

# The (ir)resistible rise of agency rents

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## Abstract

The rents agents can extract from principals increase with the magnitude of incentive problems, which the literature usually takes as given. We endogenize it, by allowing agents to choose more or less opaque and complex technologies. In our overlapping generations model, agents compete with their predecessors. We study whether the presence of old-timers earning low rents can keep young managers' rent-seeking in check. With dynamic contracts, long horizons help principals incentivize agents. Hence, old agents are imperfect substitutes for young ones. This mutes down competition between generations, especially if compensation deferral is strong. As a result, young managers can opt for more opaque and complex technologies, and therefore larger rents, than their predecessors. Thus, in equilibrium, complexity and rents rise over time.

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# 1 Introduction

In the presence of moral hazard, principals must leave rents to agents, to incentivize appropriate actions. The more complex and opaque the task delegated to the agent, the more difficult it is to monitor his actions, the larger his rents. Furthermore, while operating the project, the agent acquires knowledge and network connections, which are key to the success of the project, but are also portable. In this context the agent could leave the firm and use these skills and connections for his own profit. To induce the agent to remain in the firm, the principal must leave him rents. The two problems are compounded if the complexity of the task delegated to the agent exacerbates the consequence that would arise if the agent were to abscond.<sup>2</sup>

Agency problems due to unobservable actions have been developed, notably, by Holmstrom (1979), Grossman and Hart (1983), and Holmstrom and Tirole (1997). The agency problem arising when the agent can leave the firm is related to the limited commitment models of Thomas and Worall (1988) and Kocherlakota (1998). It is also related to the ex-post unobservability problem analyzed, notably, by Townsend (1979), Diamond (1984), and Bolton and Scharfstein (1990).

In these analyses, the severity of the agency problem is taken as given. Yet, in practice, agents can take actions that will affect the magnitude of these problems. For example, they can opt for activities, sectors or products that are extremely complex or opaque. They can even devote resources to increasing such complexity and opacity. Agents can also opt for activities relying primarily on network connections or specific knowledge, which they could carry with them if absconding.<sup>3</sup>

The first innovation of the present paper is to consider a setting in which, when agents are born, they choose the characteristics of the task they propose to conduct for principals. Correspondingly, they choose the magnitude of the incentive problem to which principals will be confronted. Thus, the agents set the potential rents they could obtain if hired.

The agents' desire to capture rents, however, could be kept in check by market forces and com-

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<sup>2</sup>A particularly perverse instance of this problem arose in the case of AIG. As was mentioned in the New York Times issue of March 16, 2009: "A.I.G. employees concocted complex... If they leave... they might simply turn around and trade against A.I.G.'s book. Why not? They know how bad it is. They built it."

<sup>3</sup>For example, Hochberg, Ljungqvist and Lu (2007) show empirically the importance of newtworks in venture capital, while Oyer (2008) notes his results are consistent with finance sector managers acquiring skills and developing networks of connections shortly after taking jobs on Wall Street.

petition among managers. If each principal could run an auction with several, otherwise identical, managers, he could select the agent with the smallest incentive problem, and hence the smallest rent. Anticipating this, managers would have to opt for activities with very limited agency problems, in order to be hired. We show, however, the existence of natural forces limiting competition between agents, thus creating the scope for rent capture. And in this context we endogenize the dynamics of agency problems.

We consider an OLG model. At each period a new principal and a new manager are born.<sup>4</sup> Each lives for two periods. At the beginning of his life, the young manager chooses (at a cost) the parameter  $b$  specifying the magnitude of the agency problem. The young principal meets the young agent, observes his  $b$ , and decides whether to hire him or not. When making this choice, the principal bears in mind that she could instead hire the agent born at the previous generation, which would be particularly attractive if that agent had a low  $b$ . Thus, if the young and old agents were otherwise perfectly substitutable, competition between generations would deter young agents from choosing higher  $b$ s than their predecessors. Consequently, opacity, complexity and rents would remain low. Incentive problems, however, endogenously induce imperfect substitutability between successive generations. The intuition is the following: To reduce rents, principals defer compensation (as in Becker and Stigler, 1974, and Rogerson, 1985). This makes it relatively unattractive for a young principal to hire an old agent. First, to poach the old agent, the young principal would have to pay him the rent he has been promised by his current employer. Second, old agents have a shorter horizon than young ones. This reduces the ability of the young principal to defer these agents' compensation to reduce their rents. Thus, other things equal, it is cheaper to incentivize young agents than old ones. Because old agents are imperfect substitutes for young ones, the latter can afford to choose technologies with greater agency problems than their predecessors', and still be hired. This gives rise to an upward trend in complexity, opacity, incentive problems and rents.

Our analysis also makes a theoretical point which, to be the best of our knowledge, had not been made before: While, at an individual level, long-term contracting and backloading of compensation is beneficial, at an aggregate level, it can generate inefficiencies in equilibrium. This is because,

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<sup>4</sup>In Section 6, we show that our analysis extends to the case where, each period,  $N$  managers and  $N$  investors are born.

when different managers have different horizons, they can have different long-term contracts and therefore be imperfect substitutes, which mutes down competition in the labor market. In that sense, backloading of compensation in individually optimal dynamic contracts, exerts negative externalities on other principals in the labor market.

Because our analysis uncovers that equilibrium can be inefficient, it calls for public policy intervention. We consider the case of a regulator, who can set transparency and simplicity standards, monitor agents, and punish those who don't comply. We focus on proportional monitoring costs. That is, we assume costs are linear in the expected number of agents that are monitored –and thus don't include a fixed component. We show that, even in the absence of fixed monitoring costs, it can be optimal to abstain from monitoring during several periods and then engage in intense monitoring for one period. The intuition is the following: To induce agents to comply with transparency and simplicity standards, it is necessary to choose a large monitoring probability. Small monitoring probabilities have no effect on agents' choices between compliance and non compliance. Therefore monitoring, when it occurs, must be on a large scale. On the other hand, intense monitoring during one period compels all young agents in that period to opt for low  $bs$ . This resets agency problems at a low level. While lack of monitoring after that period leads to a decline in standards, this decline is only gradual. It is therefore optimal to wait until standards have declined enough before incurring again the large cost of monitoring.

While the economic mechanisms we analyze can be at play in various settings, our assumptions are particularly relevant for the financial sector – which offers plenty of opportunities to create complicated and opaque products. Indeed, the implications from our theoretical model, are in line with empirical findings as well as anecdotal evidence from the financial sector.

Our theoretical model generates a gradual increase in rents. This is consistent with the finding, by Philippon and Resheff (2012), that, while in 1980, managers' earnings were similar in the finance sector and other sectors, in 2006, finance managers earned 70% more than comparable managers in other sectors. This is also in line with the finding, by Goldin and Katz (2008), that, in 2005, Harvard graduates working in finance earned 95% more than those working in other sectors. It is also consistent with more anecdotal evidence, e.g., an article entitled “Bank staff costs take bigger share of pot” (Financial Times, June 5, 2012) stated that, in a survey of 13 global financial institutions in 2011, total bankers'

compensation was £259 billion, which amounted to 81% of the sum of dividends, retained earnings and bankers' pay. It would be interesting to study more systematically the dynamics of the share of bankers' pay in banks' profits.

An important aspect of the implications of our model is that, in addition to the growth in rents, there is a simultaneous (jointly endogenous) increase in the opacity and complexity of finance activities. This is consistent with patterns documented by Greenwood and Sharfstein (2012). They find that as the finance sector was growing, the share of private equity and hedge funds also was increasing. Now, such funds are more opaque and complex than standard mutual funds. Another manifestation of the increase in complexity and opacity is the growth, documented by Greenwood and Sharfstein (2012), of the shadow banking system. As noted by Greenwood and Sharfstein (2012) shadow banking lengthens the credit intermediation process. This, in turn, increases opacity. Anecdotal evidence also points in the same direction. For example, Greg Smith, an executive director at Goldman Sachs, decided to resign after 12 years in that institution. In the article he wrote on that topic in *The New-York Times* on March 14, 2012, he underscored the rise of complexity, i.e., the increasing tendency to “pitch lucrative and complicated products to clients even if they are not the simplest investments or the ones most directly aligned with the client's goals.”<sup>5</sup>

Another implication of our theoretical analysis is that the increase in rents, opacity and complexity is not instantaneous. Rather it will be sustained and delayed. Hence our theory implies that sustained increases in rents and opacity will take place at points in time where there is no current changes in exogenous variables.

Yet another implication of our analysis is that experienced managers and junior managers are imperfect substitutes. This should manifest in the data both for hiring and for compensation. One implication is that, when new slots open up, experienced managers would be imperfect substitutes for junior ones. This is consistent with the findings of Oyer (2008) that there is a strong causal effect of initial placement in investment banking on later career. Our theory also predicts that imperfect substitutability, and its consequences, should be stronger when incentive problems are more severe and when compensation is more backloaded.

Our analysis of suboptimal occupational choices motivated by the desire to earn rents is in the same

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<sup>5</sup>See [http://www.nytimes.com/2012/03/14/opinion/why-i-am-leaving-goldman-sachs.html?\\_r=1&src=me&ref=general](http://www.nytimes.com/2012/03/14/opinion/why-i-am-leaving-goldman-sachs.html?_r=1&src=me&ref=general)

spirit as Murphy, Shleifer and Vishny (1991). But while Murphy, Shleifer and Vishny (1991) emphasize macro-determinants of rents, such as the size of the country or market as well as political factors, we focus more on micro-determinants, such as agency conflicts between investors and managers and the consequences of dynamic contracting for the imperfect substitutability between different vintages of managers. Our work is also related to Myerson (2012). In both papers overlapping generations of managers are hired by investors, and agency problems (moral-hazard or cash-diversion) lead to compensation deferral. While, both papers show how the dynamic provision of incentives can generate cycles, they focus on different objects. Myerson (2012) shows how long-term contracting designed to cope with moral hazard can generate gradual growth followed by steep recessions. In contrast we show how long-term contracting creates gives rise to a simultaneous increase in rents and complexity and opacity. Our analysis is related to that of Axelson and Bond (2012) who also analyze an equilibrium model, with overlapping generations, and dynamic contracts designed to mitigate moral hazard. Specific features of our model, which differentiate it from that of Axelson and Bond (2012), are that, in our framework, i) agents initially choose the magnitude of their agency problems, which leads to the rise of rents, and ii) the contract offered by a given principal to his agent has external effects on the actions of other principals and agents, i.e., there are contractual externalities. Our point that agents in the finance industry choose complex products and techniques to increase the rents they extract from principals, echoes the point made by Carlin (2009) that competing financial institutions design complex products to increase their market power. A major difference is that our analysis hinges on agency problems, which can arise even with large rational investors, while Carlin (2009) focuses on retail investors and abstracts from agency issues.

The next section presents our model. Section III analyzes optimal compensation contracts. Section IV characterizes the dynamics of equilibrium rents. Section V discusses policy intervention. Section VI presents extensions and discusses robustness. Section VII concludes.

## 2 Model

**Investors and managers:** Consider an overlapping generations model, where, each period, one investor and one manager are born. Both are risk neutral, have limited liability, live for two periods

and have discount factor  $\beta \in (0, 1)$ . Because we consider an overlapping generations model, successive generations of managers coexist in the market at a given point in time. This creates the scope for interactions, and in particular competition, between generations.

Each investor is initially endowed with one unit of investment good. She can invest it in a default technology, which she can operate herself and which returns 1 unit of consumption good per period during two periods. Alternatively, she can delegate the management of her capital to the agent. When entrusted with one unit of capital, the agent can generate return equal to  $R > 1$  units of consumption good per period during two periods. For simplicity the choice between self-investment and delegated investment is irreversible.

Managers have zero initial endowment. At the beginning of his life, each young manager must choose among a range of investment techniques indexed by  $b \in [b_{\min}, 1)$ , with  $b_{\min} > 0$ .<sup>6</sup> Each technique corresponds to a specific type of skills, knowhow and human capital. The cost of acquiring skills  $b$  is equal to  $cb$ , with  $c \geq 0$ .  $b$ 's are ordered according to the magnitude of the agency problem they involve. Low values of  $b$  correspond to simple investment techniques, carried in transparent anonymous markets, for which agency problems are limited. Higher values of  $b$  correspond to complex investment techniques, carried in opaque OTC markets, involving networking and repeated bilateral relations.  $c$  is the cost of designing complex products and strategies. Importantly, the choice of  $b$  is irreversible. The idea is that managers acquire skills, human capital, relations and knowledge of investment techniques at an early stage in their career. Then, they use this informational capital.<sup>7</sup> Finally, for simplicity, we assume  $R$  does not depend on  $b$ . In Section 6 we show that our qualitative results are robust to letting  $R$  increase in  $b$ , as long as this increase is not too strong.

**Sequence of play:** Within each period  $t \geq 1$ , the timing of actions is the following:

- Stage 1: The young manager chooses  $b_t \in [b_{\min}, 1)$ .
- Stage 2: The young investor meets the young manager, observes his type ( $b_t$ ), and decides whether to make him a take-it-or-leave-it offer or reject him. The assumption that investors have all the bargaining power is for simplicity. In Section 6, we present an extension of the

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<sup>6</sup>Assuming  $b_{\min} > 0$  makes Lemma 3 immediate, but this assumption is not necessary for our analysis.

<sup>7</sup>See Oyer (2008) for empirical evidence on long term effects of initial career paths in the financial sector.

model where the manager have some (but not all of) the bargaining power. It yields the same qualitative insights as the simpler present case.

- Stage 3: If the investor decides to reject the young manager or the latter rejects the offer, then the investor decides whether to self-invest or to approach the old manager (born at  $t-1$ ). In the latter case, the investor meets the old manager, observes his type ( $b_{t-1}$ ) and current employment status, and can make him a take-it-or-leave-it offer.<sup>8</sup> Also, at this stage, if the previous investor is not currently employing an agent, she can approach a manager and make him a take-it-or-leave-it offer. Similarly, if the previous manager did not get hired, he can approach the young investor and apply for a job.
- Stage 4: Investment takes place.
- Stage 5: Each manager must decide whether to remain in the firm and obtain the wage promised by the manager,<sup>9</sup> or abscond. If the manager absconds, he does not get paid, but obtains  $\delta b_t R$ , with  $\delta \leq 1$ . This corresponds to the profits he can earn by working on his own, using the valuable contacts and knowhow obtained while on the job. In that case, the return obtained by the investor is lowered to  $R(1 - b_t)$ .
- Stage 6: Consumption takes place.

For simplicity (and to limit the number of cases in the analysis below), we assume

$$R(1 - \delta b_{\min}) > 1,$$

i.e.,  $b_{\min}$  is sufficiently low that, in a one-period context, self-investment by the principal is dominated by the delegation of investment to an agent with the lowest possible  $b$ .

**Discussion of the agency problem:** One motivation for the agency problem we consider is the following. While managing the investment on behalf of the principal, the agent acquires specific knowledge about this technique and develops a network of contacts in this business. These techniques

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<sup>8</sup>The assumption that agents' types are observed by investors only when they meet them is also made for simplicity. As will be explained in Section 4, it simplifies the structure of beliefs and thus facilitates the analysis of the game.

<sup>9</sup>For simplicity also we assume the investor can commit to the contract offered.



and contacts are useful to make the investment profitable when undertaken for the principal. But they can also be useful for the agent when absconding, and working on his own.

This stylized agency problem, where the agent can abscond or not, in line with the limited commitment models of Thomas and Worall (1988) and Kocherlakota (1998). In these models the agent cannot commit not to leave the principal and earn his autarky payoff. The equivalent of this payoff in our model is  $b_t R$ . The agency problem we consider is also in line with the cash–diversion model of Townsend (1979), Diamond (1984), Bolton and Scharfstein (1990), and, more recently, DeMarzo and Fishman (2007) and Biais, Mariotti, Plantin and Rochet (2007).

Instead of the simple agency problem we consider, we could consider a variant of the Holmstrom and Tirole (1997) moral hazard model. At the beginning of each period, the agent can exert unobservable effort or not. The effort can involve spending time and energy on risk control and monitoring, or screening good investment projects. Its cost is  $B_t R$ . Equivalently,  $B_t R$  can be interpreted, as in Holmstrom and Tirole (1997), as the private benefit from shirking. When the agent exerts effort, the project generates cash flow  $R$  for sure. When the agent fails to exert effort, cash flows can be  $R$  with probability  $1 - \Delta$ , or 0 with probability  $\Delta$ . If the project fails (and generates 0 cash flow) at the first period, then it is bound to fail for sure at the second period. Relabeling  $\delta b_t = \frac{B_t}{\Delta}$ , this setting is exactly equivalent to the agency problem described above. As will be made clear in the next sections, the incentive compatibility conditions and the equilibrium actions are exactly the same in the two environments.

Finally, two comments are in order to complete the discussion of the agency problem: First, when managers abscond, they are busy working on their own, to get  $b_t R$ , thus they are not available to be hired by another investor. Second, while we assume  $\delta \leq 1$ , all our major qualitative results are upheld if  $\delta = 1$ , thus, our analysis holds both if absconding is inefficient and if it is ex–post efficient.

**First best:** To conclude this section, we describe the first best benchmark, i.e., the situation where the benevolent social planner can observe and decide what investors and managers do. Since utilities are linear, there is a unique Pareto optimum regarding real decisions, and the points on the Pareto frontier differ only in terms of purely redistributive transfers between investors and managers. Since  $R > 1$ , the optimum is reached when investors delegate the management of their capital. Since

$c \geq 0$  and  $R$  is independent of  $b$ , the socially efficient level of  $b$  is 0. The corresponding utilitarian welfare for each generation is

$$(1 + \beta)R. \tag{1}$$

### 3 Moral hazard and managerial compensation

In this section we analyze the compensation contract offered at time  $t$  by an investor hiring a young manager with given type  $b_t$ . We first analyze the contract offered by the investor hiring the manager for two periods. Next, we show that this dominates hiring the agent for one period only, and then another agent for the second period (whatever the type  $b$  of the agent at the next period).

The compensation contract offered at time  $t$  by the investor is a pair of wages,  $w_t^t$  and  $w_{t+1}^t$ , paid to the manager if he remains in the firm at the end of periods  $t$  and  $t + 1$ . In the context we consider, the optimal contract is such that the manager takes the efficient action and does not abscond. The corresponding incentive compatibility conditions are

$$w_{t+1}^t \geq \delta b_t R \tag{2}$$

and

$$w_t^t + \beta w_{t+1}^t \geq \delta b_t R. \tag{3}$$

The optimal contract maximizes the investor's net return subject to the incentive compatibility and limited liability constraints. It is spelled out in our first lemma.

**Lemma 1:** *At time  $t$ , for a given choice of  $b_t$ , and when the manager is hired for two periods, (3) binds and there is a continuum of optimal contracts, indexed by  $\lambda_t \in [1, \frac{1}{\beta})$ ,*

$$\{w_t^t, w_{t+1}^t\} = \{(1 - \beta\lambda_t)\delta b_t R, \lambda_t \delta b_t R\}.$$

**Remark 1: Complexity and Rents.** Lemma 1 implies that the present value of the fund manager's earnings is

$$w_t^t + \beta w_{t+1}^t = \delta b_t R, \tag{4}$$

while the present value of the investor's returns is

$$R(1 + \beta) - \delta b_t R. \quad (5)$$

Thus, the investor's net return is decreasing in  $b_t$ , while the manager's earning is increasing. As the complexity and opacity of the investment technology increase, the investor must give the manager a larger and larger fraction of the total revenue of the investment.

**Remark 2: Backloading and inefficiency.** The larger  $\lambda_t$ , the greater the fraction of the compensation that is deferred to the second period. For example, when  $\lambda_t = \frac{1}{\beta}$ , managerial compensation is entirely deferred to  $t + 1$ . Both the principal and the agent are indifferent between all values of  $\lambda_t \in [1, \frac{1}{\beta})$ . In the next section, however, we show that the contractual choices of one generation have external effects on the next ones. Thus, different choices of  $\lambda_t$  lead to different inefficiencies.

**Remark 3: Compensation and seniority.** Lemma 1 implies that  $w_t^t < w_{t+1}^t$ , since

$$\frac{1}{1 + \beta} < 1 \leq \lambda_t.$$

Thus, for a given generation, compensation rises with seniority, in line with stylized facts. In the next section, however, we show that the structure of the equilibrium we analyze can imply that, when comparing generations, senior managers from the previous generations earn less than junior managers from the current generation.

**Remark 4: Equivalence with an unobservable effort model à la Holmstrom and Tirole (1997).** What if the agent could not abscond, but had to exert unobservable effort to raise the probability of success, as explained in the discussion of the agency problem in the previous section? In that case, the incentive compatibility condition at time  $t + 1$  would be:

$$w_{t+1}^t \geq (1 - \Delta)w_{t+1}^t + B_t R,$$

that is

$$w_{t+1}^t \geq \frac{B_t}{\Delta} R = \delta b_t R, \quad (6)$$

as in (2). Similarly, the incentive compatibility condition at time  $t$  would be:

$$w_t^t + \beta w_{t+1}^t \geq (1 - \Delta)(w_t^t + \beta w_{t+1}^t) + B_t R,$$

that is

$$w_t^t + \beta w_{t+1}^t \geq \frac{B_t}{\Delta} R = \delta b_t R, \quad (7)$$

as in (3).

Lemma 1 characterizes the optimal contracts when the manager is hired for two periods. What if, instead, the investor hires the manager for one period only, and then hires another manager at the second period. In this case, the incentive compatibility condition for the first period is

$$w_t^t \geq \delta b_t R.$$

At the second period, the investor could hire the young manager, with type  $b_{t+1}$ . This would require matching the wage offered by the young investor at time  $t + 1$  and also providing the young manager with the incentives not to abscond. Thus the investor would have to pay that agent at least

$$\delta b_{t+1} R.$$

Overall, the present value of the returns obtained by the investor would be no larger than

$$R(1 + \beta) - \delta(b_t + \beta b_{t+1})R. \quad (8)$$

(5) is larger than (8), whatever the value of  $b_{t+1} \in [b_{\min}, 1)$ . This reflects that, with repeated moral hazard, long term contracts help the principal reduce agency rents. In line with previous analyses of dynamic contracting (Becker and Stigler, 1974, and Rogerson, 1985), the future promised rents (here  $w_{t+1}$ ) is also useful to incentivize current effort (and thus helps limiting  $w_t$ ).<sup>10</sup> This cannot be achieved when the principal hires a sequence of agents compensated with short-term contracts. Hence, it is cheaper for the investor to hire the manager for two periods. We state this result in the following lemma:

**Lemma 2:** *Hiring the manager for two periods dominates hiring him for one period and then hiring another manager.*

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<sup>10</sup>See also Biais, Mariotti, Plantin and Rochet (2007) or DeMarzo and Fishman (2007)).

## 4 The dynamics of equilibrium rents

We now turn to the dynamics of the  $b$ 's chosen by managers before they are matched with investors.

Given an initial  $b_0$ , an equilibrium is a sequence  $\mathcal{E} = \{b_t^*, w_t^{t*}, w_{t+1}^{t*}\}_{t \geq 1}$ , satisfying the following conditions:

- **Optimization:** At each time  $t$ , the young manager chooses  $b_t^*$ , to maximize his gains and the investor makes an optimal hiring decision.
- **Rational expectations:** Investors and managers at time  $t$  have rational expectations about equilibrium dynamics at all times  $\tau > t$ , and when each market participant expects the others to follow the equilibrium, he/she himself/herself finds it optimal to also play according to  $\mathcal{E}$ .
- **Labor market clearing:** At each generation, the young manager is hired by the young investor.

From Lemma 1, the young manager's gains, if he opts for  $b_t$  and is employed, are

$$(\delta R - c)b_t. \tag{9}$$

The young manager chooses  $b_t$  to maximize (9), subject to the constraint that the investor is willing to hire him. Equilibrium requires that, when the agent anticipates all the others played as specified by  $\mathcal{E}$ , he will choose  $b_t = b_t^*$ .

If  $\delta R < c$ , then the agent opts for  $b_t = 0$ . To raise the possibility that the agent would choose  $b_t > 0$ , we assume hereafter the cost  $c$  is not too large, i.e.,

$$\delta R > c.$$

To characterize the optimal decision of the investor meeting a young manager with type  $b_t$ , we need to compare her payoff if she opts for the equilibrium action (hiring the young manager at Stage 2) to what she gets if she takes an out-of-equilibrium action.

The first out-of-equilibrium option for the investor is self-investment at Stage 3 of period  $t$ . She does not choose that option if her gains from hiring the young manager

$$R(1 + \beta) - \delta b_t R. \tag{10}$$

are at least as large as the gains from self-investment  $(1 + \beta)$ . This is the case if

$$b_t \leq b_{\max} \equiv \frac{R - 1}{R} \frac{1 + \beta}{\delta}. \quad (11)$$

The second out-of-equilibrium option for the investor is to “poach” an old employed agent at Stage 3 of period  $t$  and then hire the generation  $t$  manager, unemployed at  $t$  and available at  $t + 1$ . She would have to give the former at least as much as his current wage, which she rationally expects to be  $w_t^{t-1*} = \delta \lambda_{t-1}^* b_{t-1}^* R$ , and would have to incentivize the latter. To do so, she would have to pay him at least  $\delta b_t R$  at  $t + 1$ . On the other hand, the old manager at  $t + 1$  cannot ask for more than that, since he could not obtain more from the time  $t + 1$  investor. Hence, overall, if she were to opt for that deviation, the time  $t$  investor would expect to get

$$R(1 + \beta) - \delta(\lambda_{t-1}^* b_{t-1}^* + \beta b_t)R. \quad (12)$$

The third out-of-equilibrium option for the investor is to poach an old employed manager at  $t$  and then a young one at  $t + 1$ . When evaluating the gains from this out-of-equilibrium move, the investor rationally expects both the previous and the subsequent generation to follow  $\mathcal{E}$ . Indeed, the extensive form of the game is such that the next generation’s managers and investors make their decisions before observing if their predecessor deviated. Therefore they make their decisions based on the belief that their predecessor stuck to  $\mathcal{E}$ , and find it optimal to do the same themselves. Thus, when deviating, the generation  $t$  investor expects to pay  $\delta \lambda_{t-1}^* b_{t-1}^* R$  to the old manager she hires at time  $t$ , and  $\delta b_{t+1}^* R$  to the young manager she hires at time  $t + 1$ . Consequently, the deviating investor expects to earn

$$R(1 + \beta) - \delta(\lambda_{t-1}^* b_{t-1}^* + \beta b_{t+1}^*)R. \quad (13)$$

Equating (10), evaluated at  $b_t^*$ , to the maximum of (12) and (13), as long as the no-self-investment constraint (11) does not bind, the equilibrium choice of the generation  $t$  young manager is

$$b_t^* = \lambda_{t-1} b_{t-1}^* + \beta \min[b_t^*, b_{t+1}^*]. \quad (14)$$

(14) and  $\lambda_{t-1} \geq 1$  directly imply our next lemma.

**Lemma 3:** *At time  $t$ , if (11) does not bind, then*

$$b_t^* > b_{t-1}^*.$$

Lemma 3 and (14) imply that, as long as the no-self-investment constraint (11) does not bind,

$$b_t^* = \frac{\lambda_{t-1}}{1-\beta} b_{t-1}^*. \quad (15)$$

Thus, we obtain our first proposition.

**Proposition 1:** *Set the initial manager's type to  $b_0 \geq b_{\min}$ . There exists a continuum of equilibria, indexed by  $\lambda \in [1, 1/\beta]$ , such that, for all  $t > 0$ ,  $b_t^*$  is strictly increasing in  $t$ , until it reaches  $b_{\max}$  at time  $T_{\max}$  and*

$$b_t^* = \min\left[\left(\frac{\lambda}{1-\beta}\right)^t b_0, b_{\max}\right]. \quad (16)$$

**The rise of rents:** For simplicity, the proposition only presents the equilibria in which  $\lambda_t$  is constant through time. There also exists equilibria in which  $\lambda_t$  varies as time goes by, but they yield the same qualitative insights as those described in Proposition 1. Interestingly, even if  $\lambda_t$  is constant through time,  $b_t$  is non-stationary. Indeed, (16) implies that, until  $T_{\max} - 1$ ,  $b_t$  grows at rate

$$\rho_t = \frac{b_t^* - b_{t-1}^*}{b_{t-1}^*} = \frac{\lambda + \beta - 1}{1 - \beta} > 0. \quad (17)$$

Thus opacity, complexity and rents rise in equilibrium. This is because investors can offer long-term contracts to young managers, not to old ones. This makes the former attractive relative to the latter, other things equal. Hence, at time  $t$ , the young manager can afford to choose  $b_t > b_{t-1}$  and yet be employed.

**Backloading exerts contractual externalities:** Note that  $\rho_t$  is increasing in  $\lambda$ . While, at each time  $t$ , the investor is indifferent between all  $\lambda_t \in [1, \frac{1}{\beta}]$ , his choice affects competition between successive generations of managers. The greater  $\lambda_t$ , the more compensation is backloaded, the lower the competition between generations, the stronger the growth of rents,  $\rho_t$ . The lowest possible equilibrium growth rate of rents, arises for  $\lambda = 1$ , where

$$\rho_t = \frac{\beta}{1-\beta}. \quad (18)$$

Note that, even for  $\lambda_t = 1$ ,  $\rho_t > 0$ .

**Patience and rents:** The more patient the investor, the more he suffers from the cost of incentivizing a new agent next period, the less competition between generations there is, the larger is  $b_t^*$ .

**Equivalence with an unobservable effort model à la Holmstrom and Tirole (1997):** As explained above, in Remark 4, the incentive compatibility conditions in our simple setting where the agent can abscond with  $\delta b_t R$  are the same as in a simple two-period version of Holmstrom and Tirole (1997). Similarly, the gains the principal can obtain on the equilibrium path or in the deviations involving poaching, (12) and (13), are the same in the two settings. Hence, equilibrium actions are also the same in the two settings. Thus, all our analysis and results, and in particular Proposition 1, also obtain in the simple two-period version of Holmstrom and Tirole (1997).

**Welfare:** The utilitarian welfare for generation  $t$ ,

$$R(1 + \beta) - cb_t.$$

is lower than welfare in the first best, (1). This is because managers incur wasteful costs ( $cb_t$ ) to come up with complex and opaque technologies, that increase rents but don't create value for society.

Note however that, when  $b_T$  reaches  $b_{\max}$ , utilitarian welfare becomes

$$R(1 + \beta) - c \frac{R - 1}{R} \frac{1 + \beta}{\delta} = (1 + \beta) \left( R - \frac{c}{\delta R} (R - 1) \right),$$

which is greater than welfare under self-investment under our assumption that  $R > 1$  and  $\delta R > c$ . Thus, while managers choose to incur wasteful costs, these don't wipe out all the efficiency gains from investment delegation.

## 5 Policy

The analysis above shows that the equilibrium choice of  $b$  is inefficient. This begs the question whether policy intervention can improve efficiency.



## 5.1 Monitoring managers

To analyze this issue we assume there is a benevolent regulator, maximizing utilitarian welfare. To model regulatory intervention we introduce an additional stage in the game. Each period  $t$ , at stage 0 the regulator announces a cap  $\underline{b}_t$ , and an inspection probability  $\alpha_t$ , to which we assume he can commit. Then, at stage 1, the young agent chooses  $b_t$ , and, with probability  $\alpha_t$ , is inspected by the regulator. In case of inspection, if  $b_t > \underline{b}_t$  the agent is prevented from working. Otherwise, he enters the market and meets the investor, and the game unfolds. In particular, compensation is determined as in Lemma 1. For simplicity, we hereafter focus on the equilibrium where  $\lambda_t = 1, \forall t$ . Finally, we assume the monitoring technology is linear, i.e., there exists a constant  $\gamma > 0$  such that the cost of monitoring with probability  $\alpha_t$  during one period is  $\alpha_t \gamma$ . In this section we compare the performance of three policies:

- Laissez faire, in which the regulator never intervenes.
- Permanent monitoring, in which the regulator sets a constant cap  $\underline{b}$ , and monitors with constant probability  $\alpha$  to ensure that agents always comply with the regulatory cap.
- Periodic monitoring, which operates as follows: during  $T - 1$  periods (with  $T$  finite and strictly larger than 1), laissez faire prevails, i.e.,  $\alpha = 0$ . Then, at the  $T^{th}$  period, the regulator intervenes, sets the maximum  $\underline{b}$  for this period, and monitors the agent with probability  $\alpha_T$ , sufficiently large to ensure compliance. Then a new cycle starts.

### 5.1.1 Permanent monitoring

We analyze for which values of the permanent monitoring policy  $(\underline{b}, \alpha)$  it is an equilibrium for agents to always comply. The expected gain of the agent if he complies is

$$\delta \underline{b} R.$$

When the agent chooses  $\hat{b} > \underline{b}$  and is not inspected he is matched with an investor. The latter is willing to hire him at  $t$ , rather than poaching an old agent (with type  $\underline{b}$ ) at  $t$  and then hiring the generation  $t + 1$  agent (also with type  $\underline{b}$ ) if

$$R(1 + \beta) - \delta \hat{b} R \geq R(1 + \beta) - (1 + \beta) \delta \underline{b} R.$$

Binding the constraint yields

$$\hat{b} = (1 + \beta)\underline{b}.$$

The agent prefers to comply if his gain under compliance exceeds is expected gain under non compliance. Binding this constraint we have

$$\underline{b} = (1 - \alpha)\hat{b}. \tag{19}$$

**Lemma 4:** *An optimal permanent monitoring policy  $(\underline{b}, \alpha)$ , is such that*

$$\alpha = \frac{\beta}{1 + \beta} \text{ and } \underline{b} = b_{\min}.$$

Consistent with intuition, the lemma states that the agent complies if the probability of inspection ( $\alpha$ ) is sufficiently large. That  $\underline{b} = b_{\min}$  stems from the fact that the cost of monitoring is independent of the cap  $\underline{b}$ . Thus, if the regulator opts for a permanent monitoring policy, it is optimal to minimize the cap.

The steady state utilitarian welfare of each generation under a stationary inspection policy incentivizing permanent compliance is

$$W(1) \equiv R(1 + \beta) - \frac{\beta}{1 + \beta}\gamma - cb_{\min}. \tag{20}$$

On the other hand, the steady state utilitarian welfare under laissez faire is

$$W(\infty) \equiv R(1 + \beta) - cb_{\max}. \tag{21}$$

Comparing  $W(1)$  and  $W(\infty)$  we obtain the following proposition.

**Proposition 2:** *Welfare is larger under a stationary policy incentivizing permanent compliance than under laissez faire if*

$$\gamma < \frac{1 + \beta}{\beta}c(b_{\max} - b_{\min}). \tag{22}$$

The proposition states that welfare is greater under permanent monitoring than under laissez faire if the inspection cost,  $\gamma$ , is relatively low compared to the cost of opting for complex investment techniques,  $c$ , and if  $b_{\max}$  is large while  $b_{\min}$  is low.

### 5.1.2 Periodic monitoring

Now turn to the analysis of periodic monitoring. To evaluate the efficiency of a periodic monitoring policy we consider the average welfare of the  $T$  generations, which we denote by  $W(T)$ . We first present two lemmas characterizing the equilibrium dynamics of  $b_{kT+t}$ , for all integers  $k$  and all  $t \in \{1, 2, \dots, T-1\}$ . Then we study the condition under which the agent complies after  $T$  periods. Finally we compare  $W(1)$  and  $W(\infty)$  to  $W(T)$ , for  $T$  finite and larger than 2.

**Lemma 5:** The periodic monitoring policy of period  $T$  such that  $b_{T-1} = b_{\max}$  is dominated by laissez faire or the periodic monitoring policy with period  $T-1$ .

**Proof of Lemma 5:**

Either  $W(T) \leq W(\infty)$ , and the lemma is true, or  $W(T) > W(\infty)$ . Consider the latter case. call

Otherwise: consider a periodic monitoring policy such that  $b_{T-1} = b_{\max}$ .

Prove that it is dominated by the periodic policy monitoring after  $T-1$  periods.

QED

**Lemma 6:** Consider  $T$  such that

$$\frac{1}{(1-\beta)^{T-2}} + \beta \leq \frac{b_{\max}}{\underline{b}} \quad (23)$$

If the agent complies when the regulator intervenes, for any integer  $k$ ,  $b_{kT} = \underline{b}$ , and during laissez faire periods equilibrium dynamics are as follows

$$b_{kT+n} = \frac{b_{kT+n-1}}{1-\beta} = \frac{\underline{b}}{(1-\beta)^n}, \forall n \in \{1, \dots, T-2\}, \text{ if } T > 2,$$

while

$$b_{(k+1)T-1} = b_{(k+1)T-2} + \beta \underline{b} = \left( \frac{1}{(1-\beta)^{T-2}} + \beta \right) \underline{b}.$$

Condition (23) ensures that, at the end of the cycle, at time  $(k+1)T-1$ , just before monitoring occurs, we have

$$b_{(k+1)T-1} \leq b_{\max}. \quad (24)$$

The length of the regulatory cycle ( $T$ ) must be such that (23) holds. Otherwise, regulatory intervention would take place after a sequence of periods during which  $b_t = b_{\max}$ , which would be suboptimal.

Now, turn to the monitoring probability ensuring compliance. At the time of intervention,  $t = kT$ , the regulator sets the maximum level of complexity below the previous level, i.e.,  $\underline{b} < b_{t-1}$ . If the generation  $t$  agent complies, he gets

$$\delta \underline{b} R.$$

If he deviates, he chooses the maximum level of complexity at which he is still employed, i.e.,  $\hat{b}$  such that

$$R(1 + \beta) - \delta \hat{b} R = R(1 + \beta) - \delta b_{t-1} R - \beta \delta \min[\hat{b}, b_{t+1}^*] R. \quad (25)$$

The left-hand-side is the profit of the investor if she hires at time  $t$  the manager who deviated to  $\hat{b}$ . The right-hand-side is her expected profit if she poaches an old manager at time  $t$ , and then, at time  $t + 1$ , hires either the (unemployed) generation  $t$  manager (and pays him  $\delta \hat{b} R$ ) or the young manager (whom she expects to follow the candidate equilibrium strategy and choose  $b_{t+1}^*$ ). (25) simplifies to

$$\hat{b} = b_{t-1} + \beta \min[\hat{b}, b_{t+1}^*]. \quad (26)$$

Given rational expectations about  $\hat{b}$ , the regulator will choose the lowest possible level of monitoring ensuring compliance, so that (19) holds. Following similar steps as in the previous subsection, our next proposition obtains.

**Proposition 3:** *To ensure compliance with periodic monitoring the regulator sets the monitoring probability to*

$$\alpha_T = 1 - \frac{1}{\frac{1}{(1-\beta)^{T-2}} + \beta \frac{2-\beta}{1-\beta}} \text{ if } T > 2 \text{ and } 1 - \frac{1}{(1+\beta)^2} \text{ if } T = 2.$$

The monitoring probability  $\alpha_T$  is increasing in  $T$ . The longer the regulator waits, the larger the  $b$  of the last generation before the regulatory intervention. The more tempting it is for agents not to comply, hoping to earn large rents. Note that  $\alpha_T$  is independent of  $\underline{b}$ . What determines the agent's propensity to comply is the ratio of  $b$  just before the intervention to that requested by the regulator.  $\underline{b}$  appears both on the numerator and the denominator of that ratio, and therefore simplifies out. Hence, the optimal periodic monitoring policy sets  $\underline{b} = b_{\min}$ .

Averaging welfare across generations, for any finite  $T$  strictly larger than 2, social welfare under periodic monitoring is

$$W(T) = R(1+\beta) - \frac{1}{T} \left\{ cb_{\min} \left[ 1 + \frac{1}{1-\beta} + \dots + \frac{1}{(1-\beta)^{T-2}} + \left( \frac{1}{(1-\beta)^{T-2}} + \beta \right) \right] + \left( 1 - \frac{1}{\frac{1}{(1-\beta)^{T-2}} + \beta \frac{2-\beta}{1-\beta}} \right) \gamma \right\}. \quad (27)$$

(27), Lemma 5 and Proposition 3, yield the following corollary:

**Corollary 1:** *For any finite  $T$  strictly larger than 2, average welfare under periodic monitoring is*

$$W(T) = R(1+\beta) - \frac{1}{T} \left\{ cb_{\min} \left[ (1-\beta) \frac{\left(\frac{1}{1-\beta}\right)^{T-1} - 1}{\beta} + \left(\frac{1}{1-\beta}\right)^{T-2} + \beta \right] + \left( 1 - \frac{1}{\left(\frac{1}{1-\beta}\right)^{T-2} + \beta \frac{2-\beta}{1-\beta}} \right) \gamma \right\}. \quad (28)$$

For  $T = 2$  it is equal to

$$R(1+\beta) - \frac{1+(1+\beta)}{2} cb_{\min} - \frac{1}{2} \left( 1 - \frac{1}{(1+\beta)^2} \right) \gamma. \quad (29)$$

We now compare welfare under periodic monitoring to its counterpart under permanent monitoring and under laissez faire. The next proposition states a preliminary result.

**Proposition 4:** *Welfare under monitoring with  $T = 2$  is larger than welfare under laissez faire and than welfare under permanent monitoring iff*

$$\frac{(1+\beta)^2}{\beta} cb_{\min} < \gamma < c \frac{b_{\max} - \frac{1+(1+\beta)}{2} b_{\min}}{\frac{1}{2} \left( 1 - \frac{1}{(1+\beta)^2} \right)}.$$

The next proposition offers a comparison for general values of  $T$ .

**Proposition 5:**

*Fix the parameters  $R, \beta, b_{\max}, b_{\min}$ . There exist thresholds  $0 < \gamma_1 < \gamma_2 < \gamma_3 < \gamma_4$  and  $B$  such that:*

- *If  $\gamma < \gamma_1$ , the optimal cyclical policy consists of constant monitoring imposing  $\underline{b} = b_{\min}$ .*
- *If  $\gamma > \gamma_4$ , the optimal cyclical policy consists in laissez-faire.*
- *If  $b_{\min} < B$  and  $\gamma_1 < \gamma < \gamma_2$ , the optimal cyclical policy consists of periodic interventions, at intervals of two or more periods, resetting  $b$  to  $\underline{b} = b_{\min}$ .*

**Proof of Proposition 5:**

Call  $N$  the smallest integer such that  $n > N \Rightarrow \frac{b_{\min}}{(1-\beta)^n} > b_{\max}$ . Thus, we know that for any value of  $\gamma$ , a cycle of length longer than  $N$  induces lower welfare than a cycle of length  $N$ . Thus, looking for the optimal policy is equivalent to solving the following program:

$$\max_{T \in \{1, 2, \dots, N, +\infty\}} W_T$$

where we note  $W_1$  the welfare of permanent monitoring and  $W_{+\infty}$  the welfare of laissez-faire.

$$W_T(\gamma) = \begin{cases} R(1 + \beta) - \frac{\beta}{1+\beta}\gamma - cb_{\min} & \text{for } T = 1 \\ R(1 + \beta) - \frac{1+(1+\beta)}{2}cb_{\min} - \frac{1}{2}\left(1 - \frac{1}{(1+\beta)^2}\right)\gamma & \text{for } T = 2 \\ R(1 + \beta) - \frac{1}{T}\left\{cb_{\min}\left[(1 - \beta)\frac{\left(\frac{1}{1-\beta}\right)^{T-1}-1}{\beta} + \left(\frac{1}{1-\beta}\right)^{T-2} + \beta\right] + \left(1 - \frac{1}{\left(\frac{1}{1-\beta}\right)^{T-2} + \beta\frac{2-\beta}{1-\beta}}\right)\gamma\right\} & \text{for } T > 2 \\ R(1 + \beta) - cb_{\max} & T = +\infty \end{cases}$$

$$W_T(0) = \begin{cases} R(1 + \beta) - cb_{\min} & \text{for } T = 1 \\ R(1 + \beta) - \frac{1+(1+\beta)}{2}cb_{\min} & \text{for } T = 2 \\ R(1 + \beta) - \frac{1}{T}\left\{cb_{\min}\left[(1 - \beta)\frac{\left(\frac{1}{1-\beta}\right)^{T-1}-1}{\beta} + \left(\frac{1}{1-\beta}\right)^{T-2} + \beta\right]\right\} & \text{for } T > 2 \\ R(1 + \beta) - cb_{\max} & T = +\infty \end{cases}$$

It follows that  $\forall T \in \{2, \dots, N, +\infty\} : W_1(0) > W_T(0)$ . Thus, by continuity, this inequality holds in a neighborhood of  $\gamma = 0$ . I.e.,  $\exists \gamma_1 > 0; \gamma < \gamma_1 \Rightarrow W_1 = \max_{T \in \{1, 2, \dots, N, +\infty\}} W_T$ .

Similarly, we see that

$$\lim_{\gamma \rightarrow +\infty} W_T(\gamma) = \begin{cases} -\infty & \text{for } T \in \{1, 2, \dots, N\} \\ R(1 + \beta) - cb_{\max} & \text{for } T = +\infty \end{cases}$$

It follows that  $\forall T \in \{1, \dots, N\} : \lim_{\gamma \rightarrow +\infty} W_{+\infty}(\gamma) > \lim_{\gamma \rightarrow +\infty} W_T(\gamma)$ . Thus, by continuity, this inequality holds in a neighborhood of  $\gamma = +\infty$ . I.e.,  $\exists \gamma_4 > 0; \gamma > \gamma_4 \Rightarrow W_{+\infty} = \max_{T \in \{1, 2, \dots, N, +\infty\}} W_T$ .

Now, let's prove the existence of  $(\gamma_1, \gamma_2)$ . One just needs to notice that:

$$\gamma_2 = \frac{(1 + \beta)^2}{\beta}cb_{\min} < \gamma_3 = c \frac{b_{\max} - \frac{1+(1+\beta)}{2}b_{\min}}{\frac{1}{2}\left(1 - \frac{1}{(1+\beta)^2}\right)}$$

is equivalent to:

$$b_{\min} < \frac{b_{\max}}{\frac{(1+\beta)^2}{2\beta} + 1 - \frac{1}{2\beta}} + \frac{\beta}{2} = B.$$

From proposition 5, we can conclude that for  $\gamma_1 < \gamma < \gamma_2$ :

$$\text{Arg} \max_{T \in \{1, 2, \dots, N, +\infty\}} W_T(\gamma) \notin \{1, +\infty\}$$

## 5.2 Restricting compensation deferral

In the equilibrium we have described, the choice of compensation deferral by investors at time  $t$  exercises an externality on the welfare of future investors. Indeed, investors born at time  $t$  are indifferent among all levels of deferral  $\lambda_t \in [1, \frac{1}{\beta})$ . However, the welfare all future investors is negatively impacted by a choice of  $\lambda_t > 1$ , as this increases the rents extracted in future periods by managers. This is also bad for aggregate welfare as choosing high level of  $b$  is inefficient. The intuition is that, at time  $t + 1$ , a higher  $\lambda_t$  makes it more expensive for new investors to higher an old-timer and thus allows the time  $t + 1$  managers to extract more rents by choosing a higher  $b_{t+1}$ . It follows that a regulation that imposes  $\lambda_t = 1$  for all  $t$  is Pareto-improving. We believe our model sheds light on a rarely discussed side-effect of compensation-deferral, namely the fact that it potentially reduces competition between managers by making it more costly to hire already employed managers. Several researchers have advocated clawbacks or vesting of compensation to curb managerial short-termism (see e.g. Edmans et al. (2012)). Our model suggests that one should carefully distinguish between deferred payoffs that are not contingent on the manager still working in the same firm at a future date, and payoffs that vest only if the manager still works at the same firm in the future: the latter type of compensation deferral can potentially harm the level of competition that prevails on the market for managerial skills.

## 5.3 Taxes

We now study whether a regulator can prevent the rise of rents by using taxes. Each period  $t$ , at stage 0 the regulator announces a tax  $\tau_t$ , to which we assume he can commit and a redistribution rule of the proceeds. The effect on welfare of taxes turns out to be highly dependent on the sources of incomes that can be taxed.

**Proposition 6:**

*If the regulator can tax :*

- *income by managers, including diverted income, it can implement first-best.*
- *income by managers, at the exclusion of diverted income, taxes have no impact on welfare.*
- *investors' profits from delegated management, it can implement first-best.*

- *investors' profits from all sources (including "self-investment"), taxes have no impact on welfare.*

Consider first the case where all managerial income can be taxed (first case). By choosing  $\tau$  such that  $\delta(1 - \tau)R = c$ , the regulator discourages investment in rent-extraction: managers will choose  $b = 0$ . This stems from the fact that pretax managerial income is left unaffected by taxes as the binding incentive compatibility constraint of managers is left unchanged as it writes:  $(1 - \tau)(w_t^t + \beta w_{t+1}^t) \geq \delta(1 - \tau)b_t R$ . Now, if diverted income cannot be taxed (second case), the incentive compatibility constraint writes:  $(1 - \tau)(w_t^t + \beta w_{t+1}^t) \geq \delta b_t R$ . As it binds, the rents extracted by managers are  $\frac{\delta b_t R}{(1 - \tau)}$ , so that contrary to the previous case, it is as worthwhile as in the no-tax benchmark for managers to invest in  $b$  (since  $\delta(1 - \tau)R/(1 - \tau) = c$ ). It follows that such taxes leave the equilibrium unchanged.

Now consider the possibility of taxing investors' profits from delegated management. Start with the case where investors' profits from self-investment can be taxed independently of profits from self-investment. The first-best can be implemented through a tax such that  $b_{\max} \equiv \frac{(1 - \tau)R - 1}{(1 - \tau)R} \frac{1 + \beta}{\delta} = b_{\min}$ . By contrast, a tax that affects similarly delegated investment and self-investment has no impact on  $b_{\max}$  and leaves the equilibrium unchanged (specifically, one needs to change  $R$  into  $(1 - \tau)R$ ; the sequence  $b_t$  is unaffected).

### 5.3.1 Normative and predictive implications

Our modelling of monitoring by a regulator predicts that it can be optimal to have periods of intense monitoring where the regulator performs a "crack-down" that resets rents at a low level, followed by several periods of lighter monitoring. This implies that monitoring expenses can be cyclical and should be allowed to experience spikes: it is optimal to grant from time to time regulators with abnormally high levels of funding, so that they can hire human capital to perform exceptional amounts of monitoring. In other words, the "steady state" flow cost of supervision is optimally smaller than what is spent in special times. The governance and mandate of regulators should thus allow them to expand their budget temporarily when a "reset" is needed.

Our result on monitoring cycles also has an implication for empirical research: In our model, regulatory changes are slowly offset by agents who bring back opacity and rents to their initial level. This means that the short-term and long-term effects of regulations should be expected to be different. This potentially matters for empirical studies using regulatory shocks as natural experiments: the



short-term impact of a reform should be expected to be higher than its long-term impact. In our model, the speed at which the offsetting of regulation takes place is endogenous. Our model predicts a progressive build-up in rents and complexity following deregulation episodes, in line with empirical results from Philippon&Resheff (2011).

## 6 Extensions

Coming back to the model without regulatory intervention, we now show that our qualitative results hold after relaxing several of our assumptions.

### 6.1 When $R$ increases with $b$

In this subsection, we show that our qualitative insights are robust to letting  $R$  increase with  $b$ . To do so we assume  $R(b) = \mu + \kappa b$ . When  $\kappa = 0$ , this is the model analyzed above. To examine the local robustness of our results we focus on the case where  $\kappa$  is small. The efficient choice of  $b$  maximizes  $R(b) - cb$ . In keeping with our focus on the case where  $\kappa$  is small, we suppose  $\kappa < c$ . Thus it is efficient to set  $b = 0$ .

Bearing in mind that at stage 2, when the young investor meets the young agent,  $b_t$  and  $R(b_t)$  are set, the optimal contract is

$$(w_t^t, w_{t+1}^t) = ((1 - \beta)\delta b_t R(b_t), \delta b_t R(b_t)),$$

so that fund managers' earnings are

$$w_t^t + \beta w_{t+1}^t = \delta b_t R(b_t), \tag{30}$$

and the investor's returns are

$$R(b_t)(1 + \beta) - \delta b_t R(b_t). \tag{31}$$

At period  $t$ , the young manager chooses  $b_t$  to maximize

$$\delta b_t R(b_t) - cb_t = \delta b_t (\mu + \kappa b_t) - cb_t,$$

subject to the constraint that the period  $t$  investor is willing to hire him. Without the constraint, the first order condition would be

$$\delta\mu + 2\delta\kappa b_t - c = 0.$$

Assuming  $\delta\mu > c$ , the unconstrained optimum  $b$  for the agent is

$$b_t = \frac{\delta\mu - c}{2\delta\kappa}.$$

While it would be socially optimal to have  $b_t = 0$ , the agent would prefer a positive  $b_t$ , to extract rents. Consider the case when  $\frac{\delta\mu - c}{2\delta\kappa} \geq b_{\max}$  then  $b_t$  is set by the condition under which the investor is willing to hire the young agent. The investor prefers to do so rather than starting with employing an old one, and then hiring the unemployed generation  $t$  manager, if

$$R(b_t)(1 + \beta) - \delta b_t R(b_t) \geq R(b_{t-1}) + \beta R(b_t) - \delta(b_{t-1}R(b_{t-1}) + \beta b_t R(b_t)).$$

That is

$$R(b_t) - R(b_{t-1}) \geq \delta\{b_t R(b_t) - [b_{t-1}R(b_{t-1}) + \beta b_t R(b_t)]\}.$$

When this holds as an equality we have

$$b_t = \frac{b_{t-1}}{1 - \beta} \frac{R(b_{t-1})}{R(b_t)} + \frac{R(b_t) - R(b_{t-1})}{\delta(1 - \beta)R(b_t)}.$$

When  $\kappa = 0$ , we are back to the previous case. When  $\kappa$  is small,  $R(b_{t-1})$  is close to  $R(b_t)$ , and we still have  $b_t \geq b_{t-1}$ .

## 6.2 When the agent has some bargaining power

In the above analysis we assumed the principal made take-it-or-leave-it offers to the agent. Suppose instead that, when the young time  $t$  agent and investor are matched, with probability  $\phi$  it is the former who makes a take-it-or-leave-it offer, while with probability  $1 - \phi$  it is the latter. Otherwise, the sequence of play is exactly as described above, in Section 2. As shown below, when  $\phi$  is not too large, the outcome of the game is exactly the same with this alternative extensive form.

Suppose the young principal and the young agent at time  $t$  expect the outcome of the game at all other times to be as stated in Proposition 1. What is the rent,  $W$ , the young agent can request from

the young principal when making his offer?  $W$  is limited by the constraint that the principal should prefer to hire the agent at  $t$ , rather than poaching an old, time  $t - 1$ , agent. The principal expects that, if she were to do so, she would have to pay to the old agent  $\lambda_{t-1}b_{t-1}^*$ . And then, at time  $t + 1$ , she would have to hire either the old unemployed time  $t$  agent, or the new, time  $t + 1$ , agent. Thus, the take-it-or-leave-it offer made by the time  $t$  agent must be such that

$$W \leq \lambda_{t-1}b_{t-1}^* + \beta \min[b_t^*, b_{t+1}^*].$$

Binding this constraint,  $W$  is exactly equal to the rent in Proposition 1. In this context, the young agent chooses  $b_t$  to solve

$$\max_b \phi WR + (1 - \phi)\delta b_t R - b_t c,$$

s.t. the employability constraint

$$b_t \leq \lambda_{t-1}b_{t-1}^* + \beta \min[b_t, b_{t+1}^*]. \quad (32)$$

If

$$(1 - \phi)\delta R \geq c, \quad (33)$$

the employability constraint is binding and it is optimal for the time  $t$  agent to choose the same  $b_t$  and request the same compensation as in Proposition 1. Thus, as stated above, the outcome of the game is identical to that prevailing when the principal always makes a take-it-or-leave-it offer.

The intuition is that, under (33), the ability to set  $b_t$  gives the agent the same bargaining power as the ability to make take-it-or-leave-it offers. In both cases, it is competition from the other generations that limits the bargaining power of the agent.

### 6.3 Intra-generational competition

In the model analyzed above, for simplicity, there is only one agent per generation. Our qualitative results are upheld, however, when there are several agents, as long as intra-generational competition is not perfect. To illustrate this point, consider the following extension of our basic model.

The sequence of play is almost the same as in the basic model, but, at each generation  $N$  managers and  $N$  agents are born. Then, at Stage 1 of period  $t$ , each young manager chooses his  $b$ . We focus on symmetric equilibria where all generation  $t$  young managers choose the same  $b_t^*$ . At Stage 2 of period  $t$ , each young investor is matched with one young manager. She observes his type and can make him a take it or leave it offer. If they don't strike a deal, then at Stage 3, as in the basic model, the young investor can approach an old employed agent. Alternatively, in contrast with the basic model, the investor can approach a young manager who has just been employed. In that case, she observes the type  $b$  of this manager and can make him a take it or leave it offer. From that point on, the game unfolds as in the basic model.

In equilibrium, all agents choose the same  $b$ , and investors rationally anticipate that. Hence, there is no point for the young investor to contact another young manager at Stage 3. She would get exactly the same gain as with the agent she had been initially matched with. Thus, as in the basic model, all generation  $t$  managers choose their  $b$  to leave the investor indifferent between hiring them or their predecessors, while intra-generational competition does not impose any additional constraint on managers. Hence the equilibrium is exactly the same as in Proposition 1.

## 7 Conclusion

We develop an overlapping generation model where the intensity of moral hazard that prevails in principal-agent relationships is endogenous and varies over time. Older workers are imperfect substitutes for new workers, due to their shorter horizons and due to their backloaded compensation. This allows younger generations of workers to pick technologies that increase the severity of moral hazard vis-à-vis previous generations and thus allows them to extract larger rents. We believe this model of endogenous rents is particularly well suited to understand the dynamics of rents in the finance industry, where complexity and opacity are endogenous dimensions that ultimately determine the size of rents. Innovations in the financial industry might be partly driven by the desire of agents to use technologies that lend themselves to rent extraction due to the severity moral hazard problems. Our model implies that optimal regulation might take the form of periodic "crack-downs": Regulators reset rents periodically at a low level through intense monitoring and then let them drift upwards, as the industry progressively bypasses the regulatory constraints with ad-hoc rent-enhancing technologies.

Our model also implies that excess back-loading of compensation, while being privately efficient, might negatively affect the level of competition among managers, leading to inefficiently high rents in the future.

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## Proofs

### Proof of Lemma 1:

The program of the investor is

$$\max_{w_t^t, w_{t+1}^t} R(1 + \beta) - w_t^t - \beta w_{t+1}^t, \text{ s.t., } w_{t+1}^t \geq \delta b_t R \text{ and } w_t^t + \beta w_{t+1}^t \geq \delta b_t R.$$

The Lagrangian is

$$\mathcal{L} = R(1 + \beta) - w_t^t - \beta w_{t+1}^t + \mu_t(w_t^t + \beta w_{t+1}^t - \delta b_t R) + \mu_{t+1}(w_{t+1}^t - \delta b_t R),$$

where  $\mu_t$  and  $\mu_{t+1}$  are the multipliers of the time  $t$  and  $t + 1$  incentive constraints, respectively. The first order condition with respect to  $w_t$  is:

$$-1 + \mu_t = 0.$$

Hence the incentive compatibility constraint at time  $t + 1$  binds, i.e.,

$$w_t^t + \beta w_{t+1}^t = \delta b_t R,$$

and the set of optimal values for  $w_t^t$  is the interval  $[0, (1 - \beta)\delta b_t R]$ .

QED

### Proof of Lemma 3:

Since  $\lambda_{t-1} \geq 1$  and  $b_t^* \geq b_{\min} > 0$ , (14) implies  $b_t > b_{t-1}$ .

QED

### Proof of Proposition 1:

To complete the analysis of the equilibrium, we must rule out a last possible deviation by managers. If the generation  $t$  manager chooses  $b_t = b_t^*$ , he gets hired and works for two periods. It could be tempting for the time  $t$  manager to deviate to  $b_t = \hat{b} > b_t^*$ , aware that he would not be hired at time  $t$ , but hoping he would earn large rents at  $t + 1$ .

To evaluate his gains under this deviation, the agent must form beliefs about the reaction of the next generation. Our assumption that managers and investors make choices at stages 1 and 2 facilitates



this analysis. Since they make their decision before having the opportunity to observe previous actions, they stick to the equilibrium even after deviations.

When deviating to  $\hat{b}$  at period  $t$ , the manager must ensure he will be hired at period  $t + 1$ . At that time, when making the equilibrium choice and hiring the young manager, the young investor obtains

$$R(1 + \beta) - \delta b_{t+1}^* R.$$

If, instead, the period  $t + 1$  investor hires the previous deviator, and, at the following period, the (now old) time  $t + 1$  manager, he obtains

$$R(1 + \beta) - \delta \hat{b} R - \beta \delta b_{t+1}^* R.$$

To be employed at time  $t + 1$ , the deviator must choose  $\hat{b}$  such that

$$\hat{b} \leq (1 - \beta) b_{t+1}^*. \quad (34)$$

The equilibrium choice of  $b_t^*$  dominates the deviation to  $\hat{b}$  if

$$\delta b_t^* R \geq \beta \delta \hat{b} R. \quad (35)$$

Binding (34) and substituting it into (35), the condition under which the agent is better off taking the equilibrium action rather than deviating to  $\hat{b}$  is

$$b_t^* \geq \beta(1 - \beta) b_{t+1}^*.$$

Substituting  $b_{t+1}^*$  from (16), the condition is

$$b_t^* \geq \beta(1 - \beta) \lambda \frac{b_t^*}{1 - \beta}.$$

That is

$$\frac{1}{\beta} \geq \lambda,$$

which holds since  $\lambda \in [0, 1/\beta]$ .

QED

**Proof of Lemma 6:**

First consider the case  $T > 2$ . At time  $t = kT + n$ , where  $n \in \{1, \dots, T - 2\}$ , young managers choose the highest possible  $b_t$  at which they are still employed. Following the same reasoning as in the previous analyses, binding the employability constraint yields

$$R(1 + \beta) - \delta b_t R = R(1 + \beta) - \delta b_{t-1} R - \beta \delta \min[b_t, b_{t+1}] R,$$

which simplifies to

$$R(1 + \beta) - \delta b_t R = R(1 + \beta) - \delta b_{t-1} R - \beta \delta b_t R.$$

Thus

$$b_t = \frac{b_{t-1}}{1 - \beta}.$$

This implies

$$b_{kT+n} = \frac{b_{kT+n-1}}{1 - \beta}, \forall n \in \{1, \dots, T - 2\}.$$

For the last generation before regulatory intervention,  $t = (k + 1)T - 1$ , things are slightly different since the young manager anticipates that  $b_{t+1} = \underline{b}$ . Hence, the manager in that generation chooses  $b_t$  such that

$$R(1 + \beta) - \delta b_t R = R(1 + \beta) - \delta b_{t-1} R - \beta \delta \underline{b} R.$$

That is

$$b_t = b_{t-1} + \beta \underline{b}.$$

Since  $t - 1 = kT + T - 2$ ,  $b_{t-1} = \frac{\underline{b}}{(1 - \beta)^{T-2}}$ . Thus we have

$$b_t = \left( \frac{1}{(1 - \beta)^{T-2}} + \beta \right) \underline{b}. \quad (36)$$

Second, consider the case  $T = 2$ . At  $t = 1$ , we have  $b_1 = \underline{b}$ , at  $t = 2$ , we have  $b_2 > \underline{b}$ , ...  $b_2$  binds the employability constraint:

$$R(1 + \beta) - \delta b_2 R = R(1 + \beta) - \delta \underline{b} R - \beta \delta \underline{b} R.$$

Hence

$$b_2 = (1 + \beta)\underline{b}, \quad (37)$$

which is consistent with (36) evaluated at  $T = 2$ .

QED

**Proof of Proposition 3:**

First consider the case  $T > 2$ . In this case (26) writes as

$$\hat{b} = b_{t-1} + \beta \min\left[\hat{b}, \frac{\underline{b}}{1 - \beta}\right]. \quad (38)$$

If  $\min\left[\hat{b}, \frac{\underline{b}}{1 - \beta}\right] = \hat{b}$ , that is  $\hat{b} < \frac{\underline{b}}{1 - \beta}$ , then (38) yields

$$\hat{b} = \frac{b_{t-1}}{1 - \beta}$$

which is in contradiction with  $\hat{b} < \frac{\underline{b}}{1 - \beta}$  since  $\underline{b} < b_{t-1}$ . Hence  $\min\left[\hat{b}, \frac{\underline{b}}{1 - \beta}\right] = \frac{\underline{b}}{1 - \beta}$ , and  $\hat{b}$  is set by

$$\hat{b} = b_{t-1} + \beta \frac{\underline{b}}{1 - \beta}.$$

Thus (19) writes as

$$\underline{b} = (1 - \alpha)\left[b_{t-1} + \beta \frac{\underline{b}}{1 - \beta}\right].$$

That is

$$\alpha = 1 - \frac{1}{\frac{b_{t-1}}{\underline{b}} + \frac{\beta}{1 - \beta}} = 1 - \frac{1}{\frac{b_{kT-1}}{\underline{b}} + \frac{\beta}{1 - \beta}}.$$

Note that the right-hand-side is between 0 and 1. Substituting  $b_{kT-1}$  from Lemma 5, this simplifies to

$$\alpha = 1 - \frac{1}{\frac{1}{(1 - \beta)^{T-2}} + \beta \frac{2 - \beta}{1 - \beta}}.$$

Second, consider the case  $T = 2$ . Substituting (37) in (26), we have

$$\hat{b} = (1 + \beta)\underline{b} + \beta \min\left[\hat{b}, (1 + \beta)\underline{b}\right].$$

If  $\hat{b} \leq (1 + \beta)\underline{b}$ , then this equation is equivalent to

$$\hat{b} = \frac{1 + \beta}{1 - \beta}\underline{b},$$

which is a contradiction. Hence,  $\hat{b} > (1 + \beta)\underline{b}$  and the employability constraint yields

$$\hat{b} = (1 + \beta)^2 \underline{b}.$$

Thus (19) yields

$$\alpha = 1 - \frac{1}{(1 + \beta)^2}.$$

QED

**Proof of Proposition 4:**

(29) is greater than (21), iff

$$\frac{1 + (1 + \beta)}{2} cb_{\min} + \frac{1}{2} \left(1 - \frac{1}{(1 + \beta)^2}\right) \gamma < cb_{\max}. \quad (39)$$

That is

$$\gamma < c \frac{b_{\max} - \frac{1+(1+\beta)}{2} b_{\min}}{\frac{1}{2} \left(1 - \frac{1}{(1+\beta)^2}\right)}.$$

Note that the right-hand-side of is positive, since  $b_{\max} \geq (1 + \beta)b_{\min}$ , because of (24).

(29) is greater than (20), iff

$$\begin{aligned} \frac{\beta}{2} cb_{\min} &< \left[ \frac{\beta}{1 + \beta} - \frac{1}{2} \left(1 - \frac{1}{(1 + \beta)^2}\right) \right] \gamma. \\ \frac{\beta}{2} cb_{\min} &< \frac{1}{(1 + \beta)^2} [\beta(1 + \beta) - \frac{1}{2} ((1 + \beta)^2 - 1)] \gamma. \\ \frac{\beta}{2} cb_{\min} &< \frac{1}{(1 + \beta)^2} [\beta(1 + \beta) - \frac{1}{2} (2\beta + \beta^2)] \gamma. \\ \frac{\beta}{2} cb_{\min} &< \frac{\beta}{(1 + \beta)^2} \left[ (1 + \beta) - \left(1 + \frac{\beta}{2}\right) \right] \gamma. \\ \frac{(1 + \beta)^2}{\beta} cb_{\min} &< \gamma. \end{aligned}$$

QED