Competition for talent and cyclical malpractice in corporate governance*

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Abstract

We present a model that rationalizes the cyclical nature of executive compensation and malpractice. The model features a principal-agent setting where effort and misreporting incentives are in conflict, and managerial talent is a scarce asset. In the optimal contract, investors exploit a combination of short-term bonuses and investment in monitoring. However, competition for managerial talent exacerbates malpractice and increases incentive pay. Malpractice dampens the efficient reallocation of assets, which supports regulations that modulate executive pay and corporate governance. Embedded into a dynamic general equilibrium with household savings and endogenous rates of return, the model reproduces the build-up of malpractice during expansions and its reduction after declines in aggregate output.

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It was not merely that many companies, or many Wall Street operators, misbehaved; it was that the very culture encouraged the misbehavior and was, in large measure, its accomplice.
Origins of the Crash: The Great Bubble and Its Undoing, Roger Lowenstein, 2004, page 217.

(About Sam Bankman-Fried) (H)e was a multi-billionaire and everyone's favorite boy genius; suddenly, his billions—and other people's billions—had vanished in a cloud of hubris and what looks a lot like fraud.
Stephen J. Dubner, 23 Nov 2022.

1 Introduction

During many episodes of economic expansions, malpractice appears and aggravates in conjunction with aggressive incentive compensation schemes for firms' managers and substantial capital gains for, sometimes a few, investors. Security markets crashes and economic downturns usually occur in the aftermath of these episodes, after which malpractice activities and the aggressiveness of managerial compensation declines.

These medium-run cyclical patterns may be apparent for a casual observer of recent episodes in the U.S. economy—e.g., the Dot-Com Bubble, the subprime mortgages crisis, or some crypto-asset scams—but also appear in systematic empirical analysis.[1] For instance, accounting manipulation practices are more prevalent in high-growth industries (Burns and Kedia, 2006, Kedia and Philippon, 2009), and malpractice cases in banking rise in periods of high economic growth (Sakalauskaite, 2017). Policy-makers have also shown their concern for the association between the level and structure of managerial pay and malpractice (Financial Stability Forum, 2009).[2]

This paper develops a tractable theory to explain the cyclical nature of malpractice and its association with incentive compensation schemes. Exploiting the interaction between agency problems and competition for managerial talent, the theoretical framework accounts for corporate policies that set aggressive bonus policies and jointly foster malpractice. The model provides a rationale for executive compensation and/or corporate

[1] Some commentators also highlight the similarities between the malpractice that occurred in the 1920s before the Great Depression and more recent scandals. See "Foreclosuregate: playing with systemic fire?," *Fortune Magazine*, October 26, 2010, and "ENRON'S COLLAPSE: The Accountants; Watching The Firms That Watch The Books," *The New York Times*, December 5, 2001.

[2] See, also, "Guidance on sound incentive compensation policies" Federal Register, Vol. 75, No. 122, Friday, June 25, 2010, available here.

governance regulations by linking malpractice to an inefficient allocation of resources. Besides, we embed the model in a dynamic, general equilibrium setting that fully rationalizes the cyclical build-up and later reduction of malpractice and performance pay in association with economic expansions and recessions over the medium run.

The baseline model features a principal-agent setup in which a manager can exert unobservable effort to enhance the long-term profitability of a project. Investors must induce effort through short-term compensation based on a noisy performance signal, e.g., earnings or sales reports. Short-term compensation schemes give incentives to managers to embark in malpractice, interpreted as the manipulation of the short-term signal. The possibility of ex post malpractice increases the (costly) bonuses that are needed to induce ex ante managerial effort. In order to alleviate the malpractice problem, investors can improve the projects' corporate governance through a costly monitoring technology.

Malpractice may not only imply a rent-extraction mechanism from investors to managers, but may also alter the allocation of resources by distorting the functioning of financial markets. We show that this type of result naturally arises from the presence of an interim market for liquidated assets with matching frictions, where investors may profitably reallocate their investment when a project's failure is known in advance. In this market, which can be interpreted as a market for corporate control, malpractice exacerbates the matching frictions by reducing the extent to which productive projects can expand their scale and generate a surplus. This means that firms' expected cash flows may decrease not only with the firm-level degree of malpractice but also with the intensity of malpractice at the economy-wide level. Investors internalize that malpractice reduces the chances of productively selling a failed project, but they ignore the externalities imposed on other investors through their effect on market tightness.

We first analyze the configurations of optimal contracts in partial equilibrium, where investors take as given the manager's outside option. We show that, when the participation constraint of the manager binds, an increase in the manager's outside option leads first to an increase in short-term bonuses and an increase in malpractice. This result arises because increased competition forces investors to give up rents in favor of managers. In the lack of competition for managers, incurring monitoring costs allow to reduce the expected incentive compensation costs. Competition shuts down this mechanism and generates disincentives to invest in costly monitoring.

Investors internalize some of the negative effect of malpractice on their expected cash flows, thereby moderating the incentives to induce malpractice. This moderation occurs when the manager's outside option is sufficiently high, in which case investors compete to hire managers by increasing their fixed pay instead of bonuses. Specifically, the margin of competition switches from bonuses to fixed pay when the (perceived) marginal reduction in cash flows associated with more intense malpractice exceeds the marginal cost of additional monitoring.

We then endogeneize the managers' outside option through a free-entry condition for investors, so that malpractice (weakly) increases as the opportunity cost of capital for investors decreases. Due to the externalities generated by malpractice, regulations may restore the surplus-maximizing allocation. We show that tax solutions, such as Pigovian or personal taxation, and quantity solutions, such as a pay ratio or a bonus cap, may restore the surplus-maximizing choices of malpractice. However, a bonus cap represents the most suitable regulation tool because it modulates the margins of decisions that investors exploit to compete for talent—bonus and malpractice vs. fixed pay. Tax solutions, pay ratios, or lower bounds on fixed pay may all be undesirable because they generate distorsions when the opportunity cost of capital is sufficiently high.

We further embed the baseline model into a dynamic, general equilibrium setting, where firms' funding comes from a risk-averse, representative household, who has a precautionary motive to save in the presence of systematic productivity shocks. The model features endogenous "booms" with output growth in association with increased managerial compensation and intensified malpractice. Specifically, aggregate savings tend to increase after a sequence of repeated good productivity shocks, which puts downward pressure on market rates of return. Both the increased productivity and the reduction in interest rates boost the rent-extraction by managers through malpractice. That is, the model generates endogenous "bonus cultures" (Benmelech et al., 2010, Bénabou and

Tirole, 2016) in periods of productivity growth.

When a bad shock occurs, investment demand declines and market rates of return decline even further due to the high accumulated savings, making malpractice much more prevalent. Both the capital allocation inefficiencies associated with malpractice and the low productivity shock deplete the household's stock of savings, which increases the market rates of return, thereby reducing the degree of managerial rent-extraction and malpractice after the negative shock. Then, a new process of capital accumulation begins, setting the seeds for a potential new cycle. Hence, the dynamic model rationalizes the development of "abnormal" levels of malpractice and managerial compensation during prolonged periods of high productivity.

The implications of the model rely on the managers' capacity to extract sizable rents from investors due to malpractice and aggressive bonus schemes. This assumption is consistent with the empirical evidence. For instance, accounting irregularities are related to steeper managerial incentives (Burns and Kedia, 2006, Kolasinski and Yang, 2018). Moreover, executives tend to exercise options or sell stock surrounding firms' news announcements (Bergstresser and Philippon, 2006, Edmans et al., 2014, Edmans et al., 2017a, Bennett et al., 2017). As mentioned above, malpractice aggravates in growth periods (Burns and Kedia, 2006, Kedia and Philippon, 2009, Sakalauskaite, 2017).

Besides, the theoretical framework in this model suggests that moral hazard problems become more severe as managerial talent is more valuable, thereby boosting the incentive component of managerial pay and reducing investors' oversight. In line with this, Philippon and Reshef (2012) argue that moral hazard must explain the part of executive wage profiles in the U.S. financial sector that is unaccounted by productivity. Several studies also find that reductions in the barriers to entry into an industry lead to significant increases in the fraction of performance-based pay for executives (Guadalupe, 2007, Karuna, 2007, Cuñat and Guadalupe, 2009a,b). Moreover, the effects seem to arise from increased competition for talent in the labor market.[3]

This paper is related to a large body of the theoretical literature that studies manip-

[3] This seems to be precisely what occurred in the U.S. financial industry before the 2007-2010 Global Financial Crisis (The Financial Crisis Inquiry Commission, 2011, p. 64).

ulation incentives in principal-agent models.[4] As in Pagano and Immordino (2012), we develop a model where investment in monitoring can be a substitute for performance pay, but we also analyze the joint determination of corporate governance and executive compensation in an environment of competition for talent. Within this literature, our contribution lies on proposing a channel of externalities due to malpractice. Besides, the model is tractable enough to be embedded into a dynamic general equilibrium dynamic setting and obtain further implications.

Second, this paper contributes to the theoretical literature that explores the equilibrium governance choices with competition for talent. For instance, Dicks (2012) and Acharya and Volpin (2009) show how firms choose lower governance standards to boost managerial compensation and retain talented managers. Such competition reduces investor value and provides a rationale for governance regulations. In a similar vein, Acharya et al. (2016) show how free mobility of managers reduce the learning ability of investors about managerial skills and spurs risk-taking by less skilled managers.

Thanassoulis (2012, 2014), Thanassoulis and Tanaka (2017), and Albuquerque et al. (2017) analyze the role of regulations on executive compensation in the context of risk-taking in banking. Although Edmans et al. (2017b) discuss that theories provide little support for executive compensation regulations, in this paper we provide the arguments for general corporate governance regulations based on the mis-allocation of capital generated by malpractice. We posit the relevance of taxation schemes in alleviating the negative externalities of malpractice as in other financial and macroprudential settings (Perotti and Suarez, 2011). However, a simple quantity-based bonus cap represents the less distortionary implementable regulation.

[4] See, for instance, Peng and Röell (2014), Laux (2014), Laux and Stocken (2012), Laux and Laux (2009), Crocker and Slemrod (2007), Goldman and Slezak (2006), Dutta and Gigler (2002), Arya et al. (1998), Stein (1989), Dye (1988), Stein (1988), Narayanan (1985).

2 The model

Consider a three-period risk-neutral economy. Time is denoted by $t = 0, 1, 2$ and the gross market rate of return is R between periods $t = 0$ and $t = 2$. A large number of deep-pocketed investors have access to projects that require a unit investment. Investors must hire a penniless manager that has the skills to operate the projects' technology. A unit mass of managers are present, who only live up to period $t = 1$ and have an outside option that yields an expected utility of U at $t = 0$. This short horizon captures that managers have short-tenures relative to usual long-term horizon of investment projects. At $t = 2$, the project is successful with probability p and yields cash flows equal to y. In contrast, the project fails with probability $1 - p$ and yields 0. Cash flows are publicly known and distributed to investors at $t = 2$.

Each manager makes an unobservable effort decision at $t = 0$ that determines the probability *distribution* over final cash flows. The manager can exert effort, in which case the probability of success is $p = e$, with $e \in (0, 1)$. The manager can also shirk, in which case the project fails with certainty, $p = 0$, but the manager obtains private benefits $B > 0$ that capture perquisite consumption or the opportunity cost of effort.[5]

At $t = 1$ the manager observes privately the realization of cash flows, i.e., y or 0. With this information, the manager generates a public signal x. After observing a successful project, y, the manager produces a high signal, $x = x_H$, i.e. $Pr(x_H|y) = 1$. After observing a failed project, the manager can produce a low signal, $x = x_L$, but can also embark on malpractice and manipulate the signal to announce x_H, i.e., $Pr(x_H|0) \geq 0$. We assume that the manager can choose a manipulation intensity $Pr(x_H|0) = q \in \{0, m\}$ in an unobservable manner, with $m \in [0, 1]$.

The signal x represents any information that allows investors to evaluate the long-term profitability of investment opportunities. Thus, the manipulation of the performance signal x can capture earnings or accounting manipulation practices, as well as malpractice leading to inflated perceptions about firm profitability. x can also represent a realization

[5]Similar results arise if cash flows in case of failure different from 0, or if there is a non-zero probability of success under low effort. We drop this ingredients for the sake of clarity.

of sales, which can be inflated, e.g., through the violation of customers' rights. Such action can trigger customer backlash or regulatory action in the long-term that revert the short-term gain (Kedia and Philippon, 2009, Edmans et al., 2012).

Investors set an incentive compensation contract for the manager at $t = 0$. The manager only lives up to $t = 1$ and has limited liability. Hence, investors can only provide effort incentives based on the signal $x \in \{x_L, x_H\}$ at $t = 1$. In particular, we denote by w_H the compensation of the manager after a, possibly manipulated, high signal, x_H. Correspondingly, we denote by w_L, which we label as "fixed pay," the compensation of the manager after a low signal, x_L.

On top of incentive compensation contracts, investors have at their disposal a corporate governance technology that alters the malpractice incentives of managers. Specifically, reducing the maximum malpractice intensity to a level m requires investors to incur a cost $g(m)$. The cost function $g(m)$ is decreasing and convex, i.e, $g_m < 0$, $g_{mm} \geq 0$. We also assume that reducing malpractice to zero is infinitely costly, $\lim_{m \to 0} g_m = \infty$, while it always pays to invest in a marginal amount of governance, $g_m(1) = 0$.[6]

The monitoring costs $g(.)$ capture the pecuniary and non-pecuniary expenses from establishing oversight and accounting information structures that discourage or detect malpractice. We label the variable m as an inverse measure of "corporate governance," although in strict sense it only captures the strength of monitoring structures that avoid the deception of investors by the manager. Other governance policies that remain out of our analysis may be directed at reducing the degree of private-benefits taking, as in Dicks (2012).

Malpractice may have further implications for investors apart from the costs of incentive compensation and the need to invest in corporate governance. These costs may arise from reputation losses or the inefficient investment decisions that managers make in unprofitable projects, as in Kedia and Philippon (2009). Besides, by distorting the allocation of capital, malpractice decisions may generate an externality over unrelated

[6]The governance policy can be equivalently interpreted as the manager facing a discontinuous jump in the cost of embarking in malpractice for $q > m$, such as a large punishment. Thus, the manager will never choose an intensity of malpractice greater than m.

firms' cash flows. To capture these features, we assume that the expected cash flows of a project under an effort decision p are given by $py - \ell(q, M)$, where $\ell(q, M)$ captures the direct costs of manipulation on cash flows and M is the overall degree of malpractice in the economy. We assume that $\ell_q(q, q) > 0$ and $\ell_M(q, q) > 0$. Moreover, denoting $\ell(q, q) = \ell^*(q)$, the assumptions above imply that this function is increasing, $\ell^*_q \geq 0$, while we also assume that it is weakly convex, $\ell^*_{qq} \geq 0$.

Below, we provide a micro-foundation for the function $\ell(q, M)$ that satisfies the above properties, under the assumption that a market for second-hand assets with matching frictions arises in period $t = 1$. In this market, managers of successful projects can purchase assets of unsuccessful projects and share a surplus among them. However, managers that embark in malpractice have incentives to purchase the assets of other projects and capture their bonuses, despite creating no surplus. Malpractice increases market tightness, reducing the extent of productive matches, so that individual malpractice decisions induce a negative externality over other, productive, projects.

Figure 1 depicts the timing and elements of the model.

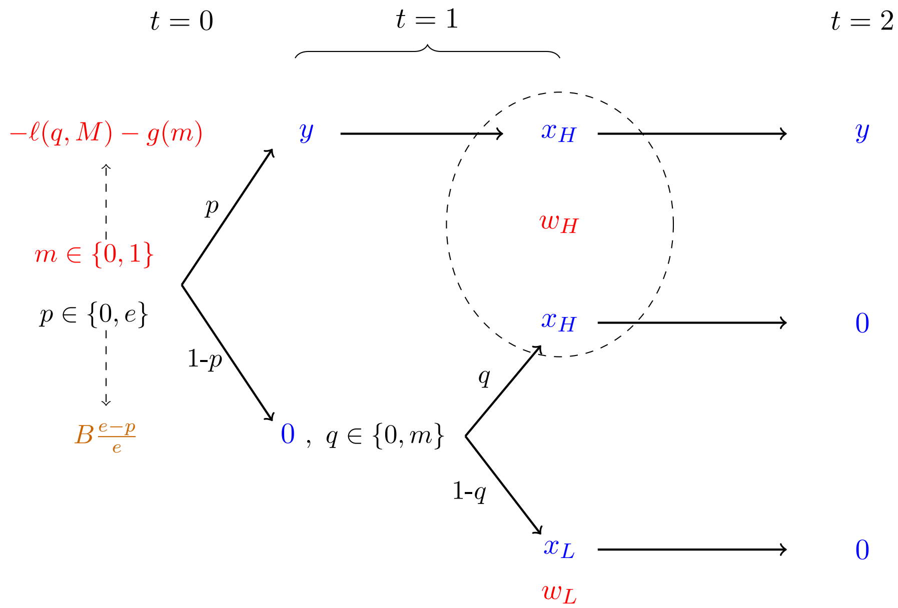

Figure 1: Timing of events and elements of the model. The ellipse represents the information set of investors after a high earnings announcement at $t = 1$.

3 Analysis of the model

In this section, we study the main properties of the model in partial equilibrium. We proceed by backwards induction, first analyzing the manager's choice of effort and malpractice given the incentive contracts and corporate governance choices. Second, we provide the analysis of the optimal incentive contracts and corporate governance given the manager's outside option and the aggregate level of malpractice. Lastly, we study the equilibrium where the manager's outside option is determined in equilibrium and the policy implications. Hereafter, we focus on a symmetric outcome where all investors and managers make the same choices. Notice that, in equilibrium, contracts must induce effort $p = e$ because choice of $p = 0$ yields cash flows equal to $0 < R$ and investors would not participate.

3.1 Managerial choices of effort and malpractice

Conditional on $p = e$, the manager's expected utility is

$$[e + (1-e)q]w_H + (1-e)(1-q)w_L$$

for $q \in \{0, m\}$. When the manager observes a bad signal x_L, she manipulates earnings, $q = m$, if $w_H > w_L$. Similarly, the manager exerts effort as long as

$$(1-q)(w_H - w_L) \geq \frac{B}{e} \ .$$

This incentive-compatibility condition highlights the conflict between the provision of effort incentives and the possibility of malpractice. A positive bonus, $w_H - w_L > 0$, is necessary to provide effort incentives but induces malpractice. Moreover, when the manager manipulates, $q = m$, incentive compensation loses effectiveness. That is, the difference $w_H - w_L$ must increase when managers manipulate and incentives must be steeper in the presence of malpractice. Therefore, in the optimal contract, the manager exerts effort, but it is unfeasible to deter malpractice below m through the configuration of incentive pay. The next lemma follows from this discussion.

Lemma 1. *Following the low realization of cash flows, the manager always manipulates,* $q = m$.

3.2 Optimal contract and governance policy

The model features a conflict between the provision of incentives to exert effort and the incentives to embark on malpractice. This situation provides a role for investors to invest into corporate governance policies. Investors choose a contract, represented by the triple (m, w_H, w_L), to maximize the expected cash flows, net of incentive compensation and monitoring costs, subject to the effort incentive-compatibility constraint and the manager's participation and limited liability constraints:

$$\max_{\substack{(w_H,w_L)\in\mathbb{R}^2_+ \\ m\in[0,1]}} \quad ey - \ell(m,M) - [e+(1-e)m]w_H - (1-e)(1-m)w_L - g(m) \tag{1}$$

$$\text{s.t. } (1-m)(w_H - w_L) \geq \frac{B}{e} \tag{IC}$$

$$[e+(1-e)m]w_H + (1-e)(1-m)w_L \geq U \tag{PC}$$

The next proposition states the configurations of the optimal contract. Proofs appear in Appendix A.

Proposition 1. *Let* $(\widehat{m}, \widehat{w}_H, \widehat{w}_L)$ *denote the solution to problem (1), given* U *and* M. *The optimal contract is characterized as follows. There exist thresholds in the manager's outside option* U_0 *and* U_1, *with* $U_0 < U_1$, *such that*

1. *For* $U < U_0$ *the participation constraint does not bind. The optimal contract pays a short-term bonus* $\widehat{w}_H = \frac{B/e}{(1-\widehat{m})}$ *and zero fixed compensation,* $\widehat{w}_L = 0$. *The optimal intensity of manipulation is defined as* $\widehat{m} = m_0 = \arg\min_{m\in[0,1]} \ell(m,M) + \frac{mB/e}{1-m} + g(m)$.

2. *For* $U \in (U_0, U_1]$ *the participation constraint binds. The optimal contract pays a short-term bonus* $\widehat{w}_H = \frac{B/e}{(1-\widehat{m})}$ *and zero fixed compensation,* $\widehat{w}_L = 0$. *The optimal intensity of manipulation is* $\widehat{m} = \frac{U-B}{U-B(1-1/e)}$.

3. *For $U > U_1$ the participation constraint binds. The optimal contract pays a short-term bonus $\widehat{w}_H = U + \frac{1-e}{e}B$ and fixed compensation $\widehat{w}_L = U - \frac{e+(1-e)\widehat{m}}{1-\widehat{m}}\frac{B}{e}$. The optimal level of manipulation is defined as $\widehat{m} = m_1 = \arg\min_{m\in[0,1]} \ell(m, M) + g(m)$.*

The main implication of the proposition is that investors exploit two margins of decision-making to compete for managerial talent, depending on the size of the manager's outside option. Figure 2 illustrates this relationship. For a sufficiently low outside option, the participation constraint shows slack. This means that the minimum rents to be appropriated by managers due to moral hazard are greater than the their outside option. In this case, investors choose an intensity of malpractice that balances the trade-off between the reduction in managerial compensation and direct cash flow costs and the increase in monitoring costs.

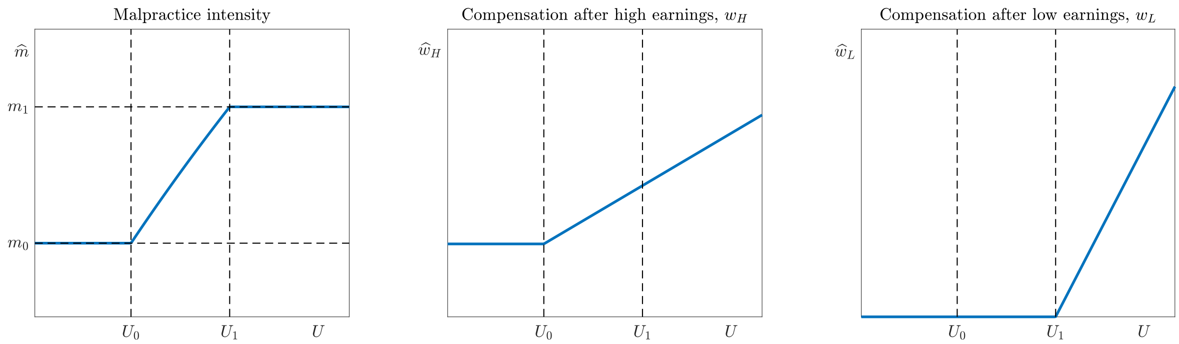

Figure 2: Optimal contract as a function of the manager's outside option. The left panel depicts the level of malpractice allowed by the optimal contract, m, the central panel depicts the optimal level of compensation after a high earnings announcement, w_H, and the right panel depicts the optimal level of fixed compensation, w_L.

In contrast, as U increases, investors must give up rents in favor of managers. First, investors will adjust the intensity of monitoring, providing rents to managers through weaker monitoring and, thus, more powerful incentives. Investors optimally choose to adjust compensation at this margin since an increase in incentive pay ensures participation by the manager, while it allows a reduction in monitoring costs. The increased malpractice has a cost through reduced cash flows, but this is more than compensated by the reduction in monitoring costs.

When U is sufficiently high, investors must provide to the manager a high level of rents, such that the marginal direct cash flow effect of manipulation, ℓ_m, would exceed the marginal reduction in monitoring costs, g_m. Thus, for a sufficiently large outside option, investors guarantee the participation of the manager through fixed pay, w_L, setting the intensity of malpractice at the level that balances the trade-off between the direct cash flow costs of manipulation and the monitoring costs, i.e., $\ell_m + g_m = 0$.

In sum, the manager's outside option determines the amount of rents that managers can appropriate for investors, who freely choose which margin of decision to exploit to provide those rents: either through higher bonuses and reduced governance costs or through fixed pay. Investors prefer the former margin when the marginal reduction in monitoring costs exceeds the marginal direct reduction in cash flows due to malpractice.

Given $(\widehat{m}, \widehat{w}_H, \widehat{w}_L)$, and assuming a binding participation constraint, we can express the investors' expected payoff $\Pi(U, M)$ as:

$$\Pi(U, M) = ey - \ell(\widehat{m}(U, M), M) - U - g(\widehat{m}(U, M)) \ .$$

Undertaking the project requires a unit investment and the gross market rate of return is R. Hence, investors participate if $\Pi(U, M) \geq R$.[7]

3.3 Laissez-faire equilibrium

Now we turn to analyze the properties of the decentralized equilibrium where the managers' outside option is determined from competitive forces. Due to free entry, investors are willing to participate and hire a manager as long as the gross return of the investment net of compensation and monitoring costs is above or equal to R. Investors can outbid any project that yields an expected value $\Pi(U, M) > R$ by offering a greater expected utility $U' > U$ to a manager. Therefore, any excess payoff above R is removed due to the investors' willingness to grant higher rents to a manager, which places investors in the region of a binding participation constraint. The equilibrium is defined as follows.

[7]Henceforth, we assume that R is always low enough to elicit participation by investors. A sufficient condition for this is that $\Pi(U_0, m_0) \geq R$, where U_0 and m_0 are defined in Proposition 1.

Definition. *An equilibrium is represented by an outside option* $\widehat{U}$ *and an aggregate malpractice intensity* $\widehat{M}$ *such that:*

1. *The solution to problem* (1) *is* $(\widehat{m}, \widehat{w}_H, \widehat{w}_L)$*, given* $\widehat{U}$ *and* $\widehat{M}$*.*

2. *All investors allow a malpractice intensity* $\widehat{m} = \widehat{M}$*.*

3. *Free-entry of investors:* $\Pi\left(\widehat{U}, \widehat{M}\right) = R$*.*

The next proposition characterizes the properties of the decentralized equilibrium.

Proposition 2. *A unique equilibrium exists. There exists* $\widehat{R}$ *such that, if* $R > \widehat{R}$*, the equilibrium intensity of manipulation and bonuses decrease with* R*, while contracts feature no fixed pay. If* $R < \widehat{R}$*, the equilibrium intensity of manipulation and bonuses are independent of* R*, while fixed pay is decreasing in* R*.*

The model yields two regimes depending on the value of R. First, the outside option of the manager is low for a relatively high R. This situation puts investors in the regime where the marginal increase in governance costs is above the marginal direct cash flow reduction due to malpractice. In such regime, investors modulate their governance to adjust to changes in the manager's outside option. As competition for talent further tightens, i.e. a relatively low R, the cash flow costs of manipulation lead investors to adjust instead the level of fixed pay.

3.4 Malpractice and the mis-allocation of capital

The setting above assumes that manipulation at the individual- and aggregate-level have a direct impact on a project's cash flows in a reduced-form manner through $\ell(m, M)$. Now, we provide a modeling framework that meets the functional assumptions that we imposed above.

Assume that, at $t = 1$, managers can expand the scale of their projects by acquiring the assets of failed projects. Managers with successful projects, where they announce x_H truthfully, can purchase a failed project's asset and generate extra cash flows $\Delta > 0$ at

$t = 2$. Managers that manipulate earnings through malpractice can also participate in the market and purchase a failed project's asset, but without generating any cash flows.

The market for liquidated assets features matching frictions. This assumption captures that firms may need specific assets that are not generally available in the economy, or transaction costs that are inherent to the market for corporate control.[8] Specifically, the frictions take the form of a Cobb-Douglas matching function, where the number of matches is $\lambda b^{\gamma} s^{1-\gamma}$. b denotes the number of buyers and s denotes the number of sellers. In this function, $\gamma \in (0, 1)$ is the elasticity of matches to changes the number of buyers and $\lambda > 0$ measures the efficiency of the matching technology. The market features a sharing rule that gives the buying side a bargaining power $\eta \in (0, 1)$ over the surplus created by a match.[9] Let $\theta = b/s$ denote the tightness of the market. Under this specification, the probability of a seller finding a buyer is $\lambda\theta^{\gamma}$ and, similarly, the probability of a buyer finding a seller is equal to $\lambda\theta^{\gamma-1}$.

Given an economy-wide malpractice intensity M and a matched pair of successful and unsuccessful projects, the buyer extracts an expected surplus equal to $\eta E(\Delta)$, where $E(\Delta)$ captures the expected cash flows from the purchased asset, given by:

$$E(\Delta) = \frac{e\Delta}{e + (1 - e)m}$$

while a seller gets $(1 - \eta)E(\Delta)$. Managers of unsuccessful projects that embark in malpractice and announce x_H will participate in the market to purchase the assets of other unsuccessful projects and pool with managers that report truthfully. Separation between manager types is impossible since manipulation and investment decisions grant short-term compensation w_H and generate no differential costs across manager types.

[8] Rhodes-Kropf and Robinson (2008) and David (2017) model mergers and acquisitions with matching frictions, and Li (2018) assumes matching frictions in financial markets to study their impact on monetary policy.

[9] We assume throughout an interior solution in which probabilities must be well defined, so that the number of matches is smaller than $\min\{b, s\}$.

With the assumptions above, we can express the expected cash flows of a project as:

$$y(m, M) = ey + e\lambda\theta(M)^{\gamma-1}\eta\Delta + (1-e)(1-m)\lambda\theta(M)^{\gamma}(1-\eta)\frac{e\Delta}{e+(1-e)M} \tag{2}$$

where market tightness is a function of aggregate malpractice, $\theta(M) = \frac{e+(1-e)M}{(1-e)(1-M)}$. We can map the assumptions we made above for the function $\ell(m, M)$ using the current formulation. First, we have that:

$$\ell_m(m, M) = -y_m(m, M) = (1-e)\lambda\theta(M)^{\gamma}(1-\eta)\frac{e\Delta}{e+(1-e)M} > 0$$

That is, manipulation in an individual project, m, reduces the expected cash flows avoiding a profitable sale of the project.

Second, regarding the effect of aggregate malpractice, M, on the expected cash flows we get the following:

$$\begin{aligned}
&\ell_M(m, M) = -y_M(m, M) = \\
&\qquad = -\frac{(1-e)e\Delta\lambda\theta(M)^{\gamma}}{[e+(1-e)M]^2}\left[(\gamma-1)\eta + \gamma(1-\eta)\frac{1-m}{1-M} - (1-m)(1-e)(1-\eta)\right]
\end{aligned}$$

An increase in aggregate manipulation, M, has three effects on the projects' expected cash flows. First, it reduces the probability that a successful project can find a profitable match by increasing market tightness through the number of buyers. Second, it increases the probability that an unsuccessful project finds a, potentially efficient, buyer of its assets. Third, it reduces the expected surplus for unsuccessful projects since more buyers are unproductive.

A sufficient condition for $\ell_M(m, m) > 0$ is that $\eta > \gamma$. This condition—common to the matching frictions literature (see, e.g., Almazan et al., 2015)—means that a firm's malpractice decision imposes a negative externality on other firms by making less likely that successful projects can generate a surplus. More specifically, this means that a marginal increase (reduction) in the number of buyers (sellers) produces a net loss in the generation of surplus. This occurs when the matching technology has a low effectiveness at generating matches from an increase in the number of buyers of assets, relative to the proportion of the surplus that successful projects can appropriate from a match. Besides, on top of the typical mechanisms that arise in a model with matching frictions, in this model malpractice leads to a "pricing" effect by reducing the expected surplus generated by a match.

Lastly, the convexity of ℓ^* can be obtained from the following:

$$\ell^*_{mm}(m) = -y_{mm}(m, m) = (1-\gamma)(1-e)\frac{e\Delta\lambda\theta(m)^\gamma}{[e+(1-e)m]^3}\left[\frac{\gamma}{(1-m)} - 2(1-e)\right]$$

A sufficient condition for $\ell^*_{mm}(m) \geq 0$ is that $\gamma \geq 2(1-e)$, meaning that the matching function does not exhaust too early at generating matches as the number of buyers increase.

3.5 Regulatory implications

The analysis of the decentralized equilibrium considers the effect of competition for managerial talent on the governance and compensation choices of investors. Investors neglect part of the impact of their governance choices on other projects' expected cash flows, which may generate a wedge between the decentralized equilibrium and an allocation that maximizes the overall surplus in the economy.

The surplus-maximizing allocation

To dissect the differences between the *laissez-faire* and surplus-maximizing solutions, we specify the objective function of the social planner as the projects' total expected cash flows, regardless of their distribution between agents. The constrained-efficient allocation then solves:

$$\max_{\substack{(w_H, w_L)\in\mathbb{R}^2_+ \\ m\in[0,1]}} \quad ey - \ell(m,m) - g(m) \tag{3}$$

$$\text{s.t. } (1-m)(w_H - w_L) \geq \frac{B}{e} \tag{IC}$$

$$ey - \ell(m,m) - g(m) - [e+(1-e)m]w_H - (1-e)(1-m)w_L \geq R \tag{PC}$$

The problem takes into account the overall impact of manipulation on the projects' cash flows, $M = m$. The first constraint highlights that the social planner is interested in inducing effort, otherwise running projects is inefficient. The second constraint highlights that the social planner will run the project as long as it generates sufficient cash flows to cover the incentive compensation costs and the opportunity cost of funding the projects.

Proposition 3. *A unique social surplus-maximizing level of malpractice exists. There exists R^* such that the laissez-faire equilibrium levels of malpractice and bonuses are above the surplus-maximizing counterparts when $R < R^*$. The laissez-faire equilibrium levels of malpractice and bonuses coincide with the surplus- counterparts when $R \geq R^*$.*

R^* represents the maximum level of the required return R below which the social planner can attain the unconstrained maximum level of cash flows, taking into account the private and social marginal cost of malpractice. However, that level of malpractice may be unfeasible to reach given the constraints of the planner. Incentive compatibility may require a large payment to the manager, to the extent that the resources generated by projects go below the opportunity cost captured by R. Thus, for relatively high levels of R the surplus-maximizing and the laissez-faire solutions prescribe the same allocation.

For rates of return below R^*, the marginal reduction in governance costs is offset by the marginal direct reduction in cash flows due to malpractice as fully internalized by the social planner. Investors individually neglect that looser corporate governance at the individual level has a negative impact on the overall expected cash flows in the economy. Thus, reductions in R below R^* lead to exacerbated competition and to an increase in the laissez-faire intensity of malpractice that inefficiently reduces the overall surplus of the economy. Next, we discuss how different regulations on executive pay are able to restore the socially optimal allocation.

Tax solutions

Due to the presence externalities, a first candidate policy to restore efficiency in a decentralized economy consists on setting Pigovian taxes that lead investors to internalize the effect of their decisions on the overall surplus. One such policy would directly tax the degree of malpractice allowed by investors— or lack of governance. Imposing a proportional tax rate τ_m, which equates the social marginal cost of malpractice evaluated at the socially-efficient allocation, may restore efficiency. That is, the efficient allocation is achieved if $\tau_m = \ell_M(m^*, m^*)$ when $R^* < R$.

From an implementation perspective, governance, m, may be multidimensional and hard to measure. Thus, an alternative approach would consist on setting a tax on executive compensation to be paid by investors. Assume that investors must pay a fraction τ_w for any compensation received by managers. Then, the expected tax bill on managerial pay would be equal to $\tau_w(w_L + B + \frac{m}{1-m}\frac{B}{e})$. The efficient allocation can then be achieved by setting

$$\tau_w = \frac{\ell_M(m^*, m^*)(1 - m^*)^2}{B/e} \ .$$

The tax could consist on non-deductible executive compensation from the corporate tax. For instance, the U.S. tax system sets a limit of \$1 million deductible compensation for certain executives in public companies.

Personal taxes on managers can also restore the efficient level of malpractice. To see this, assume that the tax rate on executive pay is τ_p. At the surplus-maximizing level of malpractice m^* the private marginal cost of manipulation is decreasing. Thus, in a regulated equilibrium where m^* is implemented, investors only use bonuses to give incentives to managers. Thus, restoring the socially-optimal allocation implies setting τ_p such that:

$$ey - \ell(m^*, m^*) - g(m^*) - \frac{B}{(1-\tau_p)} - \frac{m^*}{(1-m^*)(1-\tau_p)}\frac{B}{e} = R$$

The disadvantage of the tax solutions above is that the negative externalities of bad governance disappear when $R > R^*$, in which case taxation is distortionary. Distorsions would take the form of lower malpractice and higher corporate governance costs than in the socially-optimal allocation. That is, the optimal tax schedules should be non-linear in R: the tax rate should equal to zero for $R > R^*$, and "activated" otherwise. We summarize the above description with the following result.

Proposition 4. *Pigovian taxes and taxes on executive pay and poor corporate governance can restore the surplus-maximizing level of malpractice if $R \leq R^*$. Tax solutions are distortionary if they are in place when $R > R^*$.*

Notice that, in the tax regulations considered above, the surplus gains relative to the decentralized solution would be appropriated fully by the tax authority. Moreover, when $R \leq R^*$, managers would see their compensation level reduced, relative to the decentralized solution, since it is increasing in m. If the social planner is interested in restoring the decentralized level of managerial compensation, part of the proceeds from taxation should then distributed to managers in a lump-sum manner, for instance, through a subsidy on fixed pay, w_L.

Regulation of the size and composition of pay

Another type of regulations, namely, quantity restrictions on managerial pay, can restore the surplus-maximizing outcome. Consider a bonus cap $w_H - w_L \leq \bar{c}$. Setting $\bar{c} = \frac{B/e}{1-m^*}$, where m^* is the surplus-maximizing level of malpractice, would attain the social planner's solution in all circumstances, even when $R > R^*$. The bonus cap limits the extent to which managers are compensated with high bonuses and loose monitoring as R decreases. Once the bonus cap is reached, investors will retain managers by offering fixed pay without affecting the social surplus. If $R > R^*$, the bonus cap is not binding, while both the decentralized and the social planner's solution will coincide as in the absence of regulation.

A minimum fixed pay regulation or a bonus ratio $w_H/w_L \leq \bar{r}$ can also attain the socially-optimal equilibrium. However, the effectiveness of both regulations takes place only for $R < R^*$. If $R \geq R^*$ the efficient equilibrium prescribes the use of no fixed pay. Thus, a minimum fixed pay or a bonus ratio requirement would imply a regulated equilibrium with stronger monitoring and greater governance costs than in the surplus-maximizing outcome. In that case, firms are forced to use a margin of competition through fixed pay that is undesirable for high R.

Proposition 5. *A bonus cap can restore the surplus-maximizing level of malpractice and the laissez-faire expected level of executive compensation. A minimum level of fixed pay and a pay ratio can also restore the surplus-maximizing level of malpractice if* $R \leq R^*$*, but are distortionary when* $R > R^*$*.*

4 Dynamic general equilibrium

In the baseline framework, we analyze the equilibrium of a static model where exogenous reductions in market rates of return shift the equilibrium level of malpractice and managerial compensation towards potentially socially inefficient levels. In this section, in the fashion of Martinez-Miera and Repullo (2017), we extend the model to a general equilibrium setting in which the aggregate supply of savings at any date is the outcome of households' saving decisions and a systematic (aggregate) shock that affects firms' profitability. The dynamic model generates additional implications and matches, from a qualitative perspective, the medium-run cyclical patterns of malpractice and compensation.

Consider an infinite-horizon economy where time is denoted by $t = 0, 1, 2, ...$ The economy features an infinitely-lived representative household that is risk averse and discounts future payoffs with the parameter $\beta \in (0, 1)$. At all dates, households determine their current level of consumption, c_t, and their level of savings taken to the next date, a_{t+1}. Let $u(c_t)$ denote the utility function of households from current consumption, which we specify as a CRRA utility function with risk aversion parameter $\sigma > 1$. The economy is also populated by a unit mass of risk-neutral managers that live in a single period and supply their managerial skills.

In the economy there exists a single consumption and investment good that is produced by firms, which are owned by households. In order to produce, firms hire managers and rent capital from households in a competitive market. Let k_t denote the units of capital that firms rent from households at time t and R_t the (gross) rental rate that firms pay in exchange.[10] Firms can succeed, in which case they yield a cash flow $z_t y k_t^{\alpha}$, or fail,

[10]For simplicity we assume full depreciation of capital. It would be straightforward to introduce a

in which case they yield 0. z_t is a systematic—i.e., economy-wide—productivity shock that determines the firms' cash flows in case of success, and $\alpha > 0$ denotes the returns to scale of the investment projects. We assume that z_t follows a stationary Markov process. Aggregate productivity shocks cannot be diversified away. This means that the household makes savings and consumption decisions in an uninsurable risk environment that leads to a precautionary motive for savings, in the sense of the models of Aiyagari (1994) and Bewley (1977). Conditional on z_t, firms' cash flows realizations are independent.

As in the baseline model, the management of firms features a double moral hazard problem. After firms undertake the investment, the manager makes an unobservable effort decision. A manager that exerts low effort obtains private benefits B and the probability of success is 0. In contrast, a manager that exerts effort increases the probability of success to e. Immediately after the effort decision, the manager obtains a signal about the profitability of the firm, $x \in \{x_L, x_H\}$. The manager can embark on malpractice and manipulate the signal when the firm does not succeed. Manipulation is successful with probability m_t. Given the signal, the manager obtains some immediate compensation. Let $w_{H,t}$ and $w_{L,t}$ denote, respectively, the levels of managerial compensation after a signal x_H and after a signal x_L. Thus, managers are hired, make effort and manipulation decisions, and consume in a single date.

Firms incur costs $g(m_t)k_t$ to reduce malpractice to a level m_t, with $g_m < 0$, $g_{mm} \geq 0$. To further discipline the model, we assume the existence of a market for liquidated assets with matching frictions as introduced in Section 3.4. We assume that a successful project that buys the k units of capital from a failed project generates a surplus of $z_t y k^\alpha$. Thus, assuming that all firms make the same investment decisions, the expected cash flows are given by a function of firm-level malpractice, m_t, and aggregate malpractice, M_t, denoted by $z_t y(m_t, M_t)k^\alpha$.[11]

The timing of the model is as follows. At the beginning of each period t, households have savings equal to a_t and the shock z_t is realized. Then, firms decide on compensation contracts to attract managers, set their governance m_t, and decide their investment k_t.

depreciation rate in the model.

[11] This assumption implies that $y(m_t, M_t)$ arises from equation (2), where $\Delta = y$.

After this, managers make effort, embark in malpractice, participate in the market for liquidated assets, and receive their compensation. Finally, production is realized and the household determines the amount dedicated for consumption, c_t, and savings, a_{t+1}.

The representative household takes as given the rental rate of capital that prevails at a given date, R_t. Hence, the household's optimal consumption and saving choices solve the following recursive problem:

$$
\begin{aligned}
V(a_t, z_t) = \max_{\substack{c_t \geq 0, \\ a_{t+1} \geq \underline{a}}} \quad & u(c_t) + \beta \mathbb{E}\big\{V(a_{t+1}, z_{t+1}) | z_t\big\} \\
\text{s.t.} \quad & a_{t+1} + c_t = R_t a_t + \Pi_t
\end{aligned}
\tag{4}
$$

where $V(a_t, z_t)$ denotes the value function given state variables (a_t, z_t), $\mathbb{E}$ denotes the expectation operator, and Π_t is the firms' cash flows generated at t, defined below. $\underline{a}$ is an exogenous lower bound on household savings that captures borrowing constraints.[12]

Firms choose the incentive compensation structure and monitoring intensity over managers, taking as given the manager's outside option U_t. Because managerial compensation is immediate, each firm needs to raise from households k_t units of capital and the compensation costs of managers, defined as

$$
W_t = W(w_{H,t}, w_{L,t}, m_t) = [e + (1-e)m_t]w_{H,t} + (1-e)(1-m_t)w_{L,t}
$$

The optimization problem of firms is:

$$
\begin{aligned}
\Pi(z_t, U_t, M_t, R_t) = \max_{\substack{(w_{H,t}, w_{L,t}) \in \mathbb{R}^2_+ \\ k_t > 0, m_t \in [0,1]}} \quad & z_t k_t^{\alpha} y(m_t, M_t) - g(m_t)k_t - (W_t + k_t)R_t \\
\text{s.t.} \quad & (1-m_t)(w_{H,t} - w_{L,t}) \geq \frac{B}{e} \\
& W(w_{H,t}, w_{L,t}, m_t) \geq U_t
\end{aligned}
\tag{5}
$$

[12] A necessary condition for optimality is that the transversality condition $\lim_{s\to\infty} \beta^s \mathbb{E}(u'(c_{t+s})a_{t+s}|z_t) = 0$ holds. This is guaranteed under sufficiently risk averse or sufficiently impatient households and a smooth function for the equilibrium rental rate as a function of savings.

Competition for managerial talent sets the expected firms' cash flows to zero:

$$\Pi(z_t, U_t, M_t, R_t) = 0 \tag{6}$$

In equilibrium, the current investment demand equates the level of household savings:

$$a_t = k_t + W_t, \tag{7}$$

which determines the equilibrium rental rate R_t. Finally, the production of the single good in the economy is

$$Y_t = z_t k_t^{\alpha} y(m_t, M_t) - g(m_t) k_t \tag{8}$$

which is distributed between household consumption and savings. Thus, equilibrium requires:

$$c_t + a_{t+1} = Y_t \tag{9}$$

Given these ingredients, the next definition of equilibrium applies.

Definition. *The equilibrium is represented by a sequence of savings decisions, managerial expected utilities, malpractice intensities, and rental rates* $\left\{\widehat{a}_t, \widehat{U}_t, \widehat{M}_t, \widehat{R}_t\right\}_{t=1}^{\infty}$*, such that, given* a_0 *and a sequence of exogenous shocks* $\{z_t\}_{t=0}^{\infty}$*:*

1. *Households solve problem* (4) *given* $\{\widehat{a}_t, \widehat{R}_t\}_{t=0}^{\infty}$ *and* $\{z_t\}_{n=0}^{\infty}$.
2. *Entrepreneurs solve problem* (5) *given* $\widehat{U}_t$, $\widehat{M}_t$, *and* $\widehat{R}_t$*for all* t.
3. *Free-entry of entrepreneurs: condition* (6) *holds for all* t.
4. *Malpractice intensities are identical across firms* $\widehat{m}_t = \widehat{M}_t$ *for all* t.
5. *The capital market clears: condition* (7) *holds for all* t.

Notice that, by Walras' Law, conditions 1-5 in the previous definition imply that the consumption market clears, i.e., condition (9) holds.

Figure 3 provides a numerical illustration of the behavior of some of the equilibrium objects and choices as a function of the current level of household savings, a_t. In the numerical exercise, we allow z_t to take three values, so that the economy can be in a "High" productivity state, a "Normal" productivity state, or a "Low" productivity state. In the figure, bold lines represent the High state periods, light grey lines represent the Normal state periods, and dotted lines represent the Low state periods. In Appendix B, we provide details on the numerical solution method of the model, which relies on a modified version of the endogenous grid method of Carroll (2006) to solve the household's Euler equation.

The top panels of Figure 3 depict the optimal household consumption and savings decisions. The top left panel illustrates how households consume more when savings increase and, across states, consume more when productivity is high. Moreover, the difference in consumption across states is higher when the household is near the borrowing limit. The top right panel shows that, beyond a certain level of savings, the household dis-saves for all the realizations of the aggregate state, which sets an endogenous upper bound on the level of savings in the economy.

The bottom left panel depicts the equilibrium rental rates, R_t. As expected, the equilibrium rates decline with the current level of household savings and also decline with the realization of z_t. That is, in the Low state, households dis-save, which puts upward pressure on the rental rate. However, the lower supply of funds is more than offset by the lower demand from entrepreneurs, which lowers the rental rates. In contrast, in High state periods, the investment demand offsets the increase in household savings putting upward pressure on R_t.

The bottom right panel depicts the aggregate level of malpractice. The general equilibrium model displays some differences with respect to the baseline model, where malpractice first increases and then remains constant after reductions in the market rates of return. Specifically, the behavior of malpractice as a function of the level of savings in the economy displays two different regimes. The figure shows that, first, for low levels of a_t, malpractice increases with savings, where managers are solely compensated through bonuses. However, the intensity of malpractice shows little variation across states. The intuition behind this behavior is that the partial-equilibrium effects of high productivity are offset by the general equilibrium determination of R_t. The rental rate increases (decreases) in the High (Low) state, which alleviates (intensifies) the effects of competition for talent.

Second, when savings are sufficiently high, the model enters into a regime where managers are compensated with a combination of short-term bonuses and fixed pay. This takes place first in periods of high productivity (high z_t) because the perceived cash flow costs of manipulation are higher than in periods of low productivity (low z_t). In contrast with the partial equilibrium setup, further increases in household savings still lead to increases in malpractice. This occurs because low interest rates boost the size of projects, k_t increases, which increases the costs of monitoring and provides dis-incentives to invest in corporate governance.

Overall, the message from Figure 3 is that malpractice will tend to be relatively more intense in periods of high cumulative savings, low interest rates, and low aggregate profitability, which all in combination lead to low rates R_t. Nevertheless, notice that in order for the economy to reach a high level of savings, it must have been through a sequence of high productivity states that allow the accumulation of savings by households. To further illustrate this, Figure 4 shows how the model generates a cyclical pattern in malpractice for a sample path of productivity shocks. Colorbars below each plot depict the aggregate shock prevailing in each period, where white areas represent High state periods, light grey areas represent Normal state periods, and black areas represent Low state periods.

The top left panel shows the evolution of household savings. Households tend to accumulate savings in the High state due to a precautionary motive. The increase in household savings puts downward pressure on the equilibrium rental rates (middle left panel). As shown above in Figure 3, High state periods the increase the demand for investment and rental rates initially increase, but the accumulation process spurred by households later put downward pressure on rental rates. The top right panel shows that, when the economy visits the Normal or Low states, households eat up their savings

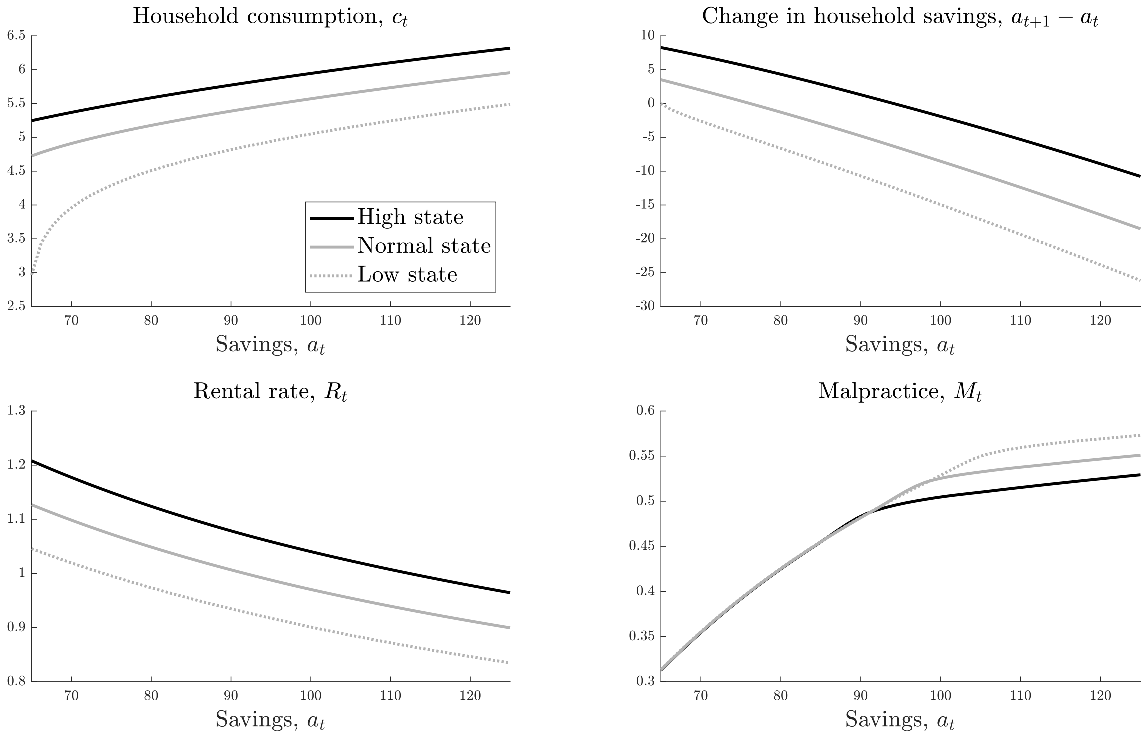

Figure 3: Dynamic general equilibrium model. The top panels depict the optimal household consumption (left panel) and saving decisions (right panel) as a function of the current level of household savings and for each state of the economy. The bottom panels depict the equilibrium rental rate (left panel) and aggregate managerial malpractice (right panel) as a function of the current level of household savings and for each state of productivity. The parameter values used in this exercise are $y = 1$, $e = 0.8$, $B = 14$, $\alpha = 2/3$, $\sigma = 3$, $\beta = 0.9$, $\underline{a} = 40$. We assume that monitoring costs have the form $g(m) = \frac{1}{2}\kappa(1-m)^2$, where $\kappa = 0.1$. The matching frictions parameters are $\lambda = 0.2$, $\gamma = 0.5$, $\eta = 0.75$. The aggregate productivity shock follows a three-state discretized version of the AR(1) model $z_t = \mu(1-\rho) + \rho z_{t-1} + \epsilon_t$, where $\mu = 7$, $\rho = 0.7$, $Var(\epsilon_t) = 0.35$. The discretization strategy follows Rouwenhorst (1995).

despite reducing their level of consumption, which puts upward pressure on rental rates. The middle right panel shows the consistency of this dynamics with the fluctuations in total output.

What are the implications of these dynamics on the level of incentive compensation and malpractice? The panels in the bottom row of Figure 4 depict the aggregate level of managerial bonuses (left panel) and the intensity of malpractice in the economy (right panel). The behavior of these variables mirrors that of output. When the economy is in the High state, firms tend to provide high compensation and allow intense malpractice by managers due to the strong competition for talent. Once the economy shifts to a Normal or Low state, the environment of low rates R_t leads to exacerbated competition for talent. The increased malpractice further contributes to the decline in output due to increased tightness and inefficient matches in the interim market for liquidated assets. However, when the economy remains in the Low state it displays large downward adjustments in managerial bonuses and malpractice.

In sum, the real-world behavior of compensation and malpractice along the business cycle can be rationalized in this dynamic general equilibrium setting with endogenous savings. The dynamic version illustrates that prolonged periods of high productivity yield low rates of return through the capital accumulation process and induce more intense malpractice through competition for managerial talent.

Figures 5 and 6 illustrate the regulatory implications of the model. Both figures show the percentage deviations of the variables of the model with respect to the surplus-maximizing allocation computed at each period. The time series are obtained from the same path of productivity shocks using for each of the three different equilibrium allocations. Figure 5 shows how the decentralized (bold) and regulated equilibria (light grey) evolve in a simulated equilibrium path of the model. The figure shows how the decentralized equilibrium tends to display lower consumption, savings, and output than the socially-optimal allocation. Firms neglect the cash flows externalities generated by malpractice, which reduces their production opportunities. Accordingly, the decentralized economy generates a lower capital accumulation capacity than the surplus-maximizing

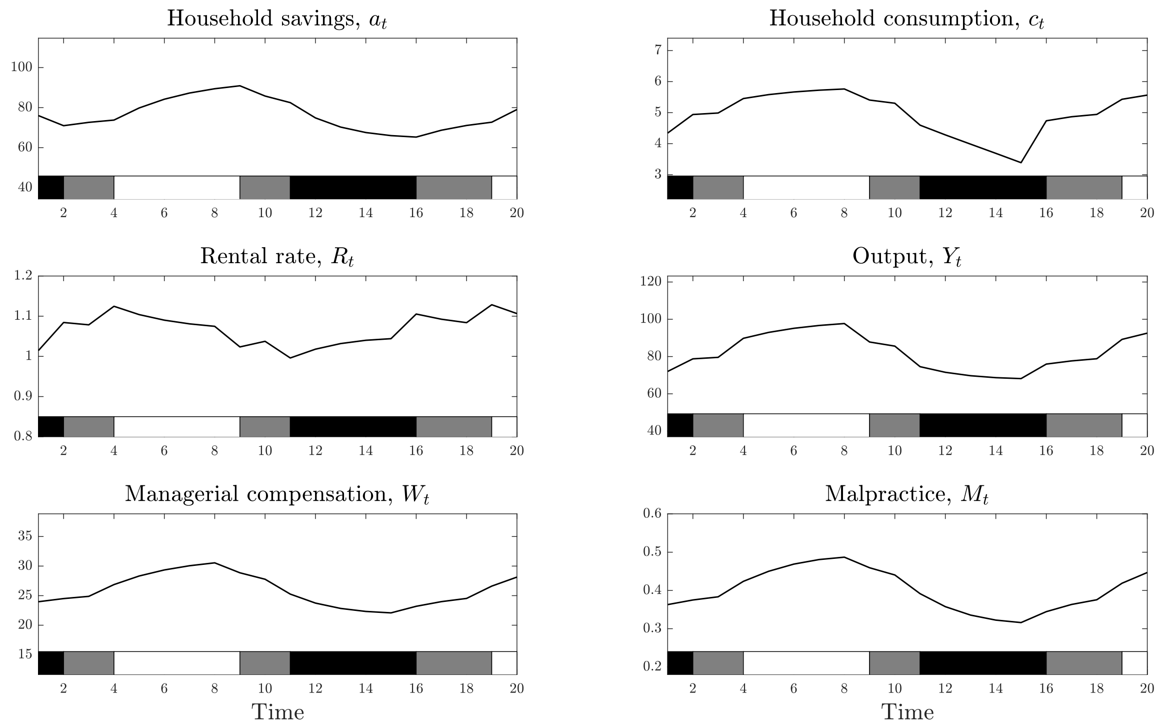

Figure 4: Dynamic general equilibrium model: Dynamics of key variables under a sample path of productivity shocks. The top panels depict the level household savings (left panel) and consumption (right panel). The middle panels depict the equilibrium rental rate (left panel) and aggregate output (right panel). The bottom panels depict the level of managerial compensation (left panel) and aggregate malpractice (right panel). Colorbars below each plot depicts the aggregate shock prevailing in each period, where white areas represent High state periods, light grey areas represent Normal state periods, and black areas represent Low state periods. The parameter values used in this exercise are $y = 1$, $e = 0.8$, $B = 14$, $\alpha = 2/3$, $\sigma = 3$, $\beta = 0.9$, $\underline{a} = 40$. We assume that monitoring costs have the form $g(m) = \frac{1}{2}\kappa(1 - m)^2$, where $\kappa = 0.1$. The matching frictions parameters are $\lambda = 0.2$, $\gamma = 0.5$, $\eta = 0.75$. The aggregate productivity shock follows a three-state discretized version of the AR(1) model $z_t = \mu(1 - \rho) + \rho z_{t-1} + \epsilon_t$, where $\mu = 7$, $\rho = 0.7$, $Var(\epsilon_t) = 0.35$. The discretization strategy follows Rouwenhorst (1995).

allocation. Notice that malpractice is more intense in the decentralized economy than in the surplus-maximizing allocation, while managerial compensation is lower due to the low total surplus.

What are the implications of introducing regulation in the economy? Figure 5 illustrates the dynamics of the regulated economy, relative to the surplus-maximizing path, when a bonus cap is introduced. As discussed above, the bonus cap is best-suited to regulate this economy since it can deal with the varying margins of decision-making by firms when competing for managerial talent. The light grey line depicts the simulated paths for each variable from using a bonus cap that is fixed across time periods, in association with a malpractice intensity of $m = 0.25$. The surplus-maximizing degree of malpractice can change over time due to the changing states of the economy, so that the "optimal" bonus cap should be also time varying. In spite of this, a constant bonus cap performs quite well in terms of narrowing the distance between the surplus-maximizing and the regulated equilibrium. Overall, consumption, savings, and output are all much closer to the surplus-maximizing allocation than the decentralized equilibrium without regulation. Moreover, malpractice and executive compensation fluctuate in line with and close to the surplus-maximizing solution.

In contrast, Figure 6 depicts the evolution of the regulated equilibrium where we set a pay ratio of $\overline{r} = 4$, where we also display the laissez-faire outcome as another benchmark. The pay ratio generates a shift in talent-attraction policies from bonuses to fixed pay. Hence, malpractice decreases, sometimes below the surplus-maximizing level as we discussed above. However, the pay ratio regulations constrain firm profitability in states of the world where R is high. Hence, consumption becomes more volatile, increasing the precautionary savings motive—savings are higher than in the surplus-maximizing allocation—and depressing rental rates. The lower rental rates spur investment, which sometimes brings total output above the surplus-maximizing solution. Notice that this is possible because we define the surplus-maximizing allocation from a static problem while, in the dynamic model, the household is forward-looking and makes savings decisions taking into account the expected effects of regulation. However, from the point of view of households, the regulated equilibrium is inferior despite the increased output: consumption is lower and more volatile than in the surplus-maximizing solution.

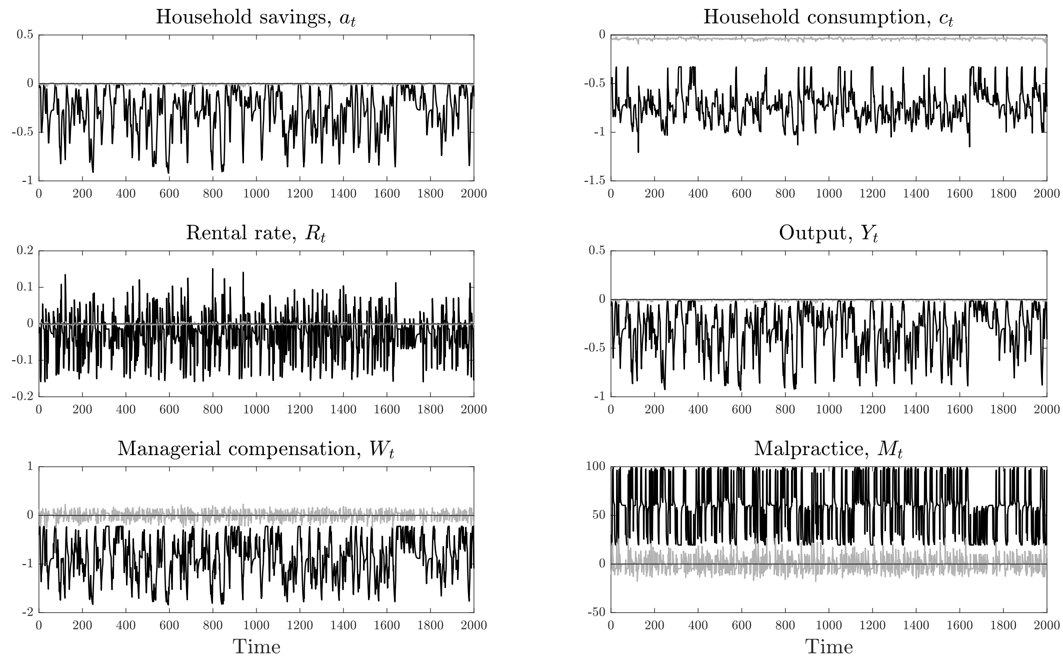

Figure 5: Dynamic general equilibrium model: Comparison of key variables among decentralized, regulated (bonus cap), and surplus-maximizing outcomes. The panels show the percentage deviations of key variables of the model in the decentralized and regulated economies relative to the surplus-maximizing allocation. We simulate the evolution of each equilibrium solution under the same path of productivity shocks. The regulated economy features a pay cap of $\overline{c} = (B/e)/0.75 = 23.3$. The top panels depict the level household savings (left panel) and consumption (right panel). The middle panels depict the equilibrium rental rate (left panel) and aggregate output (right panel). The bottom panels depict the level of managerial compensation (left panel) and aggregate malpractice (right panel). The parameter values used in this exercise are $y = 1$, $e = 0.8$, $B = 14$, $\alpha = 2/3$, $\sigma = 3$, $\beta = 0.9$, $\underline{a} = 40$. We assume that monitoring costs have the form $g(m) = \frac{1}{2}\kappa(1-m)^2$, where $\kappa = 0.1$. The matching frictions parameters are $\lambda = 0.2$, $\gamma = 0.5$, $\eta = 0.75$. The aggregate productivity shock follows a three-state discretized version of the AR(1) model $z_t = \mu(1-\rho) + \rho z_{t-1} + \epsilon_t$, where $\mu = 7$, $\rho = 0.7$, $Var(\epsilon_t) = 0.35$. The discretization strategy follows Rouwenhorst (1995).

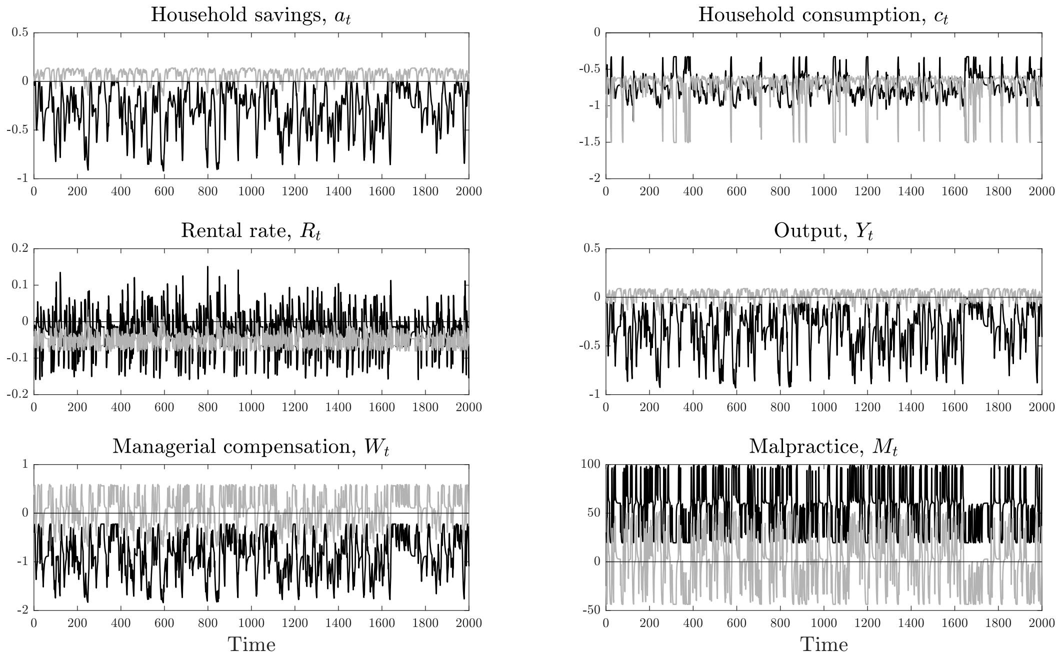

Figure 6: Dynamic general equilibrium model: Comparison of key variables among decentralized, regulated (pay ratio), and surplus-maximizing outcomes. The panels show the percentage deviations of key variables of the model in the decentralized and regulated economies relative to the surplus-maximizing allocation. We simulate the evolution of each equilibrium solution under the same path of productivity shocks. The regulated economy features a pay ratio of $\overline{r} = 4$. The top panels depict the level household savings (left panel) and consumption (right panel). The middle panels depict the equilibrium rental rate (left panel) and aggregate output (right panel). The bottom panels depict the level of managerial compensation (left panel) and aggregate malpractice (right panel). The parameter values used in this exercise are $y = 1$, $e = 0.8$, $B = 14$, $\alpha = 2/3$, $\sigma = 3$, $\beta = 0.9$, $\underline{a} = 40$. We assume that monitoring costs have the form $g(m) = \frac{1}{2}\kappa(1-m)^2$, where $\kappa = 0.1$. The matching frictions parameters are $\lambda = 0.2$, $\gamma = 0.5$, $\eta = 0.75$. The aggregate productivity shock follows a three-state discretized version of the AR(1) model $z_t = \mu(1-\rho) + \rho z_{t-1} + \epsilon_t$, where $\mu = 7$, $\rho = 0.7$, $Var(\epsilon_t) = 0.35$. The discretization strategy follows Rouwenhorst (1995).

5 Conclusions

In this paper, we provide a theoretical analysis to rationalize the cyclical behavior of managerial compensation and malpractice. In the model, competition for talent concerns limits the degree of monitoring over managers. Managerial compensation structures provide incentives to embark on malpractice that impedes an efficient allocation of capital. Malpractice and managerial compensation practices can vary along the business cycle, and may be important predictors of business cycle fluctuations. Hence, careful oversight of incentive compensation measures and corporate governance trends may provide early warnings for regulators about malpractice and economic activity. We study the role of regulatory tools that may alleviate the inefficiencies associated with malpractice, among which a bonus cap arises as the most effective.

Several extensions and directions for future research are worth mentioning. First, the dynamic general equilibrium model introduced above yields novel insights from a qualitative perspective. It would be of interest to embed the model in a more general setup that may serve as benchmark to quantify the effects of malpractice and provide guidance for policy advice. Besides, the model would yield interesting implications from an endogenous growth perspective. Productive projects may allow the accumulation of general knowledge, or innovation, that enhances the productivity of future investments. Malpractice would then reduce the process of accumulation and, perhaps, generate endogenous slowdowns in growth when the share of fraudulent projects is high enough.

Second, the model can have political economy implications. In periods with a high intensity of malpractice and with a high manipulation rate of projects will coincide with high past levels of compensation. Voters may then interpret that managers only obtain their large compensation packages out of fraudulent behavior, despite being the product of an ex-ante optimal contract designed to induce effort. Such association may increase the concerns of society about inequality or increase political unrest, which can lead to important political reforms—e.g., the form of governments—and economic reforms—e.g., tax reforms or tighter regulations.

References

Acharya, Viral, Marco Pagano, and Paolo Volpin (2016) 'Seeking alpha: Excess risk-taking and competition for managerial talent.' *The Review of Financial Studies* 29(10), 2565–2599

Acharya, Viral V., and Paolo F. Volpin (2009) 'Corporate governance externalities.' *Review of Finance* 14(1), 1

Aiyagari, S. Rao (1994) 'Uninsured idiosyncratic risk and aggregate saving.' *The Quarterly Journal of Economics* 109(3), 659–684

Albuquerque, Rui A., Luis M. B. Cabral, and Jose Guedes (2017) 'Relative performance, banker compensation, and systemic risk.' Available at SSRN: https://ssrn.com/abstract=2978003 or http://dx.doi.org/10.2139/ssrn.2978003

Almazan, Andres, Adolfo De Motta, and Sheridan Titman (2015) 'Debt, labor markets, and the creation and destruction of firms.' *Journal of Financial Economics* 118(3), 636–657

Arya, Anil, Jonathan Glover, and Shyam Sunder (1998) 'Earnings management and the revelation principle.' *Review of Accounting Studies* 3(1), 7–34

Bénabou, Roland, and Jean Tirole (2016) 'Bonus culture: Competitive pay, screening, and multitasking.' *Journal of Political Economy* 124(2), 305–370

Benmelech, Efraim, Eugene Kandel, and Pietro Veronesi (2010) 'Stock-based compensation and CEO (dis)incentives.' *The Quarterly Journal of Economics* 125(4), 1769

Bennett, Benjamin, J. Carr Bettis, Radhakrishnan Gopalan, and Todd Milbourn (2017) 'Compensation goals and firm performance.' *Journal of Financial Economics* 124(2), 307 – 330

Bergstresser, Daniel, and Thomas Philippon (2006) 'CEO incentives and earnings management.' *Journal of Financial Economics* 80(3), 511 – 529

Bewley, Truman (1977) 'The permanent income hypothesis: A theoretical formulation.' *Journal of Economic Theory* 16(2), 252 – 292

Burns, Natasha, and Simi Kedia (2006) 'The impact of performance-based compensation on misreporting.' *Journal of Financial Economics* 79(1), 35 – 67

Carroll, Christopher D. (2006) 'The method of endogenous gridpoints for solving dynamic stochastic optimization problems.' *Economics Letters* 91(3), 312 – 320

Crocker, Keith J., and Joel Slemrod (2007) 'The economics of earnings manipulation and managerial compensation.' *RAND Journal of Economics* 38(3), 698–713

Cuñat, Vicente, and Maria Guadalupe (2009a) 'Executive compensation and competition in the banking and financial sectors.' *Journal of Banking and Finance* 33(3), 495 – 504

__ (2009b) 'Globalization and the provision of incentives inside the firm: The effect of foreign competition.' *Journal of Labor Economics* 27(2), 179–212

David, Joel (2017) 'The aggregate implications of mergers and acquisitions.' Available at SSRN: https://ssrn.com/abstract=2033555 or http://dx.doi.org/10.2139/ssrn.2033555

Dicks, David L. (2012) 'Executive compensation and the role for corporate governance regulation.' *The Review of Financial Studies* 25(6), 1971

Dutta, Sunil, and Frank Gigler (2002) 'The effect of earnings forecasts on earnings management.' *Journal of Accounting Research* 40(3), 631–655

Dye, Ronald A. (1988) 'Earnings management in an overlapping generations model.' *Journal of Accounting Research* 26(2), 195–235

Edmans, Alex, Luis Goncalves-Pinto, Yanbo Wang, and Moqi Xu (2014) 'Strategic news releases in equity vesting months.' NBER Working Papers 20476, National Bureau of Economic Research, Inc, September

Edmans, Alex, Vivian W. Fang, and Katharina A. Lewellen (2017a) 'Equity vesting and investment.' *The Review of Financial Studies* 30(7), 2229–2271

Edmans, Alex, Xavier Gabaix, and Dirk Jenter (2017b) 'Executive compensation: A survey of theory and evidence.' Working Paper 23596, National Bureau of Economic Research, July

Edmans, Alex, Xavier Gabaix, Tomasz Sadzik, and Yuliy Sannikov (2012) 'Dynamic CEO compensation.' *The Journal of Finance* 67(5), 1603–1647

Financial Stability Forum (2009) 'FSB principles for sound compensation practices.' Technical Report, Financial Stability Board

Goldman, Eitan, and Steve L. Slezak (2006) 'An equilibrium model of incentive contracts in the presence of information manipulation.' *Journal of Financial Economics* 80(3), 603 – 626

Guadalupe, Maria (2007) 'Product market competition, returns to skill, and wage inequality.' *Journal of Labor Economics* 25(3), 439–474

Karuna, Christo (2007) 'Industry product market competition and managerial incentives.' *Journal of Accounting and Economics* 43(2), 275 – 297

Kedia, Simi, and Thomas Philippon (2009) 'The Economics of fraudulent accounting.' *Review of Financial Studies* 22(6), 2169–2199

Kolasinski, Adam C., and Nan Yang (2018) 'Managerial myopia and the mortgage meltdown.' *Journal of Financial Economics* 128(3), 466 – 485

Laux, Christian, and Volker Laux (2009) 'Board committees, CEO compensation, and earnings management.' *The Accounting Review* 84(3), 869–891

Laux, Volker (2014) 'Pay convexity, earnings manipulation, and project continuation.' *The Accounting Review* 89(6), 2233–2259

Laux, Volker, and Phillip C. Stocken (2012) 'Managerial reporting, overoptimism, and litigation risk.' *Journal of Accounting and Economics* 53(3), 577 – 591

Li, Victor E. (2018) 'Search, financial market frictions, and monetary transmission.' *Journal of Money, Credit and Banking* 50(8), 1935–1968

Martinez-Miera, David, and Rafael Repullo (2017) 'Search for yield.' *Econometrica* 85(2), 351–378

Narayanan, M P (1985) 'Observability and the payback criterion.' *The Journal of Business* 58(3), 309–323

Pagano, Marco, and Giovanni Immordino (2012) 'Corporate fraud, governance, and auditing.' *The Review of Corporate Finance Studies* 1(1), 109

Peng, Lin, and Ailsa Röell (2014) 'Managerial incentives and stock price manipulation.' *The Journal of Finance* 69(2), 487–526

Perotti, Enrico C, and Javier Suarez (2011) 'A pigovian approach to liquidity regulation'

Philippon, Thomas, and Ariell Reshef (2012) 'Wages and Human Capital in the U.S. Finance Industry: 1909–2006.' *The Quarterly Journal of Economics* 127(4), 1551–1609

Rhodes-Kropf, Matthew, and David T. Robinson (2008) 'The market for mergers and the boundaries of the firm.' *The Journal of Finance* 63(3), 1169–1211

Rouwenhorst, K. Geert (1995) 'Asset pricing implications of equilibrium business cycle models.' In *Frontiers of Business Cycle Research,* ed. T.F Cooley (Princeton University Press) pp. 294–330

Sakalauskaite, Ieva (2017) 'Bank risk-taking and misconduct.' (Unpublished)

Stein, Jeremy C. (1988) 'Takeover threats and managerial myopia.' *Journal of Political Economy* 96(1), 61–80

Stein, Jeremy C. (1989) 'Efficient capital markets, inefficient firms: A model of myopic corporate behavior.' *The Quarterly Journal of Economics* 104(4), 655–669

Thanassoulis, John (2012) 'The case for intervening in bankers' pay.' *The Journal of Finance* 67(3), 849–895

Thanassoulis, John (2014) 'Bank pay caps, bank risk, and macroprudential regulation.' *Journal of Banking & Finance* 48, 139–151

Thanassoulis, John, and Misa Tanaka (2017) 'Optimal pay regulation for too-big-to-fail banks.' *Journal of Financial Intermediation*

The Financial Crisis Inquiry Commission (2011) *The Financial Crisis Inquiry Commission Report: Final Report of the National Commission on the Causes of the Financial and Economic Crisis in the United States* (Washington, DC: U.S. Government Printing Office)

A Proofs

Proof of Proposition 1

First, notice that it is optimal to minimize the difference $w_H - w_L$ until the incentive-compatibility condition binds, otherwise it would be optimal to reduce w_H since it unambiguously reduces the costs for investors.

Next, consider a situation where the participation constraint of the manager does not bind. Setting $\widehat{w}_L = 0$ is optimal because w_L represents a plain cost to investors without contributing to incentives. The optimal bonus will be given by $\widehat{w}_H = \frac{B/e}{(1-\widehat{m})}$, where $\widehat{m}$ solves:

$$\widehat{m} = \arg \min_{m \in [0,1]} \; \ell(m, M) + \frac{m}{1-m}\frac{B}{e} + g(m) \tag{A.1}$$

The first order condition to the problem is given by

$$\ell_m + \frac{B/e}{(1-m)^2} + g_m = 0 \; . \tag{A.2}$$

Let m_0 denote the solution to the previous equation. We know that $m_0 > 0$ since $\lim_{m \to 0} g_m = -\infty$ and $m_0 < 1$ since $\ell_m > 0$, $\lim_{m \to 1} \frac{B/e}{(1-m)^2} = \infty$, and $g'(1) = 0$. m_0 is unique since equation (A.2) is globally convex. Moreover, the participation constraint is not binding as long as the solution m_0 to (A.2) satisfies

$$m_0 \geq \frac{U - B}{U - B(1 - 1/e)} \; .$$

Thus, U_0 is defined as

$$U_0 = \frac{e + (1-e)m_0}{1 - m_0}\frac{B}{e} \; .$$

This means that if $U < U_0$, $\widehat{m} = m_0$.

Next, consider the case in which the participation constraint of the manager binds. Together with the incentive-compatibility constraint, we can solve for $w_H - w_L$ and transform the original problem into

$$\min_{(m,w_L)\in[0,1]\times\mathbb{R}_+} \quad \ell(m,M)+U+g(m)$$
$$\text{s.t. } \; U = w_L + \frac{e+(1-e)m}{1-m}\frac{B}{e}$$

Let m_1 denote the solution to $\min_{m\in[0,1]} \ell(m,M)+g(m)$, where it is easy to check that $m_1 > m_0$. m_1 is below one, since $\ell_m(m,M) > 0$ and $g_m(1) = 0$, and unique since the problem is convex. Then, if $U > U_1 = \frac{e+(1-e)m_1}{1-m_1}\frac{B}{e}$ it is optimal to set $\widehat{m} = m_1$ and adjust w_L until the participation constraint binds, yielding $\widehat{w}_L$. The expression for $\widehat{w}_H$ follows from the incentive compatibility condition.

Finally, for $U \in (U_0, U_1)$ the solution to the problem is to increase m up to the point where the participation constraint binds. This is optimal because the objective function is increasing in m. It is optimal to set $w_L = 0$, which allows to increase m and increase the value of the objective function. The optimal level of manipulation $\widehat{m}$ then solves

$$\widehat{m} = \frac{U-B}{U-B(1-1/e)}$$

and the optimal bonus is given by $\widehat{w}_H = \frac{B/e}{(1-\widehat{m})}$. ■

Proof of Proposition 2

First, there exists a unique equilibrium of $\widehat{m}_1$ that arises from the solution to

$$\ell_m(\widehat{m}_1,\widehat{m}_1)+g_m(\widehat{m}_1) = 0 \tag{A.3}$$

Uniqueness arises from the fact that

$$\lim_{m\to 0}\ell_m(m,m)+g_m(m) = -\infty$$
$$\lim_{m\to 1}\ell_m(m,m)+g_m(m) > 0$$
$$\ell_{mm}(m,m)+\ell_{mM}(m,m)+g_{mm}(m) > 0$$

That is, equation (A.3) is monotonically increasing in m. Then, the equilibrium features an intensity of manipulation exactly equal to $\widehat{m}_1$ as long as

$$ey - \ell(\widehat{m}_1, \widehat{m}_1) - B - \frac{\widehat{m}_1}{1-\widehat{m}_1}\frac{B}{e} - g(\widehat{m}_1) > R \tag{A.4}$$

in which case the equilibrium bonus is $\widehat{w}_H - \widehat{w}_L = \frac{B/e}{1-\widehat{m}_1}$, and the equilibrium fixed pay is $\widehat{w}_L = ey + \ell(\widehat{m}_1, \widehat{m}_1) - g(\widehat{m}_1) - R - \frac{B/e}{1-\widehat{m}_1}$. The equilibrium managerial outside option is:

$$\widehat{M} = \widehat{m}_1$$
$$\widehat{U} = ey - \ell(\widehat{m}_1, \widehat{m}_1) - g(\widehat{m}_1) - R$$

If condition (A.4), the equilibrium intensity of manipulation satisfies:

$$ey - \ell(\widehat{m}, \widehat{m}) - B - \frac{\widehat{m}}{1-\widehat{m}}\frac{B}{e} - g(\widehat{m}) = R$$

with $\widehat{U} = ey - \ell(\widehat{m}, \widehat{m}) - g(\widehat{m}) - R$. $\widehat{R}$ is defined as:

$$\widehat{R} = ey - \ell(\widehat{m}_1, \widehat{m}_1) - B - \frac{\widehat{m}_1}{1-\widehat{m}_1}\frac{B}{e} - g(\widehat{m}_1)$$

■

Proof of Proposition 3

The social planners' solution is given by the smaller between (i) the highest level of m that makes the resource constraint binding and (ii) the solution m_1^* to the first order condition:

$$\ell_m^*(m_1^*) + g_m(m_1^*) = 0 \tag{A.5}$$

There is a unique m_1^* since

$$\lim_{m\to 0} \ell_m^*(m) + g_m(m) = -\infty$$
$$\lim_{m\to 1} \ell_m^*(m) + g_m(m) > 0$$
$$\ell_{mm}^*(m) + g_{mm}(m) > 0$$

We define R^* as:

$$R^* = ey - \ell(m_1^*, m_1^*) - B - \frac{m_1^*}{1-m_1^*}\frac{B}{e} - g(m_1^*)$$

For $R \geq R^*$, the resource constraint binds and both the laissez-faire and social planner solutions are identical. For $R < R^*$, notice that m_1^* is smaller than the laissez-faire equilibrium threshold $\widehat{m}_1$, from equation (A.3), since:

$$\ell_m^*(\widehat{m}_1) + g_m(\widehat{m}_1) > \ell_m(\widehat{m}_1, \widehat{m}_1) + \ell_M(\widehat{m}_1, \widehat{m}_1) + g_m(\widehat{m}_1) > \ell_M(\widehat{m}_1, \widehat{m}_1) > 0$$

Therefore, the social surplus is decreasing in m at $\widehat{m}_1$, meaning that the laissez-faire solution is higher than the surplus-maximizing solution for $R < R^*$. ■

B Solving the dynamic general equilibrium model

The solution method for the equilibrium model relies on a modified version of the endogenous grid method of Carroll (2006). From the household problem (4) we obtain the Euler equation:

$$u_c(c_t) = \beta \mathbb{E}\big\{R_{t+1} u_c(c_{t+1})\big\} \ .$$

The solution method consists on finding a decision rule for consumption as a function of the current state (a_t, z_t). That is, the method finds a function of the form $c_t = g_0^c(a_t, z_t)$. If the representative household behaves tomorrow according to this rule, given R_{t+1} we can find consumption today:

$$c_t = u_c^{-1}\bigg(\beta \mathbb{E}\big\{R_{t+1} u_c(g_0^c(a_{t+1}, z_{t+1})|z_t\big\})\bigg)$$

Then, we can build a guess for c_t as a function of future savings and current shock (a_{t+1}, z_t). We can define a grid on a_{t+1} as $A \equiv \{a_1, a_2, ..., a_{n_a}\}$ with $a_1 = \underline{a}$ and a_{n_a} large enough. Given a discrete representation of the shocks $Z \equiv \{z_1, ..., z_{n_z}\}$ with transition matrix Γ we can obtain the following guess:

$$c = \tilde{g}_0^c(a_i, z_j) = u_c^{-1}\left(\beta \sum_{l=1}^{n_z} \Gamma(z_l, z_j) R(a_i, z_l) u_c(g_0^c(a_i, z_l)\right)$$

where in equilibrium the market rate of return is a function of the following period's level of savings and the realized productivity. The decision rule $\tilde{g}_0^c(a_i, z_j)$ tells us the optimal consumption decision today given that the household has savings a_i tomorrow and the current shock is z_j. From the budget constraint we can recover the current level of assets consistent with the decision $\tilde{g}_0^c(a_i, z_j)$, defined as $a_{i,j}^*$:

$$\Pi(a_{i,j}^*, z_j) + R(a_{i,j}^*, z_j) a_{i,j}^* = \tilde{g}_0^c(a_i, z_j) + a_i$$

where $R(a^*_{i,j}, z_j)$ arises from the market-clearing condition (7), where the supply of savings is $a^*_{i,j}$. We can exploit that $\Pi(a, z) + R(a, z)a = Y(a, z)$, where $Y(a, z)$ is total output minus monitoring costs. Hence, we obtain:

$$Y(a^*_{i,j}, z_j) = \tilde{g}^c_0(a_i, z_j) + a_i$$

We can solve for $a^*_{i,j}$ using a non-linear equation solver. Instead of computing $Y(a^*_{i,j}, z_j)$ at all iterations, we can compute $Y(a_i, z_j)$ beforehand and then interpolate this function at the point $a^*_{i,j}$ at each iteration.

Notice that now we have a new guess $g^c_1(a^*_{i,j}, z_j) = \tilde{g}^c_0(a_i, z_j)$. In order to obtain the guess g^c_1 at the original points (a_i, z_j) we first need to take into account that $a^*_{1,j}$ denotes the largest level of current savings for which the borrowing constraint binds when the shock is z_j. Thus, when $a_i \leq a^*_{1,j}$ households hit the borrowing constraint, which means that today's consumption is given by

$$g^c_1(a_i, z_j) = Y(a_i, z_j) - a_1$$

For $a_i > a^*_{1,j}$ we can interpolate on A using the guess $g^c_1(a^*_{i,j}, z_j)$. Finally, we iterate by setting $g^c_0(a_i, z_j) = g^c_1(a_i, z_j)$ and repeating until convergence is achieved.

To obtain $R(a^*_{i,j}, z_j)$, first we compute the optimal choice of k_t from problem (5):

$$k = k(m, M) = \left[\frac{z_j y(m, M)}{g(m) + R}\right]^{\frac{1}{1-\alpha}}$$

The firms' problem reduces to:

$$\begin{aligned}
\Pi(z, U, M) = \max_{\substack{(w_H, w_L) \in \mathbb{R}^2_+ \\ m \in [0,1]}} \quad & zk(m, M)^\alpha y(m, M) - g(m)k(m, M) - (W + k(m, M))R \\
\text{s.t.} \quad & (1 - m)(w_H - w_L) \geq \frac{B}{e} \\
& W \geq U \\
& W = [e + (1 - e)m]w_H + (1 - e)(1 - m)w_L
\end{aligned}$$

Setting, $m = M$, let m_1 denote the solution to:

$$zk(m,m)^{\alpha}y_m(m,m) - g'(m)k(m,m) = 0$$

m_1 is the privately-optimal level of malpractice if

$$zk(m_1,m_1)^{\alpha}y(m_1,m_1) - g(m_1)k(m_1,m_1) - k(m_1,m_1)R - B - \frac{m_1}{1-m_1}\frac{B}{e} \geq 0$$

in which case $U = zk(m_1,m_1)^{\alpha}y(m_1,m_1) - g(m_1)k(m_1,m_1) - k(m_1,m_1)R$. Otherwise, the level of malpractice arises from:

$$zk(m,m)^{\alpha}y_m(m,m) - g'(m)k(m,m) - \frac{B/e}{(1-m)^2}R = 0$$

in which case, $U = B + \frac{m}{1-m}\frac{B}{e}$. From this algorithm, we obtain implicit functions $U(R)$ and $k(R)$. Given the grid $A \equiv \{a_1, a_2, ..., a_{n_a}\}$ we can iterate on R in order to find $R(a_i, z_j)$, implicitly defined from:

$$a_i = k(R(a_i,z_j)) + U(R(a_i,z_j))$$

We obtain $R(a^*_{i,j}, z_j)$ through interpolation.