

# IT, Corporate Payouts, and the Growing Inequality in Managerial Compensation

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## Abstract

Three of the most fundamental changes in US corporations since the early 1970s have been (1) the increase in the importance of *organizational capital* in production, (2) the increase in managerial income inequality, and (3) the increase in payouts to the owners. There is a unified explanation for these changes: The arrival and gradual adoption of information technology since the 1970s has stimulated the accumulation of organizational capital in existing firms. Since owners are better diversified than managers, the optimal division of rents from this organizational capital has the owners bear most of the cash-flow risk. In our model, the IT revolution benefits the owners and the managers in large successful firms, but not the managers in small firms. The resulting increase in managerial compensation inequality and the increase in payouts to owner's compare favorably to those we establish in the data.

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# 1 Introduction

The early 1970s marked the start of the information technology revolution. As its efficiency improved and its price dropped, the use of IT spread, and its adoption affected all sectors of the economy. By now, there is overwhelming evidence that computers have fundamentally altered firms' business processes, relationships with customers and suppliers, and internal organization.<sup>1</sup> The adoption of IT not only led to an increase in the organizational capital of the average US firm, it also increased heterogeneity across firms.<sup>2</sup> This widespread accumulation of organizational capital creates a new problem for successful firms: how to distribute its rents? Unlike over physical capital, the firms' managers have de facto ownership rights over organizational capital. They can leave and take some of this capital to a new firm. Our paper studies the distribution of organizational rents between the owners and the managers in this new environment.

In the data, the distribution of the rents created by organizational capital has changed in two major ways. First, the average US firm generates much larger payouts for its owners as a fraction of value-added now than 35 years ago. Second, the cross-sectional dispersion of managerial compensation is much larger now than 35 years ago. In large, successful firms, which accumulate a lot of organizational capital, managerial compensation increased substantially, but it did not in small firms. We propose a theory that ties the accumulation of organizational capital, ignited by the IT revolution, to managerial compensation. It can quantitatively account for these two key changes in the US economy.

The optimal managerial compensation contract that we derive insures the risk averse manager against shocks to the firm's productivity. This contract arises because the manager can only work for one firm at the time, while the owner invests in a perfectly diversified portfolio of corporations. The insurance is only partial because the manager has the right to quit, and transfer part of the organizational capital to a new firm. The degree of portability of organizational capital governs the value of the manager's outside option, and the degree of risk sharing that can be sustained between the manager and the owner.

Why does the arrival of IT increase the dispersion of managerial compensation? As long as firms are small, the optimal contract provides the manager with compensation that is constant (relative to aggregate output). The manager's outside option is not a binding constraint. However, when the firm size exceeds a threshold, management compensation (relative to aggregate output) increases whenever the firm accumulates more organizational capital. The increased accumulation of organizational capital, resulting from the IT revolution, improves the manager's outside option. To retain the manager, the owner of the firm increase managerial compensation in response to high productivity. At the aggregate level, the change in the firm size distribution that results from the adoption of IT triggers an endogenous shift from low-powered to high-powered incentive

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<sup>1</sup>E.g., Brynjolfsson and Hitt (1997, 2000), Bresnahan, Brynjolfsson and Hitt (2002), and an entire volume of contributions on organizational capital in the new economy Corrado, Haltiwanger and Sichel, eds (2005).

<sup>2</sup>Chun, Kim, Morck and Yeung (2007) document that IT originated a wave of Schumpeterian creative destruction that led to higher firm-specific performance heterogeneity throughout traditional US industries.

compensation contracts. Such a shift seems consistent with the current prevalence of pay-for-performance employment contracts compared to the 1970s.

Why does the IT revolution increase the average payouts to owners of the firms? The life-cycle profile of the owner's payouts is increasing. The first payout is negative because of an initial sunk cost required to start up the firm and because of a positive compensation for the manager. As the firm grows, its output and profits rise on average. This increases the payouts to the owner because management compensation stays constant initially and later rises with the firm's size. On average, this rise in pay is moderate compared to the owner's, because the manager is more impatient than the owner. Hence, the owner's payout profile is back-loaded. The owner is compensated for waiting. The more pronounced this back-loading, the higher are the owner's payouts, averaged across firms. The IT revolution increases back-loading because large firms, with a large amount of organizational capital, become more prevalent. Hence, the owner's payouts (relative to aggregate output) rise during the IT adoption. Put differently, the average owner benefits more from the knowledge economy than the average knowledge worker.

Our paper is organized as follows. Section 3 defines the technology side of the model, describes the compensation contract between manager and owner, defines an equilibrium with a continuum of managers and firms, and defines a steady-state growth path. Section 4 highlights the properties of the optimal compensation contract along a steady-state growth path. Its dynamics are fully captured by the current and the highest-ever productivity level of the firm. Managerial compensation increases whenever a new maximum productivity level is reached. These two state variables have a natural interpretation as the *size* and *market-to-book ratio* of the firm. Our model ties these two characteristics to the value of the firm and the compensation of its management. Section 5.2 describes the calibration of the model. The IT revolution is captured as a gradual increase in general productivity growth. The dissemination of this general purpose technology positively affects the productivity of all existing firms. In order to keep the growth rate of aggregate output constant along the transition path, we lower the growth rate of the second source of growth, vintage-specific productivity growth. The magnitude of this compositional shift is calibrated to match the observed decline in labor reallocation. A second key parameter is the portability of organizational capital. It is calibrated to match the increase in income inequality. We detail the labor reallocation and the income inequality data used to justify these choices. Section 5 discusses the results of the transition experiment. The model matches the two key trends we set out to explain: the increase in the owner's payouts relative to aggregate output and the increase in the dispersion of managerial compensation. Interestingly, the model's cross-sectional distribution of managerial pay, post-IT, shares many features with the observed distribution: it is skewed, fat-tailed, and has the correct relationship to the firm size distribution. Section 6 establishes the dramatic rise in corporate payout rates since the early seventies, using three data sources. It also documents the rise in the valuation of these firms relative to their replacement costs. Finally, it provides additional cross-sectional evidence for the effect of labor reallocation on payouts and valuations, which lends further credibility to the mechanism we propose.

## 2 Related Literature

In the absence of permanent monopoly profits, the value of the firm’s securities measures the value of its capital. Hall (2001) measures the intangible capital stock as the difference between the total value of US corporations and the value of the physical capital stock. By this measure, US corporations have accumulated large amounts of intangible capital over the last decades. Consistent with this, the IT revolution leads to an increase in the accumulation of organizational capital in our model. Despite the absence of a persistent decline in the cost of capital, the model can account for 40% of the run-up in firm valuations over the last 2 decades. Thus, our model provides an underpinning for the re-emerging view that cash flows play a larger role in explaining variations in the value of firms than previously thought. Recently, Larrain and Yogo (2007) and Bansal and Yaron (2006) found more evidence of cash flow predictability in similarly broad payout measures. The cash flow process in our paper is determined endogenously by technological change and market forces.

In related work on technological change and stock market valuation, Greenwood and Jovanovic (1999) and Hobijn and Jovanovic (2001) argue that the IT revolution can account for the drop in the value of the capital stock in 1973, and the rise of the stock market in the 1980s and 1990s. Pastor and Veronesi (2005) develop a general equilibrium model in which agents learn about the profitability of new technologies that come online. Stock prices of new technologies that are characterized by high uncertainty about their profitability, display bubble-like behavior. Brynjolfsson, Hitt and Yang (2002) find that a \$1 investment in computers increases a firm’s stock market valuation by \$12. They attribute this effect to strong complementarities between IT and organizational capital (see also Bresnahan et al. (2002)).

Hobijn and Jovanovic (2001), and Jovanovic and Rousseau (2003) identify the invention of the Intel 4004 micro-processor in 1971 as the start of the IT revolution. This invention prompts the start of a gradual drop in the relative price of IT equipment and increased spending on IT. Information technology is a General Purpose Technology (GPT, Bresnahan and Trachtenberg (1996)). As a GPT, IT has increased the productivity of all establishments, not only the new ones.<sup>3</sup> Chun et al. (2007) emphasize the importance of IT for the profitability and productivity of traditional sectors of the economy. McGrattan and Prescott (2007) introduce intangible investment to account for the strong performance in the US economy in the 1990s. Research and development, advertisement, and investments in building organizations grew rapidly in this period (Corrado, Hulten and Sichel (2006)).

Since we hold overall productivity growth fixed in our model, we interpret the IT revolution as a shift in the composition of productivity growth towards such *general* productivity growth.

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<sup>3</sup>For example, Wal-Mart experienced tremendous productivity gains from economies of scale in warehouse logistics and purchasing, electronic data interchange and wireless bar code scanning. Brynjolfsson et al. (2002) cite Robert Solow who notes “The technology that went into what Wal-Mart did was not brand new and not especially at the technology frontiers, but when it was combined with with the firm’s managerial and organizational innovations, the impact was huge. We don’t look enough at organizational innovation.”

More precisely, the technology side of our model follows Atkeson and Kehoe (2005, 2007) with two sources of technological progress. General productivity growth affects all existing establishments, while vintage-specific productivity growth only increases the productivity of the newest vintage. Since it is not possible to break down total productivity growth along a steady-state growth path, our focus is on transitions between steady-states. The compositional shift in productivity growth is calibrated to match the secular decline in the job reallocation rate in the US economy since the early 1970s, as documented by Davis, Haltiwanger, Jarmin and Miranda (2006) and Faberman (2006). Intuitively, IT increases the growth rate of organizational capital in existing firms and enables the successful firms to grow large. This results in fewer firm exits and less labor reallocation from old- to new-vintage firms. The declining volatility of firm growth rates, documented by Davis et al. (2006) for the entire universe of privately-held and publicly-traded firms, is consistent with the decline in labor reallocation. Finally, the prediction that IT increased the fraction of output produced in older establishments is also consistent with the evidence in Davis et al. (2006).

A large literature documents the increase of wage inequality in the US in the last three decades and its relation to technological change (e.g., Violante (2002), Guvenen and Kuruscu (2007), Autor, Katz and Kearny (2007), and Acemoglu (2002) for a survey). Our paper contributes to this literature by (i) generating an endogenous switch to high-powered incentives contracts and by (ii) connecting the changing distribution of payouts to workers to the payouts to the owners of the capital stock, and ultimately to firm value. This link is usually ignored in the literature, except by Merz and Yabsiv (2003).

In our model, managerial compensation is governed by a long-term contract that insures the manager against firm-specific shocks. There is scope for insurance when at least some of the organizational capital is match-specific. Neal (1995) provides empirical evidence on the importance of match-specific capital. The optimal dynamic compensation contract induces these managers to remain at the firm as long as continuation of the match is beneficial. The contract is set up in order to *avoid* managerial turnover. Hence, our model should be interpreted not as a model of managerial turnover, but as a model of firm entry and exit.

Many of the features of these optimal contracts have been analyzed elsewhere, but we are the first to argue these contracts play a key role in understanding the value of the firm, its cross-sectional distribution, and how that distribution evolved over time. We are also the first to provide a theoretical link between the size and book-to-market of a firm and its labor compensation practises. The wage dynamics are similar to those in Harris and Holmstrom (1982)'s seminal paper, which studies optimal long-term wage contracts with learning about the manager's productivity. The manager's compensation displays downward wage rigidity. When the manager and the owner have the same time discount rate, the compensation stays constant. Compensation increases when the manager's outside option increases. The latter occurs when the firm's productivity reaches a new all-time high. Therefore, the increase in compensation only occurs in successful, large firms. In small firms, the manager's compensation does not respond to increased productivity because of the sunk costs. The change in the size distribution generates a regime shift from *low-powered*

to *high-powered* incentives in compensation contracts. In the US, the adoption of high-powered incentives contracts started in the 80's. Holmstrom and Kaplan (2001) link this rise in stock-based compensation to the wave of leveraged buyouts. We solve the model using techniques developed in recursive dynamic contracts by Thomas and Worall (1988). However, in our model as in Krueger and Uhlig (2005) and Lustig (2007), the manager's outside option is determined endogenously.

Our model predicts a sizeable increase in within-industry between-establishment wage dispersion for skilled workers. This is consistent with the data (Dunne, Foster, Haltiwanger and Troske (2004)). At the top end of the compensation scale, the dispersion of executive compensation has increased even more in the last decades (Frydman and Saks (2006)). Gabaix and Landier (2008) relate this increase in to the changing size distribution of firms. In their model, more talented executives are matched to larger firms. The observed change in the firm size distribution can generate the observed change in the distribution of CEO compensation. Our model endogenizes both the evolution of the size and the managerial compensation distribution. It generates the empirically estimated sensitivity of log compensation to log size of 1/3 (Edmans, Gabaix and Landier (2007)).

### 3 Model

We set up a model with a fixed population (mass 1) of *managers*. We emphasize that we are not only thinking of the CEO, but rather of the entire management. Each manager is matched to an owner to form an *establishment*. The formation of a new establishment incurs a one-time fixed cost  $S_t$ . Establishments accumulate knowledge as long as the match lasts. We refer to this stock of knowledge as *organizational capital*  $A_t$ . This organizational capital affects the technology of production; it is a third factor of production besides physical capital and unskilled labor, earning *organizational rents*.

We deviate from Atkeson and Kehoe (2005) by assuming that a part of the establishment's organizational capital is embodied in the manager. The main innovation of our work is to find the optimal division of organizational rents between the owner and the manager, as governed by an optimal long-term risk-sharing contract in the spirit of Harris and Holmstrom (1982). We solve for the optimal contract recursively by using promised utility as a state variable (e.g., Thomas and Worall (1988) and Kocherlakota (1996)). The optimal contract maximizes the present discounted value of the organizational rents flowing to the owner subject to the manager's promise keeping constraint and a sequence of participation constraints that reflect the manager's inability to commit to the current match. We deviate from Krueger and Uhlig (2005) by assuming that the owner has limited liability. Separation occurs whenever there is no joint surplus in the match with the manager anymore. Upon separation, a fraction  $0 < \phi < 1$  of the organizational capital can be transferred to the manager's next match, while the remainder is destroyed. The market value of the corporate sector in the model is the value of the physical capital stock plus the value of all claims to that part of organizational rents that accrues to the owner. We start by setting up the model and defining a steady-state growth path. In Section 5, we trace out the *transition* between

two steady-state growth paths, which captures the advent and gradual adoption of information technology (IT).

### 3.1 Technology

On the technology side, our model follows Atkeson and Kehoe (2005). Each establishment belongs to a vintage  $s$ . An establishment of vintage  $s$  at time  $t$  was born at  $t-s$ . An establishment operates a vintage-specific technology that uses unskilled labor ( $l_t$ ), physical capital ( $k_t$ ), and organizational capital ( $A_t$ ) as its inputs. Output generated with this technology is  $y_t$ :

$$y_t = z_t (A_t)^{1-\nu} F(k_t, l_t)^\nu.$$

Following Lucas (1978),  $\nu$  is the ‘span of control’ parameter of the manager. This parameter governs the decreasing returns to scale at the establishment level.

We model two sources of productivity growth, which we label general and vintage-specific growth. The *general productivity* level  $z_t$  grows at a deterministic and constant rate  $g_z$ :

$$z_t = (1 + g_z)z_{t-1}.$$

General productivity growth affects establishments of all vintages alike. General productivity growth is often referred to as *disembodied* technical change. In addition, it is *skill-neutral* because it affects all three production inputs symmetrically.

Following Hopenhayn and Rogerson (1993), the match-specific level of organizational capital,  $A_t$ , follows an exogenous process. It is hit by random shocks  $\varepsilon$ , drawn from a distribution  $\Gamma$ :<sup>4</sup>

$$\log A_{t+1} = \log A_t + \log \varepsilon_{t+1}, \tag{3.1}$$

We do not explicitly model the learning process that underlies the accumulation process of organizational knowledge.<sup>5</sup> A new establishment can always start with a *blue print* or *frontier* technology level  $\theta_t$ :  $A_t \geq \theta_t$ . The productivity level of the blue print grows at a deterministic and constant rate  $g_\theta$ :

$$\theta_t = (1 + g_\theta)\theta_{t-1}.$$

This *vintage-specific growth* is often referred to as *embodied* technical change.

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<sup>4</sup>In principal, this distribution could depend on the vintage  $s$ . For example, older vintages could have shocks that are less volatile. For simplicity, we abstract from this source of heterogeneity.

<sup>5</sup>However, the  $\varepsilon$  shocks can be interpreted as productivity gains derived from active or passive learning, from matching, or from adoption of new technologies in existing firms (Atkeson and Kehoe (2005)). Additionally, they can be interpreted as reduced-form for heterogeneity across managers, or for the outcomes from good or bad decisions made by the manager. Bertrand and Schoar (2003), Bennedsen, Prez-Gonzalez and Wolfenzon (2007), and Bloom and Van Reenen (2006) show that heterogeneity across managers leads to heterogeneity in firm outcomes. Jovanovic and Nyarko (1982) explicitly model learning-by-doing.

### 3.2 Contract Between Owner and Manager

**Owner** There is a representative owner of all establishments, who is perfectly diversified. He maximizes the present discounted value of aggregate payouts from all establishments  $D_t$  using a discount rate  $r_t$ :

$$E_0 \sum_{t=0}^{\infty} e^{-\sum_{s=0}^t r_s} D_t. \quad (3.2)$$

The owner is the residual claimant to the aggregate stream of cash flows that not already claimed by the other factors:

$$\Pi_t = Y_t - W_t L_t - R_t K_t - C_t - S_t^a, \quad (3.3)$$

where  $W_t L_t$  is the aggregate compensation of unskilled labor,  $R_t K_t$  that of physical capital,  $C_t$  the aggregate compensation of all the managers of the establishments, and  $S_t^a = N_t S_t$  the total sunk costs incurred for starting  $N_t$  new establishments. In other words,  $\Pi_t$  is the sum of all rents from organizational capital accruing to the owner. In addition, we assume that the owner owns the physical capital stock. The aggregate payouts to the owner,  $D_t$ , are given by the organizational rents and the factor payments to physical capital less physical investment:

$$D_t = \Pi_t + R_t K_t - I_t, \quad \forall t.$$

Since the sunk cost is lost, value-added is defined as  $Y_t - S_t^a$ . For future reference, we define the *net payout share* in the model as

$$NPS = \frac{D_t}{Y_t - S_t^a}, \quad GPS = NPS + \frac{\delta K_t}{Y_t - S_t^a}.$$

The gross payout share (GPS) adds the consumption of fixed capital to the NPS.

We define the organizational rents (before sunk costs and physical capital income) generated by an existing establishment and accruing to the owner as:

$$\pi_t = y_t - W_t l_t - R_t k_t - c_t.$$

These are the per period profits of the establishment as a going concern. The sunk costs were paid only once when the establishment started up.

**Manager** The owner offers the manager a binding, i.e. non-renegotiable, contingent contract  $\{c_t(h^t), \beta_t(h^t)\}$  at the start of the match, where  $\{c_t(h^t)\}$  is the compensation of the manager as a function of the history of shocks  $h^t = (\varepsilon_t, \varepsilon_{t-1}, \dots)$  and  $\{\beta_t(h^t)\}$  governs whether the match is dissolved or not in history  $h^t$ . The manager is risk averse with CRRA parameter  $\gamma$  and time discount rate  $\rho_m$ . In contrast to the owner, the manager cannot make a binding commitment: He always has the option to leave to accept a job at another establishment.

The optimal contract is the contract that maximizes the total expected payoff of the owner



subject to delivering initial utility  $v_0$  to the manager:

$$v_0(h^0) = E_{h^0} \left[ \sum_{\tau=0}^{\infty} e^{-\rho_m \tau} \frac{c_\tau (h^\tau)^{1-\gamma}}{1-\gamma} \right].$$

In general, the history-dependence of the manager's compensation makes this a complicated problem. However, as is common in the literature on dynamic contracts, we use the manager's promised utility as a state variable to make the problem recursive. The contract delivers  $v_t$  in total expected utility to the manager today by delivering current consumption  $c_t$  and state-contingent consumption promises  $v_{t+1}(\cdot)$  tomorrow. Promised utilities lie on a domain  $[\underline{v}, \bar{v}]$ .

We use  $V_t(A_t, v_t)$  to denote the value of the owner's equity in an establishment with current organizational capital  $A_t$ , and an outstanding promise to deliver  $v_t$  to the manager. It is the value of the owner's claim to the rents from organizational capital. I.e., it does not include the value of income from physical capital. Importantly, the owner has limited liability; the option to terminate the contract when there is no joint surplus in the match. Limited liability implies the constraint:  $V_t(A_t, v_t) \geq 0$ .

Finally, we use  $\omega_t(A_t)$  to denote the outside option of a manager currently employed in an establishment with organizational capital  $A_t$ . When a manager switches to a new match, a fraction  $\phi$  of the organizational capital is transferred to the next match and a fraction  $1 - \phi$  is destroyed. Free disposal applies: If the manager brings organizational capital worth less than the current blue print  $\theta_t$ , then the new match starts off with the blue print technology for the new vintage. Taken together, the organizational capital of a match of vintage  $t$  is  $\max\{\phi A_t, \theta_t\}$ . The value of the outside option  $\omega$  is determined in equilibrium by a zero-profit condition for new entrants. In the extreme case where all knowledge is destroyed upon termination of the match ( $\phi = 0$ ), the outside option of the manager cannot depend on the amount of organizational capital accumulated in the preceding match.

**Recursive Formulation** For given outside options  $\{\omega_t\}$  and discount rates  $\{r_t\}$ , the optimal contract in an establishment that has promised  $v_t$  to its manager maximizes the owner's value  $V$

$$V_t(A_t, v_t) = \max \left[ \widehat{V}_t(A_t, v_t), 0 \right], \quad (3.4)$$

and

$$\widehat{V}_t(A_t, v_t) = \max_{c_t, v_{t+1}(\cdot)} \left[ \pi_t + \int e^{-r_t} V(A_{t+1}, v_{t+1}) \Gamma(\varepsilon_{t+1}) d\varepsilon_{t+1} \right], \quad (3.5)$$

by choosing the state-contingent promised utility schedule  $v_{t+1}(\cdot)$  and the current compensation  $c_t$ , subject to the law of motion for organizational capital (3.1), a promise keeping constraint

$$\begin{aligned} v_t &= u(c_t) + e^{-\rho m} \int \beta_{t+1}(v_t, \varepsilon_{t+1}) v_{t+1}(A_{t+1}) \Gamma(\varepsilon_{t+1}) d\varepsilon_{t+1} \\ &\quad + e^{-\rho m} \int \omega_{t+1}(A_{t+1}) (1 - \beta_{t+1}(v_t, \varepsilon_{t+1})) \Gamma(\varepsilon_{t+1}) d\varepsilon_{t+1} \end{aligned} \quad (3.6)$$

and a series of participation constraints

$$v_{t+1}(A_{t+1}) \geq \omega_{t+1}(A_{t+1}). \quad (3.7)$$

The indicator variable  $\beta$  is one if continuation is optimal and 0 elsewhere:

$$\begin{aligned} \beta_{t+1} &= 1 \text{ if } v_{t+1}(A_{t+1}) \leq v^*(A_{t+1}) \\ \beta_{t+1} &= 0 \text{ elsewhere.} \end{aligned}$$

The minimum value of zero on  $V$  in equation (3.4) reflects limited liability of the owner: The match will be terminated if the joint surplus of the match is negative. If the match is dissolved, the manager receives  $\omega_{t+1}(A_{t+1})$  in promised utility. To obtain this recursive formulation, we have used the fact that  $V_t(A_t, \cdot)$  is non-increasing in its second argument. For each  $A_t$ , there exists a cutoff value  $v^*(A_t)$  that satisfies  $\widehat{V}_t(A_t, v^*(A_t)) = 0$ . The match is dissolved when the promised utility exceeds the cutoff level:  $\beta_{t+1} = 0$  if and only if  $v_{t+1}(A_{t+1}) > v^*(A_{t+1})$ . Put differently, only establishments with high enough productivity  $A_t > \underline{A}_t(v_t)$  survive.

### 3.3 Equilibrium

A competitive equilibrium is a price vector  $\{W_t, R_t, r_t\}$ , an allocation vector  $\{k_t, l_t, c_t, \beta_t\}$ , an outside option process  $\{\omega_t\}$ , and a sequence of distributions  $\{\Psi_{t,s}, \lambda_{t,s}, N_t\}$  that satisfy optimality and market clearing conditions spelled out below.

**Physical Capital and Unskilled Labor** Unskilled labor  $l$  and physical capital  $k$  can be reallocated freely across different establishments. Hence, the problem of how much  $l$  and  $k$  to rent at factor prices  $W$  and  $R$ , is entirely static. We use  $K_t$  and  $L_t$  to denote the aggregate quantities, and we use  $\bar{A}_t$  to denote the average stock of organizational capital across all establishments and vintages:

$$\bar{A}_t = \sum_{s=0}^{\infty} \int_A A \Phi_{t,s} dA,$$

where  $\Phi_{t,s}$  denotes the measure over organizational capital at the start of period  $t$  for vintage  $s$ . Physical capital and unskilled labor are allocated in proportion to the establishment's productivity

level  $A_t$ :

$$\begin{aligned} k_t(A_t) &= \frac{A_t}{\bar{A}_t} K_t \\ l_t(A_t) &= \frac{A_t}{\bar{A}_t} L_t. \end{aligned}$$

This allocation satisfies the first order conditions, and the market clearing conditions for capital and labor. The fact that establishments with larger  $A$  have more physical capital and hire more unskilled labor suggests an interpretation of  $A$  as the size of the establishment.

The equilibrium wage rate  $W_t$  for unskilled labor and rental rate for physical capital  $R_t$  are determined by the standard first order conditions:

$$W_t = \nu z_t \bar{A}_t^{1-\nu} F_L(K_t, L_t)^{\nu-1}, \quad R_t = \nu z_t \bar{A}_t^{1-\nu} F_K(K_t, L_t)^{\nu-1}$$

The factor payments to unskilled labor and physical capital absorb a fraction  $(1 - \nu)$  of aggregate output  $Y_t$ , where  $Y_t$  is given by:

$$Y_t = z_t \bar{A}_t^{1-\nu} F(K_t, L_t)^\nu.$$

In the remainder, we assume a Cobb-Douglas production function  $F(k, l) = k^\alpha l^{1-\alpha}$ .

**Organizational Rents** A fraction  $\nu_t$  of aggregate output  $Y_t$  goes to organizational capital. These organizational rents are split between the owners  $\Pi_t$ , managers  $C_t$ , and sunk costs  $S_t^a = N_t S_t$ :

$$\sum_{s=0}^{\infty} \int_v \int_A \pi_t(A, v) \Psi_{t,s}(A, v) d(A, v) - N_t S_t = Y_t - W_t L_t - R_t K_t - C_t - S_t^a = \Pi_t,$$

where the measure  $\Psi_{t,s}(A, v)$  is defined below. The second equality follows from (3.3) and ensures that the goods market clears.

**Discount Rate** The payoffs are priced off the inter-temporal marginal rate of substitution (IMRS) of the representative owner. Just like the manager, the owner has constant relative risk aversion preferences with CRRA parameter  $\gamma$ . His subjective time discount factor is  $\rho_o$ . Let  $g_t$  denote the rate of change in  $\log D_t$ . Then, the equilibrium log discount rate or ‘‘cost of capital’’  $r_t$  is given by the owner’s IMRS:<sup>6</sup>

$$r_t = \rho_o + \gamma g_t. \tag{3.8}$$

**Managerial Compensation** Having solved for the value function  $\{V_t(\cdot, \cdot)\}$  that satisfies the Bellman equation above for given  $\{\omega_t(\cdot), r_t\}$ , we can construct the optimal contract for a new

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<sup>6</sup>Because there is no aggregate uncertainty and the owner holds a diversified portfolio of establishments, our setting is equivalent to one with a risk neutral owner who discounts future cash-flows as in equation (3.2). The cost of capital evolves deterministically.

match starting at  $t$   $\{c_{t+j}(h^{t+j}), \beta_{t+j}(h^{t+j})\}$  in sequential form.

**Outside Option** We assume the sunk cost  $S_t$  grows at the same rate as output. Free entry stipulates that the equilibrium value of a new establishment to the owner is equal to the sunk cost  $S_t$ :

$$V_t(\max(\phi A_t, \theta_t), \omega_t(A_t)) = S_t, \quad (3.9)$$

The first argument indicates that a new establishment starts with organizational capital equal to the maximum of the frontier level of technology  $\theta_t$  and the organizational capital the manager brought from the previous match  $\phi A_t$ . The total utility  $\omega_t(A_t)$  promised to the manager at the start of a new match is such that the value of the new match is zero in expectation. Therefore, equation (3.9) pins down the equilibrium  $\omega_t(A_t)$ .

**Law of Motion for Distributions** We use  $\chi$  to denote the implied probability density function for  $A_{t+1}$  given  $A_t$ .  $\kappa$  is an indicator function defined by the policy function for promised utilities:  $\kappa(A'; A, v) = 1$  if  $v'(A'; A, v) = v'$ , 0 elsewhere. Using this indicator function, we can define the transition function  $Q$  for  $(A, v)$ :

$$Q((A', v'), (A, v)) = \chi(A'|A)\kappa'(A'; A, v).$$

We use  $\Psi_{t,s}$  to denote the joint measure over organizational capital  $A$  and promised utilities  $v$  for matches of vintage  $s$ . Its law of motion is implied by the transition function:

$$\Psi_{t+1,s+1}(A', v') = \int_0^\infty \int_{\underline{v}}^{\bar{v}} Q((A', v'), (A, v)) \lambda_{t,s}(A, v) d(A, v), \quad (3.10)$$

where  $\lambda_{t,s}(A, v)$  is the measure of active establishments in period  $t$  of vintage  $s$ :

$$\lambda_{t,s}(A, v) = \int_0^A \int_{\underline{v}}^v \beta(a, u) d\Psi_{t,s}(a, u) \geq 0. \quad (3.11)$$

In equilibrium, the mass of new establishments created in each period  $N_t$  (entry) equals the mass of matches destroyed in that same period (exit):

$$N_t = \sum_{s=0}^{\infty} \int_0^\infty \int_{\underline{v}}^{\bar{v}} (1 - \beta_{t,s}(A, v)) \Psi_{t,s}(A, v) d(A, v) \geq 0.$$

### 3.4 Back-loading

The free entry condition implies that the expected net present discounted value of a start-up is exactly zero:

$$\int_0^\infty \int_{\underline{v}}^{\bar{v}} \sum_{j=0}^\infty e^{-\sum_0^j r_s ds} \pi_{t+j}(A, v) \Psi_{t+j,s}(A, v) d(A, v) - S_t = 0$$

Importantly, this does not imply that the organizational rents that flow to the owners are zero. As long as discount rates  $r$  are strictly positive (Atkeson and Kehoe (2005)), the zero profit condition in (3.9) implies that expected net payouts are strictly positive:

$$\int_0^\infty \int_{\underline{v}}^{\bar{v}} \sum_{j=0}^\infty \pi_{t+j}(A, v) \Psi_{t+j,s}(A, v) d(A, v) - S_t > 0,$$

for two reasons. The first reason is a **back-loading** effect. The owners are compensated for waiting in the form of positive payouts. The more back-loaded the payments are, the higher the expected payments. The expected payout profile of an establishment is steeply increasing: the first payout is a large negative number ( $-S_t$ ), the establishment then grows and starts to generate higher and higher profits (in expectation). Most of the organizational rents are paid in the future. Second, there is a **selection** effect operative. Only the establishments that have fast enough organizational capital growth, or equivalently productivity growth, survive. When we compute aggregate (or expected) payouts, we are only sampling from the survivors who satisfy  $A_t > \underline{A}_t(v_t)$ . This sample selection effect is the second reason why aggregate payouts to owners are positive. As we show below, the IT revolution increases the back-loading effect and therefore increases the net and gross payout shares.

As pointed out by Hopenhayn (2002), selection among establishments can explain why Tobin's (average)  $q$ ,  $q_t = \frac{V_t^a}{K_t}$ , is larger than one on average. The aggregate value of establishments is given by the present discounted value of a claim to  $\{D_t\}$ . It equals the sum of all equity values across all establishment minus sunk costs plus the value of the physical capital stock  $K_t$ :

$$V_t^a = \sum_{s=0}^\infty \int_0^\infty \int_{\underline{v}}^{\bar{v}} V_t(A, v) \Psi_{t,s}(A, v) d(A, v) - S_t^a + K_t \geq K_t,$$

Tobin's  $q$  is larger than one on average, in spite of the fact that new matches are valued at zero (net of their physical capital). The reason is selection: when we compute  $q$ , we only sample survivors. For example, for establishments of vintage  $s$ , we only sample from the ones with  $A_t > \underline{A}_t(v_t)$ . For future reference, we also define aggregate managerial wealth in the economy as:

$$M_t^a = \sum_{s=0}^\infty \int_A \int_v v_t(A, v) \Psi_{t,s}(A, v) d(A, v).$$

### 3.5 Steady-State Growth Path

In a first step, we solve for a steady-state growth path in which all aggregate variables grow at a constant rate. Aggregate establishment productivity  $\{\bar{A}_t\}$  and the productivity of the newest vintage  $\{\theta_t\}$  grow at a constant rate  $g_\theta$ , the variables  $\{r_t, R_t, N_t\}$  are constant, the economy-wide productivity-level grows at a constant rate  $g_z$ , and all other aggregate variables grow at a constant rate

$$g = ((1 + g_z)(1 + g_\theta)^{1-\nu})^{\frac{1}{1-\alpha\nu}}. \quad (3.12)$$

We normalize the population  $L$  to one. To construct the steady-state growth path, we normalize organizational capital by the frontier level of technology, and we denote the resulting variable with a hat:  $\hat{A}_t = A_t/\theta_t$ . By construction,  $\hat{A} \geq 1$  for a new establishment. A key insight is that the organizational capital of existing establishments, expressed in units of the frontier technology, *shrinks* at a rate  $(1 + g_\theta)$ :

$$\log(\hat{A}') = \log(\hat{A}) - \log(1 + g_\theta) + \log(\varepsilon'). \quad (3.13)$$

The prime denotes next period's value. The lower  $g_\theta$ , the higher the growth rate of  $\hat{A}$ . Below, we model the IT revolution as a decline in  $g_\theta$ , and therefore as an increase in organizational capital growth in existing firms.

Appendix B contains a detailed definition of a steady-state growth path. It shows how to express all other variables in efficiency units. Those variables are denoted by a tilde in rescaled units. Finally, it reformulates the optimal contract along the steady-state growth path. The Bellman equation is defined over the rescaled variables.

## 4 Properties of Wage Contract

Although the managerial compensation contract allows for complicated history-dependence, the optimal contract along a steady-state growth path turns out to have intuitive dynamics. Two state variables summarize all necessary information: the current level of productivity  $A_t$ , which we have given an interpretation as the size of the establishment, and the highest level of productivity recorded thus far  $A_{max,t}$ , which we will give an interpretation as the book-to-market ratio of the establishment. Hence our theory describes the cross-section of size and value firms, a familiar theme in the empirical asset pricing literature.

### 4.1 No Discount Rate Wedge

First, we consider the benchmark case in which the manager and the owner are equally impatient ( $\rho_m = \rho_o$ ). The promised utility state variable can be replaced by the running maximum of the productivity process:  $\hat{A}_{max,t} = \max\{\hat{A}_\tau, \tau \leq t\}$ . We let  $T$  denote the random stopping time when

the establishment is shut down:

$$T = \inf\{\tau \geq 0 : \widehat{V}(\widehat{A}_\tau, \widetilde{v}_\tau) = 0\}.$$

**Proposition 4.1.** *Optimal management compensation along a steady-state growth path is determined by the running maximum of productivity:  $\widetilde{c}_t(\widehat{A}_{max,t}) = \max\{c_0, C(\omega(\widehat{A}_{max,t}), \widehat{A}_{max,t})\}$  for all  $0 < t < T$  where the function  $C(\widetilde{v}, \widehat{A})$  is defined such that the implied compensation stream  $\{\widetilde{c}_\tau\}_{\tau=t}^\infty$  delivers total expected utility  $\widetilde{v}_t$  to the manager.*

Management compensation is constant as long as the running maximum is unchanged. The constancy is optimal because of the concavity of the manager's utility function, and arises as long as the participation constraint does not bind. When the productivity process reaches a new high, the participation constraint binds, and the compensation is adjusted upwards. Armed with this result, we can define the owner's value recursively as a function of  $A_t$  and the running maximum  $A_{max,t}$ :

$$\widetilde{V}(\widehat{A}, \widehat{A}_{max}) = \max\left[\widehat{V}(\widehat{A}, \widehat{A}_{max}), 0\right]$$

and

$$\widehat{V}(\widehat{A}, \widehat{A}_{max}) = \widetilde{y} - \widetilde{W}l - R\widetilde{k} - \widetilde{c}(\widehat{A}_{max}) + e^{-(\rho_0 - (1-\gamma)\widehat{g})} \int \widetilde{V}(\widehat{A}', \widehat{A}'_{max}) \Gamma(\varepsilon') d\varepsilon',$$

subject to the law of motion for organizational capital in (3.13) and the implied law of motion for the running maximum.

Figure 1 illustrates the dynamics of the optimal compensation. It plots  $A_t$  on the vertical axis against  $A_{max,t}$  on the horizontal axis. By definition,  $A_t \leq A_{max,t}$ , so that only the area on and below the 45-degree line is relevant. New establishments start with  $A_t = A_{max,t} \geq 1$ . When an establishment grows and this growth establishes a new maximum productivity level, it travels along the 45-degree line. When its productivity level falls or increases but not enough to establish a new record, it travels along a vertical line in the  $(A_{max,t}, A_t)$  space. The region  $[0, 1/\phi]$  for  $A_{max}$  is an *insensitivity region*. Managerial compensation is constant ( $\widetilde{c}_t = c_0$ ) in this region. Wages are constant for small establishments because of the sunk cost. The manager will not leave because his productivity level is insufficient to justify a new sunk cost. To the right of this region, managerial compensation is pinned down by the binding outside option that was 'last' encountered:  $\widetilde{c}(\widehat{A}_{max,t})$ . As long as current productivity stays below the running maximum, the manager's compensation is constant. Along this  $\Delta\widetilde{c} = 0$  locus, the variation in current productivity is fully absorbed by the net payouts to owners, as long as  $A_t$  stays above the  $V = 0$  locus. When productivity falls below this locus, the match is terminated. Every time current productivity exceeds the running maximum, the establishment inches up along the 45-degree line, and managerial compensation increases.

[Figure 1 about here.]

**Growth and Value** In the  $(\widehat{A}_{max,t}, \widehat{A}_t)$ , there is a line with slope  $\phi$  along which the owner's value  $\widehat{V}_t = \widehat{S}$  is constant. This is the locus of pairs for which  $\widehat{A}_t = \phi \widehat{A}_{max,t}$ . On this locus, the existing establishment pays the same compensation as a new establishment that hires its management and it has the same productivity:

$$\widehat{V} \left( \phi \widehat{A}_{max,t}, \omega_t(\widehat{A}_{max,t}) \right) = \widehat{S}, \quad (4.1)$$

This means that the firm's market-to-book ratio, or average q ratio, on this line is given by:

$$q = 1 + \frac{\widehat{V}(\widehat{A}_t, \widehat{A}_{max,t})}{\widehat{k}_t(\widehat{A}_t)} = 1 + \frac{\widehat{S}}{\widehat{k}_t(\widehat{A}_t)}$$

This suggests a natural interpretation of the ratio of current productivity relative to the running maximum as an indicator of the market-to-book ratio. Compare two establishments with the same size  $A_t$ . The establishment with the lower ratio of  $A_t/A_{max,t}$  has the same physical capital stock  $k_t(A_t)$ , but higher (current and future) managerial compensation. This is because the manager is compensated for the best past performance, which is substantially above current productivity. Hence,  $\widehat{V}(\widehat{A}_t, \widehat{A}_{max,t})$  is lower. These low  $A_t/A_{max,t}$  firms have a low market-to-book ratio  $1 + \widehat{V}/k$ . They are *value* firms. High  $A_t/A_{max,t}$  firms are growth firms. In Figure 1, firms with the same market-to-book ratio are on the same line through the origin. Value firms are farther from the 45-degree line, growth firms are closer. In Figure 2, which plots the market-to-book ratio on the horizontal axis, value firms are on the left side of the picture. The model provides a link between the book-to-market ratio of a firm and its managerial compensation.

[Figure 2 about here.]

**Organizational Capital as Collateral** The limited portability of organizational capital creates the collateral in the matches necessary to sustain risk sharing. Two extreme cases illustrate this point. In the first case, there is no capital specific to the match and there are no other frictions (Krueger and Uhlig (2005)). The manager can transfer 100% of the organizational capital of the establishment to a future match ( $\phi = 1$ ) and there are no sunk costs ( $S_t = 0$ ). When  $\phi = 1$  in Figure 1, the  $\widehat{V} = \widehat{S}$  line coincides with the 45-degree line. Therefore,  $\widehat{V}_t \leq \widehat{S} = 0$  everywhere. Limited liability then implies that  $\widehat{V}_t = 0$ . Because there is no relationship capital, no risk sharing can be sustained, and the managers earn all the rents from organizational capital. The value of the owner's stake in the organizational capital is zero everywhere. This implies that  $V_t^a = \widehat{K}_t$  and Tobin's q equals one for all  $t$ .

In the second case,  $\phi = 0$ : all of the organizational capital is match-specific (Atkeson and Kehoe (2005)). The insensitivity regions extends over the entire domain of  $\widehat{A}$ . The manager's outside option is constant so that perfect risk sharing can be sustained. In this case, the horizontal axis is the  $V_t = S_t$  line. This means the owners gets all of the rents, which in turn leads to large q ratios.



**Compensation and Payout Dynamics** We use 300-period simulations from a calibrated version of the model to illustrate the dynamics; the details of the calibration are in section 5.2. Figure 3 tracks a single, successful establishment through time. The left panel plots the realized  $(\widehat{A}_{max,t}, \widehat{A}_t)$  values, as in Figure 1. The right panel shows the corresponding time series for productivity (or size)  $\widehat{A}$  (solid line, measured against the left axis) and managerial compensation  $\tilde{c}$  (dashed line, measured against the right axis). Because  $\phi = 0.5$ , the insensitivity regions extends until  $\widehat{A} = 2$ . In that region the compensation is constant. When the establishment size exceeds 2, around period 50, and leaves the insensitivity region, managerial compensation starts to increase in response to increases in  $\widehat{A}$ . The establishment travels along the 45-degree line in the left panel. The manager’s compensation does not track the downward movements in productivity/size that occur between periods 75 and 100. This is the first vertical locus of points in the left panel. The second big run-up in productivity increases the manager wage once more. Eventually, when the productivity level drops below the lower bound  $\underline{A}(v)$ ,  $V = 0$ , the match is dissolved, and the worker switches to a new match. This endogenous break-up is indicated by an arrow. A new match start off at productivity level  $max(\phi\widehat{A}, 1)$ . This match only lasts for about 20 periods because of poor productivity shock realizations. The third match on the figure lasts longer, but the establishment never leaves the insensitivity region, so that wages are constant.

[Figure 3 about here.]

Figure 4 compares the managers payouts  $\tilde{c}$  (left panel) and the owner’s payouts  $\tilde{\pi}$  (right panel) for the same history of shocks as the previous figure. The left panel is identical to the right panel in Figure 3. The key message of the figure is that the owner’s payouts are more sensitive to productivity shocks than the manager’s compensation. The dashed line in the right panel is more volatile than the dashed line in the left panel. In the insensitivity region, the owner bears all the risk from fluctuating productivity. In addition, whenever the productivity level falls below the running maximum, the owner’s payouts (profits) absorb the entire decline in output. This is because the (essentially risk-neutral) owner provides maximal insurance to the risk averse manager.

[Figure 4 about here.]

## 4.2 Discount Rate Wedge

In this benchmark case, managerial compensation does not respond to *decreases* in firm size and productivity. Hence, the management is completely ‘entrenched’. In the quantitative section of the paper, we consider a less extreme version, by allowing for a wedge between the discount rates of the management and the owners. In particular, we consider the case in which the manager discounts cash flows at a higher rate than the owner ( $\rho_m > \rho_o$ ). This is the relevant case when the manager faces binding borrowing constraints, has a lower willingness to substitute consumption over time, or simply has a higher rate of time preference.

We let  $t_{max}$  denote the random stopping time that indicates when the participation constraint was last binding:

$$t_{max} = \sup\{T > \tau \geq 0 : \omega(\widehat{A}_\tau) = \widetilde{v}_\tau\}.$$

**Proposition 4.2.** *Optimal management compensation evolves according to:  $c_t = c(\widehat{A}_{t_{max}})e^{-\gamma(\rho_m - \rho_o)(t - t_{max})}$  for all  $0 < t < T$ . We define  $c(\widehat{A}_{t_{max}})$  such that  $\{\widetilde{c}_\tau\}_{\tau=t_{max}}^\infty$  delivers total expected utility  $\omega(\widehat{A}_{t_{max}})$  to the manager.*

The additional state variable is a discounted version of the running maximum; it depreciates at a rate that is governed by the rate of time preference gap between the manager and the owner. In the absence of binding participation constraints, managerial compensation  $c$  grows at a rate smaller than the rate of value-added on the steady-state growth path. Put differently, whenever the current productivity of the establishment declines below its running maximum, the manager's scaled compensation  $\widetilde{c}$  drifts down. Management is less 'entrenched'. The left panel of Figure 4 illustrates this downward drift, for example between periods 150 and 200. This compensation structure further front-loads management compensation and further *back-loads* the owner's payoffs. Therefore it increases average payouts to the owner.

[Figure 5 about here.]

## 5 The IT Revolution: Transition Experiment

### 5.1 Constant Cost of Capital Transition

We model the IT revolution as a gradual increase in general (disembodied) productivity growth  $g_z \uparrow$ . The arrival of this general purpose technology increases productivity growth for all establishments regardless of vintage. To keep the analysis tractable, we assume that the total productivity growth rate of the economy  $g_t$  is constant at its initial *steady-state growth path* value:<sup>7</sup>

$$g = ((1 + g_{t,z})(1 + g_{t,\theta})^{1-\nu})^{\frac{1}{1-\alpha\nu}}. \quad (5.1)$$

Holding fixed  $g$ , the increase in  $g_z$  corresponds to a decrease in the rate of depreciation of organizational capital  $\widehat{A}$  in the stationary version of the model:  $g_\theta \downarrow$ . One interpretation is that IT allows existing firms in traditional industries to remain competitive, and grow larger. Their organizational capital depreciates less quickly now than thirty years ago.

In Figure 1, a lower  $g_\theta$  has two distinct effects. First, it reduces the rate at which  $\widehat{A}_t$  drifts down along a vertical line. Second, it shifts more probability mass to higher realizations of  $\widehat{A}_{max}$ . So, a decrease in  $g_\theta$  shifts more probability mass closer to the 45-degree line, and more mass in the northeast quadrant. The IT revolution creates larger establishments and more of them are

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<sup>7</sup>First, there is little evidence that the last 35 years have seen higher average GDP growth  $g$  than the 35-year period that preceded it. Second, changing GDP growth along the transition path is computationally challenging.

*growth* rather than *value* firms. The increased importance of growth firms seems consistent with the evidence.

Establishments accumulate more organizational capital and are longer-lived in the new steady state. Because more establishments will grow larger, the managers' outside option constraint will bind more frequently. This increases the sensitivity of pay to performance. In addition, the arrival of more large establishments increases the back-loading of the owner's payouts. This raises the owner's average payouts in the cross-section as a fraction of output. Managerial compensation is more front-loaded.

We study the transition between a low and a high general-purpose innovation growth path. At  $t = 0$ , agents know the entire future path for  $\{g_{t,\theta}\}_{t=0}^T$ , although the arrival of the GPT itself at  $t = 0$  is not anticipated at  $t = \dots, -2, -1$ . Appendix C defines the constant discount rate transition. It also explains the reverse shooting algorithm we use to solve for the entire transition path. This is a non-trivial problem because we need to keep track of how the cross-sectional distribution of  $(A, v)$  evolves. We then simulate the economy forward for a cross-section of 5,000 establishments, starting in the initial steady state. We assume the change in the relative importance of growth rates is accomplished in 20 years. However, the economy continues to adjust substantially afterwards on its way to the final steady state. Figure 6 summarizes these transitional dynamics. These dynamics are similar to what we will document in the data in Section 6. Even though we compute a constant cost-of-capital transition, all important aggregate variables, such as log TFP, vary along the transition path. Interestingly, the model generates slow productivity growth in the 1970s and faster growth in the 1980s and 1990s (last panel of Figure 6).

[Figure 6 about here.]

## 5.2 Benchmark Parameter Choices

In order to assess its quantitative implications, we calibrate the model at annual frequency. Table 1 summarizes the parameters.

**Production Technology and Preferences** The parameter  $\nu$  governs the decreasing returns to scale at the establishment level. It is set to .75, at the low end of the range considered by Atkeson and Kehoe (2005). The other technology and preferences parameters are chosen to match the depreciation, the average capital-to-output ratio and the average cost of capital for the US non-financial sector over the period 1950-2005. The depreciation rate  $\delta$  is calibrated to .06 based on NIPA data. Next, we calibrate the Cobb-Douglas productivity exponent on capital,  $\alpha$ . Because there is no aggregate risk, the rate of return on physical capital is deterministic in the model. In equilibrium, that rate equals the discount rate. Both are fixed along the transition path. From the Euler equation for physical capital, we get:

$$r = (1 - \tau_c) \left( 1 - \delta + \alpha \nu \frac{Y}{K} \right)$$

We compute the cost of capital  $r$  in the data as the weighted-average realized return on equity and corporate bonds; it is 5.5%. The weights are given by the observed leverage ratio. The average corporate tax rate  $\tau_c$  is 28%. The average capital-to-output ratio is 1.77. The above equation then implies  $\alpha\nu = 0.23$ . As a result,  $\alpha = 0.30$ . Appendix D provides more details.

We chose the rate of time preference of the owner  $\rho_o = .02$  such that his subjective time discount factor is  $\exp(-\rho_o) = .98$ . In our benchmark results, we assume that the manager is less patient:  $\rho_m = .03$ . Finally, we choose a coefficient of relative risk aversion  $\gamma = 1.6$ . This is the value that solves equation 3.8 given our choices for  $r$ ,  $\rho_o$ , and given the average growth rate of real aggregate output of  $g = 0.022$ .

[Table 1 about here.]

**Organizational Capital Accumulation and Transfer Technology** To calibrate the organizational capital accumulation, its portability, and the sunk costs of forming a new match, we match the excess job reallocation rate and the firm exit rate in the old steady state to those observed in the data in 1970-74, and we match the increase in managerial wage inequality to that in the data. The data are described in Section 6 below.

Following Atkeson and Kehoe (2005), we assume the  $\varepsilon$  shocks are log-normal with mean  $m_s$  and standard deviation  $\sigma_s$ . We abstract from the dependence on these parameters on the vintage  $s$ . For parsimony, the mean  $m_s$  is set zero. However, younger matches (lower  $s$ ) will grow faster in equilibrium because of selection, even without age-dependence in  $m_s$ . The standard deviation  $\sigma_s = \sigma$  of these shocks is chosen to generate an excess job reallocation rate of 19% in the initial steady state. This choice matches the 1970-74 reallocation rate in the data. The size of the sunk cost ( $S$ ) is chosen to match the entry-exit rates in the initial steady state. The sunk cost is equal to 6.5 times the annual cash flow generated by the average firm. This delivers an entry/exit rate of 4.3% in the initial steady-state, again matching the 1970-74 data. The portability or match-specificity parameter  $\phi$  governs the increase in wage dispersion in the model. We set it equal to 0.5, which means that 50% of organizational capital is transferable to a next match. This value matches the increase in intra-industry wage inequality described below.

**Productivity Growth Composition** In the baseline experiment, we assume the change in the composition of growth to  $g_{new,z}$  occurs over 20 years, and we assume it starts in 1971. After 20 years, in 1990, productivity growth settles down at  $(g_{new,z}, g_{new,\theta})$ . The actual transition to a new steady-state growth path takes much longer. The change in the composition of growth is calibrated to match the decline in reallocation rates in the data from 19% to 11%. General productivity growth increases from  $g_{old,z} = 0.3\%$  in the initial steady state to  $g_{new,z} = 1.45\%$  in the new steady-state. Correspondingly, vintage-specific productivity growth decreases from  $g_{old,\theta} = 5.5\%$  to 0.8%.

### 5.3 Main Results: Compensation and Size Distribution

We are now ready to describe the main results from our transition experiment. We start by comparing the size and compensation distribution in the initial and final steady states, as well as its evolution during the transition. Next, we trace out the dynamics of key aggregates such as the payout share.

Figure 7 illustrates how a relatively modest change in the size distribution of firms, brought about by a change in the composition of productivity growth, translates in a much larger change in the distribution of compensation. The left panel plots the log compensation of managers ( $\log \tilde{c}$ ) against the log of establishment size ( $\log \hat{A}$ ) in the initial steady-state growth path of the model. The right panel shows the new steady state, after the adoption of IT is complete. Each dot represents one establishment in the cross-section. The key to the amplification is the compensation contract. Because of the sunk cost, the optimal contract features a lower bound on size below which the skilled wage does not respond to changes in size. Above a certain size, the manager's compensation only responds to good news about the establishment's productivity. In the old steady state, few establishments become large enough to exceed the insensitivity range. Managerial compensation hardly responds to changes in size; there is little cross-sectional variation in managerial compensation in the left panel. In the initial steady-state, the kurtosis of log size is 1.92, while the skewness is .02. The right panel shows that this is no longer true in the new steady-state. Establishments live longer on average and the successful ones grow larger. The log size distribution is more skewed than in the initial steady-state. The figure shows a strong positive cross-sectional relationship between size and managerial compensation. Thus, the model endogenously generates a shift from low-powered to high-powered incentive compensation contracts.

[Figure 7 about here.]

The distribution of managerial compensation has much fatter tails than the size distribution, as shown in Figure 8. Its left panel shows the histogram of log compensation in the new steady state; the right panel is the histogram of log size. Both were demeaned. The distribution of managerial compensation is more skewed and it has fatter tails than the size distribution. The kurtosis of log compensation is 19.82, compared to 3.38 for log size. The skewness is 3.81 for log compensation, compared to .47 for log size.

[Figure 8 about here.]

There is a large finance literature that studies compensation for top managers (e.g., Frydman and Saks (2006) and Kaplan and Rauh (2007)). Gabaix and Landier (2008) and other studies have documented that managerial compensation is well-described by a power function of size, a finding referred to as *Roberts' law*. In our model too, the compensation distribution has much fatter tails than a log-normal. On average, the relation between compensation and size in the new steady state satisfies  $\log \tilde{c} = \alpha + \kappa \log \hat{A}$ . The slope coefficient  $\kappa$  is .24 in the new steady-state, similar to

what is found in the empirical literature. Our model therefore not only provides a rationale for the large and skewed increase in managerial compensation, but is also quantitatively consistent with the observed size-compensation distribution.

Our model also has implications for the size distribution of firms. Luttmer (2005) and others show that the size distribution for *large* firms follows a Pareto distribution. The same is true for the large firms in our new steady-state. Figure 9 shows that the relation between log rank and log size is linear for large establishments. Quantitatively, the slope of that relationship is somewhat too steep compared to the data with a Pareto coefficient around -1.5 instead of -1. For small firms, the relationship is less steep, a finding reminiscent of the city-size literature.<sup>8</sup>

[Figure 9 about here.]

Table 2 reports the impact of the change in the composition of growth on the distribution of compensation and productivity. The log of establishment productivity (TFP) is given by  $(1 - \nu) \log \hat{A}$ . The log of the manager’s wage is given by  $\log \tilde{c}$ . The left panel reports the cross-sectional standard deviation, *IQR*, and *IDR* for log wages; the right panel does the same for log TFP. The first (last) line shows the values in the initial (final) steady-state. The numbers in between are five-year averages computed along the transition path. Small changes in the productivity (or size) distribution cause big changes in the distribution of compensation. The standard deviation of managerial compensation increases by 7.3 percentage points in the first 35 years of the transition, similar to what we reported for the increase in within-industry wage dispersion in the data.<sup>9</sup> In the next ten years from 2006-2015, the standard deviation of log wage dispersion is predicted to increase by another 4.5 percentage points and the *IDR* by as much as 11.5 percentage points.<sup>10</sup> In sum, the shift towards high-powered incentives leads to a substantial increase in income inequality.

The increase in productivity dispersion that generate this explosion in compensation inequality is rather modest. The standard deviation increases by only 1.5 percentage points in the first 35 years of the transition. The *IQR* for increases from 18.3 to 18.4% and the *IDR* from 29.2 to 31.8% over the same period. Overall, productivity dispersion in our model is somewhat smaller than what is found in the data. Using 1977 US manufacturing data at the 4-digit industry level, Syverson (2004) reports a within-industry *IQR* of log TFP between 29 and 44%. Increasing log TFP dispersion in the model would give rise to too much reallocation, absent other frictions.

[Table 2 about here.]

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<sup>8</sup>While Gabaix (1999), Rossi-Hansberg and Wright (2006), and others find that the city-size distribution has a Pareto distribution, Eeckhout (2004) argues that it is log-normal. The discrepancy comes from the fact that Eeckhout studies all “places” (including the smallest towns), whereas the others focus only on (much larger) cities. Our model has a firm-size distribution with similar characteristics. We follow Gabaix and Ibragimov (2007) who argue to estimate the Pareto coefficient  $b$  from a regression of the form  $\log(\text{Rank}-1/2) = a - b \log(\text{Size})$ .

<sup>9</sup>In the model, unskilled wages are equalized across establishments and do not affect the dispersion.

<sup>10</sup>In the new steady-state, compensation becomes very skewed: the *IDR* increases so much that the *IQR* actually decreases.

## 5.4 Main Results: Payout Shares and Valuation Ratios

Table 3 summarizes the other main aggregates of interest. The first column shows the excess job reallocation rate. We calibrated the shift in the composition of productivity so as to match the initial steady-state value of 19% as well as the subsequent decline to 12.2% over the ensuing 35 years. The model successfully matches the decline in entry/exit rate (on a steady-state growth path those are identical). The exit rate starts from 4.3% (chosen to match the sunk costs) and declines to 3.0% by 2001-05. In the data, it declined from 4% to 2.5%. The exit rate is highest in the first ten years of the transition because there is a shake-out of establishments that are no longer profitable under the increased managerial compensation.

[Table 3 about here.]

The third column shows that our model generates a 7% increase in the net payout share, an important and new stylized fact we document in Section 6. The NPS increases gradually from 3.3% in the initial steady state to 10.3% in the early 2000s, tracking the data. The model generates this increase in average payouts because some firms become larger than before, which increases the back-loading of payments to the owners. When computing average payouts, we are only sampling from survivors. The gross payout share in the fourth column, which adds in depreciation of physical capital, shows a similar increase.

The last three columns of Table 3 report valuation ratios. As establishments start to live longer and accumulate more organizational capital, the aggregate value of organizational capital starts to increase. This is the same selection effect: We are only sampling the survivors when computing the market value of matches. Correspondingly, Tobin's  $q$  increases from 1.4 in 1971-75 to 1.6 in 2001-05 (Column 5). The value of organizational capital as a fraction of value-added  $(V_t^a - K_t)/(Y_t - S_t^a)$  increases from 0.83 to 1.18, a 42% increase (Column 6). The increase in the data from 1.54 to 2.41 represents a 45% increase (See Section 6).

Managerial workers capture only part of this increase in organizational rents because of the sunk costs and limited portability of organizational capital. The sunk costs create an insensitivity range in which managerial compensation does not respond to productivity shocks. In addition, the discount rate wedge imputes a downward drift to the managerial compensation. As matches live longer, managers end up with a smaller share of the surplus. This is consistent with the findings of Lustig and Van Nieuwerburgh (2007), who document a negative correlation between innovations to future cash flow growth for financial (owners) and human wealth (managers). The managerial wealth-to-output ratio  $(M^a/(Y - S^a))$  declines from 8.3 to 7.2% (Column 7). The model thus implies a large transfer of wealth from the managers to the owners.

Figure 10 shows an enormous amount of heterogeneity in the evolution of managerial wealth to value-added  $(M/(Y - S^a))$ , echoing the increase in managerial compensation dispersion documented earlier. We sorted all managers by their final steady-state  $M/(Y - S^a)$ -ratio. Managers in the 95<sup>th</sup> percentile saw a large *increase*, managers in the 90<sup>th</sup> percentile maintained the status quo, while

all other managers (especially those in the smaller establishments) suffered a decline in wealth. Managers in the 5<sup>th</sup> see their wealth decline from 8 to 6.5 times (per capita) value added.

[Figure 10 about here.]

## 5.5 Stock Market Sampling Bias

The increase in aggregate Tobin's  $q$  generated by the model is smaller than in the data. This could partially be due to a reduction in the cost of capital during that period that we deliberately abstract from (Jagannathan, McGrattan and Scherbina (2000)). However, it is possible that the data overstate the increase in Tobin's  $q$ . Our model helps us understand this potential bias. Table 4 shows the cross-sectional distribution of Tobin's  $q$ , where establishments were sorted by market value. In the 95<sup>th</sup> percentile, market values increased from 1.94 to 2.48, an increase of 29%. In the 10<sup>th</sup> percentile, the increase is only 6%.

The Flow of Funds (FoF) computes the market value of all equities outstanding as the value of all common and preferred stock for firms listed on the NASDAQ, the NYSE, AMEX, and other US exchanges plus the *FOF estimate* of closely held shares.<sup>11</sup> This FoF estimate effectively imputes the returns on the publicly traded firms to non-traded firms. Because publicly traded firms are much more likely to be drawn from the 95<sup>th</sup> than the 10<sup>th</sup> percentile of the entire firm distribution, the imputation procedure may overstate the increase in Tobin's  $q$ . Put differently, the stock market over-samples larger establishments because of selection.

[Table 4 about here.]

## 5.6 Robustness

**Different Portability** The degree of portability  $\phi$  governs several key aspects of the model. WE studied both a higher value ( $\phi = .75$ ) and a lower value ( $\phi = 0$ ) than our benchmark case ( $\phi = .50$ ). When we lower the portability parameter  $\phi$  from .5 to 0, the model no longer generates any increase in managerial compensation. Indeed, the managers are fully insured and the owners capture all organizational rents. The owners' initial net payout share is much higher (8% versus 3.3%). The IT revolution leads to a larger increases in the owners' wealth  $V^a$  relative to value-added, and higher aggregate valuation ratios: Tobin's  $q$  goes up from 1.40 to 1.76. This increase is almost twice as big as in the benchmark case. In sum, the predictions for valuation ratios improve, but the predictions for wage dispersion are counter-factual.

In contrast, increasing  $\phi$  to a value of 0.75 gives managers more ownership rights to organizational capital. As a result, not only is initial income dispersion higher (the standard deviation of log wages is 9.6% instead of 0.9% in the initial steady-state), the increase in dispersion is also higher. The standard deviation increases by 14.9, the IQR by 8 and the IDR by 42 percentage

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<sup>11</sup>It also subtracts the market value of financial companies and the market value of foreign equities held by US residents.



points from the initial situation to 2001-05. These increases are much larger than in the benchmark case and fit the increase in *managerial* income inequality in the data better. Figure 11 summarizes the pronounced shift towards high-powered incentives. Some other desirable features of the  $\phi = .75$  calibration are that (i) Robert's coefficient, which measures the elasticity of managerial compensation to firm size, is 0.32, exactly matching the data, and (ii) the Pareto coefficient of the firm size distribution is -1.05, also very close to empirical values that are estimated around 1. The only downside is that the increase in valuation ratios is only half as big as in the benchmark case.

[Figure 11 about here.]

**No Discount Rate Wedge** We also solved a calibration where the owner and manager share the same subjective time discount factor  $\rho_o = \rho_m$ . Making the manager more patient reduces the back-loading effect and therefore reduces the value accumulation to the owner. The top panel of Table 5 shows that the model with no wedge can still generate an increase in compensation inequality, albeit a smaller one. The increase in the net payout share is also mitigated; the model generates a 3.6% increase over the last 30 years (bottom panel). Conversely, the effects are stronger for a higher discount rate wedge (2%). Overall, the effects of the discount rate wedge are quantitative, not qualitative in nature.

[Table 5 about here.]

**A Decline in Idiosyncratic Volatility** The increase in valuation ratios in the data suggests that a simpler model, based on a decline in the volatility of shocks to firm productivity  $\sigma$ , cannot account for the facts. Because an establishment's operations are discontinued when the match has no value ( $V \geq 0$  in equation 3.4), it has an option-like structure. A decrease in volatility would reduce the value of the option, and therefore reduce valuation ratios. Our explanation features this increase in valuation ratios.

**A Rise in Portability** Frydman and Saks (2006) argues that general skills became more important for managers, and provides this as a potential explanation for the rise in executive pay. To the extent that this is also true for the broader group of managers we study, such an effect could be modeled as an increase in the transferability of organizational capital,  $\phi$ . An increase in  $\phi$  would lead to less risk-sharing over time and a higher compensation elasticity with respect to size. Since more of the organizational rents would go to the manager, the net payout share and firm valuation ratios would increase by less. Finally, an increase in  $\phi$  would lead to more firm exit and more labor reallocation. The decreasing reallocation and exit rates and the strong increase in owner's payouts and  $q$  suggest that a decline in  $\phi$  cannot be the whole story.

## 6 Supporting Evidence from Data

Finally, we provide supporting evidence from the data. Several of the model’s parameters we chosen to match moments of the data we describe below. This is true for the decline in job reallocation, the increase in wage dispersion, and the initial exit rate. All other data moments constitute over-identifying restrictions implied by the model. Most notably, these are the facts on the dynamics of the net payout share, on the elasticity of managerial compensation to size, on the firm size distribution, and on the dynamics of the exit rate.

### 6.1 Intra-Industry Wage Dispersion

We provide three sources of data, all of which document a large increase in wage inequality. The first and broadest measure studies wages of all workers. The data are from the Quarterly Census of Employment and Wages (QCEW) collected by the Bureau of Labor Statistics (BLS). The unit of observation is an establishment, and the data report the average wage. We calculate the within-industry wage dispersion from a panel of 55 2-digit SIC-code industries, and average across industries. Panel A of Table 6 shows that the cross-sectional standard deviation of log wages increased by 7.3, the inter-quartile range by 5.4, and the inter-decline range by 14.7 percentage points between 1975-1979 and 2000-2004.<sup>12</sup>

The second body of evidence comes from managerial wages. While our model has implications for overall wage inequality, managerial data arguably provide a cleaner match. We use wage income data from the March Current Population Survey and select only workers in managerial occupations (See Appendix A.6). Panel B of Table 6 shows that in this sample, the cross-sectional standard deviation of log wages increased by 9.4, the inter-quartile range by 11.3, and the inter-decline range by 19.6 percentage points between 1975-1979 and 2000-2004. Hence the increase in managerial compensation is more pronounced than for the population at large.

[Table 6 about here.]

The third and most narrow measure focusses on the top of the compensation scale. Frydman and Saks (2006) documents a strong increase in executive compensation. They measure total compensation (salaries, bonuses, long-term bonus payments, and the Black-Scholes value of stock option grants) for the three highest-paid officers in the largest 50 firms in 1960 and 1990. Panel C of Table 6 shows a spectacular increase in the dispersion of top managers’ pay.<sup>13</sup> Since the mid-1970s, the inter-quartile and inter-decile range of log compensation more than doubled to 1.5 and

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<sup>12</sup>According to Dunne et al. (2004), increasing within-industry, between-establishment wage dispersion accounts for a large fraction of the increase in overall income inequality in the US. This is true especially for non-production workers, which includes managers. They study US manufacturing establishments. Between 1977 and 1988, the between-plant coefficient of variation for non-production worker’s wages increased from 44% to 56%, while the within-plant dispersion actually decreased. They also document an increase in the dispersion of productivity between plants.

<sup>13</sup>We thank Carola Frydman for graciously making these data available to us.

2.6, respectively. The cross-sectional standard deviation increased by 43 log points. The inequality and the increase in inequality are strongest for this group.

## 6.2 Declining Excess Job Reallocation

The excess job reallocation rate is a direct measure of the cross-sectional dispersion of establishment growth rates. It is defined as the the sum of the job creation rate plus the job destruction rate less the net employment growth rate. Before 1990, we only have establishment-level reallocation data for the manufacturing sector. Figure 12 shows that the excess reallocation rate in manufacturing declined from 10.9% in 1965-1969 to 8.4% in 2000-2005, and further to 7.8% between 2006-2007.I. After 1990, the BLS provides establishment-level data for all sectors of the economy. Over the 1990-2007 sample, the excess reallocation rate declined from 10.6 to 7.2% in manufacturing, from 15 to 12.4% in services, and from 15.6 to 12.8% in the entire private sector. Half of this decline is due to a decline in entry and exit rates for establishments, from 4% to 2.5%. The other half is due to a decline in expansions and contractions of existing establishments.

[Figure 12 about here.]

Similar trends have been documented in *firm-level* (rather than establishment-level) data. Davis et al. (2006) document large declines in the dispersion and the volatility of firm growth rates for the US economy, either measured based on employment or sales. The employment-weighted dispersion of firm growth rates declined from .70 in 1978 to .55 in 2001, while the employment-weighted volatility of firm growth rates declined from .22 in 1980 to .12 in 2001. The former measures the cross-sectional standard deviation of firm growth rates, while the latter measures the standard deviation of firm growth rates over time.<sup>14</sup> This decline in volatility is present across sectors.

Finally, Haltiwanger and Schuh (1999) constructs a proxy for establishment-level reallocation by studying intra-industry *job flows*. This is the only series that is continually available for our sample period. The excess reallocation rate for the non-financial sector declines from 19% in 1960 to an average of 11.5% in 2000. This 19-11.5% change is what we calibrate to in our benchmark model.

## 6.3 Corporate Payouts

The previous section showed that our model generates a 7.7% increase in the net payout share, following the IT revolution. This section measures the payout share for the aggregate corporate (non-farm, non-financial) sector in the US, and shows that the data show the same size increase.

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<sup>14</sup>Comin and Philippon (2005) show that there is an increase in volatility for the subsample of publicly traded firms. Our analysis is for the entire non-financial sector, publicly-traded and privately-held. The discrepancy between the findings for public and for all firms may have to do with private firms that go public earlier. The IPO decision is outside of our model.

### 6.3.1 Measuring Corporate Payouts

In our model, corporations issue shares which are claims to the physical capital stock. The model abstracts from the decomposition of corporate liabilities into equity and debt because the Modigliani-Miller theorem applies. In the data, corporations issue both equity and debt, and they may purchase financial assets. The aggregate value of corporations is the sum of the value of all securities issued by these corporations **less** the value of financial assets (Hall (2001)). We use  $V_t^a = p_t s_t$  to denote the value of a claim to the aggregate US capital stock at time  $t$ ;  $p_t$  equals the price (per share) of a claim to the US capital stock and  $s_t$  the number of shares. The payouts  $D_t$  to the owners come in two forms: cash (denoted  $D_t^c$ ) and net repurchases ( $D_t^{nr}$ ).

$$D_t = \underbrace{Div_t + Int_t}_{cash} + \underbrace{p_t(s_{t-1} - s_t)}_{repurchases}$$

Cash payments include dividend payments to equity holders ( $Div_t$ ) and interest payments to bond holders and other lenders ( $Int_t$ ). The other payments measure *net* repurchases of shares  $s_t$  at a price  $p_t$ . In the data, this includes net equity repurchases and net debt repurchases. Net equity repurchases are defined as total equity repurchases less issuance of new equity. Net debt repurchases are defined as the change in financial assets less the change in financial liabilities. As in the model, the value of the US corporate sector is the present discounted value of total payouts  $D_{t+j}$ :

$$V_t^a = E_t \sum_{j=0}^{\infty} e^{-\sum_{s=t}^j r_s} D_{t+j},$$

where  $r_t$  is the discount rate.

The stand-in corporation's flow budget constraint links the corporate cash flows to its payouts. The stand-in US corporation at time 0 maximizes its value  $V_0^a$  by choosing gross investment in physical capital  $I_t = K_{t+1} - (1 - \delta)K_t$  and it decides how much labor to hire subject to the flow budget constraint for all  $t \geq 0$ :

$$D_t = Y_t - S_t^a - Comp_t - I_t - Tax_t, \tag{6.1}$$

where  $Y_t - S_t^a$  denotes value-added in the corporate sector,  $Comp_t = W_t L_t + C_t$  denotes the total compensation of unskilled and managerial (or skilled) labor, and  $Tax_t$  denotes corporate taxes.<sup>15</sup> To give an example of how this flow budget constraint works, suppose that the US corporate sector has more internal funds than it invests in a given year  $t$ :  $Y_t - S_t^a - Comp_t - Tax_t - D_t^c > I_t$ . Suppose also that it invests this surplus in the money market. Then its financial assets on the balance sheet increase, this shows up as a net repurchase (net reduction in net financial liabilities), and hence a non-cash payout to securities holders:  $p_t(s_{t-1} - s_t) = D_t^{nc} = Y_t - S_t^a - Comp_t - Tax_t - D_t^c - I_t > 0$ .

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<sup>15</sup>There are no taxes in the model. In the data, we want to compute the payouts to securities holders and hence we take out all the taxes paid by corporations.

We use three different approaches to measure the corporate payout rate. The first one is to measure the payouts directly in the Federal Flow of Funds (Section 6.3.2). The second approach uses the corporate flow budget constraint to back out the corporate payouts from the National Income and Products Accounts (Section 6.3.3). The last measure is based on firm-level data from Compustat (Section 6.3.4).

### 6.3.2 Corporate Payouts in the Flow of Funds

The data to construct our measure of firm value were obtained from the Federal Flow of Funds' flow tables for the non-farm, non-financial corporate sector. The aggregate value of the corporate sector  $V_t^a$  is measured as the market value of equity plus the market value of all financial liabilities minus the market value of financial assets. We correct for changes in the market value of outstanding bonds by applying the Dow Jones Corporate Bond Index to the level of outstanding corporate bonds (which are valued at book values) at the end of the previous year. The payouts  $D_t$  are measured as the sum of dividend payments and interest payments, plus net equity repurchases plus the increase in financial assets less the increase in financial liabilities. The net payout share (NPS) is the sum of net payouts to securities holders divided by gross value-added:

$$NPS_t = \frac{D_t}{Y_t - S_t^a}.$$

Appendix A.1 contains a detailed description of the data construction. Larrain and Yogo (2007) use a similar measure of payouts for the non-financial corporate sector.

Column (1) of Table 7 shows five-year averages for the NPS from these Flow of Funds data. After an initial decline from the second half of the 1960s to the first half of the 1970s, the NPS increases virtually without interruption from 1.7% to 9.4% of value-added over the next three decades, an increase of 7.7 percentage points. This is exactly the increase generated by the model. Our model does not speak to the decomposition of the net payout share. Berk, Stanton and Zechner (2005) investigate the optimal capital structure problem in an optimal contracting model similar to ours. Appendix A.1 shows how the composition of the payout share has evolved, and cites some of the recent literature on this topic.

[Table 7 about here.]

### 6.3.3 Corporate Payouts in the National Income Accounts

Instead of using the Flow of Funds data to get a direct measure of payouts, we can also infer corporate payouts indirectly from the National Income and Product Accounts (NIPA) data. Using the corporate flow budget constraint (6.1), total corporate payouts can be measured as gross value-added for non-financial corporate business minus compensation of employees minus corporate taxes

minus investment. Appendix A.2 contains the details.<sup>16</sup> By dividing the adjusted payouts by value-added, we create the net payout share from NIPA data. The same appendix also shows how to decompose payouts into a cash and a non-cash component based on NIPA data. Column 2 in table 7 lists the five-year average NPS using the NIPA measure. We obtain a similar pattern as in Column 1: After an initial decrease from 3.7% in the last part of the 60's to 2% in the first part of the seventies, the NPS climbs to 7.6% in 2000-2004. The total increase between 1970-74 and 2000-2004 is about 5.6 percentage points. Figure 13 offers a direct comparison of the 8-quarter moving averages of the NPS series obtained from NIPA data (dashed line) and from the FoF (solid line). The figure shows that both measures display the same pattern in aggregate corporate payouts over the last 40 years.

[Figure 13 about here.]

We also compute the gross payout share share (*GPS*) of the non-financial corporate sector. The numerator adds the consumption of fixed capital  $\delta K_t$  to the payouts  $D_t$ :

$$GPS_t = \frac{(D_t + \delta K_t)}{Y_t - S_t^a} = \frac{Y_t - S_t^a - Comp_t - Tax_t - (I_t - \delta K_t)}{Y_t - S_t^a}.$$

Columns 3 and 4 of Table 7 show that, after an initial decrease, the GPS increases from 11.5% in 1970-74 to 22.3% in 2000-04 with FoF data. With NIPA data, the increase is from 11.8% to 20.5%.

### 6.3.4 Corporate Payouts in Compustat

As a third measure, we used Compustat's data and aggregate firm-level payouts to compute aggregate payouts. Since we do not have value-added data for the firms in Compustat, we define a net payout ratio *NPR* as:

$$NPR_t = \frac{D_t}{Comp_t + D_t}.$$

Appendix A.3 contains the details on measurement. In Columns (2) and (4) of Table 8 we use Compustat information on labor and retirement expenses to form  $Comp_t$ . Since this information is missing for many firms, we alternatively compute  $Comp_t$  as the product of the number of employees from Compustat (which is available for most firms) and the average wage per job from the Bureau of Labor Statistics in the industry the firm operates in. The corresponding NPR measures start in 1976 and are reported in Columns (3) and (5). Columns (2) and (3) are NPR measures that include net debt repurchases, while Columns (4) and (5) exclude them. The latter measures are useful because the net debt repurchase series from Compustat are highly volatile. All four series in Columns (2)-(5) show a 5-7% increase in the NPR between 1975-79 and 2000-04. This is somewhat

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<sup>16</sup>To make the NIPA payouts comparable to the Flow of Funds payouts, we add foreign earnings retained abroad and net capital transfers (both from the Flow of Funds) to the NIPA payouts. The reason is that the FoF series contains these foreign payouts, whereas the NIPA measure does not. Whether earnings are retained abroad or at home does not matter for investors in US corporations.

smaller than the 10.8% increase in the NPR rate in the Flow of Funds data, which is reported in Column (1) for comparison. However, the increase is still substantial. The Compustat NPR measures are much higher than the NPR from the FoF. In the Compustat data, we cannot **net out** payments among firms in the non-financial corporate sector. In addition, Compustat only covers large firms. Finally, we do not have data on IPOs, which should be counted as new issuance of equities in total payouts. The Flow of Funds data does take all these issues into account. However, the secular change we documented in NIPA and FoF data also arises in the Compustat data.

[Table 8 about here.]

## 6.4 Measuring Valuation

The increase in the payouts to securities holders over the last 30 years coincided with a doubling of Tobin’s average  $q$  and the value-output ratio. Tobin’s  $q$  is measured as the market value of US non-financial corporations, constructed from the Flow of Funds data divided by the replacement cost of physical capital:

$$q_t^a = \frac{V_t^a}{K_t}.$$

We construct the replacement cost of physical capital using the perpetual inventory method with FoF investment and inventory data (see Appendix A.1). The first column in Table 9 shows that Tobin’s  $q$  decreased from 2.0 in the 1965-1969 period to 1.0 in the 1975-1979 period. After that, it gradually increases to 2.6 in the 1995-1999 period and then it levels off to 2.3 and 2.0. The value-output ratio for the US corporate sector, reported in Column 2, is computed as the ratio of  $V_t^a$  to gross value-added  $Y_t$ . It tracks the evolution of Tobin’s  $q$  almost perfectly. The third column reports the ratio of net payouts to the value of the corporate sector,  $D/V^a$ ; its is the net payout yield of the (non-financial) corporate sector.

The table shows that the value of US corporations per unit of physical capital has more than doubled since the late seventies. As a result, the measured increase in payouts to the owners of US corporations over the same period (third column) cannot be explained as merely compensation for physical capital. Rather the increase in valuations seems to be linked to the increase in payouts due to the accumulation of organizational capital rather than physical capital.<sup>17</sup>

[Table 9 about here.]

## 6.5 Evidence from the Cross-Section

Our analysis so far focused on the time-series relationship between the composition of productivity growth and the payout share, reallocation rate, and Tobin’s  $q$ . In the model, these same relation-

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<sup>17</sup>Likewise, the increase in Tobin’s  $q$  cannot be explained solely by a decrease in taxes. Indeed, in a model without organizational capital and no adjustment costs, Tobin’s  $q$  is always one. In a world with reasonable adjustment costs, a decrease in taxes could increase Tobin’s  $q$  above one, but only temporarily. Finally, the large deviations of Tobin’s  $q$  from one occur in the second half of the sample when the average tax rate is slightly *increasing*.

ships hold in the cross-section. We investigate now in the data whether the same relationships hold in the cross-section of industries. The empirical relationships we uncover are supportive of the main mechanism in the model.

We identify high vintage-specific growth industries as those with high reallocation rates. The key question then becomes whether industries characterized by high vintage-specific growth have lower payout and valuation ratios.<sup>18</sup> We build a panel of 55 industries at the 2-digit SIC level covering the 1976-2005 sample. The payout data are from Compustat. The employment data are from the QCEW program (see Appendices A.3 and A.5 for details). As before, we exclude the financial sector. To gauge the effects of reallocation on payout ratios in the cross-section of industries, we estimate fixed-effects regression of the payout ratios on the reallocation rates, excess reallocation rates and the reallocation rates interacted with the ratio of intangibles to physical capital (property, plants and equipment). Table 10 lists the results from four different specifications. In Column (1) we use the excess reallocation rate (*EREALL*), in Column (2) we use the reallocation rate (*REALL*), which is measured as the sum of job creation and job destruction rates. We find that payout ratios tend to be lower when the reallocation rates are higher, and they tend to decline, when the reallocation rates increase, consistent with the theory. These results are statistically significant and quite robust across different specifications and samples. On average, a one standard deviation increase in the reallocation rate in an industry decreases the payout ratio by about 1.8 percentage points. In Columns (3) and (4) we interact the reallocation effect with the ratio of intangibles to plants, property and equipment (*INTAN*). Intangibles are a proxy for the organization-capital intensity of an industry. The effect of reallocation on payout ratios is much *larger* in industries with more intangible assets.

[Table 10 about here.]

We also examined the cross-sectional relationship between reallocation and the average Tobin's  $q$  in the same panel of 55 industries. Table 11 reports the results. We use two different measures for the average Tobin's  $q$  in each industry. The first measure (Columns 1 and 2) uses total assets less financial assets at book value in the denominator. The second measure (Columns 3 and 4) uses the book value of total assets in the denominator. The numerator in both ratios is the market value of the firm. Appendix A.3 provides more details. We find that an increase in the reallocation rate tends to lower Tobin's  $q$ . The results are statistically significant at the 1% level across all four specifications. A one percentage point drop in the reallocation rate increases Tobin's  $q$  by 0.12.

[Table 11 about here.]

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<sup>18</sup>The results of Edmans (2007) empirically suggest a positive relationship between human capital and shareholder value.



## 7 Conclusion

Total payouts received by owners of US non-financial corporations increased from 1.7% of gross value-added in the first half of the 1970s to 9.4% in the first half of the 2000s. In the same period, there has been a marked increase in managerial compensation inequality. This paper argues that both changes can be tied to the information technology revolution and the increases in organizational capital that resulted from it.

In our model, establishments combine organizational capital, physical capital and unskilled labor to produce output. The division of organizational rents between the owner and the manager of the establishment is governed by a long-term compensation contract. The well-diversified owner will offer insurance to the risk averse manager, but this insurance is limited by the manager's ability to leave and by the owner's limited liability. Because the manager can transfer a fraction of the organizational capital to a future employer, the increased accumulation of organizational capital after the IT revolution improves the outside option of successful managers. Optimal managerial compensation increases in response to positive performance. In less productive, unsuccessful firms, compensation does not change. Together they account for the increase in compensation inequality. The owner's payouts are optimally more sensitive to performance than the manager's compensation. Put differently, the owner receives a small fraction of the payouts from small, unsuccessful establishments, but a large fraction of the organizational rents generated by large successful establishments. The IT revolution generates more heterogeneity in firm performance and therefore more risk to the owner. The owner's payouts correspondingly increase. Additionally, the model generates an increase in firm valuation relative to the physical capital or to output, which reflects the higher value of organizational capital. It is also broadly consistent with trends in labor reallocation, the firm size distribution, and firm exit and entry.

More broadly, this paper attempts to study the macro-economic implications from technological change. We have shown that the interaction of micro-level frictions in compensation contracts and a change in productivity growth prompted by the IT revolution can go a long way towards accounting for several macro trends in the data. Simultaneously, the model has implications for the cross-sectional distribution of size, book-to-market, productivity, and wages at the establishment-level. Several of these implications deserve further study.

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# A Data Appendix

## A.1 Using Flow of Funds Data

The computation of firm value returns is based on Hall (2001). The data to construct our measure of returns on firm value were obtained from the Federal Flow of Funds, henceforth FoF.<sup>19</sup> We use the (seasonally-unadjusted) flow tables for the non-farm, non-financial corporate sector, in file UTABS 102D. We calculate the market value of the corporate sector  $V^a$  as the market value of equity (item 1031640030) plus net financial liabilities. Net financial liabilities are defined as financial liabilities (item 144190005) minus financial assets (item 144090005). Because outstanding bonds (a part of financial liabilities) are valued at book value, we transform them into a market value using the Dow Jones Corporate Bond Index. We construct the levels from the flows by adding them up, except for the Market Value of Equity. This series is downloaded directly from the Balance series BTABS 102D. (item 103164003).

Net (aggregate corporate) pay-outs is measured as dividends (item 10612005) plus the interest paid on debt (from the NIPA Table 1.14 on the Gross Product of Non-financial, Corporate Business, line 25) less the net issuance of equity (item 103164003) less the increase in net financial liabilities (item 10419005).

The same NIPA Table 1.14 is used to obtain gross value-added (line 17),  $Y_t - S_t^a$ .

Finally, capital expenditures (item 105050005) are obtained from the Flow of Funds.

Tobin's  $q$  for the non-financial sector is constructed as the ratio of the market value of the corporate sector  $V^a$  and the replacement cost of physical capital ( $K$ ). We construct the replacement cost of physical capital using the perpetual inventory method with FoF investment data (item 105013003) and inventory data (item 10502005). To deflate the series, we use the implicit deflator for fixed non-residential investment from NIPA, Table 7.1. The depreciation rate is set to 2.6% per quarter.

**Decomposing the Payout Share** Table 12 decomposes the payout share into a dividend yield component (Column 1), an interest component (Column 2), a net debt repurchase component (Column 3), and a net equity repurchase component (Column 4). Over the 1965-2004 period, cash payments increased from 5.5% to 8% of value-added, while the net repurchase share increased from -3.3% to 1.2%. The cash component accounts for most of the increase in the first half of the sample, while the repurchase component accounts for the bulk of the change in the last twenty years. Until the 1985-89 period, US corporations were issuing debt, and to a lesser extent equity, at a high rate. Afterwards, they started to buy back equity, and to a lesser extent debt, instead. At the end of the sample the composition of the non-cash component changes. Between 2005.I and 2007.I, US corporations issued debt to the tune of 5.8% of value-added, and used this debt to buy back 7.3% of value-added in equity, presumably because of the low cost of debt. Indeed, Fama and French (2001), Grullon and Michaely (2002), Brav, Graham, Harvey and Michaely (2005), and others have argued that equity repurchases have substituted for dividend payments over the last 20 years. Baker and Wurgler (2004) evaluate alternative theories for the propensity to pay dividends. Boudoukh, Michaely, Richardson and Roberts (2004) investigate the importance of total equity payout yields for stock return predictability. There are many reasons, including taxes and flexibility, why firms may prefer to substitute dividends for interests or cash for non-cash payments.

[Table 12 about here.]

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<sup>19</sup>Data are available at <http://www.federalreserve.gov/RELEASES/z1/current/data.htm>

## A.2 Using NIPA Data

To compute the payouts using National Income and Product Accounts, henceforth NIPA, data for the US non-financial corporate sector, we use Table 1.14. on Gross Value Added of Nonfinancial Domestic Corporate Business in Current and Chained Dollars.<sup>20</sup>

Payouts are the sum of cash and net repurchases. The cash payouts are defined as the sum of net dividend payments (line 30) plus interest payments (line 25). Net repurchases are the difference between *internal funds* and capital expenditures. Capital expenditures are from the Flow of Funds, as defined above. Internal funds can be computed in a direct and an indirect way.

Internal funds (*indirect measure*) can be defined as gross value added (line 17) minus compensation of employees (line 20) minus taxes on production and imports less subsidies (line 23) minus business current transfer payments (line 26) minus taxes on corporate income (line 28) minus cash payouts (line 25+30). In other words, internal funds IF are given by:  $IF_t = Y_t - S_t^a - Comp_t - Tax_t - D_t^c$ .

Equivalently, internal funds (*direct measure*) are defined as profits before tax without inventory valuation and capital consumption adjustment (line 36) minus taxes on corporate income (line 28) minus net dividends (line 30) plus capital consumption adjustment (line 39) plus inventory valuation adjustment (line 38) plus consumption of fixed capital (line 18).

The direct measure to calculate Internal Funds exactly mimics the way the Flow of Funds calculates Internal Funds.<sup>21</sup> To make the payouts comparable to the Flow of Funds series, we follow the construction methodology in the Flow of Funds and add Foreign Earnings Retained Abroad (FoF: FU266006105.Q) and Net Capital Transfers (FoF: FU105400313.Q) to Internal Funds. After all, this represents foreign-earned income that accrues to the shareholders.

**Capital Share** In macroeconomics, the capital share is commonly assumed to be constant. This is not inconsistent with a large increase in the gross payout share. We define the capital share

$$CS = \frac{Y_t - S_t^a - Comp_t}{Y_t - S_t^a} = \frac{Tax_t}{Y_t - S_t^a} + \frac{I_t - \delta K_t}{Y_t - S_t^a} + GPS.$$

The second equality shows that the capital share can be decomposed as the share of taxes in value-added plus the share of net investment in value-added plus the gross payout share. The first column of Table 13 shows that the capital share fluctuates, but only moderately. It is equal to 33% both at the beginning (1970-74) and at the end (2000-04) of our sample. However, the composition of the capital share shifts dramatically. The 3.1% decline in the share of taxes (Column 2) and the 4.4% decline in the net investment share (Column 3) are offset by a 7.5% increase in the gross payout share (Column 4).

[Table 13 about here.]

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<sup>20</sup>Data are available at <http://bea.gov/bea/dn/nipaweb/SelectTable.asp>

<sup>21</sup>See <http://www.federalreserve.gov/RELEASES/Z1/Current/Coded/> - Flow Tables - Page 13, rows 1 through 9.

### A.3 Using Compustat Data

We use annual and quarterly data from Compustat.<sup>22</sup> If an item from Compustat is not available quarterly, we use its annual figure for each quarter, dividing by four if it is a flow variable. For each industry, the **net payout ratio** is defined as the ratio of payouts to security holders over payouts to workers plus security holders.

**Payouts** Payouts to security holders are computed as the sum of interest expense (item 22), dividends from preferred stock (item 24), dividends from common stock (item 20) and equity repurchases, computed as the difference between the purchase (annual item 115) and the sale (annual item 108) of common and preferred stock. If there is no information available on the purchase and sale of stock, we assume that it is zero.

Payouts to workers are computed as the product of number of employees (Compustat, annual item 29) and wages per employee (see Appendix A.5 below). We only include those firms for which the payouts to security holders is less than the firm assets (annual item 6).

The intangibles ratio is defined as the ratio of intangibles (annual item 33) to net property, plant and equipment (PPE, annual item 8). We filter out those firms whose intangibles ratio is greater than 1000. The intangibles ratio for each industry is then computed as the total intangibles over the total PPE for each industry.

**Tobin's q** The variable  $q_1$  is computed first for all firms having the following items available from COMPUSTAT: *DATA1* (Cash and Short-Term Investments), *DATA2* (Receivables - Total), *DATA6* (Assets - Total), *DATA9* (Long-Term Debt - Total), *DATA34* (Debt in Current Liabilities), *DATA56* (Preferred Stock - Redemption Value), *DATA68* (Current Assets - Other), and the following items available from CRSP: *PRC* (Closing Price of Bid/Ask average), *SHROUT* (Number of shares outstanding). For each firm, Tobin's q is defined as follows

$$q_1 = \frac{\text{totalvaluefirm}}{\text{DATA6} - \text{fin\_assets}},$$

where:

$$\text{totalvaluefirm} = \text{mcap} + \text{totaldebt} - \text{fin\_assets}$$

$$\text{totaldebt} = \text{DATA9} + \text{DATA34} + \text{DATA56}$$

$$\text{fin\_assets} = \text{DATA1} + \text{DATA2} + \text{DATA68}$$

$$\text{mcap} = \text{PRC} * \text{SHROUT}/1000.$$

We select only those firms for which  $0 < q_1 < 100$ . For the selected firms, we compute industry  $I$ 's Tobin's q as :

$$q_{1,agg} = \frac{\sum_{i \in I} \text{totalvaluefirm}_i}{\sum_{i \in I} \text{DATA6}_i - \text{fin\_assets}_i}.$$

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<sup>22</sup>Data are available at <http://wrds.wharton.upenn.edu/>



We use a second definition of Tobin’s q. The variable  $q_2$  is defined as :

$$q_2 = \frac{\text{firm\_value}}{\text{DATA6}},$$

where

$$\text{firm\_value} = \text{mcap} + \text{DATA6} - \text{DATA60} - \text{DATA74}$$

$$\text{mcap} = \text{PRC} * \text{SHROUT}/1000$$

and computed for all firms having the necessary items available in COMPUSTAT. We select only those firms for which  $0 < q_2 < 100$ . For the selected firms, we compute industry I’s average q as:

$$q_{2,agg} = \frac{\sum_{i \in I} \text{firm\_value}_i}{\sum_{i \in I} \text{DATA6}_i}$$

## A.4 Manufacturing

We checked our findings by recomputing payout shares and valuation ratios for the US manufacturing sector. Much of the literature on the size distribution of establishments focusses on manufacturing. The *NPS* increases from 6.5% in the late seventies to 15.7% in the early 2000s, an increase of 9.2 percentage points. Over the same period, Tobin’s q for the manufacturing sector more than doubles from .74 to 1.74. These trends are similar to the entire non-financial corporate sector.

[Table 14 about here.]

## A.5 Labor Reallocation

We use data from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) program.<sup>23</sup> This program reports monthly employment and quarterly wages data at the SIC code level from 1975 to 2000, and at the NAICS code level from 1990 to 2005. Since there is no one-to-one correspondence between SIC and NAICS codes, we form industries at the 2-digit SIC code level that match industries at the 3-digit NAICS code level. We finally end up with 55 different industries, that match to only 47 different Compustat industries. We exclude the financial sector from our calculations. The employment data from the QCEW program is spliced in 1992.

We first compute the change in employment from month to month at the SIC and NAICS code level. If it is positive it is recorded as Job Creation, otherwise it corresponds to Job Destruction. We then aggregate Job Creation, Job Destruction and Employment by quarter, and de-seasonalize each of these series separately using the X12-arma from the Census. Job Reallocation is then computed as the sum of Job Creation and Job Destruction, divided by Employment. Excess Job Reallocation is computed as the sum of Job Creation and Job Destruction minus the absolute change in Employment, divided by Employment.

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<sup>23</sup>Data are available at <http://www.bls.gov/>

## A.6 Managerial Wage Data from Current Population Survey

We use the IPUMS-CPS data on respondents' annual wage earnings from 1971-2006. Managerial occupations are defined as follows: for 1971-82, (previous year) occupation codes 220-246 except 221 and 226; for 1983-1991, codes 003-019; for 1992-2002, codes 003-022; and codes 001-043 after 2002. We restrict the sample to managers who were over 21 years old, were employed in the private sector, and who were full-time workers in the previous year (i.e., they averaged at least 35 hours per week). We drop observations with annual earnings less than \$2000 in 1983\$. Finally, because wages are subject to top-coding, we follow Autor et al. (2007) and multiply top-codes by 1.5 (this adjustment only affects the reported standard deviations, not the IQR or IDR). The final sample size is about 3000 managers in the 1970s and grows to around 6000 managers in the 2000s.

## B Steady-State Growth Path

**Definition 1.** A steady-state growth path is defined as a path for which aggregate establishment productivity  $\{\bar{A}_t\}$  and the productivity of the newest vintage  $\{\theta_t\}$  grow at a constant rate  $g_\theta$ , the variables  $\{r_t, R_t, N_t\}$  are constant, the economy-wide productivity-level grows at a constant rate  $g_z$ , and all aggregate variables  $\{Y_t, K_t, W_t, S_t, C_t, D_t, V_t^a\}$  grow at a constant rate

$$g = ((1 + g_z)(1 + g_\theta)^{1-\nu})^{\frac{1}{1-\alpha\nu}}.$$

Along the steady-state growth path, the measure over establishment productivity and promised utilities satisfies:

$$\Psi_{t+1,s+1}(A, v) = \Psi_{t,s} \left( \frac{A}{1 + g_\theta}, v \right),$$

the measure of active establishments satisfies:

$$\lambda_{t+1,s}(A, v) = \lambda_{t,s} \left( \frac{A}{1 + g_\theta}, v \right),$$

and the value of an establishment of vintage  $s$  evolves according to:

$$V_{t+1}(A, v; s + 1) = (1 + g)V_t \left( \frac{A}{1 + g_\theta}, v(1 + g)^{1-\gamma}, s \right).$$

To construct the steady-state growth path, we normalize variables in efficiency units. This allows us to restate the production technology as follows :

$$\tilde{y}_t = \tilde{k}_t^{\alpha\nu},$$

where a variable with a tilde,  $\tilde{x}_t$ , denotes the variable,  $x$ , expressed in per capita terms and in adjusted efficiency units of the latest vintage (blueprint):

$$\tilde{x}_t = \frac{x_t}{z_t^{\frac{1}{1-\alpha\nu}} \theta_t^{\frac{1-\nu}{1-\alpha\nu}}}.$$

We have normalized the population  $L$  to one.

As noted in the main text, we normalize productivity by the blueprint level of technology, and denote the normalized variables with a hat:  $\hat{A}_t = A_t/\theta_t$ . By construction,  $\hat{A} \geq 1$  for a new establishment (vintage zero). The organizational capital of existing establishments in the new efficiency units *shrinks* at a rate  $(1 + g\theta)$ . See equation (3.13). This notation allows us to reformulate the optimal contract along the steady-state growth path.

The owner maximizes his value  $\hat{V}(\hat{A}, \tilde{v})$  by optimally choosing current compensation  $\tilde{c}$  and future promised utilities  $\tilde{v}'(\cdot)$ :

$$\hat{V}(\hat{A}, \tilde{v}) = \max \left[ \hat{V}(\hat{A}, \tilde{v}), 0 \right]$$

and

$$\hat{V}(\hat{A}, \tilde{v}) = \max_{\tilde{c}, \tilde{v}'(\cdot)} \left[ \begin{array}{c} \tilde{y} - \tilde{W} - R\tilde{k} - \tilde{c} \\ + e^{-(\rho_o - (1-\gamma)\tilde{g})} \int \tilde{V}(\hat{A}', \tilde{v}') \Gamma(\varepsilon') d\varepsilon', \end{array} \right]$$

subject to the law of motion for organizational capital in (3.13), the promise keeping constraint

$$\tilde{v} = u(\tilde{c}) + e^{-(\rho_m - (1-\gamma)\tilde{g})} \left[ \int \beta_{s'}(\tilde{v}, \varepsilon') \tilde{v}'(\hat{A}') \Gamma(\varepsilon') d\varepsilon' + \tilde{\omega}(\hat{A}') \int (1 - \beta(\tilde{v}, \varepsilon')) \Gamma(\varepsilon') d\varepsilon' \right], \quad (\text{B.1})$$

and subject to participation constraints for all  $\hat{A}'$ :

$$\tilde{v}'(\hat{A}') \geq \tilde{\omega}(\hat{A}').$$

The indicator variable  $\beta$  is one if continuation is optimal and zero elsewhere:

$$\begin{aligned} \beta &= 1 \text{ if } \tilde{v}'(\hat{A}') \leq \tilde{v}^*(\hat{A}') \\ \beta &= 0 \text{ elsewhere} \end{aligned}$$

The outside option process is determined in equilibrium by the zero-profit condition for new entrants:

$$\hat{V}(\max(\hat{A}\phi, 1), \omega(\hat{A})) = S, \quad (\text{B.2})$$

Equation (B.2) implies that the outside option  $\omega(\hat{A}_t)$  is constant in the range  $A \in [0, \phi^{-1}]$ . We refer to this range as the insensitivity region, because the outside option does not depend on the organizational capital accumulated in the current establishment. When the fraction of capital  $\phi$  that is portable is zero, the outside option is constant for all  $A > 0$ .

## Proof of Proposition 4.1

*Proof.* The first-order condition implies that compensation  $\tilde{c}$  is constant as long as the participation constraint does not bind. When a new match is formed, the normalized promised utility  $\tilde{v}$  starts off at  $\tilde{v}_0 = \omega(\hat{A}_t)$ . The dynamics of the optimal wage contract can be characterized by setting up the Lagrangian. Let  $\mu$  denote the multiplier on the promised utility constraint and let  $\lambda(\hat{A}')$  denote the multiplier on the participation constraint in state  $\hat{A}'$ . We assume  $\hat{V}(\cdot)$  is strictly concave and twice continuously differentiable. When the participation constraint  $\hat{A}'$  does not bind ( $\lambda(\hat{A}') = 0$ ), conditional

on continuation of the relationship ( $\beta = 1$ ), the law of motion for the promised utility in efficiency units  $\tilde{v}$  satisfies the first order condition:

$$\mu = \frac{-\partial \widehat{V}(\widehat{A}', \tilde{v}')}{\partial \tilde{v}'}$$

The left hand side is the cost to the owner of increasing the manager's compensation today. It equals  $\mu$ , the shadow price of a dollar today, from the envelope condition. From the first order condition for consumption we know that  $\mu = 1/u_c(\tilde{c})$ . The right-hand side is the cost of increasing the manager's compensation tomorrow, from the first-order condition for  $\tilde{v}'$ . From the envelope condition, this equals  $\mu' = 1/u_c(\tilde{c}')$ . So, the first order condition implies that consumption  $\tilde{c}$  must be constant over time, as long as the manager's participation constraint does not bind. As a result, actual managerial compensation  $c$  grows at the rate of output growth  $g$  on the steady-state growth path. When the participation constraint does bind, the following inequality obtains:

$$\mu < \frac{-\partial \widehat{V}(\widehat{A}', \tilde{v}')}{\partial \tilde{v}'}$$

The utility cost of increasing the manager's compensation to the owner increases. From the concavity of  $u(\cdot)$ , it follows that the manager's promised utility and current compensation (in efficiency units) increase when the participation constraint binds. When the constraint does bind, we increase  $\tilde{c}$  to make sure the constraint holds with equality. This is optimal (see Kuhn-Tucker conditions).

This suggests a simple consumption rule is optimal. We conjecture the optimal consumption function  $C(\tilde{v}, \widehat{A})$  such that:

$$C(\tilde{v}, \widehat{A}) = u_c^{-1}(1/\mu)$$

where  $\mu = \frac{-\partial \widehat{V}(\widehat{A}, \tilde{v})}{\partial \tilde{v}}$ . Define the running maximum of  $\widehat{A}$  as  $\widehat{A}_{max,t} = \max\{\widehat{A}_\tau, \tau \leq t\}$ . In addition, let  $T$  denote the random stopping time when the match gets terminated because of zero surplus:

$$T = \inf\{\tau \geq 0 : \widehat{V}(\widehat{A}_\tau, \tilde{v}_\tau) = 0\}$$

Compensation is determined by the running maximum of productivity for all  $0 < t < T$ :

$$c_t = c(\widehat{A}_{max,t}) = \max\left\{c_0, C\left(\omega(\widehat{A}_{max,t}), \widehat{A}_{max,t}\right)\right\}.$$

This consumption function satisfies the necessary and sufficient Kuhn-Tucker conditions if the continuation probability  $\beta$  is non-increasing in  $\widehat{A}$ . This being the case, the participation constraint only binds if  $\widehat{A}$  exceeds its previous maximum. It is easy to verify that  $\beta$  is indeed non-increasing in  $\widehat{A}$  given this consumption function.  $\square$

## Proof of Proposition 4.2

*Proof.* The discount rate wedge induces a downward drift in the manager's consumption and promised utility. When the participation constraint does not bind, the envelope condition and the first order

condition for  $\tilde{v}'$  imply the following:

$$\frac{-\partial\widehat{V}(\widehat{A}, \tilde{v})}{\partial\tilde{v}} = \mu = e^{(\rho_m - \rho_o)} \frac{-\partial\widehat{V}(\widehat{A}', \tilde{v}'')}{\partial\tilde{v}'}$$

Because  $e^{\rho_m - \rho_o} > 1$ , the owner's utility cost of providing compensation tomorrow is lower than  $\mu$ , the cost today. As a result, the optimal promised utility is decreasing over time. Because  $\mu = u_c^{-1}(\tilde{c})$ , this also implies that current consumption drifts down. By construction, this consumption policy satisfies the necessary and sufficient first order conditions for optimality.  $\square$

## C Transition Experiment

**Definition 2.** A constant-discount rate transition between two steady state growth paths is defined as a path for which the productivity of the newest vintage grows at rate  $g_{t,\theta}$ , the economy-wide productivity-level grows at a rate  $g_{z,t}$ , and all aggregate variables  $\{Y_t, K_t, w_t, C_t\}_{t=0,T}$  have a constant trend growth rate

$$g = ((1 + g_z)(1 + g_\theta)^{1-\nu})^{\frac{1}{1-\alpha\nu}}.$$

The rental rate on capital  $R_t$  and the discount rate  $r_t$  are constant. The measure over promised utilities and establishment productivity satisfies (3.10) and (3.11) during the transition. At  $t = T$ , this economy reaches its new steady-state growth path. So for  $i > 1$ :

$$\Psi_{T+i,s}(A, v) = \Psi_{T+i-1,s}\left(\frac{A}{1 + g_\theta}, v\right) \quad (\text{C.1})$$

$$\lambda_{T+i,s}(A, v) = \lambda_{T+i-1,s}\left(\frac{A}{1 + g_\theta}, v\right). \quad (\text{C.2})$$

Output deviates from its trend growth path during the transition because the average establishment productivity level deviates from its initial steady-state growth path  $\{\bar{A}_{old,t}\}$ . The average productivity levels changes, because the joint measure over establishment-specific productivity and promised utility is changing. Along the transition path, we check that the rental rate for physical capital is constant:

$$R_t = \alpha v \tilde{K}_{new,t}^{\alpha\nu-1} = \alpha v \left(\tilde{K}_{old,t}\right)^{\alpha\nu-1},$$

where  $\tilde{K}_t = \frac{K_t}{A_t^{\frac{1-\nu}{1-\alpha\nu}} z_t^{\frac{1-\nu}{1-\alpha\nu}}}$  denotes the capital stock in *adjusted* efficiency units. The aggregate capital stock is adjusted such that

$$\varphi_t = \frac{\widehat{K}_{new,t}}{\widehat{K}_{old,t}} = \left(\frac{\bar{A}_{new,t}}{\bar{A}_{old,t}}\right)^{\frac{1-\nu}{1-\alpha\nu}}.$$

Capital is supplied perfectly elastically at a constant interest rate. Along the transition path, all aggregate variables  $\{Y_{new,t}, K_{new,t}, W_{new,t}, C_{new,t}\}_{t=0,T}$  are scaled up by  $\varphi_t$ . This is the productivity adjustment relative to the old steady-state growth path. Once we have computed  $\{\varphi_t\}$ , we can back out the transition path for all the other variables.

**Reverse Shooting Algorithm** The objective is to compute the transition for the value function, aggregate productivity, the outside option function and the joint measure over promised consumption and productivity  $\{V_t, \bar{A}_t, \omega_t, \Psi_{t,s}, \lambda_{t,s}\}$ . We start in the new steady state with the new vintage-specific growth rate  $g_{\theta,T}$  at  $T$ , and the “stationary” joint measure  $\Psi_{T,s}$  over organizational capital and promised consumption, which satisfy the conditions in equation (C.2). We conjecture a  $\{\varphi_t\}_{t=0}^T$  sequence. Because we know  $\hat{V}_T$ , the owner’s value of an establishment at the beginning of period  $t$  can be constructed recursively, starting in  $i = 1$ :

$$\hat{V}_{T-i}(\hat{A}, \tilde{v}; s) = \max_{\tilde{c}, \tilde{v}'(s)} \left[ \begin{array}{c} \tilde{y}_{T-i+1} - W - R\tilde{k}_{T-i+1} - \tilde{c}_{T-i+1} \\ + R^{-1}(1+g) \int \tilde{V}_{T-i+1}(\hat{A}', \tilde{v}'; s+1) Q_{s'}(\varepsilon') d\varepsilon' \end{array} \right],$$

subject to the law of motion for capital in (3.13), the promised consumption constraint in (B.1), and a series of participation constraints:

$$\tilde{v}' \geq \tilde{\omega}_{T-i+1}(A')$$

and, finally, the value of the firm is defined as:

$$\tilde{V}_{T-i}(\hat{A}, \tilde{v}) = \max \left[ \hat{V}_{T-i}(\hat{A}, \tilde{v}), 0 \right].$$

We solve for  $\{V_t, \bar{A}_t, \omega_t, \Psi_{t,s}, \lambda_{t,s}\}_{t=1}^T$  starting in the last period  $T$ .

**Simulating Forward** Next, we simulate this economy forward, starting at the initial values for  $(V_0, \bar{A}_0, \omega_0, \Psi_{0,s}, \lambda_{0,s})$  in the old steady-state growth path, using our solution for the transition path  $\{V_t, \bar{A}_t, \omega_t, \Psi_{t,s}, \lambda_{t,s}\}_{t=1}^T$ . We use a sample of  $N = 5000$  establishments. This gives us a new guess for the aggregate establishment productivity series and hence for  $\{\varphi'_t\}_{t=0}^T$ . We continue iterating until we achieve convergence.

## D Calibration Details

To calibrate the depreciation rate, the tax rate and the capital share  $\alpha\nu$ , we used mostly NIPA data. Let  $CFC$  denote the consumption of fixed capital. Let  $K_{INV}$  denote the stock of inventories, obtained from NIPA Table 5.7.5B. (Private Inventories and Domestic Final Sales by Industry). Let  $K_{ES}$  denote fixed assets, obtained from NIPA Table 6.1. (Current-Cost Net Stock of Private Fixed Assets by Industry Group and Legal Form of Organization). The depreciation rate is computed as

$$\delta = CFC / (K_{ES} + K_{INV}).$$

The average tax rate  $\tau_c$  is computed as follows. Let  $CT$  denote corporate taxes, let  $NP$  denote net product, let  $ST$  denote Sales Taxes, and let  $SLPTR$  denote state and local taxes. The tax rate is computed as

$$\tau_c = CT / (NP - CE - ST),$$

where we compute  $ST$  as  $CT - \text{RATIO} \times \text{SLPTR}$  and  $\text{RATIO}$  is the average ratio of fixed assets held by non-farm, non-financial corporations to total fixed assets.

To compute the average cost of capital  $r$ , we computed the weighted-average of the average return on equity and the average return on corporate bonds over the period 1950-2005. The average return on corporate bonds was computed using the Dow Jones corporate bond index.<sup>24</sup> The average return on equity is computed from the log price/dividend ratio and a constant real growth rate for dividends of 1.8%, the average growth rate over the sample.<sup>25</sup> The dividend series and the price/dividend ratio from CRSP are adjusted for repurchases. The weights in the average are based on the aggregate market value of equity and corporate bonds. The resulting average cost of capital is 5.5%.

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<sup>24</sup>Data are available at <http://www.globalfinancialdata.com>

<sup>25</sup>Data are available at <http://wrds.wharton.upenn.edu>

Figure 1: Optimal Compensation and Size

This figure plots the running maximum of productivity on the horizontal axis,  $\hat{A}_{max,t}$  against current productivity,  $\hat{A}_t$ , on the vertical axis. It considers the case in which managers and owners share the same rate of time preference  $\rho_m = \rho_o$ .

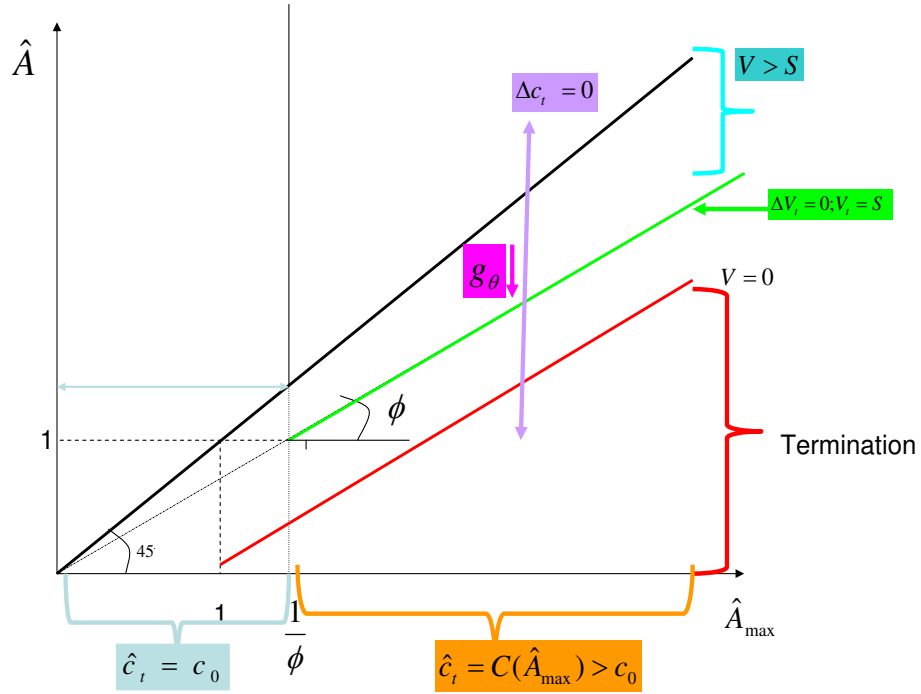




Figure 2: Value vs. Growth

This figure plots the ratio of current and the running maximum of productivity on the horizontal axis,  $\hat{A}_t/\hat{A}_{max,t}$  against current productivity,  $\hat{A}_t$ , on the vertical axis. It considers the case in which managers and owners share the same rate of time preference  $\rho_m = \rho_o$ .

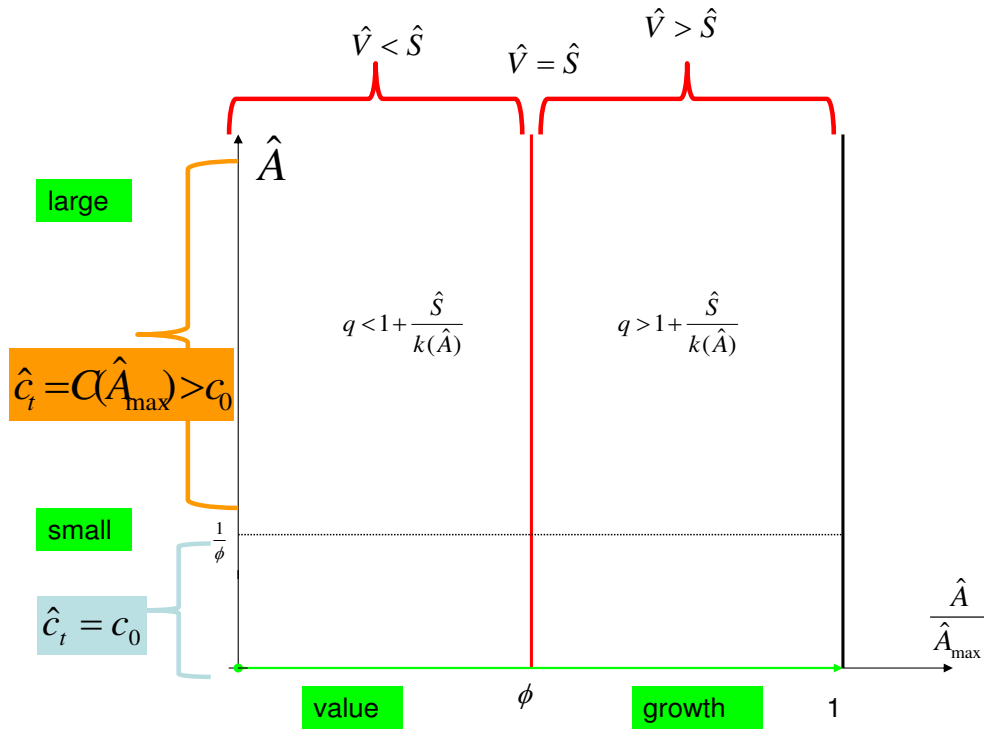


Figure 3: Optimal Compensation Contract

The left panel plots the current productivity  $A_t$  (y-axis) against the running maximum  $A_{max,t}$  (x-axis). The right panel figure plots the evolution of the optimal current consumption of the manager  $\tilde{c}$  (dashed line) alongside the evolution of the establishment's organizational capital  $\hat{A}$  (full line). The latter is a measure of size and productivity of the establishment. The two time-series are produced by simulating model for 300 periods (horizontal axis) under the benchmark calibration described below ( $\phi = .5$ ), except that the time discount rates of owners and managers are held equal:  $\rho_o = \rho_m$ .

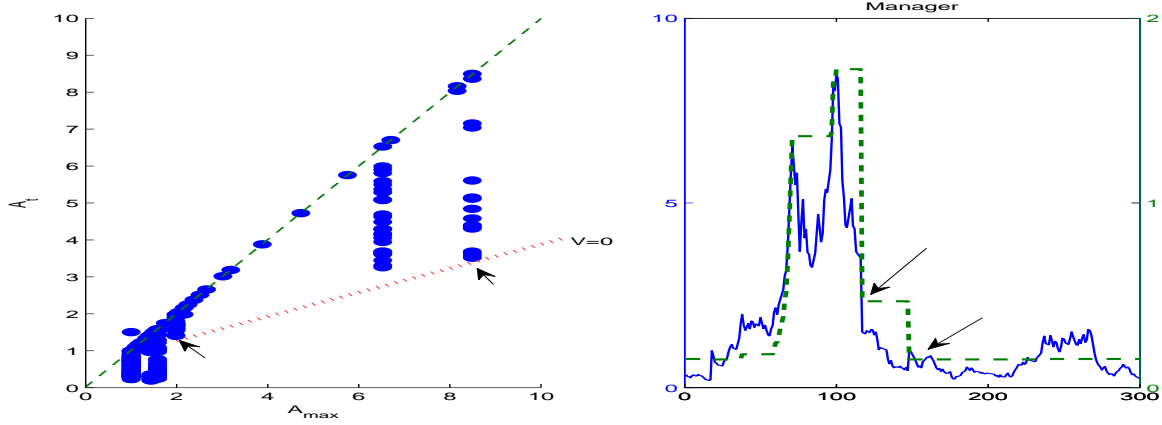


Figure 4: Payouts to Manager and Owner

The left panel plots the evolution of the optimal current consumption of the manager  $\tilde{c}$  (dashed line, measured against the right axis) alongside the evolution of the establishment's organizational capital  $\hat{A}$  (full line, measured against the left axis). The right panel plots the payouts to the owner  $\tilde{\pi}$ . The two time-series are produced by simulating the model for 300 periods (horizontal axis) under the benchmark calibration described below, except that the time discount rates of owners and managers are held equal:  $\rho_o = \rho_m$ .

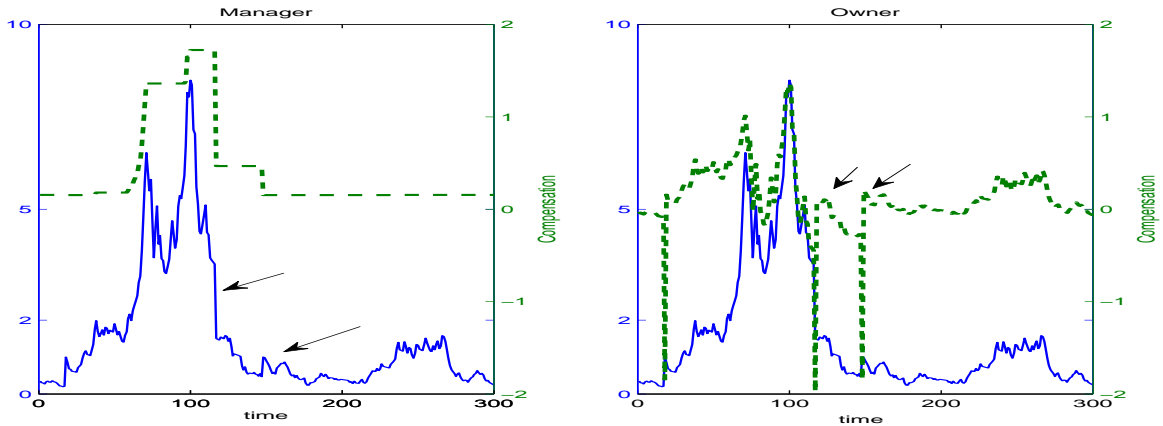


Figure 5: Payouts to Manager and Owner: Discount Rate Wedge

The left panel plots the evolution of the optimal current consumption of the manager  $\tilde{c}$  (dashed line, measured against the right axis) alongside the evolution of the establishment's organizational capital  $\log \hat{A}$  (full line, measured against the left axis). The right panel plots the payouts to the owner  $\tilde{\pi}$ . The two time-series are produced by simulating the model for 300 periods (horizontal axis) under the benchmark calibration described below, except that the time discount rates of owners and managers are held equal:  $\rho_o < \rho_m$ .

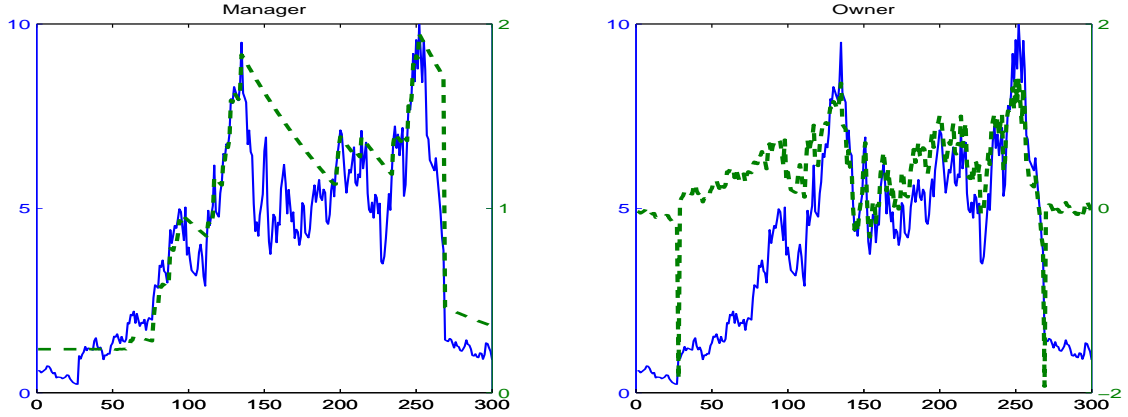


Figure 6: Summary Transitional Dynamics of Key Aggregates

The economy transitions from high vintage-specific growth  $g_{\theta,0}$  before 1971 to low vintage-specific growth  $g_{\theta,T}$  after 1971. The transition takes place over  $T = 20$  years. The results are for the benchmark parameters.

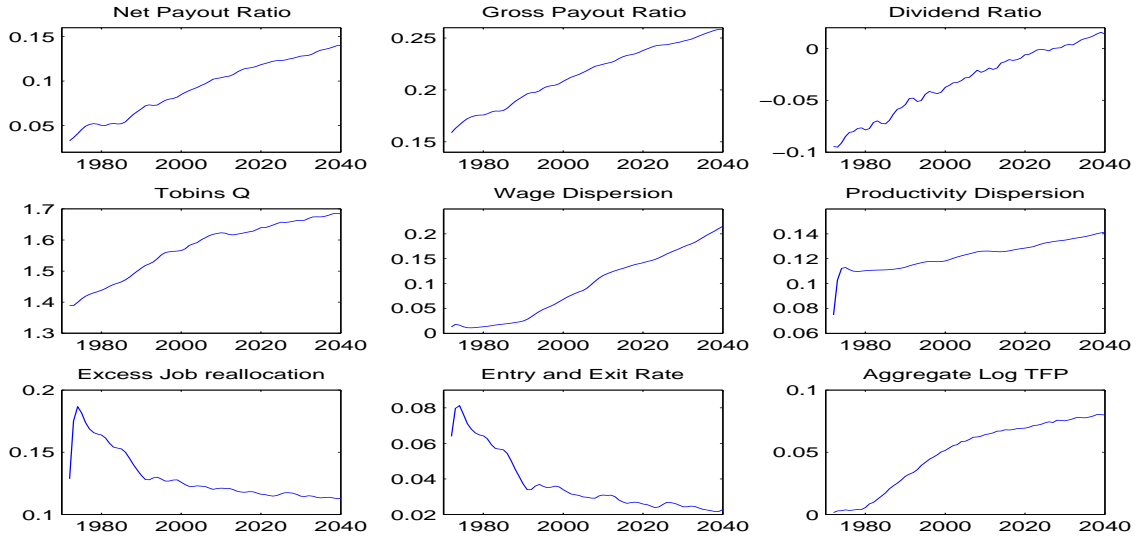


Figure 7: From Low-Powered to High-Powered Incentives

Plot of log compensation against log size of establishment. The left panel shows the initial steady-state growth path (high vintage-specific growth). The right panel shows the new steady-state growth path (high general productivity growth). The data are generated from the model under its benchmark calibration.

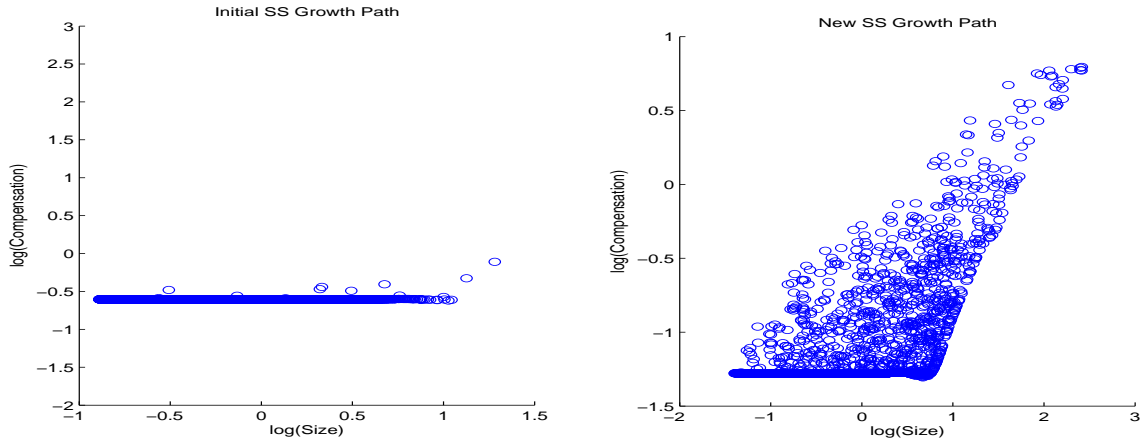


Figure 8: Compensation and Size Distribution in the New Steady State

Histogram of log compensation and log size of establishments. The data are generated from the model's new steady state (high general productivity growth) under its benchmark calibration.

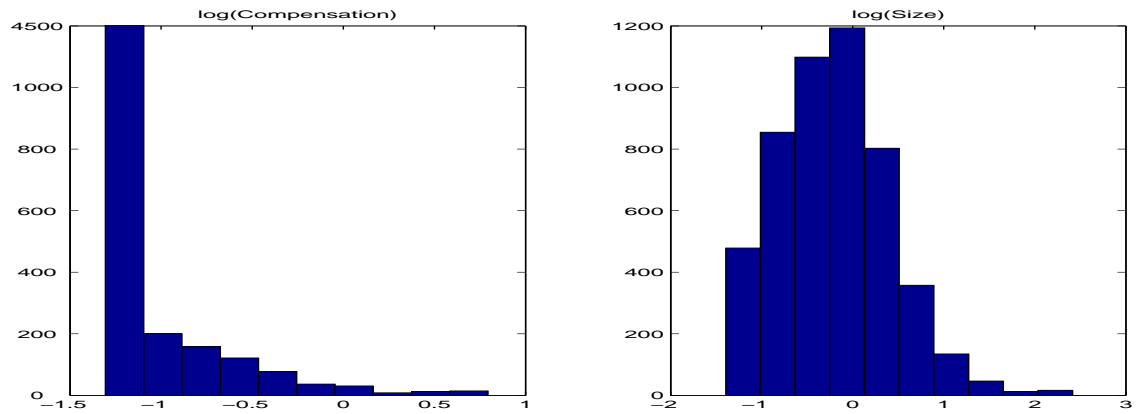


Figure 9: Size Distribution in the New Steady State

The figure plots the relationship between the log size of establishments on the horizontal axis and the rank in the distribution  $\log(\text{Rank} - .5)$  on the vertical axis. The figure is for the new steady state growth path under our benchmark calibration.

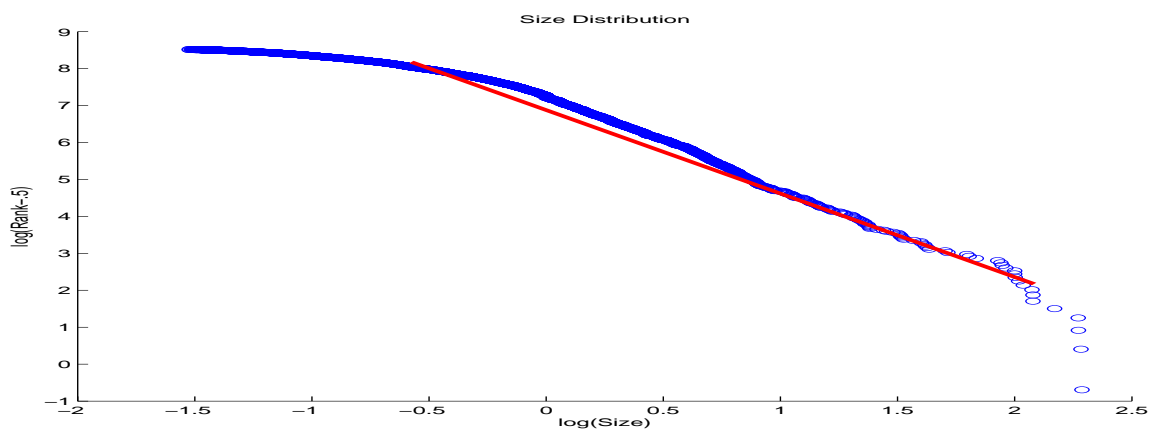


Figure 10: Cross-section of Managerial Wealth-to-Output

This figure shows the ratio of managerial wealth to aggregate output at different percentiles. We ranked establishments according to managerial compensation. The economy transitions from high vintage-specific growth  $g_{\theta,0}$  before 1971 to low vintage-specific growth  $g_{\theta,T}$  after 1971. The transition takes place over  $T = 20$  years. The results are for the benchmark parameters.

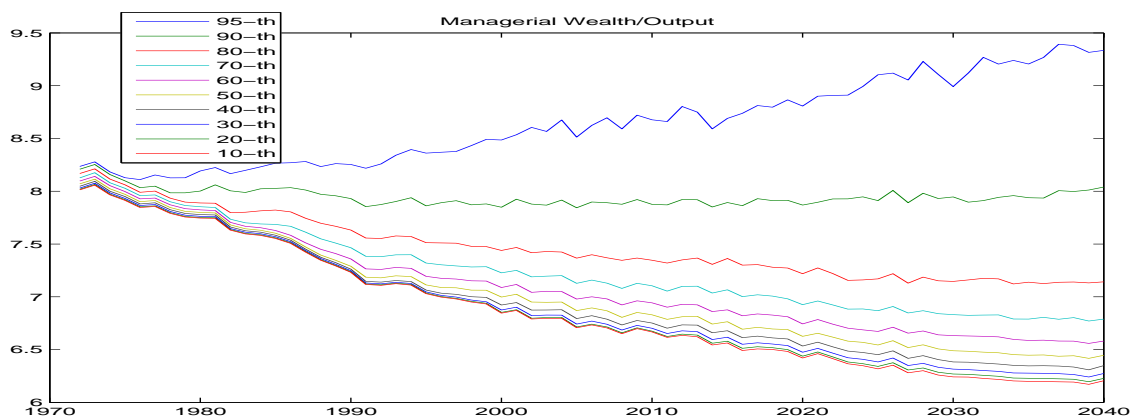


Figure 11: From Low-Powered to High-Powered Incentives - High Portability

Plot of log compensation against log size of establishment. The left panel shows the initial steady-state growth path (high vintage-specific growth). The right panel shows the new steady-state growth path (high general productivity growth). The data are generated from the model under its benchmark calibration, except that  $\phi = .75$ .

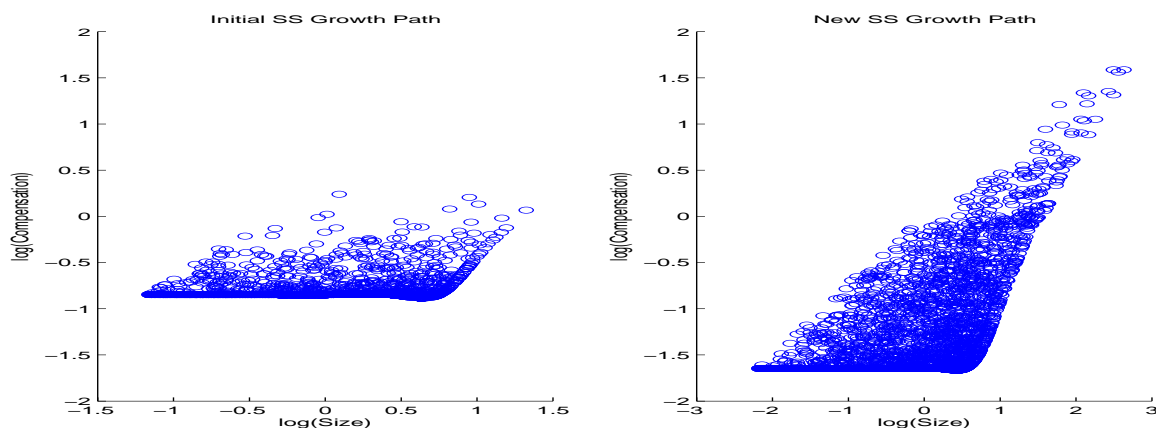


Figure 12: Excess Reallocation Rate

The dashed line is the excess reallocation rate for the manufacturing sector, constructed by Faberman (2006). The excess job reallocation rate is a direct measure of the cross-sectional dispersion of establishment growth rates. It is defined as the sum of the job creation rate plus the job destruction rate less the net employment growth rate. The Faberman data are extended to 2007.I using BLS data. The solid line is the 8-quarter moving average.

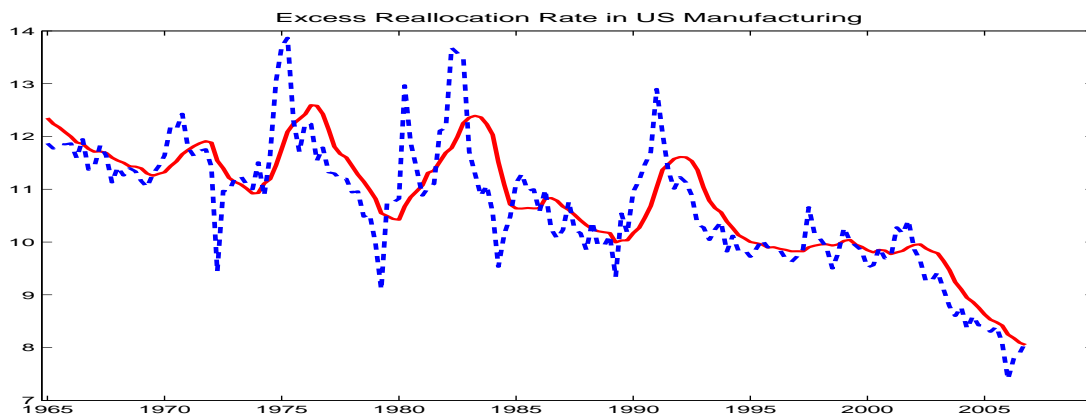


Figure 13: Payout Share: FoF vs. NIPA

The dashed line is the 8-quarter moving average of the net payout share (NPS), defined as the sum of net payouts to securities holders, divided by value-added, computed using NIPA data for the non-financial corporate sector. The full line is the 8-quarter moving average of the net payout share (NPS) computed using FoF data for the non-financial, non-farm corporate sector.

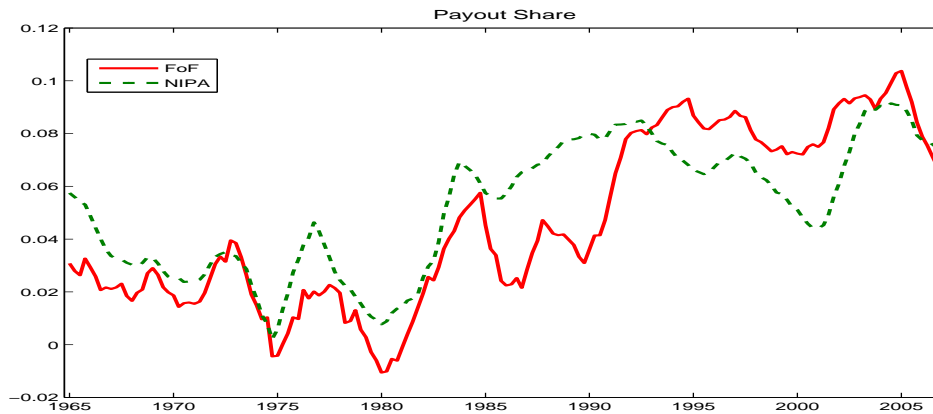


Table 1: Benchmark Calibration

<i>Parameter</i>	<i>Value</i>	<i>Source</i>
$\nu$	.75	<i>Atkeson and Kehoe (2005)</i>
$\delta$	.06	<i>NIPA</i>
$\alpha$	.30	<i>K/Y = 1.77</i>
$r$	.055	<i>FoF, CRSP, DJCBI</i>
$\rho_o$	.02	
$\rho_o$	.03	
$\gamma$	1.6	<i>equation (3.8)</i>
$g$	.022	<i>NIPA</i>
$m_s$	0	
$\sigma_s$	19% exc. reall. rate	<i>job reallocation - QCEW BLS</i>
$S$	5% exit rate	<i>entry and exit</i>
$\phi$	0.5	<i>wage inequality - QCEW BLS</i>

*Notes:* This Table lists our benchmark parameter choices. Section 5.2 justifies these choices and Appendix D provides more details on the data we used. NIPA stands for National Income and Products Accounts, CRSP for Center for Research in Securities Prices, DJCBI for Dow Jones Corporate Bond Index, QCEW stands for Quarterly Census of Employment and Wages, and BLS for Bureau of Labor Statistics. The abbreviation “exc. reall. rate” stands for excess reallocation rate in the initial steady state.



Table 2: Compensation and Productivity Along the Transition Path

	Log Compensation			Log Productivity		
	<i>Std</i>	<i>IQR</i>	<i>IDR</i>	<i>Std</i>	<i>IQR</i>	<i>IDR</i>
<i>before</i>	0.94	0.01	0.08	10.69	18.27	29.16
<i>1971-1975</i>	1.48	0.01	0.09	10.80	18.32	28.99
<i>1976-1980</i>	1.24	0.01	0.08	11.00	18.25	29.13
<i>1981-1985</i>	1.75	0.01	0.10	11.09	18.42	29.38
<i>1986-1990</i>	2.31	0.02	0.11	11.26	18.32	29.80
<i>1991-1995</i>	4.34	0.03	0.13	11.67	18.43	30.76
<i>1996-2000</i>	6.41	0.09	11.77	11.79	18.05	30.84
<i>2001-2005</i>	8.22	0.13	9.73	12.22	18.36	31.78
<i>2006-2010</i>	11.03	8.63	8.94	12.58	18.53	32.58
<i>2011-2015</i>	12.78	8.82	21.47	12.57	18.50	32.52
<i>after</i>	26.98	0.09	35.07	15.36	21.14	38.98

Notes: The economy transitions from high vintage-specific growth  $g_{\theta,0}$  before 1971 to low vintage-specific growth  $g_{\theta,T}$  after 1971. The transition takes place over  $T = 20$  years. The table reports the cross-sectional standard deviation (Std), inter-quartile range (IQR) and the inter-decile range (IDR) for log compensation  $\log \tilde{c}$  and log productivity  $(1 - \nu) \log \hat{A}$  in percentage points. The results are for the benchmark parameters.

Table 3: Main Aggregates Along Transition Path

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	<i>EREALL</i>	<i>EXIT</i>	<i>NPS</i>	<i>GPS</i>	<i>Tobin's q</i>	$\frac{V^a}{(Y-S^a)}$	$\frac{M^a}{(Y-S^a)}$
<i>before</i>	18.96	4.33	3.27	15.73	1.40	0.83	8.27
<i>1971-1975</i>	17.83	7.74	4.14	16.67	1.40	0.83	8.04
<i>1976-1980</i>	16.62	6.65	4.96	17.47	1.43	0.89	7.88
<i>1981-1985</i>	15.30	5.62	5.28	18.03	1.46	0.93	7.72
<i>1986-1990</i>	13.52	4.08	7.46	19.99	1.50	1.00	7.51
<i>1991-1995</i>	12.87	3.56	8.24	20.62	1.54	1.07	7.37
<i>1996-2000</i>	12.70	3.53	9.31	21.53	1.56	1.12	7.29
<i>2001-2005</i>	12.26	3.05	10.32	22.41	1.59	1.18	7.22
<i>2006-2010</i>	12.02	2.94	10.98	23.00	1.62	1.23	7.17
<i>2011-2015</i>	11.90	2.84	11.65	23.61	1.62	1.22	7.11
<i>after</i>	11.35	1.20	13.01	24.83	1.64	1.26	6.47

Notes: The economy transitions from high vintage-specific growth  $g_{\theta,0}$  before 1971 to low vintage-specific growth  $g_{\theta,T}$  after 1971. The transition takes place over  $T = 20$  years. The table reports the excess job reallocation rate (*EREALL*), the entry/exit rate (*EXIT*), the net payout share (*NPS*), the gross payout share *GPS*, Tobin's  $q$ , the ratio of aggregate firm value to output ( $V/(Y - S^a)$ ), and the ratio of managerial wealth to output ( $M/(Y - S^a)$ ). The results are for the benchmark parameters.

Table 4: Cross-section of Tobin's Q

<i>percentile</i>	95	90	80	70	60	50	40	30	20	10
<i>1971-1975</i>	1.94	1.82	1.68	1.56	1.45	1.35	1.26	1.18	1.11	1.05
<i>1976-1980</i>	2.02	1.89	1.73	1.59	1.48	1.38	1.28	1.20	1.13	1.06
<i>1981-1985</i>	2.07	1.94	1.77	1.63	1.51	1.40	1.31	1.22	1.14	1.07
<i>1986-1990</i>	2.15	1.99	1.81	1.67	1.55	1.44	1.34	1.24	1.16	1.08
<i>1991-1995</i>	2.27	2.07	1.87	1.72	1.59	1.47	1.36	1.27	1.18	1.09
<i>1996-2000</i>	2.34	2.10	1.88	1.74	1.61	1.50	1.39	1.29	1.19	1.10
<i>2001-2005</i>	2.42	2.16	1.92	1.77	1.63	1.52	1.41	1.30	1.20	1.11
<i>2006-2010</i>	2.48	2.21	1.96	1.80	1.66	1.53	1.42	1.31	1.21	1.11
	2.76	2.40	2.07	1.88	1.73	1.59	1.45	1.33	1.23	1.13

Notes: The economy transitions from high vintage-specific growth  $g_{\theta,0}$  before 1971 to low vintage-specific growth  $g_{\theta,T}$  after 1971. The transition takes place over  $T = 20$  years. The table reports the ratio of market value of the establishment to the aggregate capital stock, at different percentiles of the cross-sectional market value distribution. The results are for the benchmark parameters.

Table 5: No Wedge

	Log Wages			Log TFP		
	<i>Disp.</i>	<i>IQR</i>	<i>IDR</i>	<i>Disp.</i>	<i>IQR</i>	<i>IDR</i>
<i>before</i>	2.12	0.00	0.00	8.43	14.05	21.89
<i>1971-1975</i>	0.73	0.02	0.06	9.88	15.48	26.84
<i>1976-1980</i>	2.11	0.02	0.05	10.43	17.63	28.19
<i>1981-1985</i>	2.60	0.02	0.04	10.65	18.07	28.05
<i>1986-1990</i>	2.16	0.02	0.04	10.64	17.55	28.07
<i>1991-1995</i>	2.67	0.02	0.07	10.69	17.56	27.95
<i>1996-2000</i>	2.93	0.02	0.08	10.89	17.60	28.33
<i>2001-2005</i>	3.66	0.02	0.08	11.22	18.09	28.99
<i>2006-2010</i>	6.47	0.02	6.90	11.32	17.99	29.43
<i>2011-2015</i>	9.63	0.03	17.20	11.36	17.35	29.62
	<i>ERALL</i>	<i>EXIT</i>	<i>NPR</i>	<i>GPR</i>	<i>Tobin'sq</i>	
<i>before</i>	20.87	5.61	16.34	30.20	1.33	
<i>1971-1975</i>	14.34	4.27	10.89	22.40	1.51	
<i>1976-1980</i>	19.04	8.68	1.76	15.87	1.47	
<i>1981-1985</i>	17.93	8.08	2.53	16.64	1.52	
<i>1986-1990</i>	16.19	6.47	4.18	17.64	1.54	
<i>1991-1995</i>	15.05	5.50	4.69	18.00	1.55	
<i>1996-2000</i>	14.60	5.10	4.73	18.32	1.57	
<i>2001-2005</i>	13.67	4.34	5.30	18.91	1.60	
<i>2006-2010</i>	13.55	4.35	5.56	19.28	1.60	
<i>2011-2015</i>	12.71	3.65	6.74	20.15	1.62	
<i>after</i>	11.38	1.18	18.45	31.30	1.56	

Notes: Benchmark Calibration. The match specificity parameter  $\phi$  is .5. The economy transitions from (high)  $g_{\theta,0}$  to (low)  $g_{\theta,T}$  in  $T = 20$  years.

Table 6: Increasing Wage Dispersion

	<i>Std Wages</i>	<i>75%-25% Wages</i>	<i>90%-10% Wages</i>
<b>Panel A: All Workers - Establishment-Level Data</b>			
<i>1975-1979</i>	21.4	29.1	53.2
<i>1980-1984</i>	22.9	29.3	57.2
<i>1985-1989</i>	24.2	30.8	58.5
<i>1990-1994</i>	25.1	31.6	61.1
<i>1995-1999</i>	26.9	32.8	65.7
<i>2000-2004</i>	28.7	34.5	67.9
<b>Panel B: All Managers - Individual-Level Data</b>			
<i>1975-1979</i>	59.4	72.9	140.8
<i>1980-1984</i>	61.3	79.8	147.5
<i>1985-1989</i>	62.9	82.5	152.7
<i>1990-1994</i>	64.8	83.8	156.6
<i>1995-1999</i>	67.2	83.3	157.7
<i>2000-2004</i>	68.8	84.2	160.4
<b>Panel C: Top-3 Managers in 50 Largest Firms</b>			
<i>1975-1979</i>	55.7	74.1	135.1
<i>1980-1984</i>	58.3	74.0	146.7
<i>1985-1989</i>	69.7	90.2	172.6
<i>1990-1994</i>	76.9	100.0	186.8
<i>1995-1999</i>	92.6	124.0	231.7
<i>2000-2004</i>	99.4	149.5	260.9

*Notes:* All three panels plot the cross-sectional standard deviation, inter-quartile range, and inter-decile range of log wages. Statistics are averaged over 5-year periods. In Panel A, we measure intra-industry, between-establishment wage inequality. The data are from the Quarterly Census of Employment and Wages (QCEW) collected by the Bureau of Labor Statistics (BLS). The unit of observation is an establishment, for which we know the average wage. We calculate the within-industry wage dispersion from a panel of 55 2-digit SIC-code industries, and average across industries. In Panel B, we use individual-level data from the Current Population Survey, March issue. We select only the managerial occupations. Finally, Panel C uses data from Frydman and Saks (2006) for the three highest-paid officers in the largest 50 firms in 1960 and 1990.

Table 7: Payout Share for US Corporate Sector: FoF and NIPA Data

	(1)	(2)	(3)	(4)
	<i>NPS FoF</i>	<i>NPS NIPA</i>	<i>GPS FoF</i>	<i>GPS NIPA</i>
<i>1965-1969</i>	2.36	3.66	11.82	13.11
<i>1970-1974</i>	1.74	1.99	11.53	11.78
<i>1975-1979</i>	1.06	2.70	10.68	12.32
<i>1980-1984</i>	3.51	4.42	15.58	16.50
<i>1985-1989</i>	3.08	7.26	16.08	20.26
<i>1990-1995</i>	8.26	7.61	20.20	19.55
<i>1995-1999</i>	7.86	6.21	19.86	18.21
<i>2000-2004</i>	9.41	7.64	22.26	20.49
<i>2005-2007</i>	6.73	7.61	15.97	16.85

Notes: *NPS FoF* is the net payout share, the ratio of net payouts to securities holders (Flow of Funds) to gross value-added (NIPA) in the US non-farm, non-financial, corporate sector. *GPS FoF* is the gross payout share, the ratio of gross payouts to securities holders (including consumption of fixed capital) to gross value-added in the US non-farm, non-financial, corporate sector. We also report the same payout measures based on NIPA data in *NPS NIPA* and *GPS NIPA* for the non-financial corporate sector.

Table 8: Net Payout Ratio for US Non-financial Corporate Sector

	(1)	(2)	(3)	(4)	(5)
	<b>FoF</b>	<b>Compustat: Includes Debt</b>		<b>Compustat: Excludes Debt</b>	
<i>1965-1969</i>	3.45	7.69		14.57	
<i>1970-1974</i>	2.38	11.91		14.36	
<i>1975-1979</i>	1.48	13.97	18.01	14.00	17.04
<i>1980-1984</i>	4.91	14.57	17.93	17.36	20.56
<i>1985-1989</i>	4.31	19.37	22.58	22.97	25.70
<i>1990-1994</i>	11.07	20.16	24.37	23.59	24.29
<i>1995-1999</i>	10.77	21.85	20.74	22.98	23.63
<i>2000-2004</i>	12.26	18.90	24.93	19.85	23.13

Notes: Net Payout Ratio for the non-financial corporate sector, based on Compustat data. The net payout ratio is the ratio of net payouts to securities holders to the sum of payouts to securities holders and payouts to employees  $Comp_t$ . Columns (2) and (4) use labor expenses plus retirement expenses reported in Compustat to measure  $Comp_t$ . Columns (3) and (5) use BLS data on wages per sector to form  $Comp_t$ . The BLS data start only in 1976.

Table 9: Valuation Ratios for US Corporate Sector

	(1)	(2)	(3)
	<i>Tobin's q</i>	$V/(Y - S^a)$	$D/(V - S^a)$
<i>1965-1969</i>	1.96	1.80	1.29
<i>1970-1974</i>	1.49	1.54	0.98
<i>1975-1979</i>	0.97	1.13	0.86
<i>1980-1984</i>	0.94	1.16	2.95
<i>1985-1989</i>	1.33	1.49	2.00
<i>1990-1994</i>	1.70	1.82	4.52
<i>1995-1999</i>	2.58	2.53	3.21
<i>2000-2004</i>	2.33	2.41	4.08
<i>2005-2007</i>	2.02	2.15	3.13

Notes: Tobin's  $q$  is the ratio of the market value of US corporations  $V^a$  divided by the replacement cost of the physical capital stock  $K$ . The value-output ratio ( $V/(Y - S^a)$ ) is  $V^a$  divided by value-added  $Y - S^a$  of the non-financial corporate sector. The net payout yield is the ratio of net payouts  $D$  to the market value  $V^a$ .



Table 10: Cross-sectional Results: Payout Ratios

	(1)	(2)	(3)	(4)
Constant	0.167 (0.004)***	0.170 (0.004)***	0.140 (0.004)***	0.140 (0.005)***
<i>INTAN</i>			0.075 (0.005)***	0.084 (0.005)***
<i>EREALL</i>	-0.300 (0.067)***		-0.071 (0.068)	
<i>REALL</i>		-0.306 (0.067)***		-0.061 (0.067)
<i>EREALL*INTAN</i>			-0.612 (0.063)***	
<i>REALL*INTAN</i>				-0.640 (0.064)***
$\Delta$ Payout Ratio / $\Delta$ <i>EREALL</i>			-0.273 (0.067)***	
$\Delta$ Payout Ratio / $\Delta$ <i>REALL</i>				-0.272 (0.066)***
Number of Industries			47	
Observations			5452	

Notes: \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. This table reports fixed effects estimates of the Payout Ratio (Payout Ratio) on Excess Job Reallocation (*EREALL*), Job Reallocation (*REALL*), Intangibles Ratio (*INTAN*), the interaction of Excess Job Reallocation Intangibles Ratio (*EREALL\*INTAN*) and the interaction of Job Reallocation and Intangibles Ratio (*REALL\*INTAN*) for the periods 1976-2005. The definition of these variables is detailed in Appendix A.3. Partial effects of changes in Excess Job Reallocation and Job Reallocation on the Payout Ratio are also reported. Robust standard errors are shown in parentheses.

Table 11: Cross-sectional Results: Tobin's q

	(1)	(2)	(3)	(4)
Constant	1.349 (0.021)***	1.303 (0.018)***	1.462 (0.014)***	1.427 (0.012)***
<i>EREALL</i>	-2.004 (0.317)***		-1.507 (0.229)***	
<i>REALL</i>		-1.462 (0.320)***		-1.108 (0.228)***
Number of Industries			47	
Observations			5452	

Notes: \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. This table reports fixed effects estimates of *Tobin q1* and *Tobin q2* on Excess Job Reallocation (*EREALL*), Job Reallocation (*REALL*), for the periods 1976-2005. The definition of these variables is detailed in Appendix A.3. Robust standard errors are shown in parentheses.

Table 12: Decomposition of the Net Payout Share

	(1)	(2)	(1)+(2)	(3)	(4)	(3)+(4)
	<i>Div</i>	<i>Int</i>	<i>Cash</i>	<i>Debt Rep.</i>	<i>Equity Rep.</i>	<i>Repurchases</i>
<i>1965-1969</i>	3.78	1.71	5.49	-2.98	-0.29	-3.27
<i>1970-1974</i>	2.91	2.88	5.79	-2.95	-1.22	-4.17
<i>1975-1979</i>	2.67	2.74	5.41	-4.12	-0.37	-4.49
<i>1980-1984</i>	2.96	3.80	6.76	-3.97	0.52	-3.46
<i>1985-1989</i>	3.06	4.01	7.08	-7.97	3.82	-4.16
<i>1990-1994</i>	4.02	3.74	7.76	0.21	0.24	0.46
<i>1995-1999</i>	4.70	2.90	7.60	-2.12	2.24	0.12
<i>2000-2004</i>	4.85	3.16	8.02	-0.16	1.36	1.20
<i>2005-2007</i>	3.73	2.05	5.78	-5.77	7.37	1.61

Notes: This table lists the components of the payouts to securities holders for the US non-financial corporate sector as a fraction of value-added: dividend payments (Column 1), interest payments (Column 2), net debt repurchases (Column 3) and net equity repurchases (Column 4). Cash payments are the sum of dividends and interest payments. Repurchases are the sum of net debt and net equity debt repurchases. All series are scaled by aggregate gross value-added, so that the table gives a decomposition of the Net Payout Share. This table uses data from the Flow of Funds.

Table 13: Link With Capital Share

	(1)	(2)	(3)	(4)
	<i>CS</i>	<i>Taxes</i>	<i>Net Inv</i>	<i>GPS</i>
<i>1965-1969</i>	35.85	16.28	8.81	10.76
<i>1970-1974</i>	32.99	15.23	7.99	9.78
<i>1975-1979</i>	33.73	14.30	7.59	11.84
<i>1980-1984</i>	33.62	12.50	6.58	14.53
<i>1985-1989</i>	34.24	12.90	4.58	16.75
<i>1990-1994</i>	34.04	13.22	3.75	17.07
<i>1995-1999</i>	35.19	13.22	6.43	15.55
<i>2000-2004</i>	33.14	12.14	3.60	17.40
<i>2005-2007</i>	35.37	13.99	3.08	18.30

*Notes:* This table lists the following ratios for the US non-financial corporate sector as a fraction of value-added: capital share (column 1), taxes (column 2), net investment ( $I - \delta K$ ) (column 3) and the gross payouts (column 4). The last column is the difference between the first and the second and third. The small discrepancy arises because the GPS measure does not adjust for foreign-earned payouts, unlike the measure in Table 7.

Table 14: US Manufacturing Sector

	<i>NPR</i>	<i>Tobin's q</i>
<i>1976-1979</i>	6.51	0.75
<i>1980-1984</i>	9.10	0.74
<i>1985-1989</i>	15.32	1.02
<i>1990-1994</i>	14.15	1.16
<i>1995-1999</i>	17.00	1.80
<i>2000-2005</i>	15.68	1.74

*Notes:* The payout ratio is the ratio of payouts to securities holders to total payouts (to securities holders and employees), based on Compustat data for publicly traded companies in the manufacturing sector. Tobin's q is computed as the value of all securities divided by the value of PPE (Property, Plants and Equipment).