

# The Shrinking of Middle Management

*by*

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We analyse a model in which (1) managers require experience in order to be productive; (2) providing managers with experience is costly and non-contractible. We demonstrate that if there is an increase in the mobility of managers, there may be a free-riding problem, in that each firm has too little incentive to give managers experience. Surprisingly, welfare may be higher in the state of the world with more mobility. We explore individual managers' incentives to invest in generalizing their skills to improve their mobility. *Journal of Economic Literature* Classification Numbers: L20, J24, J60

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## **Section 1. Introduction**

Inequality has been steadily increasing since the 1960s (Gottschalk and Danziger 2007), particularly in the US, but to a lesser extent in most OECD countries. The most common explanation for this increase is “skill-biased technical change” (Katz and Murphy 1992): The argument is that changes in production technology (such as the introduction of the computer) have had a bigger impact on the productivity of skilled workers than unskilled workers. But it has been difficult to verify this claim empirically. For example, while the returns to education have increased, education can only explain some inequality across individuals: a rise in the returns to a college education accounts for only a third of the increase in inequality (Krusell et al. 2000) and inequality is increasing between members of the same age-education bracket (Juhn 1993). To account for the data, we posit a high return to “ability”, a conveniently unobservable variable. For example, a recent article in the Economist stresses that “talent” is increasingly well-rewarded in modern economies, where “the nature of critical talent varies from company to company: it may be the ability to crack a few jokes while turning an aeroplane around in 25 minutes” (*The Economist*, October 5, 2007).

In a striking series of papers, Garicano (2000) and Garicano and Rossi-Hansberg (2006) have explored skill-biased technical change in a model of “management by exception.” Workers can handle standard problems but must pass exceptional problems up the line to managers, who have acquired the knowledge to handle more exceptional problems. Able workers choose to become managers because their cost of learning a wide range of exceptional problems is lower. Garicano and Rossi-Hansberg (2006) argue that the second half of the 20<sup>th</sup> century had two forms of “skill-biased technical change”: first, the cost of information processing fell from the 60s to the 80s, and second, the cost of communication fell in the 90s. A fall in the cost of processing information leads to more productivity at all levels, flattening hierarchies (because fewer problems are passed upwards), fewer managers, and greater inequality. A fall in the cost of communication means that it’s easier to pass problems up to managers, which leads to more layers in hierarchies and also greater inequality; the number of managers increases and they earn substantially higher earnings.

The predictions of Garicano and Rossi-Hansberg (2006) line up well with data on inequality in earnings and the nearly exponential growth in CEO earnings.<sup>1</sup> But their prediction of deepening hierarchies in the late 90s is not so clearly supported (in contrast to the flattening hierarchies of the 80s, which are relatively well-documented). Instead, the shrinking of middle management appears to take place over this entire period, not just the 80s. Rajan and Wulf (2006) look at 300 large US companies from 1986 to 1998, and find that a number of intermediary management positions (such as the Chief Operating Officer) have disappeared, and that lower-level managers are now earning more.

Another important trend over the last 50 years is that the mobility of workers has also greatly increased (de Fontenay, Gørgens and Liu 2002). Kambourov and Manovskii (2008) document steady increases in mobility across occupations and industries, in all education strata, since the 1960s. There is evidence that managers as well have increased their mobility: for example, Comte and Mihal (1990) and Billger and Hallock (2005) document steady increases in the turnover of CEOs from the 1950s to the present.<sup>2</sup> Garicano and Rossi-Hansberg do not address the issue of mobility. Our model argues that higher mobility may in fact be a cause of the other observed trends.

The literature by Garicano and Rossi-Hansberg assumes that the skills that managers are acquiring are contractible: either the manager can acquire the skills in an educational market, or, if the firm trains the manager, the firm can write a complete contract with the manager, covering the training period and the post-training wages. But some dimensions of skill are not fully contractible, in particular those related to experience. The important features of experience are that (1) formal education cannot substitute for experience; and therefore, (2) giving a worker experience is costly, because the worker must be involved in the real production process to gain experience, and initially his productivity is low. For instance, a critical determinant of the success of a surgery is the number of operations of that type a surgeon has performed before; but at some point, that surgeon must have

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<sup>1</sup> Frydman and Saks (2008) have constructed data on CEO compensation from 1945 to the present, to carefully document this trend.

<sup>2</sup> Comte and Mihal (1990) count the number of CEO turnovers at 300 large US firms, from 1945 to 1984, and show a linear increase; Billger and Hallock (2005) find a similar linear pattern in CEO turnover from 1970 to 2000.

performed her first operation. Giving a manager experience of real responsibility involves the risk that s/he will make the wrong decisions. The final feature is that (3) a manager may not be able to pay a firm to train her, because of wealth constraints or legal constraints such as the minimum wage, or because the firm cannot contractually commit to providing the right (costly) type of experience (Acemoglu and Pischke 1999).

The model developed here explores what would happen if work experience became more “portable,” in the sense that workers could easily move to a new firm. We compare two states: An “Old” equilibrium in which workers are not mobile at all, which corresponds to the stylized facts of the 1950s: a firm undertakes to give its workers experience as part of their training, in the expectation of employing those workers for life. Then, a “New” equilibrium, in which workers are highly mobile. In that New equilibrium, firms engage in free riding, hoping to poach experienced workers from other firms rather than develop their own experienced workers. Far fewer workers are trained and as a consequence wages are substantially higher.

Remains the question of what has caused this increase in the mobility of managers. There are two broad types of explanations, which we explore in turn: It could be the result of a choice by firms, or by managers. The most obvious candidate for a change in the behaviour of firms is the decline of the lifetime employment model in the United States and other Western countries. The implicit contract between firms and workers, in which workers invested effort (or invested in learning firm-specific skills) and the firm rewarded them with job security, was broken by a number of firms, first for blue-collar workers in the 1970s, and then for white-collar workers in the mass layoffs of the 1980s (Gordon 1996).<sup>3</sup> As a result, firms were no longer restricted to promoting internally, and as a consequence, managers had employment options outside their own firm. Managers may also have become more mobile in this transition, if they switched to investing in general rather than in firm-specific skills.

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<sup>3</sup> Note however that historical research by Moriguchi (2003) dates this change in the implicit contract as having begun much earlier. She argues that the decline of the implicit contract was triggered by the financial stress of the Great Depression.

Managers may also have been making explicit investments to raise the portability of their skills. Another trend over this same period is the dramatic rise in generalist managerial education, otherwise known as the MBA: Peters and April (2006) document an increase from 3200 MBAs a year in 1955 to 102,000 a year, in the US alone, in addition to the growth of MBAs in Europe and Asia. Institutions that confer MBAs claim to take students with some specific managerial experience, and then equip them to apply those skills to every other managerial environment. If that rhetoric is true, even in part, then managers would become more mobile over this time period.

Finally, it is possible that increased mobility was just a consequence of other changes in the production environment. If firm operations became more standardized over this time period (and the evidence is mixed), managerial experience from another firm might become more applicable.

This paper is closest to Acemoglu and Pischke (1999), which revisits Becker's (1964) intuition that firms will never give workers general training that is valuable at any firm. The general training they have in mind is apprenticeships, for example apprenticeships in German firms, which in the 1990s cost firms almost DM 7,500 a year. They argue that if switching jobs is more costly for skilled workers than for unskilled, firms will increase the skill level of their workers to make it more difficult for workers to switch. (The cost of switching jobs is incurred by the worker, but it has implications for negotiated wages, as switching costs worsen the worker's outside option.) As to why switching is more costly for the skilled, but it could be an opportunity cost of foregone unemployment, or adverse selection problems in the labor market, or the loss of firm-specific skills developed simultaneously. Yet much of the literature on inequality and mobility suggests that skilled workers are more mobile, which does not support their prediction.<sup>4</sup> In our paper, training workers (giving them experience) does not affect their mobility, which would imply zero training in their model. The difference is that we assume that the hiring

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<sup>4</sup> For example, Buchinsky and Hunt (1999) find that despite growing turnover rates, the probability of remaining in the highest quintiles was higher than for other quintiles, over the entire period of their study (1979 to 1991). The implication is that movement between jobs is not so costly to higher earners.

decision of one firm still affects the total supply of managers: thus firms still train, despite the free riding problem.<sup>5</sup>

Section 2 begins with a highly simplified black-box bargaining process, to contrast the “Old” and “New” equilibrium states. Section 3 extends those results to a general equilibrium setting. The paper models the wage formation process as bargaining, rather than merely supply and demand, in order to be able to explore the transition between equilibria: what is the change in a manager’s bargaining power when she invests in the portability of her skills? Section 4 presents a more detailed bargaining model, in order to study the transition in Section 5. Section 6 concludes.

## **Section 2. A simple Black-box bargaining model**

Firms are composed of two types of workers: the first type, “managers”, need experience to be productive, and once they have experience, they have some form of bargaining power. The firm hires  $n$  of these workers. The second type of workers requires no training and is productive immediately. These workers may have skills, but they can acquire these skills in an educational market. Therefore the firm pays these workers their reservation wage plus the cost of skill acquisition, and hires the profit-maximizing quantity of such workers. So we abstract away from this second category of workers and simply denote the output of the firm as  $Q(n)$ , a function of  $n$  the number of experienced managers. For simplicity, here, they are all treated symmetrically within the firm’s hierarchy, and there are no differences in ability. We also do not explore in more detail the nature of the agent we call “the firm,” which could be an owner or a board of directors.

Output of the firm  $Q(n)$  is concave and increasing in the number of managers  $n$ , but there is a cost  $c(n)$  of giving them experience. Managers must be retained in the firm for a

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<sup>5</sup> Alternatively, we could assume that training was not completely portable (workers are not perfectly mobile between firms) in the new equilibrium, which would also give a reason to train.

length of time, during which they are unproductive, in order to develop valuable skills. We assume that *it is not possible for managers to completely compensate the firm for giving them experience*. Thus the “training” stage is costly to the firm, whatever the subsequent benefits for the manager.

The timing of the game is simple:

- **Stage 1:** Firms hire workers and train them, at a cost  $c(n)$
- **Stage 2:** Firms bargain with workers over their wages (possibly with some movement of workers between firms) and after agreement, production occurs.

We begin with an extremely simple bargaining model, and one which cannot allow for asymmetries: when  $f$  identical firms bargain with  $N$  identical workers with reservation wage  $\bar{w}$ , and any worker could work for any firm, the wage is denoted  $w(f, N, \bar{w})$ .

**Assumption on the bargaining process:**  $w_1 > 0, w_2 < 0, w_3 > 0; w \geq \bar{w};$

$$\forall k, \quad w(kf, kN, \bar{w}) = w(f, N, \bar{w})$$

The first three assumptions are obvious: a sensible bargaining process would imply higher wages when (ceteris paribus) there are more firms hiring, or fewer workers available, or when the reservation wage is higher. The fourth assumption is also obvious: given that the worker would earn  $\bar{w}$  if she had no bargaining power, she must be earning at least  $\bar{w}$  from the bargaining process.

The fifth assumption, which we will call *scale-invariance*, is not an automatic feature of most bargaining models. We make this assumption in order to avoid biasing the results: we assume that when the market grows, and more workers and firms are present, neither side of the market benefits from scale *in se*.

The reservation wage  $\bar{w}$  is the wage paid in a second sector, in which no experience is required. From the point of view of a firm,  $\bar{w}$  is a constant, but in point of fact  $\bar{w}$  rises as more firms enter, because the total number of workers drawn in to the first sector rises.

We make this assumption in order to endogenise  $\bar{w}$  without having to assume heterogeneity in the population of workers (for example, if this were the only sector of the economy, but there was an upward-sloping labor supply curve arising from different disutilities of work).

The comparative statics exercise compares two states of the world:

- State “**Old**”, in which the firm must train its workers itself; the experience is only valuable at that firm.
- State “**New**”, in which experience from one firm can be applied in other firms in the sector (broadly or narrowly defined). Workers still need to spend time in some firm to gain experience, but that experience is now portable, and can be used at any firm.

**In the “Old” state:** Each firm bargains only with the workers that it trains, because those workers cannot work for any other firm in the sector, and firms cannot hire workers from other firms, as those workers are not productive without firm-specific experience. The bargained wage at firm  $i$  is  $w(1, n_i, \bar{w})$ , a function of the number of workers the firm chose to hire initially. The maximization problem for the firm is then<sup>6</sup>:

$$\begin{aligned} \text{Max}_{n_i} \quad & Q(n_i) - w(1, n_i, \bar{w})n_i - c(n_i) \\ \Leftrightarrow \quad & Q'(n_i) - w_2(1, n_i, \bar{w})n_i - w(1, n_i, \bar{w}) = c'(n_i) \end{aligned} \quad (1)$$

**In the “New” state:** Workers still need to have experience, but it is more portable. For simplicity we assume that workers can now costlessly generalise their experience; then there is no difference between workers with internal experience and workers with experience in another firm in the same sector. The bargained wage in the sector is  $w(f, N, \bar{w})$ , a function of the total number of firms  $f$ , and the total number of workers that were trained. Note that, because the wage bargaining function is homogeneous of

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<sup>6</sup> We are assuming that the firm must employ all the workers that it trains. The underlying assumption is that if a worker were to spend time unemployed, his experience would erode and he would no longer be “available” to the firm; thus he would no longer be of value to the firm in depressing the wages of other workers. Hence, if the firm bothers to train the worker, the firm will choose to retain her after training.

degree zero, if firms were symmetric and hired the same number of workers as before, then  $N = fn_i$  and the wage would be exactly the same as before:

$$w(f, fn_i, \bar{w}) = w(1, n_i, \bar{w}).$$

Under symmetry, once the training stage is completed, each of the firms will end up with an equal share  $\frac{1}{f} \sum n_j$  of all the trained workers. The maximization problem for firm  $i$  is therefore:

$$\begin{aligned} & \text{Max}_{n_i} \quad Q\left(\frac{1}{f} \sum n_j\right) - w\left(f, \sum n_j, \bar{w}\right) \left(\frac{1}{f} \sum n_j\right) - c(n_i) \\ \Rightarrow & \quad \frac{1}{f} Q'\left(\frac{1}{f} \sum n_j\right) - w_2\left(f, \sum n_j, \bar{w}\right) \left(\frac{1}{f} \sum n_j\right) - \frac{1}{f} w\left(f, \sum n_j, \bar{w}\right) = c'(n_i) \quad . \\ \Leftrightarrow & \quad \frac{1}{f} \left[ Q'\left(\frac{1}{f} \sum n_j\right) - w_2\left(1, \frac{1}{f} \sum n_j, \bar{w}\right) \left(\frac{1}{f} \sum n_j\right) - w\left(1, \frac{1}{f} \sum n_j, \bar{w}\right) \right] = c'(n_i) \end{aligned}$$

(We are using the fact that if  $w$  is homogeneous of degree zero, its partial derivative  $w_2$  is homogeneous of degree -1, that is  $w_2(fx, fy, \bar{w}) = \frac{1}{f} w_2(x, y, \bar{w})$ .) Once we take symmetry into account, noting that  $\left(\frac{1}{f} \sum n_j\right) = n_i$ , the first-order condition becomes:

$$\Leftrightarrow \quad \frac{1}{f} \left( Q'(n_i) - w_2(1, n_i, \bar{w}) n_i - w(1, n_i, \bar{w}) \right) = c'(n_i) \quad (2)$$

This is identical to equation (1), but with the left-hand-side of the equation divided by  $f$ , which in turn implies that  $n_i^{Old} \gg n_i^{New}$ , and in turn, that  $w(1, n_i^{Old}, \bar{w}) \ll w(1, n_i^{New}, \bar{w})$ .

Essentially, there are two inefficiencies, which can potentially cancel each other out: over-hiring and under-training. In the “Old” equilibrium, the firm will choose to overhire, if by doing so it can reduce the wages it pays to its workers. Relative to a Neoclassical equilibrium in which firms pay their workers the outside wage  $\bar{w}$ , the wages in the “Old” equilibrium are:

$$Q' - c' = w + \underbrace{w_2 n}_{<0}$$

Looking at the two terms on the right-hand side of the equation, the wage  $w$  is higher than the reservation wage  $\bar{w}$ , and thus employment would tend to be higher than employment in a Neoclassical world, in which firms post job offers at workers’ reservation wage

( $Q' - c' = \bar{w}$ ). But the second term is negative: if hiring more workers has a significant effect on wages, the firm may choose to hire more than the Neoclassical number of workers. (See Stole and Zwiebel 1996 for a bargaining model with overhiring.)

In the “New” equilibrium, firms are imposing externalities on each other by seeking to free ride on training: one firm bears the cost of training a worker, but then all the firms share the pool of workers. Ceteris paribus, this would lead to an inefficiently low level of hiring. But if there is overhiring in the Old equilibrium, the New equilibrium may potentially result in hiring that is closer to Neoclassical hiring levels. To address these tradeoffs, we turn to general equilibrium analysis.

### **Section 3. General Equilibrium effects with this Black-Box Bargaining Model**

We now allow for the free entry of firms into the sector. Firms incur fixed costs  $K$  and then enter until they are breaking even given the current  $\bar{w}$ . We analyze the equilibria in the “Old” and “New” states, in terms of the number of employees per firm, the reservation wage, and total welfare.

**Proposition 1: Suppose that the wage bargaining function satisfies**

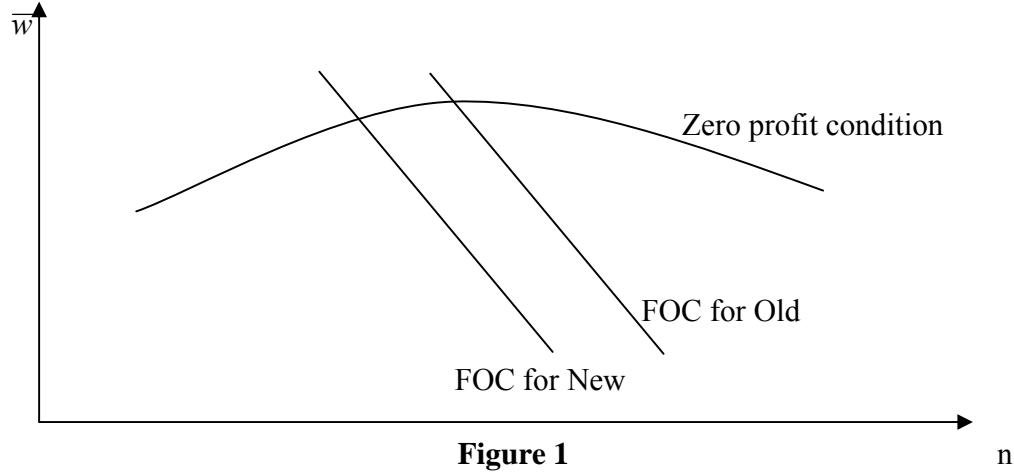
$w(1, n, \bar{w}) = w(f, fn, \bar{w})$ . **Then**  $N^{Old} > N^{New}$ ,  $n^{Old} > n^{New}$  **and**  $w^{Old} < w^{New}$ .

**Proof:** The set of equations satisfied by the solution in the “Old” and “New” states are the first-order condition for hiring, and the free-entry condition:

$$OLD : \begin{cases} Q'(n) - w_2(1, n, \bar{w}) - w(1, n, \bar{w}) = c'(n) \\ Q(n) - w(1, n, \bar{w})n - c(n) - K = 0 \end{cases} \quad (3)$$

$$NEW : \begin{cases} Q'(n) - w_2(1, n, \bar{w})n - w(1, n, \bar{w}) = fc'(n) \\ Q(n) - w(1, n, \bar{w})n - c(n) - K = 0 \end{cases} \quad (4)$$

The solution is a pair of values  $(n^{Old}, \bar{w}^{Old})$  and  $(n^{New}, \bar{w}^{New})$  that we will characterize as the intersection of two lines: First, the line defined by the free-entry condition, which is the same for both; and second, the first-order condition, which differs for each.



Recall that for the same value of  $\bar{w}$ , the first-order-conditions imply that  $n^{New}(\bar{w}) \ll n^{Old}(\bar{w})$ , and thus the curve for the New equilibrium is to the left of the curve for the Old equilibrium.

Notice that the first-order conditions for the Old equilibrium intersects the zero-profit curve at its maximum.<sup>7</sup> Therefore  $n^{New} < n^{Old}$  and  $\bar{w}^{New} < \bar{w}^{Old}$ . Note however that  $w(f, fn^{New}, \bar{w}^{New}) = w(1, n^{New}, \bar{w}^{New}) > w(1, n^{Old}, \bar{w}^{Old})$ . This last step follows from re-writing the zero-profit condition in each bracket:

$$\begin{cases} w(1, n^{New}, \bar{w}^{New}) = \frac{Q(n^{New}) - c(n^{New}) - K}{n^{New}} \\ w(1, n^{Old}, \bar{w}^{Old}) = \frac{Q(n^{Old}) - c(n^{Old}) - K}{n^{Old}} \end{cases}$$

Since  $Q(n) - c(n) - K$  is a concave function, its average is a decreasing function, and therefore  $n^{New} < n^{Old}$  implies  $w(1, n^{New}, \bar{w}^{New}) > w(1, n^{Old}, \bar{w}^{Old})$ .  $\square$

<sup>7</sup> The shape of the zero-profit curve is derived from totally differentiating the second equation in each bracket:  $\frac{d\bar{w}}{dn} = -\left(\frac{Q'(n) - w_2 n - w - c'(n)}{-w_3 n}\right)$ . Given that  $w_3 > 0$  and that  $Q'(n) - w_2 n - w - c'(n) = \begin{cases} 0 \\ (f-1)c'(n) \end{cases}$  at the respective intersections with the first-order conditions for Old and New, we conclude that the zero-profit curve is increasing until its maximum at the intersection with the first-order-conditions for Old.

**Welfare comparison:** It is clear from Proposition 1 that neither equilibrium Pareto dominates the other, as managers in this sector earn more in the New equilibrium, but there are fewer of them.

In the Old equilibrium, more people are drawn into this sector, pushing up the wage in the other sectors of the economy. Therefore the Old equilibrium is preferred for any welfare function that places a large enough weight on low earners, or for strongly concave utility functions. However, with very low training costs, linear utility, and a welfare function that weights individuals equally, the New equilibrium can be preferable.

**Proposition 2: Welfare can be higher under the New equilibrium.**

Proof: See Appendix 1.

#### **Section 4: Results under a more explicit bargaining model: Core Bargaining**

We turn to the question of the transition between these equilibria. A transition will occur when firms or workers have an incentive to look elsewhere for bargaining partners, and an “investment” makes that possible. For instance, firms may choose to break the implicit contract of lifetime employment with their existing workers, by looking elsewhere for workers, in exchange for some long-term cost, perhaps in the form of reduced worker effort. Or workers may choose to invest in education that allows them to generalise their experience, for example an MBA degree.

The black-box model of bargaining that we have been using does not allow for asymmetries between players, and therefore it cannot be used to consider transitions between equilibria. We therefore turn to a more detailed model of bargaining, but one that is still fairly black-box, namely Core bargaining.

A number of recent papers have used the Core (a cooperative bargaining concept) to model the bargaining stage between multiple players, rather than modeling a more detailed process that may not be robust to slight changes in the process. Brandenburger and Stuart (2007) provide an overview of this approach, which they call “biform games”: a cooperative bargaining stage is preceded by a non-cooperative investment stage, in which agents make investments to improve their payoff from bargaining. However, because the core is a prediction about the *range* of possible outcomes, comparative statics can be problematic. Macdonald and Ryall (2004) and Kranton and Minehart (2001) resolve this difficulty by focusing on one extreme of the range of possible allocations. We follow this approach, and focus on the **core allocation that is least favorable to workers**.

**Assumption 1: Under the equilibrium allocation, firms receive the highest share of surplus possible.** (This allocation may be unique.)

Core bargaining does not possess the property of scale-invariance required for Proposition 1. We will therefore need to use a slightly modified version of Proposition 1:

**Proposition 3: Suppose that the wage bargaining function satisfies**

$$w(f, fn, \bar{w}) \geq w(1, n, \bar{w}) \text{ and also } w_2(1, n, \bar{w}) \geq \frac{1}{f} w_2(f, fn, \bar{w}) . \text{ Then } n^{Old} > n^{New} \text{ and } w^{Old} < w^{New} .$$

Proof: See Appendix 2.

Remains to show that the Core Bargaining outcome least favorable to workers satisfies the conditions of Proposition 3. One more assumption is required.

**Assumption 2: Training costs are sufficiently large that once workers are trained, the marginal product of the trained workers is always above  $\bar{w}$ , even if there are**

**only (f-1) firms in operation:  $Q'\left(\frac{fn}{f-1}\right) > \bar{w}$ .**

Assumption 2 is necessary because core bargaining assumes that agents all agree to take the surplus-maximizing decisions: but if the workers were producing less than their reservation wage, it would be surplus-maximizing for them to leave the sector. If workers are scarce, it is surplus-maximizing to retain them all in the sector, and allocate them evenly across firms.

The intuition behind Core Bargaining is that no subset of players can receive less than the subset would receive if it were to split off and take the actions that maximize its own surplus (Myerson 1991: 427). For example, core bargaining rules out any payments from a firm to workers that it does not employ, because if such payments took place, the firm and its workers would earn more by breaking off from all other players. Thus core bargaining is a set of inequality restrictions on the payoffs of players.

**In the Old equilibrium**, in which each firm can negotiate with its  $n$  workers: All other firms and workers are irrelevant, as no cooperation is possible when there is no mobility. The lowest payoff the workers can receive is their outside option,  $\bar{w}$ , otherwise they would be better off breaking off and obtaining their outside option. Appendix 3 demonstrates that this allocation is within the core (i.e. satisfies the other restrictions): therefore  $\Pi^{Old}(n) = Q(n) - n\bar{w}$ .

**In the New equilibrium**, in which all firms can negotiate with all workers: A firm and its  $n$  workers must receive exactly  $Q(n)$ , as discussed above. A breakoff group composed of a firm and  $(n+1)$  workers must receive at least  $Q(n+1)$ . Therefore any worker must receive at least  $[Q(n+1) - Q(n)]$ , which is more than  $\bar{w}$  by assumption 2. If a worker must receive this minimum amount, then by implication, a firm receives the remainder of the  $Q(n)$  not paid as wages, that is,

$$\Pi^{New}(n) = Q(n) - n[Q(n+1) - Q(n)] = (n+1)Q(n) - nQ(n+1) \quad (6)$$

This payoff is positive by the assumption of concavity. In Appendix 3 we show that this allocation is in the core, that is, that no other constraints are binding. Therefore this is the least favorable allocation for workers.

Notice that the first condition of Proposition 3,  $(w(f, fn, \bar{w}) \geq w(1, n, \bar{w}))$ , is satisfied by this allocation rule. It is immediate to show that the other condition of Proposition 3 is satisfied.<sup>8</sup> Therefore, even after allowing for the free entry of firms, wages are higher and employment is lower in the New equilibrium than in the Old.

## **Section 5: Transitions from the Old to the New Equilibrium, under Core Bargaining**

### **Transition by Workers toward the New equilibrium:**

Now we are in a position to evaluate whether workers might drive a transition towards the “New” state of the world. Suppose that a worker/manager could make an investment that rendered her skills completely general, for example by getting an MBA degree. If the investment improved her negotiated wages, then there is some price at which the investment is profitable.

Suppose one worker has now acquired these general skills. By the same logic as above, a breakoff group composed of this worker plus another firm and its workers must receive at least  $Q(n+1)$ , therefore this worker must receive at least  $[Q(n+1) - Q(n)]$ . In Appendix 4 we demonstrate that this is what he receives, and that the other workers continue to receive  $\bar{w}$ , in the Core allocation that is least favorable to workers. More generally, as proven in Appendix 4:

**Proposition 4: Suppose the economy is initially in the Old Equilibrium. If investment costs less than  $[Q(n^{Old} + 1) - Q(n^{Old}) - \bar{w}]$ , an additional manager will find it worthwhile to invest, given any number of managers in any firms who have already invested in generalizing their experience. As a consequence, the economy transitions from the Old Equilibrium to the New Equilibrium.**

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<sup>8</sup> We wish to show that  $w_2(1, n, \bar{w}) \geq \frac{1}{f} w_2(f, fn, \bar{w})$ . Calculating:  $w_2(1, n, \bar{w}) = \frac{d(\bar{w})}{dn} = 0$  and

$$w_2(f, N, \bar{w}) = \frac{d(Q(n+1) - Q(n))}{dN} = \frac{d\left(Q\left(\frac{N}{f} + 1\right) - Q\left(\frac{N}{f}\right)\right)}{dN} = \frac{1}{f} \left[ Q'\left(\frac{N}{f} + 1\right) - Q'\left(\frac{N}{f}\right) \right] < 0, \text{ because } Q' \text{ is decreasing. } \square$$

Looking at the evidence, one has to ask why the transition occurred when it did, and why it was gradual. The gradual diffusion of MBA programs, and their growing recognition in the market, may explain why managers' mobility increased only gradually over this period.

**Transition by a Firm toward the New equilibrium:**

In this model, firms have no incentive to improve their bargaining power, because they have already pushed worker/managers down to their reservation wage  $\bar{w}$ . But this is an artifact of assuming that the bargaining outcome is most favorable to firms. Under a less extreme allocation of bargaining power, firms would seek to improve their bargaining position by having access to workers outside the firm.

A firm considering renegeing on an implicit contract with workers (lifetime employment in exchange for effort or firm-specific investment) might find that the short-term benefits in terms of improved bargaining power outweighed the long-term cost, at some discount rates.

**Section 6: Conclusion**

This paper seeks to harmonize some of the trends observed in managerial compensation and the size of hierarchies. Explanations of these trends have centered on skill-biased technological change. But those trends and trends in mobility could also be accounted for by increased portability of managerial skills, which affects the negotiations between firms and managers, and more importantly, leads to free riding in the training of managers.

For the moment, this paper does not model any actual mobility. All workers remain at their firm, but it is their potential mobility that drives the results; in equilibrium no workers change firms. It would be simple to extend the model to allow for shocks to the preferences of the workers for a specific firm, or a shock to the productivity of a worker-firm match, that (in the New State of the World) led to some changes in employment

from one period to the next. But we leave this for future work, as it does not add much to the intuition.

The structural empirical literature on mobility (Altonji and Williams 2005, Buchinsky et al. 2008) attempts to estimate the returns to experience and the returns to seniority (tenure in a firm). In principle these estimates should give us an idea of whether the returns to experience have increased over time. This literature generally does model each firm-worker match as having a specific value, over and above the value of the worker's ability. This literature is extremely sophisticated in its ability to deal with unobserved heterogeneity in data, namely, that the individual's ability is correlated with the likelihood that she is a good match with a firm. But that literature does not incorporate many of the bargaining considerations we have introduced here. For example, if another firm makes a high offer to a worker who is currently employed, her current employer does not revise the wage. Overlooking bargaining may affect the estimates of the returns to seniority and experience. Therefore there is certainly more work to be done incorporating bargaining considerations into models of wages and mobility.

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## Appendix 1: Proof of Proposition 2

Notice that the sets of equations (3) and (4) defining the Old and New equilibria are identical when  $c'=0$ .

As illustrated in Figure 1, the “NEW” equilibrium is located to the left of the “OLD” equilibrium along the zero-profit curve. We demonstrate that a slight movement to the left from the “OLD” equilibrium is always welfare-improving. Therefore, for sufficiently low values of  $c'$ , the “New” equilibrium would be only slightly to the left of the “OLD” equilibrium, and would be a welfare improvement.

Totally differentiating the zero-profit condition from equation pairs (3) and (4) gives the following relationship along that line:

$$\frac{d\bar{w}}{dn} = \frac{Q'(n) - w - w_2n - c'}{w_3n}$$

Let us assume a linear utility function and a welfare function that weights all individuals equally. Then Total Welfare  $W$  is the sum of all agents' earnings. If there are  $\bar{N}$  agents in the economy as a whole,  $W = wN + \bar{w}(\bar{N} - N)$ , where we take  $N$  to be a function of  $\bar{w}$  (more workers  $N$  are drawn into this sector if the reservation wage is higher). And thus there are only two variables,  $n$  and  $\bar{w}$ :

$$\frac{dW}{dn} = \frac{\partial W}{\partial n} + \frac{\partial W}{\partial \bar{w}} \left( \frac{d\bar{w}}{dn} \right) = \underbrace{w_2N}_{<0} + \frac{\partial W}{\partial \bar{w}} \underbrace{\left( \frac{Q'(n) - w - w_2n - c'}{w_3n} \right)}_{=0 \text{ at } n^{old}}$$

Therefore welfare falls if we increase  $n$  around  $n^{old}$ , and rises if we decrease  $n$ , i.e. if we move to the left from that point.  $\square$

### Appendix 2: Proof of Proposition 3

The set of equations satisfied by the solution in the “Old” state is a first-order condition and a free-entry condition that are identical to (3):

$$\begin{cases} Q'(n_i^{Old}) - w_2(1, n_i^{Old}, \bar{w}^{Old})n_i^{Old} - w(1, n_i^{Old}, \bar{w}^{Old}) = c'(n_i^{Old}) \\ Q(n_i^{Old}) - w(1, n_i^{Old}, \bar{w}^{Old})n_i^{Old} - c(n_i^{Old}) - K = 0 \end{cases} \quad (7)$$

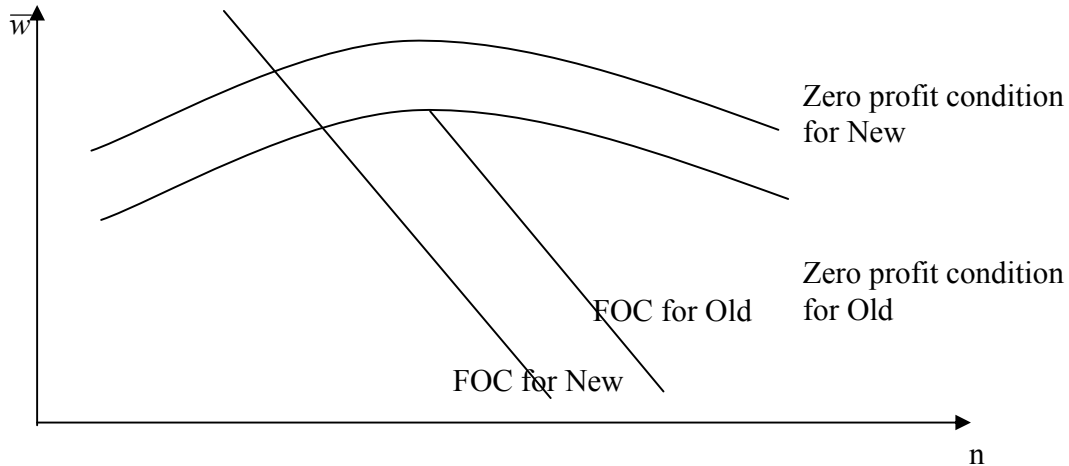
However, in state “New”, both conditions are different to the conditions in (4):

$$\begin{cases} \frac{1}{f}Q'(n_i^{New}) - w_2(f, fn_i^{New}, \bar{w}^{New})n_i^{New} - \frac{1}{f}w(f, fn_i^{New}, \bar{w}^{New}) = c'(n_i^{New}) \\ Q(n_i^{New}) - w(f, fn_i^{New}, \bar{w}^{New})n_i^{New} - c(n_i^{New}) - K = 0 \end{cases} \quad (8)$$

which lead to the following inequalities:

$$\begin{cases} \frac{1}{f}Q'(n_i^{New}) - w_2(f, fn_i^{New}, \bar{w}^{New})n_i^{New} - \frac{1}{f}w(f, fn_i^{New}, \bar{w}^{New}) = c'(n_i^{New}) \\ \leq \frac{1}{f} [Q'(n_i^{New}) - w_2(1, n_i^{New}, \bar{w}^{New})n_i^{New} - w(1, n_i^{New}, \bar{w}^{New})] \\ < [Q'(n_i^{New}) - w_2(1, n_i^{New}, \bar{w}^{New})n_i^{New} - w(1, n_i^{New}, \bar{w}^{New})] \\ Q(n_i^{New}) - w(1, n_i^{New}, \bar{w}^{New})n_i^{New} - c(n_i^{New}) - K > 0 \end{cases} \quad (9)$$

Consequently, comparing the first-order equation in brackets (7) and (9), we find that for a given value of  $\bar{w}$ , we have  $n^{Old}(\bar{w}) < n^{New}(\bar{w})$ . And comparing the zero-profit equation in brackets (7) and (8), using (9), we find that for a given value of  $n$ , we have  $\bar{w}(n^{Old}) < \bar{w}(n^{New})$ . The graph is therefore as follows:



And thus the graphical proof still applies:  $n^{Old} > n^{New}$  but can no longer be shown that  $\bar{w}^{Old} > \bar{w}^{New}$ . But it is still the case that  $w^{Old} < w^{New}$ , by a similar logic to Proposition 1.

**Appendix 3: Proof that the allocations described are in the core**

**3a) Allocation in the “Old” Equilibrium:** Workers get  $\bar{w}$  each, the firm gets  $Q(n)$ . We need only consider one firm and its  $n$  workers, because no cooperation of any sort is possible with other players.

Could any subset of the players create more total value? Any subset of  $m$  workers that does not include the firm would work in the other sector, and earn  $m\bar{w}$ , which is what they are currently earning; therefore workers could not do better by breaking off. Any subset that includes the firm and  $m < n$  workers would earn  $Q(m)$  in total, which is less than what they are earning in the current allocation,  $Q(n) - (n-m)\bar{w}$  (given Assumption 2, that  $Q'(n) > \bar{w}$ ).

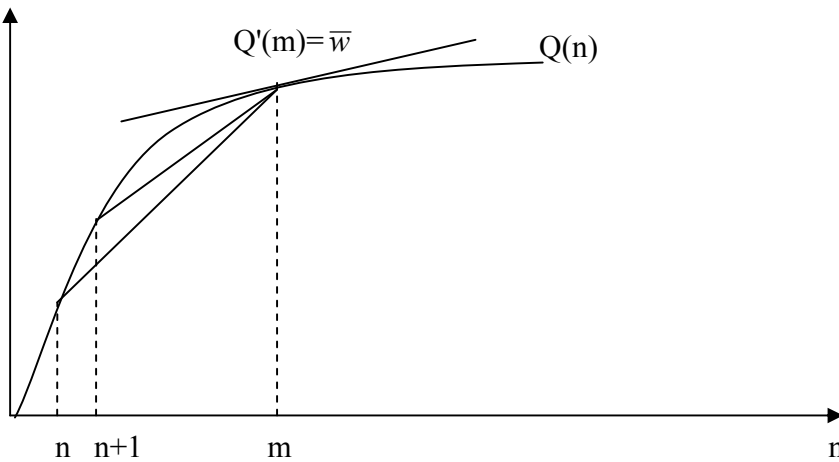
**3b) Allocation in the “New” Equilibrium:** Workers earn  $(Q(n+1) - Q(n))$  each and the firm earns  $\Pi(n) = (n+1)Q(n) - nQ(n+1)$ . To show that this allocation is in the core, we need to prove that a subset of  $M$  workers and  $k$  firms could not earn more by breaking away and working together.

We begin with the case in which  $M$  is large. The breakoff subset faces integer constraints and therefore earns slightly less than  $\text{Max}_{m \leq \frac{M}{K}} \{KQ(m) + \bar{w}(M - km)\}$ , where  $Q'(m) = \bar{w}$ .

We show that:

$$\begin{aligned}
 & KQ(m) + \bar{w}(M - km) \leq K((n+1)Q(n) - (n)Q(n+1)) + M(Q(n+1) - Q(n)) \\
 \Leftrightarrow & 0 \leq K(Q(n) - Q(m)) - \bar{w}(M - Km) + (M - Kn)(Q(n+1) - Q(n)) \\
 \Leftrightarrow & 0 \leq -K(m-n) \underbrace{\left( \frac{Q(m) - Q(n)}{m-n} \right)}_{w_1} - \bar{w}(M - Km) + (M - Kn) \underbrace{\left( \frac{Q(n+1) - Q(n)}{(n+1) - n} \right)}_{w_2} \\
 \Leftrightarrow & 0 \leq K(m-n)(w_2 - w_1) + (M - Km)(w_2 - \bar{w})
 \end{aligned}$$

A graphical illustration serves to show that  $\bar{w} < w_1 < w_2$ , because all these points are below  $m$ :



If instead  $M < mK$ , then the breakaway subset would earn slightly less than it would earn in the absence of integer constraints, namely, less than  $KQ\left(\frac{M}{K}\right)$ . We show that:

$$\begin{aligned}
KQ\left(\frac{M}{K}\right) &\leq K((n+1)Q(n) - (n)Q(n+1)) + M(Q(n+1) - Q(n)) \\
\Leftrightarrow 0 &\leq K\left(Q(n) - Q\left(\frac{M}{K}\right)\right) + (M - Kn)(Q(n+1) - Q(n)) \\
\Leftrightarrow 0 &\leq K\left(\frac{M}{K} - n\right) \left[ \underbrace{\frac{Q(n+1) - Q(n)}{(n+1) - n}}_{w_2} - \underbrace{\frac{Q\left(\frac{M}{K}\right) - Q(n)}{\frac{M}{K} - n}}_{w_1} \right]
\end{aligned}$$

The right-hand expression is only negative if  $n < \frac{M}{K} < n+1$ . For that case, we will have to write out the earnings of the subset in slightly more detail: In that case the earnings of the subset are  $KQ(n) + \bar{w}(M - Kn)$ , and we aim to show that:

$$\begin{aligned}
KQ(n) + (M - Kn)\bar{w} &\leq K((n+1)Q(n) - (n)Q(n+1)) + M(Q(n+1) - Q(n)) \\
\Leftrightarrow 0 &\leq (M - Kn)(Q(n+1) - Q(n) - \bar{w}) \\
\Leftrightarrow 0 &\leq (M - Kn)(\pi(n+1) - \pi(n))
\end{aligned}$$

where  $\pi(n)$  is the neoclassical profit function,  $\pi(n) = Q(n) - \bar{w}n$ . As both  $(n+1)$  and  $(n)$  are below the optimum of  $\pi$ , the right-hand side is indeed positive.  $\square$

#### **Appendix 4: Proof of Proposition 4**

By an argument similar to that outlined earlier, the investing worker must earn at least  $[Q(n+1) - Q(n)]$  and the non-investing earn at least  $\bar{w}$ . Here we demonstrate that the allocation in which they earn  $[Q(n+1) - Q(n)]$  and  $\bar{w}$  respectively is in the core; therefore this is the allocation that is least favorable to workers.

Suppose that currently  $u_i < n$  of firm  $i$ 's managers have generalized their skills and are now "unattached". The firm will earn:

$$\Pi^{u_i}(n) = (u_i + 1)Q(n) - u_i Q(n+1) - (u_i - n)\bar{w}$$

Now suppose that a set of firms and workers have broken off from the main group. We denote by  $k_i^u$  the unattached workers coming from firm  $i$ , and by  $k_i^a$  the attached workers coming from firm  $i$ . There is a set of  $K$  firms in the breakoff group; we assume w.l.o.g. that the first  $K$  firms break off.<sup>9</sup>

We need to show that the earnings of the breakoff group are less than the group's total payoff in the core: We focus on the case in which  $\sum_{i=1}^K (k_i^a + k_i^u) < KQ'(\bar{w})$ , so that all the workers are used in firms (otherwise the condition is less stringent).

$$\begin{aligned} & \text{Max}_{\tilde{k}_i \geq 0, \sum_{i=1}^F \tilde{k}_i = \sum_{i=1}^F k_i^u} \left\{ \sum_{i=1}^K Q(k_i^a + \tilde{k}_i) \right\} \\ & \leq \sum_{i=1}^K ((u_i + 1)Q(n) - u_i Q(n+1) - (n - u_i)\bar{w}) + \sum_{i=1}^F k_i^u (Q(n+1) - Q(n)) + \bar{w} \sum_{i=1}^F k_i^a \\ \Leftrightarrow & 0 \leq \sum_{i=1}^K ((Q(n) - Q(k_i^a + \tilde{k}_i)) - (u_i - k_i^u)(Q(n+1) - Q(n)) - (n - u_i - k_i^a)\bar{w}) \end{aligned}$$

We rewrite terms as a function of  $\pi(n) = Q(n) - \bar{w}n$ , the neoclassical profit function, using the fact that  $\sum_{i=1}^K k_i^u = \sum_{i=1}^K \tilde{k}_i$ .

$$\begin{aligned} \Leftrightarrow & 0 \leq \sum_{i=1}^K (\pi(n) - \pi(k_i^a + \tilde{k}_i) - (u_i - k_i^u)(\pi(n+1) - \pi(n))) \quad (*) \\ \Leftrightarrow & 0 \leq \sum_{i=1}^K (u_i - k_i^u) \left( \left( \frac{\pi(n) - \pi(k_i^a + \tilde{k}_i)}{n - (k_i^a + \tilde{k}_i)} \right) \left( \frac{n - (k_i^a + \tilde{k}_i)}{u_i - k_i^u} \right) - \left( \frac{\pi(n+1) - \pi(n)}{(n+1) - n} \right) \right) \end{aligned}$$

<sup>9</sup> If the breakaway group includes any attached workers whose employer is not part of the breakaway group, we ignore them, as they can only generate  $\bar{w}$  in additional payoff (by working in the other sector for their reservation wage), but they are paid  $\bar{w}$ .

For each of these firms, it must be that  $k_i^a + u_i \leq n$  (that is, the number of unattached workers that firm  $i$  employs, out of its total  $n$ , under normal circumstances, and the number of firm  $i$ 's attached workers who have joined the breakaway subset, must be less than or equal to the total number of workers that firm  $i$  has in all), and therefore that  $n - k_i^a - \tilde{k}_i \geq u_i - \tilde{k}_i$ . Therefore there are 3 cases to consider:

- $u_i - \tilde{k}_i > 0$ , which implies  $n > k_i^a - \tilde{k}_i$ . The first term is now average profits from  $n$  to a smaller value ( $k_i^a - \tilde{k}_i$ ), multiplied by a term that is greater than 1, so it is larger in absolute value than the second term, which is average profits from  $n$  to a larger value, by the concavity of the profit function. (This is a similar argument to Appendix 3b).
- $n \geq k_i^a - \tilde{k}_i$ , but  $u_i - \tilde{k}_i < 0$ . Now, looking at the upper line of the calculation, labeled (\*), it is clear that both terms are positive.
- $n + 1 \leq k_i^a - \tilde{k}_i$ , and  $u_i - \tilde{k}_i < 0$ . (Note that because of integer constraints, there is no case in which  $n < k_i^a - \tilde{k}_i < n + 1$ .) Now the second term (average profits from  $n$  to  $n+1$ ) is larger in absolute value, and the whole expression is multiplied by a negative number, so the second term is positive.  $\square$