Human Capital, Competition and Mobility in the Managerial Labor Market*

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May 25, 2025

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Abstract

We pose and estimate a model of the managerial labor market to quantify the relative importance of general and firm-specific human capital, managerial bargaining power, and labor market competition in shaping compensation and mobility. We decompose compensation growth over both tenure at the firm and labor market experience, finding firm-specific human capital to be an important driver in both cases. Firm-specific skill restricts mobility and can help explain the low rate of external CEO hiring. We decouple the effects of managerial bargaining power and labor market competition on managers' realized share of rents and show that neglecting the role of competition biases estimates of managers' bargaining power. Furthermore, we find that firm-specific human capital enhances managers' ability to extract rents from incumbents as it raises the match-specific quality between the manager and firm.

Keywords: managerial human capital, CEOs, the market for CEOs, executive pay, executive mobility, on-the-job search, structural estimation, human capital accumulation, firm-specific human capital

*This paper is a work in progress and results are subject to change, all errors our are own. We thank Thomas Geelen, Luca Flabbi, Nick Gantchev, Todd Milbourne, Jeremy Bertomeu, Franklin Qian, and many others, for their helpful comments. We are also grateful to audiences of seminars/conferences at Rice University, Warwick Business School, Duke Fuqua School of Business, MARC, ITAM Finance Conference, BOCA-ECGI Corporate Finance and Governance Conference, SWFA, IAF, and the Lone Star Finance Conference for their valuable feedback.

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1. Introduction

In this paper, we quantify the relative importance of human capital, managerial bargaining power, and labor market competition in determining compensation and mobility in the market for US corporate executives. We do so by posing and estimating a dynamic model of managerial careers featuring both general and firm-specific human capital accumulation, strategic bargaining over compensation contracts, and competitive bidding for managerial talent. Our paper contributes to the literature in three ways.

First, decomposing managerial human capital into general and firm-specific components has important implications for the study of executives: prevailing theories rationalize the recent rise in CEO pay via a premium on general, portable CEO skill (e.g., Gabaix and Landier, 2008; Murphy and Zabojnik, 2007).[1] A shared feature of these models is that competition for generalist CEOs induces higher wages via an outside option channel, and while these models may not be intended to explain managerial mobility, a direct empirical implication is a high degree of mobility in the managerial labor market. Yet, as shown in Cziraki and Jenter (2024), around 73% of new CEOs at the largest companies in the US are internally promoted; only a small percentage of external hires are poached CEOs (Graham et al., 2020; Cziraki and Jenter, 2024). This suggests that firm-specific managerial skill may be more important than previously considered.[2]

Second, decoupling the relative contributions of pure bargaining power and imperfect labor market competition to managerial surplus capture informs the large literature on CEO bargaining power and its influence on compensation policy.[3] Competition for managerial talent and strategic bargaining work in tandem to drive up managerial compensation. Explicitly modeling the

[1] Gabaix and Landier (2008) is an example of a competitive assignment model that allow for complementarity between CEO skill and firm size, which helps explain the rise in CEO pay. Murphy and Zabojnik (2007), in a separate but related setting, shows that general managerial skill improves managers' outside options, which can also help rationalize the increase in CEO pay.

[2] Cziraki and Jenter (2024) show that 73% of new CEOs at S&P500 firms are internal hires from 1994-2012, and a large proportion of external hires are known to the Board (either a former executive, or a Board member). Graham et al. (2020) show that 68% of new CEOs are internal hires (a current or previous officer of the firm) for a fuller sample of NYSE/Amex firms from 1933-2011.

[3] See, e.g., Core et al. (1999); Bertrand and Mullainathan (2001); Bebchuk and Fried (2003); Fahlenbrach (2009); Bebchuk et al. (2011); Morse et al. (2011); Taylor (2013); Coles et al. (2014).

influence of labor market competition permits us to estimate managers' bargaining power net of any influence from market forces, essential for quantifying agency frictions in the pay-setting process.

Third, we show that the managerial human capital and surplus capture channels interact in determining mobility and compensation. Firm-specific human capital accumulation increases the manager's match quality with the firm, which can help explain the low rate of cross-firm mobility. However, it can also have a positive impact on realized managerial surplus capture: more firm-specific skill also raises the firm's cost of losing the manager, incentivizing the firm to more generously match outside offers. This represents a compensating differential of firm-specific human capital and helps reconcile two stylized facts that often seem at odds, low CEO mobility and high CEO rent capture, by showing that scarce outside options can still constitute powerful bargaining chips when the firm's dependence on the incumbent CEO is high.

Our structural model is a comprehensive, tractable characterization of managerial careers (both non-CEO and CEO), incorporating general and firm-specific human capital accumulation, managerial bargaining power, labor market competition, mobility (including both internal and external promotion opportunities), search frictions, and executive and firm heterogeneity. Unlike the existing literature which generally focuses on firm demand for managerial talent, we model the executive's career through the lens of on-the-job search (Bagger et al., 2014).[4]

Managers in the model may be employed as a (non-CEO) executive or as the CEO of the firm.[5] Over their careers, executives may receive job offers — to move horizontally, be promoted internally to CEO, or to be promoted externally to CEO; the arrival rates of these job offers differ and are estimated in the data. CEOs may receive job offers to be CEOs at other firms.

We follow an important strand of the search literature (Lazear, 2000; Postel-Vinay and Robin, 2002; Cahuc et al., 2006; Bagger et al., 2014) and model managerial compensation as a piece-rate

[4]Indeed, while firm-specific human capital can help explain preference for insiders and low CEO mobility (Cziraki and Jenter, 2024), its impact is not immediately separable from search frictions inhibiting the movements of CEOs across firms (such as a preference for internal CEO promotions, He and Schroth, 2024). Moreover, differences in wages across executives and firms may be attributable to time-invariant (possibly unobserved) heterogeneity, either across managers or firms, or both.

[5]To limit confusion, throughout the paper we refer to non-CEO executives as "executives" and CEOs as "CEOs."

contract: managers receive a portion $R \in [0,1]$ of their contribution to firm output. When a manager receives an attractive outside offer, the incumbent and poaching firm may bargain over the manager's services (in the spirit of Rubinstein, 1982). Firm-switching events occur when the poaching firm values the manager more than the incumbent, and on-the-job search leads to stochastic, discrete increases in pay as firms bargaining over managerial services, even if the manager ultimately stays in their current position.

We adapt the setting in Bagger et al. (2014) to allow for firm-specific human capital (in addition to general) and for both external and internal promotion of executives. Importantly, we let search rates differ across internal and external promotion opportunities, which enables us to distinguish a preference for insiders (He and Schroth, 2024) from the impact of firm-specific human capital on internal *vs.* external executive mobility.

One insight from the model is that firm-specific human capital accumulation leads to increased match-specific productivity between the firm and manager over the manager's tenure. This makes the manager less likely to be tempted away by poaching offers as they advance at the incumbent (decreasing job-to-job transitions). However, firm-specific human capital increases the likelihood that the incumbent firm is willing to match attractive outside offers, precisely because of the increased match-specific productivity. We show theoretically that cross-firm mobility decreases with firm-specific skill, whereas within-firm mobility (contract renegotiation due to outside offers) can increase, arising as a compensating differential of firm-specific human capital.

Our model also provides closed-form solutions for managerial contracts, and we demonstrate that, all else being equal, internally promoted CEOs receive a smaller share of rents compared to externally-hired candidates, with poached CEOs receiving the largest share. This outcome holds regardless of the level of firm-specific human capital. The reason lies in the differing outside options available to these three types of managers. Consequently, our model predicts that CEO contracts are path-dependent, shaped by whether the CEO was hired internally or externally.

We estimate the model on a rich panel of managerial careers spanning 1992-2023 (Execucomp), combined with manually-collected data on managers' tenures at firms and their experience in the executive labor market. This allows us to track experience, tenure, compensation, and mobility over the working life of an executive. Transitions of managers (non-CEO and CEO) across firms, and the resultant impacts on wages and mobility, allow us to separately identify general and firm-specific components of executive human capital.

Our estimation produces several sets of results. First, we quantify the key drivers of managerial compensation by decomposing wage growth into the separate impacts of mobility (transferring into higher-productivity firms), labor market competition (contractual improvements from job offers) and human capital (both general- and firm-specific). Firm-specific (general) human capital accounts for about 25% (33%) of managerial compensation growth over experience in the labor market. These numbers are about 40% (50% for general) when focusing on compensation growth over tenure at a particular firm. As such, firm-specific skill is an important determinant of executive compensation.

We also analyze how firm-specific human capital impacts the hiring of internal vs. external CEOs. By simulating a counterfactual with in which firm-specific skill does not impact mobility and comparing to the baseline estimation, we find that firm-specific human capital raises the proportion of internal CEO hires by about 8 percentage points (an increase from 67% to 75%, or nearly an 12% increase). While search frictions and cross-firm competition explain the majority of the observed rate of internal vs. external hiring, this result contributes to the understanding of mobility in the CEO labor market.

Our second set of results concerns realized managerial surplus capture and labor market competition. Our estimation allows us to decompose CEO rent sharing into pure CEO bargaining power and labor market competition pushing CEO wages up (inspired by Cahuc et al., 2006). We find that, on average, CEOs capture about 56% of rents, which is closely in line with estimates from papers in the literature. However, our estimate of pure CEO bargaining power is 44%, and that about 30% of realized CEO surplus capture is driven by labor market competition.

We also find that realized CEO surplus capture varies depending on if the CEO was internally promoted or externally poached, with poached CEOs commanding the greatest share of rents:

internal CEOs capture 65.% of surplus, poached CEOs 87%, with 33% (50%) of this surplus capture driven by labor market competition.[6] These results show that endogenizing labor market competition for executives is crucial for understanding agency frictions in executive compensation.

Lastly, we show that firm-specific human capital impacts realized CEO surplus capture. We study how CEOs' shares of rents evolve over the tenure of the CEO in the baseline estimation and a counterfactual in which firm-specific human capital does not impact bargaining. Over labor market experience, firm-specific human capital lowers the manager's piece-rate growth (that is, job lock reduces the contractual gains from job hopping). Over tenure at a firm, however, firm-specific human capital increases piece-rate growth as the firm is willing to match attractive offers to retain the accumulated firm-specific skill. These results arise directly out of our model's theoretical predictions concerning firm-specific skill and managers' realized surplus capture.

The paper is organized as follows. The rest of this section discusses our paper's place in the literature. Section 2 summarizes our estimation sample. Section 3 introduces the theoretical model. Section 4 discusses our estimation and identification strategies and Section 5 gives the estimated parameters. Section 6 analyzes CEO bargaining power and labor market competition. Section 7 analyzes the role of firm-specific human capital (and other channels) in determining mobility and compensation. Finally, Section 8 concludes. Model proofs and additional details are in Appendix A, and estimation details are contained in Appendix B.

1.1. Literature Review

Our paper lies in the intersection of the search literature in labor economics and the study of executives in corporate finance. On the labor side, our paper relates to preceding work concerning on-the-job search, bargaining, and human capital. Starting with Postel-Vinay and Robin (2002) and Cahuc et al. (2006), these papers develop and microfound a workhorse structural model of careers with on-the-job search. Bagger et al. (2014) continues by adding general human capital accumulation to the model.

[6] This result stems from our theoretical result that poached CEOs receive strictly larger contracts than internally-hired CEOs.

We expand these models in several key ways. First, we allow the worker to accumulate both general and firm-specific capital, and show that firm-specific skill has previously unstudied impacts on labor market mobility and renegotiation over worker careers. As pointed out by Lazear (2009) and Bagger et al. (2014), firm-specific human capital has received relatively less attention than general in the labor economics literature, perhaps because of the focus on rank-and file workers. Quoting Bagger et al. (2014), "firm-specific human capital is a somewhat elusive concept." However, firm-specific human capital is likely to be more important in the executive labor market, where, for example, fostering corporate culture (Graham et al., 2022) or efficiently deploying the firm's factors of production are skills that may not transfer.[7] Second, we allow to experience internal and external promotions over their careers.

On the corporate finance side, the relative importance of general and firm-specific skill, or more specifically how this relative importance can explain CEO wage growth over time, has been extensively studied. Indeed, a large literature has arisen which stresses the importance of transferable executive skill in explaining the large observed increase in CEO wages over time.[8] However, to our knowledge, no paper has explicitly attempted to directly quantify the weights of general and firm-specific human capital in managerial skill.

Murphy and Zabojnik (2007) (and the related Murphy and Zabojnik, 2004) model the firm's choice of an internal *vs.* an external candidate, and show that, in a market with an elastic supply of executive labor, a larger importance on general executive skill (relative to firm-specific) can rationalize the observed increases in executive pay that have been observed in the data. As Custódio et al. (2013) point out, a direct implication of a competitive executive labor market is that firm-specific human capital receives a lower premium in wages, because firm-specific human capital does not improve the executive's outside option. Cziraki and Jenter (2024) find that the

[7] As explained in Lazear (2009), one can think of firm-specific skill as a combination of general skills that is unique to the firm, which seems to readily apply to managers. From Lazear: "… A small Silicon Valley firm provides enterprise software that does tax optimization. The typical managerial employee in this firm must know something about tax laws, something about economics, and something about software and computer programming … Most employees must have at least some knowledge of each. None of these skills, taken alone, is firm-specific."

[8] This is a large, important recent literature in corporate finance, for example, Gabaix and Landier (2008); Terviö (2008); Edmans et al. (2009); Murphy and Zabojnik (2007); Custódio et al. (2013); Frydman (2019)

CEO labor market at large public firms is frictional: executives rarely switch firms and exercise their outside option. These frictions suggest the presence of firm-specific capital, with CEO-firm matches generating surplus split through bargaining.

In a model of the executive labor market with on-the-job search, managerial bargaining power, in which incumbents and poachers compete for managerial talent, the above predictions of Murphy and Zabojnik (2007) and Custódio et al. (2013) are not necessarily true. While the manager's utilization of the outside option may decrease with tenure, the importance of the *renegotiation option*, in which managers use outside offers to improve their incumbent contract, become relatively more important. Moreover, our estimates contribute to understanding of the role of labor market competition in determining CEO rent shares, which contributes to the structural literature on the executive labor market (Taylor, 2010, 2013; Page, 2018; Barry, 2023; Lyman, 2024).

Several papers have measured the importance of general and firm-specific human capital in high-skilled industries (Gao et al., 2021; Ma et al., 2023). These papers allow the worker to accumulate human capital via learning-by-doing, and study how this shapes mobility choice across career. Our paper complements these studies by (i) focusing on the managerial labor market at US public companies more generally, and (ii) explicitly studying how firm-specific capital shapes mobility paths across careers. Indeed, our analysis on the role of job search in determining managerial rent shares is similar in spirit to the measure of "bargaining capital" in these papers.

2. Data

We estimate our model on a panel dataset covering executive careers at US public firms from 1992 to 2023. We supplement data from Execucomp with manually-collected data on when managers first joined their firm, extending the data work from Gayle et al. (2015). Doing so allows us to accurately define managerial tenure and measure firm-specific human capital.

We classify each manager in our sample as being employed in an executive (non-CEO), a CEO position, or unattached. Unattachment refers to managers who stop working at a firm in our sample for at least one year, but begin work at another public firm later in their career. Managers that permanently attrit from the sample are classified as retired.[9]

Our measure of compensation is TDC1, which includes each year's salary, bonus, stock grants, option grants, long-term incentive payouts, and other non-equity incentive payouts. Following arguments in Taylor (2013), we assume that the wage level set each year induces the manager to deploy their human capital at the firm and produce, and any negotiated future incentive today is incorporated into the current piece-rate. Indeed, piece-rates function as near-pure incentive contracts, directly linking compensation to output produced by the manager.

We identify each labor market event for managers in our sample. Executives can be internally promoted, externally promoted, or move horizontally to be an executive at another firm. CEOs can move horizontally to other CEO positions. All managers can enter unattachment or retire. Unattached managers can enter executive or CEO employment.

Table 1 displays summary (Panel A) and labor market transitions statistics (Panel B), which are displayed conditional on employment state (executive, CEO, or unattached). The median CEO in our sample receives about 3 million dollars, with the median executive receiving 958 thousand dollars. Wage growth is on average about 9.8% per year for CEOs.

External CEO hires are uncommon relative to internal promotions (667 total external CEO hires relative to 4,170 promotions). These differences could reflect firm-specific human capital, or different search probabilities for internal and external candidates. There are more executive-to-executive transitions, which prove useful as our identification strategy relies on changes in wages around job-switching events.

[9]The data does not allow us to perfectly separate unattachment and retirement. Indeed, any manager who initially enters unattachment (and is still looking for managerial positions), but ultimately never shows up again in Execucomp will be labeled as retirement. As such, it is likely that our separation rate η is biased downward, and our retirement rate μ is biased upwards. This has implications for the stock of managers that firms consider for unfilled positions. However, this does not impact within- and across-job bargaining, mobility and wages.

3. Model

3.1. Environment

The labor market consists of firms and managers. Time is continuous. For a given manager, we let t denote their total experience in the managerial labor market and $\tau \leq t$ denote experience at their current firm (i.e., tenure). At any point in time, managers may find themselves in one of three employment states: if currently employed in a managerial position, managers may hold a CEO position (C) or a non-CEO position (E), where we refer to the latter type of manager as an "executive." Otherwise, managers may be "unattached" (U), in which case they do not currently hold a position in the managerial labor market.

Production and human capital. A manager's total human capital (in logs) is given by:

$$h = a + g(t) + k(\tau) \tag{1}$$

The parameter $a \sim N(0, \sigma_a^2)$ is a manager-specific skill parameter reflecting permanent differences in individual ability. The functions $g(t)$ and $k(\tau)$ denote general and firm-specific human capital accumulated through work experience. Importantly, any time a manager leaves their firm, their general human capital $g(t)$ is retained while their firm-specific capital $k(\tau)$ is not: $k(\tau)$ resets to $k(0) = 0$ upon switching firms.

At each point in time, the manager-firm match generates output Y, with natural logarithm y:

$$y = h + f = a + g(t) + k(\tau) + f, \quad f \sim \Psi \tag{2}$$

where $f \in [f_{min}, \infty)$ is a firm effect summarizing firm-specific characteristics which augment managerial productivity such as firm size, organizational culture, proprietary technology, etc. As f is firm specific, it is redrawn from distribution Ψ any time a manager switches firms. Output is thus determined both by characteristics of the manager which are independent of the firm, namely the skill parameter a and general human capital $g(t)$, as well as characteristics specific to the manager-firm match, captured by f and $k(\tau)$. It is convenient to define $p = f + k(\tau)$ as the manager's *match productivity*, which represents the component of total productivity tied to the current match and which is lost upon switching firms.

As we will show, the dynamics of match productivity p play a critical role in a manager's decision to accept a competing job offer or remain in their current position. When considering job transitions, the potential gains in total productivity, and thereby compensation, realized upon transition from a a low-f to a high-f position must be weighed against the firm-specific capital, $k(\tau)$, lost during the transition. As such, managers with high levels of human capital accrued at the incumbent firm may be inclined to reject offers from more productive, competing firms.

While unattached, a manager's tenure τ is fixed at zero and firm-specific human capital does not accumulate. We allow experience t to accumulate while unattached. The nature of the data on executive wages and mobility necessarily limits us to analyzing publicly-listed firms and it is likely that unattached executives are accumulating experience, for example by managing a private firm. Upon entering managerial employment, a manager's tenure and firm-specific capital immediately begin to accumulate.

Retirement, unattachment and on-the-job search. Employed managers engage in on-the-job search and may be contacted by a potential employer about a position at any time. Managers' current employment state impacts the types of offers they may field. For executives, three possible offers may be received: internal promotion to CEO, external promotion to CEO, or a lateral move to an executive position with another firm. Opportunities for an internal promotion arrive at rate λ_0. Relative to cross-firm transitions, internal promotions do not entail losses in firm-specific capital: if an executive accepts an internal promotion to CEO, $k(\tau)$ continues to accumulate.

External promotions arrive at rate λ_1. Differences in the arrival rates of internal and external promotion offers may reflect, for example, preferences for or against hiring CEOs from within or differences in firms' cost of internal and external search for executive talent. Upon receiving and accepting an external promotion offer, the executive assumes the CEO role at the poaching firm and their firm-specific capital resets to zero. Lastly, offers for an executive position at a different firm arrive at rate λ_2, and upon accepting such an offer, the executive switches firms and $k(\tau)$ similarly resets to zero.

For CEOs, the only types of viable outside offers are for CEO positions at different firms; we rule out demotions *ex ante*.[10] As in the case of executives, we assume that offers for outside CEO positions arrive at rate λ_1. We will show that despite this assumption, the rates of executive-to-CEO and CEO-to-CEO transitions will differ in equilibrium. As in all previous cases, CEOs forgo their firm-specific capital $k(\tau)$ upon taking a position with another firm.

In addition to receiving job offers, managers may receive employment shocks inducing separation or exit from the labor market. We assume that managers retire and exit the labor market permanently at rate μ. Alternatively, at rate η manager-firm matches are dissolved and the manager enters unattachment. While unattached, managers may potentially re-enter the labor market by receiving an offer for an executive or CEO position, which arrive at rates γ_E and γ_C, respectively. Note that unattachment is not synonymous with unemployment. Unattached managers have no tie to any publicly-held firm, but may be employed in the government or private sector, for example; explicitly modeling these types of employment is beyond the scope of this paper.

3.2. Bargaining and Wage Contracts

Compensation takes the form of a piece-rate contract: managers receive an endogenous share $R \in (0,1]$ of their marginal product Y (Postel-Vinay and Robin, 2002; Bagger et al., 2014). Consequently, log compensation is given by:

$$w = r + a + g(t) + k(\tau) + f \tag{3}$$

[10]This assumption is motivated by the data. When examining potential demotions (when a manager is the CEO at a firm in year t and a non-CEO executive in year $t+1$) in our data, we find that a large majority are advisory positions. For example, the previous CEO stays on at the firm explicitly as an advisor to the current CEO, or implicitly by taking chairmanship of the board. However, a small number of true demotions do exist in our data. Our model is not intended to study the decision to promote a (possibly interim) CEO and subsequently demote them, so we remove these managerial spells from our estimation sample.

Piece rates $r = \log(R) \leq 0$ are determined via strategic bargaining between firms and managers, with $r = 0$ capturing the extreme case in which the manager fully extracts the surplus generated by the position. For a manager with experience t, match productivity p and a contract stipulating piece rate r, we denote the discounted value of their position by $V_i(r, t, p)$, for $i \in \{E, C\}$.

Throughout their careers, managers leverage competing job offers to garner themselves higher payoffs. Any time an offer arrives, a bargaining game is initiated between the manager and firm(s) bidding for their services. The outcome of the bargaining determines both the manager's potentially new position and the piece rate characterizing their new contract. The bargaining protocol is as an extension of Cahuc et al. (2006), which we microfound in full in Appendix A, and the exact form of the bargaining game will depend on the type of job transition in question: internal promotion, external promotion, or lateral move.

3.2.1. Internal Promotions

Consider a manager employed in an executive position with state (r, t, p), where $p = f + k(\tau)$ represents the manager's match productivity with their current firm. Suppose their firm approaches them with a potential promotion to CEO. The firm offers piece rate r' characterizing the manager's contract were they to accept to promotion. The firm's offer satisfies the following condition:

$$\begin{aligned} V_C(r', t, p) &= V_E(r, t, p) + \beta(V_C(0, t, p) - V_E(r, t, p)) \\ &= \beta V_C(0, t, p) + (1 - \beta)V_E(r, t, p) \end{aligned} \tag{4}$$

The value to the manager of accepting promotion, $V_C(r', t, p)$, is the value of remaining in their current position $V_E(r, t, p)$ plus a share β of the additional surplus created by the new position. The parameter β, to be estimated, measures managers' bargaining power. The sharing rule (4) implies that it is in the manager's interest to accept promotion to CEO if and only if $V_C(0, t, p) > V_E(r, t, p)$.

We define $\bar{\theta}(r,p)$ as the critical level of match productivity satisfying the indifference condition:[11]

$$V_C(0,t,\bar{\theta}(r,p)) = V_E(r,t,p) \tag{5}$$

The following proposition provides an important characterization of the indifference frontier $\bar{\theta}(r,p)$.

Proposition 1. *When $r < 0$, we have that:*

$$\bar{\theta}(r,p) < \bar{\theta}(0,p) \leq p \tag{6}$$

Proof. See Appendix A. ■

Proposition 1 implies that all else equal, managers are weakly better off in CEO positions relative to executive positions. Hence, all internal promotion offers are accepted, with starting contract r' satisfying (4).

3.2.2. Cross-Firm Transitions

For internal promotions, only two parties (the manager and incumbent firm) take part in negotiations. The situation is more nuanced for cross-firm job offers as negotiations entail three parties: the manager, the incumbent firm and the poaching firm. Here, the two firms competitively bid for the manager's contract, while the manager exercises bargaining power over both.

We let $f' \sim \Psi$ denote the productivity of the poaching firm, which is public information. Cross-firm bargaining has three possible outcomes, ultimately depending on the value of f'. First, if f' is sufficiently high, the poaching firm ultimately wins the manager. Second, if f' is sufficiently low, the manager ignores the offer entirely. Third, if f' lies in an intermediate range, the incumbent firm can retain the manager with a renegotiated contract.

Consider a manager employed in a position of type $i \in \{E, C\}$ with state (r,t,p). Suppose they are offered a position of type $j \in \{E, C\}$ with another firm and assume momentarily that the

[11] We suppress dependence on experience t for notational convenience.

poaching firm can outbid the incumbent (leading the manager to switch firms). The manager's piece rate r' upon accepting this new position satisfies:

$$V_j(r', t, f') = \beta V_j(0, t, f') + (1 - \beta) V_i(0, t, p) \tag{7}$$

which again states that the value of accepting the external type-j offer $V_j(r', t, f')$ is a weighted combination of the total surplus of the new match $V_j(0, t, f')$ and the manager's outside option $V_i(0, t, p)$. The value of accepting the competing offer reflects the fact that the manager will begin their new job spell with $k = 0$, implying that their match productivity at the new firm initiates at f'. Additionally, the outside option is no longer the manager's current value of employment, but the value of the best offer they could extract from the losing firm (the incumbent in this case). Appendix A.1 shows that competition between the two firms drives the incumbent to bid the full surplus $V_i(0, t, p)$ which, while never accepted in equilibrium, is a viable threat point which the manager can use as leverage. Managers are thus in more favorable bargaining positions when fielding external offers than internal offers (Cahuc et al., 2006).

Such competition may still benefit the manager even if they ultimately elect not to accept the outside position. In particular, the value of rejecting the new offer and retaining employment with the incumbent firm is given by:

$$V_i(r', t, p) = \beta V_i(0, t, p) + (1 - \beta) V_j(0, t, f') \tag{8}$$

Similar to the previous case, competition between the two firms drives the losing firm's bid (the poacher in this case) up to full surplus $V_j(0, t, f')$. Again, while this is not accepted by the manager in equilibrium, the threat of acceptance induces the incumbent to favorably renegotiate their contract to encourage the manager to stay.

Importantly, it is possible that a competing offer is not threatening enough to trigger renegotiation by the incumbent. For a type-i manager with state (r, t, p) who receives an outside offer for a position of type j, the incumbent firm is induced to renegotiate only if the productivity of the poacher f' exceeds $\underline{\theta}_{ij}(r,t,p)$, defined by:

$$V_i(r,t,p) = \beta V_i(0,t,p) + (1-\beta)V_j(0,t,\underline{\theta}_{ij}(r,t,p)) \tag{9}$$

Equation (9) states that an outside offer originating from a firm with productivity $\underline{\theta}_{ij}(r,t,p)$ would leave the manager no better off than their current contract. If $f' < \underline{\theta}_{ij}(r,t,p)$, the manager ignores the offer entirely. We summarize managers' acceptance criteria in the following proposition:

Proposition 2. *Suppose a type-i manager with state (r,t,p) receives an outside offer for a position of type j. Let f' denote the productivity of the poaching firm. The poacher wins the manager with piece rate r' satisfying (7) only if $f' > x_{ij}$, where:*

$$x_{EC} = \bar{\theta}(0,t,p) \tag{10}$$

$$x_{CC} = x_{EE} = p \tag{11}$$

The incumbent retains the manager with piece rate r' satisfying (8) only if $f' \in [\underline{\theta}_{ij}, x_{ij}]$. Lastly, if $f' < \underline{\theta}_{ij}$, the offer is ignored.

The new firm's productivity f' determines whether the manager accepts an outside offer, is retained under a renegotiated contract, or ignores the offer entirely. The external acceptance thresholds (x_{ij}) reflect the fact that in all cases of cross-firm transitions, the match productivity of the new position must be high enough to compensate for the firm-specific capital $k(\tau)$ lost during the job transition. Additionally, the likelihood of accepting an offer declines as $k(\tau)$ increases as firm-specific human capital accumulation increases match productivity p, gradually driving up the opportunity cost of switching firms. This induces *job lock*: imperfect transferability of human capital reduces the realized rate of cross-firm transitions.

Proposition 2 also provides information about the equilibrium proportions of internally- and externally-hired CEOs. Conditional on receiving an offer from firm type f', the probability of accepting a poaching CEO offer is lower for CEOs than executives.[12] This arises because CEOs,

[12]This arises because outside executives have lower poaching thresholds: for a given $k(\tau)$, $x_{EC} < x_{CC}$ (i.e.,

all else equal, have better outside options than executives, making them harder to poach.

Additionally, in an extreme case of the model with no firm-specific capital and equal rates of internal and external promotion offers (i.e. $\lambda_0 = \lambda_1$), internal promotions would still be more frequent in equilibrium. This is a consequence of cross-firm competition. When attempting to poach an outside executive, the subsequent bidding war between the poaching and incumbent firms decreases the likelihood of eventual acceptance, as executives may instead elect to remain with the incumbent at a renegotiated piece rate. Hence, internal promotions constitute a "path of least resistance" and will be more prominent in equilibrium.

3.2.3. Unattached Managers

Recall that unattached managers can re-enter the labor market with an executive or CEO job offer (which arrive at rates γ_E and γ_C). For tractability, we follow Bagger et al. (2014) and assume that the value of unattachment $V_U(t)$ is equivalent to employment in the least-productive executive position: $V_U(t) = V_E(0, t, f_{min})$. An implication is that unattached managers will accept any offer. Upon receiving an offer of type $j \in \{E, C\}$ from a type-f' firm, managers exit unattachment and begin their new position with piece rate r' satisfying:

$$V_j(r', t, f') = \beta V_j(0, t, f') + (1 - \beta) V_E(0, t, f_{min}) \tag{12}$$

3.3. Equilibrium Contracts

We next summarize the equilibrium piece rate contracts implied by the bargaining rules outlined above. We focus on piece rates set following transitions into CEO employment; discussion of the piece rates following lateral executive moves appears in Appendix A.[13] The specific form of CEOs' contracts will depend on the route that led them to the CEO position. In other words, contracts will be different for CEOs who were promoted from within, promoted from outside,

$\bar{\theta}(0, t, p) < p$). For the p-distribution's survivor function $S(\cdot) = 1 - \Psi(\cdot)$, the preceding inequality implies that $S(p) < S(\bar{\theta}(0, t, p))$, so outside CEOs are more likely to stay in their current position if they receive an offer.

[13]In Appendix A.2, we first fully derive the executive and CEO value functions, and then use these to derive contracts in closed-firm in Appendix A.4.

or poached from a CEO position at another firm. To aid exposition, we adopt the following terminology: *horizontal* moves refer to cross-firm CEO to CEO transitions, *diagonal* moves refer to cross-firm executive to CEO transitions, and *vertical* moves refer to within-firm executive to CEO transitions. In general, equilibrium piece rates are of the form $r_i^m(p,z)$ for $i \in \{E, C\}$ and $m \in \{hor, diag, vert\}$, where p is manager's match productivity at time of negotiation and z is a jump process tracking the manager's outside option.[14]

We begin by analyzing the case of horizontal CEO transitions. Let k_- be shorthand for the CEO's level of firm-specific human capital just before leaving their previous firm. Consider a CEO who transitions from a type-f firm to a type-f' firm. The initial piece rate in their new position is given by:

$$r_C^{hor}(f', f + k_-) = -(1-\beta)\int_{f+k_-}^{f'} q(x)\, dx \tag{13}$$

where

$$q(x) = 1 + \lambda_1(1-\beta)\frac{\partial V_C}{\partial p}(0, t, p)S(x), \quad S(x) = 1 - \Psi(x)$$

The piece rate (13) resembles that of Bagger et al. (2014), but differs through its dependence on k_-. A CEO's firm-specific human capital at their previous firm has no effect on output in their new position, yet directly impacts the structure of their new contract. Namely, to compensate managers for firm-specific capital lost upon switching firms, negotiated piece rate increase with respect to their accumulated human capital at their previous firm.

Consider next an executive in a type-f firm who is externally promoted by a type-f' firm.

[14]For example, consider a CEO with current match productivity $p = f + k(\tau)$. Suppose they take a CEO position at a new firm. Their outside option z has initial value p. Suppose at some point in the future, an outside CEO offer arrives from a type-f' firm, which is ultimately rejected. Following this, the CEO's outside option jumps to $z = f'$. Thus, outside options jump upon receiving a meaningful offer and remain constant otherwise. The dynamics of the renegotiation boundary $\underline{\theta}_{ij}$ ensure that z is weakly increasing. We suppress the piece rate's dependence on t for notational convenience.

Their initial piece rate is given by:

$$r_C^{diag}(f', f + k_-) = r_C^{hor}(f', f + k_-) - (1 - \beta) \int_{\bar{\theta}(0, f+k_-)}^{f+k_-} q(x)dx \tag{14}$$

Proposition 1 implies that the second term in (14) is negative. This implies that externally-hired executives are initially paid less than externally-hired CEOs (all else equal), which reflects differences in outside options between these two types of managers at the time of the pay negotiation: CEO positions are more valuable sources of employment, making CEOs more expensive to successfully poach than executives.

Finally, consider an executive in a type-f firm who is internally promoted into the CEO position. The initial piece rate is given by:

$$\begin{aligned} r_C^{vert}(f + k_-, f + k_-) &= r_C^{diag}(f, f + k_-) \\ &\quad - (1 - \beta)\left[\int_{f}^{f+k_-} q(x)dx + \int_{\bar{\theta}(r,p)}^{\bar{\theta}(0,p)} q(x)dx \right] \end{aligned} \tag{15}$$

The above condition highlights the two channels which yield differences in initial pay when comparing internally and externally-promoted CEOs. First, vertically-promoted CEOs retain their firm-specific human capital upon accepting the promotion, so firms do not need to offer internal hires as much surplus to induce acceptance (reflected in the second term of 15). Additionally, inside executives, unlike outsiders, do not benefit from cross-firm competition when negotiating the terms of a promotion, further decreasing the starting pay of internally-promoted executives (reflected in the third term above).

3.3.1. Renegotiation

We next analyze the effect of outside CEO offers emanating from firms of type $f' \in [\underline{\theta}_{ij}, x_{ij}]$, in which case CEOs are retained and contracts renegotiated. We refer to this interval as the *renegotiation region*, representing the set of competing positions which, while not lucrative enough for the CEO to accept, would provide the CEO with enough leverage over their current employer to induce renegotiation in the event of an offer. Upon receiving an outside offer with firm productivity f' in this range, the renegotiated piece rate will be:

$$r_C^{reneg}(f + k_-, f') = -(1 - \beta) \int_{f'}^{f+k_-} q(x)\, dx \tag{16}$$

Renegotiated piece rates have structure mirroring that of the piece rates sets following employment transitions. As before, they are contingent on incumbent firm's productivity f, the CEO's firm-specific capital at time of negotiations k_-, and the CEO's outside option which in this case is the productivity f' of the attempted poacher. As discussed previously, the manager will discard offers which do not favorably improve the current contract (i.e., fall below the threshold $\underline{\theta}_{ij}$). The match productivity of the marginal position triggering favorable renegotiation, $\underline{\theta}_{ij}$, evolves with tenure such that the following result holds:

Proposition 3. *For every transition type $ij \in \{CC, EC, EE\}$:*

1. *The renegotiation threshold $\underline{\theta}_{ij}$ rises with tenure:*

$$\frac{\partial \underline{\theta}_{ij}}{\partial \tau} > 0 \tag{17}$$

2. *The mass of the renegotiation region, $m_{ij} \equiv x_{ij} - \underline{\theta}_{ij}$ expands with tenure if and only if:*

$$\frac{\partial}{\partial p} log(V_i(0, t, p)) < \frac{\psi(p)}{S(p)} \equiv H(p) \tag{18}$$

where $\psi(p)$ is the density of distribution $\Psi(p)$ and $H(p)$ is the associated hazard rate.

Proof. See Appendix A. ■

The above result highlights the effect of firm-specific capital accumulation on managers' capacity to extract surplus through renegotiation. As CEOs' tenure increases, two forces work in opposing directions. First, match productivity grows with firm-specific capital $k(\tau)$, increasing the value of remaining in the current position. Second, outside threats fade; as p grows larger, the CEO faces a decreasing likelihood of outside offers that induce job-switch. Condition (18) compares the marginal gain from the first force against the marginal loss from the second. When the hazard rate $H(p)$ is high, that is, outside opportunities become scarce faster than the "inside" value rises, the second (negative) effect dominates. The firm must then widen the range of offers it is willing to match in order to dissuade the CEO from leaving. That is, the probability of renegotiation conditional on receiving an offer must increase with tenure.

While firm-specific human capital may lock managers in place, it simultaneously strengthens their realized internal bargaining power: a wider range of credible, but ultimately unaccepted, outside offers induce the incumbent to concede a greater share of surplus to the manager. This "compensating differential" turns firm-specific skill accumulation into a channel for rent extraction rather than a pure restriction on mobility.

3.4. The Managerial Wage Process

For a manager of type $i \in \{E, C\}$, the equilibrium wage process is given by:

$$w_i = a + g(t) + k(\tau) + f + r_i^*(p, z) \tag{19}$$

where r_i^* is the realized piece rate following the manager's most recent pay negotiation. Managerial compensation can be decomposed into a manager fixed effect a, an experience trend $g(t)$, a tenure trend $k(\tau)$, a firm fixed effect f, and a persistent random variable r_i^* reflecting the dynamic influence of bargaining, outside options, and cross-firm competition on managerial pay. The empirical value of (19) is apparent, and replicating it forms the basis of our identification strategy. As managers will have faced distinct histories with respect to job search, wage levels and contracts will be path-dependent. Our structural approach allows us to decompose pay into its observable and unobservable primitives, and determine the relative importance of each.

4. Estimation

We estimate the model via indirect inference (McFadden, 1989; Smith, 2016). We outline in this section our estimation algorithm, identification strategy, and set of target moments used to recover our structural parameters. We then discuss the estimated model's fit. The estimation procedure goes as follows. We first compute a set of empirical moments using the estimation sample described in Section 2. Then, we simulate the model and compute an identical set of moments using the resulting simulated data set. Parameter estimates are selected to minimize the optimally-weighted distance between the empirical and simulated moments, where weights are obtained using the inverse of the variance-covariance matrix of the empirical moments, clustered at the manager level. Further details are included in Appendix B.

4.1. Empirical Implementation

To simulate the model, we discretize time and start with an initial cross-section of I managers at time 0, drawing each an ability $a \sim N(0, \sigma_a^2)$ and subsequently assigning them to executive and CEO positions based on the rates γ_E and γ_C. Tenure τ and experience t are initialized at zero. For each employed manager, we draw a firm heterogeneity parameter f and set the the lower renegotiation bound at f_{min}.[15] Following Bagger et al. (2014), we assume that firm heterogeneity follows a Weibull distribution:

$$\Psi(f) = 1 - \exp\left(-\left(\frac{f - f_{min}}{s_1}\right)^{s_2}\right) \tag{20}$$

where the scale parameter s_1, shape parameter s_2, and the location parameter f_{min} are parameters to be estimated.

Labor market shocks (separation, job offers, retirement) arrive at the relevant rates for each manager at any given time. In the event of a job offer, a corresponding productivity f' is drawn and employment outcomes are realized following the discussion in Section 3.3. Managers are

[15]This follows from Equation (12). As all managers are assumed unattached prior to their first position, their initial renegotiation region is $[f_{min}, f]$.

immediately replaced in case of retirement (which we force after 45 years of experience if it has not already occurred). We assume that the general and firm-specific components of human capital follow cubic trends so that $g(t) = \sum_{q=1}^{3} \delta_g^q t^q$ and $k(\tau) = \sum_{q=1}^{3} \delta_k^q \tau^q$, where we estimate both $\{\delta_g^q\}$ and $\{\delta_k^q\}$.

Given managers' states, we compute their compensation according to (19). We augment the theoretical wage equation with additive, persistent individual shocks $\epsilon_{ijt} = \nu_e \epsilon_{ijt-1} + e_{ijt}$ capturing unmodeled sources of idiosyncratic pay fluctuations. We assume that $e_{ijt} \sim N(0, \sigma_e^2)$ and jointly estimate ν_e and σ_e alongside the previously-defined structural parameters.[16] We simulate the model for a total of 100 years, using the first 25 years as a "burn-in" period to allow the economy to approach a steady-state, which forms our simulated sample.[17]

4.2. Identification Strategy

We show there is a tight relation between the reduced-form moments of the auxiliary models and structural parameters. Our three sets of moments target different sets of structural parameters, and our identification argument follows key papers in the structural search and human capital literature (e.g., Cahuc et al., 2006; Bagger et al., 2014). Crucial to its success is separating the impacts of search frictions, imperfect labor market competition, and firm-specific human capital accumulation in determining compensation and mobility over the manager's career.

4.2.1. Labor Market Mobility

Managers may transition across three labor market states: unattachment, executive employment, and CEO employment. CEO spells may end with unattachment, retirement, or a horizontal move;

[16]To avoid issues of econometric singularity, it is common practice in the empirical implementation of labor search models to add idiosyncratic noise to theoretical wage equations (See for example: Eckstein and Wolpin (1990) and Flinn (2006)). These shocks are typically viewed as the natural consequence of measurement error. Strictly speaking, including the AR(1) process ϵ_{ijt} is not necessary in our setting, as the theoretical wage equation (19) already features unobserved heterogeneity across managers, across firms, and within employment spells. Nevertheless, we include this process in the simulated wage equation in the interest of empirical realism.

[17]We could in principle derive the relevant steady-state distributions analytically and initialize individual states by taking draws from these distributions. However, obtaining an analytic characterization of the steady state is intractable in our case. We therefore follow previous literature (e.g., Bobba et al., 2021) and take the approach of obtaining model stationarity via forward simulation.

executive spells with an internal promotion, external promotion, or horizontal move. Unattached managers may re-enter the labor market through offers of executive or CEO employment. We externally calibrate μ, the retirement rate, to 0.0619, which matches the average lifetime experience as a manager in the estimation sample of 16.16 years. To identify the arrival rates corresponding to other labor market transitions, we fit Kaplan-Meier estimates of the survivor function for each type of employment and transition event.

As an example, consider horizontal CEO transitions. Let $N_C(\tau)$ be number of managers at tenure τ who can experience a horizontal CEO transition and let $M_C(\tau)$ be the number of managers that end up in a horizontal CEO transition. The Kaplan-Meier estimate of the survival function is

$$\hat{S}_C(\tau) = \prod_{s=0}^{\tau} \frac{N_C(s) - M_C(s)}{N_C(s)}.$$

The survival function estimates are defined analogously for all other labor market events. Manager survival functions for job-to-job transitions are defined over tenure, while transitions into retirement and unattachment are defined over experience. Transitions from unattachment into employment are defined over years in unattachment. For transitions between employment types and into unattachment, we match $1-\hat{S}(5)$ and $\hat{S}(5)-\hat{S}(10)$, which give the estimated probability that a manager experiences a transition within the first five years of tenure and between the fifth and 10th year of tenure, respectively. For transitions from unattachment, we target $1-\hat{S}(2)$, as the majority of unattached managers find managerial employment (executive or CEO) within 2 years in our data. Note that, as job transition probabilities in our model are endogenously related to both employer effects and tenure (which determine tenure-varying match quality), so these moments also carry information about the underlying firm heterogeneity distribution and human capital accumulation parameters.

Lastly, to control the stock of CEOs in our economy, we also target the average share of managers employed in CEO positions. This ensures that the flows into CEO employment (via unattachment and internal/external promotion) and executive employment (via unattachment) are consistent with the observed structure of the managerial labor market.

4.2.2. Mincer Wage Regression

Our model admits a process for managerial compensation as a function of experience, tenure, manager and firm heterogeneity, and labor market competition. As such, a natural starting point for identification is an empirical model of compensation via a Mincer-AKM wage regression (Mincer, 1974; Abowd et al., 1999, i.e., AKM). We estimate, for manager i and year y:

$$w_{iy} = g_{rf}(t_{iy}) + k_{rf}(\tau_{j(i,y)}) + \zeta_{j(i,y)} + \xi_i + u_{iy}, \tag{21}$$

where w_{iy} is the manager's log total compensation and $j(i, y)$ is a matching function assigning manager i to firm j in year y. $\tau_{j(i,y)}$ is tenure at her current firm and t_{iy} is her labor market experience; both enter as cubic polynomials in our empirical model and the subscript rf signifies that the reduced-form trends for g and k will be different than the accumulation functions in our structural model. $\zeta_{j(i,y)}$ is a firm fixed effect (tracking the manager's current employer), ξ_i is a worker fixed effect, and u_{iy} is the residual. Note that (21) does not have a structural interpretation: the empirical model suffers from misspecification as we do not observe the impact of labor market competition on compensation. Our identification strategy aims to uncover the set of parameters that drives this misspecification.

Experience accumulates as the manager remains in the workforce, whereas tenure resets when a manager leaves their current firm. Conditional on the firm, manager, and labor market history, variation in wages across differing levels of experience and tenure identify the parameters driving the general and firm-specific human capital accumulation functions $g(t)$ and $k(\tau)$.

Targeting moments of the firm fixed effect $\zeta_{j(i,y)}$ distribution helps identify the parameters of the firm heterogeneity distribution (20). We winsorize the firm fixed effects at the 1st and 99th percentiles and target the first three moments of its empirical distribution to back out the location, shape and scale parameters of the Weibull distribution. We include an AR1 residual in our empirical model to account for measurement error (there are aspects of compensation our model cannot perfectly capture); the volatility and autocorrelation of u_{iy} help pin down σ_e and

ν_e, the two parameters of the error process.

4.2.3. Within- and Across-Job Wage Growth

We consider the following empirical model of managerial wage growth within- and across-jobs:

$$\Delta w_{iy} = \Delta g_{rf}(t_{iy}) + \Delta k_{rf}(\tau_{iy}) + \zeta_{j(i,y)} - \zeta_{j(i,y-1)} + \Delta u_{iy}, \tag{22}$$

where Δg_{rf} and Δk_{rf} represent the change in the tenure and experience cubic polynomials year-over-year and $j(i, y)$ is again a manager-firm matching function (i.e., we include current and previous firm effects). Tenure resets upon switching firms, so Δg_{rf} and Δk_{rf} provide separate identification of the human capital trends as we control for contemporaneous changes in firm wage premia. We focus on managers with at least two years of consecutive employment to estimate (22). We also target the volatility and autocorrelation of Δu to further capture σ_e and ν_e.[18]

The difference between the level and first-differenced wage (21 and 22, respectively) convey information about the bargaining power parameter β, which controls the response of compensation to job changes (a change in employer type f) and to contract renegotiations (a change in the piece rate r induced by job offers). Variation in compensation across both tenure and experience profiles and around job events (switches/renegotiations) jointly inform β.

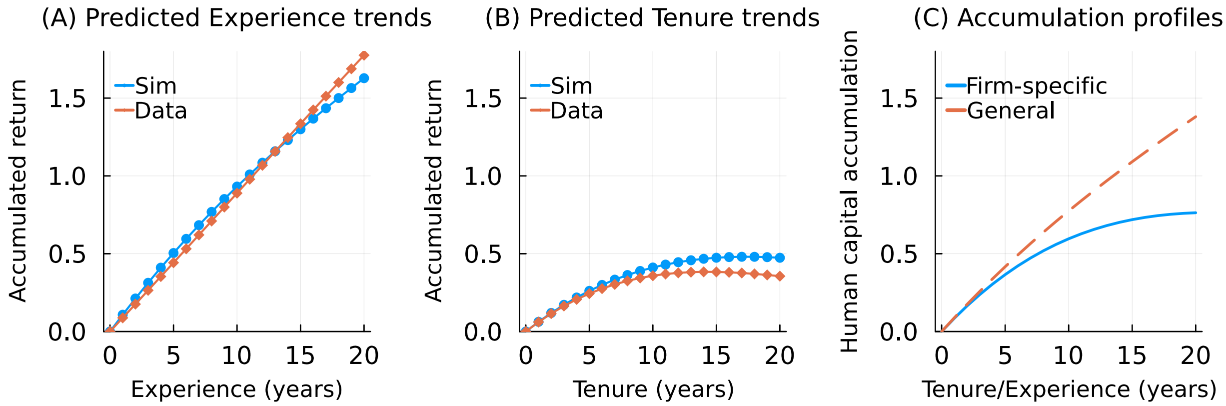
4.3. Model fit

Labor market mobility. Panel A of Table 2 reports job transition probabilities based on the Kaplan-Meier estimates and the share of CEO. Our simulated transition rates replicate the observed rates quite well. In both the simulated and empirical sample, internal CEO hires are by far the most common transitions into CEO employment, followed next by external promotions and lastly by lateral CEO transitions. Our model also generates a near-perfect match of the total share of managers employed in CEO positions. Overall, our model does an exceptional job capturing the key characteristics of managerial employment dynamics.

[18]For both (21) and (22), we require 8 consecutive years of employment to estimate the residual autocorrelation.

Figure 1. Cumulative wage-experience and wage-tenure profiles

This table displays cumulative wage-experience and wage-tenure profiles. Panel A and Panel B compare the experience and tenure profiles based on the Mincer wage regression (21), by using the tenure and experience polynomial coefficients shown in Table 2, Panel B. Panel C plots the structurally-estimated tenure and experience accumulation profiles based on the model wage process (19).



Auxiliary regressions. Table 2 Panel B reports the moments of the Mincer wage regression as in (21) and the wage growth regression as in (22). Our model closely matches the moments of the Mincer wage regression. The simulated coefficients on the quadratic and cubic terms in the tenure and experience polynomials differ slightly from the data, but their combined effects are similar (see Figure 1. In the wage growth regression, residual variance and covariance are well-matched, and the same logic applies to the tenure and experience growth terms as in the wage growth regression.

Figure 1 shows experience and tenure wage profiles. Panel A and Panel B compare the reduced-form experience and tenure profiles based on the Mincer wage regression (21). The simulated and data profiles align very closely. Panel C plots the structural tenure and experience accumulation profiles based on the model wage process (19), using the estimated parameters. Note that the structural tenure accumulation profile is larger than its reduced-form counterpart, while converse is true for experience. This suggests that the reduced-form tenure and experience trends are biased, highlighting the need for a structural model.

5. Structural Parameter Estimates

Parameter estimates are reported in Table 3. Regarding transitions into CEO employment, our estimates of λ_0 (0.0276) and λ_1 (0.0062) imply that internal CEO offers arrive at a higher rate than external offers. There are several factors which may explain this disparity: the prevalence of non-compete agreements (Shi, 2023), external search costs (Geelen and Hajda, 2024), or non-pecuniary preferences for internal candidates (He and Schroth, 2024; Capron et al., 2024). While this gap is large, the gap in internal and external CEO transitions is also affected by firm-specific skill.

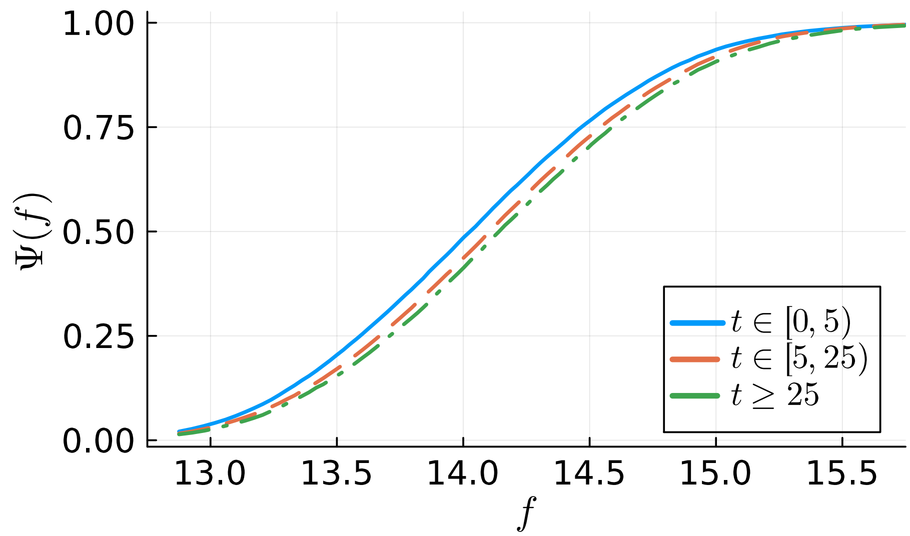
Our estimates of human capital accumulation functions $g(t)$ and $k(\tau)$ (Figure 1 Panel C) show that the accumulation of general human capital is near linear with respect to experience, whereas firm-specific human capital plateaus after roughly 15 years of tenure. The trajectory of total human capital $h(t, \tau)$, is contingent on managers' career path. As an example, consider two managers of equal ability (a), both with 10 years of experience. Total human capital $h(t, \tau)$ will be 36% higher for the manager who stays in the same position after five years. For managers, enhanced human capital accumulation due to job stability raises the opportunity cost of switching firms and contributes in part to the empirically low rate of cross-firm mobility.

In addition, Table 4 reports the decomposition of total human capital into general human and firm-specific human capital. In aggregate, 68.82% of total human capital is general, though this proportion varies significantly with both experience and tenure. The share of the variation in total human capital explained by firm-specific skills is generally higher early on in managers' careers: 66.92% of total human capital is firm-specific among those with 5 to 10 years of experience, and this share drops to 16.4% for those with more than 25 years of experience. The gradual decline in the relative importance of firm-specific human capital over the career cycle is driven by two factors. First, as discussed above, firm-specific human capital accumulation exhibits diminishing returns. Second, as experience progresses, it becomes increasingly likely that manager has switched firms, thereby resetting their firm-specific human capital.

Our estimates of the distributional parameters s_1, s_2, and f_{min} imply that heterogeneity in firm productivity (f) is substantial, suggesting that differences across firms drive dispersion in man-

Figure 2. Firm heterogeneity distribution

This figure displays the estimated position productivity distribution, which is characterized by location f_{min}, shape s_1 and scale s_2 from Table 3. In the figure, we display the (simulated) empirical CDFs of position-types, conditional on experience t.

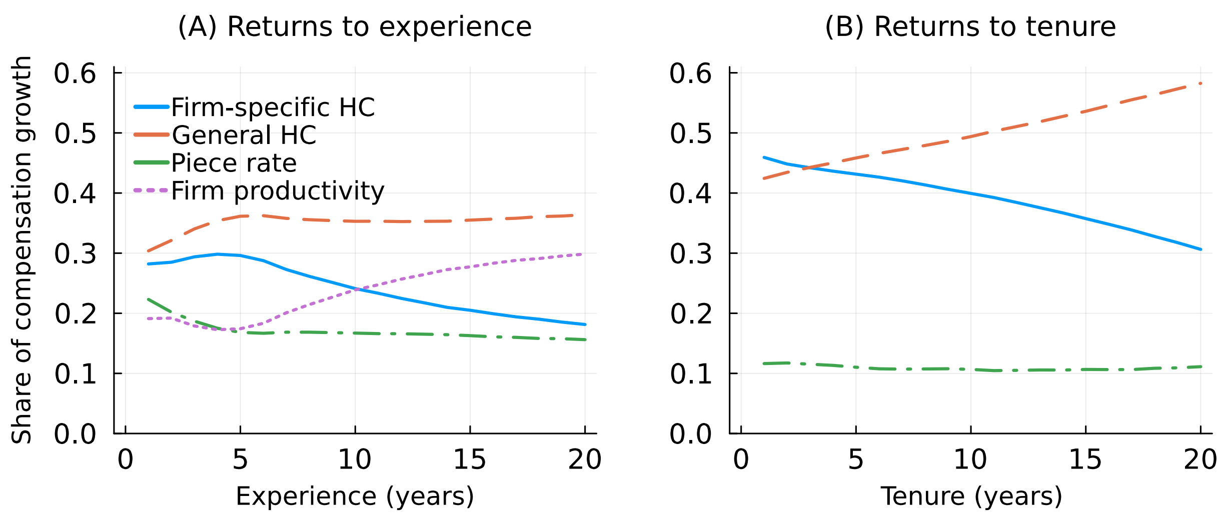


agerial compensation. Further, while we do not impose any direct dependence of f on experience, the equilibrium distribution of match productivity varies systematically with experience. We illustrate this in Figure 2, which plots the simulated cumulative distributions of match productivity separately for different levels of managerial experience. In terms of stochastic dominance, match productivity (f) increases with experience. Though the market is rigid, managers have capacity to transition into higher-quality matches over careers. Endogenous sorting of this nature has important empirical implications. As experience is correlated with unobservable firm productivity, naive regressions of managerial compensation on experience will yield biased coefficient estimates. To decouple the compensation effects of sorting and human capital accumulation, we decompose CEO compensation growth over experience and tenure in Figure 3.

In Figure 3 Panel A, we first compute average CEO compensation growth for each year of experience. We then compute average growth of each experience-varying component of CEO pay: general human capital, firm-specific human capital, piece rates, and match productivity. Finally, to compute the share of compensation growth attributable to growth in each component, we scale the growth of each component by total compensation growth. Figure 3 Panel B displays

Figure 3. CEO Compensation Growth Decomposition

This figure accumulated wage growth for CEOs over tenure and experience. We use (19) to decompose accumulated wage growth into changes in the piece rate, general and firm-specific human capital, and position productivity (which does not play a role for tenure).



the same decomposition within-position (we omit match productivity as it is fixed within a given position). When explaining the returns to experience, Panel A suggests that general and firm-specific human capital together explain over half of wage growth, with general human capital being the dominant component of the two.

The share of pay growth stemming from piece-rate improvements tapers off with experience, suggesting diminishing returns to renegotiation; most of the scope for raising the piece rate is exhausted in the early career years, while later compensation gains stem increasingly from other channels. Conversely, the share attributable to firm productivity growth steadily increases with experience. For the average mid-career managers with 15-20 years of experience, transitioning into higher productivity firms is among the top drivers of compensation growth.

The returns to tenure, (Panel B of Figure 3), tell a different story. Unlike the previous case, human capital is the main driver of within-position compensation growth, with general human capital being slightly more important. The contribution of piece rate growth is modest and remains stable throughout CEO tenure. The stability of the within-position piece rate contribution suggests that in spite of the job-lock effect, the influence of outside competition on CEO compensation (i.e. renegotiation) is persistent. However, comparing this with the piece rate contribution in the returns to experience, it is clear that within-position piece rate renegotiations are less consequential than cross-position piece rate increases due to job transitions.

6. CEO Bargaining Power and Labor Market Competition

Our estimate of β (0.4398) implies a level of managerial bargaining power consistent with the literature.[19] However, in our simulated data, managerial surplus capture is in general much higher than the percentage implied by *ex ante* bargaining power. In our model, managers capture rents through both bargaining power and by leveraging cross-firm competition to improve contracts: bargaining power and competition work in tandem to increase managerial compensation. By modeling the influence of outside competition on managerial pay-setting, we can decouple competition and bargaining power in determining CEOs' surplus capture (Cahuc et al., 2006).

This is important in the context of executives. The high observed share of managerial rents is often taken as evidence of managers exercising undue influence on the pay-setting process (Bebchuk and Fried, 2006). Our results suggest that surplus capture is in part determined by well-functioning labor market competition. In this section, we present a decomposition of managers' observed share of rents into components attributable to managerial bargaining power and labor market competition. We then provide an assessment of the bias that results from attempting to estimate CEO bargaining power in the absence of an explicitly-modeled labor market.

6.1. Decomposition of CEO Surplus

Our model provides a simple way to separate the compensation effects of bargaining power and competition. Following Cahuc et al. (2006), we derive a "naive" estimate of bargaining power in an alternative version of the model with no on-the-job search, and hence no cross-firm competition. Comparing this alternative estimate of bargaining power to our structural estimate from the main model then gives the share of managers' observed surplus explainable by competitive forces as opposed to pure bargaining power.

[19]For example, Taylor (2013) estimates that CEOs capture about 50% of surplus given upside news about their ability.

This experiment amounts to setting CEOs' on-the-job search parameter λ_1 to zero. This forces the CEO's outside option to unattachment, which in turn ascribes any CEO surplus in excess of unattachment value to pure bargaining power.[20] Consider for example a CEO with match productivity (or firm-type) p, tenure τ, and experience t. With no on-the-job search, the log wage equation must be of the form:

$$w = b\big(p, \underline{\theta}_{CC}\big)(f + k(\tau)) + \big(1 - b(p, \underline{\theta}_{CC})\big) f_{min} + a + g(t), \tag{23}$$

where b measures the CEO's observed share of match surplus. In the absence of on-the-job search, $\mathbb{E}[b]$ would be our estimate of CEO bargaining power. We can relate this to bargaining power in the main model (β) by setting equal the structural wage equation and the counterfactual wage equation (23):

$$\begin{aligned} b(p, \underline{\theta}_{CC}) &= \frac{r\big(p, \underline{\theta}_{CC}\big) + f + k(\tau) - f_{min}}{f + k(\tau) - f_{min}} \\ &= 1 + \frac{r\big(p, \underline{\theta}_{CC}\big)}{f + k(\tau) - f_{min}} \end{aligned} \tag{24}$$

Note that $b(p, \underline{\theta}_{CC}) \in [\beta, 1]$,[21] so the bias that arises when neglecting competition is weakly positive. We can then decompose average total surplus b into a bargaining component and competition component using the simple identity:

$$1 \quad = \quad \underbrace{\mathbb{E}\left[\frac{\beta}{b(p, \underline{\theta}_{CC})}\right]}_{\text{CEO bargaining power}} \quad + \quad \underbrace{\mathbb{E}\left[\frac{b(p, \underline{\theta}_{CC}) - \beta}{b(p, \underline{\theta}_{CC})}\right]}_{\text{labor market competition}} \tag{25}$$

With this decomposition, we estimate $b(p, \underline{\theta}_{CC})$ in our simulated sample and report results in Table 5. In the full sample, our naive estimate of CEO bargaining power is 30.23%, in line with

[20] In our model, unattachment has the same value as an offer from the least productive firm, f_{min}.

[21] If $r(p, \underline{\theta}_{CC}) = 0$, then $b = 1$. The minimum value of $r\big(p, \underline{\theta}_{CC}\big)$ arises when the true λ_1 equals zero, where

$$r(p, f_{min}) = -(1 - \beta)(f + k(\tau) - f_{min})$$

and $b = \beta$.

previous estimates in the literature. Comparing this to our estimate of CEO bargaining power β, it is clear that a large proportion of CEO surplus capture is driven by competition. We find that 30.23% of the observed share of CEO surplus is the product of labor market competition as opposed to pure bargaining power. Despite the low empirical rate of CEO cross-firm mobility, the influence of competition on CEO pay is substantial.

Additionally, we report a number of subsample estimates of $b(p, \underline{\theta}_{CC})$ to illustrate that this bias varies systematically across observables. Panel A of Table 5 reports estimates separately across CEO types, namely whether a given CEO was promoted from within, poached from a CEO position, or poached from an executive position. Panels B and C report estimates across the distributions of experience and tenure, respectively. Starting with the CEO type subsamples, we see upward bias in the bargaining power estimate in all cases and the magnitude of this bias varies across CEO type, being largest among CEOs who are poached from competing firms. Attempting to poach a manager initiates a bidding war with the incumbent, introducing a degree of competition which the manager can then leverage to negotiate a more favorable contract. This is distinct from internal bargaining, in which there is no direct influence of outside competition. The surplus capture of poached managers is thus more attributable to competition.

We also see heterogeneous effects of labor market competition on CEOs' captured surplus across the distributions of experience and tenure. Panel B of Table 5 shows that estimates of $b(p, \underline{\theta}_{CC})$ increase with managerial experience. Put differently, the share of CEO surplus explained by labor market competition increases with experience. This follows from the history-dependence of piece-rate contracts. The impact of a one-off bidding war has a persistent effect on managers' compensation throughout their careers. As experience increases, these extracted benefits accumulate and comprise an increasing share of their total captured surplus.

Similarly, competition explains an increasing share of CEO surplus as tenure progresses, and the rationale is similar to the previous result. As tenure increases, CEOs receive a growing number of outside offers which trigger renegotitations with their incumbent employers. This gradually increases CEOs' share of total surplus, despite their bargaining power remaining constant.

7. Firm-Specific Human Capital, Mobility, and CEO Rents

The previous section highlights the influence of competition on CEO pay. This influence may be surprising: the low-degree of mobility in the managerial labor market may suggest that competition should play a small role. If the majority of CEOs work for only on firm over their career, how can cross-firm competition have such an impact on compensation? This apparent puzzle is the focus of the section, which we resolve by illustrating the impact of firm-specific human capital on both CEO cross-firm mobility and CEOs' ability to capture rents.

To do so, we compare CEO compensation and employment outcomes in the estimated model to a counterfactual version of the model which eliminates firm-specific human capital. We first discuss how much firm-specific human capital impacts mobility in the CEO labor market. We then examine how managerial bargaining outcomes, and the persistent effect of competition, are affected by their human capital. Though firm-specific human capital hampers managerial mobility, we find that it enhances their capacity for rent extraction.

7.1. Human Capital and Transitions into CEO Employment

We first discuss the effect of firm-specific human capital accumulation on cross-firm mobility in the managerial labor market. In Figure 4, we compare the baseline and counterfactual probabilities of transitioning into CEO employment through a lateral move, external promotion, or internal promotion.

When human capital has a firm-specific component, there is a marked decline in the rate of cross-firm transitions, whether a lateral CEO move or external promotion. This results from job lock: as firm-specific human capital accumulates, the opportunity cost of switching employers gradually increases. However, even in the absence of firm-specific human capital, the rate of cross-firm transitions is still quite low. For example, the counterfactual rate of lateral CEO moves after 20 years of tenure is only about 3%.

In contrast with cross-firm transition rates, the rate of internal promotions is virtually unaffected by firm-specific human capital. This is unsurprising, as managerial capital is fully retained

Figure 4. Firm-specific human capital and transition rates

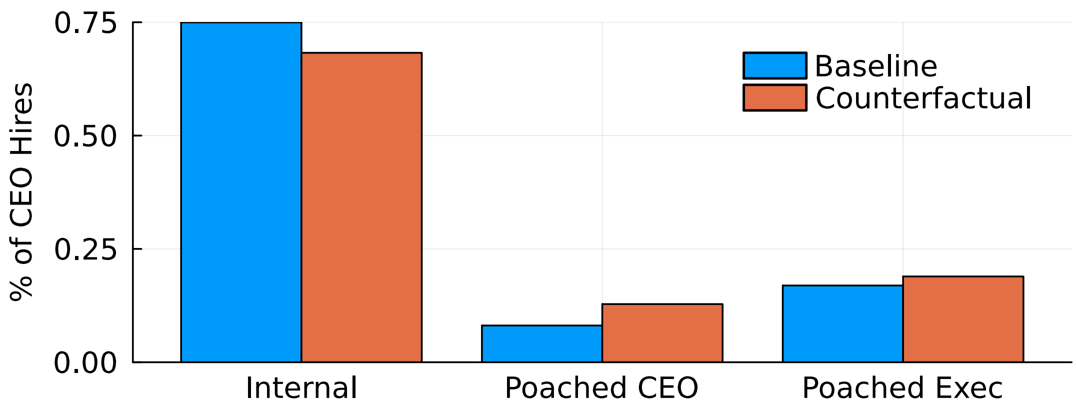
This figure displays cumulative hazard rates of a manager experiencing (A) a lateral CEO move (conditional on being a CEO); (B) an external promotion (conditional on being an executive); and (C) an internal promotion (conditional on being an executive). The blue line displays the estimated rates, the orange lines the counterfactual when $k = 0$.

upon switching positions within a given firm. Though this rate is stable, the increased frequency of cross-firm transitions will imply that a smaller share of CEOs are appointed from within the firm when firm-specific human capital is immaterial.

We illustrate this in Figure 5, which plots the baseline and counterfactual shares of CEOs hired from within the firm, poached from CEO positions, or poached from executive positions. The proportion of internally-hired CEOs decreases when eliminating firm-specific capital while the share of external hires increases. In the counterfactual, internal promotions remain the most common route to CEO employment. Thus, while firm-specific human capital accumulation explains a portion of firms' "preference" for hiring internally, other factors primarily contribute.

The remaining gap in rates of CEO appointments is attributable to a combination of exogenous and endogenous characteristics of the executive labor market. In our model, the main driver is the differing arrival rates of internal and external job offers. As previously discussed: $\lambda_0 > \lambda_1$, implying that insiders are more likely to receive offers in the first place. As these parameters are exogenously given in our model, whether this is gap in arrival rates is the product of inefficient preference for internal candidates or the efficient bypassing of external search costs outside the scope of our analysis. However, our model highlights that the disparity in hiring rates is due in large part to endogenous labor market competition.

Figure 5. Firm-specific human capital and internal vs. external CEO hiring
This figure displays baseline and counterfactual (with $k = 0$) proportions of internal CEO promotions, externally poached CEOs and externally poached non-CEO executives.



When attempting to poach a manager, firms must contend with the manager's incumbent employer. This decreases the likelihood of a successful poach, as incumbent employers have the capacity to dissuade managerial exit via contract renegotiations. In the case of internal promotions, negotiations are free from such competitive pressure, representing a "path of least resistance" to the top of the job ladder. Hence, the high share of internal CEO hires is not entirely the byproduct of labor market frictions, but an outcome to be expected in the face of labor market competition.

7.2. Firm-Specific Human Capital and Managerial Rent Extraction

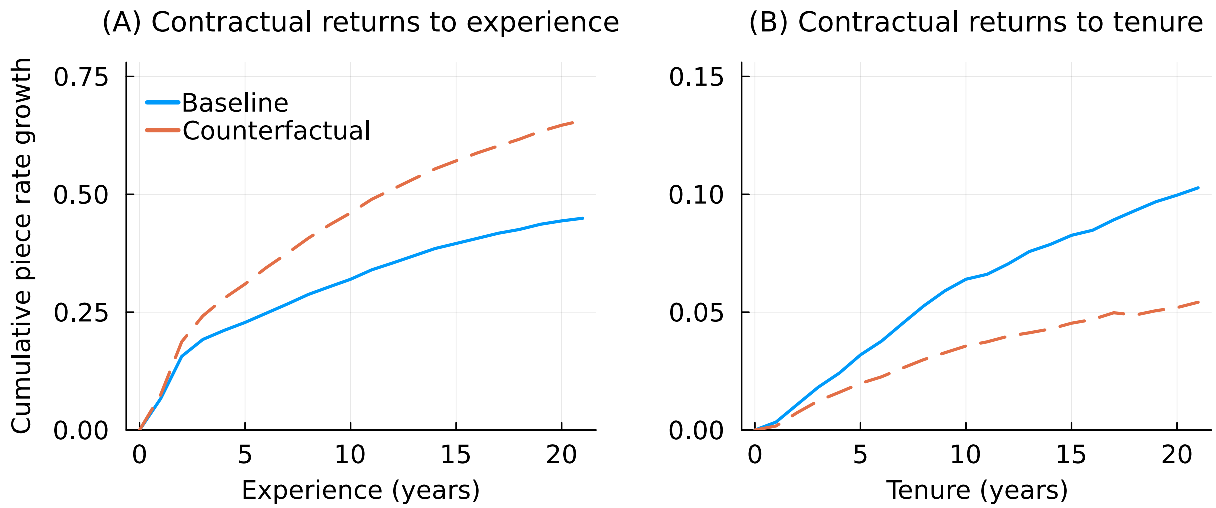
Firm-specific human capital reshapes competition for top managers along two tightly linked margins. The first is job lock: as match quality increases with tenure, the likelihood of receiving a poach-worth outside offer declines. Second, and crucial for what follows, Proposition 3 implies that firm-specific capital accumulation widens the renegotiation band:[22] the likelihood that outside offers result in renegotiation, as opposed to moving, rises with tenure. Put differently, firm-specific skills decrease pure mobility while increasing bargaining leverage: transitions become rarer, but the piece rate embedded in the current contract climbs more steeply with tenure.

In Figure 6, we illustrate the impact of these two channels on managerial rent extraction. In Panel A, we analyze the impact of firm-specific human capital on cumulative piece-rate growth

[22]This is true as long as condition (18) holds. Under our parameter estimates, (18) holds for all $x \in [f_{min}, \infty)$.

Figure 6. Firm-specific human capital and CEO rent extraction

Panel A plots average piece rate growth over the first 20 years of managers' careers. Specifically, for a given manager, letting $r(0)$ and $r(t)$ respectively denote their piece rate in the initial and t^{th} year of their career, we plot the average of $r(t) - r(0)$ across all managers. Panel B is analogous, where we instead define piece rate growth over tenure in a given position. In both Panels, we plot piece rate trends in both the baseline case and the counterfactual case with no firm-specific human capital.



over labor market experience; in Panel B, we do the same for tenure within a position. The results are striking. Looking first at the experience profile: by removing firm-specific human capital, thereby eliminating job lock, managers are freer to transition across firms so that poachers, not incumbents, supply most of the contractual upgrades. Firm-specific capital tightens this outside option channel, decreasing mobility, and with it, cumulative piece rate growth. After 20 years of labor market experience, the baseline curve (with $k(\tau)$) is roughly 20 percentage points below that of the counterfactual, a direct consequence of job lock.

Over tenure, however, we see the opposite pattern: after 20 years, cumulative piece rate growth is roughly double in the baseline. To compensate managers for job lock, incumbent firms more frequently match outside offers that arrive, so the piece rate accelerates even as mobility stalls. Through this compensating differentia channel, we see incumbents, not poachers, provide most of the contractual upgrades in environments with firm-specific human capital.

The two figures provide a nuanced view of the relation between competition and firm-specific human capital. Although firm-specific skill curbs managers' ability to shop the market, they are not left empty handed. When skill is perfectly portable (the counterfactual), most pay gains arrive through job moves. With firm-specific skill, these gains are instead extracted from the incumbent. Thus, firm-specific human capital redirects surplus extraction from external transitions to internal renegotiations.

8. Conclusion

We present a structural model of the managerial labor market that quantifies the importance of general and firm-specific human capital accumulation, managerial bargaining power, and labor market competition. Our model allows for internal and external promotions and admits closed-form expressions for equilibrium contracts.

Our paper makes three primary empirical contributions. First, we measure the relative importance of general and firm-specific human capital in managerial skill over the manager's career, and show that firm-specific human capital lowers cross-firm mobility (less job-switching), but raises within-firm mobility (higher surplus capture with current firm). Second, we decompose realized CEO surplus capture into contributions from pure CEO bargaining power and labor market competition and show that labor market competition is generally the larger component. Third, we show that firm-specific human capital shapes managerial surplus capture over the course of a career, affecting compensation beyond its level impact on compensation.

Our work has important implications for the corporate finance literature. First, our decomposition of managerial human capital is crucial for understanding the CEO labor market, particularly the literature focusing on general CEO skill (Gabaix and Landier, 2008; Murphy and Zabojnik, 2007; Cziraki and Jenter, 2024; Graham et al., 2020).

Second, our decomposition of realized CEO surplus is important for understanding the role of CEO bargaining power and agency frictions in determining CEO compensation. We show that, in an imperfect labor market with search frictions, in which CEO-CEO transitions are rare, CEO surplus capture can largely be explained by competition in the labor market. In models without an explicit managerial labor market, estimates of agency frictions which induce high CEO wages or low turnover may be over-stated.

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Table 1. Summary and labor market transition statistics

This table displays summary statistics for managerial wages, and labor market experience and tenure (Panel A); and labor market transition statistics (Panel B). In Panel A, statistics are displayed based on employment status (executive or CEO). In Panel B, labor market transition statistics are displayed conditional on employment state (executive, CEO, unattached); the first two columns display the number of transitions and the proportion of observations conditional on state. Columns 3 and 4 display the average years of experience of tenure that the transition occurs, respectively.

Panel A: Summary statistics

	N	Mean	Std Dev	25%	50%	75%
	CEOs					
Log wage	61,558	14.857	1.208	14.067	14.917	15.685
Wage ($ million)	61,558	5.342	10.872	1.286	3.007	6.485
Wage Growth (%)	56,245	9.772	73.908	-15.123	7.432	35.274
Experience	61,558	22.186	11.719	13	21	31
Tenure	61,558	15.267	11.543	6	12	22
	Non-CEO executives					
Log wage	262,162	13.790	1.067	13.051	13.773	14.507
Wage ($ million)	262,162	1.744	3.905	0.465	0.958	1.997
Wage Growth (%)	210,196	13.734	64.974	-11.185	9.573	36.749
Experience	262,162	15.239	11.901	5	12	23
Tenure	262,162	5.776	5.848	2	4	7

Panel B: Labor market transition statistics

	N	%	Experience	Tenure
	CEOs			
Horizontal CEO move	293	0.476%	22.631	12.840
Unattachment	543	0.882%	20.722	11.560
Retirement	8,735	14.190%	23.673	15.538
	Non-CEO executives			
Internal CEO promotion	4,170	1.591%	17.190	10.474
External CEO promotion	374	0.143%	16.321	5.495
Horizontal executive move	1,535	0.586%	14.383	4.805
Unattachment	5,098	1.945%	15.048	4.595
Retirement	41,169	15.704%	15.680	6.340
	Unattached managers			
Executive position	5,085	22.644%	19.197	
CEO position	823	3.665%	22.176	

Table 2. Model fit

This table displays the closeness of observed and simulated moments, given the estimation sample describe in Table 1. "Observed" refers to the real data. "Simulated" refers to the simulated data. Standard errors are displayed below each moment in parentheses. Moments in Panel A concern labor market mobility and steady-state shares of employment. Moments in Panel B concern the two auxiliary regressions

Panel A: Labor market mobility

	Description	**Observed**	**Simulated**
(1)	Internal CEO hire (0-5 yrs)	0.133	0.137
		(0.001)	(0.001)
(2)	Internal CEO hire (5-10 yrs)	0.158	0.121
		(0.001)	(0.003)
(3)	External CEO hire (0-5 yrs)	0.020	0.021
		(0.000)	(0.000)
(4)	External CEO hire (5-10 yrs)	0.016	0.017
		(0.001)	(0.001)
(5)	External exec hire (0-5 yrs)	0.093	0.086
		(0.001)	(0.001)
(6)	External exec hire (5-10 yrs)	0.062	0.076
		(0.001)	(0.002)
(7)	Unattachment shock (0-5 yrs)	0.066	0.058
		(0.001)	(0.001)
(8)	Unattachment shock (5-10 yrs)	0.056	0.066
		(0.001)	(0.002)
(9)	Unattached to exec (0-2 yrs)	0.408	0.436
		(0.008)	(0.008)
(10)	Unattached to CEO (0-2 yrs)	0.068	0.058
		(0.005)	(0.017)
(11)	CEO share	0.342	0.344
		(0.004)	(0.004)

Panel B: Auxiliary regressions

	Description	Observed	Simulated
	Auxiliary Mincer regression		
(1)	Tenure (linear)	0.064	0.065
		(0.002)	(0.006)
(2)	Tenure (quadratic)	-0.335	-0.270
		(0.017)	(0.055)
(3)	Tenure (cubic)	0.514	0.321
		(0.048)	(0.113)
(4)	Experience (linear)	0.088	0.110
		(0.003)	(0.005)
(5)	Experience (quadratic)	0.019	-0.192
		(0.022)	(0.035)
(6)	Experience (cubic)	-0.069	0.247
		(0.042)	(0.063)
(7)	Firm effect (mean)	12.411	12.408
		(0.004)	(0.004)
(8)	Firm effect (variance)	0.589	0.588
		(0.005)	(0.005)
(9)	Firm effect (skewness)	-0.166	-0.183
		(0.023)	(0.021)
(10)	Executive effect (variance)	1.551	1.592
		(0.011)	(0.011)
(11)	Wage residual (variance)	0.270	0.291
		(0.004)	(0.004)
(12)	Wage residual (autocovariance)	0.347	0.354
		(0.009)	(0.033)
	Auxiliary wage growth regression		
(13)	Tenure growth (quadratic)	-0.371	-0.163
		(0.020)	(0.029)
(14)	Tenure growth (cubic)	0.602	0.202
		(0.040)	(0.044)
(15)	Experience growth (quadratic)	-0.169	-0.282
		(0.015)	(0.019)
(16)	Experience growth (cubic)	0.133	0.338
		(0.024)	(0.027)
(17)	Wage growth residual (variance)	0.365	0.383
		(0.006)	(0.007)
(18)	Wage growth residual (autocovariance)	-0.377	-0.406
		(0.011)	(0.011)

Table 3. Structural parameter estimates

This table displays the estimated structural parameters, given the estimation sample describe in Table 1. Parameter standard errors, derived via the Delta method using the optimal weight matrix, are displayed in parentheses next to each parameter.

Description	Notation	Parameter value
Arrival rates		
Internal CEO offer	λ_0	0.0276 (0.0007)
External CEO offer	λ_1	0.0062 (0.0002)
External exec offer	λ_2	0.0187 (0.0015)
Unattachment shock	η	0.0287 (0.0009)
Unattachment to CEO	γ_C	0.0287 (0.0023)
Unattachment to exec	γ_E	0.2565 (0.0354)
Managerial Bargaining Power		
Managerial bargaining power	β	0.4398 (0.0613)
Human capital accumulation		
Tenure polynomial (linear)	δ_k^1	0.0886 (0.0040)
Tenure polynomial (quadratic)	$\delta_k^2 \times 10^2$	-0.3282 (0.0215)
Tenure polynomial (cubic)	$\delta_k^3 \times 10^4$	0.3793 (0.0135)
Experience polynomial (linear)	δ_g^1	0.0901 (0.0086)
Experience polynomial (quadratic)	$\delta_g^2 \times 10^2$	-0.1471 (0.0270)
Experience polynomial (cubic)	$\delta_g^3 \times 10^4$	0.2078 (0.0245)
Firm heterogeneity (Weibull)		
Location	f_{min}	12.2462 (0.4171)
Scale	s_1	2.2002 (0.2529)
Shape	s_2	2.3645 (0.1970)
Manager heterogeneity		
Ability (volatility)	σ_a	1.7783 (0.0143)
Idiosyncratic shock (volatility)	σ_e	0.6729 (0.1310)
Idiosyncratic shock (persistence)	ν_e	0.1335 (0.0291)

Table 4. CEO human capital composition across labor market experience

This table shows a decomposition of accumulated CEO human capital into general human capital $g(t)$, and firm-specific human capital $k(\tau)$ across labor market experience t. We compute a variance decomposition: $s_x = cov(h,x)/var(h)$ for $x \in \{g,k\}$.

	(1)	(2)	(3)	(4)	(5)
	Full sample	**Conditional on experience (t)**			
		[0,5)	[5,10)	[10,25)	≥ 25
General human capital (g)	68.82%	53.41%	33.08%	60.35%	83.60%
Firm-specific human capital (k)	31.18%	46.59%	66.92%	39.65%	16.40%

Table 5. CEO surplus capture decomposition

This table shows realized CEO surplus capture. Panel A displays realized CEO surplus capture by eventual CEO hire type. Panel B displays across labor market experience and Panel B by firm tenure. We display realized CEO surplus capture $\mathbb{E}[b \mid X]$, for comparison against exogenously estimated pure CEO bargaining power $\beta_1 = 43.98\%$ in (25). The first row displays average realized surplus capture b. The second row displays the share attributable to labor market competition

Panel A: CEO surplus capture decomposition by CEO hire type

	(1)	(2)	(3)
	Full sample	**Conditional on CEO hire type**	
		Internal CEO	External CEO
Realized surplus capture (b)	63.04%	65.20%	87.23%
Labor market competition $\left(\frac{b-\beta_1}{b}\right)$	30.23%	32.55%	49.58%

Panel B: CEO surplus capture decomposition by labor market experience

	(1)	(2)	(3)	(4)	(5)
	Full sample	**Conditional on experience (t)**			
		$[0, 5)$	$[5, 10)$	$[10, 25)$	≥ 25
Realized surplus capture (b)	63.04%	53.69%	61.46%	65.31%	66.31%
Labor market competition $\left(\frac{b-\beta_1}{b}\right)$	30.23%	18.09%	28.44%	32.66%	33.68%

Panel C: CEO surplus capture decomposition by firm tenure

	(1)	(2)	(3)	(4)	(5)
	Full sample	**Conditional on tenure (τ)**			
		$[0, 5)$	$[5, 10)$	$[10, 25)$	≥ 25
Realized surplus capture (b)	63.04%	59.41%	62.80%	64.84%	65.00%
Labor market competition $\left(\frac{b-\beta_1}{b}\right)$	30.23%	25.97%	29.97%	32.17%	32.34%

A. Model Appendix

A.1. Derivation of Bargaining Rules

Derivation of sharing rule for internal promotions. Suppose an executive is approached by their firm and offered a promotion to CEO. Each party makes alternating offers over the piece rate r'. If the offer is accepted, the bargaining game ends. If the offer is rejected, some time elapses before a counteroffer is made. Let $\Delta_e = \beta\epsilon$ and $\Delta_f = (1-\beta)\epsilon$ respectively denote the lengths of time which elapse following a rejection by the executive and firm. It is also assumed that during negotiations, the match severs at rate ξ in which case the executive remains in their current position, and additional offers for outside CEO and non-CEO positions respectively arrive at rates λ_1 and λ_2. The subgame perfect equilibrium of this game consists of piece rate offers (r_e, r_f) which make the other party indifferent between immediate acceptance and waiting to make a counteroffer. That is, r_e and r_f respectively solve:

$$V_C(r_f, t, p) = \frac{1}{1+\rho\Delta_e}\Bigg[w_t\Delta_e + \xi\Delta_e V_E(r, t+\Delta_e, p+\Delta_e k') + \lambda_1\Delta_e\tilde{V}_C(\cdot) + \lambda_2\Delta_e\tilde{V}_E(\cdot)$$
$$+ (1-\Delta_e(\xi+\lambda_1+\lambda_2))V_C(r_e, t+\Delta_e, p+\Delta_e k')\Bigg] \tag{A.1}$$
$$\Pi_C(r_e, t, p) = \frac{1}{1+\rho\Delta_f}\Bigg[\pi_0\Delta_f + \xi\Delta_e\Pi_0 + \lambda_0\Delta_f\tilde{\Pi}_C(\cdot) + \lambda_1\Delta_f\tilde{\Pi}_C(\cdot)$$
$$+ (1-\Delta_f(\xi+\lambda_0+\lambda_1))\Pi_C(r_f, t+\Delta_f, p+\Delta_f k')\Bigg] \tag{A.2}$$

$\Pi_C(x)$ denotes the value to the firm of filling the CEO position given state x. π_0 and Π_0 denote the flow and net present values to the firm of having a vacant CEO position, both of which we assume to equal 0. $\tilde{V}_C$ and $\tilde{V}_E$ denote the executive's net present value of initiating a new bargaining game for a CEO or non-CEO position upon the arrival of a competing offer. Similar for $\tilde{\Pi}_C$. The two equations above can be rewritten as:

$$V_C(r_f, t, p) - V_C(r_e, t+\Delta_e, p+\Delta_e k') = -\Delta_e\Bigg[(\xi+\lambda_1+\lambda_2)V_C(r_e, t+\Delta_e, p+\Delta_e k') + \rho V_C(r_f, t, p)$$

$$- w_t - \xi V_E(r, t + \Delta_e, p + \Delta_e k') - \lambda_1 \tilde{V}_C(\cdot) - \lambda_2 \tilde{V}_E(\cdot)\Big] \tag{A.3}$$

$$\Pi_C(r_e, t, p) - \Pi_C(r_f, t + \Delta_f, p + \Delta_f k') = -\Delta_f \Big[(\xi + \lambda_0 + \lambda_1)\Pi_C(r_f, t + \Delta_f, p + \Delta_f k') + \rho \Pi_C(r_e, t, p)$$

$$- \pi_0 - \xi \Pi_0 - \lambda_0 \tilde{\Pi}_C(\cdot) - \lambda_1 \tilde{\Pi}_E(\cdot)\Big] \tag{A.4}$$

The above conditions imply that $r_f \to r_e$ as $\epsilon \to 0$. Denote their common limit by r' and define:

$$\frac{\partial V_C}{\partial r}(r, t, p) = \lim_{\epsilon \to 0} \frac{V_C(r_f, t, p) - V_C(r_e, t + \Delta_e, p + \Delta_e k')}{r_f - r_e} \tag{A.5}$$

$$\frac{\partial \Pi_C}{\partial r}(r, t, p) = \lim_{\epsilon \to 0} \frac{V_C(r_f, t, p) - V_C(r_e, t + \Delta_f, p + \Delta_f k')}{r_f - r_e} \tag{A.6}$$

Using the definitions above and taking the ratios of (A.3) and (A.4) yields:

$$-\frac{\frac{\partial V_C}{\partial r}(r', t, p)}{\frac{\partial \Pi_C}{\partial r}(r', t, p)} = \frac{\Delta_e(\rho + \xi + \lambda_1 + \lambda_2)}{\Delta_f(\rho + \xi + \lambda_0 + \lambda_1)} \frac{V_C(r', t, p) - \frac{w_t + \xi V_E(r, t + \Delta_e, p + \Delta_e k') + \lambda_1 \tilde{V}_C(\cdot) + \lambda_2 \tilde{V}_E(\cdot)}{\rho + \xi + \lambda_1 + \lambda_2}}{\Pi_C(r', t, p) - \frac{\pi_0 + \xi \Pi_0 + \lambda_0 \tilde{\Pi}_C(\cdot) + \lambda_1 \tilde{\Pi}_E(\cdot)}{\rho + \xi + \lambda_0 + \lambda_1}} \tag{A.7}$$

Next, define $S(t, p) = \Pi_C(r', t, p) + V_C(r', t, p) - V_E(r, t, p)$ as the surplus associated with the position. Note that $\Pi_C(0, t, p) = 0$, which implies that $\Pi_C(r', t, p) = V_C(0, t, p) - V_C(r', t, p)$. Thus, $\frac{\partial \Pi_C}{\partial r}(r', t, p) = -\frac{\partial V_C}{\partial r}(r', t, p)$. Applying this to (A.7) and taking the limit as $\xi \to \infty$ yields (after some algebra):

$$V_C(r', t, p) = \beta V_C(0, t, p) + (1 - \beta) V_E(r, t + \Delta_e, p + \Delta_e k') \tag{A.8}$$

Finally, taking $\epsilon \to 0$ yields the continuous time limit:

$$V_C(r', t, p) = \beta V_C(0, t, p) + (1 - \beta) V_E(r, t, p) \tag{A.9}$$

Proof of Proposition 2. To prove the Proposition, we go through each case of an external transition one at a time. We begin with horizontal executive transitions.

Derivation of sharing rule for horizontal moves (Executive). Consider an executive who is approached by an outside firm to serve in an executive position. Upon the arrival of the offer, the executive along with the competing and incumbent firms initiate a bargaining game with the following structure:

1. Stage 1: Both firms simultaneously offer a piece rate to the executive

2. Stage 2: The executive chooses one of the offers, or rejects and keeps their current position.

3. Stage 3: If the executive accepted an offer in Stage 2, some time elapses. The executive then renegotiates with the firm whose offer was rejected, where the renegotiation protocol mirrors that of the previous section. Unlike the previous section, however, the executive's outside is option is not their current position, but the offer accepted in Stage 2.

The bargaining game is solved via backward induction. Let r_1' and r_1 denote the respective Stage 1 offers from the poacher and incumbent. Suppose that r_1 was accepted in the second stage, triggering a Stage 3 renegotiation with the poacher. The counteroffer will satisfy:

$$V_E(r, t, f') = \beta_1 V_E(0, t, f') + (1 - \beta_1) V_E(r_1, t, p) \tag{A.10}$$

Conversely, suppose that r_1' was accepted in Stage 2. In the subsequent renegotiation with the incumbent firm, their counteroffer will satisfy:

$$V_E(r, t, p) = \beta_1 V_E(0, t, p) + (1 - \beta_1) V_E(r_1', t, p) \tag{A.11}$$

The form of the counteroffers implies that:

- If r_1' was accepted in Stage 2, renegotiate and eventually work with the incumbent iff:

$$V_E(0, t, p) \geq V_E(r_1', t, f') \tag{A.12}$$

- If r_1 was accepted in Stage 2, renegotiate and eventually work with the poacher iff:

$$V_E(0,t,f') > V_E(r_1,t,p) \tag{A.13}$$

Thus, the value of accepting r_1 at Stage 2 is:

$$\max\{\beta V_E(0,t,f') + (1-\beta)V_E(r_1,t,p), V_E(r_1,t,p)\} \tag{A.14}$$

Similarly for r_1':

$$\max\{\beta V_E(0,t,p) + (1-\beta)V_E(r_1',t,f'), V_E(r_1',t,f')\} \tag{A.15}$$

Moving back to Stage 1, both firms make simultaneous offers. For the poacher to eventually win the executive, they must bid r_1' such that $V_E(r_1',t,f') > V_E(0,t,p)$ so that the incumbent cannot afford to outbid. In particular, the poacher eventually wins the worker if and only if $f' > p$. In this case, to avoid wasting time in the renegotiation stage, the poacher immediately offers r_1' such that:

$$V_E(r_1',t,f') = \beta V_E(0,t,f') + (1-\beta)V_E(0,t,p) \tag{A.16}$$

Conversely, if $f' < p'$, the incumbent will eventually win the executive's services. The fastest way of doing so is to immediately offer r_1 such that:

$$V_E(r_1,t,p) = \beta V_E(0,t,p) + (1-\beta)V_E(0,t,f') \tag{A.17}$$

Note additionally that a competing offer does not necessitate an alteration of the current piece rate r. The minimal value of f' such that something happens is defined by:

$$V_E(r,t,p) = \beta V_E(0,t,p) + (1-\beta)V_E(0,t,\underline{\theta}_{EE}(r,p)) \tag{A.18}$$

Derivation of sharing rule for external promotions. Consider an executive who is approached by an outside firm to become CEO. A three-player bargaining game is initiated with the same structure as in the previous case. Note, however, that unlike the previous case, the executive is weighing two separate types of positions: a CEO position and a non-CEO position. Because the two position types are associated with different event spaces describing the possible set of future offers, the executive's value of accepting these positions, for a given state, is not equal in general.

As before, the bargaining game is solved via backward induction. Let $(r_1', 1)$ and $(r_1, 0)$ denote the respective stage 1 offers from the poacher and incumbent, where the second coordinate indicates if the offer is for a CEO position or not. Suppose the executive accepted $(r_1, 0)$ at Stage 2, then renegotiates with the poacher in Stage 3. The counter offer will satisfy:

$$V_C(r, t, f') = \beta V_C(0, t, f') + (1 - \beta) V_E(r_1, t, p) \tag{A.19}$$

Conversely, suppose that $(r_1', 1)$ was accepted at stage 2, and a stage 3 renegotiation was triggered with firm p. The counteroffer will satisfy:

$$V_E(r, t, p) = \beta V_E(0, t, p) + (1 - \beta) V_C(r_1', t, f') \tag{A.20}$$

Implications:

- If $(r_1', 1)$ is accepted at stage 2, renegotiate and eventually work with p iff:

$$V_E(0, t, p) \geq V_C(r_1', t, f') \tag{A.21}$$

- If $(r_1, 0)$ is accepted at stage 2, renegotiate and eventually work with p' iff:

$$V_C(0, t, f') > V_E(r_1, t, p) \tag{A.22}$$

Thus, the value of accepting $(r_1, 0)$ at stage 2 is:

$$\max\{\beta V_C(0, t, f') + (1 - \beta)V_E(r_1, t, p), V_E(r_1, t, p)\} \tag{A.23}$$

Similarly for $(r_1', 1)$:

$$\max\{\beta V_E(0, t, p) + (1 - \beta)V_C(r_1', t, f'), V_C(r_1', t, p)\} \tag{A.24}$$

At stage 1, simultaneous offers are made. For the poacher to win the executive, they must bid r_1' such that: $V_C(r_1', t, f') > V_E(0, t, p) = V_C(0, t, \bar{\theta}(0, p))$. Hence, the poaching firm eventually wins the manager if and only if $f' > \bar{\theta}(0, p)$. In this case, to avoid wasting time in the renegotiation stage, the poacher immediately offers r_1' such that:

$$V_C(r_1', t, f') = \beta V_C(0, t, f') + (1 - \beta)V_E(0, t, p) \tag{A.25}$$

Conversely, suppose that $p' < \bar{\theta}(0, p)$. Similar to the above case, the incumbent will retain the worker in the fastest manner possible by immediately offering r_1 such that:

$$V_E(r_1, t, p) = \beta V_E(0, t, p) + (1 - \beta)V_C(0, t, f') \tag{A.26}$$

As in the case of horizontal moves, an outside offer for a CEO appointment need not trigger a change in the current piece rate r. The minimum value of f' such that something happens is defined by:

$$V_E(r, t, p) = \beta V_E(0, t, p) + (1 - \beta)V_C(0, t, \underline{\theta}_{EC}(r, p)) \tag{A.27}$$

Derivation of sharing rule for horizontal moves (CEO). This case is identical to the case for horizontal executive moves if we simply change subscripts. Upon receiving an offer for a CEO position with match productivity $f' > p$, the CEO switches positions and receives initial piece rate r' defined by condition:

$$V_C(r', t, f') = \beta V_C(0, t, f') + (1 - \beta) V_C(0, t, p) \tag{A.28}$$

As in the previous cases, if instead $f' \leq p$, the current firm retains the CEO and a renegotiation may be triggered. The minimum value of f' such that the piece rate is revised is defined by:

$$V_C(r, t, p) = \beta V_C(0, t, p) + (1 - \beta) V_C(0, t, \underline{\theta}_{CC}(r, p)) \tag{A.29}$$

■

A.2. Value Function Derivation

To obtain closed-form expressions for managerial piece rates, we first simplify the value functions associated with both CEO and executive employment. We assume that managers have logarithmic flow utility and that there is no transfer of wealth across time. We impose two shape restrictions on the value functions:

Assumption 1. *The effects of experience t and productivity p are separable:*

$$\frac{\partial^2 V_j}{\partial t \partial p}(r, t, p) = 0 \quad \textit{for} \quad j \in \{E, C\} \tag{A.30}$$

Assumption 2.

$$\lim_{p \to \infty} \frac{\partial V_C}{\partial p}(r, t, p) = \frac{1}{\rho + \mu + \eta} \tag{A.31}$$

A.2.1. CEO Value Function

Let $S(\cdot) = 1 - \Psi(\cdot)$ be the survivor function for the distribution of firm productivity. Given the threshold productivity $\underline{\theta}_{ij}$ for each transition type ij which leads to no contract revision, $S(\underline{\theta})$

represents the fraction of positions for which the manager discards the job offer. The value of CEO employment is represented by:

$$
\begin{aligned}
\big(\rho + \mu + \eta + \lambda_1 S(\underline{\theta}_{CC})\big)V_C(r,t,p) = \; & w \; + \frac{\partial V_C}{\partial t}(r,t,p) + \delta_k \frac{\partial V_C}{\partial p}(r,t,p) \; + \eta V_U(t) + \\
& \lambda_1 \int_p^\infty \Big[(1-\beta)V_C(0,t,p) + \beta_1 V_C(0,t,x)\Big]\, dF(x) + \\
& \lambda_1 \int_{\underline{\theta}_{CC}}^p \Big[(1-\beta)V_C(0,t,x) + \beta_1 V_C(0,t,p)\Big]\, dF(x)
\end{aligned}
$$

The net present value of holding a CEO position is the sum of flow compensation and expectations over future employment transitions. Note that the integral terms in the value function above reflect the structure of the CEO bargaining process. Rearranging (A.32) via integration by parts yields:

$$
\begin{aligned}
(\rho + \mu + \eta)V_C(r,t,p) = w + \eta V_U(t) + \frac{\partial V_C}{\partial t}(r,t,p) + \delta_k \frac{\partial V_C}{\partial p}(r,t,p) \\
+ \lambda_1 \beta \int_p^\infty \frac{\partial V_C}{\partial x}(0,t,x)S(x)dx + \lambda_1(1-\beta)\int_{\underline{\theta}_{cc}}^p \frac{\partial V_C}{\partial x}(0,t,x)S(x)dx \qquad \text{(A.32)}
\end{aligned}
$$

Consequently, the value function evaluated at $r = 0$ is given by:

$$
\begin{aligned}
(\rho + \mu + \eta)V_C(0,t,p) = g + f + k + \eta V_U(t) + \frac{\partial V_C}{\partial t}(0,t,p) + \delta_k \frac{\partial V_C}{\partial p}(0,t,p) \\
+ \lambda_1 \beta \int_p^\infty \frac{\partial V_C}{\partial x}(0,t,x)S(x)dx \qquad \text{(A.33)}
\end{aligned}
$$

Differentiating with respect to p yields:

$$
(\rho + \mu + \eta + \lambda_1 \beta S(p))\frac{\partial V_C}{\partial p}(0,t,p) = 1 + \delta_k \frac{\partial^2 V_C}{\partial p^2}(0,t,p) \qquad \text{(A.34)}
$$

Note that the cross partial $\frac{\partial^2 V_C}{\partial p \partial t}(r,t,p)$ vanishes as the effects of t and p are separable (Assumption 1). Next, define $\phi_C(x) \equiv \frac{\partial V_C}{\partial p}(0,t,x)$. Additionally, let $\omega_C(x) = \rho + \mu + \eta + \lambda_1 \beta S(p)$. Then Equation

(A.34) can be written as:

$$\omega_C(x)\phi_C(x) = 1 + \delta_k \phi_C'(x) \tag{A.35}$$

This is a first-order linear ODE in x which can be solved explicitly. Define $\Omega_C(x)$ as:

$$\Omega_C(x) = exp\left(-\frac{1}{\delta_k} \int_{f_{min}}^{x} \omega_C(z)dz \right) \tag{A.36}$$

Rearranging (A.35) and multiplying both sides by $\Omega(x)$ yields:

$$\begin{aligned}
\Omega_C(x)\phi_C'(x) - \frac{\omega_C(x)}{\delta_k}\Omega_C(x)\phi_C(x) &= -\Omega_C(x)\frac{1}{\delta_k} \\
\frac{\partial}{\partial x}[\Omega_C(x)\phi_C(x)] &= -\Omega_C(x)\frac{1}{\delta_k} \\
\int_{f_{min}}^{p} \frac{\partial}{\partial x}[\Omega_C(x)\phi_C(x)]dx &= -\frac{1}{\delta_k}\int_{f_{min}}^{p} \Omega_C(x)ds \\
\Omega_C(p)\phi_C(p) - \underbrace{\Omega_C(f_{min})\phi_C(f_{min})}_{=C} &= -\frac{1}{\delta_k}\int_{f_{min}}^{p} \Omega_C(x)dx \\
\phi_C(p) &= \frac{1}{\Omega_C(p)}\left[C - \frac{1}{\delta_k}\int_{f_{min}}^{p} \Omega_C(x)dx\right] \qquad \text{(A.37)}
\end{aligned}$$

The constant of integration C is pinned down by the transversality condition in Assumption 2. Letting $C = \frac{1}{\delta_k}\int_{f_{min}}^{\infty} \Omega_C(x)dx$, we can use L'Hospital's rule to verify:

$$\lim_{p\to\infty} \phi_C(p) = \lim_{p\to\infty} \frac{\frac{1}{\delta_k}\int_p^\infty \Omega_C(x)dx}{\Omega_C(p)} = \lim_{p\to\infty} \frac{1}{\omega_C(p)} = \frac{1}{\rho+\mu+\eta} \tag{A.38}$$

Finally, the value function (A.32) can then be expressed as:

$$\begin{aligned}
(\rho+\mu+\eta)V_C(r,t,p) = w + \eta V_U(t) + \frac{\partial V_C}{\partial t}(r,t,p) + \delta_k \frac{\partial V_C}{\partial p}(r,t,p) \\
+ \lambda_1\beta \int_p^\infty \phi_C(x)S(x)dx + \lambda_1(1-\beta)\int_{\underline{\theta}_{CC}}^{p} \phi_C(x)S(x)dx \qquad \text{(A.39)}
\end{aligned}$$

A.2.2. Executive Value Function

The procedure for the executive value function is effectively the same as before, though notation is slightly more cumbersome. The net present value of executive employment can be represented as:

$$\begin{aligned}
\big(\rho+\mu+\eta+\lambda_0+\lambda_1 S\big(\underline{\theta}_{EC}\big)+\lambda_2 S\big(\underline{\theta}_{EE}\big)\big)V_E(r,t,p) = \;& w+\frac{\partial V_E}{\partial t}(r,t,p)+\delta_k\frac{\partial V_E}{\partial p}(r,t,p)+\eta V_U(t)+\\
&\lambda_0\Big[(1-\beta)V_E(r,t,p)+\beta V_C(0,t,p)\Big]+\\
&\lambda_1\int_{\bar{\theta}(p)}^{\infty}\Big[(1-\beta)V_E(0,t,p)+\beta V_C(0,t,x)\Big]\,dF(x)+\\
&\lambda_1\int_{\underline{\theta}_{EC}}^{\bar{\theta}(p)}\Big[(1-\beta)V_C(0,t,x)+\beta V_E(0,t,p)\Big]\,dF(x)+\\
&\lambda_2\int_{p}^{\infty}\Big[(1-\beta)V_E(0,t,p)+\beta V_E(0,t,x)\Big]\,dF(x)+\\
&\lambda_2\int_{\underline{\theta}_{EE}}^{p}\Big[(1-\beta)V_E(0,t,x)+\beta V_E(0,t,p)\Big]\,dF(x)
\end{aligned} \tag{A.40}$$

Noting that $V_C(r,t,f_{min})=V_U(t)$ by assumption, we can rewrite this as:

$$\begin{aligned}
\big(\rho+\mu+\eta+\lambda_0\beta+\lambda_1 S\big(\underline{\theta}_{EC}\big)+\lambda_2 S\big(\underline{\theta}_{EE}\big)\big)V_E(r,t,p) = \;& w+\frac{\partial V_E}{\partial t}(r,t,p)+\delta_k\frac{\partial V_E}{\partial p}(r,t,p)+\\
&(\eta+\lambda_0\beta)V_U(t)\;+\;\lambda_0\beta\int_{f_{min}}^{p}\frac{\partial V_C}{\partial x}(0,t,x)dx+\\
&\lambda_1\int_{\bar{\theta}(0,p)}^{\infty}\Big[(1-\beta)V_E(0,t,p)+\beta V_C(0,t,x)\Big]\,dF(x)+\\
&\lambda_1\int_{\underline{\theta}_{EC}}^{\bar{\theta}(0,p)}\Big[(1-\beta)V_C(0,t,x)+\beta V_E(0,t,p)\Big]\,dF(x)+\\
&\lambda_2\int_{p}^{\infty}\Big[(1-\beta)V_E(0,t,p)+\beta V_E(0,t,x)\Big]\,dF(x)+\\
&\lambda_2\int_{\underline{\theta}_{EE}}^{p}\Big[(1-\beta)V_E(0,t,x)+\beta V_E(0,t,p)\Big]\,dF(x)
\end{aligned} \tag{A.41}$$

Similar to the case of CEOs, we simplify the executive value function by first rearranging (A.40) via integration by parts:

$$
\begin{aligned}
(\rho+\mu+\eta+\lambda_0\beta)V_E(r,t,p) = w &+ \frac{\partial V_E}{\partial t}(r,t,p) + \delta_k \frac{\partial V_E}{\partial p}(r,t,p) \\
&+ (\eta+\lambda_0\beta)V_U(t) + \lambda_0\beta \int_{f_{min}}^{p} \phi_C(x)dx \\
&+ \lambda_1\beta \int_{\bar{\theta}(0,p)}^{\infty} \phi_C(x)S(x)dx + \lambda_1(1-\beta)\int_{\underline{\theta}_{EC}}^{\bar{\theta}(0,p)} \phi_C(x)S(x)dx \\
&+ \lambda_2\beta \int_{p}^{\infty} \frac{\partial V_E}{\partial x}(0,t,x)S(x)dx + \lambda_2(1-\beta)\int_{\underline{\theta}_{EE}}^{p} \frac{\partial V_E}{\partial x}(0,t,x)S(x)dx
\end{aligned}
\tag{A.42}
$$

Again setting $r = 0$ and differentiating with respect to p yields:

$$
\frac{\partial V_E}{\partial p}(0,t,p) = \frac{1 + \delta_k \frac{\partial^2 V_E}{\partial p^2}(0,t,p) + \lambda_0\beta\phi_C(p)}{\rho+\mu+\eta+\lambda_0\beta+\lambda_1\beta S(\bar{\theta}(p)) + \lambda_2\beta S(p)} \tag{A.43}
$$

Similar to before, defining $\phi_E(p) \equiv \frac{\partial V_E}{\partial p}(0,t,p)$ leaves us with a first-order linear ODE in p whose solution is given by:

$$
\phi_E(p) = \frac{1}{\Omega_E(p)}\left[C - \frac{1}{\delta_k}\int_{p_{min}}^{p} \Omega_E(x)\Big(1+\lambda_0\beta\phi_C(x)\Big)dx\right] \tag{A.44}
$$

where:

$$
\Omega_E(p) = exp\left(-\frac{1}{\delta_k}\int_{f_{min}}^{p} \omega_E(x)dx\right) \tag{A.45}
$$

$$
\omega_E(p) = \rho+\mu+\eta+\lambda_0\beta+\lambda_1\beta S(\bar{\theta}(0,p)) + \lambda_2\beta S(p) \tag{A.46}
$$

Similar to the case for CEOs, letting $C = \frac{1}{\delta_k}\int_{f_{min}}^{\infty} \Omega_E(x)(1+\lambda_0\beta\phi_C(x))dx$, we have that:

$$
\lim_{p\to\infty} \phi_E(p) = \lim_{p\to\infty} \frac{\frac{1}{\delta_k}\int_p^{\infty} \Omega_E(x)(1+\lambda_0\beta\phi_C(x))dx}{\Omega_E(p)}
$$

$$= \lim_{p\to\infty} \frac{1+\lambda_0\beta\phi_C(p)}{\omega_E(p)} = \frac{1+\lambda_0\beta(\rho+\mu+\eta)^{-1}}{\rho+\mu+\eta+\lambda_0\beta} \tag{A.47}$$

The executive value function can then by written as:

$$\begin{aligned}(\rho+\mu+\eta+\lambda_0\beta)V_E(r,t,p) = w + \frac{\partial V_E}{\partial t}(r,t,p) + \delta_k\frac{\partial V_E}{\partial p}(r,t,p) + (\eta+\lambda_0\beta)V_U(t) + \lambda_0\beta_0\int_{f_{min}}^{p}\phi_C(x)dx \\ + \lambda_1\beta\int_{\bar{\theta}(0,p)}^{\infty}\phi_C(x)S(x)dx + \lambda_1(1-\beta)\int_{\underline{\theta}_{EC}(r,p)}^{\bar{\theta}(0,p)}\phi_C(x)S(x)dx \\ + \lambda_2\beta\int_{p}^{\infty}\phi_E(x)S(x)dx + \lambda_2(1-\beta)\int_{\underline{\theta}_{EE}(r,p)}^{p}\phi_E(x)S(x)dx\end{aligned} \tag{A.48}$$

A.3. Characterizing $\bar{\theta}(0,p)$

Following the analysis above, we can further analyze the properties of the critical value $\bar{\theta}(0,x)$. Given the definition of $\phi_E(x)$, $\bar{\theta}(0,x)$ is defined by:

$$\frac{\partial\bar{\theta}}{\partial x}(0,x) = \frac{\phi_E(x)}{\phi_C(\bar{\theta}(0,x))} \tag{A.49}$$

Lemma 1. $\phi_C(p) > \phi_E(p)$

Proof. Define $d(p) := \phi_C(p)-\phi_E(p)$. Subtracting (A.34) from (A.43) and writing $\omega_E(p) = \omega_C(p)+\Delta(p)$, $\Delta(p) > 0$, yields:

$$\begin{aligned}\delta_k\, d'(p) = \omega_C(p)\, d(p) - \Delta(p)\,\phi_E(p) - \lambda_0\beta\,\phi_C(p). \\ d'(p) - \frac{\omega_C(p)}{d(p)} = -\frac{1}{\delta_k}[\Delta(p)\phi_E(p) + \lambda_0\beta\phi_C(p)]\end{aligned} \tag{A.50}$$

Because every term in the bracket is non-negative and at least one is strictly positive, the right-hand side of (A.50) is smaller than $\omega_C(p)d(p)$ whenever $d(p) \leq 0$.

Multiply (A.50) by $\Omega_C(p)$ to obtain:

$$\frac{d}{dp}\big[\Omega_C(p)\,d(p)\big] = -\frac{\Omega_C(p)}{\delta_k}\big[\Delta(p)\,\phi_E(p) + \lambda_0\beta\,\phi_C(p)\big] < 0 \tag{A.51}$$

Integrating from p to ∞ and using $\Omega_C(\infty)d(\infty) = 0$ yields:

$$d(p)\,\Omega_C(p) = \int_p^{\infty} \frac{\Omega_C(x)}{\delta_k}\big[\Delta(x)\,\phi_E(x) + \lambda_0\beta\,\phi_C(x)\big]dx \;>\; 0 \tag{A.52}$$

Since $\Omega_C(p) > 0$, $d(p) = \phi_C(p) - \phi_E(p) > 0$ for all $p < p_\infty$, while $d(\infty) = 0$ by the common limit ■

Proof of Proposition 1. By the previous lemma, we know that $\phi_E(x) < \phi_C(x)$ for all $x \in [f_{min}, \infty)$. Next, define $D(p) = \bar{\theta}(0, p) - p$. Given that $\bar{\theta}(0, f_{min}) = f_{min}$, we can prove that $\bar{\theta}(0, p) < p$ by establishing that $D(p) \leq 0$ for all $p \in [f_{min}, \infty)$.

For the sake of contradiction, suppose there exists a p^* such that $D(p^*) > 0$. As $D(p)$ is continuous and $D(f_{min}) = 0$, there must in this case be a point p_0 such that $D(p_0) = 0$ and $D(p) > 0$ for all $p \in (p_0, p^*]$. Further, it must be true that $D'(p_0) \geq 0$.

From the definition of $D(p)$, we know that:

$$D'(p_0) = \frac{\phi_E(p_0)}{\phi_C(\bar{\theta}(0, p_0))} - 1 \tag{A.53}$$

Given that $\phi_C(x)$ is monotonic, if $D(p_0) = 0$, the we must have that $\bar{\theta}(0, p_0) = p_0$. This then implies that:

$$D'(p_0) = \frac{\phi_E(p_0)}{\phi_C(p_0)} - 1 < 0 \tag{A.54}$$

where the inequality follows from the fact that $\phi_E(x) < \phi_C(x)$ for all $x \in [f_{min}, \infty)$. This contradicts the original assumption that $D'(p_0) \geq 0$. Hence, it must be true that $D(p) \leq 0$ for all $p \in [f_{min}, \infty)$.

Finally, to establish that $\bar{\theta}(r, p) < \bar{\theta}(0, p)$, note that by the fundamental theorem of calculus:

$$\bar{\theta}(r, p) = \bar{\theta}(0, p) - \int_{-\infty}^{r} \frac{\partial \bar{\theta}}{\partial s}(s, p)ds \tag{A.55}$$

Differentiating the indifference condition (5) with respect to r yields:

$$\frac{\partial\bar{\theta}}{\partial r}(r,p) = \frac{\frac{\partial V_E}{\partial r}(r,t,p)}{\phi_C(\bar{\theta}(r,p)} \tag{A.56}$$

Rewriting Equation (A.55):

$$\bar{\theta}(r,p) = \bar{\theta}(0,p) - \int_{-\infty}^{r} \frac{\frac{\partial V_E}{\partial s}(s,t,p)}{\phi_C(\bar{\theta}(s,p))} ds \tag{A.57}$$

As both $\frac{\partial V_E}{\partial s}(s,t,p) > 0$ and $\phi_C(\bar{\theta}(s,p)) > 0$, it must be the case that $\bar{\theta}(r,p) < \bar{\theta}(0,p)$ for $r < 0$. ■

A.4. Piece Rate Derivation

A.4.1. CEO piece rates

Horizontal Hires. The bargaining condition (A.28) implies:

$$\begin{aligned}
r' &= -(1-\beta)(f'-p) + \beta\left[\frac{\partial V_C}{\partial t}(0,t,f') + \delta_k \frac{\partial V_C}{\partial p}(0,t,f')\right] \\
&+ (1-\beta)\left[\frac{\partial V_C}{\partial t}(0,t,p) + \delta_k \frac{\partial V_C}{\partial p}(0,t,p)\right] - \frac{\partial V_C}{\partial t}(r',t,f') - \delta_k \frac{\partial V_C}{\partial p}(r',t,f') \\
&+ \lambda_1\beta^2 \int_{f'}^{\infty} \phi_C(x)S(x)dx + \lambda_1\beta(1-\beta)\int_{f'}^{\infty} \phi_C(x)S(x)dx \\
&- \lambda_1\beta \int_{f'}^{\infty} \phi_C(x)S(x)dx - \lambda_1(1-\beta)\int_{p}^{f'} \phi_C(x)S(x)dx
\end{aligned} \tag{A.58}$$

Note that (A.28) implies the following two conditions:

$$\frac{\partial V_C}{\partial t}(r',t,f') = \beta\frac{\partial V_C}{\partial t}(0,t,f') + (1-\beta)\frac{\partial V_C}{\partial t}(0,t,p) \tag{A.59}$$

$$\delta_k\frac{\partial V_C}{\partial p}(r',t,f') = \delta_k\beta\frac{\partial V_C}{\partial p}(0,t,f') + \delta_k(1-\beta)\frac{\partial V_C}{\partial p}(0,t,p) \tag{A.60}$$

The partial derivative terms in Equation (A.58) then cancel, and we can simplify the expression by combining integrals:

$$
\begin{aligned}
r' &= -(1-\beta)(f'-p) - \lambda_1(1-\beta)^2 \int_p^{f'} \phi_C(x)S(x)dx \\
&= -(1-\beta)\int_p^{f'} q(x)dx \equiv r_C^{hor}(f',p) \qquad \text{(A.61)}
\end{aligned}
$$

$$
q(x) = 1 + \lambda_1(1-\beta)\phi_C(x)S(x) \qquad \text{(A.62)}
$$

Diagonal Hires. Applying the definition of $\bar{\theta}$ (Equation (5)), the bargaining condition (A.26) can be rewritten as:

$$
V_C(r',t,f') = \beta V_C(0,t,f') + (1-\beta)V_C(0,t,\bar{\theta}(0,p)) \qquad \text{(A.63)}
$$

Inserting the associated value functions then yields:

$$
\begin{aligned}
r' = \beta\left(f' + \lambda_1\beta\int_{f'}^{\infty}\phi_C(x)S(x)dx\right) + (1-\beta)\left(\bar{\theta}(0,p) + \lambda_1\beta\int_{\bar{\theta}(0,p)}^{\infty}\phi_C(x)S(x)dx\right) \\
- f' - \lambda_1\beta\int_{f'}^{\infty}\phi_C(x)S(x)dx - \lambda_1(1-\beta)\int_{\bar{\theta}(0,p)}^{f'}\phi_C(x)S(x)dx \qquad \text{(A.64)}
\end{aligned}
$$

Collecting terms and rearranging yields:

$$
\begin{aligned}
r' &= -(1-\beta)\big(f' - \bar{\theta}(0,p)\big) - \lambda_1(1-\beta)^2\int_{\bar{\theta}(0,p)}^{f'}\phi_C(x)S(x)dx \\
&= -(1-\beta)\int_{\bar{\theta}(0,p)}^{f'} q(x)dx \\
&= r_C^{hor}(f',p) - (1-\beta)\int_{\bar{\theta}(0,p)}^{p} q(x)dx \equiv r_C^{diag}(f',p) \qquad \text{(A.65)}
\end{aligned}
$$

Vertical Hires. Similar to the previous case, we can apply the definition of $\bar{\theta}$ and rewrite the bargaining condition (A.9) as:

$$
V_C(r',t,p) = \beta V_C(0,t,p) + (1-\beta)V_C(0,t,\bar{\theta}(r,p)) \qquad \text{(A.66)}
$$

Inserting the definition of the value function yields:

$$
\begin{aligned}
r' = {} & \beta\left(p + \lambda_1\beta\int_p^\infty \phi_C(x)S(x)dx\right) + (1-\beta)\left(\bar{\theta}(r,p) + \lambda_1\beta\int_{\bar{\theta}(r,p)}^\infty \phi_C(x)S(x)dx\right) \\
& - p - \lambda_1\beta\int_p^\infty \phi_C(x)S(x)dx - \lambda_1(1-\beta)\int_{\bar{\theta}(r,p)}^p \phi_C(x)S(x)dx
\end{aligned} \tag{A.67}
$$

Collecting terms yields:

$$
\begin{aligned}
r' &= -(1-\beta)\int_{\bar{\theta}(r,p)}^p q(x)dx \\
&= r_C^{diag}(p,p) - \int_{\bar{\theta}(r,p)}^{\bar{\theta}(0,p)} q(x)dx \equiv r_C^{vert}(p,p)
\end{aligned} \tag{A.68}
$$

A.4.2. Executive Piece Rate Derivation

Recall the sharing rule for horizontal executive transitions:

$$
V_E(r',t,f') = \beta V_E(0,t,f') + (1-\beta)V_E(0,t,p) \tag{A.69}
$$

Inserting the executive value function yields:

$$
\begin{aligned}
r' = {} & \beta\left(f' + \lambda_0\int_{f_{min}}^{f'} \phi_C(x)dx + \lambda_1\beta\int_{\bar{\theta}(0,f')}^\infty \phi_C(x)S(x)dx + \lambda_2\beta\int_{f'}^\infty \phi_E(x)S(x)dx\right) \\
& + (1-\beta)\left(p + \lambda_0\beta\int_{f_{min}}^p \phi_C(x)dx + \lambda_1\beta\int_{\bar{\theta}(0,p)}^\infty \phi_C(x)S(x)dx + \lambda_2\beta\int_p^\infty \phi_E(x)dx\right) \\
& - f' - \lambda_0\beta\int_{f_{min}}^{f'} \phi_C(x)dx - \lambda_1\beta\int_{\bar{\theta}(0,f')}^\infty \phi_C(x)S(x)dx - \lambda_1(1-\beta)\int_{\bar{\theta}(0,p)}^{\bar{\theta}(0,f')} \phi_C(x)S(x)dx \\
& - \lambda_2\beta\int_{f'}^\infty \phi_E(x)S(x)dx - \lambda_2(1-\beta)\int_p^{f'} \phi_E(x)S(x)dx
\end{aligned} \tag{A.70}
$$

Collecting terms yields:

$$
r' = -(1-\beta)(f'-p) - (1-\beta)\beta\lambda_0\int_p^{f'} \phi_C(x)dx - (1-\beta)^2\lambda_1\int_{\bar{\theta}(p)}^{\bar{\theta}(f')} \phi_C(x)S(x)dx
$$

$$= -(1-\beta)^2\lambda_2 \int_p^{f'} \phi_C(x)S(x)dx \tag{A.71}$$

Note that the second integral term can be rewritten as follows:

$$\int_{\bar{\theta}(0,p)}^{\bar{\theta}(0,f')} \phi_C(x)S(x)dx = \int_p^{f'} \phi_C(\bar{\theta}(0,x))\frac{\partial\bar{\theta}}{\partial x}(0,x)S(\bar{\theta}(0,x))dx = \int_p^{f'} \phi_E(x)S(\bar{\theta}(0,x))dx \tag{A.72}$$

The executive piece rate can then be expressed as:

$$r' = -(1-\beta)\int_p^{f'} q_E(x)dx \tag{A.73}$$

$$q_E(x) = 1 + \beta\lambda_0\phi_C(x) + (1-\beta)\phi_E(x)[\lambda_1 S(\bar{\theta}(0,x)) + \lambda_2 S(x)] \tag{A.74}$$

A.5. Characterization of the CEO Renegotiation Set

In this section, we prove proposition 3 by characterizing the dynamics of the renegotiation boundary $\underline{\theta}_{ij}$ for each transition type $ij \in \{CC, EC, EE\}$.

Proof of Proposition 3. We begin by characterizing the dynamics of $\underline{\theta}_{CC}$. Recall the definition of $q(x)$ in Equation (A.62). Differentiating $q(x)$ yields:

$$q'(x) = \lambda_1(1-\beta)[\phi_C'(x)S(x) - \phi_C(x)\psi(x)] \tag{A.75}$$

where $\psi(x)$ is the PDF corresponding to $\Psi(x)$. Equation (A.75) implies that $q(x)$ is strictly decreasing if and only if $\frac{\phi_C'(x)}{\phi_C(x)} < \frac{\psi(x)}{S(x)}$, and weakly increasing otherwise. Whether $q'(x)$ is positive or negative has important implications for the dynamics of $\underline{\theta}_{CC}(r,p)$. Note that Equation (9) implies the identity:

$$\int_z^f q(x)dx = \int_{\underline{\theta}_{CC}(r,p)}^p q(x)dx \tag{A.76}$$

Differentiating both sides with respect to p yields:

$$\frac{\partial\underline{\theta}_{CC}}{\partial p}(r,p) = \frac{q(p)}{q(\underline{\theta}_{CC}(r,p))} > 0 \tag{A.77}$$

Noting that $\frac{\partial \underline{\theta}_{CC}}{\partial \tau}(r,p) = \frac{\partial \underline{\theta}_{CC}}{\partial p}(r,p)\frac{dk}{d\tau}(\tau)$, we have that:

$$\frac{\partial \underline{\theta}_{CC}}{\partial \tau}(r,p) = \frac{dk}{d\tau}(\tau)\frac{q(p)}{q(\underline{\theta}_{CC}(r,p))} > 0 \tag{A.78}$$

As the upper bound p of the renegotiation set $[\underline{\theta}_{CC}(r,p),p]$ grows at rate $\frac{dk}{d\tau}(\tau)$, whether the mass of the interval $[\underline{\theta}_{CC}(r,p),p]$ increases or decreases with tenure depends on the magnitude of the ratio $\frac{q(p)}{q(\underline{\theta}_{CC}(r,p))}$. There are two possible cases. First, if $\frac{\phi_C'(x)}{\phi_C(x)} < \frac{\psi(x)}{S(x)}$, then $q(x)$ is monotonically decreasing, in which case we have that $\frac{q(p)}{q(\underline{\theta}_{CC}(r,p))} < 1$. Hence, the mass of the interval $[\underline{\theta}_{CC}(r,p),p]$ grows with tenure if and only if $\frac{\phi_C'(x)}{\phi_C(x)} < \frac{\psi(x)}{S(x)}$. Otherwise, $[\underline{\theta}_{CC}(r,p),p]$. Otherwise $[\underline{\theta}_{CC}(r,p),p]$ shrinks in mass with tenure.

Characterizing the dynamics of $\underline{\theta}_{EC}$ is effectively the same as in the previous case. Equation (9) implies that:

$$\int_{z}^{\bar{\theta}(r,f)} q(x)dx = \int_{\underline{\theta}_{EC}(r,p)}^{\bar{\theta}(0,p)} q(x)dx \tag{A.79}$$

Differentiating both sides with respect to p yields:

$$\frac{\partial \underline{\theta}_{EC}}{\partial p}(r,p) = \frac{\partial \bar{\theta}}{\partial p}(0,p)\frac{q(\bar{\theta}(0,p))}{q(\underline{\theta}_{EC}(r,p))} > 0 \tag{A.80}$$

As before, we can rewrite the Equation above as:

$$\frac{\partial \underline{\theta}_{EC}}{\partial \tau}(r,p) = \frac{\partial \bar{\theta}}{\partial \tau}(0,p)\frac{q(\bar{\theta}(0,p))}{q(\underline{\theta}_{EC}(r,p))} > 0 \tag{A.81}$$

Whether the mass of the interval $[\underline{\theta}_{EC}(r,p),\bar{\theta}(0,p)]$ grows or shrinks with tenure again depends on the hazard $\frac{f(x)}{S(x)}$. If $\frac{\phi_C'(x)}{\phi_C(x)} < \frac{\psi(x)}{S(x)}$, then p grows faster than $\underline{\theta}_{EC}(r,p)$ and $[\underline{\theta}_{EC}(r,p),p]$ widens with tenure. Otherwise, $[\underline{\theta}_{EC}(r,p),p]$ shrinks with tenure.

Finally, we consider $\underline{\theta}_{EE}$. Recall the definition of $q_E(x)$ in Equation (A.74). Differentiating $q_E(x)$ yields:

$$q_E'(x) = \beta\lambda_0\phi_C'(x) + (1-\beta)\phi_E'(x)[\lambda_1 S(\bar{\theta}(0,x)) + \lambda_2 S(x)]$$

$$-(1-\beta)\phi_E(x)[\lambda_1\psi(\bar{\theta}(0,x))\frac{\partial\bar{\theta}}{\partial x}(0,x)+\lambda_2\psi(x)] \tag{A.82}$$

Rearranging the condition above reveals that $q_E'(x) < 0$ if and only if:

$$\frac{\phi_E'(x)}{\phi_E(x)} < \frac{\lambda_1\psi(\bar{\theta}(0,x))\frac{\partial\bar{\theta}}{\partial x}(0,x)+\lambda_2\psi(x)-\frac{\beta}{1-\beta}\lambda_0\frac{\phi_C'(x)}{\phi_E(x)}}{\lambda_1 S(\bar{\theta}(0,x))+\lambda_2 S(x)} \equiv A \tag{A.83}$$

Equation (9) implies:

$$\int_z^f q_E(x)dx = \int_{\underline{\theta}_{EE}(r,p)}^p q_E(x)dx \tag{A.84}$$

Differentiating both sides with respect to p and rearranging yields:

$$\frac{\partial\underline{\theta}_{EE}}{\partial\tau}(r,p) = \frac{\partial k}{\partial\tau}(\tau)\frac{q_E(p)}{q_E(\underline{\theta}_{EE}(r,p))} > 0 \tag{A.85}$$

Following the same argument from before, we have that the mass of the renegotiation set $[\underline{\theta}_{EE}(r,p),p]$ grows with tenure if and only if $\frac{\phi_E'(x)}{\phi_E(x)} < A$. ■

B. Estimation Appendix

B.1. Weighting Matrix

From the empirical sample we obtain a $K\times 1$ vector of moments $\hat{M}$. Let Σ denote the corresponding $N \times K$ matrix of influence functions, N being the number of observations in the sample. Each element Σ_{nk} is the influence function describing observation n's contribution to moment k. The covariance matrix of the vector of moments can then be estimated as:

$$a\hat{v}ar(\hat{M}) = \Sigma'\Sigma \tag{B.1}$$

The weighting matrix $\hat{W}$ is then obtained as the inverse of matrix B.1. Let $\Theta \in \mathbb{R}^P$ denote an arbitrary vector of structural parameters. Define the moment residual $g : \mathbb{R}^P \to \mathbb{R}^M$ as:

$$g(\Theta) = \hat{M} - \frac{1}{S}\sum_{s=1}^{S} \hat{m}^s(\Theta) \tag{B.2}$$

Where $\hat{M}$ is the vector of empirical moments, $\hat{m}^s(\Theta)$ is the vector of simulated moments given parameter values Θ in simulation s, and S is the total number of simulations. The vector of estimates $\hat{\Theta}$ minimizes the SMM objective function:

$$\hat{\Theta} = \arg\min_{\Theta} \; g(\Theta)\hat{W}g(\Theta)' \tag{B.3}$$

B.2. Model Estimation Algorithm

We minimize the SMM quadratic form using the TikTak algorithm. The routine proceeds as follows:

1. *Set initial guesses for model parameters*: We set bounds for each parameter and draw a sequence of 100,000 Sobol points from the resulting bounded parameter space. We then simulate the model, construct our simulated panel, and compute the SMM objective at each Sobol point.

2. *Parallel local minimization*: We then rank the Sobol points by objective function value, and compute the local minimum around the top 225 points (225 is motivated by core usage on the cluster we use). We compute local minima using the Subplex algorithm via NLopt (Rowan, 1990). We use 500 iterations for each of the 225 local minima, as we do not need to find the exact local minimum, rather just be in the neighborhood. We rank these 225 local minima by objective function value.

3. *Parallel global minimization*: We then compute convex combinations of each local minima with the current best point: for $i \ldots N_S, i > 1$, we set $\theta_2 = 0.995$ and $\theta_{N_S} = 0.005$ as the

maximum and and minimum weight on the current best local minimum and the remaining Sobol points (ranked 2 to 225). We then compute the local minimum of each candidate global minimum point, using 1000 iterations of the Subplex algorithm. If $i^* > 1$, we update to the position of the best possible global minimum point and repeat the parallel global minimization by re-computing the convex combination of the current best candidate and all remaining points. We do this until i^* is stable between iterations

B.3. Standard Errors for Parameter Estimates

For true parameter vector Θ and consistent estimate $\hat{\Theta}$, we have the following asymptotic distribution (Duffie and Singleton, 1993):

$$\sqrt{n}(\hat{\Theta} - \Theta) \to^d N(0, avar(\hat{\Theta})) \tag{B.4}$$

$avar(\hat{\Theta})$ can be expressed as:

$$avar(\hat{\Theta}) = \left(1 + \frac{1}{S}\right)\left(\frac{\partial g(\Theta)}{\partial \Theta} W \frac{\partial g(\Theta)}{\partial \Theta'}\right)^{-1} \tag{B.5}$$

where $\frac{\partial g(\Theta)}{\partial \Theta}$ is the Jacobian of the moment residual (B.2) with respect to the structural parameters, W is the optimal weighting matrix, and S is the number of simulations. We approximate the Jacobian using:

$$\frac{\partial \hat{g}_m(\Theta)}{\partial \Theta_p} = \frac{g_p(\hat{\Theta} + h_p) - g_p(\hat{\Theta})}{h_p} \tag{B.6}$$

for each moment m and parameter p. h_p is the perturbation size for parameter which we set to 1% of the absolute value of the parameter estimate. The standard errors are the square root of the diagonal elements of the matrix:

$$\left(1 + \frac{1}{S}\right)\left(\frac{\partial \hat{g}(\Theta)}{\partial \Theta} \hat{W} \frac{\partial \hat{g}(\Theta)}{\partial \Theta'}\right)^{-1} \tag{B.7}$$

where $\hat{W}$ is the sample counterpart of the optimal weighting matrix.