the endogenous relation between prior firm performance and the likelihood of hiring an outsider is a key factor behind the observed performance gap between insiders and outsiders. Consistent with our results in Section 6, differences in prior information about insider and outsider candidates and systematic differences in non-pecuniary preferences for CEO types are main model mechanisms generating the performance gap.

To answer the question of why insiders outperform outsiders, we first isolate the impact of prior performance by allowing firms to hire and fire their CEOs optimally and then counterfactually randomizing their initial condition of prior performance *after* the optimal hiring decision has been made; the new randomized initial condition is drawn from 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, scaling firm-year ROA by the total assets of the median-sized firm in our sample.

The first row of Panel A in Table 5 shows a baseline profitability gap of roughly $12 million in favor of insiders. The second row indicates that the gap disappears when the initial condition is randomized after the optimal hiring decision has been made. Consistent with previous suggestive evidence in the literature (Allen et al., 1979; Shen and Cannella, 2002; Quigley et al., 2019), our results show that prior performance at the time of hire is indeed a main driver of the observed gap in firm performance between insider and outsider-led firms. Since the higher rate of external hiring among firms with low prior performance is endogenous (see Section 6), we also use the

structure of the model to study how the gap changes as we shut off the various mechanisms driving the dynamic selection of CEOs. Following the same sequence from Section 6, 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 5 reports the results of this exercise. In addition to expected annual profits, Panel B 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 indicates the potential impact of selection and the state of the firm at the time the CEO is hired.

TABLE 5: 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	238.6	226.3	12.29
Randomized prior firm performance upon hire	249.3	252.1	-2.79

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	0.363	238.6	226.3	12.29
(2): $\mu_{\theta_I}=\mu_{\theta_O}$	0.498	240.4	227.7	12.63
(3): (2) and $\pi=c=0$	0.380	247.1	211.3	35.78
(4): (3) and $\gamma_1=\gamma_2=0$	0.427	241.3	230.3	11.01
(5): (4) and no insider signal	-0.005	230.3	230.5	-0.19

Notes: *Panel A* shows results from a counterfactual exercise (second row) 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; the new randomized initial condition is drawn from the empirical distribution of prior performance conditional on turnover. *Panel B* 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 6. 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.

Mirroring the previous section, we begin by first equalizing the means of the distributions of candidate quality $\mu_{\theta_I}=\mu_{\theta_O}$ (Panel B, row (2)). Given the small advantage in average candidate quality in favor of outsiders, equalizing the means of the distributions contributes minimally to the performance gap. A much larger change in the gap is realized when setting the turnover costs (π, c) to zero (row (3)). 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 5, 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, expanding the performance gap.

Next, we eliminate the preference parameters γ_1 and γ_2 (row (4)), which 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, denoted $\mathbb{E}[\theta_I] - \mathbb{E}[\theta_O]$, shows that difference in match quality between insiders and outsiders at the time of hire increases significantly. 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 6, this paradoxical result follows from a heterogenous effect of non-pecuniary preferences for CEO types along the support of prior performance at the 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.

Lastly, eliminating differences in prior information eliminates the last systematic difference between firms lead by insiders and outsiders, thereby erasing the remaining performance gap (row (5)). 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 (row (5), second column), as well as any outstanding difference in dynamic selection over tenure. Neutralizing the insider signal therefore yields a large change in the gap between insiders and outsiders. Consistent with our results in Panel (e) of Figure 6, our model suggests that the disparity in boards' information quality over insider and outsider CEO candidates is a key 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.

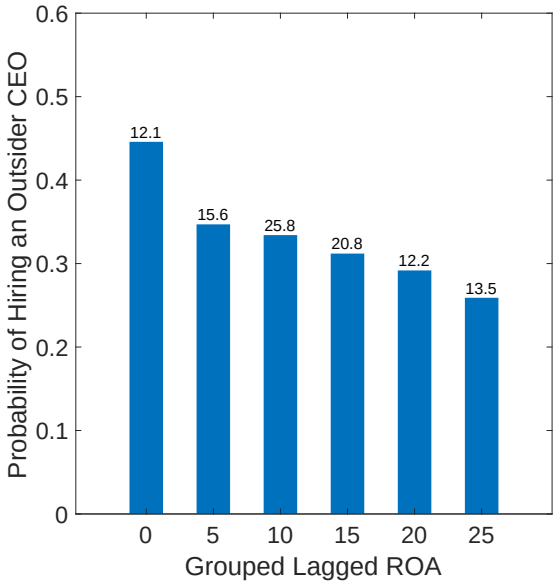
Our main findings indicate that selection bias greatly contributes to the observed gap in firm performance between insider and outsider CEOs. Outsiders, who are more often appointed in bad times, underperform insiders partly as a result of these poor and endogenous initial conditions coupled with the high persistence of firm profitability. However, 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 only a minor difference exists ex-ante. Our estimates imply that a considerable degree of dynamic selection on match quality takes place for internally-hired CEOs, while very little dynamic selection occurs for externally-hired CEOs. Hence, insiders generally survive termination thanks to high executive quality, while the lack of dynamic selection for outsiders renders their survival largely a consequence of luck. Finally, it is that same uncertainty associated with the outsider candidate pool that increases their likelihood to be hired in times of crisis. 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 Data Appendix

A.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.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.

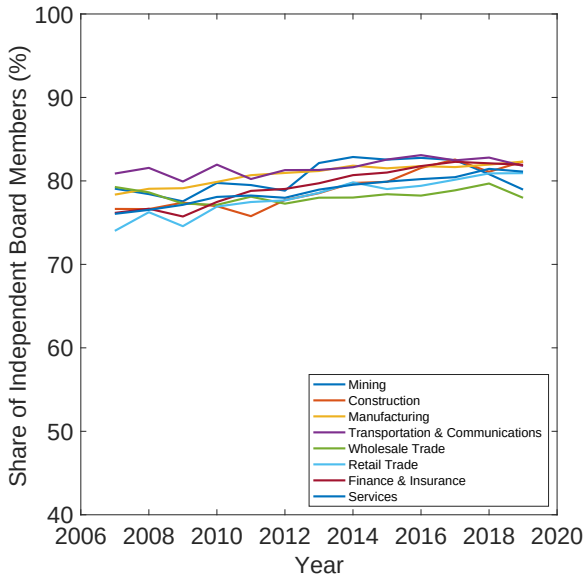
In Table A.1, we present the results from two regressions of IA-ROA on lagged performance and a vector of CEO and firm characteristics, with and without CEO-firm fixed effects. In both instances, the coefficient on CEO tenure is not statistically distinguishable from zero. We conclude that such a pattern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

A.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

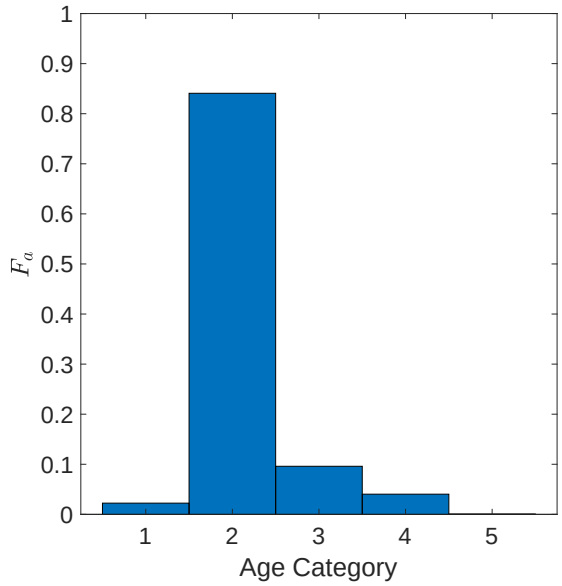


B Model Appendix

B.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 B.1. The categories for $\bar{a}_{ijt}$ are as follows:

FIGURE B.1: Empirical Distribution of Executive Age at Hiring



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

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 B.1: 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

B.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:

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

where we make the parametric assumption for identification that:

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

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 B.2.

TABLE B.2: Voluntary Turnover Estimates

Constant	*Tenure*		*CEO Age*			*Insider*
ω_0	ω_1	ω_2	α_1	α_2	α_3	ι
-1.305	0.033	-0.002	-1.563	-1.848	-0.448	0.126
(0.084)	(0.012)	($5.6e^{-4}$)	(0.799)	(0.072)	(0.084)	(0.041)

Notes: Standard errors are shown in parentheses.

B.3 Identification

B.3.1 Proof of Proposition 1

Consider all observations of CEOs with tenure $\tau = 2$. We can write the first differences in profitability as:

$$\Delta y_{ijt} = (1 - \rho)\Delta y_{ijt-1} + \Delta \eta_{ijt} \tag{B.4}$$

The *Interim CEOs* assumption implies that $E[\Delta \eta_{ij1} | \tau_{ijt} = 2] = 0$; this is so as the idiosyncratic shocks observed at tenures $\tau = 1, 2$ are not truncated by selection. Hence, we can write:

$$1 - \frac{E[\Delta y_{ijt} | \tau_{ijt} = 2]}{E[\Delta y_{ijt-1} | \tau_{ijt} = 2]} = \rho \tag{B.5}$$

Consider now observations of outsider CEOs with tenure $\tau = 1$. The average residual performance for these observations is:

$$E[y_{ijt} - (1-\rho)y_{ijt-1}|\tau_{ijt} = 1, O] = \rho E[\theta_{ij}|\tau_{ijt} = 1, O] \tag{B.6}$$

Since outsiders with one year of tenure are draws from the population:

$$E[y_{ijt} - (1-\rho)y_{ijt-1}|\tau_{ijt} = 1, O] = \rho \mu_{\theta_O} \tag{B.7}$$

and

$$Var[y_{ijt} - (1-\rho)y_{ijt-1}|\tau_{ijt} = 1, O] = \rho^2 \sigma_\theta^2 + \sigma_\eta^2 \tag{B.8}$$

and from equation (B.4), across all CEOs with two years of tenure:

$$Var[\Delta y_{ijt} - (1-\rho)\Delta y_{ijt-1}|\tau_{ijt} = 2] = Var[\Delta \eta_{it}|\tau_{ijt} = 2] = 2\sigma_\eta^2 \tag{B.9}$$

Hence, since ρ is identified from the ratio of first differences in (B.5), equations (B.7), (B.8) and (B.9) show that μ_{θ_O}, σ_θ^2, and σ_η^2 are identified using the first two moments of residual profitability. Q.E.D.

B.3.2 Proof of Proposition 2

Consider all observations of internal CEOs with tenure $\tau = 1$. For these observations the average residual performance can be written as:

$$\begin{aligned} E[y_{ijt} - (1-\rho)y_{ijt-1}|\tau_{ijt} = 1, I] &= \rho E[\theta_{ij}|\tau_{ijt} = 1, I] \\ &= \rho E[\theta_{ij}|\tilde{\theta}^0_{Iijt} > \bar{\tilde{\theta}}_{1it}, \tau_{ijt} = 1] \end{aligned} \tag{B.10}$$

where $\tilde{\theta}^0_{Iijt}$ is the mean belief after receiving the pre-hire internal signal s_{it}, and $\bar{\tilde{\theta}}_{1it}$ is the cutoff value of internal mean belief after which internal candidates are chosen for hire over outsider candidates, conditional on observables.[32] The cutoff $\bar{\tilde{\theta}}_{1it}$ is an implicit function of the parameters of the model and observable characteristics given by:

$$\{\bar{\tilde{\theta}}_{1it} = \min \tilde{\theta} : V_0(x^I_{it}) > V_0(x^O_{it})\} \tag{B.11}$$

[32] Such a cutoff exists because both expected utility and future beliefs are increasing in the current mean beliefs.

where $V_0(x_{it}^m)$ are the conditional value functions at the time of hire implied by equation (10) and $\tilde{\theta}$ is part of x_{it}^I. Using the expression for beliefs at the time of hire in (5) we can write (B.10) as:

$$\begin{aligned} E[y_{ijt} - (1-\rho)y_{ijt-1} | \tau_{ijt} = 1, I] &= \rho E[\theta_{ij} | \frac{\sigma_s^2 \mu_{\theta_I} + \sigma_\theta^2 s_{it}}{\sigma_s^2 + \sigma_\theta^2} > \bar{\tilde{\theta}}_{1it}, \tau_{ijt} = 1] \\ &= \rho E[\theta_{ij} | s_{it} > \bar{\tilde{\theta}}_{1it} \left(\frac{\sigma_s^2 + \sigma_\theta^2}{\sigma_\theta^2} \right) - \frac{\sigma_s^2}{\sigma_\theta^2} \mu_{\theta_I}, \tau_{ijt} = 1] \\ &= \rho E[\theta_{ij} | \theta_{ij} + n_{it} > q_{it}(\mu_{\theta_I}, \sigma_s^2; \cdot), \tau_{ijt} = 1] \end{aligned} \tag{B.12}$$

where we have written the pre-hire internal signal in terms of the CEO's ability and an idiosyncratic prior information disturbance $n_{it} \sim N(0, \sigma_s^2)$, and where $q_{it}(\mu_{\theta_I}, \sigma_s^2; \cdot)$ is the implied function in the right hand side of the inequality, function of the data, identified parameters, and the parameters to be identified μ_{θ_I} and σ_s^2. Since the signal disturbance n_{it} is unobserved to the econometrician, we can re-write (B.12) as:

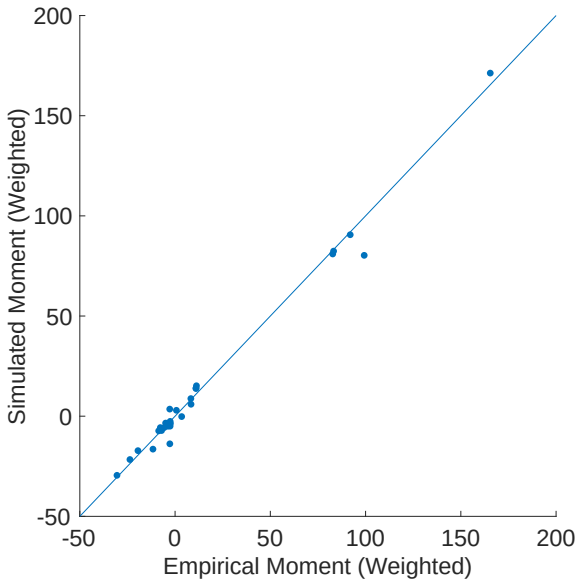
$$\begin{aligned} E[y_{ijt} - (1-\rho)y_{ijt-1} | \tau_{ijt} = 1, I] &= \rho E_n[E[\theta_{ij} | \theta_{ij} > q_{it} - n_{it}, n_{it}, \tau_{ijt} = 1]] \\ &= \rho \mu_{\theta_I} + \rho \sigma_\theta E_n \left[\frac{\phi(\delta_{it})}{1 - \Phi(\delta_{it})} \middle| \tau_{ijt} = 1 \right] \end{aligned} \tag{B.13}$$

where $\delta_{it} \equiv (q_{it} - n_{it} - \mu_{\theta_I})/\sigma_\theta)$, ϕ is the probability density function of the standard normal distribution, and Φ is its cumulative distribution function. Similarly we can write the variance residual performance for these observations as:

$$\begin{aligned} Var[y_{ijt} - (1-\rho)y_{ijt-1} | \tau_{ijt} = 1, I] &= \rho^2 E_n[Var[\theta_{ij} | \theta_{ij} > q_{it} - n_{it}, n_{it}, \tau_{ijt} = 1]] \\ &= \rho^2 \sigma_\theta^2 \left(1 + E_n \left[\frac{\delta_{it} \phi(\delta_{it})}{1 - \Phi(\delta_{it})} - \left(\frac{\phi(\delta_{it})}{1 - \Phi(\delta_{it})} \right)^2 \middle| \tau_{ijt} = 1 \right] \right) \end{aligned} \tag{B.14}$$

Noticing that equations (B.13) and (B.14) depend on data, previously identified parameters, and the parameters to be identified, these equations establish a system of two (highly non-linear) equations on two unknowns (μ_{θ_I} and σ_s^2). Importantly, notice that equation (B.13) ensures separation between μ_{θ_I} and σ_s^2. Hence, μ_{θ_I} and σ_s^2 are identified. Q.E.D.

FIGURE B.2: Model Fit: Empirical and Simulated Moments Difference



B.4 Model Fit

TABLE B.3: Summary of Model Fit

	Empirical Coefficient	Simulated Coefficient	Standard Error	t-stat
Voluntary Turnover Regression				
ω_0	-1.794	-1.638	(0.076)	-2.069
ω_1	0.078	0.056	(0.009)	2.415
ω_2	-2.5e^{-3}	-1.8e^{-3}	(3.2e^{-4})	-2.050
α_1	-1.895	-1.915	(0.268)	0.074
α_2	-1.759	-1.703	(0.058)	-0.981
α_3	-0.473	-0.402	(0.055)	-1.286
ι	0.029	0.123	(0.042)	-2.236
Profitability Regression				
δ_0^y	-0.177	0.223	(0.063)	-6.337
δ_1^y	0.258	-0.014	(0.075)	3.657
δ_2^y	0.794	0.783	(8.6e^{-3})	1.352
$\delta^{(-1)}$	-0.716	-3.590	(0.260)	11.04
$\delta^{(0)}$	-2.864	-4.058	(0.247)	4.840
$\delta^{(1)}$	-1.371	-0.946	(0.276)	-1.539
Hazard Regression				
$\delta_{0,1}^d$	0.024	0.025	(2.9e^{-3})	-0.500
$\delta_{0,2}^d$	0.044	0.056	(4.0e^{-3})	-3.025
$\delta_{0,3}^d$	0.042	0.053	(3.8e^{-3})	-2.856
$\delta_{0,4}^d$	0.023	0.031	(2.0e^{-3})	-3.977
$\delta_{1,1}^d$	-8.7e^{-3}	-8.7e^{-3}	(3.4e^{-3})	4.2e^{-3}
$\delta_{1,2}^d$	-0.018	-0.023	(4.6e^{-3})	1.201
$\delta_{1,3}^d$	-0.012	-0.022	(4.5e^{-3})	2.362
$\delta_{1,4}^d$	-5.8e^{-3}	-8.7e^{-3}	(2.4e^{-3})	1.193
Residual Profitability				
$\mathbb{E}[\bar{\sigma}_{ij}]$	39.46	40.84	(0.238)	-5.824
$Var(\bar{\varepsilon}_{ij})$	17.30	13.99	(0.174)	18.98
$Var_I(\bar{\varepsilon}_{ij})$	13.82	13.52	(0.167)	1.769
Hiring Probability				
$\mathbb{P}$(Insider Hire)	0.649	0.643	(7.8e^{-3})	0.802
κ_0	-0.734	-0.648	(0.038)	-2.282
κ_1	-0.022	-0.022	(3.8e^{-3})	-0.049

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.

B.5 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).

↪ *Model A6: Insider signal observed post-turnover.* For our final sensitivity test, we assess the robustness of our main findings to a change in the timing of information acquired about insider CEO candidates. We alter the model structure by assuming that the insider signal is only revealed after turnover has occurred. As a result, if the board chooses to retain the current CEO, it receives no new information about an internal candidate; only following a

turnover event (voluntary or forced) does the firm observe the insider signal and compare it to the outsider option. This alternative timing reflects a more restricted internal succession process in which insider candidate evaluation is deferred until replacement is necessary.

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 B.4 and Figures B.3 and B.4.

Models A1 and A2 yield similar estimates to our baseline model for virtually all parameters. Specifically, we find that outsider average quality continues to exceed that of insiders, there are economically meaningful firing costs, and strong persistence in profitability. In Model A1 we do see a substantial increase in the baseline board distaste for hiring outsider candidates (γ_1), which can be explained by the reclassification of some potentially lower average match quality outsiders as insider candidates, which is captured by the marginal increase in the difference between the type-specific match quality population averages. Additionally, while we do observe a slight change in the magnitude of the insider signal variance in Models A1 and A2, yet all of these differences are not large enough to change the conclusions discussed in Sections 5 and 6.

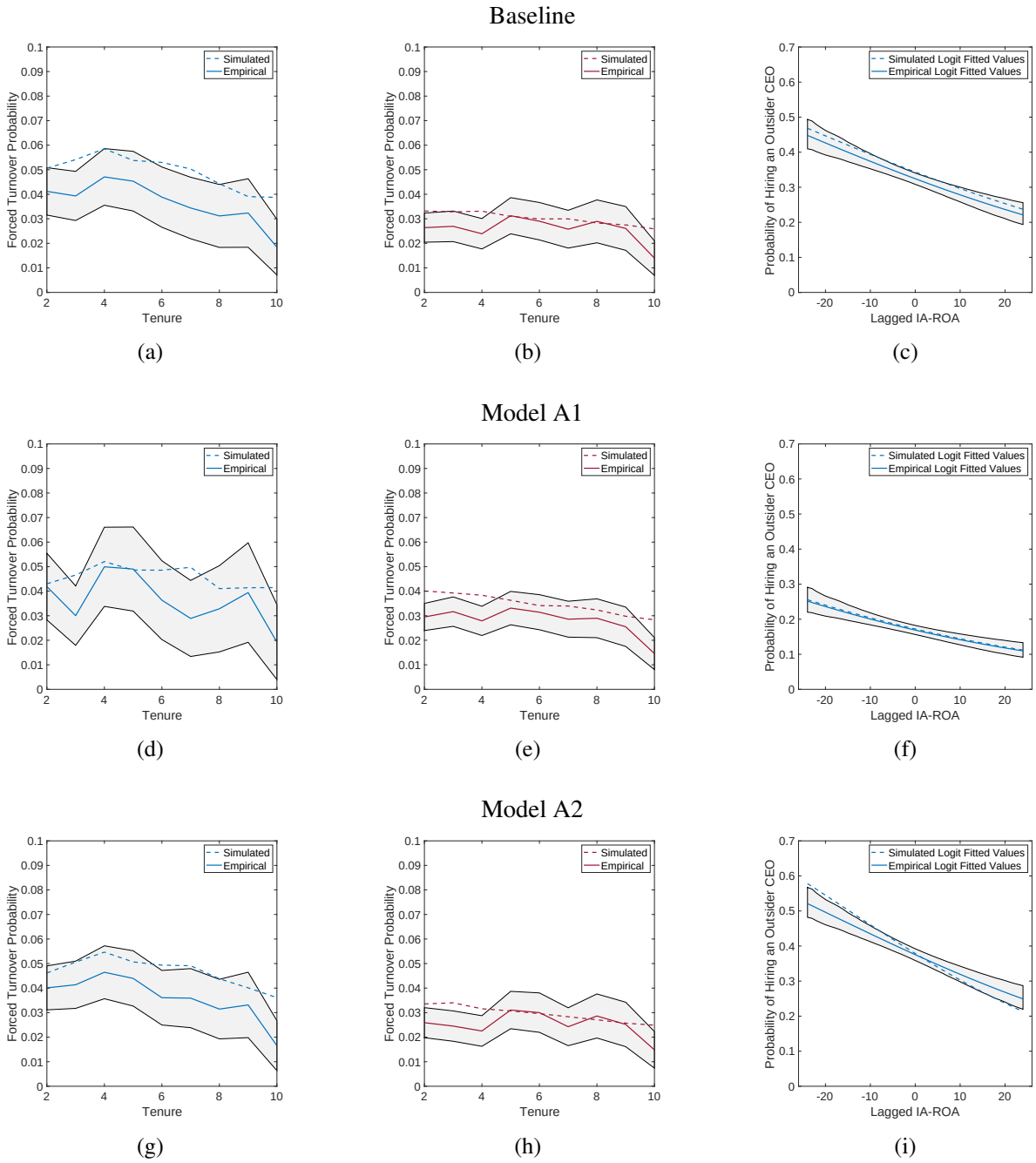
Model A3 yields estimates that are entirely consistent with our baseline specification, indicating that our model is robust to the levels of fading memory used in the literature. Estimates from the limited recall model (Model A4) yield the most differences relative to our baseline but it is also the one that offers the poorest fit (Figure B.4). The limited recall model yields the largest difference in the average quality of insider and outsider candidates, large non-pecuniary firing costs, and a very high level of persistence in profitability, all of which contradict prior findings in the literature (Jenter and Kanaan, 2015; Taylor, 2010). In Model A5, the estimate of γ_2 is large, positive, and statistically and economically significant. 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 an active role in explaining the gradient between the rate of outsider hiring and prior firm performance. Finally, despite the shift in the insider signal timing in Model A6, our parameter estimates remain remarkably consistent with the baseline results. The insider and outsider candidate match quality distributions, the variance of the insider signal, and the parameters governing profitability, turnover costs, and hiring preferences all show minimal changes. These findings provide additional confidence in our baseline modeling assumptions.

TABLE B.4: 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									
-0.387	-0.563	0.943	0.712	44.25	0.203	0.775	4.689	-1.032	-0.030
(0.086)	(0.058)	(0.086)	(0.080)	(0.261)	(0.007)	(0.179)	(0.253)	(0.137)	(0.011)
Model A1: Stricter definition of outsider									
-0.274	-0.489	0.9494	0.9213	45.30	0.221	0.496	4.934	-2.301	-0.041
(0.061)	(0.052)	(0.063)	(0.081)	(0.243)	(0.007)	(0.182)	(0.218)	(0.229)	(0.009)
Model A2: Looser definition of outsider									
-0.409	-0.669	0.878	0.527	44.70	0.209	0.695	4.696	-1.083	-0.050
(0.104)	(0.066)	(0.079)	(0.075)	(0.309)	(0.007)	(0.202)	(0.217)	(0.271)	(0.013)
Model A3: Memory decay (decay parameter: 0.9)									
-0.427	-0.490	0.855	0.756	44.40	0.205	0.761	4.328	-0.833	-0.043
(0.107)	(0.054)	(0.077)	(0.119)	(0.295)	(0.007)	(0.222)	(0.249)	(0.158)	(0.007)
Model A4: Limited recall (recall window: 5 years)									
-5.825	-5.453	8.882	10.92	44.64	0.117	0.246	11.66	-2.102	-0.004
(0.514)	(0.279)	(0.063)	(1.889)	(0.349)	(0.005)	(0.207)	(0.677)	(0.365)	(0.009)
Model A5: Non-linear preference for outsiders in bad times									
-0.338	-0.579	0.837	0.512	44.77	0.214	0.584	4.613	-1.468	1.015
(0.086)	(0.086)	(0.085)	(0.075)	(0.303)	(0.008)	(0.152)	(0.209)	(0.236)	(0.231)
Model A6: Insider signal observed post-turnover									
-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. "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. "Model A6" corresponds to the specification with the insider signal observed post-turnover.

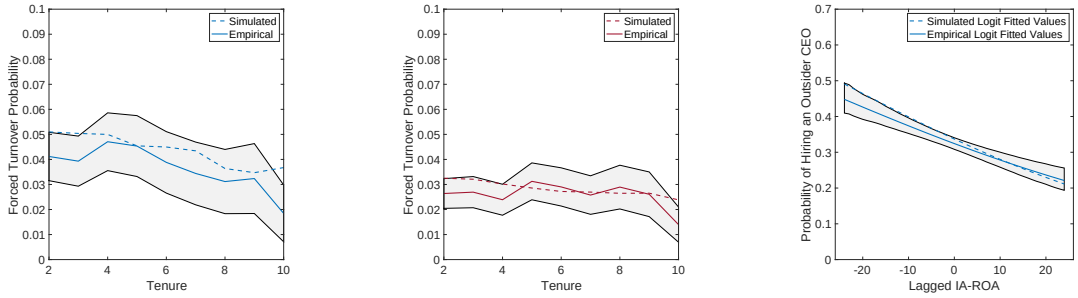
FIGURE B.3: Model Fit for Robustness Specifications



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 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).

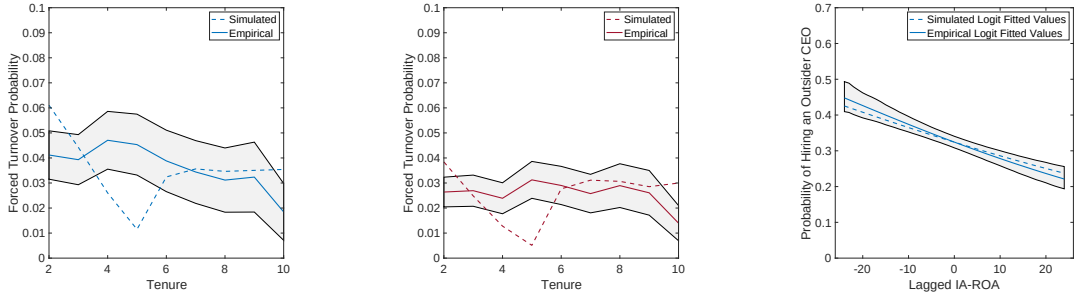
FIGURE B.4: Model Fit for Robustness Specifications (Continued)

Model A3



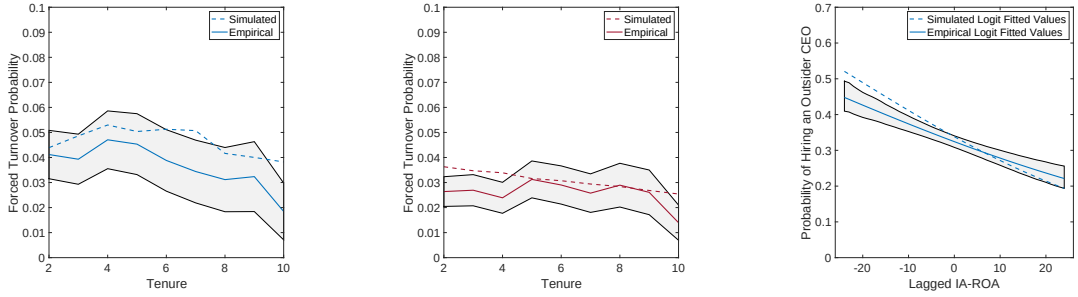
(a) (b) (c)

Model A4



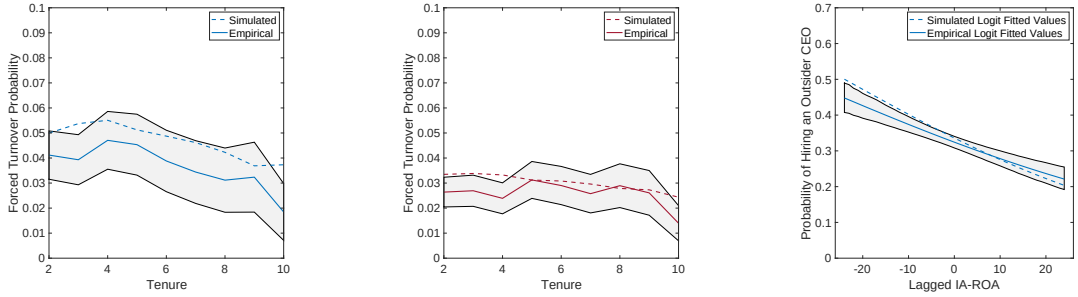
(d) (e) (f)

Model A5



(g) (h) (i)

Model A6



(j) (k) (l)

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. "Model A6" corresponds to the specification with the insider signal observed post-turnover.

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