Commitment in Organizations and the Competition for Talent

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We show that a change in organizational structure from partnerships to public companies—which weakens contractual commitment—can lead to higher investment in high return-and-risk activities, higher productivity (value added per employee) and greater income dispersion (inequality). These predictions are consistent with the observed evolution of the financial sector where the switch from partnerships to public companies has been especially important in the decades that preceded the 21st Century financial crisis.

Key words: Partnerships, Public companies, Limited commitment, Directed search, On-the-job search, Dynamic contracts, Organizational structure.

JEL Codes: E02, J41, G32, D21, L22, O43

1. INTRODUCTION

Until 1970, the New York Stock Exchange prohibited member firms from being public companies. When the organizational restriction on financial companies was relaxed, there was a movement to go public and traditional partnerships began to disappear. Merrill Lynch went public in 1971, followed by Bear Stearns in 1985, Morgan Stanley in 1985, Lehman Brothers in 1994, and Goldman Sachs in 1999. Other venerable investment banks were taken public and either absorbed by commercial banks or converted to bank holding companies. Today, there are very few partnerships remaining and they are small. The same evolution occurred in Britain where the closed ownership Merchant Banks virtually disappeared.

As the organizational shift was taking place, the financial sector experienced other changes. First, as documented by Philippon and Resheff (2012), the size of the financial sector has increased significantly. The first panel of Figure 1 shows that the GDP share of the financial industry doubled in size between 1970 and 2011. The share of employment also increased but less than for GDP. This is especially noticeable starting in the mid-1980s when the share of employment stopped

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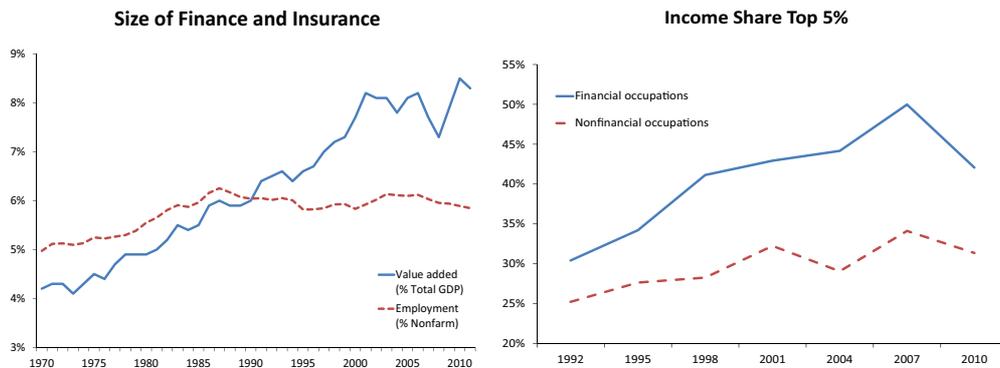2   REVIEW OF ECONOMIC STUDIES

FIGURE 1

Share of value added and employment, and income concentration in finance (FIRE).

Sources: Bureau of Economic Analysis and Survey of Consumer Finances.

growing while the share of value added continued to expand. Accordingly, we see a significant increase in value added per worker compared to the whole economy.

The second important change experienced by the financial sector is the sharp increase in compensation. Clementi and Cooley (2009) show that between 1993 and 2006 the average compensation of CEOs in the financial sector increased from parity with other sectors of the economy to nearly double. At the same time, compensation became more unequal. The second panel of Figure 1 shows that the income concentration in the financial sector (measured by the income share of the top 5%) has increased compared to the rest of the economy.

The question addressed in this article is whether the changes observed in the financial industry are related to the organizational shift from partnerships to public companies.

Addressing this question requires a theory of the differences between the two forms of organization. Of course, there are many specific features that differentiate partnerships from public companies. In this article, we focus on contractual differences that derive from commitment. The key idea is that partnerships are characterized by stronger contractual commitment (weaker agency frictions) than public companies. We then show that a change in organization from partnerships to public companies could generate the empirical trends just described.

But why did financial firms change their organizational form? Even though the 1970s regulatory changes made it easier for financial firms to become public companies, this does not explain why they chose to do so. After all, from the perspective of a single firm, the stronger commitment of a partnership allows more flexibility in the design of contracts and should increase its value.

This consideration ignores the negative equilibrium effects associated with the partnership form of organization: the higher internal efficiency of existing partnerships implies that it will be more difficult for new entrants to hire the managers of existing partnerships. This would ultimately deter entry. By choosing the public company form (characterized by lower internal efficiency), firms encourage the entry of new firms which in turn facilitates the reallocation of managers to more productive uses when the quality of the existing matches deteriorate. The equilibrium benefit could dominate the lower "internal" contractual efficiency, which could help to explain why financial firms decided to become public companies after the 1970s regulatory changes.[1]

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1. Charles Ellis (2008) in his history of Goldman Sachs—the last major firm to go public—suggests that one major motivation for going public was to increase the capital available for their proprietary trading operations through an IPO. In this article, we propose an additional mechanism that is separate from the desire to raise more capital.

To show these effects, we develop a model in which investors compete for managers. There are matching frictions and, therefore, managers and firms are matched through a process of *directed search* (Moen, 1997). Although the productivity of a match may be high initially, it could deteriorate in the future. When that happens, it would be efficient for the manager to re-match with another firm.

Firms could be organized in partnerships or public companies. In both organizations managers have limited commitment, meaning that they can leave the firm at any point in time. The commitment of firms, however, differs in the two organizations. While partnerships are able to commit to the optimal contract, this is not the case for public companies. In particular, public companies will repudiate the contract if their value becomes negative. Instead, partnerships continue to fulfil their promises even if the value of the contract with a single partner becomes negative. Therefore, in a partnership there is "one-sided commitment" (the firm commits but the manager does not commit) while in a public company there is "two-sided limited commitment" (neither the firm nor the manager commit).

Managers decide portfolio allocations in safe and risky investments with returns that depend on the human capital of the manager. Three features of the model are especially important. First, human capital is enhanced by managing riskier investments. In addition to having higher expected returns, successful risky investments also increase the next period human capital of managers. Second, human capital is embodied in managers and, therefore, can be transferred to other firms if they change occupation. Third, the productivity of human capital depends on the quality of the match between the manager and the firm. This implies that the productivity of managers in their current firms could be lower than in other firms.

When the quality of a match is low (mismatch), it will be optimal to reallocate managers to new firms (separation). But this can happen only if outside firms have an incentive to search for employed managers. With costly searching, firms will search only if they anticipate a profit from a new match. This depends crucially on whether incumbent firms respond to external offers received by their managers. A key insight of this article is that partnerships always respond to external offers while public companies may not be able to do so credibly.

Responding to external offers is always optimal for the incumbent firm because it increases the threat value of the manager with a newly matched firm. Absent commitment from the incumbent firm (which is the case in public companies), this is not credible if the productivity of the current match is lower than in a newly matched firm. This allows external firms to make a profit when matched with employed managers. The prospect of positive profits will then encourage firms to search for employed managers, and this, in turn, reduces the overall mismatch.

To assess the quantitative importance of the change in organizational structure in the financial sector, we calibrate the model using data from the 1970s. Although our theory is general, the reason we focus on the financial sector is because this is where the organizational change has been most prevalent. In the baseline model, we assume that all firms are organized in the form of a partnership (one-sided commitment). We then assume that firms become public companies and compare the resulting equilibrium with the (baseline) equilibrium in which all firms are partnerships. This shows that the organizational change generates (i) greater risk-taking; (ii) larger size of the financial sector with higher value added per employees; and (iii) higher compensation and greater income inequality within the financial sector. Quantitatively, these changes are large. For example, the value added per worker and the top 1% of earnings in the equilibrium with public companies are more than twice the values in the equilibrium with partnerships.

In our calibration exercise we also show that, starting from the baseline equilibrium in which all firms are partnerships, an individual firm prefers to be a public company (as the status of public company limits the ability of the firm to respond to any external offer). This may help to

explain why many financial firms became public companies once the 1970s regulatory changes made easier for them to do so.

The article is organized as follows. After a brief literature review, Section 2 presents a stylized model that illustrates the central theoretical mechanism proposed in the article. Section 3 extends the stylized model by adding features that allow to better relate the theory to the trends observed in the financial sector. Section 4 characterizes the optimal contract, and Section 5 the industry equilibrium. Section 6 conducts the calibration exercise, and Section 7 provides empirical support for the main predictions of the model. The final Section 8 concludes.

1.1. *Relation to the literature*

The basic framework often used to study executive compensation is adapted from the principle-agent model of dynamic moral hazard with private information by Spear and Srivastava (1987). Examples include Wang (1997), Quadrini (2004), Clementi and Hopenhayn (2006), and Fishman and DeMarzo (2007). In Albuquerque and Hopenhayn (2004), the agency frictions derive from limited enforcement.

An assumption typically made in this class of models is that the outside value for the manager is exogenous. However, since the outside value of the manager can be thought of as seeking employment elsewhere, it will depend on market conditions. Accordingly, it is important to derive these conditions endogenously.

A second assumption typically made in principal-agent models is that investors fully commit to the contract. However, the clearer separation between investors and managers that followed the transformation of financial partnerships to public companies, could have also reduced the commitment of investors. In this article, we relax both assumptions: we make the outside option of managers endogenous, and we allow for the limited commitment of investors.[2]

Levin and Tadelis (2005) also propose a theory of partnerships where agency problems play an important role in determining the comparative advantages of a partnership over a corporation. In their theory, however, the agency frictions (in the form of information asymmetry) are between the firm and the customers of the firm. There are no agency problems within the firm. Our theory, instead, relies on agency frictions within the firm. Kaya and Vereshchagina (2014) show that the organizational form (partnerships vs. public companies) affects the trade-off between workers complementarities and free-riding.

The article is also related to the literature on searching and matching frictions in the labour market. In particular, the literature that allows for on-the-job search. See, for example, Postel-Vinay and Turon (2013). We depart from this literature by allowing for full and limited commitment of firms. We show that full commitment (*i.e.* one-sided limited commitment) can be a "barrier to entry"; however, in contrast with Aghion and Bolton (1987), in our model post-entry profits are not necessarily lower for the incumbent firm and the latter knows the efficiency of the entry firm.

Shi (2018) studies the long-term contract between firms and managers when the latter could receive external offers in an environment that corresponds to our definition of "two-sided limited commitment," with the exception that, in her model (following Postel-Vinay and Robin, 2002), external offers take the form of "take it or leave it." Shi's paper shows that non-competing clauses with a buyout option could increase the individual value of a firm thanks to the extraction of the surplus created by a new match. Surplus extraction is also a feature of our model. However, this is

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2. Cooley *et al.* (2004) endogenized the outside value but kept the assumption that investors commit to the long-term contract. Marimon and Quadrini (2011) relaxed both assumptions but abstracted from matching frictions and organizational forms.

made possible by higher commitment of incumbent firms with a different organizational form—the partnership—rather than non-competing clauses. Importantly, our article characterizes the general equilibrium effects of different contractual environments on the endogenous probability of matching, which are central for our results.[3]

The empirical trends described in this article have also motivated other studies. However, we are unaware of any study that connects the switch in organizational structure to the increased competition for managerial talents. Cheng *et al.* (2015) and Edmans and Gabaix (2011) explain how, in a principal-agent relationship with a fixed sharing rule, an *exogenous* increase in risk can result in higher compensation for risk-averse financial managers. Bolton *et al.* (2016) propose a model in which it is "cream skimming" in the more opaque financial transactions that have encouraged excessive compensation for financial managers. Acharya *et al.* (2014) explain how firms competition for scarce managerial talent can result in excessive risk taking because managers churn across firms and take on aggregate risks to weaken the revelation of their managerial type. In our article, the increase in risk is a consequence of the *weaker* commitment in public companies and on how human capital accumulates.

2. A STYLIZED MODEL

To illustrate the key theoretical mechanism, we first describe a stylized model with only two periods: period 1 and period 2. In period 1, there is a firm matched with a manager, that invests one unit of financial capital in both periods. The return generated in period 1 is known and equal to $R_1 = \bar{A}$. The return generated in period 2 is $R_2 \in \{\underline{A}, \bar{A}\}$. The return could be low, $\underline{A}$, or high, $\bar{A}$, with equal probability. We refer to the investment return as "productivity."

In period 2, after observing R_2 but before making the investment, with probability ρ the manager rematches with another firm where productivity is $\bar{A}$. We think of the event in which the manager re-matches with a new firm as receiving an "external offer." An important assumption is that the re-matching probability ρ cannot be affected by the incumbent firm. However, since ρ will be determined in equilibrium, the aggregation of all firms' decisions will affect this probability. For the characterization of an individual contract, however, we can take ρ as given.

The manager has reservation values $D < \underline{A}$ in both period 1 and period 2, respectively. However, if the manager receives an external offer in period 2, the reservation is the value of changing occupation.

In summary, the manager starts with high productivity $\bar{A}$ in period 1 but in period 2 it could drop to $\underline{A}$. If the manager re-matches and moves to the new firm, productivity is $\bar{A}$. If the productivity of the existing match in period 2 is $\underline{A}$, it would be efficient for the manager to switch to the new firm.

2.1. *Contract*

The contract defines the manager's compensation in periods 1 and 2, for any possible contingency. We denote by C the manager's compensation in period 1 and by $C(A, \xi)$ the compensation in period 2. The variable ξ is a dummy that takes the value of 1 if the manager re-matches in period 2 (where productivity is $\bar{A}$) and 0 otherwise. Thus, compensation in period 2 is contingent on productivity A and external offer ξ.

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3. Shi (2018) characterizes the equilibrium with a matching probability that is invariant to the contractual environment. By making this probability endogenous, our model predicts that higher surplus extraction (partnerships) leads to lower investment. The opposite happens in Shi (2018).

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The optimal contract maximizes the value for the firm subject to the enforcement constraints. This is equivalent to assuming that in period 1 the firm has all bargaining power. In period 2, if the manager switches firm, her compensation will be determined by Nash bargaining. Given η the bargaining power of the new firm, the manager gets the fraction $1-\eta$ of the net surplus.

The threat value for the manager is the compensation promised by the incumbent firm, $C(A,1)$, and the net bargaining surplus is $\bar{A}-C(A,1)$. Thus, the compensation received in period 2 after switching is

$$\widehat{C}\big(C(A,1)\big) = \begin{cases} C(A,1)+(1-\eta)\Big[\bar{A}-C(A,1)\Big], & \text{if} \quad C(A,1)<\bar{A} \\[2mm] \bar{A} & \text{if} \quad C(A,1)\geq\bar{A}. \end{cases} \tag{2.1}$$

The function $\widehat{C}(C(A,1))$ is strictly increasing for $C(A,1)<\bar{A}$ and becomes constant at $\bar{A}$ since this is the maximum that the new firm is willing to pay.

2.2. *Two enforcement regimes*

We characterize the optimal contract signed in period 1 under two enforcement regimes. In the first regime the firm "commits" to the long-term contract. This means that the firm will not renege the contract in period 2 even if it implies negative profits. In the second regime, instead, the firm "does not commit" and will repudiate the contract if profits are negative. We refer to the first regime as "one-sided" commitment (the firm commits but the manager does not) and to the second as "two-sided" limited commitment (both the firm and the manager can repudiate the contract). We think of the first regime as representative of "partnerships" and the second regime as representative of "public companies."

2.3. *Characterization with one-sided commitment*

When the firm commits to not renegotiate in period 2, the optimal contract solves the problem,

$$\max_{\substack{C,C(\underline{A},0),C(\underline{A},1),\\ C(\bar{A},0),C(\bar{A},1)}} \bar{A}-C+\frac{1-\rho}{2}\big(\bar{A}-C(\bar{A},0)\big)+\frac{1-\rho}{2}\big(\underline{A}-C(\underline{A},0)\big)+\frac{\rho}{2}\big(\bar{A}-C(\bar{A},1)\big)$$

subject to

$$C+\frac{1-\rho}{2}C(\bar{A},0)+\frac{1-\rho}{2}C(\underline{A},0)+\frac{\rho}{2}C(\bar{A},1)+\frac{\rho}{2}\widehat{C}\big(C(\underline{A},1)\big)\geq D \tag{2.2}$$

$$C(\bar{A},0)\geq D \tag{2.3}$$

$$C(\underline{A},0)\geq D \tag{2.4}$$

$$C(\bar{A},1)\geq\bar{A} \tag{2.5}$$

$$C(\underline{A},1)\leq\bar{A}. \tag{2.6}$$

The contract maximizes the lifetime value of profits by choosing state-contingent compensations subject to a set of enforcement constraints for the manager. In the event that in period 2 productivity is low, $\underline{A}$, and the manager receives an external offer, $\xi=1$, it is optimal to separate. The firm's profits under this contingency—which happens with probability $\rho/2$—are then zero.

The first constraint, equation (2.2), is the enforcement constraint for the manager in period 1. It imposes that the expected lifetime value of compensation (left-hand side) cannot be smaller than the outside option D. The term $\widehat{C}(C(\underline{A}, 1))$ is the compensation received by the manager in period 2 if she receives an external offer and productivity in the incumbent firm is low. In this case, the manager will switch to the newly matched firm and $\widehat{C}(C(\underline{A}, 1))$ is the compensation received from the new firm, as determined by equation (2.1).

Equations (2.3) and (2.4), are the enforcement constraints in period 2 when the manager does not receive an external offer. In this case, the contract must guarantee a compensation that is not lower than the reservation value. Equation (2.5) is the enforcement constraint when productivity is high and the manager receives an external offer. In this case, the value of the external offer becomes the reservation value. Since the external firm is willing to increase the manager's compensation as long as it breaks even, the maximum value of the external offer is $\bar{A}$. Thus, in order to retain the manager, the incumbent firm cannot pay less than $\bar{A}$.

Constraint (2.6) is for the case in which the productivity in the incumbent firm is low ($\underline{A}$) and the manager receives an external offer ($\xi = 1$). Since in this case it is optimal to separate (which we have implicitly assumed) the compensation promised by the incumbent firm cannot exceed $\bar{A}$, that is, the maximum compensation offered by the external firm. Otherwise, the manager would not quit.

Proposition 1 *The optimal contract sets $C(\underline{A}, 1) = \bar{A}$ while C, $C(\underline{A}, 0)$, $C(\bar{A}, 0)$, $C(\bar{A}, 1)$ are indeterminate. Any combination that satisfies constraint (2.2) with equality and constraints (2.3)–(2.5) with either equality or inequality, is optimal.*

Proof. Appendix A.

Since the contract maximizes the value of the firm, it is optimal to minimize the expected manager's compensation, which explains why constraint (2.2) is satisfied with equality. When the match is separated, however, it is optimal to promise the highest possible value. This happens when productivity is low and the manager receives an external offer. By promising $C(\underline{A}, 1) = \bar{A}$, the threat value for the manager in the new match is $\bar{A}$, which allows the manager to extract the whole surplus from the new match. A higher value received by the manager in period 2 in the event of separation will then increase her expected value in period 1. This allows the incumbent firm to pay a lower C in period 1.

The indeterminacy for the remaining compensation structure derives from the risk-neutrality of the manager: to the extent that it does not violate the constraints, both parties would be indifferent in paying less in period 1 and more in period 2 for contingencies where constraints are slack, or viceversa. With a risk-averse managers, which will be the case in the general model, the compensation structure would be determinate. Without loss of generality, in the rest of this section we will focus on the optimal contract that satisfies all constraints (2.3)–(2.5) with equality.

2.4. *Characterization with two-sided limited commitment*

An implication of the optimal contract just described is that, by committing to $C(\underline{A}, 1) = \bar{A}$, if the manager chooses to stay with the incumbent firm even if the contract recommends separation, the firm would make negative profits: the firm pays $\bar{A}$ to the manager but production is only $\underline{A}$. This is not a problem when the firm commits to the long-term contract. However, if the firm does not commit, the promise of $C(\underline{A}, 1) = \bar{A}$ is not credible. In this case, the optimal contract must satisfy additional constraints insuring that the firm does not incur losses in all possible contingencies.

Formally,

$$C(\bar{A}, 0) \leq \bar{A} \tag{2.7}$$

$$C(\underline{A}, 0) \leq \underline{A} \tag{2.8}$$

$$C(\bar{A}, 1) \leq \bar{A} \tag{2.9}$$

$$C(\underline{A}, 1) \leq \underline{A}. \tag{2.10}$$

While the first three constraints are satisfied in the optimal contract with one-sided commitment, this is not the case for constraint (2.10). When productivity is low and the manager receives an external offer, the maximum "credible" promise is $C(\underline{A}, 1) = \underline{A}$, that is, the break-even compensation for the incumbent firm.

Proposition 2 *The optimal contract sets* $C(\underline{A}, 1) = \underline{A}$, $C(\bar{A}, 1) = \bar{A}$, *while* C, $C(\underline{A}, 0)$, $C(\bar{A}, 0)$ *are indeterminate. Any combination that satisfies constraint (2.2) with equality and constraints (2.3)–(2.4) with either equality or inequality, is optimal.*

Proof. Appendix B.

Also in this case we have some indeterminacy but without loss of generality we can focus on the optimal contract that solves constraints (2.3) and (2.4) with equality.

The key difference with one-sided commitment is that $C(\underline{A}, 1) = \bar{A}$, while with two-sided limited commitment $C(\underline{A}, 1) = \underline{A}$. This difference has important equilibrium implications that operate through the probability of external offers ρ.

2.5. *Equilibrium*

New matches are formed in a frictional labour market where firms post vacancies targeted at managers employed in low quality matches. The number of matches are determined by an aggregate matching function $m(N, S)$, where N is the number of vacancies, and S the number of managers that in period 2 are in matches with low productivity, $\underline{A}$. Since productivity in existing matches drops to $\underline{A}$ with 50% probability, we have that $S = 0.5$.

The matching probability is $\rho(N) = m(N, S)/S$ and the probability of filling a posted vacancy is $\phi(N) = m(N, S)/N$. We express these two probabilities as functions of N only since $S = 0.5$. We make the following assumption.

Assumption 1 *The matching probability* $\rho(N)$ *is strictly increasing in* N *and satisfies* $\lim_{N \to 0} \rho(N) = 0$ *and* $\lim_{N \to \infty} \rho(N) = 1$. *The probability* $\phi(N)$ *is strictly decreasing in* N *and satisfies* $\lim_{N \to 0} \phi(N) = 1$ *and* $\lim_{N \to \infty} \phi(N) = 0$.

Denote by τ the cost of posting a vacancy. The free-entry condition reads

$$\phi(N)(\bar{A} - \widehat{C}) \leq \tau, \tag{2.11}$$

where $\widehat{C}$ is the managers compensation paid by new firms. This condition determines the number of posted vacancies N. If the condition is satisfied with the inequality sign, there will be no entry and the matching probability is zero.

The free-entry condition illustrates the important equilibrium difference between one-sided commitment and two-sided limited commitment. With one-sided commitment the compensation

received from a newly matched firm is $\widehat{C}(C(\underline{A},1))=\bar{A}$. This implies that the free-entry condition is satisfied with the inequality sign and there is no entry: if firms cannot make a profit, they will not post vacancies.

In the regime with two-sided limited commitment, instead, the compensation received from the new firm is $\widehat{C}(C(\underline{A},1))=\underline{A}+(1-\eta)(\bar{A}-\underline{A})$ and the new firm makes the profit $\eta(\bar{A}-\underline{A})>0$. Provided that this is bigger than τ, firms will post vacancies and in equilibrium $\rho(N)>0$.

Proposition 3 *Assume $\tau<\eta(\bar{A}-\underline{A})$. In the equilibrium with one-sided commitment $\rho(N)=0$ while with two-sided limited commitment $\rho(N)>0$.*

Proof. It follows directly from the free entry condition (2.11). ∎

2.6. *Efficiency*

To show the importance of the equilibrium effects for efficiency, it is sufficient to compare the expected value of the contract for the firm in the environments with one-sided commitment and two-sided limited commitment. In both environments, the expected value of the contract for managers in period 1 is D. Therefore, managers are indifferent. With two-sided limited commitment there is entry in period 2, which implies searching costs. However, new firms are fully compensated in expectation (break even). This implies that the Pareto ranking is fully determined by the contract value for incumbent firms in period 1.

The proofs of Propositions 1 and 2 have shown that the expected contract values for a firm in the two environments are

$$V^c = \bar{A}+\frac{1}{2}(\bar{A}+\underline{A})-D+\frac{\rho}{2}(\bar{A}-\underline{A}) \tag{2.12}$$

$$V^{lc} = \bar{A}+\frac{1}{2}(\bar{A}+\underline{A})-D+\frac{\rho}{2}(\bar{A}-\underline{A})-\frac{\eta\rho}{2}(\bar{A}-\underline{A}). \tag{2.13}$$

The first equation is the firm's value with one-sided commitment (the superscript c stands for "commitment") while the second equation is the firm's value with two-sided limited commitment (the superscript lc stands for "limited commitment").

We can see that, if the matching probability ρ is the same in the two environments (which would be the case if ρ was exogenous), the contract value with one-sided commitment is bigger than with two-sided limited commitment. Specifically, we have $V^c(\lambda)-V^{lc}(\lambda)=\eta\rho(\bar{A}-\underline{A})/2>0$. Therefore, ignoring equilibrium effects, the contract with one-sided commitment is more efficient. However, once we make ρ endogenous, we reach the opposite conclusion, as we now show.

In the equilibrium with one-sided commitment, the matching probability ρ is zero while with two-sided limited commitment $\rho>0$. Setting $\rho=0$ in the environment with one-sided commitment, the difference in contract values is

$$V^c - V^{lc} = -\frac{(1-\eta)\rho}{2}(\bar{A}-\underline{A})<0.$$

This shows that, once we take into account equilibrium effects, the firm's value is smaller with one-sided commitment. Thus, the equilibrium with two-sided limited commitment Pareto dominates the equilibrium with one-sided commitment.

2.7. *Summary and moving forward*

We have shown that, abstracting from equilibrium effects, the environment with one-sided commitment is more efficient. This is consistent with the principle that greater enforcement enhances efficiency. However, in equilibrium, greater commitment reduces competition for managers which results in lower turnover and higher mis-allocation.

This finding is important for capturing the empirical facts that motivated this article. First, the fact that firms have higher value with two-sided limited commitment (public company) could be important for understanding why financial firms decided to become public companies after the 1970s regulatory change.

Second, as financial firms change their organizational structure from partnerships to public companies, the expected lifetime productivity of managers increases. This has implications for the incentive to invest in human capital, a feature that is missing in the stylized model presented here but will be central to the general model. With this feature, a greater allocation efficiency facilitates the accumulation of human capital which generates large increases in value added per worker.

Third, if the return from human capital is risky, more investment generates greater dispersion in compensation. In this way, the model could generate higher income inequality, another empirical fact outlined in Section 1. To illustrate these points more precisely, the Supplementary Appendix provides an extension of the stylized model with endogenous human capital.

3. GENERAL MODEL

Now, we extend the two-period model in two important dimensions. First, time is infinite and agents live for potentially many periods. Second, there is accumulation of human capital and investment portfolio choice.

3.1. *Agents*

There is a continuum of risk neutral investors and a unit mass of risk-averse managers. Investors are the owners of the firms while managers are skilled workers hired by firms to run their investments.

Managers survive with probability ϖ and a mass $1-\varpi$ of managers is born in every period so that the total mass remains constant at 1. New born managers enter the economy with human capital h_0, after which it evolves endogenously over the life-cycle as specified below. The expected lifetime utility is

$$Q_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(C_t),$$

where C_t is consumption. The period utility is strictly increasing and concave and takes the standard CES form. Future utilities are discounted by $\beta = \bar{\beta}\varpi$, where $\bar{\beta}$ is the intertemporal discount rate and ϖ is the survival probability. Investors are infinitely lived and discount the future also by $\bar{\beta}$ as managers.

3.2. *Partnership versus public company*

Firms operate an investment technology linear in the number of managers. Each firm, independently of their organizational structure, employs a large number of managers so that the aggregate performance is not impacted by idiosyncratic shocks related to an individual manager.

The key difference between a partnership and a public company is in the ownership. A partnership is owned by partners/managers and will never renege on them. Therefore, we assume

that the partnership commits to long-term contracts but managers do not commit and separate at will (one-sided commitment).

In a public company, instead, the owners of the firm—the shareholders—are distinct from managers. Even if managers own some shares, the direct ownership is small. Because the firm operates on behalf of shareholders—not managers—reneging on previous promises to managers becomes possible—in particular, if the shareholders' value turns negative (limited liability). Thus, we characterize the contract structure in a public companies as having two-sided limited commitment.

Even if a partnership is owned by managers, the linearity of the technology together with the assumption of a large partnership allow us to focus on the contractual relationship between an individual manager and a firm that operates on behalf of all other partners. The firm acts as if it were owned by a risk-neutral investor. Thus, in both environments, the objective of the firm can be specified as

$$V_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\Pi_t - C_t \right),$$

where Π_t is a measure of earnings generated by the manager within the firm and C_t is the manager's compensation. Thus, $\Pi_t - C_t$ is the firm's payout.

3.3. *Investment technology*

At an point in time, a manager is characterized by a level of human capital denoted by h_t. Human capital can be allocated to manage two types of investments: "safe" and "risky."

Let K_t^s and h_t^s be, respectively, the financial and human capital allocated to safe investments, while K_t^r and h_t^r are the financial and human capital allocated to risky investments. The next period returns are

$$R_{t+1}^s = A_t \min \left\{ K_t^s, h_t^s \right\},$$

$$R_{t+1}^r = z_{t+1} A_t \min \left\{ K_t^r, h_t^r \right\}.$$

Both variables A_t and z_{t+1} follow stochastic processes. However, while A_t is known before making the investment decision, z_{t+1} is observed in the next period, and therefore, after the choice of K_t^r and h_t^r. The variable $z_{t+1} \in \{\underline{z}, \bar{z}\}$ is independently and identically distributed across firms and times with $\mathbb{E}(z_{t+1}) > 1$. The risky investment has a higher expected return but is uncertain (risky).

The variable A_t represents the *quality* of the match and can take two values, $\underline{A}$ and $\bar{A}$, with $\underline{A} < \bar{A}$. Since A_t is firm-specific, when $A_t = \underline{A}$, it would be efficient for a manager to be re-employed in a new firm if the quality of the new match is higher. In this way, the model could generate job turnover.

Assumption 2 *The initial quality of a new match is always $A_t = \bar{A}$. After that, it drops permanently to $A_t = \underline{A}$ with probability θ.*

Under this assumption, when the matching quality deteriorates to $A_t = \underline{A}$, the only way for the manager to restore high productivity is by rematching with a new firm. The assumption that $\underline{A}$ is an absorbing shock is not essential.[4]

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4. Assuming a more standard Markov process would not change the main properties of the model. Provided that the process displays persistence, when $A_t = \underline{A}$ the expected future productivity in the current match is lower than $\bar{A}$ and would be optimal to relocate the manager.

Given the Leontief structure for the aggregation of financial and human capital, the optimal input of financial capital is always equal to the input of human capital, that is, $K_t^s = h_t^s$ and $K_t^r = h_t^r$.[5] We can then write the total return as

$$R_{t+1} = R_{t+1}^s + R_{t+1}^r = \Big[1 + \lambda_t(z_{t+1} - 1)\Big]A_t h_t,$$

where λ_t denotes the fraction of the portfolio allocated to the risky investment. We refer to this variable as the "portfolio choice."

The management of the risky investment is costly. The cost function takes the form $e(\lambda_t)K_t$ with $e(0) = 0$, $e'(.) > 0$, and $e''(.) > 0$. This captures the idea that managing risky investments is more demanding than safe investments and as more capital is allocated to risky investments, the management efficiency declines. For notational simplicity, we formalized this idea with a convex cost instead of a reduction in the investment return.

3.4. *Human capital accumulation*

Human capital h_t increases with the success of the investment, that is, $h_{t+1} = h_t + \kappa R_{t+1}$.

Define $\Pi_t = -K_t - e(\lambda_t)K_t + \bar{\beta}(K_t + \mathbb{E}_t R_{t+1})$. This is the discounted expected "gross" cash flow, $\bar{\beta}(K_t + \mathbb{E}_t R_{t+1})$, minus the investment cost $K_t + e(\lambda_t)K_t$. Since $K_t = h_t$, we can use the more compact notation

$$\Pi_t = \pi(A_t, \lambda_t)h_t,$$
$$h_{t+1} = g(A_t, \lambda_t, z_{t+1})h_t,$$

where

$$\pi(A_t, \lambda_t) = -1 - e(\lambda_t) + \bar{\beta}\left\{1 + \Big[1 + \lambda_t(\mathbb{E}z - 1)\Big]A_t\right\} \tag{3.14}$$

$$g(A_t, \lambda_t, z_{t+1}) = 1 + \kappa\Big[1 + \lambda_t(z_{t+1} - 1)\Big]A_t. \tag{3.15}$$

The function $\pi(A_t, \lambda_t)$ shows that a riskier portfolio (higher λ_t) has a higher expected return but it is more uncertain and requires a higher management cost. The function $g(A_t, \lambda_t, z_{t+1})$ is the gross growth rate of human capital which increases with the fraction of the portfolio allocated to risky investments. Successful investments increase both the immediate financial return but also future expected returns by raising human capital. In order to insure that the problem is well defined, the expected growth rate of human capital cannot be too big. We will then impose that $\beta \mathbb{E} g(A_t, 1, z_{t+1}) < 1$, that is, the maximum expected growth rate (when $\lambda_t = 1$) is smaller than the intertemporal discount factor.

3.5. *Market for managers*

Managers could match with new posted vacancies not only when they are unemployed but also when matched with an incumbent firm (on-the-job search). Since managers are heterogeneous in

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5. The assumption of a Leontief aggregator is without loss of generality. Since the cost of capital is constant and equal to the inverse of the intertemporal discount factor for investors, $\bar{\beta}$, the use of a CES aggregator would imply a constant ratio between financial and human capital.

the quality of the current job, A_t, and in human capital, h_t, a posted vacancy specifies A_t and h_t. If the manager is unemployed, the quality of the existing match is simply $A_t = 0$.

Managers are also heterogeneous in the value of the existing match, that is, their expected lifetime utility, denoted by Q_t. However, we assume that vacancies cannot target a specific value of Q_t. We will relax this assumption in the extension considered in the Supplementary Appendix. The cost of posting a vacancy for managers of type (A_t, h_t) is τh_t, where τ is a parameter.

We focus on industry steady states where industry-level variables are constant. Denote by $N(A, h)$ the posted vacancies with matching quality A and human capital h. Furthermore, denote by $S(A, h)$ the number of managers with these characteristics. Matches are determined by the function $m(A, h) = \bar{m} N(A, h)^\eta S(A, h)^{1-\eta}$, where $\bar{m}$ is a constant. The filling and matching probabilities are

$$\phi(A, h) = \frac{m(A, h)}{N(A, h)},$$

$$\rho(A, h) = \frac{m(A, h)}{S(A, h)}.$$

3.6. *Value of a match*

When a new match is formed, the parties negotiate the initial value of the contract for the manager $\hat{Q}_t$. This is the expected discounted utility received from switching to the newly matched firm. The hat sign is used to differentiate the value received in the new firm from the value Q_t received if staying with the incumbent firm. We refer to $\hat{Q}_t$ as "external offer."

The firm's value, denoted by $V(\bar{A}, \hat{Q}_t, h_t)$, depends on three variables: (1) the matching quality (which for a new match is always $\bar{A}$); (2) the expected utility received by the manager; and (3) the manager's human capital. Although the firm's value is endogenous, it would be convenient to make the following assumption.

Assumption 3 *$V(\bar{A}, \hat{Q}_t, h_t)$ is strictly decreasing, differentiable, and weakly concave in $\hat{Q}_t$. Furthermore, there is $\hat{Q}^{Max}(h_t) < \infty$ for which $V(\bar{A}, \hat{Q}^{Max}(h_t), h_t) = 0$.*

The decreasing property is intuitive: if the value for the manager increases, the firm has to pay higher compensation, which reduces its value. The term $\hat{Q}^{Max}(h_t)$ is the promised utility for which the firm breaks even. It imposes an upper bound to the value that the manager can receive from a new match. When we later derive $V(\bar{A}, \hat{Q}_t, h_t)$ endogenously, we will see that it satisfies Assumption 3.

The value of an external offer, $\hat{Q}_t$, is determined through Nash bargaining. The threat value for the manager is the value of staying with the current firm, Q_t. The threat value for the firm is zero. Thus, the bargaining problem solves

$$\hat{Q}^{\text{Nash}}(Q_t, h_t) = \underset{\hat{Q}_t}{\arg\max} \, V\left(\bar{A}, \hat{Q}_t, h_t\right)^\eta \left(\hat{Q}_t - Q_t\right)^{1-\eta}, \tag{3.16}$$

where η is the bargaining power for the firm. We assume that the bargaining power is equal to the share parameter in the matching function. It is important to emphasize that bargaining will take place only if the threat value for the manager, Q_t, is not bigger than the break-even value for the firm, $\hat{Q}^{Max}(h_t)$.

The bargaining solution depends on two variables: the value of the existing job, Q_t, and the manager's human capital, h_t. The value of the existing job (the threat value for the manager) is especially important because it determines the part of the surplus generated by the new match going to the manager.
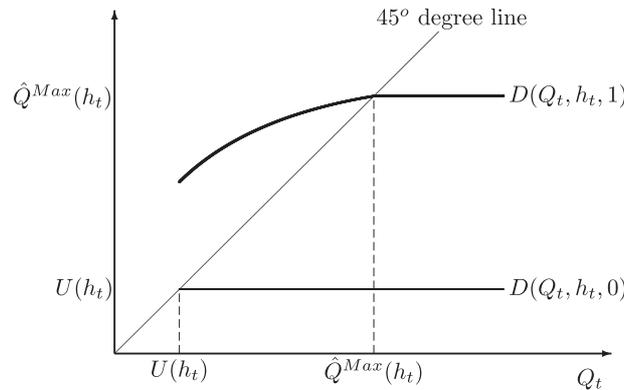
FIGURE 2

Outside value for the manager for given h, as a function of Q_t and ξ_t.

Lemma 1 *The value of a new contract for the manager, $\hat{Q}^{\mathrm{Nash}}(Q_t,h_t)$, is strictly increasing in $Q_t < \hat{Q}^{\mathrm{Max}}(h_t)$.*

Proof. Appendix C.

3.7. *Agency frictions for managers*

Managers can quit and take a new job (if she receives an external offer) or become unemployed. The value of switching to a new firm is $\hat{Q}^{\mathrm{Nash}}(Q_t,h_t)$, as defined in (3.16), while the value of being unemployed is $U(h_t)$. Although the unemployment value will be determined in equilibrium, for the moment we assume that $U(h_t)$ is exogenous and strictly increasing is h_t.

Denote by ξ_t the dummy variable that takes the value of 0 if the manager does not receive an external offer (no match with a new firm) and 1 if she receives an external offer. The outside value for the manager is

$$D(Q_t,h_t,\xi_t) = \begin{cases} U(h_t), & \text{if } \xi_t = 0, \\[2mm] \hat{Q}^{\mathrm{Nash}}(Q_t,h_t), & \text{if } \xi_t = 1 \text{ and } Q_t < \hat{Q}^{\mathrm{Max}}(h_t), \\[2mm] \hat{Q}^{\mathrm{Max}}(h_t), & \text{if } \xi_t = 1 \text{ and } Q_t \geq \hat{Q}^{\mathrm{Max}}(h_t). \end{cases} \qquad (3.17)$$

Figure 2 plots the outside value as a function of Q_t and for a given h_t, separately for $\xi_t = 0$ and $\xi_t = 1$. Without an external offer ($\xi_t = 0$), the outside option is unemployment and, therefore, the outside value is $U(h_t)$. With an external offer ($\xi_t = 1$), the outside value is the value of the new match which increases in Q_t until it reaches the break-even condition for the external firm, $\hat{Q}^{\mathrm{Max}}(h_t)$. Above this the outside value remains $\hat{Q}^{Max}(h_t)$ since the contract value for the external firm would be negative. Notice that we are implicitly assuming that the unemployment value $U(h_t)$ is always smaller than Q_t. This requires some parameter restrictions which we assume throughout the article.

4. THE OPTIMAL CONTRACT

The definition of the outside value of the manager relies on the function $V(\bar{A},\hat{Q}_t,h_t)$. To derive this function, we need to characterize the optimal contract.

4.1.   *One-sided commitment: the case of a partnership*

In a partnership managers are the owners of the firm. So, in principle, there should not be any contractual frictions. This would certainly be the case if there were only one owner-manager. But in a partnership there is more than one partner. Assuming that in a partnership there is a large number of partners (so that idiosyncratic uncertainty cancels out for the whole partnership) and the investment technology is linear in the number of partners (scaled by human capital), we can characterize the contractual problem by focusing on the contract between a risk-averse partner and a risk-neutral firm that represents all other partners. While the firm commits to the contract, the manager can leave at any time.

The contractual problem is subject to a set of constraints. The first is the *promise keeping* constraint. This requires that the manager receives the lifetime utility promised by the firm in the bargaining stage,

$$u(C_0) + \mathbb{E}_0 \sum_{t=1}^{\infty} \delta_{0,t} \left[\omega_t u(C_t) + (1 - \omega_t) D(Q_t^s, h_t, \xi_t) \right] \geq Q_0. \tag{4.18}$$

The discount factor, $\delta_{t,n} = \beta^n \Pi_{j=1}^{n-1} \omega_{t+j}$, takes into account the possibility of exogenous separation with $\beta = \bar{\beta}\varpi$ and endogenous separation with $\omega_{t+j} \in \{0,1\}$.

After the starting date $t = 0$, if the match is not separated, the contract must guarantee a value for the manager that is not smaller than the value of quitting. This gives rise to the *enforcement constraint*

$$u(C_t) + \mathbb{E}_t \sum_{n=1}^{\infty} \delta_{t,n} \left[\omega_{t+n} u(C_{t+n}) + (1 - \omega_{t+n}) D(Q_{t+n}^s, h_{t+n}, \xi_{t+n}) \right] \geq$$
$$D\left(\hat{Q}^{\text{Max}}(h_t), h_t, \xi_t \right). \tag{4.19}$$

The left-hand side is the value of the contract for the manager in period t conditional on continuation. We previously denoted this value by Q_t. The right-hand side is the value of quitting. Notice that when the manager receives an external offer, in order to retain the manager the incumbent firm has to offer at least $\hat{Q}^{\text{Max}}(h_t)$, that is, the break-even value for the new firm. Thus, the outside value is $D(\hat{Q}^{\text{Max}}(h_t), h_t, \xi_t)$. The enforcement constraint (4.19), which is conditional on not separating, must be satisfied for all $t \geq 1$ until the partnership is separated.

The final constraint is an *incentive constraint*. It guarantees that the manager does quit when it is optimal to separate. This requires that the promised utility conditional on separation, denoted by Q_t^s, is not greater than the value of quitting. More specifically, if it is optimal to separate (*i.e.* $\omega_t = 0$), then

$$Q_t^s \leq D(Q_t^s, h_t, \xi_t), \tag{4.20}$$

which must be satisfied for all $t \geq 1$.

As in Marcet and Marimon (2019), the optimal contract can be characterized by maximizing the weighted sum of the lifetime utilities of both parties. Given 1 as the weight for the firm and zero for the manager, the contractual problem is

$$V(\bar{A}, Q_0, h_0) = \max_{\{\lambda_t, C_t, \omega_{t+1}, Q_{t+1}^s\}_{t=0}^{\infty}} \left\{ \pi(A_0, \lambda_0) h_0 - C_0 + \mathbb{E}_0 \sum_{t=1}^{\infty} \delta_{0,t} \omega_t \left[\pi(A_t, \lambda_t) h_t - C_t \right] \right\} \tag{4.21}$$

s.t.   (4.18), (4.19), (4.20).

4.2. *Optimal partnership policies*

We start with the characterization of the optimal Q_{t+1}^s, that is, the utility promised to the manager conditional on separation. This is the value that received by the manager if she chooses to stay with the current firm, even though the optimal contract prescribes separation. Of course, if it is optimal to separate, the manager will quit and her continuation value will be the value of quitting, not Q_{t+1}^s. However, Q_{t+1}^s is still important because it determines the threat value in the negotiation with the new firm.

Lemma 2   *In a partnership (one-sided commitment), if the manager matches with a new firm,*
$Q_{t+1}^s = \hat{Q}^{Max}(h_{t+1})$.

Proof. Appendix D.

If it is optimal to separate when the manager matches with a new firm, the optimal continuation utility, conditional on separation, maximizes the outside value of the manager, that is, $Q_{t+1}^s = \text{argmax}_Q D(Q, h_{t+1}, \xi_{t+1})$. Given the outside value function defined in (3.17), the solution is $Q_{t+1}^s = \hat{Q}^{Max}(h_{t+1})$.

This result has a simple intuition. By increasing the future outside value of the manager, the incumbent firm can reduce the compensation paid to the manager today. This is achieved by increasing Q_{t+1}^s because, in case of future separation, it allows the manager to negotiate a higher contract value with the new firm. Since promising a higher continuation utility conditional on separation has no cost for the incumbent firm (the manager will quit after receiving the offer), it allows the firm to reduce the manager's compensation today, which increases the firm's value.

To characterize the other partnership policies, it would be convenient to rewrite the contractual problem recursively. The decision variables are the portfolio allocation, λ, the current compensation for the manager, C, the next period separation, $\omega(\mathbf{s}')$, and the next period continuation utility *conditional* on continuation, $Q(\mathbf{s}')$. The prime sign denotes next period variables. The choices of separation and continuation utility are contingent on the next period exogenous states $\mathbf{s}' = (A', z', \xi')$.

$$V(A, Q, h) = \max_{\lambda, C, \omega(\mathbf{s}'), Q(\mathbf{s}')} \left\{ \pi(A, \lambda)h - C + \beta \mathbb{E}\omega(\mathbf{s}')V\Big(A', Q(\mathbf{s}'), h'\Big) \right\} \qquad (4.22)$$

s.t.

$$Q = u(C) + \beta \mathbb{E}\left[\omega(\mathbf{s}')Q(\mathbf{s}') + \Big(1 - \omega(\mathbf{s}')\Big)D\Big(Q^{s'}, h', \xi'\Big)\right],$$

$$Q(\mathbf{s}') \geq D\Big(\hat{Q}^{Max}(h'), h', \xi'\Big),$$

$$h' = g(A, \lambda, z')h,$$

$$Q^{s'} = \hat{Q}^{Max}(h')$$

The first constraint is the promise keeping constraint, which has been derived by rewriting (4.18) recursively. The second is the enforcement constraint for the manager—equation (4.19)— also in recursive form. The third constraint is the law of motion for human capital. The fourth constraint defines $Q^{s'}$, the promised utility conditional on separation which, according to Lemma 2, is equal to $\hat{Q}^{Max}(h')$.

Appendix E characterizes Problem (4.22) and shows that $V(A,Q,h)$ is strictly increasing in A and h, strictly decreasing in Q, and differentiable. Furthermore, under some conditions, $V(A,Q,h)$ is also strictly concave in Q and the optimal policies can be characterized with first order conditions.

4.3. Two-sided limited commitment: the case of a public company

In public companies, there is separation between management and ownership and the firm could repudiate the contract if its value becomes negative. This introduces an *enforcement constraint* also for the firm,

$$\pi(A_t,\lambda_t)h_t - C_t + \mathbb{E}_t\sum_{n=1}^{\infty}\delta_{t,n}\omega_{t+n}\Big(\pi(A_{t+n},\lambda_{t+n})h_{t+n} - C_{t+n}\Big) \geq 0, \qquad (4.23)$$

which must be satisfied for any $t \geq 1$.

With two-sided limited commitment, there is another condition that needs to be satisfied: the promised utility *conditional* on separation, Q_t^s, must be credible. More specifically, if the contract prescribes separation but the manager chooses to stay and accepts Q_t^s, the firm's value cannot be negative. Formally,

$$V(A_t,Q_t^s,h_t) \geq 0. \qquad (4.24)$$

With one-sided commitment (partnership), instead, the firm commits and, therefore, it will not repudiate the contract even if its value becomes negative.

Constraint (4.24) implies that the optimal Q_{t+1}^s can differ from the utility that maximizes the outside value of the manager.

Lemma 3 *In a public company (two-sided limited commitment), $Q_{t+1}^s < \hat{Q}^{\mathrm{Max}}(h_{t+1})$ if $A_{t+1} = \underline{A}$.*

Proof. See Appendix F.

If $A_{t+1} = \underline{A}$, the continuation utility $Q_{t+1}^s = \hat{Q}^{Max}(h_{t+1})$ implies a negative value for the incumbent firm if the manager stays. Because the firm has limited commitment, this promise is not credible. The optimal and credible utility satisfies $V(\underline{A},Q_{t+1}^s,h_{t+1}) = 0$. For the newly matched firm, instead, the value is positive since the quality of the match is high, that is, $A_{t+1} = \bar{A}$. This is the key difference between one-sided commitment and two-sided limited commitment.

The contractual problem takes the same form as Problem (4.22) with two modifications. First, the utility conditional on separation, $Q^{s'}$, is no longer equal to $\hat{Q}^{\mathrm{Max}}(h)$ (the last constraint in Problem (4.22)) but is determined by $V(A',Q^{s'},h') = 0$. Second, the problem is subject to the additional constraint $V(A',Q(\mathbf{s}'),h') \geq 0$ since the firm's value cannot be negative. Appendix G provides further details.

4.4. Normalization with log-utility and solution procedure

Since human capital grows on average over time, so does the values for the manager and the firm. It is then convenient to normalize the growing variables. Appendix H normalizes the problem so that we can work with a stationary system.

5. INDUSTRY EQUILIBRIUM

In each period, vacancies are posted and new matches are formed. A vacancy specifies the human capital h and the matching quality of the current job. Upon matching, the value of the contract for the manager is determined through Nash bargaining and solves Problem (3.16). The solution, denoted by $\hat{Q}^{\text{Nash}}(Q_t, h_t)$, depends on the threat value of the manager, Q_t, and her human capital h_t.

The threat value depends on the quality of the existing match. When $A_t = 0$, meaning that the manager is unemployed, the threat is the unemployment value $Q_t = U(h_t)$. If $A_t = \underline{A}$ or $A_t = \bar{A}$, meaning that the manager is employed, the threat value is the continuation utility promised by the existing contract conditional on separation, that is, $Q_t = Q_t^s$.

Once we have the initial value of the contract for the manager, we can determine the initial value for the firm, that is,

$$\overline{V}(Q_t, h_t) = V\Big(\bar{A}, \hat{Q}^{\text{Nash}}(Q_t, h_t), h_t\Big),$$

where the firm's value function $V(.)$ has been defined earlier.

The free-entry condition is

$$\phi(A, h)\overline{V}(Q, h) \leq \tau h,$$

where $\phi(A, h)$ is the probability of filling a vacancy, $\overline{V}(Q, h)$ is the value of a filled vacancy for the firm, and τh is the cost of posting the vacancy. Since we are focusing on a steady state, we eliminated time subscripts.

The free-entry condition requires that the expected value of posting a vacancy (left-hand side) cannot be bigger than its cost (right-hand side). If the condition is satisfied with the inequality sign, no vacancies will be posted. In this case, the filling probability is $\phi(A, h) = 1$ and the matching probability is $\rho(A, h) = 0$. Since a vacancy specifies the quality of the pre-exiting match and the human capital of the manager, the filling and matching probabilities could also depend on A and h.

The value of being unemployed is determined by the equation

$$U(h_t) = u(\underline{c}h_t) + \beta\left[\rho(0, h_t)\hat{Q}^{Nash}\Big(U(h_t), h_t\Big) + \Big(1 - \rho(0, h_t)\Big)U(h_t)\right],$$

where $\underline{c}$ is the "exogenous" consumption flow when the manager is unemployed.

We have shown in the Appendix that the firm's value $V(.,.,.)$ is linear in h. This implies that the value of a new match is also linear, that is, $\overline{V}(Q, h) = \bar{v}(q)h$. We can then normalize the free entry condition to

$$\phi(A, h)\bar{v}(q) = \tau. \tag{5.25}$$

This shows that the filling probability $\phi(A, h)$ and, therefore, the matching probability $\rho(A, h)$, are independent of human capital. Therefore, in the analysis that follows we omit h as an argument of these probabilities. Notice that this condition also depends on q, the normalized threat value in bargaining. This could differ across managers. However, q cannot be observed by external firms.

Definition 1 *A steady state industry equilibrium is defined by a distribution of managers $\mathcal{M}(A, q, h)$ and vacancies $N(A, h)$ such that (1) contracts are optimal; (2) The free-entry condition (5.25) is satisfied for all A and h; (3) The distribution $\mathcal{M}(A, q, h)$ does not change over time.*

Notice that once we know the distribution of managers over A and h, we know the mass of managers that could fill the vacancies $N(A, h)$. This allows us to determine the filling and matching probabilities $\phi(A)$ and $\rho(A)$.

The following proposition characterizes the steady state equilibria in the two regimes with one-sided commitment and two-sided limited commitment.

Proposition 4 *In a steady state industry equilibrium with one-sided commitment (partnerships) $\rho(A)$ is positive only for $A = 0$. In a steady state with two-sided limited commitment (public companies) $\rho(A)$ is positive for $A = 0$ and $A = \underline{A}$.*

Proof. Appendix I.

In the environment with one-sided commitment, managers received offers only if they are unemployed, that is, $A = 0$. This implies that existing matches are never separated endogenously. They are separated only exogenously when an employed manager dies. Therefore, there is no endogenous turnover of managers. In a steady state with two-sided limited commitment, instead, some employed managers (those with matching quality $A = \underline{A}$), receive external offers and switch to new firms. Therefore, an important difference between an industry where partnerships are prevalent versus an industry dominated by public companies is that the latter is characterized by higher turnover.

This result has a simple intuition. It is always efficient to separate when the quality of the existing match is low ($A = \underline{A}$) and the manager receives an external offer (given the higher quality of the new match). With one-sided commitment, however, it is also efficient to set the promised utility so that the external firm breaks even, that is, $q^s = \hat{q}^{\text{Max}}$. But then, a new match does not generate any expected profits for the external firm. As a result, no vacancies will be posted in equilibrium. The only vacancy posted are those targeted at unemployed managers (which are those who have never been employed). With two-sided limited commitment, however, the normalized promised utility $q^s = \hat{q}^{\text{Max}}$ is not credible since the incumbent firm would not break even if the manager stays. The maximum promised utility is smaller than $\hat{q}^{\text{Max}}$ and the external firm will be able to share some of the surplus with the newly hired manager. Vacancies will then be posted also for employed managers.

Corollary 1 *The average matching quality A in the steady state with two-sided limited commitment (public companies) is higher than in the steady state with one-sided commitment (partnerships).*

Proof. Appendix J.

Since in the environment with one-sided commitment, matches are never separated (besides natural death), when high quality matches switch to low quality, they never switch back. In the environment with two-sided limited commitment, instead, low quality matches switch back to high quality with positive probability. The average matching quality is then higher compared to one-sided commitment.

6. QUANTITATIVE EXERCISE

In this section, we conduct a quantitative exercise to assess the impact of the organizational change in the finance industry. To do so we calibrate the version of the model with only partnerships to the 1970s data, that is, the period that preceded the organizational shift from partnerships to public companies. Then, keeping all parameters constant, we solve for the equilibrium with only public companies. The impact of the organizational change is assessed by comparing the steady state equilibrium with partnerships to the steady state equilibrium with public companies.

The quantitative analysis should be interpreted as a counter-factual experiment aimed at capturing the changes induced by the organizational shift, keeping everything else fixed. Obviously, the organizational shift is not the only change that took place during the last 40 years. But the goal of the article is not to capture all possible factors that could have caused the changes described in introduction. Instead, the goal is to assess the quantitative importance of one particular factor: the shift in organizational structure from partnerships to public companies.

6.1. *Calibration*

The model is calibrated yearly using 1970s data. The first parameter to pin down is the discount rate for investors (firms) and managers $r = 1/\bar{\beta} - 1$, which is also the investment return for firms. Following the literature we set $r = 0.04$. The annual survival rate of managers is $\varpi = 0.975$, which implies an average working life of 40 years.

The matching function takes the Cobb–Douglas form, that is, $m_t = \bar{m} N_t^{\eta} S_t^{1-\eta}$. There is limited evidence to pin down the share parameter η. We set it to 0.5 which is the number often used in the macro-labour literature. The scaling parameter $\bar{m}$ does not play any significant role, but it has to be smaller than 1 in order to keep both the filling and matching probabilities below 1. We set it to $\bar{m} = 0.5$.

Consumption when the manager is unemployed, $\underline{c}$, has to be sufficiently small so that separation is not optimal even when the quality of the match is low. An assumption made in the theoretical analysis. As long as this condition is satisfied, $\underline{c}$ does not play an important role. The value we use is 0.0001.

The matching quality can take two values, $\underline{A}$ (low) and $\bar{A}$ (high), and the probability of switching from $\bar{A}$ to $\underline{A}$ is θ. The parameter θ together with the parameter ϖ (calibrated above) determine the steady state fractions of low and high quality matches. In absence of a direct measures, we impose that in the steady state half of the matches are of low quality and half are of high quality.

The matching qualities $\underline{A}$ and $\bar{A}$ correspond to the return from safe investments. They cannot be lower than the discount rate r. Otherwise, financial firms with matching quality $\underline{A}$ would not continue operation. Given the calibration of $r = 0.04$, we set $\underline{A} = 0.05$, which is slightly above the discount rate. The return for high quality matches, $\bar{A}$, is also difficult to pin down from the data. Increasing $\bar{A}$ increases income inequality. So, in principle, we could use some income distribution statistics to pin down $\bar{A}$. The problem, however, is that the concentration of income also increases with the dispersion of the iid shock z_{t+1}. Therefore, we cannot pin down both $\bar{A}$ and the dispersion of the z_{t+1}. Because of this, we set $\bar{A}$ to be 50% higher than the value of $\underline{A}$. We provide a sensitivity analysis in the Online Appendix to show the importance of this parameter.

The return from risky investments, is $z_{t+1} A_t$, where the stochastic variable z_{t+1} takes two values, $\underline{z}$ and $\bar{z}$, both with equal probability $p = 0.5$. Thus, the stochastic process for z_{t+1} is characterized by two parameters: $\underline{z}$ and $\bar{z}$. They will be calibrated jointly with the remaining parameters.

The cost of risky investments takes the quadratic form $e(\lambda_t) = \alpha \lambda^2$. The parameter α is important for determining the optimal composition of portfolio: higher is α and lower is the fraction of risky investments. The last two parameters are κ and τ. The first links the investment return to the growth of human capital and the second is the entry cost.

We calibrate α, κ and τ together with $\underline{z}$ and $\bar{z}$ by targeting the following five moments: (1) average growth rate of income; (2) cross-sectional income inequality; (3) aggregate share of risky investments on total investments; (4) return premium on risky investments; and (5) unemployment rate.

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TABLE 1
Model parameters

Description	Value
Intertemporal discount rate/interest rate	$r = 0.04$
Survival probability	$\varpi = 0.975$
Matching function efficiency and bargaining	$\bar{m} = 0.5, \eta = 0.5$
Consumption when unemployed	$\underline{c} = 0.0001$
Matching quality	$\underline{A} = 0.05, \bar{A} = 0.075, \theta = 0.026$
Risky investment iid shock	$\underline{z} = -6.5, \bar{z} = 9.5, p = 0.5$
Cost of risky investment	$\alpha = 0.032$
Human capital dependence on investment return	$\kappa = 0.232$
Cost of posting a vacancy	$\tau = 0.35$

(1) We impose that the average growth rate of human capital in the model (which in the model is a proxy for the growth rate of income) is equal to the average growth rate of real GDP over the period 1970–80. Here the assumption is that in the 1970s the productivity growth of the financial sector was similar to the productivity growth in the rest of the economy.

(2) As a cross-sectional measure of inequality we use the ratio of the 80th percentile over the 20th percentile of the distribution of earnings in the financial industry, averaged over 1970–80. Data are from the March supplement of the Current Population Survey (CPS). See Section 7. The reason we use this particular measure of inequality is because it is not affected by income top coding, which is a feature of CPS data. In the model, the inequality index is computed using the distribution of human capital.

(3) To compute the share of risky investments in the finance sector we use balance sheet data from the Financial Accounts of the U.S. compiled by the Federal Reserve Board (Flow of Funds). The fraction of risky investments is computed by allocating the various components of assets in the financial industry to safe and risky investments. A detailed description is provided in Appendix K. For the period 1970–80, the average fraction of risky investments is 48.6%.

(iv) The average premium on risky investments is computed from CRSP using the average real stock market return in the U.S. over the period 1970–80 minus the average real return on 5-year treasuries, also over the period 1970–80. The average premium over this period is 3.4%.

(v) The unemployment rate is set to the average national rate over the period 1970–80, which is equal to 6.3% (from BLS data).

The full set of parameter values are reported in Figure 1, and the numerical procedure is described in the Supplementary Appendix.

6.2. *Results*

Figure 3 illustrates some of the properties of the equilibrium in the environments with one-sided commitment (left panels) and two-sided limited commitment (right panels). The top panels plot the portfolio allocation λ_t as a function of the (normalized) promised utility q_t and the bottom panels plot the firm's value, also as a function of the (normalized) promised utility. The short-dashed lines are for low quality matches ($A_t = \bar{A}$) and long-dashed lines for high quality matches ($A_t = \bar{A}$).

The lines are defined over different ranges of q_t, which correspond to the ergodic sets of q_t. In all cases, the lower bound is the value of being unemployment, u. For the upper bounds, we have to distinguish whether we are in the environment with one-sided commitment or two-sided
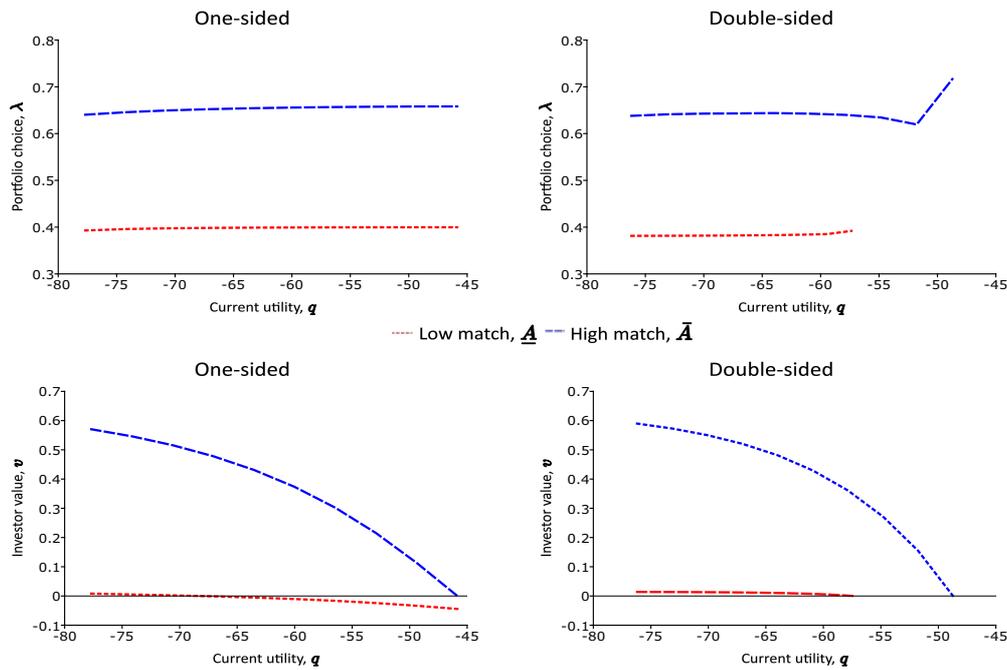
FIGURE 3

One-sided commitment versus two-sided limited commitment. *Short-dashed lines*: values when the quality of the match is low ($A_t = \underline{A} = 0.05$); *Long-dashed lines*: values when the quality of the match is high ($A_t = \bar{A} = 0.075$).

limited commitment. With one-sided commitment, the firm always responds to any external offer received by the manager. Therefore, the upper bound is the break-even condition for the external firm (since new matches are always of high quality). This will be the case independently of whether the incumbent firm has high productivity $\bar{A}$ (long-dashed lines) or low productivity $\underline{A}$ (short-dashed lines).

With two-sided limited commitment, however, an incumbent firm can credibly match external offers only if its productivity is high. When productivity is low, the maximum offer is determined by its own break-even condition. This implies that the maximum q_t that the firm can credibly offer is smaller than the maximum value for the external firm. This explains why in the case of two-sided limited commitment the range of q_t when the incumbent firm has low productivity $\underline{A}$ (short-dashed lines) is smaller than with high productivity $\bar{A}$ (long-dashed lines).

As can be seen from the top panels, the portfolio allocation in risky investments is bigger when the quality of the match is high. This is because the expected return differential between risky and safe investments—which is equal to $(\mathbb{E}z_{t+1} - 1)A_t$—increases with A_t. The incentive to choose riskier investments in high quality matches is further enhanced by the fact that higher returns increase the growth in human capital ($h_{t+1} - h_t = \kappa R_{t+1}$).

The bottom panels plot the value of the contract for the firm. As expected, the value for the firm declines as the utility promised to managers, q_t, increases. This is intuitive: higher promised utilities imply that the firm has to pay higher compensations, which reduce the value of the contract for the firm. It is also intuitive that the firm's value is smaller when the matching quality is low.

In the environment with one-sided commitment (left-panel), when the quality of the match is low (short-dashed line), the value of the firm becomes negative for high values of q_t.

TABLE 2
Equilibrium properties with one-sided and two-sided limited commitment

	One-sided	Two-sided
Probability of matching when unemployed	0.278	0.281
Probability external offer	0.000	0.139
Job separation	0.025	0.045
Fraction of high quality matches	0.497	0.863
Average matching quality	0.062	0.072
Per-capita human capital	2.868	6.474
Human capital growth (average)	0.018	0.022
Human capital growth (standard deviation)	0.069	0.085
Gini index for human capital	0.504	0.745
Ratio 80/20 percentiles	2.940	3.425
Share of human capital top 5%	0.344	0.640
Share of human capital top 1%	0.182	0.496
Utility value unemployed manager	−77.682	−76.193
Utility value new match for unemployed manager	−60.965	−59.297
Firm value when matched with unemployed manager	0.389	0.393

The commitment of the firm is crucial here. Without commitment the firm would renege the contract when the value becomes negative. With commitment, however, the firm will continue to honour its promises. With two-sided limited commitment, instead, this is not credible: as we can see from the last panel of Figure 3, the value of the firm is plotted only when it is positive and stops at the point in which it becomes zero.

Table 2 reports statistics for the steady state equilibrium with one-side commitment and two-sided limited commitment. The comparison of the statistics associated with the two equilibria shows the key quantitative findings of the article:

1. *Increase in value added per worker.* Table 2 shows that switching from the steady state equilibrium with one-sided commitment to the steady state equilibrium with two-sided limited commitment increases per-capita human capital by more than 100%. This corresponds to a similar increase in value added. In contrast, the number of managers working in the financial sector does not increase substantially since the matching probability for unemployed managers increases only marginally (from 27.8% to 28.1%). The large increase in value added together with a relatively small increase in employment in the financial sector is consistent with the first panel of Figure 1.

    To understand this result, we should consider first that in the equilibrium with two-sided limited commitment there is a 13.9% probability that a low productivity manager receives an external offer and switches to a new high productive firm (in the steady state with one-sided commitment this probability is zero). This implies that in the steady state with two-sided limited commitment, a larger fraction of managers are in high quality matches compared to the equilibrium with one-sided commitment (about 86% compared to 50%). Since firms with high matching quality choose higher λ_t (see Figure 3), the average growth in human capital is bigger in the economy with two-sided limited commitment. As a result, the average human capital is bigger and the financial sector produces higher value added.

2. *Increase in inequality.* The fact that in the environment with two-sided limited commitment there is a larger fraction of managers in high quality matches and these managers choose higher values of λ_t, has also another implication. It generates higher dispersion in the

growth rates of individual human capital, both inter-generational (due to higher average growth) and intra-generational (due to higher incidence of z_{t+1} when with λ_t is higher). As a result of higher dispersion in individual growth of human capital, the distribution of income becomes more concentrated. The Gini index rises from 0.5 to 0.75 and the share of human capital of the top 1% increases from 18.2% to 49.6%. This follows from the higher average growth differential between low and high productivity matches (which increases inter-generational inequality) and the higher share of risky investments (which increases intra-generational inequality). The increase in income concentration is consistent with the empirical pattern shown in the second panel of Figure 1.

To summarize, the model predicts that the change in organizational structure in the financial sector has generated large changes in turnover, productivity, and inequality. The quantitative results should be interpreted as upper bounds for the changes induced by the organizational structure observed in the data. For example, in the model, all firms were initially partnerships and they all became public companies. But in reality, not all financial firms were partnerships in 1970s and became public companies afterwards. Also, our counterfactual exercise is based on the assumption that, besides the organizational structure of financial firms, anything else is kept constant. Of course, the observed changes were the result of many changing factors, not only the shift from partnerships to public companies. The goal of our exercise is not to capture all these factors but only the impact of full scale organizational change.

6.3. *Organizational structure and welfare*

To evaluate the welfare associated with the two organizational regimes, we ask the following question: would a newborn manager be better-off in an environment with one-sided commitment or two-sided limited commitment? The answer is obtained by comparing the ex ante utilities of an unemployed manager, u.

The last row of Table 2 shows that the value of a newborn unemployed manger is higher in the environment with two-sided limited commitment.

It is important to emphasize that this finding does not derive from the higher probability of finding an occupation when the financial sector is dominated by public companies. In fact, the matching probabilities for an unemployed manager are very similar in the two environments (27.8% versus 28.1%). Instead, it derives from the higher surplus of a new match in the environment with two-sided limited commitment. As can be seen from the last two rows of Table 2, the values of a new match for both the manager and the firm are bigger in the environment with two-sided limited commitment.

This finding may seem counter-intuitive: two-sided limited commitment imposes additional restrictions on the optimal contract which should reduce the surplus. This is not incorrect from the perspective of an individual firm: the ability to respond to external offers in the environment with one-sided commitment increases the value of the contract for the firm. However, when all firms do so, there will not be external offers in equilibrium. Receiving external offers is efficient because it allows low productivity managers to become more productive in new matches. This is not taken into account by firms when they choose to match external offers since they do not internalize that this discourages new firms from searching for employed managers (externality). For the calibrated model, the negative equilibrium effect dominates the individual efficiency of stronger commitment.

Another important question is whether financial firms choose to become public companies once the legal system allows them to do so.

TABLE 3
Deviation of a single firm to public company in the equilibrium with partnerships

	Partnership	Public company
Probability new match when unemployed	0.278	0.278
Probability external offer	0.000	0.139
Initial value for the manager, q_t	−60.965	−59.804
Initial value for the firm, $v_t(q_t)$	0.389	0.402

To answer this question, we consider the following thought experiment. Starting from the steady state equilibrium with one-sided commitment, suppose that one single firm has the option to choose its organizational form. Would the firm prefer to be a partnership (so that it will be able to commit to the long-term contract with the manager) or a public company (in which case it will be unable to commit but would receive external offers)?

It is important to emphasize that this is a single deviation from the equilibrium, that is, only one single vacancy will be posted by this new firm. All other firms, new and old, will continue to be partnerships. Because of the atomistic nature of the deviation, all equilibrium variables remain the same. For example, the unemployed value u does not change. However, if the new firm chooses to be a public company and the posted vacancy is filled, the hired manager will receive external offers once the quality of the match falls to $A_t = \underline{A}$.[6]

Table 3 reports the initial values of a new match when the newly formed firm is a partnership or a public company. As can be seen, the values of the contract are higher when the firm is a public company. By choosing this organizational form, the firm limits its ability to respond to external offers, increasing the incentive of new firms to search for the employed manager when productivity is low. This raises the ex ante value of the firm, which may explain why financial firms switched to public companies once the regulation made easier for them to do so.

When all firms are allowed to choose the organizational structure, as opposed to a single firm assumed in the thought experiment, there will be a transition dynamics during which the economy converges to a new steady state. Computing the transition, however, is much more involved numerically.

7. EMPIRICAL SUPPORT

As a result of the change from partnerships to public companies, the model predicts:

1. *Higher turnover*: The turnover of managers in the financial sector increases relatively to the non-financial sector.
2. *Higher compensation of managers*: The average compensation of managers in the financial sector increases relatively to the non-financial sector.
3. *Higher inequality*: The cross-sectional dispersion of compensation in the financial sector increases relatively to the non-financial sector.
4. *Higher idiosyncratic volatility*: The individual volatility of compensation in the financial sector increases relatively to the non-financial sector.

The empirical analysis would ideally focus on "managerial" turnover and "managerial" compensation. Unfortunately, managerial data are limited. The most commonly used in the

6. We are assuming that a vacancy can specify the organizational form in which the manager is employed, in addition to the matching quality A_t and human capital h_t.

literature is Execucomp. However, Execucomp data are limited to top executives of very large public companies. There is no compensation data for partnerships. Furthermore, data are available only starting in 1992, that is, after many organizational changes in the financial sector had already taken place.

Given the limited availability of suitable data, we decided to expand the empirical focus and consider all employees, not only managers. Data come from the March supplement of the Current Population Survey (CPS) which contains a large sample of individuals in the U.S. The advantage of the CPS is that it allows us to start the empirical analysis in the 1970s, that is, the period that preceded the regulatory changes that facilitated the organizational shift in finance.

We focus on the period 1975–2000. The starting date is dictated by the availability of data for employees' turnover, which can be computed starting in 1975. The choice of the end date is motivated by the fact that most of the organizational changes experienced by the financial industry took place before 2000. The sample is further restricted to full-time male employees.

Occupations in finance are identified using the industry classification variable "IND50LY." Our definition of the finance sector comprises two industries: "code 716" (Banking and credit agencies) and "code 726" (Security and commodity brokerage and investment companies). The non-finance sector comprises all other sectors. Notice that our definition of finance does not include insurance and real estate. Therefore, it is more restrictive than FIRE (finance, insurance, and real estate).

7.1. *Definition of variables and empirical findings*

We first describe the empirical variables that relate to the four theoretical predictions and then we show their pattern over the period of interest.

7.1.1. Turnover. To construct the turnover rate, we use the variable "NUMEMPS" which contains the number of employers in which the respondent had his main job in the year before the survey was conducted. Reporting two or more employers indicates a job change. The turnover rate is the ratio of the weighted number of job changes over the whole weighted sample. More specifically, denote by n_{it} the number of employers in the main job for individual i, in year t, and by ω_{it} the individual weight. Furthermore, define d_{it}^j the dummy variable that takes the value of 1 if the individual is employed in industry j in year t and $n_{it} \geq 2$, that is, if the respondent has changed job. The turnover rate in industry j in year t is defined as

$$\text{Turnover}_t^j = \frac{\sum_{i=1}^{I_t}(n_{it}-1)\omega_{it}d_{it}^j}{\sum_i^{I_t}\omega_{it}d_{it}^j},$$

where I_t is total number of observations in year t. The relative dynamics of turnover between finance and non-finance is captured by

$$\text{Relative turnover}_t = \text{Turnover}_t^F - \text{Turnover}_t^{NF},$$

where the superscript F stands for "finance" and NF for "non-finance."

The first panel of Figure 4 plots the relative job turnover over the period 1975–2000. Job turnover in finance increases relatively to the non-finance sector. The 5% confidence band shows that the change is statistically significant.

Educational composition of the labour force in the two sectors may affect the change in turnover. To control for this, we regress the relative turnover on a year variable (linear time
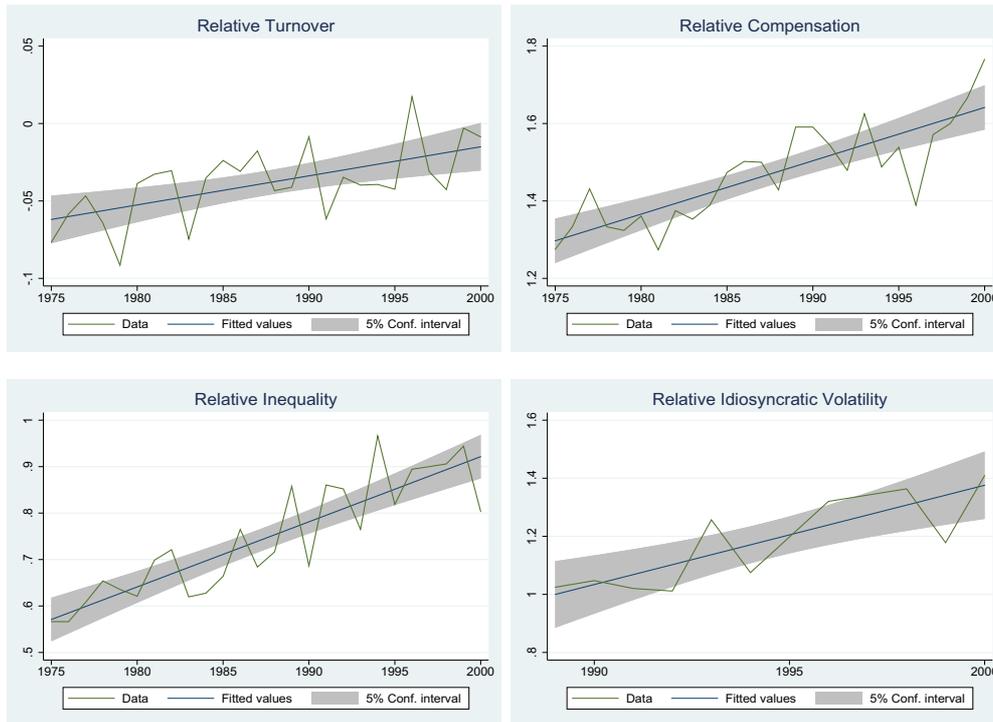
FIGURE 4

Job turnover, compensation, inequality, and idiosyncratic volatility in finance sector relative to the non-finance sector.
Panel 1: Job turnover in finance relatively to non-finance, 1975–2000. *Panel 2*: Median earnings in finance relatively to
non-finance, 1975–2000. *Panel 3*: Ratio 80th percentile of earnings over the 20th percentiles of earnings in finance
relatively to non-finance, 1975–2000. *Panel 4*: Standard deviation of earnings in finance relatively to non-finance,
1989–2000. Source: Current Population Survey.

TABLE 4
Regression of relative turnover rates, compensation, and inequality on time trend and relative education shares

	(1) Turnover	(2) Compensation	(3) Inequality
Year	0.0015**	0.0123***	0.0146***
	(0.0006)	(0.0021)	(0.0018)
Share of college	0.0555	0.2109	−0.0728
	(0.0368)	(0.1371)	(0.1161)
R^2	0.417	0.714	0.778
Number of Obs.	26	26	26

trend) and the ratio of college graduates in finance over non-finance. The estimation results,
reported in the first column of Table 4, show that the coefficient for the "year" variable is positive
and statistically significant, indicating that relative turnover has increased over time. Instead,
education is not statistically significant.

7.1.2.   Compensation.   As a measure of compensation we use the variable "INCWAGE," which contains total pre-tax wage and salary income earned in the previous year.

One problem with CPS data is that individual incomes are top coded. As a result, we cannot use all typical sample statistics to infer the corresponding statistics in the population. We have to restrict our attention to statistics that are unaffected by top coding. We then use "median" earnings instead of "mean" earnings. Formally, we define the function $E_t^j(p)$ that returns the value of earnings at percentile p (after sorting the sample according to earnings and calculating the percentiles using individual weights ω_{it}). Median earnings in industry j and year t is $E_t^j(0.5)$. The relative compensation of finance and non-finance is computed as

$$\text{Relative compensation}_t = \frac{E_t^F(0.5)}{E_t^{NF}(0.5)}.$$

The second panel of Figure 4 shows that median earnings in finance increase significantly relatively to the non-finance during the period 1975–2000.

Since the skills composition of the labour force in the two sectors has changed during this period, the higher compensation in finance may be the result of more qualified employees, at least in terms of educational achievements. To control for this, we regress the relative compensation in the two sectors on the year variable and the ratio of college graduates in finance over non-finance. The estimation results, reported in the second column of Table 4, shows that the year-coefficient is positive and statistically significant. Thus, the increasing relative compensation in finance is not just the result of a more educated labour force.

Inequality.   We measure the cross-sectional concentration of income using the ratio of the 80th percentile of earnings over the 20th percentile, that is, $E_t^j(0.8)/E_t^j(0.2)$. Since the 80th percentile of earnings is not top coded, this measure of inequality is immune to top coding. Relative inequality between finance and non-finance is the ratio of the sectoral inequality measures, that is,

$$\text{Relative inequality}_t = \frac{\frac{E_t^F(0.8)}{E_t^F(0.2)}}{\frac{E_t^{NF}(0.8)}{E_t^{NF}(0.2)}}.$$

As we can see from the third panel of Figure 4, the degree of inequality in finance increases relatively to non-finance. The significance of the increase is further confirmed by the regression of this variable on the year variable and the ratio of college graduates in finance over non-finance (see third column of Table 4). The coefficient estimate for the year variable is positive and statistically significant.

7.2.   *Idiosyncratic volatility*

The relative inequality plotted in the third panel of Figure 4 is based on cross-sectional measures. The model predicts that the increase in cross-sectional inequality is driven by an increase in the idiosyncratic volatility of earnings. In order to capture changes in idiosyncratic volatility, we need to observe the earnings of the same individual over time (panel dimension). This can be done by taking advantage of the rotating structure of the CPS.

The CPS interviews the same individual for 8 months. After a break of 4 months, the individual is interviewed again for an additional 4 months. Because of this, some respondents enter the March CPS supplement for two consecutive years. This allows us to compute a measure of idiosyncratic volatility.

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A complication, however, is that the identification of individuals interviewed in two consecutive years requires a unique identifier for linking these individuals over time. Unfortunately, the proper identifier is available only starting in 1988. Therefore, for the analysis of idiosyncratic volatility, the analysis is limited to 1988–2000. Also, because only some of the respondents are surveyed in the March supplement for two consecutive years, the sample size drops significantly. Keeping this in mind, we now describe how we compute idiosyncratic volatility.

Denote by e_{it}^{j} the labour earnings of individual i in year t in sector j. Idiosyncratic volatility is measured by the cross-sectional standard deviation of individual log-difference in earnings, that is, the standard deviation of $\ln(e_{i,t+1}^{j}) - \ln(e_{i,t}^{j})$. Because of the log transformation, we winsorize the bottom 5% of earnings. This eliminates observations with zero or very small earnings. Relative idiosyncratic volatility between finance and non-finance is given by

$$\text{Relative idiosyncratic volatility}_t = \frac{\text{std}\left(\ln(e_{i,t+1}^{F}) - \ln(e_{i,t}^{F})\right)}{\text{std}\left(\ln(e_{i,t+1}^{NF}) - \ln(e_{i,t}^{NF})\right)}.$$

The last panel of Figure 4 shows that the relative volatility measure has increased significantly during the sample period, providing empirical support to another prediction of the theoretical model.

7.3. *Other empirical studies*

There are empirical studies that, although not designed to test the predictions of our model, report findings that provide support for our theory.

7.3.1. Individual earning profiles. Philippon and Resheff (2012) use CPS data to estimate wage equations that separate the finance sector from the rest of the economy, and for three sub-periods: 1971–80, 1981–90, and 1991–2005. They find that in 1971–80 wages in the financial sector start 5% higher than in the rest of the economy and the slope is 0.7 percentage points lower compared to wages in the non-financial sector. In 1991–2005, finance wages start 8.64% higher and the slope is 2.45 percentage points bigger (than in the non-financial sector). The standard deviation of the regression residuals in the financial sector was 4% higher than in the non-financial sector in 1971–80 but increases to 9.26% in the period 1991–2005. These findings show that the slope and volatility of the wage profile in the financial sector increased over time relatively to the non-financial sector.

The higher slope of the wage profile can be interpreted as evidence of higher accumulation of human capital in the financial sector relatively to the rest of the economy. The increase in the standard deviation suggests that the higher accumulation of human capital has been associated to higher risk. Finally, the higher intercept together with the higher slope indicate that the overall compensation in the financial sector has increased significantly compared to the rest of the economy. This is what our model predicts when financial companies change their organizational form from partnerships to public companies. The timing of the switch is also consistent with the sub-periods considered by Philippon and Resheff (2012).

7.3.2. Income distribution. Philippon and Resheff (2012) also compute the share of top earners in the finance industry, relatively to the nonfarm private sector. This is done by first

determining the top decile threshold for the whole non-farm private sector. Then, using this threshold, they compute the share of wage earners in the finance industry who earn more than the threshold. The share of top earners in the finance industry is the share difference in the finance industry and in the nonfarm sector. In 1979, the share of top earners in finance was only 1.3% higher than the share in the non-farm private sector. In 2009 the difference reached 10%.

Another measure of income concentration in finance compared to the non-farm private sector is the relative wage in the top deciles. This is captured by the average wage in the top decile in the finance sector divided by the average wage in the top decile in the non-farm private sector. This ratio increases from 1 in 1980 to about 1.8 in the 2000s. So, clearly, the concentration of incomes in the finance industry has increased much more than for the whole economy.

7.3.3.   Manager turnover and productivity.

Although in the model turnover takes place when an external firm hires a worker employed in another firm, in practice, mergers and acquisitions generate a similar outcome. When a firm acquires an exiting firm, it hires workers and managers from an incumbent firm. The same is for mergers. Following this logic, an increase in mergers and acquisitions can be interpreted as indirect evidence of increased turnover.

DeYoung *et al.* (2009) show that the number of mergers and acquisitions in the financial sector increased dramatically after the 1980s. The acquisition of human resources (workers and managers) could be an important driver for M&A. Something that may have been facilitated by the change in the organizational structure of financial firms.

Another indirect evidence comes from empirical studies that explore the effects of interstate bank deregulation. Hubbard and Palia (1995) use interstate bank regulation as a proxy for the extent of competition in markets in which banks operate. They find that CEO compensation and turnover increased substantially after the deregulation of restrictive interstate banking legislation. Although interstate deregulation is different from regulatory reforms that facilitated financial firms to become public companies, they both increased competition and this led to higher compensation and higher turnover as predicted by the model.

8. CONCLUSION

We have studied the equilibrium properties of an industry where allocations are determined by optimal long-term contracts between firms and managers. The structure of the optimal contract depends on the ability of the parties to commit which in turn depends on the organizational structure of the firm.

We have considered two environments. In the first environment firms commit to long-term contracts but managers do not commit (one-sided commitment). In the second environment, neither the firm nor the manager commit and, therefore, repudiate the contract if the value of the contract becomes smaller than their outside values. We think of the first environment as capturing the contractual frictions in a "partnership." We think of the second environment as capturing the contractual frictions in public companies where the separation of ownership and control weakens the enforcement of contracts.

The stronger commitment of a partnership allows for a more efficient allocation within the partnership. However, in the presence of matching frictions, the stronger commitment may deter entry and, therefore, competition for managers. This could lead to less reallocation of human resources which in turn leads to less investment in human capital. We show that the inefficiency of lower turnover in an environment with partnerships may dominate the benefit of greater contractual efficiency. As a result, firms may prefer to be organized in the form of public companies. This could explain why financial firms have chosen to become public companies once the 1970s regulatory changes made easier for them to do so.

The model captures several trends observed in the financial sector during the last three decades. In particular, it generates higher value added per worker, higher average compensation, steeper, and more volatile income profiles. Also, the overall distribution of income becomes more concentrated (greater income inequality). Although several factors contributed to these trends, we have shown that the switch away from partnerships could have played an important role.

The analysis presented here is based on the assumption that the probability of external offers cannot be affected by the compensation structure of an individual firm. However, in an Supplementary Appendix we extend the model by assuming that an individual firm could affect the probability of external offers (partially) internalizing the equilibrium effects. The quantitative analysis shows that the qualitative predictions of the model do not change. However, managers and firms are now better off with *one-sided* commitment. In the Supplementary Appendix, we also discuss the plausibility of the extended model.

APPENDIX

A. PROOF OF PROPOSITION 1

The objective function does not depend on $C(\underline{A},1)$ but an increase in $C(\underline{A},1)$ relaxes constraint (2.2). Therefore, the optimal solution for this variable is its maximum admissible value $\bar{A}$ (see constraint (2.6)). Condition (2.1) then implies $\widehat{C}=\bar{A}$.

The variables C, $C(\underline{A},0)$, $C(\bar{A},0)$, $C(\bar{A},1)$ also relax the enforcement constraint (2.2) but have negative impacts on the objective function. Therefore, the optimal solution minimizes the expected compensation paid by the firm subject to constraints (2.2)–(2.5). This implies that constraint (2.2) is satisfied with equality. However, there are different combinations of C, $C(\underline{A},0)$, $C(\bar{A},0)$, $C(\bar{A},1)$ that satisfy constraint (2.2) with equality and do not violate (2.3)–(2.5). Without loss of generality, we focus on the solution for which all constraints are satisfied with equality. In this case, we have $C(\underline{A},0)=D, C(\bar{A},0)=D, C(\bar{A},1)=\bar{A}$. After setting the compensation in period 2, current compensation is determined by (2.2) and it is equal to $C=\rho(D-\bar{A})$.

The profits of the firm in period 1 and period 2 are, respectively,

$$\pi_1 = \bar{A}-\rho(D-\bar{A})$$

$$\pi_2 = \begin{cases} \underline{A}-D, & \text{if } \xi=0 \ \& \ A'=\underline{A} & \text{(which arises with probability } (1-\rho)/2) \\ \bar{A}-D, & \text{if } \xi=0 \ \& \ A'=\bar{A} & \text{(which arises with probability } (1-\rho)/2) \\ 0, & \text{if } \xi=1 \ \& \ A'=\underline{A} & \text{(which arises with probability } \rho/2) \\ 0, & \text{if } \xi=1 \ \& \ A'=\bar{A} & \text{(which arises with probability } \rho/2) \end{cases}.$$

Given the profit structure, the expected value of the contract for the firm is equal to

$$V=\bar{A}-D+\frac{1}{2}(\bar{A}+\underline{A})+\frac{\rho}{2}(\bar{A}-\underline{A}).$$

∎

B. PROOF OF PROPOSITION 2

The objective function does not depend on $C(\underline{A},1)$ but a higher value of $C(\underline{A},1)$ relaxes constraint (2.2). Therefore, the optimal solution for this variable is its maximum value which, with two-sided limited commitment, is equal to $C(\underline{A},1)=\underline{A}$ (constraint (2.10)). Condition (2.1) then implies $\widehat{C}=\eta\underline{A}+(1-\eta)\bar{A}$. Next we consider constraints (2.5) and (2.9). They imply $C(\bar{A},1)=\bar{A}$.

The remaining compensation C, $C(\underline{A},0)$, $C(\bar{A},0)$ also relax the enforcement constraint (2.2) but have a negative impact on the objective function. Therefore, the optimal solution minimizes the expected compensation paid by the firm. This implies that constraint (2.2) is satisfied with equality. This, together with constraints (2.3) and (2.4), are not enough to pin down C, $C(\underline{A},0)$, and $C(\bar{A},0)$. Without loss of generality, we will focus on the solution for which also constraints (2.3) and (2.4) are satisfied with equality. This implies $C(\underline{A},0)=D$ and $C(\bar{A},0)=D$. After setting the optimal compensation in period 2, current compensation is determined by (2.2) and it is equal to $C=\rho(D-\bar{A})+\eta\rho(\bar{A}-\underline{A})/2$.

The profits of the firm in period 1 and period 2 are, respectively,

$$\pi_1 = \bar{A} - \rho(D - \bar{A}) - \frac{\eta\rho}{2}(\bar{A} - \underline{A})$$

$$\pi_2 = \begin{cases} \underline{A} - D, & \text{if } \xi = 0 \ \& \ A' = \underline{A} & \text{(which arises with probability } (1-\rho)/2) \\ \bar{A} - D, & \text{if } \xi = 0 \ \& \ A' = \bar{A} & \text{(which arises with probability } (1-\rho)/2) \\ 0, & \text{if } \xi = 1 \ \& \ A' = \underline{A} & \text{(which arises with probability } \rho/2) \\ 0, & \text{if } \xi = 1 \ \& \ A' = \bar{A} & \text{(which arises with probability } \rho/2) \end{cases}$$

Given the profit structure, the expected value of the contract for the firm is equal to

$$V = \bar{A} - D + \frac{1}{2}(\bar{A} + \underline{A}) + \frac{\rho}{2}(\bar{A} - \underline{A}) - \frac{\eta\rho}{2}(\bar{A} - \underline{A}). \qquad \blacksquare$$

C. PROOF OF LEMMA 1

The first order condition for the bargaining problem is

$$\eta(\hat{Q}_t - Q_t)V_2\left(\bar{A}, \hat{Q}_t, h_t\right) + (1-\eta)V\left(\bar{A}, \hat{Q}_t, h_t\right) = 0.$$

This can be re-arranged as

$$Q_t = \hat{Q}_t + \left(\frac{1-\eta}{\eta}\right)\frac{V\left(\bar{A}, \hat{Q}_t, h_t\right)}{V_2\left(\bar{A}, \hat{Q}_t, h_t\right)}.$$

If $V(\bar{A}, \hat{Q}_t, h_t)/V_2(\bar{A}, \hat{Q}_t, h_t)$ is weakly increasing in $\hat{Q}_t$ (a property guaranteed by the concavity of $V(\bar{A}, \hat{Q}_t, h_t)$ imposed by Assumption 3), the right-hand side is strictly increasing in $\hat{Q}_t$. Therefore, a higher threat value of Q_t (left-hand side) must be associated to a higher value of an external offer $\hat{Q}_t$. $\qquad \blacksquare$

D. PROOF OF LEMMA 2

We can see from (4.21) that Q_{t+1}^s does not enter the objective function. It only enters constraints (4.18), (4.19), (4.20). Constraint (4.20) restricts Q_{t+1}^s to be weakly smaller than $\hat{Q}^{\text{Max}}(h_{t+1})$. We want to show that any solution with $Q_{t+1}^s \leq \hat{Q}^{\text{Max}}(h_{t+1})$ is not optimal.

Given a candidate solution, suppose that we consider an alternative with $\tilde{Q}_{t+1}^s = Q_{t+1}^s + \epsilon < \hat{Q}^{\text{Max}}(h_{t+1})$, where ϵ is a small positive number. We also choose $\tilde{C}_t < C_t$ so that the promise-keeping constraint (4.18) is satisfied. If (4.18) is satisfied, (4.19) is also satisfied. Since $\tilde{Q}_{t+1}^s$ does not enter the objective (4.21) but C_t enters it negatively, the alternative solution is strictly preferred. The optimum is then $Q_{t+1}^s = \hat{Q}^{\text{Max}}(h_{t+1})$. $\qquad \blacksquare$

E. CHARACTERIZATION OF THE CONTRACT WITH ONE-SIDED COMMITMENT

To facilitate the characterizing of Problem (4.22), we make the following assumption:

Assumption E.1 *If the manager's utility is logarithmic, the outside value of the manager takes the form $D(Q, h, \xi) = d(Q/h, \xi) + \mathcal{B}\ln(h)$, where $\mathcal{B} = 1/(1-\beta)$. With a more general CES utility the outside value takes the form $D(Q, h, \xi) = d(Q/h, \xi)u(h_t)$. The function $d(.,.)$ is weakly increasing in Q/h.*

We will see later that this is not just an assumption but the outside value does take this functional form. Under this assumption, we have the following proposition.

Proposition E.1 *Assume $\beta\mathbb{E}g(A_t, 1, z_{t+1}) < 1$. There is a unique value function $V(A, Q, h)$ that is strictly increasing in A and h, strictly decreasing in Q, and differentiable. Furthermore, if the optimal λ is not too sensitive to Q, $V(A, Q, h)$ is strictly concave and the optimal policies are unique.*

The condition that the optimal λ is not too sensitive to Q is sufficient but not necessary for the value function to be concave. In what follows, we assume that this condition is satisfied so that the optimal policies can be characterized with first order conditions. We will verify the condition numerically. We prove Proposition E.1 separately for the case of log-utility and for the case with a more general CES utility.

Proof. The case with non-logarithm utility. Human capital h grows over time without a limit. This implies that manager's compensation C and firm's value $V(A,Q,h)$ are not bounded. It would be convenient then to normalize the growing variables by h. Given that the utility function has the CES form, we can write it as $u(C) = u(C/h)u(h)$. We will use small letters to denote the normalized compensation $c = C/h$. We also define the $q = Q/u(h)$ as the normalized lifetime utility of the manager and conjecture that the firm's value is linear in human capital, that is, $V(A,Q,h) = v(A,q)h$. We can then rewrite the contractual problem (4.22) as

$$v(A,q) = \max_{\lambda,c,\omega(\mathbf{s}'),q(\mathbf{s}')} \left\{ \pi(A,\lambda) - c + \beta \mathbb{E}g(A,\lambda,z')\omega(\mathbf{s}')v\Big(A',q(\mathbf{s}')\Big) \right\} \tag{E.1}$$

s.t.

$$q = u(c) + \beta \mathbb{E}u\Big(g(A,\lambda,z')\Big)\left[\omega(\mathbf{s}')q(\mathbf{s}') + \Big(1-\omega(\mathbf{s}')\Big)d(\hat{q}^{Max},\xi') \right], \tag{E.2}$$

$$q(\mathbf{s}') \geq d(\hat{Q}^{Max},\xi'), \tag{E.3}$$

We can see that the objective and the constraints are no longer dependent on h. Furthermore, they depend on the normalized variables c and q, not the original C and Q. This confirms our conjecture that $V(A,Q,h) = v(A,q)h$.

It would be convenient to make a change of variables by defining $x = u(c)$. Using the variable x, the normalized manager's consumption can be expressed as $c = \psi(x)$, where $\psi(.) = u^{-1}(.)$ is the inverse of the utility function. Since $u(.)$ is strictly concave, $\psi(.)$ is strictly convex. Furthermore, it would be convenient to separate the choice of λ, c and $q(\mathbf{s}')$ from separation $\omega(\mathbf{s}')$. We can then rewrite the recursive problem as

$$v(A,q) = \max_{\lambda,c,\tilde{q}(\mathbf{s}')} \left\{ \pi(A,\lambda) - \psi(x) + \beta \mathbb{E}g(A,\lambda,z')\tilde{v}\Big(\mathbf{s}',\tilde{q}(\mathbf{s}')\Big) \right\} \tag{E.4}$$

s.t.

$$q = x + \beta \mathbb{E}u\Big(g(A,\lambda,z')\Big)\tilde{q}(\mathbf{s}'), \tag{E.5}$$

$$\tilde{q}(\mathbf{s}') \geq d(\hat{q}^{Max},\xi'), \tag{E.6}$$

$$\tilde{v}(\mathbf{s}',\tilde{q}') = \max_{\omega'} \left\{ \omega'v\Big(A',q'\Big) \right\} \tag{E.7}$$

s.t.

$$\tilde{q}' = \omega q' + (1-\omega)d(\hat{q}^{Max},\xi') \tag{E.8}$$

In the second problem (E.7), $q' = \tilde{q}'$ if $\omega' = 1$. Separation ($\omega = 0$) is feasible only if $\tilde{q}' = d(\hat{q}^{Max},\xi')$. So, when $\tilde{q}(\mathbf{s}')$ is chosen in the first stage, it will be set to $\tilde{q}(\mathbf{s}') = d(\hat{q}^{Max},\xi')$ if it is optimal to separate in state $\mathbf{s}'$. Notice that the function $\tilde{v}(\mathbf{s},\tilde{q})$ is decreasing and concave in $\tilde{q}$ if $v(A,q)$ is decreasing and concave in q. Also, $\tilde{v}(\mathbf{s},\tilde{q})$ is increasing in A if $v(A,q)$ is increasing in A.

Let's now consider the functional equation

$$\varphi(v)(A,q) = \max_{\lambda,x,\tilde{q}(\mathbf{s}')} \left\{ \pi(A,\lambda) - \psi(x) + \beta \mathbb{E}g(A,\lambda,z')\tilde{v}\Big(\mathbf{s}',\tilde{q}(\mathbf{s}')\Big) \right\} \tag{E.9}$$

s.t. (E.5)-(E.8)

To show that the Bellman's equation is a contraction, we have verified the Blackwell's conditions for monotonicity and discounting. To show the discounting property, it is important that the expected growth rate of human capital is not too big, which is guaranteed by the assumption $\beta \mathbb{E}g(A,1,z') < 1$. Since the Bellman's equation is a contraction mapping, there is a unique fixed point $v(A,q)$ in the space of continuous and bounded functions.

To show that the function $v(A,q)$ is strictly increasing in A and strictly decreasing in q, we use a guess and verify approach. Let's start with the dependence on A. Suppose that the current matching quality is $A_1 = \underline{A}$. The associated solution is $(\lambda_1,x_1,\tilde{q}_1(\mathbf{s}'))$.

Now suppose that the matching quality is $A_2 = \bar{A}$. Associated with this new and higher matching quality, consider the policy $(\lambda_1,x_2,\tilde{q}_1(\mathbf{s}'))$, where

$$x_2 = q - \beta \mathbb{E}u\Big(g(A_2,\lambda_1,z')\Big)\tilde{q}_1(\mathbf{s}').$$

The policy is equivalent to the optimal policy under A_1 with the exception of x_2, which is chosen to satisfy the promise keeping constraint (E.5). This guarantees feasibility.

Since the function $g(A,\lambda,z')$ is increasing in A, we have that $x_2 < x_1$. Therefore, $\psi(x_2) < \psi(x_1)$. Because $\pi(A,\lambda)$ is strictly increasing in A, the first two terms in the functional equation (E.9) increase when the matching quality switches from $\underline{A}$ to $\bar{A}$.

Let's look at the third term in the functional equation, that is, $\beta\mathbb{E}g(A,\lambda,z')\tilde{v}(\mathbf{s}',\tilde{q}(\mathbf{s}'))$. Since the probability that $A' = \bar{A}$ is bigger when $A = \bar{A}$, this term also increases in A if the $\tilde{v}$ is increasing in A'. We have already established that, if the function v is increasing in A', $\tilde{v}$ is also increasing. Thus, we have proved that when $A = \bar{A}$, the value for the firm increases under the policy $(\lambda_1,x_2,\tilde{q}_1(\mathbf{s}'))$. Of course, if the value of the contract for the firm increases with A under the assumed policy, it could further increase by choosing the optimal policy. This shows that the functional equation preserves the increasing property of the value function and, therefore, the fixed point is increasing in A.

To prove that the function $v(A,q)$ is strictly decreasing in q, we use a similar argument. Now, however, we keep A fixed and increase q. Consider $q = q_1$ with the associated optimal policy $(\lambda_1,x_1,\tilde{q}_1(\mathbf{s}'))$. Now consider $q_2 > q_1$ and the policy $(\lambda_1,x_2,\tilde{q}_1(\mathbf{s}'))$, where

$$x_2 = q_2 - \beta\mathbb{E}u\Big(g(A,\lambda_1,z')\Big)\tilde{q}_1(\mathbf{s}').$$

The policy is equivalent to the optimal policy under q_1 with the exception of x_2 which is chosen to satisfy the promise-keeping constraint (E.5), so that the policy is feasible when $q = q_2$. In this case, we have that $x_2 > x_1$ which implies a higher compensation cost for the firm. We can then proceed as we did above. More specifically, if $v(A,q)$ is decreasing in q, then the functional equation (E.9) preserves the decreasing property. The fixed point in the contraction mapping is then strictly decreasing in q.

The next step is to prove the concavity of $v(A,q)$ with respect to q. In general, this cannot be established without further assumptions. In particular, we need that the optimal λ is not very sensitive to q. Denoting by $\lambda(A,q)$ the optimal portfolio policy, this property can be stated as $\lambda(A,q_1) \approx \lambda(A,q_2)$ for any q_1 and q_2.

Consider two values of promised utility, q_1 and q_2. The optimal solutions associated with these two states are, respectively, $(\lambda_1,x_1,\tilde{q}_1(\mathbf{s}'))$ and $(\lambda_2,x_2,\tilde{q}_2(\mathbf{s}'))$. Denote by $\bar{q} = \theta q_1 + (1-\theta)q_2$ the convex combination of q_1 and q_2. Similarly, we denote by $(\bar{\lambda},\bar{x},\bar{q}(\mathbf{s}'))$ the convex combinations of the optimal solutions associated to the two states q_1 and q_2. Under the assumption that the optimal λ is not very sensitive to q, we impose the approximation $\bar{\lambda} = \lambda_1 = \lambda_2$.

When $q = \bar{q}$, consider the policy $(\bar{\lambda},\bar{x},\bar{q}(\mathbf{s}'))$. Clearly the solution is feasible, that is, it satisfies the promise keeping and enforcement constraint. Since $-\psi(x)$ is strictly concave, if $v(A,q)$ is concave in q, the function $\tilde{v}(\mathbf{s},\tilde{q})$ is concave in $\tilde{q}$. We then have

$$\theta\varphi_1(v) + (1-\theta)\varphi_2(v) < \bar{\varphi}(v).$$

This shows that the functional equation $\varphi(v)$ preserves concavity. Therefore, the fixed point $v(A,q)$ is strictly concave.

The differentiability of $v(A,q)$ with respect to q can be proved by verifying the conditions of Theorem 9.10 in Stokey *et al.* (1989). This theorem, however, assumes that the solution is interior while in our problem constraint (E.6) could be binding. See Marimon and Werner (2019) for an alternative proof that applies also to the case of binding solutions. Obviously, if $v(A,q)$ is increasing in A, decreasing in q and differentiable in q, then $V(A,Q,h) = v(A,Q/h)h$ is increasing in A and h, decreasing in Q, and differentiable in h and Q.   ∎

Proof. Logarithmic utility. When the utility function takes the logarithmic form, we have $u(C) = u(C/h) + u(h)$. Define $c = C/h$ and $q = Q - \mathcal{B}\ln(h)$, where $\mathcal{B} = 1/(1-\beta)$. Under the conjecture that the firm's value can be written as $V(A,q,h) = v(q)/h$, the contractual problem (4.22) can be rewritten as

$$v(A,q) = \max_{\lambda,c,\omega(\mathbf{s}'),q(\mathbf{s}')}\left\{\pi(A,\lambda) - c + \beta\mathbb{E}g(A,\lambda,z')\omega(\mathbf{s}')v\Big(A',q(\mathbf{s}')\Big)\right\} \tag{E.10}$$

s.t.

$$q = \ln(c) + \beta\mathbb{E}\left[\omega(\mathbf{s}')q(\mathbf{s}') + \Big(1 - \omega(\mathbf{s}')\Big)d(\hat{q}^{Max},\xi') + \mathcal{B}\ln\Big(g(A,\lambda,z')\Big)\right], \tag{E.11}$$

$$q(\mathbf{s}') \geq d(\hat{q}^{Max},\xi'). \tag{E.12}$$

We can see that the objective function and the constraints are no longer depend on human capital h. Also, they depend on the normalized variables c and q, not the original C and Q, which confirms the conjecture that $V(A,Q,h) = v(A,q)h$. The proof with a logarithmic utility follows the same steps as those used for a generic CES utility.   ∎

First order conditions.   The **separation policy** is characterized by differentiating problem (4.22) with respect to $\omega(\mathbf{s}')$, from which we obtain the Kuhn–Tuker condition

$$\omega(\mathbf{s}') = \begin{cases} 1, & \text{if} \quad V\Big(A',Q(\mathbf{s}'),h'\Big) + \mu Q(\mathbf{s}') \geq \mu D\Big(\hat{Q}^{\text{Max}}(h'),h',\xi'\Big), \\[2ex] 0, & \text{if} \quad V\Big(A',Q(\mathbf{s}'),h'\Big) + \mu Q(\mathbf{s}') < \mu D\Big(\hat{Q}^{\text{Max}}(h'),h',\xi'\Big), \end{cases} \tag{E.13}$$

where μ is the Lagrange multiplier associated with the promise-keeping constraint. The inequalities arise because the solution may not be interior, that is, $\omega(\mathbf{s}') = 0$ or $\omega(\mathbf{s}') = 1$.

The left-hand side terms denote the surplus of the match. By multiplying the continuation utility by μ, the value of the manager is expressed in consumption units so that it can be added to the firm's value. The right-hand side terms denote the surplus from separation. In this case, the firm gets zero while the manager receives the outside value (which, being multiplied by μ, is expressed in consumption units). The optimal choice is to continue if the surplus from the match is at least as big as from separation.

Lemma E.1 *A match is separated only if $A' = \underline{A}$ and $\xi' = 1$.*

Proof. We have already shown that $V(A, Q, h)$ is strictly increasing in A. When a manager finds a new match, in order to retain the manager, the incumbent firm has to promise $\hat{Q}^{\mathrm{Max}}(h)$. But with this promised utility the value of the firm is negative if $A = \underline{A}$. Since $D(\hat{Q}^{\mathrm{Max}}(h), h, 1) = \hat{Q}^{\mathrm{Max}}(h)$, from condition (E.13) we can see that the solution is $\omega(\mathbf{s}) = 0$ (separation). When instead $A = \bar{A}$, we have that $V(\bar{A}, \hat{Q}^{\mathrm{Max}}(h), h) = 0$. Therefore, according to (E.13), the solution is $\omega(\mathbf{s}) = 1$. ∎

Since a new firm runs the same technology as incumbent firms, it is not optimal to let the manager switch to a new firm unless she becomes more productive. This will be the case if $A' = \underline{A}$. We made the implicit assumption that the value function for a new firm is identical to that of an incumbent firm, which will be the case in equilibrium.

The *compensation policy* for the manager has two parts: the current compensation, C, and the future compensation summarized by the state contingent utility $Q(\mathbf{s}')$. Differentiating problem (4.22) with respect to C we obtain,

$$C = u_u^{-1}\left(\frac{1}{\mu}\right), \tag{E.14}$$

where the subscript in the utility function denotes the derivative and the superscript the inverse. The variable μ is the Lagrange multiplier associated with the promise-keeping constraint. Condition (E.14) shows that current compensation C increases with μ.

The evolution of the multiplier is characterized by the first order condition for the continuation utility. Differentiating Problem (4.22) with respect to $Q(\mathbf{s}')$ we obtain

$$\mu(\mathbf{s}') = \mu + \gamma(\mathbf{s}'), \tag{E.15}$$

where we have defined $\beta\omega(\mathbf{s}')\gamma(\mathbf{s}')$ the multiplier for the enforcement constraint. The derivation also uses the envelope condition $V_2(A, Q, h) = -\mu$.

Condition (E.15) shows that μ increases if the enforcement constraint binds in the next period. The previous condition (E.14) implies that the manager's consumption increases whenever the enforcement constraint is binding. Since h grows in expectation and with it the outside value of the manager $D(\hat{Q}^{\mathrm{Max}}(h), h, \xi)$, the enforcement constraint becomes binding at some point in the future. This raises the value of μ and, therefore, the manager's compensation C. Thus, the growth of μ is inherited by the growth of consumption. An implication is that the contract does not provide full consumption insurance.

The *portfolio choice policy* is characterized by the first-order condition with respect to λ, which can be written as

$$\pi_\lambda(A, \lambda) + \beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[V_{h'}\left(A', Q(\mathbf{s}'), h'\right) - \gamma(\mathbf{s}')D_{h'}\left(\hat{Q}^{Max}(h'), h', \xi'\right)\right] + \right.$$
$$\left. \left(1 - \omega(\mathbf{s}')\right)\mu D_{h'}\left(\hat{Q}^{Max}(h'), h', \xi'\right)\right\}g_\lambda(A, \lambda, z') = 0. \tag{E.16}$$

Equation (E.16) defines the net marginal benefit per unit of human capital of a riskier portfolio. The first term is the expected net marginal return. As λ increases, this term declines and at some point it becomes negative because of the convex cost of allocating a larger share of capital to risky investments. The second term is the expected marginal benefit from increasing the next period human capital h, if the partnership is not separated. This is equal to the increase in the value for the firm minus the cost of making the enforcement constraint tighter. The third term is the benefit when the partnership is separated, which is equal to the increase in the outside value for the manager.

Binding enforcement constraints imply positive values of $\gamma(\mathbf{s}')$, which reduce the benefit of higher human capital (second term in (E.16)) and, therefore, the optimal λ. Intuitively, when the constraint becomes binding, the value of quitting for the manager is higher than the value of staying. To retain the manager, her contract value must increase or the value of quitting must decline. The former can be increased by promising higher lifetime compensation while the latter can be reduced by lowering λ.

F. PROOF OF LEMMA 3

We have already proved that $V(A,Q,h)$ is increasing in A and decreasing in Q. The value of $\hat{Q}^{\mathrm{Max}}(h)$ is determined by the condition $V(\bar{A},\hat{Q}^{\mathrm{Max}}(h),h)=0$. The monotonicity of the firm's value in A implies that $V(\underline{A},\hat{Q}^{\mathrm{Max}}(h),h)<0$. Since Q_{t+1}^s is determined by $V(A_{t+1},Q_{t+1}^s,h_{t+1})=0$, when $A_{t+1}=\underline{A}$, Q_{t+1}^s must be smaller than $\hat{Q}^{\mathrm{Max}}(h_{t+1})$. ∎

G. CHARACTERIZATION OF THE CONTRACT WITH TWO-SIDED LIMITED COMMITMENT

Proposition E.1 also applies to the case of two-sided limited commitment. The *separation policy* is the same as with one-sided commitment, that is, the firm separates only if the quality of the match deteriorates to $A'=\underline{A}$ and the manager receives an external offer, that is, $\xi'=1$. Thus, Lemma E.1 is also valid with two-sided limited commitment.

The *compensation policy* without separation satisfies the first-order condition

$$C=u_u^{-1}\left(\frac{1}{\mu}\right). \tag{G.1}$$

This is the same condition as in the environment with one-sided commitment (equation (E.14)). What changes is the evolution of μ, the Lagrange multiplier for the promise-keeping constraint. Differentiating Problem (4.22) with respect to $Q(\mathbf{s}')$ we obtain

$$\mu(\mathbf{s}')=\frac{\mu+\gamma(\mathbf{s}')}{1+\psi(\mathbf{s}')}, \tag{G.2}$$

with $\beta\omega(\mathbf{s}')\psi(\mathbf{s}')$ the multiplier for the firm's enforcement, conditional on continuation.

The next period value of μ continues to increase when the enforcement constraint for the manager binds ($\gamma(\mathbf{s}')>0$) as with one-sided commitment. Now, however, $\mu(\mathbf{s}')$ decreases if the enforcement constraint for the firm binds ($\psi(\mathbf{s}')>0$). A binding enforcement constraint for the firm requires that the value of the contract for the firm increases, which in turn requires a reduction in the value for the manager. Since the manager's compensation and her contract value are positively related to μ, a binding enforcement constraint for the firm induces a reduction in $\mu(\mathbf{s}')$.

The *portfolio choice policy* is characterized by the first-order condition for λ,

$$\pi_\lambda(A,\lambda)+\beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[\left(1+\psi(\mathbf{s}')\right)V_{h'}\left(A',Q(\mathbf{s}'),h'\right)-\gamma(\mathbf{s}')D_{h'}\left(\hat{Q}^{Max}(h'),h',\xi'\right)\right]\right.$$
$$\left.+\left(1-\omega(\mathbf{s}')\right)\mu D_{h'}\left(Q^{s'},h',\xi'\right)\right\}g_\lambda(A,\lambda,z')=0. \tag{G.3}$$

As with one-sided commitment, the first term is the current marginal benefit of a riskier portfolio per unit of human capital. The second term is the expected future marginal benefit. One difference compared one-sided commitment is that the marginal increase in the firm's value—$V_{h'}(A',Q(\mathbf{s}'),h')$—is multiplied by $1+\psi(\mathbf{s}')$. Since $\psi(\mathbf{s}')$ increases when the enforcement constraint for the firm binds, risk-taking rises when the value of the contract approaches zero. The second difference is that the argument in the outside value of the manager in case of separation (second row of equation (G.3)) is not $\hat{Q}^{\mathrm{Max}}(h')$ but the value of $Q^{s'}$ for which the firm breaks even, $V(A'^{s'},h')=0$.

H. NORMALIZATION WITH LOG-UTILITY

The value of the contract for the manager can be expressed as $Q=q+\mathcal{B}\ln(h)$, where q is the normalized value. The firm's value can be expressed as $V(A,Q,h)=v(A,q)h$ where $v(A,q)$ is the normalized value.

H.1. *One-sided commitment*

The promise-keeping and enforcement constraints can be normalized to

$$q=\ln(c)+\beta\mathbb{E}\left[\omega(\mathbf{s}')q(\mathbf{s}')+\left(1-\omega(\mathbf{s}')\right)d\left(\hat{q}^{\mathrm{Max}},\xi'\right)+\mathcal{B}\ln\left(g(A,\lambda,z')\right)\right], \tag{H.1}$$

$$q(\mathbf{s}')\geq d\left(\hat{q}^{\mathrm{Max}},\xi'\right), \tag{H.2}$$

where $\hat{q}^{\mathrm{Max}}$ is the normalized value for the manager for which the firm breaks even. The function $d(\hat{q}^{\mathrm{Max}},\xi)$ is weakly increasing in the first argument (Assumption E.1).

The optimality conditions for C, $Q(\mathbf{s}')$ and λ—equations (E.14), (E.15), and (E.16)—become

$$c = \tilde{\mu}, \tag{H.3}$$

$$\tilde{\mu}(\mathbf{s}')g(A,\lambda,z') = \tilde{\mu} + \tilde{\gamma}(\mathbf{s}'), \qquad \text{if } \omega(\mathbf{s}') = 1, \tag{H.4}$$

$$\pi_\lambda(A,\lambda) + \beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[v_h\left(A',q(\mathbf{s}')\right)g(A,\lambda,z') - \tilde{\gamma}(\mathbf{s}')\mathcal{B}\right] + \right.$$
$$\left. \left(1 - \omega(\mathbf{s}')\right)\tilde{\mu}\mathcal{B}\right\}\frac{g_\lambda(A,\lambda,z')}{g(A,\lambda,z')} = 0, \tag{H.5}$$

where $\tilde{\mu} = \mu/h$ and $\tilde{\gamma}(\mathbf{s}') = \gamma(\mathbf{s}')/h$ are the normalized multipliers associated with the promise-keeping and enforcement constraints. As human capital increases, the manager compensation also increases. This implies that the multiplier μ increases with h. However, dividing μ and $\gamma(\mathbf{s}')$ by h, the normalized multipliers become stationary.

The term $v_h(A,q)$ is the normalized derivative of $V(A,Q,h)$. Differentiating Problem (3.16) and normalizing by h we obtain

$$v_h(A,q) = \pi(A,\lambda) + \beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[v_h\left(A',q(\mathbf{s}')\right)g(A,\lambda,z') - \gamma(\mathbf{s}')\mathcal{B}\right] + \left(1 - \omega(\mathbf{s}')\right)\tilde{\mu}\mathcal{B}\right\}. \tag{H.6}$$

H.2.   *Two-sided limited commitment*

The normalization in the environment with two-sided limited commitment is similar with few qualifications. The promise-keeping constraint is

$$q = \ln(c) + \beta\mathbb{E}\left[\omega'q(\mathbf{s}') + \left(1 - \omega(\mathbf{s}')\right)d\left(\hat{q}^s,\xi'\right) + \mathcal{B}\ln\left(g(A,\lambda,z')\right)\right], \tag{H.7}$$

where $\hat{q}^s$ is the normalized value promised by the incumbent firm to the manager when she receives an external offer, conditional on separation. This is the value for which the incumbent firm breaks even. With one-sided commitment, instead, this is determined by the break-even condition for the "new" firm, not the "incumbent" firm.

The optimality conditions for $Q(\mathbf{s}')$ and λ—equations (E.15), and (E.16)—become,

$$\tilde{\mu}(\mathbf{s}')g(A,\lambda,z') = \frac{\tilde{\mu} + \tilde{\gamma}(\mathbf{s}')}{1 + \psi(\mathbf{s}')}, \qquad \text{if } \omega(\mathbf{s}') = 1, \tag{H.8}$$

$$\pi_2(A,\lambda) + \beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[\left(1 - \psi(\mathbf{s}')\right)v_h\left(A',q(\mathbf{s}')\right)g(A,\lambda,z') - \tilde{\gamma}(\mathbf{s}')\mathcal{B}\right] + \right.$$
$$\left. \left(1 - \omega(\mathbf{s}')\right)\tilde{\mu}\mathcal{B}\right\}\frac{g_2(A,\lambda,z')}{g(A,\lambda,z')} = 0. \tag{H.9}$$

$$\tag{H.10}$$

These conditions differ from one-sided commitment because of the multiplier $\psi(\mathbf{s}')$. The term $v_h(A,q)$ is derived by differentiating Problem (4.22) and normalizing by h,

$$v_h(A,q) = \pi(A,\lambda) + \beta\mathbb{E}\left\{\omega(\mathbf{s}')\left[\left(1 + \psi(\mathbf{s}')\right)v_h\left(A',q(\mathbf{s}')\right)g(A,\lambda,z') - \gamma(\mathbf{s}')\mathcal{B}\right] + \right.$$
$$\left. \left(1 - \omega(\mathbf{s}')\right)\tilde{\mu}\mathcal{B}\right\}. \tag{H.11}$$

I.   PROOF OF PROPOSITION 4

Lemma 2 established that in the environment with one-sided limited commitment q^s is such that a new firm breaks even. This implies that for $A = \underline{A}$ or $A = \bar{A}$, we have that $\bar{v} = 0$. We can then see that the entry condition (5.25) is satisfied with the inequality sign and no vacancies targeted at employed managers will be posted.

With two-sided limited commitment, the value of a new firm will be zero only if the matching quality of the incumbent firm is $A = \bar{A}$. So there will not be vacancies targeted at managers employed in high quality matches. However, when $A = \underline{A}$, q^s is smaller than the break-even condition for a new firm (Lemma 3). Therefore, $\bar{v}(q^s) > 0$ when $A = \underline{A}$, and in equilibrium there will be vacancies targeted at managers with $A = \underline{A}$.   ∎

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J. PROOF OF COROLLARY 1

Denote by $\underline{M}_t$ the mass of firms with low matching quality $A = \underline{A}$ and by $\overline{M}_t$ the mass of firms with high matching quality $A = \overline{A}$. These two variables satisfy

$$\underline{M}_{t+1} = \underline{M}_t \varpi (1-\rho) + \overline{M}_t \varpi \theta,$$
$$\overline{M}_{t+1} = \overline{M}_t \varpi (1-\theta) + \underline{M}_t \varpi \rho + n_t,$$

where ϖ is the survival probability, ρ is the probability of rematching when productivity is low, θ is the probability that a high productivity match becomes a low productivity match, and n_t is the mass of new matches for unemployed managers. In a steady state, $\overline{M}_{t+1} = \overline{M}_t$ and $\underline{M}_{t+1} = \underline{M}_t$. Imposing this condition in the first equation, we obtain

$$\frac{\overline{M}}{\underline{M}} = \frac{1 - \varpi (1-\rho)}{\varpi \theta},$$

which defines the steady state ratio of high productivity matches over low productivity matches. This ratio is strictly increasing in the probability of a match ρ.   ∎

K. SHARE OF RISKY INVESTMENTS IN THE FINANCE SECTOR

The share of risky investment in the finance industry is computed using balance sheet data from the Financial Accounts of the U.S. compiled by the Federal Reserve Board (Flow of Funds). We use annual "levels" data for the Domestic Financial Sectors (L tables). Our definition of the financial industry includes only some of the domestic financial sectors. More specifically, we include (1) Private Depositary Institutions, (2) Private and Public Pension Funds, (3) Money Market Funds, (4) Mutual Funds, (5) Closed End Funds, (6) Government Sponsored Enterprises, (7) Agency and GSE Baked Mortgage Institutions, (8) Finance Companies, (9) Security Brokers and Dealers, (10) Holding Companies, and (11) Funding Corporations. We exclude insurance companies, real estate companies, and the monetary authority.

For each of the selected sectors, we classify the assets listed in the balance sheet as "safe" and "risky." The aggregation across all institutions provides the total safe and risky investments in the financial industry. Following is the description of our classification.

(i) Private Depositary Institutions, L110. *Safe*: Vault cash, Reserves at Monetary authority, Federal funds and security repurchase agreements, Debt securities, Miscellaneous assets. *Risky*: Loans, Corporate equities, Direct investments abroad.

(ii) Private and Public Pension Funds, L117. *Safe*: Checkable deposits and currency, Time and saving deposits, Money market fund shares, Security repurchase agreements, Debt securities, Total miscellaneous assets. *Risky*: Loans, Corporate equities, Mutual fund shares.

(iii) Money Market Funds, L121. *Safe*: Private foreign deposits, Checkable deposits and currency, Time and saving deposits, Security repurchase agreements, Debt securities, Unidentified miscellaneous assets. *Risky*: None.

(iv) Mutual Funds, L122. *Safe*: Security repurchase agreements, Debt securities, Unidentified miscellaneous assets. *Risky*: Syndicated loans to nonfinancial corporate business, Corporate equities.

(v) Closed End Funds, L123. *Safe*: Debt securities. *Risky*: Corporate equities.

(vi) Government Sponsored Enterprises, L125. *Safe*: Checkable deposits and currency, Time and saving deposits, Federal funds and security repurchase agreements, Debt securities, Unidentified miscellaneous assets. *Risky*: Loans.

(vii) Agency and GSE Baked Mortgage Institutions, L126. *Safe*: None. *Risky*: Home mortgages, Multifamily residential mortgages, Commercial mortgages, Farm mortgages.

(viii) Finance Companies, L128. *Safe*: Checkable deposits and currency, Time and saving deposits, Corporate and foreign bonds, Total miscellaneous assets. *Risky*: Loans, Direct investment abroad.

(ix) Security Brokers and Dealers, L130. *Safe*: Checkable deposits and currency, Security repurchase agreements, Debt securities, Total miscellaneous assets. *Risky*: Other loans and advances, Corporate equities, Direct investment abroad.

(x) Holding Companies, L131. *Safe*: Time and savings deposits, Security repurchase agreements, Long-term debt securities, Life insurance reserves, Total miscellaneous assets. *Risky*: Other loans and advances.

(xi) Funding Corporations, L132. *Safe*: Money market fund shares, Security repurchase agreements, Debt securities. *Risky*: Syndicated loans to nonfinancial corporate business, Corporate equities.

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Denote by S_{it} and R_{it}, respectively, the values of safe and risky assets for sector i in year t. Safe and risky investments for the whole financial industry in year t are

$$K_t^s = \sum_{i=1}^{n} S_{it}, \qquad K_t^r = \sum_{i=1}^{n} R_{it},$$

where n is the number of financial sectors included in our definition of financial industry (the list (i)–(xi)). The share of risky investment for the whole financial industry in year t is $K_t^r/(K_t^s + K_t^r)$. The average share of risky investments used for the calibration is

$$\frac{1}{11} \sum_{t=1970}^{1980} \left(\frac{K_t^r}{K_t^s + K_t^r} \right) = 0.486.$$

Supplementary Data

Supplementary data are available at *Review of Economic Studies* online.

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