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Managerial Incentives, Capital Reallocation, and the Business Cycle

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Abstract

This paper argues that when managers have private information about how productive assets are under their control and receive private benefits, substantial bonuses are required to induce less productive managers to declare that capital should be reallocated. Moreover, the need to provide incentives for managers to relinquish control links aggregate capital reallocation to executive compensation and turnover over the business cycle. Capital reallocation and managerial turnover are procyclical if expected managerial compensation increases with the number of managers hired. The agency problem between owners and managers makes bad times worse because capital is less productively deployed when agency costs render reallocation too costly. Empirically we find that both CEO turnover and executive compensation are remarkably procyclical.

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Managers play an important role in the decision to reallocate capital because they are likely to have private information about how productive assets are under their control. Moreover, their incentives to redeploy capital may differ significantly from those of the owners of the assets. Owners desire to allocate assets to their most productive use. Managers, on the other hand, prefer to keep assets under their control even if they may not be the most productive managers of those assets.[1] In order for productive reallocation to take place as soon as it becomes possible managers must willingly participate in the decision to reallocate assets. We study the agency problem between owners and managers in order to understand how the compensation required to induce managers to reveal that they should be downsized affects whether and when capital reallocation takes place.

Specifically, we study a model where a representative investor needs to hire managers to run projects. Managers privately observe how productive capital is under their control and need to be given incentives to reveal this productivity to enable value-increasing reallocation. But managers get private benefits from control and hence need to be compensated for the loss in private benefits when they relinquish control in order for them to have an incentive to announce their productivity truthfully. Thus, reallocation requires paying large bonuses to unproductive managers and hence may not always be in the best interest of the investor. In good times, when the compensation required to recruit managers is high, such bonuses can be financed by reducing cash compensation to high productivity managers who receive additional capital and the associated private benefits. However, in bad times, when expected compensation is low, such payments must be financed by the investor. Hence, reallocation is more costly from the investor's perspective in bad times, and as a result the investor may forgo reallocation and the associated productivity gains.

Our model has three main implications for capital reallocation: First, reallocation requires paying incentivizing bonuses to unproductive managers. Second, the need to provide incentives for managers to let go links aggregate capital reallocation to aggregate managerial compensation and turnover. Finally, aggregate capital reallocation

[1]See Jensen (1986, 1993) for models of empire building. See also Stulz (1990) and Hart and Moore (1995) for related models of capital structure decisions when managers are reluctant to pay out resources.

and managerial compensation and turnover are procyclical due to countercyclical agency costs. We discuss each of these in more detail below.

Substantial bonuses must be paid to unproductive managers to incentivize them to reveal that capital should be reallocated away from them. Clearly, there is considerable controversy in the popular press over paying big bonuses to managers who are being downsized. Recent work by Hartzell, Ofek, and Yermack (2004) finds that target CEOs in negotiated mergers on average experience a wealth gain of ten to sixteen times their annual pre-merger compensation. Paying bonuses to someone who will no longer affect the firm's prospects seems gratuitous. In fact, such bonuses reward poor performance and thus have adverse incentive effects. But these bonuses serve an important purpose by providing incentives to managers to reveal bad news about productivity early, in time to enable productive reallocation.[2] Consistent with this idea, Heitzman (2006) finds that equity grants to target firm CEOs are typically largest in the year before an acquisition and provides evidence that equity awards are used to compensate the CEO for his expected loss from selling the firm. He concludes that "equity awards to the target CEO reflect the CEO's and board's information and incentives relating to the upcoming acquisition consistent with shareholder value maximization." Harford (2003), in an interesting study of target directors' incentives, finds that the financial impact on outside directors of a completed merger is predominantly negative. Moreover, he reports that when Bank of America merged into Nationsbank, Bank of America directors received a cash bonus of $300,000 which officials explained as follows: "the purpose also was to thank people who had, after all, voted themselves out of a job by approving the merger" (*Wall Street Journal*, Feb. 10, 1999, B1). Thus, it may be the coalition of high level executives, including the CEO, and board members, which jointly learns about the productivity of capital and requires incentives to suggest redeployment of capital elsewhere.[3] Relatedly,

[2]Our model abstracts from the ex ante incentive cost of bonuses received by unproductive managers. This tradeoff has been considered by Levitt and Snyder (1997) and Povel (1999).

[3]Schwert (2000) finds that deals described as hostile are not distinguishable from friendly deals in economic terms. Thus, information provided by the target management team may play a role in both types of deals. Indeed, the informational advantage of incumbent management is the source of their power and entrenchment in our model.

Harris and Raviv (1990) study the role of debt when "managers are reluctant to relinquish control and unwilling to provide information that could result in such an outcome." In a similar spirit, Levitt and Snyder (1997), in a study of the flow of information within organizations, show that "to elicit early warning, contracts must reward agents for coming forward with bad news."[4]

A second, related implication of our model is that variation in managerial compensation is linked to variation in the amount of capital reallocation; big bonuses are associated with large reallocations. Indeed, we will provide empirical evidence that managerial compensation and CEO turnover are strongly procyclical and that managerial compensation and managerial turnover are highly correlated. The focus in the literature studying executive compensation and reallocation is on the compensation of the bidding CEO.[5] Our model suggests that the compensation of target CEOs may also increase around the time of an acquisition, and that the fact that the target CEO must be compensated for being downsized may influence whether such transactions occur. Thus, CEOs of bidding and target firms face competing incentives. It is not obvious whose incentives are stronger, managers seeking to grow assets under their control or managers seeking to hold on to their assets. Indeed, there is a large literature on takeover resistance.[6] The effect of managerial incentives on the disinvestment decisions of a single manager has been studied by Boot (1992).[7] He

[4]See also Povel (1999), who argues that "it may pay if the creditors are forgiving in bankruptcy, thereby inducing the revelation of difficulties as early as possible." Hertzberg (2003) studies a model where managers attempt to hide low intermediate date cash flow realizations in a dynamic business cycle model which generates slow booms and rapid recessions.

[5]Many papers examine the relationship between acquisitions and bidding CEO compensation; see, for example, Benston (1985), Lambert and Larcker (1987), Avery, Chevalier, and Schaefer (1998), Khorana and Zenner (1998), Bliss and Rosen (2001), Datta, Iskandar-Datta, and Raman (2001), Grinstein and Hribar (2004), and Harford and Li (2005). In contrast, as noted in Agrawal and Walkling (1994), prior to their study only Martin and McConnell (1991) had examined target manager compensation around merger and acquisition events, although Hartzell, Ofek, and Yermack (2004) and Heitzman (2006) are a notable recent exception as is Harford (2003) on target director compensation.

[6]For example, both Walkling and Long (1984) and Cotter and Zenner (1994) provide evidence that managerial resistance to takeovers is negatively related to the effect of the takeover on target managers' wealth.

[7]Empirically, Mehran, Nogler, and Schwartz (1998) investigate CEOs' incentives to liquidate

studies the role of takeovers in a model where unskilled managers might be reluctant to divest projects which are unproductive in their hands, because this would partially reveal their lack of ability. In related work, Almazan and Suarez (2003) study the role of severance pay and managerial entrenchment in optimal replacement decisions of CEOs,[8] and Inderst and Müller (2006) study the role of severance pay and in particular options compensation in providing CEOs with incentives to exit. Our paper builds on the firm level intuition developed in these papers in order to study how the microeconomic contracting friction between owners and managers interacts with macroeconomic conditions to affect aggregate capital reallocation.

The focus of our study is the reallocation of capital across firms, but the economic nature of the incentive problem of reallocating capital across divisions within the firm is closely related. See, for example, Bernardo, Cai, and Luo (2004) for a model where managerial compensation is designed to mitigate agency problems in allocating resources within a multi-division firm.[9] Our model would imply that the total compensation of managers within a firm may be an important determinant of the capacity for intra-firm capital reallocation. In this context it is interesting to note that CEO turnover not related to mergers and acquisitions is also procyclical, although less so than external turnover.

Finally, our theory implies that the reallocation of capital is procyclical due to the procyclical nature of the compensation which managers require. In good times, the higher average cash compensation to managers enables the investor to charge the high productivity managers for the private benefits associated with the additional

their firms and conclude that the extent of CEOs' incentive compensation, in terms of the fraction of shares held by the CEO and the exposure of the CEO through options, increases the probability of voluntary liquidations. Hite, Owers, and Rogers (1987) and Kim and Schatzberg (1987) document that interfirm asset sales and voluntary corporate liquidations seem to imply a value-improving reallocation of resources.

[8]In a related paper, Harris (1990) studies shareholder welfare in the presence of golden parachutes and anti-takeover measures.

[9]Papers which study the incentive issues in capital budgeting with multiple projects or divisions and in internal capital markets include Stein (1997), Harris and Raviv (1998), Scharfstein and Stein (2000), De Motta (2003), and Bernardo, Luo, and Wang (2006). Relatedly, Brusco and Panunzi (2005) study the reallocation of capital across divisions in a model where managers require incentives to provide effort and derive utility from capital under their control.

capital they receive and this reduces the cost of reallocation borne by the investor. In contrast, in bad times required compensation is low, and the bonuses necessary to induce reallocation must be financed by the investor. This inhibits reallocation in bad times since the reallocation cost borne by the investor is higher. Thus, heterogeneity in productivity makes bad times worse because less reallocation implies that capital is less efficiently deployed. This is despite the fact that productivity gains from reallocation do not vary procyclically. As a result, the agency problem between owners and managers induces endogenous variation in productivity over the business cycle. Aggregate productivity from the perspective of the representative investor is determined by three elements: the exogenous aggregate productivity shock, the endogenous distribution of capital across high and low productivity managers, and the endogenous share of output which goes to the investor rather than the managers. The procyclical nature of capital reallocation has been documented in Eisfeldt and Rampini (2006), which shows that not only acquisitions, but also asset sales, are procyclical. It is also shown there that, in contrast, the benefits to reallocation, measured as the cross-sectional dispersion of the productivity of capital, appear countercyclical. This suggests that the frictions impeding reallocation are considerably countercyclical.

We argue that the contracting friction of having to provide managers with incentives to relinquish control results in countercyclical reallocation frictions. While there is an extensive literature on the interaction between informational and contracting frictions and aggregate economic conditions,[10] the focus of this literature is on the impact of these frictions on new investment rather then on the reallocation of existing capital.[11] Since reallocation always implies investment by one party and dis-

[10]See, for example, Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Rampini (2004).

[11]Exceptions which explicitly consider the reallocation of existing assets include Shleifer and Vishny (1992), who study the impact of the value of assets which are reallocated on debt capacity ex ante, and Eisfeldt (2004), who shows that the amount of adverse selection in the market for existing assets might vary countercyclically and hence reduce reallocation in bad times. An alternative to reallocating capital or projects themselves is to reallocate the funds required for investment across borrowers instead. This problem has been studied more extensively in the literature, e.g., by Holmström and Tirole (1998) and Caballero and Krishnamurthy (2001). See also Gorton and Huang (2004), who allow for both reallocation of funds and projects.

investment by another, credit constraints per se do not necessarily imply procyclical reallocation.

The paper proceeds as follows. Section 1 provides some stylized facts regarding the cyclical properties of capital reallocation as well as new empirical evidence on the cyclical properties of CEO turnover and executive compensation. Section 2 discusses the problem of a representative investor providing incentives for managers to relinquish control and reallocate capital in a model with three dates. The three date economy develops the link between agency problems, managerial compensation, and capital reallocation. Section 3 embeds this three date economy into a dynamic infinite horizon economy in order to examine the implied business cycle properties for capital reallocation. A calibrated version of this model is also provided. Section 4 discusses several extensions, including managerial effort, private benefits which depend on output, and the role of managers' ex post outside options. We show that if managers' outside options deteriorate in recessions they are more reluctant to let go and thus require more compensation to do so. This renders capital reallocation even more costly in bad times. Section 5 concludes.

1 Stylized Facts

We start by reviewing some of the stylized facts regarding the cyclical properties of capital reallocation and then provide some new evidence regarding the cyclical properties of CEO turnover and executive compensation.

1.1 Capital Reallocation and the Business Cycle

Eisfeldt and Rampini (2006) show that capital reallocation is procyclical while the benefits to reallocation in terms of potential productivity gains are not. The correlation between the cyclical component of capital reallocation and GDP is 0.64 and is highly significant.[12] Measures of the cross-sectional dispersion in productivity in contrast seem countercyclical.

[12] See Eisfeldt and Rampini (2006), Table 2, for details.

Related findings about the business cycle properties of capital reallocation can be found in, for example, Maksimovic and Phillips (2001), who show that the fraction of plants which change hands per year is higher in expansion years than in recession years. There is also an extensive literature on mergers and merger waves (see, e.g., Andrade, Mitchell, and Stafford (2001) and Holmström and Kaplan (2001) for recent surveys), but theories of merger waves do not address the broadly procyclical nature of capital reallocation. See Shleifer and Vishny (2003), Rhodes-Kropf and Viswanathan (2004), and Rhodes-Kropf, Robinson, and Viswanathan (2005) for theories and evidence relating variation in aggregate merger activity to valuation waves. Harford (2005) finds that an aggregate credit spread measure has additional predictive power for merger activity.[13]

1.2 CEO Turnover, Executive Compensation, and the Business Cycle

Murphy (1999), in a survey of the executive compensation literature, and Bebchuk and Grinstein (2005) document many stylized facts about the cross section of executive compensation as well as the substantial increase in the level of compensation in recent years. The focus of the literature is typically on the growth of executive compensation, i.e., the trend component. In contrast, we provide evidence on the cyclical component of CEO turnover and executive compensation. We find the following new stylized fact: CEO turnover and executive compensation are remarkably procyclical. The correlation between CEO turnover and output is 0.82 and the correlation between executive compensation and output is around 0.9. Furthermore, the correlation between CEO turnover and executive compensation exceeds 0.9 in most cases.

For CEO turnover we use new data from Kaplan and Minton (2006) who report the percentage turnover of CEOs in publicly traded *Fortune* 500 companies due to mergers and acquisitions and delistings from a major stock exchange for 1992 to 2005. They consider a CEO to have turned over if his or her company was taken over by

[13]For a more detailed discussion of the empirical literature on capital reallocation see Eisfeldt and Rampini (2006).

another company and he or she is not the CEO of the combined firm.[14] We compute the deviations from trend using the Hodrick and Prescott (1997) filter and report the contemporaneous correlation of the cyclical component of CEO turnover and GDP. The results are summarized in Table 1. The correlation of CEO turnover and GDP is 0.818 and is significant at the 5% level. Indeed, all our estimates are significant at the 5% level or higher. Given the relatively short time series it is notable that the correlations are estimated this precisely and our estimates are so highly statistically significant.

The executive compensation data is from Bebchuk and Grinstein (2005) for the years 1993 to 2003. They report the mean compensation levels for CEOs and the top 5 executives in firms that belong to three sub-groups of the S&P 1500 index, namely the S&P 500 index, the Mid-Cap 400, and the Small-Cap 600.[15] Compensation is defined as the sum of salary, bonus, total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long term incentive payouts and other compensation. Compensation for the top 5 executives is the sum of the five largest compensation packages for the firm in a given year. For firms in the S&P 1500 index, the correlation between CEO pay and output is 0.91 and the correlation between the compensation of the top 5 executives and output is 0.92. These are, we think, strikingly high. The results for firms in the three sub-indexes, the S&P 500, Mid-Cap 400, and Small-Cap 600, are similarly high. The correlations are a bit lower for the smaller firms, but still 0.70 or higher and significant at the 5% level or higher. Figure 1 illustrates the striking relationship between output and both CEO turnover

[14] We use data from Table 2 in their paper. Kaplan and Minton (2006) also report standard or internal turnover, which is turnover of the CEO that is not due to a merger or delisting. Interestingly, such turnover is also procyclical (with a correlation with output of 0.54) and positively correlated with executive pay (with a correlation of 0.51), but these correlations are not significant. Similar evidence is reported by Mikkelson and Partch (1997). They find that complete turnover of the president, CEO, and board chair is much higher during the active takeover period than during a less active period (23% vs. 16% for 1984-1988 and 1989-1993, respectively) in firms which are *not* acquired. Turnover of the CEO is 39% in the active period and 34% in the less active period. In firms in the lowest quartile of performance, the rate of complete turnover drops from 33% in the active period to 17% in the less active period.

[15] See Bebchuk and Grinstein (2005), Table 1.

and executive compensation.

In order to investigate the relationship between CEO turnover and compensation more directly, we also compute the direct correlation between CEO turnover and the various measures of executive pay. The correlation between the deviations from trend of CEO turnover and the deviations from trend of executive pay are between 0.78 and 0.96, with most of our estimates above 0.9, and are very highly statistically significant (see Panel B of Table 1). The comovement of executive turnover and compensation at the business cycle frequency is hence substantial.[16]

To sum up, there is substantial procyclical variation in capital reallocation on the one hand, as previously documented, and in CEO turnover and executive compensation on the other hand, as documented here. Our model provides an explanation consistent with these stylized facts.

2 Incentives for Relinquishing Control

In this section we study the problem of a risk averse representative investor who has access to projects and has the means to finance them, but does not have the skill to run them. Thus, the investor must hire managers to run any projects in which he chooses to invest. Managers get private benefits from the capital under their control. Furthermore, managers privately observe at an intermediate date whether capital under their control will be productive or not. At the intermediate date, capital can be reallocated across managers. In this section we study the one period problem of hiring managers and providing them with incentives to declare the productivity of capital under their control truthfully and to agree to the redeployment of the capital prior to production if desirable. In the next section, we will embed this problem in a dynamic model in order to study the effect of this agency problem on capital reallocation over the business cycle.

[16]Kaplan and Minton (2006) note that the period in which CEO pay increased substantially coincides with a period in which CEO turnover increased substantially, and argue that the fact that CEOs' jobs have become riskier may partially explain the increase in CEO pay. We argue that increased pay may be required to induce turnover.

2.1 Environment

Consider a one period economy with three within period dates 0, 1/2, and 1, which we will refer to as "spring," "summer," and "fall," respectively, in the dynamic economy in the next section.

Representative investor. There is a representative investor with preferences over date 1 consumption c, $u(c)$, where u is assumed to be strictly increasing and strictly concave. The investor has access to a continuum of identical production technologies which require an initial investment of k units of capital as well as a manager each. In this section, we will assume that the investor has a total of $K = k$ units of capital at date 0. Hence the investor hires measure one of managers to operate measure one projects.

Managers. There is a continuum of managers with Lebesgue measure on $\mathbb{R}_+$. Managers vary in their reservation utility v where $v \in [0, \infty)$ and we assume that if measure $\bar{m}$ of managers gets hired, the reservation utility of the marginal manager is $\bar{v} = v(\bar{m})$ where $v(m)$ is increasing and weakly convex in m. In this section, since aggregate capital $K = k$, $\bar{m} = 1$. The convexity assumption is needed only to ensure that the aggregate production function discussed in section 3 is concave. There are many reasons to expect $\bar{v}$ to increase as more managers are hired. For example, imagine a supply curve for managers in which as more managers are hired, the investor is forced to hire managers with better outside options, or with higher costs of supplying managerial talent. The representative investor knows the distribution over reservation utilities, but cannot discern the reservation utility of any particular manager. Thus, to get $\bar{m}$ managers to participate, the managerial compensation contract has to satisfy the marginal manager's participation constraint. As a result, the cost of hiring managers increases as more managers get hired.

Managers are ex ante identical except for their reservation utility v. At date 1/2, managers observe whether the productivity of capital under their control is high, a_H, or low, a_L, where $a_H > a_L$, with probability π and $1-\pi$, respectively. Productivity is independent and identically distributed across managers. Capital reallocation occurs after managers realize their productivity and announce their type. A manager of type s who announces type $\hat{s}$ and who deploys $k_{\hat{s}}$ units of capital after reallocation produces $a_s k_{\hat{s}}$ consumption goods at date 1 depending on their productivity a_s, where $s, \hat{s} \in \{H, L\}$. Hence, productivity is not embedded in the capital itself, but is determined by who deploys it.[17] Output at date 1 is observable by both managers and the investor, and can be seized in full by the investor if he chooses to do so. There is no output at date 1/2.

In addition, managers get private benefits from running a project in the amount of $bk_{\hat{s}}$ if they have an amount of capital $k_{\hat{s}}$ under their control at date 1. Private benefits are not in terms of the consumption good and cannot be seized. Moreover, managers have limited liability, i.e., their compensation in consumption goods cannot be negative. Finally, managers have zero wealth when hired and thus cannot be sold a stake in their project.

To summarize, the timing is as follows: At date 0, the investor hires measure $\bar{m} = 1$ of managers and gives them k units of capital each. At date 1/2, the managers observe the productivity of capital under their control and announce their productivity to the investor, and capital is reallocated if the investor so chooses. At date 1, output is produced, payments are made, and managers obtain the private benefits from capital under their control. Figure 2 describes the timing of the contracting problem of this section.

In this section we take aggregate capital K and hence the measure of required managers $\bar{m}$ and the reservation utility of the marginal manager $\bar{v}$ as given. In Section 3, aggregate capital will be determined by the investor's dynamic consumption and investment problem. The effect of aggregate productivity on the investor's choices will provide a link between capital reallocation and the business cycle.

We study the problem of a representative investor both here as well as in the dynamic model in section 3. However, if we assume that markets are complete from the vantage point of individual investors, we could alternatively start with a continuum of such identical investors with preferences as described in the text.[18]

[17]See Eisfeldt and Rampini (2006) for a similar assumption and a discussion of the supporting microeconomic evidence. We have in mind that some organizations are more productive users of capital due to superior managerial talent or organization capital.

[18]By the revelation principle, managers announce their type truthfully and thus investors can trade a full set of contingent claims on dates and (truthfully reported) states.

In that case, there is a representative agent and in fact our economy aggregates, i.e., the preferences of the representative agent take the same functional form as the preferences of the individual investors. Since only the managers have an incentive problem, our economy has a representative agent under similar assumptions as the ones used in equilibrium asset pricing. Effectively, each individual investor would hold a perfectly diversified portfolio of claims on the production technologies and all investors would agree on the contract to offer each manager.

2.2 Contracting Problem

Denote the amount of capital deployed after reallocation by a manager who announces type s truthfully by k_s, $s \in \{H, L\}$, and the dividend paid by that manager to the investor by d_s. Also, denote the dividend paid by a manager of type s who announces type $\hat{s} \neq s$ by $d_{\hat{s}s}$. The representative investor's utility maximization problem is as follows:

$$\max_{k_H, k_L, d_H, d_L, d_{LH}, d_{HL}} u(c)$$

subject to a participation constraint for the marginal manager,

$$\pi\{(a_H + b)k_H - d_H\} + (1 - \pi)\{(a_L + b)k_L - d_L\} \geq \bar{v},$$

two incentive compatibility constraints,

$$(a_s + b)k_s - d_s \quad \geq \quad (a_s + b)k_{\hat{s}} - d_{\hat{s}s}, \quad \forall s, \hat{s} \in \{H, L\}, \quad s \neq \hat{s},$$

two resource constraints,

$$\begin{aligned} \pi d_H + (1 - \pi)d_L &\geq c \\ k &\geq \pi k_H + (1 - \pi)k_L, \end{aligned}$$

as well as non-negativity and limited liability constraints

$$\begin{aligned} k_s \geq 0, &\quad \forall s \in \{H, L\}, \\ a_s k_s - d_s \geq 0, &\quad \forall s \in \{H, L\}, \\ a_s k_{\hat{s}} - d_{\hat{s}s} \geq 0, &\quad \forall s, \hat{s} \in \{H, L\}, \quad s \neq \hat{s}. \end{aligned}$$

Notice that we have used the fact that the investor does not face any aggregate risk in the one period economy since project returns are independent. We have also assumed that given their type, all managers are treated symmetrically, i.e., they deploy the same amount of capital and make the same payments, but this is without loss of generality given the linearity of the problem.

We start by characterizing the solution when the participation constraint does not bind. We show that, depending on parameter values, there are two possible solutions to the contracting problem: either there is no reallocation or all the capital in the hands of managers with low productivity is reallocated. The interesting case is the one in which there is no reallocation when the participation constraint does not bind since otherwise the investor always chooses full reallocation. Thus, we restrict attention to this case. We then show that, when the participation constraint binds, the investor chooses to provide incentives for managers who announce low productivity to reallocate some capital, but not necessarily all of it.

In fact, we show that the amount of reallocation is increasing in the expected compensation that managers require (and hence in the reservation utility of the marginal manager). If the reservation utility of the marginal manager is low enough that the participation constraint does not bind, then the investor chooses no reallocation. Thus, for low $\bar{m}$ there is no reallocation. The higher is the reservation utility of the marginal manager, the (weakly) more reallocation the investor chooses. Once the participation constraint binds, reallocation is increasing in $\bar{m}$ until full reallocation is reached.

Consider the case in which the participation constraint is not binding. It is intuitive that if capital is reallocated at all, it is reallocated from the less productive managers to the more productive managers, i.e., that $k_H \geq k_L$. Since all of the constraints are linear, there are only two cases to consider. Either there is no reallocation or there is full reallocation.

No reallocation means that both types of managers deploy the same amount of capital $k_H = k_L = k$. If there is no reallocation, it is as if capital is deployed at the average productivity and the payoff to the investor is $(\pi a_H + (1-\pi)a_L)k$. All managers get to deploy their original k units of capital and hence they each get a payoff of bk, all of which accrues in private benefits.

Full reallocation means that managers who announce that their productivity is low relinquish control and deploy no capital whereas managers who announce that their productivity is high deploy both their initial capital as well as the capital that is reallocated. Thus, managers with high productivity deploy k/π units of capital each and obtain private benefits of bk/π. This is only incentive compatible if managers with low productivity obtain a sufficiently high bonus. In fact, the bonus to managers with low productivity has to be bk/π. Why? A manager with low productivity who announces high productivity gets to deploy k/π units of capital instead of none and would hence get a payoff in terms of benefits from control of bk/π instead of zero. The manager would get no additional pay since the investor observes output at date 1 and will seize all of it given that the manager has deviated. But this means that the manager with low productivity can obtain a payoff of bk/π by deviating and thus the bonus required equals bk/π. Notice that the bonus to the low productivity manager needs to be paid in consumption goods, unlike the payoff to the high productivity manager which accrues in private benefits.[19] The expected payoff to the managers is hence $(\pi)(bk/\pi)+(1-\pi)(bk/\pi) = bk+(1-\pi)bk/\pi$ where the first term on either side is expected private benefits (which a fraction π of managers will receive since they realize high productivity) and the second term is expected bonuses to relinquish control (which a fraction $(1-\pi)$ will receive since they realize low productivity). Thus, the investor's payoff is $a_H k - (1-\pi)bk/\pi$ since all capital is deployed at the high productivity but bonuses need to be paid out of consumption goods to induce managers to relinquish control and reallocate capital.

This discussion is summarized in the following proposition which is proved in the appendix.

Proposition 1 *Assume the participation constraint does not bind. Then either (i) there is no reallocation and the investor's payoff is* $(\pi a_H + (1-\pi)a_L)k$ *and managers get a payoff of* bk*, or (ii) there is full reallocation and the investor's payoff is* $a_H k - (1-\pi)bk/\pi$ *and managers get a payoff of* $bk + (1-\pi)bk/\pi = bk/\pi$*.*

[19]Section 4 discusses an extension of our model which also includes bonuses paid to managers whose capital performs well to induce effort provision, so that high productivity managers receive bonuses as well.

Notice that this implies a surplus, i.e., a sum of the investor's payoff and the payoff to managers, when there is no reallocation of $(\pi a_H + (1-\pi)a_L)k + bk$ and when there is full reallocation of $a_H k + bk$. Since $a_H > a_L$, reallocation is always efficient, i.e., $a_H k + bk > (\pi a_H + (1-\pi)a_L)k + bk$, but it may not be in the interest of the investor since bonuses must be paid to managers to induce reallocation. The interesting case is where the investor prefers not to induce reallocation when the participation constraint does not bind so that full reallocation is not always chosen and the amount of reallocation varies. Using the investor's payoffs under no and full reallocation, we assume in the remainder of the paper that:

Assumption 1 $\pi a_H + (1-\pi)a_L > a_H - (1-\pi)b/\pi$.

Proposition 1 describes the solution assuming that the participation constraint does not bind. We now consider the fact that the participation constraint may bind. The payoffs for the investor and the manager for the case in which Assumption 1 is satisfied are graphed in Figure 3 for different levels of $\bar{v}$. The left panel shows the case where $\bar{v} \leq kb$, the middle panel the case where $\bar{v} \in (bk, bk/\pi)$, and the right hand panel the case where $\bar{v} \geq bk/\pi$. In all panels, the vertical line labeled "NR" refers to no reallocation with the payoffs at the intersection of NR and the dotted line. The vertical line labeled "R" refers to full reallocation with the payoffs at the intersection of R and the dashed line. First, we claim that if $\bar{v}$ is sufficiently low then the participation constraint in fact does not bind. To see this, note that when $\bar{v} \leq bk$, if the participation constraint is ignored, the program is solved by the investor choosing no reallocation since this maximizes his payoff. The payoff associated with this choice also satisfies the managers' participation constraint, so no reallocation is the solution. This can be seen from the left panel in Figure 3. The feasible set (with no reallocation) is the dotted line to the right of bk and to the right of $\bar{v}$ and, since $\bar{v} \leq bk$, choosing the intersection of NR and the dotted line, i.e., no reallocation, is optimal.

For higher $\bar{v}$, the participation constraint binds and the amount of reallocation depends on the reservation utility of the marginal manager. If the reservation utility of the marginal manager is sufficiently high, namely if $\bar{v} = bk/\pi$, then the investor will choose the full reallocation solution (the intersection of NR and the dashed line in the right panel of Figure 3). Indeed, for $\bar{v} \geq bk/\pi$, the investor will choose to induce full reallocation. The feasible set (with full reallocation) is the dashed line to the right of bk/π and to the right of $\bar{v}$. Thus, the optimal choice is at the intersection of the vertical line at $\bar{v}$ and the dashed line, i.e., full reallocation. The intuition is that for high $\bar{v}$ managers' cash compensation is sufficiently high that high productivity managers can be charged for the private benefits associated with the additional capital they manage through reduced cash compensation. Since expected compensation exceeds the "cash" bonus necessary to induce low productivity managers to release capital, the investor can transfer cash compensation from the high productivity managers to the low productivity managers and capital (with the associated private benefits) from the low productivity managers to the high productivity managers. Note that, although we model the compensation which is tied to capital as private benefits, what is important is that managers receive some compensation that cannot be reduced without reducing the capital under the managers' control. In this range, the incentive problem is solved without additional funds supplied by the investor. Hence, agency costs are zero and it is free to induce managers to reveal their productivity truthfully, given that their expected compensation exceeds the necessary bonus. Note, however, that for these high values of $\bar{v}$ the investor's payoff is reduced by the additional compensation necessary to get managers to participate. Full reallocation maximizes total surplus and is efficient. However, ignoring the participation constraint it does not maximize the investor's payoff. As a larger fraction of capital is reallocated, more and more of the total surplus must be assigned to the managers. Thus, the investor only chooses to reallocate if the managers require a large fraction of the surplus simply to agree ex ante to participate in managing the projects.

For intermediate values of $\bar{v}$, as in the middle panel in Figure 3, inducing partial reallocation of capital is optimal, and the fraction of reallocation is increasing in $\bar{v}$ (see the chord connecting the intersection of NR and the dotted line and the intersection of R and the dashed line). The following proposition characterizes the solution formally in this case:

Proposition 2 *Suppose Assumption 1 holds. Then: (i) If* $\bar{v} \leq bk$*, there is no* *reallocation and the payoffs are as in part (i) of Proposition 1. (ii) If* $bk < \bar{v} < bk/\pi$*, there is partial reallocation and the payoff to the investor is* $\pi\frac{\bar{v}}{bk}a_H k + \left(1 - \pi\frac{\bar{v}}{bk}\right) a_L k - (\bar{v} - bk)$ *while the managers get* $\bar{v}$*. (iii) If* $bk/\pi \leq \bar{v}$*, there is full reallocation and the investor's payoff is* $a_H k - (\bar{v} - bk)$ *and the payoff to the managers is* $\bar{v}$*.*

The proof is in the appendix.

When there is partial reallocation, the amount of capital reallocation R is

$$R \equiv \frac{\bar{v} - bk}{bk/\pi} k.$$

The intuition for this expression is straightforward. If the investor is willing to pay $\frac{bk}{\pi}$ in cash, k units of capital can be reallocated since that bonus exactly compensates the loss in private benefits to a manager who declares low productivity. Similarly, to reallocate one unit of capital, the investor must pay $\frac{b}{\pi}$ in cash bonuses. Since $\bar{v} - bk$ is the cash compensation required to meet managers' expected compensation for a given $\bar{v}$, we have that reallocation increases in $\bar{v}$. A δ increase in $\bar{v}$ leads to $\frac{\delta}{b/\pi}$ more reallocation.

The intuition for the payoff to the investor with partial reallocation (part (ii) in Proposition 2) follows. The fraction of capital deployed by high productivity managers is simply the fraction originally managed by high productivity managers, plus the fraction that is reallocated, or, $\pi + \frac{\bar{v}-bk}{bk/\pi} = \pi\frac{\bar{v}}{bk}$. Using this fraction and the production function, and subtracting off what must be paid in cash bonuses to achieve the chosen reallocation we get the expression for the investor's payoff. One interpretation of the expression in the proposition is that each low productivity manager is induced to reallocate only part of their capital such that, after partial reallocation, a fraction $\pi\frac{\bar{v}}{bk}$ of capital is deployed at the high productivity and the rest remains deployed at the low productivity. The last term $(\bar{v} - bk)$ is the part of managers' compensation paid in terms of consumption goods. Thus, managerial compensation in consumption goods is increasing in $\bar{v}$. In the next section, we will develop the link between aggregate managerial compensation, capital reallocation, and the business cycle. Notice that as $\bar{v}$ goes from bk to bk/π, the fraction of capital deployed at the high productivity $\pi\frac{\bar{v}}{bk}$ goes from π, i.e., the unconditional probability of high productivity, to 1.

Instead of interpreting partial reallocation as involving all low productivity managers reallocating some fraction of their capital (i.e., "downsizing"), we can alternatively, and equivalently, think of the investor giving a fraction of managers with low productivity incentives to reallocate all of their capital. This enables us to make predictions about the fraction of managers who relinquish control of their firms, i.e., managerial turnover. The fraction of managers given such incentives solves

$$p\frac{bk}{\pi} + (1-p)bk = \bar{v},$$

since the fraction p of managers who are given incentives to reallocate will earn bk/π (either in private benefits or reallocation bonuses) while managers who are not given incentives earn bk in private benefits only, and managers' payoff overall needs to be $\bar{v}$. This implies that the fraction $p = \frac{\bar{v}-bk}{(1-\pi)bk/\pi}$, and the payoff to the representative investor with partial reallocation can thus be written as

$$\frac{\bar{v}-bk}{(1-\pi)bk/\pi}\left(a_H - (1-\pi)b/\pi\right)k + \left(1 - \frac{\bar{v}-bk}{(1-\pi)bk/\pi}\right)\left(\pi a_H + (1-\pi)a_L\right)k.$$

The interpretation of this expression is that only a fraction $\frac{\bar{v}-bk}{(1-\pi)bk/\pi}$ of managers are given incentives to reallocate capital if their productivity is low (which implies a return to the investor of $a_H k - (1-\pi)bk/\pi$ on this capital) while fraction $1 - \frac{\bar{v}-bk}{(1-\pi)bk/\pi}$ of managers are not given incentives to reallocate (and thus the return on this capital is $\left(\pi a_H + (1-\pi)a_L\right)k$). Managerial turnover is then $\frac{\bar{v}-bk}{bk/\pi}$. Again, as $\bar{v}$ goes from bk to bk/π, the fraction of managers who are given incentives to reallocate capital if their productivity is low $\frac{\bar{v}-bk}{(1-\pi)bk/\pi}$ goes from 0 to 1, and managerial turnover goes from 0 to $1-\pi$.

Finally, agency costs AC measured as the amount of output lost due to the asymmetry of information about productivity are

$$AC = \left(1 - \pi\frac{\bar{v}}{bk}\right)\left(a_H - a_L\right)k$$

when there is partial reallocation and are decreasing in $\bar{v}$. For $\bar{v} \leq bk$, there is no reallocation and agency costs are constant at $(1-\pi)\left(a_H - a_L\right)k$. Likewise, for $\bar{v} \geq bk/\pi$, reallocation is equal to the amount of capital held by low productivity managers, $(1-\pi)k$, and agency costs are zero. This is because managers must be paid so much that the high productivity managers can be charged for the private benefits associated with the additional capital and thus the bonuses to unproductive managers do not need to be financed by the investor.

The economic intuition of our model of managerial incentives and the reallocation of capital is as follows: An increase in $\bar{v}$ means that expected compensation of managers increases which is clearly costly for the investor and reduces his payoff. However, the good news is that the more managers make, the more it is possible to charge the high productivity managers for the private benefits by reducing their cash compensation. Thus, the cash bonuses to low productivity managers are effectively financed by high productivity managers rather than the investor. Thus, as $\bar{v}$ increases, the amount of capital which is reallocated and hence the amount of capital deployed at the high productivity increases. In the next section, we use the contracting problem developed here in a dynamic economy to study the business cycle properties of capital reallocation.

3 Capital Reallocation and the Business Cycle

The stylized facts documented in Section 1 suggest that capital reallocation, CEO turnover, and executive compensation are all procyclical. In this section we use our model of incentives for relinquishing control from the previous section in a dynamic environment to explain these stylized facts in a calibrated model and in particular to explain why there may be less reallocation in bad times. The calibrated model can quantitatively match the procyclicality of reallocation and managerial turnover observed in the data. Our model suggests that it may be too expensive to get managers to release assets when productivity is low and hence managers' expected compensation is low. When managers' expected compensation is low, the bonuses necessary to induce managers to relinquish control would need to be financed by the investor and hence reallocation may not be in the investor's interest.

3.1 Environment

Consider an infinite horizon discrete time economy with periods $0, 1, 2, \ldots$. Each period has three seasons, "spring," "summer," and "fall," which correspond to dates 0, 1/2, and 1 in the previous section. The within period problem is essentially unchanged from section 2.

The investor is infinitely lived and has preferences

$$E\left[\sum_{t=0}^{\infty} \beta^t u(C_t)\right]$$

where $\beta < 1$, C_t is consumption at time t, and u is strictly increasing and strictly concave. The investor starts the spring of every period with output Y_{t-1} and capital K_{t-1} in hand and observes the aggregate productivity Ω_t. Given these, the investor chooses in the spring how much of the output to consume, C_t, and how much to invest in capital I_t, and then consumes and invests. The investor then has to hire one period managers to manage the aggregate amount of capital implied by his investment decision, $K_t = K_{t-1}(1-\delta) + I_t$. Each project requires an initial investment of k units of capital and one manager, thus measure $\bar{m}_t = K_t/k$ of managers need to be hired. Managers live for one period and hence the contracting problem is the same as in Section 2.[20] In summer, managers observe their idiosyncratic productivity (i.e., the productivity of capital if it is under their control), declare it to the representative investor, and capital is reallocated. In fall, output is produced, and managers obtain private benefits from capital under their control, get paid, and consume. Any payoff that accrues to the investor in fall gets carried over to the spring of the next year to be consumed or invested at that time. Figure 4 describes the timing of a single period of the infinite horizon economy.

In this economy, both aggregate and manager specific productivity varies. As before, capital under the control of any given manager has either a high productivity $a_{H,t}$ or a low productivity $a_{L,t}$, $a_{H,t} > a_{L,t}$, with probability π and $1-\pi$, respectively. Conditional on the aggregate state, projects are identically and independently dis-

[20] If managers were longer lived, reputation and long term incentive provision might mitigate the agency problem, but would not eliminate it. In fact, if manager specific productivity is persistent, low productivity managers may be even more reluctant to reveal their type.

tributed. However, in the dynamic economy each manager's productivity has two components, an aggregate component Ω_t and an idiosyncratic component $\omega_{s,t}$. Aggregate productivity Ω_t shifts managers' productivities as follows: $a_{H,t} = \Omega_t + \omega_{H,t}$ and $a_{L,t} = \Omega_t + \omega_{L,t}$ where $\omega_{H,t} = \omega_H$ and $\omega_{L,t} = \omega_L$. Finally, aggregate productivity follows a Markov chain with transition probability matrix Π. Recall that the timing is such that in the spring of period t, the investor and managers observe the aggregate productivity of capital for that year Ω_t while the managers observe the idiosyncratic productivity of capital under their control $(a_{s,t})$ only once summer arrives.

The timing is chosen such that the contracting problem of Section 2 is identical to the within period contracting problem in the dynamic economy. Furthermore, the timing assumptions imply that the risk neutral managers cannot bear any aggregate risk and thus do not provide insurance for the risk averse investor. Aggregate productivity for period t, Ω_t, is observed in the spring before managers are hired and thus managers cannot provide insurance about Ω_t. In addition, managers get paid and consume in the fall of the same year and thus cannot provide insurance about aggregate productivity for the next period, Ω_{t+1}, either. Thus, there is no resolution of aggregate uncertainty within the duration of the contract.

3.2 Investor's Problem

The representative investor's problem can now be written recursively as follows. Consider the investor's problem in the "spring." The investor has K_{-1} units of capital and Y_{-1} units of output carried over from last period. The investor also observes aggregate productivity for this period, Ω. Given these three state variables (K_{-1}, Y_{-1}, Ω), he decides how much to consume now, C, and how much to invest in capital, I, to solve:

$$V(K_{-1}, Y_{-1}, \Omega) = \max_{C,I} u(C) + \beta E[V(K, Y, \Omega')]$$

subject to

$$\begin{aligned} Y &= A(\Omega, K)K \\ Y_{-1} &\geq C + I \\ K &= K_{-1}(1-\delta) + I \end{aligned}$$

where

$$A(\Omega, K) \equiv \Omega \quad + \quad \frac{v(K/k) - bk}{(1-\pi)bk/\pi}\left(\omega_H - (1-\pi)b/\pi\right) \\ + \quad \left(1 - \frac{v(K/k) - bk}{(1-\pi)bk/\pi}\right)\left(\pi\omega_H + (1-\pi)\omega_L\right).$$

for $bk < v(K/k) < bk/\pi$,

$$A(\Omega, K) \equiv \Omega + (\pi\omega_H + (1-\pi)\omega_L)$$

for $v(K/k) \leq bk$, and

$$A(\Omega, K) \equiv \Omega + \omega_H - \frac{v(K/k) - bk}{k}$$

for $v(K/k) \geq bk/\pi$. The investor's problem is well-behaved. Moreover, it closely resembles a standard business cycle model, except that aggregate productivity is endogenously determined by the agency problem between the investor and the managers and the resulting cross-sectional allocation of capital. The production function $A(\Omega, K)K$ is weakly concave in K since productivity is weakly concave in $\bar{v}$ and $v(m)$ is convex in $m = K/k$ by assumption. The contracting problem in Section 2, which is graphed in Figure 3, determines the amount of reallocation and hence $A(\Omega, K)$, which in turn determines how much output the investor can get out of the capital he owns. This measure of "productivity" summarizes the aggregate productivity shock, the distribution of capital amongst high and low productivity managers, and the share of output which accrues to the investor relative to the managers. Thus, the within period agency problem between the investor and the managers is reflected in the aggregate productivity $A(\Omega, K)$ at which the investor can deploy capital. Considering managerial incentives in the decision to reallocate capital leads to endogenously determined productivity.

We now turn to the implications of our model for capital reallocation, managerial compensation, and managerial turnover. Aggregate reallocation is given by:

$$R \equiv \left(\frac{v\left(\frac{K}{k}\right) - bk}{bk/\pi}\right) K.$$

Thus, reallocation increases in the aggregate capital stock to be managed. If v is weakly convex in $m = K/k$, as we have assumed, then reallocation is convex in K.[21] Managerial compensation in consumption goods is given by:

$$\left(v\left(\frac{K}{k}\right) - bk\right) K/k$$

and is hence linear in aggregate reallocation and convex in aggregate capital if reallocation is. Managerial turnover in the model is

$$\frac{v\left(\frac{K}{k}\right) - bk}{bk/\pi}$$

and hence linear in aggregate reallocation as well. Interestingly, this implies that managerial compensation and turnover inherit the cyclical properties of capital reallocation in our model. This prediction of the model is borne out by the data since capital reallocation, managerial compensation, and managerial turnover are all strongly procyclical.

3.3 Calibration

We calibrate our model to be consistent with standard business cycle stylized facts for the capital output ratio, the investment rate, and the standard deviation of log output, investment, and consumption. Accordingly, for standard preference and technology parameters, we use values from previous microeconomic studies of preferences and production and from canonical business cycle studies such as Kydland and Prescott (1982). To calibrate the level of private benefits, we require that the managerial turnover rate in our model matches that in Kaplan and Minton (2006). For managerial compensation, we use the relationship between CEO compensation and the value of the aggregate corporate capital stock reported in Gabaix and Landier (2006). Table 2 summarizes the calibration. We use discrete state space dynamic programming to solve the model, and choose a state space for capital which is non-binding at either the upper or lower bound.[22]

[21] Reallocation will be convex in K as long as v is not "too concave", i.e., as long as $-\frac{v'' K/k}{v'} \leq 2$.

[22] The grid size and spacing is chosen based on computational feasibility. We chose the finest grid possible, but, reassuringly, our results were very similar with a slightly coarser grid.

For preferences, we assume constant relative risk aversion (CRRA), i.e.,

$$u(C) \equiv \frac{c^{1-\sigma}}{1-\sigma}$$

and choose the coefficient of relative risk aversion $\sigma = 2$, as estimated by Friend and Blume (1975) using individual portfolio observations. We set the discount rate $\beta = 0.96$, which is consistent with an annual interest rate of 4%, as in Kydland and Prescott (1982).[23] Also following Kydland and Prescott (1982), depreciation, δ, is set to 0.1. Without loss of generality, individual project size k is normalized to one.[24]

We calibrate the process for aggregate productivity shocks to match the quarterly AR(1) process found by Cooley and Prescott (1995) to match the US Solow residual. The quarterly process is $\Omega_q = \exp(z_q)$ where

$$z'_q = 0.95 z_q + \varepsilon_q$$

and $\varepsilon_q \sim N(0, (0.007)^2)$. Table 2 contains the corresponding annualized process. We use the quadrature method described in Tauchen and Hussey (1991) to construct an eight state Markov chain which closely approximates the variance and autocorrelations of the annualized AR(1) process. We set average productivity to 0.4, which implies a capital to output ratio of 2.6, consistent with the calibration of Kydland and Prescott (1982) and Prescott (1986). We use a two state approximation to a normal distribution with zero mean and a standard deviation of 5.7%, which matches the cross-sectional standard deviation of productivity estimated using data from Basu, Fernald, and Kimball (2006), to calibrate the manager specific shocks.

To calibrate private benefits, b, we use the managerial turnover rate from Kaplan and Minton (2006) of 3.11%. The larger private benefits are per unit of capital, the more costly it will be to incentivise managers to downsize and to reallocate capital. In our model, managerial turnover is tied to capital reallocation, and this rate is also within the range of capital reallocation rates reported in Eisfeldt and

[23] See also Prescott (1986).

[24] The required initial investment k affects the number of managers hired, however, since private benefits are specified per unit of capital, what is important for capital reallocation is the amount of capital that is reallocated and not how many managers are downsized. (See also the discussion in Section 2.2 which describes how reallocation may involve either whole firms or fractions of firms.)

Rampini (2006) of 1.39% to 5.52%. Moreover, the reallocation to gross investment ratio reported there, which is 23.89%, implies a capital turnover rate of 3.14%, which is almost identical to the managerial turnover rate above. Setting $b = 0.2525$ implies a managerial turnover rate, and a capital reallocation rate, of 3.1%, and satisfies Assumption 1.

The private benefits are considerable in our calibration since the agency costs we focus on are the only frictions inhibiting capital reallocation whereas in practice physical reallocation costs, adverse selection, search frictions, etc. are likely to play a role. Although in our model, strictly interpreted, private benefits accrue to managers, it is plausible that private benefits to stakeholders as a whole (including other high level executives, board members, employees, etc.) are quite large, and that these stakeholders may also play a significant role in the decision to reallocate capital.[25]

Finally, it is necessary to specify expected managerial compensation, $v(m)$. Gabaix and Landier (2006) report that over the period from 1980 to 2003 both CEO pay and the value of the aggregate corporate capital stock increased six fold. This implies that CEO pay is proportional to aggregate capital under management. To be consistent with this fact, we specify compensation to be proportional to the aggregate capital stock. Since $m = K/k$ and $k = 1$, $m = K$, and this allows us to specify v as a function of aggregate capital, K. Thus, we specify that $v(K) = \nu K$. This functional form is also consistent with our assumption in Section 2 that v is increasing and weakly convex in m, which ensures that the production function is concave. It turns out that the only relevant restriction on the parameter ν is that it be greater than zero. All positive values will yield the same model predictions since if $v(K) = \nu K$

[25]See, as a recent example, Dyck and Zingales (2004), for a discussion of sources and the potential magnitude of private benefits, as well as a review of empirical studies using block share sales and multiple share classes to estimate private benefits. Of course, private benefits to stakeholders who are not primarily firm owners are harder to estimate given the available data. A notable study which documents the effects of the decision to reallocate on other stakeholders is Harford (2003). He finds that outside directors of target firms hold fewer directorships in the future and that the direct financial impact of a completed merger is predominantly negative. Indeed, he argues that outside directors often have very limited incentives to reallocate capital since their compensation is primarily in the form of a cash retainer, which would cease in the event of a successful takeover. Moreover, directors may also lose lucrative consulting arrangements with their companies.

the optimization problem is linearly homogenous in ν, which implies that changing ν simply scales the economy up and down leaving all ratios and correlations the same. We set ν=0.05.

3.4 Results

We start by verifying that our calibration is consistent with the standard business cycle facts and then discuss the implications for managerial turnover and capital reallocation. The simulation results are summarized in Table 3. A depreciation rate δ of 0.1 directly implies an investment to capital ratio of 0.1 since the model is stationary. Furthermore, the unconditional average of Ω is calibrated to 0.4 because this implies a capital output ratio of 1/0.4=2.5 if reallocation and the cost of hiring managers were ignored. Of course, this is only approximately the case when the endogeneity of $A(\Omega, K)$ is taken into account, which is influenced by both the amount of capital and agency costs in equilibrium. The model implies a capital output ratio of about 2.6 when reallocation costs are considered, which is equal to the value in Prescott (1986). The implied standard deviations for the log of output, investment, and consumption are 2.77%, 4.59%, and 2.60% respectively. Using data from the Federal Reserve Economic Data series, the corresponding values for annual US data from 1954 to 2005 are 2.13%, 7.00%, and 1.86%. Thus, the volatilities in our model are broadly consistent with US data, although, like in the standard business cycle model, the implied volatility of investment is a bit too low.[26]

Next, we examine the quantitative implications of our model for capital reallocation, managerial compensation, and managerial turnover. Table 1 reports that the correlation between CEO turnover and output at the business cycle frequency is 0.82. Eisfeldt and Rampini (2006) report that the correlation between capital reallocation and output at the business cycle frequency is 0.64. Since managerial turnover and capital reallocation are closely linked in our model, the correlations with output implied by the model will be close in value. When b and $v(m)$ are cali-

[26]The volatility of output and consumption could be reduced by lowering σ_ε in the process for the productivity shock, however we chose to use a value consistent with that in previous business cycle studies.

brated to match the stylized facts for managerial turnover from Kaplan and Minton (2006), and the relationship between CEO compensation and the value of aggregate corporate capital from Gabaix and Landier (2006) the model implies a correlation between output and reallocation of 0.72, and a correlation between output and managerial turnover, and managerial compensation, of 0.74. Our calibrated model thus does a good quantitative job of matching the procyclical nature of capital reallocation and managerial turnover; the model correlations are near the center of the empirical range for managerial turnover from Kaplan and Minton (2006) and capital reallocation from Eisfeldt and Rampini (2006). To sum up, our model of managerial incentives and capital reallocation generates strongly procyclical variation in reallocation and managerial compensation and turnover. We conclude that the reluctance of managers to relinquish control generates countercyclical reallocation frictions and results in procyclical capital reallocation.

4 Extensions

In this section we consider several extensions of our model. First, we discuss the role that variation in managers' ex post outside options might play. We argue that this may be an additional mechanism rendering reallocation frictions countercyclical. Poor outside options make managers even more reluctant to let go. Second, we show that if the model is extended to include an effort decision by the manager, then managers will receive cash bonuses not just when they release capital but also when the capital under their control performs well. Nevertheless, our main results are unaffected; in particular, inducing reallocation is more costly in bad times. Finally, we argue that if the private benefits that accrue to the manager scale with output instead of capital, then the fraction of capital reallocated is still procyclical as long as the marginal manager's reservation utility increases sufficiently with productivity.

4.1 The Role of Ex Post Outside Options

The compensation managers require to reveal that they are unproductive may depend on their ex post outside option as well as their ex ante reservation utility. We show that if outside options are worse in bad times, this can be an additional mechanism rendering agency costs countercyclical and hence capital reallocation procyclical.

Suppose that, in summer, managers have an ex post outside option where they can earn $\underline{v}$[27] per unit of capital which they release and that the environment is otherwise as in Section 2. Specifically, suppose that a manager who controls $k_s \leq k$ units of capital after reallocation earns $\underline{v}(k - k_s)$ from this alternative activity (in addition to benefits from control on the capital that he retains (k_s) and any cash compensation that he might receive). If no reallocation occurs, neither the managers' nor the investor's payoffs are changed. If full reallocation occurs, then the bonus to managers who declare that their productivity is low plus the payoff from the alternative activity $\underline{v}k$ has to exceed the private benefits these managers would get from declaring high productivity, thus the bonus equals $bk/\pi - \underline{v}k$. The managers' payoffs are unchanged in this case, but the investor's payoff is $a_H k - (1-\pi)(bk/\pi - \underline{v}k)$ and the surplus is $(a_H + b)k + (1-\pi)\underline{v}k$. The equivalent of Assumption 1 is then to require that $\pi a_H + (1-\pi)a_L > a_H - (1-\pi)b/\pi + (1-\pi)\underline{v}$.

Thus, if outside options deteriorate in recessions, reallocation becomes more costly. The lower the managers' outside option, the more they are trying to hold on and the more costly it is to induce them to let go. To get the low productivity managers to release capital, they have to be compensated for the difference between what they get if they pretend to be high productivity (bk/π) and what they get elsewhere ($\underline{v}k$). These reallocation bonuses need to be paid by the investor in cash. Thus, a lower outside option increases the required bonus. Similarly, if the managers' outside option $\underline{v}$ improves when aggregate productivity is higher, then reallocation becomes cheaper in good times. High productivity then raises the investor's payoff both directly and indirectly by reducing the cost of reallocation and reallocation will be procyclical as before.

Notice that one might expect that if managers' outside options decrease in bad times, smaller bonuses are required to induce managers to let go since managers can be pushed down to their ex post outside option. However, this logic fails to recognize that the investor does not know which managers are less productive and cannot push

[27]Recall that the ex ante reservation utility of the marginal manager is denoted by $\bar{v}$.

managers down to their ex post outside option since they can obtain more than that by staying. Rather, to induce managers to announce that their productivity is low bonuses have to compensate managers for the difference between what they can obtain by staying and their outside option. Thus, a decreased outside option increases the required bonus and makes reallocation more costly.

4.2 Moral Hazard and Performance Bonuses

In the simplest version of our model, cash bonuses are only paid to downsized managers. This is not an essential feature of our model. The following extension includes bonuses paid to induce effort. In this extension, managers who retain capital and exert effort may also earn bonuses which increase in the amount of capital under their control. By combining these two incentive provision problems, one can generate managerial compensation with realistic properties where bonuses for reallocation still play an important role.

Consider the following extension to our model in Section 2. Suppose that the manager has to exert an unobservable effort in summer, after observing and announcing the (expected) productivity of capital under his control and after the reallocation of capital occurs. Specifically, suppose that if the manager exerts high effort e (per unit of capital), then productivity will be $\bar{a}_s$ with probability q and $\underline{a}_s$ with probability $1-q$ and that if the manager exerts low effort, which we assume is zero, then productivity will be $\underline{a}_s$ with probability 1. We assume that effort is sufficiently productive such that it is optimal to induce high effort and that $\bar{a}_H \neq \bar{a}_L$ such that expected productivity, or managerial type, is still fully revealed in fall. Furthermore, we assume that $a_s = q\bar{a}_s + (1-q)\underline{a}_s$ such that the productivity that managers observe in summer is their expected productivity given high effort.

We again start by assuming that the participation constraint does not bind. Taking the manager's (expected) productivity a_s and amount of capital under his control k_s as given, the incentive constraint for managerial effort can be written as follows:

$$q\bar{x}_s + bk_s - ek_s \geq bk_s$$

where $\bar{x}_s$ is the manager's bonus when productivity $\bar{a}_s$ is realized. Note that no bonus is paid when productivity is $\underline{a}_s$. The right hand side denotes the manager's payoff when he puts in low effort: the probability of productivity $\bar{a}_s$ is zero and hence he does not receive a bonus; the effort cost is zero; and the manager has capital k_s under his control and hence enjoys private benefits in the amount of bk_s. The left hand side denotes the manager's payoff when he puts in high effort, in which case he gets the bonus with probability q, gets private benefits in the amount bk_s, and incurs effort cost in the amount ek_s. Thus, the expected bonus is $q\bar{x}_s = ek_s$ which exactly compensates for effort cost. The bonus when productivity is high is $\bar{x}_s = \frac{e}{q}k_s$. Moreover, the payoff net of effort cost to the manager who announces his productivity truthfully and deploys capital k_s is then bk_s as before. If no reallocation is induced, both types of managers deploy k units of capital and get a payoff (net of effort cost) of bk. This allocation of capital is also incentive compatible, since by deviating managers get bk in private benefits and nothing else; they get no bonuses and hence exert no effort. If full reallocation is induced, then the high types deploy k/π capital and get a payoff (net of effort cost) of bk/π as before. They get bk/π in private benefits, expected cash bonuses of ek/π, and incur effort cost equal to ek/π. The low types can ensure private benefits of bk/π if they declare to be the high type and hence reallocation bonuses of size bk/π are required. To sum up, the managers' payoffs (net of effort cost) are unaffected in either case. The investor's payoff is reduced by ek, the cash bonuses required to induce effort, in either case. The expressions for the fraction of managers who are given incentives, the fraction of capital deployed at high productivity, the amount of reallocation and agency costs are all unaffected. The cash compensation of managers increases to $\bar{v} - bk + ek$. Finally, the conclusions regarding the business cycle properties of capital reallocation and managerial turnover are unchanged.

4.3 Private Benefits Depending on Output

Private benefits are typically assumed to be associated with the size of the firm since managers' power increases with the resources under their control (see Jensen (1986)). When thinking about the decision to downsize specifically, Jensen (1993, p. 848) argues that "Even when managers do acknowledge the requirement for exit, it is often difficult for them to accept and initiate the shutdown decision. For the managers who must implement these decisions, shutting down plants or liquidating the firm causes personal pain, creates uncertainty, and interrupts or sidetracks careers. Rather than confronting this pain, managers generally resist such actions ..." In this spirit, we have assumed thus far that private benefits scale with the amount of capital under the managers' control. However, suppose that the private benefits that accrue to managers scale with output instead. While this implies that private benefits are higher when aggregate productivity is higher and hence the cost of reallocating capital in terms of reallocation bonuses is higher as well, the amount of reallocation will still be procyclical as long as the marginal manager's reservation utility increases sufficiently with productivity.

When private benefits depend on output, the payoff to a manager who has productivity a_s, deploys capital k_s and pays dividends d_s is $a_s k_s(1+b) - d_s$. With no reallocation the managers get an expected payoff of $(\pi a_H + (1-\pi)a_L)bk$, while the investor's payoff is as before. When there is full reallocation, a low productivity manager would get private benefits of $a_L bk/\pi$, if he were to claim high productivity, and hence the reallocation bonus is $a_L bk/\pi$. The managers' expected payoff is $\pi a_H bk/\pi + (1-\pi)a_L bk/\pi$, the investor's payoff is $(a_H - (1-\pi)a_L b/\pi)k$, and overall surplus is $a_H(1+b)k$.

Suppose as in Section 3 that aggregate productivity Ω shifts managers' productivities by $a_H = \Omega + \omega_H$ and $a_L = \Omega + \omega_L$. Note that an increase in aggregate productivity (by ε, say) now raises the managers' payoffs both when no reallocation occurs (by $bk/\pi\varepsilon$) and when reallocation occurs (by $bk\varepsilon$). However, as long as the marginal manager's reservation utility $\bar{v}$ increases sufficiently with Ω, the reallocation of capital will continue to be procyclical. A sufficient condition is that $\Delta\bar{v} \geq bk/\pi\varepsilon$. Of course, if private benefits scale less than linearly with output, less variation in $\bar{v}$ is required.

5 Conclusions

We show that when managers are reluctant to relinquish control and release assets, capital reallocation can be considerably procyclical, consistent with stylized empirical facts. We consider the problem of providing managers with incentives to announce that the capital under their control should be redeployed elsewhere when the productivity of capital in their hands is low and show that this requires that bonuses be paid to unproductive managers. When aggregate productivity is high and managers are scarce, managerial compensation is high and hence these bonuses are not borne by the investor since they can effectively be financed by charging productive managers for the private benefits associated with the additional capital they receive. In contrast, when aggregate productivity is low and managerial talent is more abundant, these bonuses would have to be financed by the investor. This may not be in the interest of the representative investor and hence he may choose not to induce otherwise productive reallocation in bad times. Thus, the managerial agency problem implies countercyclical reallocation frictions and as a result capital is, on average, less productively deployed in bad times. Our theory is also consistent with the new stylized facts reported in this paper, namely that CEO turnover and executive compensation are remarkably procyclical, with a correlation with GDP of 0.82 and over 0.9, respectively.

Appendix

Proof of Proposition 1. First, notice that without loss of generality $d_{LH} = a_H k_L$ and $d_{HL} = a_L k_H$ since otherwise d_{LH} and d_{HL} could be raised which would relax the constraints. Thus, the incentive constraints can be combined and written as

$$a_L k_L - d_L \geq b(k_H - k_L) \geq d_H - a_H k_H. \tag{1}$$

Also recall that the left most term is non-negative and the right most term is non-positive due to limited liability.

Second, we claim that $k_H \geq k_L$. For suppose to the contrary that $k_H < k_L$, then $a_H k_H - d_H > 0$ and $(a_L + b)k_L - d_L > bk_H$. Consider the following perturbation of the allocation of capital $\Delta k_H > 0 > \Delta k_L$ such that $\pi \Delta k_H + (1-\pi)\Delta k_L = 0$. In addition, change the payments by $\Delta d_H = a_H \Delta k_H$ which satisfies the limited liability (LL) constraint and $\Delta d_L = a_L \Delta k_L$ which satisfies both the incentive compatibility (IC) constraint and LL for type L. This allows for a change in the payoff to the investor of $\Delta c = \pi a_H \Delta k_H + (1-\pi) a_L \Delta k_L > 0$ since more weight is put on the positive term of the perturbation with zero expected value. Note also that the change in the participation constraint (PC) is $\Delta PC = 0$. This would be a feasible and incentive compatible improvement, a contradiction.

Now suppose that neither IC constraint holds with equality. Then it must be the case that $d_H = a_H k_H$ and $d_L = a_L k_L$ since otherwise d_H and d_L could be raised. But then the high type's IC constraint implies $bk_H > bk_L$ and the low type's $bk_L > bk_H$, a contradiction. Thus, at least one of the IC constraints must be satisfied with equality.

Next we show that it cannot be the case that only the high type's IC constraint is satisfied with equality. Suppose that were the case, i.e., suppose that $(a_H + b)k_H - d_H = bk_L$ and $(a_L + b)k_L - d_L > bk_H$. If $a_H k_H - d_H = 0$, then type H's IC constraint implies $k_H = k_L$ and type L's IC constraint in turn implies $a_L k_L - d_L > 0$. But then it would be possible to raise d_L and improve the objective and thus $a_H k_H - d_H > 0$. Now rewriting H's IC constraint we have

$$(a_H + b)k_H - d_H = bk_H + (a_H k_H - d_H) > bk_H \geq bk_L$$

which means that H's IC constraint does not hold with equality, a contradiction.

Suppose both IC constraints hold with equality. Then

$$0 \leq a_H k_H - d_H = b(k_H - k_L) = d_L - a_L k_L \leq 0$$

which implies that $k_H = k_L = k$ and $d_H = a_H k_H$ and $d_L = a_L k_L$. The investor's payoff in this case is $c = (\pi a_H + (1-\pi)a_L)k$ and the managers' payoff bk. This is the no reallocation allocation. Note that for the participation constraint to be slack this requires that $\bar{v} < bk$.

Suppose that only the low type's IC constraint is satisfied with equality, i.e., $(a_L + b)k_L - d_L = bk_H$ and $(a_H + b)k_H - d_H > bk_L$. Since the participation constraint does not bind, it must then be the case that $a_H k_H - d_H = 0$ since otherwise d_H could be raised. But then, by H's IC constraint $k_H > k_L$. Also, if $a_L k_L - d_L = 0$ this would imply $k_H = k_L$ and $a_H k_H - d_H > 0$, which is impossible, and hence $a_L k_L - d_L > 0$. Thus, $d_H = a_H k_H$ and $d_L = a_L k_L - b(k_H - k_L)$ and the payoff to the investor is $c = \pi a_H k_H + (1-\pi)(a_L k_L - b(k_H - k_L))$. Notice that the objective is essentially linear and hence that either k_H or k_L is zero, where the former is impossible since $k_H > k_L$. Hence, $k_H = k/\pi$ and $k_L = 0$ which implies payoffs of $a_H k - (1-\pi)bk/\pi$ to the investor and $bk + (1-\pi)bk/\pi$ to the managers. This is the full reallocation allocation. □

Proof of Proposition 2. If the participation constraint does not bind, the no reallocation allocation solves the contracting problem given Assumption 1. The no reallocation allocation from Proposition 1 satisfies the participation constraint if and only if $\bar{v} \leq bk$. This establishes part (i) of the proposition. Thus, the participation constraint binds if and only if $\bar{v} > bk$.

Consider the case where the participation constraint binds. By the same arguments as in the proof of Proposition 1, we have $d_{LH} = a_H k_L$ and $d_{HL} = a_L k_H$, and $k_H \geq k_L$. Also, again following the proof of Proposition 1, if both incentive compatibility constraints were satisfied at equality, then $k_H = k_L = k$, $d_H = a_H k_H$, and $d_L = a_L k_L$. But then the managers' payoff would be $bk < \bar{v}$ which would violate the participation constraint. Thus, at most one IC constraint can hold with equality.

Suppose H's IC constraint holds with equality, i.e., $(a_H + b)k_H - d_H = bk_L$ and hence $(a_L + b)k_L - d_L > bk_H$. If $a_L k_L - d_L = 0$, then type L's IC constraint implies

$bk_L > bk_H$ which is impossible. Thus, $a_L k_L - d_L > 0$. Consider $\Delta k_H > 0 > \Delta k_L$ such that $\pi \Delta k_H + (1-\pi)\Delta k_L = 0$. This relaxes H's IC constraint and satisfies L's IC and both types' LL constraints and is feasible unless $k_L = 0$. It is then possible to increase d_H by $\Delta d_H > 0$ and improve the objective. If $k_L = 0$, then $k_H = k/\pi$ and H's IC constraint would be slack, a contradiction. Thus, H's IC constraint cannot hold with equality.

Suppose both IC constraints are slack. Suppose further that $k_L > 0$. Consider $\Delta k_H > 0 > \Delta k_L$ such that $\pi \Delta k_H + (1-\pi)\Delta k_L = 0$, and $\Delta d_H = a_H \Delta k_H$ and $\Delta d_L = a_L \Delta k_L$. Such a perturbation does not affect the participation constraint $\Delta PC = 0$ and improves the objective by $\pi a_H \Delta k_H + (1-\pi) a_L \Delta k_L > 0$. Thus, $k_L = 0$ and $k_H = k/\pi$. The participation constraint implies that

$$\bar{v} = \pi\{(a_H+b)k_H - d_H\} + (1-\pi)\{(a_L+b)k_L - d_L\} \geq \pi b k_H + (1-\pi)\{(a_L+b)k_L - d_L\} > bk_H,$$

where the first inequality is implied by H's LL constraint and the second by L's IC constraint. Thus, both IC constraints can be slack only if $\bar{v} \geq bk/\pi$ and there is full reallocation in this range. This establishes part (iii).

Finally, for $bk < \bar{v} < bk/\pi$, L's IC constraint must be satisfied at equality. Since the participation constraint together with H's LL constraint and L's IC constraint imply that $\bar{v} \geq bk_H$, k_L cannot be zero. Otherwise, $k_H = k/\pi$ and $\bar{v} \geq bk/\pi$, a contradiction. Thus, $k_L > 0$.

Now suppose $a_H k_H - d_H > 0$. Consider $\Delta d_H > 0 > \Delta d_L$ such that $\pi \Delta d_H + (1-\pi)\Delta d_L = 0$. Then there exists $\Delta k_H, \Delta k_L$ such that $\Delta k_H > 0 > \Delta k_L$, $\pi \Delta k_H + (1-\pi)\Delta k_L = 0$, and $(a_L + b)\Delta k_L - \Delta d_L \geq b \Delta k_H$. But this would relax the participation constraint by $\pi a_H \Delta k_H + (1-\pi) a_L \Delta k_L > 0$ and thus d_H could be further increased, a contradiction. Thus, $a_H k_H - d_H = 0$. The participation constraint then implies that $bk_H = \bar{v}$. Furthermore, $k_L = \frac{k}{1-\pi} - \frac{\bar{v}}{(1-\pi)b/\pi}$, $d_H = a_H \frac{\bar{v}}{b}$, and using the participation constraint we have $d_L = \frac{1}{1-\pi}\left(\left(1 - \pi\frac{\bar{v}}{bk}\right) a_L k - (\bar{v} - bk)\right)$. Thus, the payoff to the investor is $c = \pi \frac{\bar{v}}{bk} a_H k + \left(1 - \pi \frac{\bar{v}}{bk}\right) a_L k - (\bar{v} - bk)$. This completes the proof of part (ii). □

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Table 1: CEO Turnover, Executive Compensation, and the Business Cycle

This table reports the correlation of GDP with CEO turnover and executive pay, as well as the correlation of CEO turnover with executive pay. Data on CEO turnover are from Kaplan and Minton (2006), specifically the percentage turnover of CEOs in publicly traded *Fortune* 500 companies due to mergers and acquisitions and delistings from a major stock exchange. Data on mean CEO compensation levels and mean compensation for the top 5 executives for firms that belong to the S&P 500, the Mid-Cap 400, and the Small-Cap 600 indexes are from Bebchuk and Grinstein (2005). Deviations from trend for turnover, log GDP, and log executive pay are computed using the Hodrick and Prescott (1997) filter. Standard errors are corrected for heteroscedasticity and autocorrelation of the residuals à la Newey and West (1987) and are computed using a GMM approach adapted from the Hansen, Heaton, and Ogaki Gauss programs.

Panel A: Correlation with Output		
CEO Turnover	0.818	
	(0.158)	
Executive Pay	CEO only	Top 5 Executives
S&P 1500	0.912	0.918
	(0.062)	(0.061)
Large firms (S&P 500)	0.911	0.921
	(0.070)	(0.058)
Medium firms (Mid-Cap 400)	0.831	0.881
	(0.093)	(0.099)
Small firms (Small-Cap 600)	0.736	0.701
	(0.135)	(0.207)

Panel B: Correlation with CEO Turnover		
Executive Pay	CEO only	Top 5 Executives
S&P 1500	0.927	0.931
	(0.056)	(0.051)
Large firms (S&P 500)	0.913	0.913
	(0.061)	(0.063)
Medium firms (Mid-Cap 400)	0.946	0.963
	(0.041)	(0.038)
Small firms (Small-Cap 600)	0.778	0.821
	(0.161)	(0.150)

Table 2: Parameter Values for Calibration

This table shows the parameter values, sources, and moments used for the calibration of the model: [BFK] Basu, Fernald, and Kimball (2006), [CP] Cooley and Prescott (1995), [FB] Friend and Blume (1975), [GL] Gabaix and Landier (2006), [KP] Kydland and Prescott (1982), [P] Prescott (1986), [TH] Tauchen and Hussey (1991).

Parameter		Value	Source/Moment
Preferences			
β	discount rate	0.96	Implies annual interest rate of 4% as in [KP]
σ	rel. risk aversion	2	Estimated by [FB] using individual portfolio data
Technology			
δ	depreciation rate	0.1	Value from [KP]
Ω, $\Pi(\Omega'\|\Omega)$	agg. prod.	$\Omega = \bar{z}\exp(z)$	Functional form as in [CP]
		$z' = \rho z + \varepsilon$	AR(1) as in [CP]
		$\varepsilon \sim N(0, \sigma_\varepsilon^2)$	Normal innovations as in [CP]
		$\rho = (\rho_q)^4$, $\rho_q = 0.95$	Quarterly value from [CP] annualized
		$\sigma_\varepsilon^2 = \frac{1-\rho^2}{1-\rho_q^2}(0.007)^2$	Quarterly var. from [CP] annualized to match $var(z_t)$
		$\bar{z} = 0.4$	Implies $K/y \approx 2.5$ as in [KP] and [P]
ω_s, π	idio. productivity	$\pi = 0.5$	2 state approx. to normal distribution matching the
		$\omega_H = -\omega_L = 0.057$	cross-sectional std. dev. using data from [BFK]
k	capital/manager	1	Normalization (w.l.o.g.)
Private Benefits and Reservation Utility			
b	private benefits	0.2	Used to match reallocation/turnover rate of 3.1%
$v(K/k)$	res. utility	$v(K/k) = \nu K/k$	Assumed proportional to K consistent with [GL]
		$\nu = 0.05$	Normalization (w.l.o.g.)
Discretization			
K	state space	[5 : 0.015 : 5.9]	Bounds on state space not binding
z, Π	agg. productivity	8 states	Discretized using quadrature-based method from [TH] to match ρ and σ_ε^2

Table 3: Simulation Results

Panel A: Capital, Output, Investment, and Consumption	
Ratios	
$E[K]/E[Y]$	2.593
$E[I]/E[K]$	0.100
Standard Deviations	
$\sigma(\ln(Y))$	2.77%
$\sigma(\ln(I))$	4.59%
$\sigma(\ln(C))$	2.60%

Panel B: Reallocation, Compensation, and Turnover	
Ratios	
$E[R]/(E[I]+E[R])$	23.82%
$E[R]/E[K]$	3.11%
Correlation	
$\rho(\ln(R), \ln(Y))$	0.715
$\rho(\ln(\text{compensation}), \ln(Y))$	0.742
$\rho(\text{turnover}, \ln(Y))$	0.742

Figure 1: CEO Turnover, Executive Compensation, and the Business Cycle

CEO turnover and executive compensation over the business cycle. Solid line denotes GDP, dash dotted line denotes CEO Turnover, and dashed line denotes mean compensation for the top 5 executives in firms that belong to the S&P 1500 index. See Table 1 for details and sources of the data. Plotted series are the cyclical component of Hodrick Prescott (1997) filtered data.

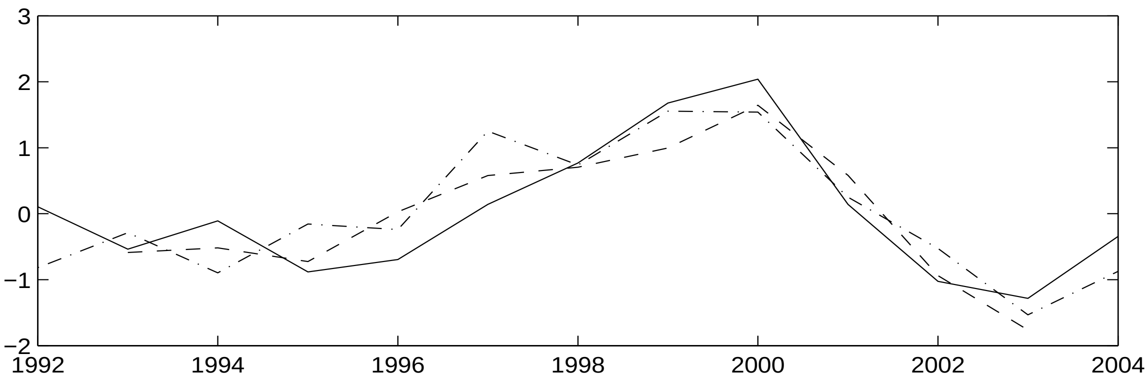

Figure 2: Timeline for 3 Date Economy

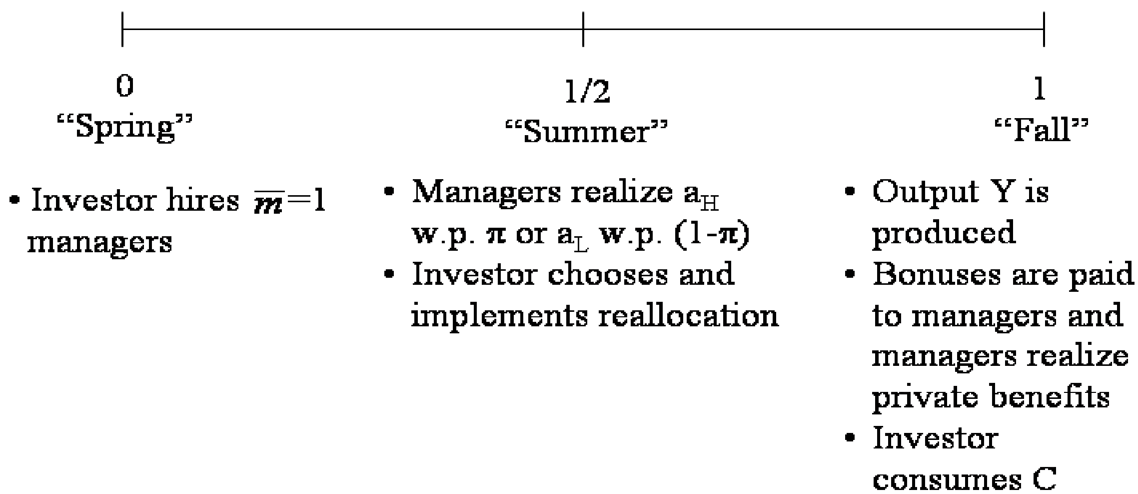

Figure 3: Payoffs to Managers (x Axis) and the Investor (y Axis)

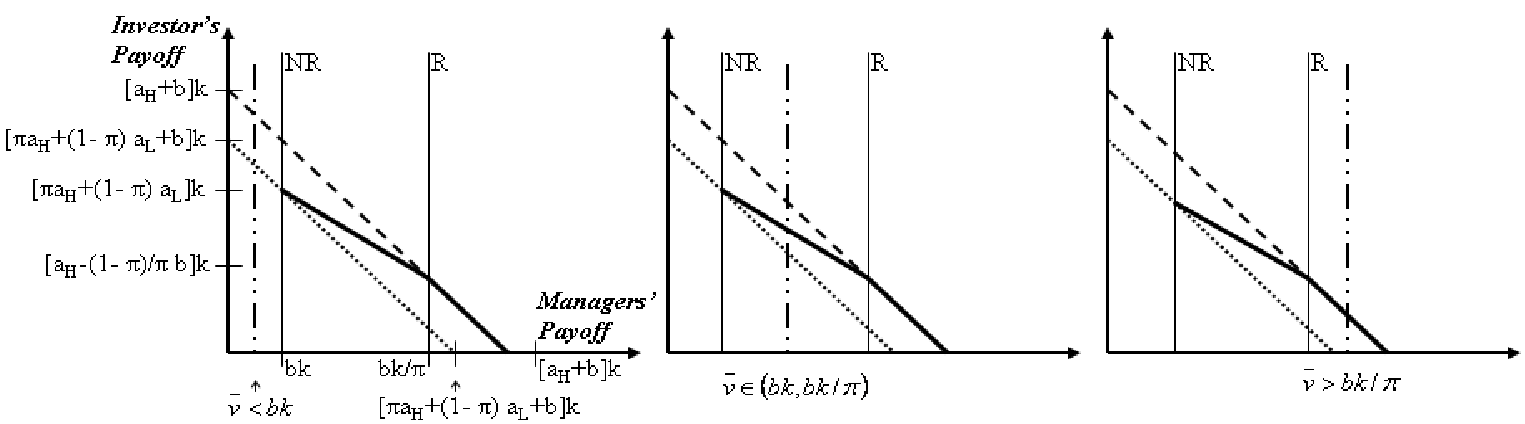

Figure 4: Timeline for Infinite Horizon Economy