DISCOURAGING RIVALS: MANAGERIAL RENT SEEKING AND ECONOMIC INSUFFICIENCIES

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ABSTRACT

Management has enormous discretion in choosing the form of a firm's investment. We ask: what sort of investments will management make in order to entrench itself, minimizing the probability of being ousted and maximizing its rents? The paper analyzes a number of managerial entrenchment activities. In our main model we explain how investing in risky investments -- and particularly those whose risks are sooner or more fully resolved for insiders than for outsiders -- leads to managerial entrenchment. We identify a number of complementary reasons that such investments will be favored by management that seeks its own rents over firm value. The model is adapted to rationalize management touting itself, independent of other egoistic explanations. Finally, we present a simple model which illustrates the entrenching value of idiosyncratic investments and organizational structure which can provide motivation for the creation of standard operating procedures.

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Discouraging Rivals:

Managerial Rent Seeking and Economic Inefficiencies[1]

1. Introduction

Managerial theories of the firm have a long and controversial history in economics, dating at least back to Berle and Means' classic [1932] study.   This literature postulated that managers had a great deal of discretion in the running of the enterprises that were entrusted to them, and that they exercised this discretion to pursue objectives other than that associated with maximizing shareholder market value.

Critics of this literature argued that if the managers of a firm did not maximize shareholder value, the firm would be taken over. Any policy other than value maximization could not be part of an equilibrium. Alternatively, shareholders would vote the management out of office. In effect, these critics claimed that managers really have no discretion.

The recent literature on information economics has laid these criticisms to rest. The very information problems which give rise to a _need_ for management lead to information asymmetries between management and shareholders.   Indeed, it has become increasingly

apparent that there are major information asymmetries between Boards of Directors--whose job it is to represent the interests of the shareholders--and management; these information asymmetries mean that Boards of Directors can provide only limited discipline on management (which is not to say that that discipline is not itself vital). And these information asymmetries provide management with considerable discretion.

At the same time, it is now recognized that neither the take-over mechanisms nor the shareholder-voting mechanism may exercise effective discipline.[2] These analyses have focused on the facts that information is costly and that the Good management of a firm is a Public Good in the sense that if the profits of a firm increase, all shareholders benefit simply in proportion to their ownership claims (just as if the likelihood of default is decreased, all creditors within the same priority class benefit essentially equally). Since it is costly to obtain information, any small shareholder has an incentive to free ride on the efforts of others to make the company perform better (e.g. replacing ineffective management). It does not pay any

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[2]The theoretical literature on take-overs includes Stiglitz [1972, 1975] and Grossman and Hart [1980]. There is by now a vast empirical literature on the subject, which includes Scharfstein [1988], Shleifer and Vishny [1988], and Jensen [1988]. For discussions of the voting (or proxy) and other control mechanism, see Stiglitz [1982], Morck, Shleifer, and Vishny [1989], and Jensen and Ruback [1983].

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shareholder to obtain the information necessary to exercise his proxy vote intelligently. Moreover, upon seeing a take-over which will enhance the productivity of the firm, and hence the firm's market value, a small shareholder is better off holding on to his shares; and by definition, since he is small, he believes that the outcome of the take-over battle will be unaffected by his decision. Indeed, the theoretical arguments suggest that the take-over mechanism should be even less effective than it seems to be. At this point, the theoretical puzzle is not so much how to explain the existence of managerial discretion, but to explain the existence of managerial discipline.[34]

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[3]Early literature, such as Berle [1926], stressed the role of banks (as opposed to shareholders) in exercising this discipline. See also Stiglitz [1985]. More recently, organization theorists and some economists have began to emphasize what might loosely be referred to as social control mechanisms (attempts to make managers identify with the company, to adopt the "well-being" of the corporation as their own private goals.) See Simon [1991] and Akerlof [1991].

[4]While this literature was establishing the possibility that management might not maximize stock market value--and still survive--another strand of the literature argued that shareholders might not want (at least unanimously) the firm to maximize shareholder value. Essentially, only under the stringent assumptions of a complete set of risk markets would there be unanimity on shareholder maximization as a goal (Stiglitz [1969, 1972b], Grossman and Stiglitz [1977, 1980]; an extensive literature, beginning with Radner [1974] and Leland [1974] attempted to show that there might be somewhat weaker, but economically relevant,

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Recent thinking has thus returned to the position of the earlier managerial literature which simply took the existence of managerial discretion as an obvious fact and focused on what objectives the managers did in fact pursue. Baumol [1959] and Marris [1964] emphasized growth maximization. March and Simon, while drawing attention to a number of the factors that determined

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conditions under which unanimity in favor of value maximization would exist; in retrospect, it is clear that these attempts failed.) Another line of argument growing out of the Stiglitz [1969,1972] analysis showing that shareholder value maximization would not be constrained Pareto efficient argued that there might be unanimity among shareholders, but on an objective that was different from value maximization. Curiously, this literature simply ignored the possibility of take-overs; moreover, a critical assumption in these models was that there was no trade in the stock-market.

The issue of non-value maximizing behavior is more than just a theoretical possibility. Assume that the controlling shareholders believe (on the basis of their inside information) that a particular project will yield enormous returns; outsiders, not having that information, and not finding management's statements credible, think the project will be a disaster. Short run value maximization would entail abandoning the project. Management claims that long run value maximization necessitates sacrificing current market value maximization. Issues of this form lie behind many take-over battles (or at least lie behind the debates used by one or the other side justifying their actions or plans). The theoretical literature simply emphasizes that these real life issues are simply ignored by the neoclassical model which underlies so much of economic analysis. It is the uncertainty associated with the consequences of the actions which, ultimately, provides management with its managerial discretion. (See Stiglitz [1972])

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what drew managerial attention (such as putting out fires), introduced the notion of "satisficing." Leibenstein [1965] talked about this as providing the basis for what he referred to as X-efficiency.

This paper is a continuation of that tradition. It begins with the hypothesis that management acts in a self-interested manner. It wishes to maximize its own income. The information imperfections which underlie managerial discretion provide management with the opportunity to obtain rents, that is, payments in excess of their opportunity costs. This paper accordingly explores the consequences of managerial rent-seeking behavior. It thus takes up on a theme first explored in Shleifer and Vishny's extremely insightful paper [1989] on "Managerial Entrenchment."[5]

A recent literature on incomplete contracting has emphasized its consequences for investment. Concern about the possibility of opportunism (to use Oliver Williamson's phrase) leads to underinvestment in relationship specific investments. If management invests heavily in human capital which is specific to the firm, then it exposes itself to the possibility that the Board of Directors will take advantage of it; since that capital is worth little elsewhere, the firm (through its Board of Directors) can expropriate the

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[5]They cite an earlier, unpublished paper by DeAngelo and DeAngelo [1983]. Later discussions will clarify the ways in which our analysis modified and expands on Shleifer and Vishny's work.

returns to that capital.

We argue here that there are a wider range of biases associated with the allocation of resources by management. What is affected is not so much the <u>level</u> of investment, but the form.[6] And it is not only investment in human capital, but also physical capital.

The basic hypothesis is a simple one: the pay that management receives is the outcome of a bargaining process between management and the Board of Directors.[7] An essential determinant of the outcome of that bargaining process is their productivity relative to the quality of alternative management teams and the wages that they would insist on receiving, were they to replace the current management. There are thus <u>two</u> ways of increasing compensation: increasing one's own productivity (the aspect stressed by most of the literature to date), and decreasing the threat of alternative management teams. Reducing the threat of alternative management can be accomplished in several different ways:

(a) Investments, the return to which requires specific information controlled by current management,

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[6]See Edlin [1992] for the argument in an incomplete contracts context like Williamson's that the important distortions there are also in the form and not in the level of investment.

[7]Since the Board of Directors is often chosen by the management, this model really understates the scope for managerial rent seeking behavior.

or which is well matched to the attributes of current managements, but ill matched with attributes of alternative management, may reduce the productivity of alternative management. Just as an idiosyncratic filing system can make a secretary "irreplaceable," an idiosyncratic management or organizational structure can make current management "irreplaceable."

(b) By investing in activities for which problems of information asymmetries are greater, current management can decrease the quality of the alternative management applicant pool, and again increase its rents.

Both of these provide examples of how the interests of management and the interests of shareholders may come into direct conflict; managerial discretion can provide management with the ability to pursue its interests at the expense of shareholders. Management would, of course, never openly explain that that was what is was doing. It would claim that the idiosyncratic organizational structure was necessary in order optimally to exploit the peculiar attributes of this particular firm's niche in the market. It would claim that the investment was undertaken because of the merits of the investment, and that the failure of outsiders to understand the merits of the investment was an example of the extra-ordinary depth of insight of the current management. They were not just run of the mill people who saw the world as everyone else did. Management might actually believe these lines. There might even be a grain of truth in them. The essential

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problem posed by information imperfections is that we will never know! Not even ex post, when the project turns out to be less successful than management "promised" can we be sure whether it was management's pursuing its own interests, at the expense of the company, that was the source of the problem: in a world with risk, there are a host of explanations for why things turned out badly. But as economists, we approach matters simply: we postulate that there is a tendency for individuals to act in their self-interest; we attempt to identify the incentives present in any situation, and presume incentives give us a good guide to understanding economic behavior in that situation. Thus, our argument is that given the by now well established scope for managerial discretion, managers have an incentive to exercise that discretion in ways which enhance their income. And a principal way of doing so is to reduce the threat of competition from alternative management teams.[8]

This paper is divided into four sections, beyond this introduction. In the next section, we analyze a model where current management attempts to "discourage" rival applicants by affecting the information they have

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[8]There is a strong similarity between our argument in this context and Salop and Scheffman's [1983, 1987] analysis of behavior of firms in imperfectly competitive markets. They argue that firms can enhance their profits not only by increasing their own productivity, but also by reducing the threat of rivals, i.e. by raising rivals' costs.

available. In section 3, we use the model of section 2 to explain the rationality of managers without large egos making decisions that could be interpreted as self-aggrandizing. In section 4, we analyze a model where current management attempts to lower the productivity of alternative management teams. The final section discusses some of the implications of our analysis.

2. Discouraging Rivals: I
Investing to Create Asymmetries of Information (Noise)

The model we now present has two stages. In the first, the manager has discretion in choosing investments. After investments are chosen, in the second stage, the Board of Directors has some choice in who manages the firm's assets. The Board can negotiate to rehire the incumbent manager to manage them, or it can hire some alternative manager or management team. After investments are made and uncertainty is realized, the firm's profits depend upon the inherent quality of the manager who ends up managing the assets, the level of effort the manager exerts and the amount the manager is paid; the Board hires the manager who it anticipates will leave the firm the highest profits. The effort the manager exerts will in general depend upon her appraisal of her returns to effort given her incentive contract.

We postulate that managers invest in pursuit of an objective function of an extremely simple form. They invest to maximize the probability that they are rehired after the investments times the rents they expect to

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accrue conditional upon being rehired:

Max   Prob (Manager rehired) E [Rents | manager rehired].

These rents are intended to be in units of utility and are the difference between the utility the manager could get from outside opportunities and the manager's utility from the stage two contract, which is a function of the wage she negotiates and the effort level she chooses to expend under the wage contract.[9] The model we present will allow us to be more specific about the sources of these rents. At a general level, though, our arguments will be that as the inherent quality of a manager's rivals goes down, or as the effort of alternative managers goes down, or as alternative managers demand higher wages to accept the position, other things being equal the incumbent manager will gather increased rents as a result of bargaining with the Board. At the same time these three effects should all increase the probability that incumbent management is rehired. In short, it pays incumbent management to discourage potential rivals to increase its own tenure and rents. Below, we show how management can accomplish this.

Firms receive returns R on their investments

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[9]Our formulation will ignore the consequences of managers' actions on the wages they receive if their employment is terminated. We shall comment on this later.

$$R = q(C_1 + C_2) \tag{1}$$

where

q = the effective quality of workers (which may depend either on their inherent ability or their level of effort e), and

C_i measures "prospects" of the firm in project i.[10]

C can be thought of as the underlying "capital" of the project. This capital is related to the firms' investment (with noise). We could relate the firm's eventual outcome (profits) to C, with noise. For simplicity, however, we shall assume that the outcomes are just measured by C, but that outsiders can only observe C with noise.[11] The noise increases with the size of the investments--the random component increases just proportionately. Thus, we postulate that

$$C_i = F_i \ (I_i) + \theta_i \tag{2}$$

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[10]We can associate a project with a time period, so the two projects can be thought of as a "short run" project or a "long run" project.

[11]We owe a debt to Paul [1991] for some of the basic approach here. He analyses the incentives of managers to be myopic in allocating their effort in order to boost stock price.

where

$$\theta_i \sim N(0, I_i^2 \sigma_i^2), \quad i \in \{1,2\}. \tag{3}$$

While the insiders--the directors and the incumbent--both observe C_i accurately, outsiders see only the investments I_i and a noisy signal, Y:

$$Y_i = C_i + \epsilon_i, \tag{4}$$

where

$$\epsilon_i \sim N(0, I_i^2 w_i^2), \quad i \in \{1,2\}, \tag{5}$$

and where ϵ_1 and θ_1 are independent. Accordingly, to the outsiders, the expected value of the prospects of the firm conditional upon the observations Y_1 and Y_2 are given by[12]

$$E[C_1 + C_2 \mid Y_1, Y_2) = \beta_0 + \beta_1 Y_1 + \beta_2 Y_2 \tag{6}$$

where

$$\beta_i = \sigma_i^2 / (\sigma_i^2 + w_i^2), \quad i \in \{1,2\}.$$

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[12]We derive this result in Appendix A.

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Discouraging Rivals' Effort

After the investments are chosen, the assets must be managed, either by the incumbent management, or by some alternative management team. In either case, management maximizes its expected utility, given its information. For simplicity, we assume that the management has a pre-specified contract that gives it a share in profits.[13] Thus, if W represents managers' fixed wage income that is not dependent on the outcomes, s their share of profits, U their utility function, $p(e)$ their personal cost of expending effort e, and Φ their information set, the managers' effort problem is to

$$\text{maximize} \quad E\, U\, [W + s(C_1 + C_2)q(e) - p(e) \mid \Phi]. \quad (7)$$

We simplify further by assuming a constant absolute risk aversion utility function, so that the certainty equivalent is linear in the mean and variance.[14] Thus,

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[13]The empirical evidence suggests that in fact s may be quite small. See Jensen and Murphy [1990]. Obviously, the distortions with which we are concerned in this paper would not arise if s=1, i.e. the manager owned the firm. We now have a good understanding of why typically s is small: even if the manager had enough capital, he is risk averse; and in general, he has insufficient capital. A variety of adverse incentive effects arise from debt financing.

[14]We do not really require constant absolute risk aversion for lemma 1 to hold and all the subsequent analysis to be valid. In particular we do not require the strong linearity that accompanies constant absolute

managers

$$\text{maximize} \quad W + sq(e) \ E[(C_1 + C_2) \mid \Phi] - ks^2q^2$$
$$x \ (\text{Var} \ (C_1 + C_2) \mid \Phi \ )) - p(e) \qquad (8)$$

where

$$\text{Var} \ (C_1 + C_2) \mid \Phi \ )$$

is the variance of $C_1 + C_2$ conditional upon the information Φ and where k equals 1/2 of the degree of absolute risk aversion. Because effective worker quality q is assumed to increase with effort, it is easy to establish

Lemma 1. e^{*i}, the value which solves the manager's effort choice problem above, increases with $E[(C_1 + C_2) \mid \Phi]$ and decreases with Var $(C_1 + C_2) \mid \Phi$).

For manager i, with reservation level r(i), to be willing to work for the firm, it must be the case that

$$W + sq(e^{i}*) \ E\{(C_1 + C_2) \mid \Phi] - p(e^{i}*)$$
$$> r(i) + ks^2q^2 \ \text{Var} \ (C_1 + C_2 \mid \Phi). \qquad (9)$$

Firms form some direct appraisal of alternative

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risk aversion. It would be sufficient for our purposes that managers' utility be some increasing function of expected wages and decreasing in the variance of wages; effort might enter arbitrarily.

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management's quality:

$$q_e = q^i(e*^i) + u^i. \tag{10}$$

Our analysis focuses on the effect of current management's actions in (i) affecting the "applicant" pool for the managers' job; and (ii) affecting the board of directors' assessment of (and in this case, the actual level of) effectiveness of alternative management.

In this model, current management acts to reduce the effectiveness of alternative management by increasing their perceived uncertainty about the value of the assets which they may manage. Thus, an increase in

$$(\text{Var }((C_1 + C_2)|\ \Phi_{alt}\ ) - \text{Var }((C_1 + C_2)|\ \Phi_{inc}) \tag{11}$$

(where, in the obvious notation, Φ_{alt} denotes the information of the alternative management teams and Φ_{inc} that of the incumbent management team) increases the difference in the effort levels of incumbent management relative to alternative management teams.

Since the incumbent observes $C_1 + C_2$, whereas the alternative management team can only form probability expectations from observing the noisy signals Y_1, Y_2, other things equal, in order to increase risk for the alternative, the incumbent will emphasize investments in the highly noisy (high w^2) investments. For, as is

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shown in Appendix A,

$$\text{Var } (C_1 + C_2 \mid Y_1, Y_2) = \frac{\sigma_1^2 w_1^2 I_1^2}{\sigma_1^2 + w_1^2} + \frac{\sigma_2^2 w_2^2 I_2^2}{\sigma_2^2 + w_2^2} \quad [15] \quad (12)$$

It is also true, therefore, that investing in high risk investments (high σ^2) from a class of investments with the same level of noise is evidence of rent seeking behavior. Finally, in choosing among projects with similar risk levels (σ^2) and noise for outside investors (w^2), managers will increase the risk to alternative management teams by concentrating their investments, because of the convexity of I^2. Accordingly, over specialization may result from rent seeking.

Discouraging Applicants

By the same token, the increased risk makes it more likely that the reservation wage equation will be violated, i.e. the alternative management team will simply choose not to apply. (Alternatively, it will have to be given a larger compensation to offset the

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[15]This conditional variance can be rewritten as half the harmonic mean of the underlying variances σ^2 and the observational variances w^2: i.e.,

$$\frac{\sigma^2 w^2}{\sigma^2 + w^2} = \frac{1}{\frac{1}{\sigma^2} + \frac{1}{w^2}}.$$

risk; we return to this later.)

Increasing Rivals' Winners Curse

Secondly, by increasing noise, the incumbent management enhances the perception of a winners' curse problem on the part of alternative management teams, and this discourages applicants (or leads them to insist on higher offsetting compensation). To see this, recall that the incumbent knows $C_1 + C_2$, so that

$$E(C_1 + C_2 \mid \Phi_{inc}) = C_1 + C_2 \tag{13}$$

The alternative management does not know $C_1 + C_2$, but it knows that if it observed a value of Y_1 and Y_2 such that its expectation of $C_1 + C_2$ were the same as that of the incumbents, the Board of Directors would likely stick with the incumbents, for two reasons: (a) all else being equal, incumbents will work harder (because they perceive less risk); and (b) they will be willing to accept the job at lower compensation, since their perceived risk is smaller.[16]

Thus, the incumbents will be able to cut a deal with the Board of Directors beating out rival management offers except if (a) the quality of the current management is very low or its reservation wage is very

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[16]This assumes that the alternative management team cannot observe the quality of the incumbent management team; if they can, then they would have to take this into account.

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high; (b) the Board of Directors' estimate of the alternative management team's ability is high (e.g. as a result of a high value of u); (c) the alternative management team has seriously overestimated the value of the project (ϵ is high relative to θ.) Holding the first two sets of factors constant, the alternative management knows it gets the job only when its signal is very good relative to the true prospects. It takes this into account in forming its expectations.

Thus, in determining whether to apply, the alternative management teams look at

$$E[C_1 + C_2 \mid Y_1 , Y_2, \text{incumbents not hired}), \quad (14)$$

not just at

$$E[C_1 + C_2 \mid Y_1 , Y_2]. \quad (15)$$

Since

$$E[C_1 + C_2 \mid Y_1 , Y_2, \text{incumbents not hired})$$
$$< E[C_1 + C_2 \mid Y_1 , Y_2] \quad (16)$$

outsiders are further disadvantaged: this reduces both their effort, and their willingness to accept a job.[17]

We now assume that the incumbent managers' rents

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[17]Alternative management teams estimate of the relevant variances may also have to be altered to take into account the winners' curse phenomenon, but the truncation should still leave the risk ordering of investments the same.

conditional upon being rehired go up linearly with the wedge[18]

$$C_1 + C_2 - E(C_1 + C_2 \mid Y_1, Y_2, \text{incumbents not rehired}),$$

and the conditional variance

$$\text{Var } (C_1 + C_2 \mid Y_1, Y_2, \text{incumbents not rehired}) \tag{17}$$

that is,

rents conditional upon being rehired
$$= \max \{0, b_1 [C_1 + C_2 - E(C_1 + C_2 \mid Y_1, Y_2, \text{incumbents not rehired})]$$
$$+ b_2 \text{Var } (C_1 + C_2 \mid Y_1, Y_2, \text{incumbents not}$$

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[18]This formulation is made for simplicity, and probably underestimates the incentives for distortionary behavior. An alternative formulation would assume rents go up linearly with the differences in expected outputs, which would depend both on the expected value of "q" of alternative management and on the wedge. Since effort increases with the expected value of $C_1 + C_2$, this would suggest that rents would increase more than proportionately with the magnitude of the wedge. Moreover, this formulation does not take into account the effect of the size of the applicant pool on the rents which the incumbents can garner for themselves; as we have seen, incumbent management can reduce this.

rehired)).[19]   (18)

The incumbent managers' investment problem is to

$$\max_{\{I_1, I_2\}} \text{E [rents conditional upon being rehired]}$$
$$\text{x P\{incumbents are rehired\}} \tag{19}$$

Thus, the return to noisy investments (those with a high value of w^2 or σ^2) are larger than those for which Y's are good signals of the projects C's, for four distinct reasons: (a) the noise directly discourages rivals' effort, and thus makes them less attractive as alternative management; (b) the noise directly discourages rivals' from applying (and makes them insist on higher compensation), thus making them a less viable threat; (c) the noise increases the asymmetry of information and accordingly the winner's curse effect; and (d) rents are expressed as the maximum of zero and the difference between what the firm appears to be worth to insiders, $C_1 + C_2$, and to alternative management, $E(C_1 + C_2 \mid Y_1, Y_2, \text{incumbent not rehired})$; importantly this maximum is a convex function of rivals' expectations and so noise increases its value.

Reason (d) deserves some elaboration. Even apart from the direct effect of noise on alternative's effort

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[19]Rents, which are by definition the excess of what managers are paid over their outside opportunities, can never be negative or the managers would accept their outside opportunities.

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(a) and wage demands (b) that come from the conditional variance term, and apart from the winner's curse phenomenon (c), investment in high σ^2 activities would still constitute rent seeking. With those simplifications, although there would be no expected "wedge," i.e. $E(C_1 + C_2 - E(C_1 + C_2 \mid Y_1, Y_2)) = 0$, the fact that outside opportunities serve as a floor for managers' pay means the convex "max" interposes itself when equation (18) is plugged into (19) so that incumbents are not concerned with $E["\text{wedge}"]$ but with $E[\max\{0, "\text{wedge}"\}]$. Therefore, increased dispersion in the form of high σ^2 investments raises managers' ex ante returns. This follows from the fact that $E[C_1 + C_2 \mid Y_1, Y_2]$ is a normal variable and its variance can be seen to be $I_1{}^2 \sigma_1{}^2 + I_2{}^2 \sigma_2{}^2$ by inspecting equation 6.

If outside potential managers can see C_1, C_2 perfectly, then the wedge and the variance term disappear, and there are no managerial rents.

Consider the extreme case where project 1 can be observed perfectly and there is considerable noise in the observation of project 2, with project 2 being slightly worse than project 1. We would expect all investments to be made in the noisy project, even though shareholders would like it in project 1. By investing in the second project, managers raise both the probability of staying and the average rents they obtain when they stay.

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Extensions: Multidimensional Effort

Much of the same analysis could be done regarding how a manager devotes her efforts if effort were a multidimensional variable. In allocating a given amount of effort, we would expect to see managers over-emphasize effort in activities that create noise over those that create higher expected returns. The analysis would come to largely opposite conclusions of Paul [1991], who studied the allocation of managerial effort in a model where managers seek to maximize stock market value which is determined by outsiders' valuations. Here, in contrast, incumbent management seeks rents by lowering outsiders' valuations.

Extensions: Unobservable Investment

Another difference between Paul [1991] and this model is that effort in his model was unobservable, whereas investment, the comparable variable in our model, is observable. If our investment were unobservable, a new bias in favor of high noise investments would emerge. The outsider's, or rival's, expectations $E(C_1 + C_2 \mid Y_1, Y_2)$ are formed from equilibrium and not deviated investment levels. Deviations serve to change Y_1 and Y_2 without changing the rule, or conditional expectation formula given by equation 6, through which these expectations are formed. Assume that with rational expectations outsiders come to believe that managers are choosing a particular mix of projects with particular signal-to-noise ratios. An

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unobserved increase in investment in a high noise-to-

signal ratio investment (high $\frac{w^2}{\sigma^2}$) would raise $E(C_1$

+ C_2 | Y_1, Y_2) by less than an investment with a low

$\frac{w^2}{\sigma^2}$. With the same level of real returns F',

investment would be reallocated to the noisy investment
which would increase the expectation of the wedge C_1 +
C_2 - $E(C_1 + C_2$ | $Y_{1,2})$.[20] Therefore, there is a bias in
favor of very noisy investments and a corner solution to
the investment problem is only avoided if there are
sufficiently decreasing real returns to the noisy
investment $F'' < 0$.

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[20]With full knowledge of her investment level, the
incumbent manager forms expectations about what
outsiders' uninformed expectations will be. The
incumbent's expectations might be written $E_{in}[E_{out} (C_1 +
C_2$ | Y_1, $Y_2)$ | I_1, $I_2]$, and it is important to realize
that it is an equilibrium condition that at the
equilibrium investment levels, I_1^*, I_2^* $E_{in}[E_{out} (C_1 + C_2$
| Y_1, $Y_2)$ | I_1^*, $I_2^*]$ = $E_{in}(C_1 + C_2)$ I_1^*, $I_2^*)$. Because of
the information difference of the two expectation
operators, this equality would not hold "out of
equilibrium" if the incumbent reallocated investment to
try to create a wedge in an effort to seek rents. This
equality is a condition reflecting consistent or
rational expectations.

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It is also worthwhile to compare our analysis to
Shleifer and Vishny [1989].   They get the result that
managers   overinvest   in   projects   that   they   are
particularly good at because managers can get rents from
the specific asset that is created.   They see the
situation as being different from a Williamson-style
underinvestment in firm-specific human capital (by the
employee) because in the case of asset acquisition, the
manager spends the firm's money instead of her own time
or energy, as in human capital development.   We might
argue that even in the case of human capital, a manager
might overinvest.   For the situation is not nearly so
simple as if the result were merely that the firm held
the manager up for some of her returns.   After all, the
signals Y that alternative managers see are in reality
apt to conflate the manager's quality q with the firm's
prospects $C_1 + C_2$, as we explain in the next section.
And, if larger self-investments in q are associated with
higher noise, then outsiders' estimates of $C_1 + C_2$ will
be   noisier   and   this   will   discourage   alternative
management teams.

3.   Discouraging Rivals: II
The Rationality of Hubris

Numerous commentators have commented on the role
of managerial hubris (Roll [1986]).   An apocryphal story
has it that the likelihood of a firm undertaking a

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hostile take-over is related to the size and prominence of the CEO's picture in the annual report. In this view, it is not managerial economics but managerial egos which drives many a corporate decision.

These views can, in a formal sense, be incorporated within the standard agency framework. Managers get utility out of controlling large firms and winning take-over battles. At the margin, they are willing to trade-off stock market value (most of the costs of which are borne by others) for an increase in their managerial utility. Thus, they are willing to undertake even value decreasing take-overs.

One can use the framework developed in the previous section to argue for another perspective. There is a certain rationality involved in managers undertaking actions which "tout" themselves, even apart from its direct "ego boosting" impact on managerial utility. Assume that outsiders do not observe C_i, but qC_i, that is, the product of the quality of the project and the quality of the incumbent management. They cannot tell whether the prospects of the firm are good (C's are high) or whether the incumbent management is simply doing an extraordinary job of extracting high returns out of a lousy set of assets (C's are low, q is high).

The incumbent would like to convince outsiders that any observed high returns are due to his high quality (his q), rather than to the firms' intrinsic assets. This may lead the incumbent to put too much

energy into high visibility projects, such as those reported on the business pages of the major newspapers, to make himself look high quality, and, by implication, the corporation's assets look correspondingly smaller. These actions lower $E(\ C_1 + C_2\ |\Phi_{alt})$.[21]   Such high visibility projects may be motivated by rent seeking and need not, then, be motivated by ego.

4. Discouraging Rivals III
Idiosyncratic Investments

Shleifer and Vishny [1988], in their article, focus on the role of idiosyncratic investments in managerial entrenchment, assets the value of which is greater to incumbent management than to alternative management. Here, we extend their analysis by showing how it distorts the allocation of investment.

It may be helpful to think of a computer programmer who is writing a program that must be long and intricate. A program is not uniquely defined by its functionality, as many possible programs function similarly. The programmer can invest her time in writing a well-documented program that another

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[21]There is a certain similarity between this argument, and the distortions in behavior of a monopolist attempting to discourage rivals. Salop [1979] and Milgrom and Roberts [1982] argued that by producing more, or pricing lower, outsiders might infer that the producers' marginal costs were lower, and this would discourage entry, thus providing a rationale for "limit pricing."

programmer can understand or she can write it with no useful documentation or "comments." She may organize the program along conventional lines, or strike out on her own, with algorithms that she invented. If she writes it in an idiosyncratic way and without documentation, then if the program is unfinished or could be productively modified or improved, she will have improved her bargaining position immensely by ruining her rival's ability to be productive at her job.

To formalize this idea, we assume the firm has a choice of two investment projects, yielding revenues

$$R = q_{1j} \; f(I_1) \; + \; q_{2j} \; f(I_2)$$

where

q_{ij} = effective quality of manager j in managing project i.

We postulate that each project can be set up optimally for the idiosyncrasies of particular managers. Denote a project's sensitivity to the idiosyncratic system by υ, i.e.

$$q_{ij} = 1 - \upsilon_i \; (\; s^j \; -s_i* \;)^2$$

where s^j denotes the style of the manager. The incumbent chooses s_i* corresponding to his own style. The incumbent manager then has an incentive to allocate

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more investment to the project with the higher sensitivity.

Consider first a situation where every manager has his own style s different from all others, but where search is costless. In this model, then, rents are

$$b \ [(\Sigma \ f(I_i) \ \upsilon_i \ \underset{\{alt \ managers\}}{Min} \ (s_{alt} - s*)^2]$$

which implies that managers will invest so that

$$f'(I_1) \ \upsilon_1 \ -f'(I_2) \ \upsilon_2$$

This should be contrasted with the pattern of investment where the manager simply maximize firm returns:

$$f'(I_1) \ =f'(I_2)$$

Thus, the manager invests more in the highly idiosyncratic projects than he would if he were interested in maximizing the firm's returns.

The weight placed on idiosyncratic investment is greater than suggested by this calculation, since it ignores the effect on the applicant pool, and on the probability of being replaced. Projects with a higher value of υ will, in general, have higher values of υ Min $(s_{alt} - s*)^2$, lowering the attractiveness of the job to outside managers; more of them will find it unattractive to apply; and the Board of Directors is more likely to

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determine that none of them represent an improvement over current management.

With costly search and imperfect information on the part of potential managers or the Board of Directors, there are further incentives for idiosyncratic investments. First,

$$\text{Min} \quad (s_{alt} - s*)^2 < E \quad (s_{alt} - s*)^2,$$

that is, the minimum value of the idiosyncratic cost is less than the expected value at the point where search is terminated.

Secondly, if alternative managers cannot perfectly observe s*, and they are risk averse, their expected value because of $(s_{alt} - s*)^2$ will be higher than the true value by Jensen's inequality and their expected utility will be lower; it is more likely that they will not apply for the job, or will insist on a sufficiently higher wage to make them unattractive to the Board of Directors.

Thirdly, if the Board of Directors cannot perfectly observe s_{alt}, then the expected loss from a mismatch (even with rational expectations) is increased (again because of Jensen's inequality).

5. Implications

In this concluding section we discuss some of the implications and interpretations of our analysis. We ask four questions:

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1)   To what extent can this model provide an
interpretation   of   certain   alleged   "biases"   or
peculiarities in managerial behavior, e.g. the bias to
excessive growth?

The model does provide a _partial_ explanation of
the bias toward growth. In our view, managers' rents
are associated with the noise associated with the assets
they manage. If a firm never invested in new projects,
this noise might diminish as the returns provided by the
project would provide good information about the value
of the assets.   For although firms do have large
discretion in shifting income from one year to another,
and this is one of the factors that makes income a noisy
signal, they cannot simply make up income figures, at
least not indefinitely. Indiscriminate growth will not
help management much, of course, and if growth were
comprised of replication of established ventures of
known value, it would not benefit management. In our
model, it is growth in new areas where it is
simultaneously the case that returns are uncertain, σ^2
> 0, and the uncertainty is resolved sooner for insiders
than outsiders, so $w^2 > 0$. The larger are both σ^2 and
w^2, the larger will be the managers' rents.   In our
view, it is a fair generalization to think that in new
and emerging enterprises both σ^2 and w^2 are quite high;
but even if the noise w^2 to outsiders were not higher
than other investments once θ is realized, we would
contend that the harmonic mean of σ^2 and w^2 is
substantially higher for an emerging technology than for

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other investments.

There is both a positive and a negative side to this. The negative side is that noise is favored over value. The positive side is that this bias towards innovative activity--investments in new areas and expenditures on R & D--countervails several other tendencies in managerial firms towards excessive conservatism, including (i) the fact that managers are likely to be more risk averse than the widely-diversified shareholders that predominate among most major corporations, and (ii) the bias towards short term investments with immediate returns that many have claimed characterized modern capitalist economies.[22]

The model also provides an explanation of the insistence in many firms on the use of standard operating procedures (SOPs). Since idiosyncratic organization of the firm and its projects helps management entrench itself and earn rents, requiring conformity with SOPs reduces the scope for managerial entrenchment. SOPs are to organizations what standardized fittings and replaceable parts are to machines; they enable any manager to be replaced at relatively low cost.

Finally, we should point out here that our model may provide insight into the value to a manager of

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[22]See Paul [1991] for a short survey of the literature on myopia and for an excellent theory of managerial myopia, based on managers maximizing stock market value in a noisy world.

having loyal subordinates and the tendency of new managers to do a great deal of hiring and firing among the top ranks. Most obviously, having loyal subordinates makes the company less valuable in the hands of an alternative CEO for reasons along the lines of the idiosyncratic investments in section 4. But also, to the extent that there is uncertainty about the degree of loyalty of subordinates, and correspondingly of the difficulties new management will face, we are in the ambit of section 2. Moreover, once a new manager takes over, even if he can work adequately well with the old managers' supposed "loyalists," so that he himself becomes entrenched. He will want to bring in new people to create noise regarding the extent to which new management can easily start running this company.

2) What implications does the theory have concerning the efficiency of corporate acquisitions and divestitures--the rearrangements of the control of society's assets which so characterized the 1980s? Standard take-over theory argued that these rearrangements were necessarily efficiency enhancing; in each case, the asset was sold to the manager/management team that could most effectively deploy those assets.

Our view questions this conclusion. To a large extent, these corporate reorganizations can be viewed as (multilateral) exchanges. A firm trades in one "division" in one industry for a division in some other industry. In the model of Section 4, where there are no

information problems, these corporate rearrangements are efficiency enhancing: as in usual trade theory, exchanges are mutually beneficial, allowing each firm to specialize in those activities in which it has a comparative advantage. The inefficiencies in that model occur prior to the trade--in the design of the investment, which, it will be recalled, was made so that others were at a disadvantage. By assumption, if there exists some other management team which could more productively use those assets (relative to its alternative opportunities, which defines, in effect, the payments which are required to compensate it), then of course the managers can receive no rents (at least attributable to that part of the business). Continuing to own those assets increases the probability of being replaced, because it implies that (overall) there exist alternative management teams with higher values for those assets. The argument, of course, is perfectly symmetric[23]: if a firm acquired an asset for which there exists an alternative managerial team that could use those assets more productively, it would (in general) lower the difference between the aggregate productivity of the firm's assets with the current

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[23]Contrary to the suggestion in Shleifer and Vishny [1989].

management team and with alternative management teams.[24]

The analysis of Section I, based on information asymmetries, provides a more plausible analysis of patterns of divestiture and acquisition, patterns which can give rise to inefficiencies. In this view, there are no rents associated with well established enterprises. Thus, it pays to spin off these assets, to owner-managers for whom rent seeking is not important; while managers in firms with managerial discretion can use the proceeds from such spin-offs to purchase assets the value of which is hard (for outsiders) to ascertain. Thus, in an auction for an asset, what any manager is willing to pay depends not only on what return he believes the firm can extract from the asset, but also

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[24]There are, of course, exceptions: the firm might acquire an asset for which its nearest management rivals are particularly ill-suited. But even this case is not persuasive: for the alternative management teams know that they could divest themselves of that asset, and be no worse off. That is, the correct way of looking at the productivity of alternative management teams with a particular firm's assets is to take account of any divestitures which would occur afterwards. It is possible that these investments are sunk costs in the sense that they cannot be spun off and be divested from the firm. How important these sunk costs are, however, is problematical.

Perhaps the most important distortion arises from the fact that managers might be tempted to focus on acquisitions in which there are sunk costs (so that they cannot easily be undone) and in which there is scope for altering the shape of the investments to make them more idiosyncratic.

the rents which he can extract from his control of the asset. These rents are likely, for instance, to be larger if he can quickly alter the asset, so that its market value (even taking account of the information established in the sale by which he acquired it) becomes more uncertain. Thus, the "managerial" value of an asset may differ across firms; and the asset will be sold to the firm with the highest "managerial" value, which need not be the firm which has the highest expected value of returns.

3)   Boards of Directors are, or should be, aware of these biases in managerial behavior. Is there anything they can do to offset or limit these effects? (This assumes, of course, that the Board of Directors is not, itself, part of management, in which case there is no real direct control on managers, other than through the very imperfect mechanisms discussed in section 1.) There are several answers.

First, by being aware of the natural potential biases in managerial behavior, the Board can inspect managerial recommendations for investments to uncover, and stop, the most flagrant instances of biased investment behavior. (Many of the biases are subtle; given the uncertainty surrounding managerial decision making, it may be difficult to detect the presence of the bias; management will come up with alternative justifications for management-entrenchment investments. Still, it is more likely that biases will be detected if

Boards of Directors are on the look-out; and knowing that the Board of Directors is worried about this may discourage management from undertaking the most flagrant forms of managerial-entrenchment investments.)

Secondly, in our analysis, we have assumed that after the investments there are no asymmetries of information between the Board and management. It may actually pay to create such asymmetries (e.g. through the appointment of relatively uninformed outside Directors); outside Directors will view projects much as potential outside managerial teams do. Thus, projects which look less attractive (perhaps because they appear riskier) to other possible alternative management teams (thus increasing managerial rents) also look less attractive to "outside" managers.[25]

This outside director strategy, however, is not without its drawbacks, because it may conflict with another obvious strategy to combat rent seeking-- preventing management from making entrenching investments to begin with. And, it is an open question whether the independence of an outside director is a good trade-off for the insights of insiders who might, as in many Japanese firms, be chosen from future

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[25]Since the value a worker contributes to the firm from the point of view of the Board increases in $E[C_1 + C_2 \mid \Phi \text{ Board}]$ we would expect a manager's rents to be lower, other things equal, when this expectation is lower. This will counter balance the distortion from the $-E[C_1 + C_2 \mid \Phi_{alt}]$ term in section 2.

generations of the firm's leaders who may want to avoid squandering the firm's resources.

Third, as we have already noted, by insisting on the firm developing standard operating procedures, the firm can make the replacement of existing managers easier, and thus reduce their rents.

A major quandary facing firms, however, is that many investments which increase firm profits also increase managerial rents. That is, pure profits are low or non-existent in standardized commodities (sometimes referred to as commodity markets); they are high in new enterprises, in areas where there is learning with little spill-overs to those outside, i.e. where the information which is acquired is not easily transferable. But the barriers which serve to enhance firm profits also serve to enhance managerial rents.

Thus, for instance, managerial rents are likely to be small in the context of the production of a commodity which is produced by many firms. There will be many alternative management teams. But then, profits of the firm are likely to be small for this form of investment as well.

Firms face another quandary: by enhancing managerial job security they may reduce managers perceived return to entrenchment. (Job security relates to the change in the probability of being replaced, but it is natural to assume that if the average probability of being replaced is reduced, so is the marginal return.) But then they not only reduce managerial

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incentives, but also increase the scope for managerial discretion, and thus the opportunity for managers to divert the firm's resources to their private gain. And since managerial rents are a function of the difference between the value of the firm under the current management and under alternative management, there remains a marginal return to reducing the value under alternative management (as described in the previous sections of the paper); accordingly, management will have an incentive to use this discretion to increase their rents. Thus, it is not clear that enhanced managerial security will significantly reduce managerial biases; it may even exacerbate the problems.

A final possibility would be for the Board to seek a way to prevent renegotiation of wages. It might "constitutionalize" the matter by putting the CEO's pay into the corporate charter (as a function of stock performance). Corporate charters may, however, be changed, and to the extent the Board's hands are tied, that too will come with a cost.

Perhaps the strongest way to minimize the rent seeking we analyze is the common plan to solve other agency problems--at the expense of risk, high stock ownership by management.

4) Is there anything the government can do to alleviate these problems? The underlying problem that we have uncovered here is an information problem, the inability of the Boards of Directors to distinguish

entrenchment activities from legitimate business activities, at least in time to stop them. It would appear, a fortiori, that the government would be at a disadvantage in distinguishing these, and so direct government action restricting entrenchment is unlikely to be productive.

But the government can take actions which affect the magnitude of the rents, and accordingly of the rent seeking behaviors. To be sure, there is no general theorem assuring that a reduction in rents will reduce the marginal return to rent seeking activities, and therefore will reduce managerial biases. Still, in a wide variety of circumstances, one might think that by and large, reducing the magnitudes of the rents will lead to a shift in managerial attention to more constructive, value enhancing activities.

Rents can be reduced in three different ways. First, to a large extent managerial pay is established by reference to the pay received by other managers; there is no evidence that the lower levels of pay received by managers in Europe and Japan have adverse effects, either on those entering managerial jobs or on the efforts which are exert on their companies behalf. Thus, making it more expensive for firms to pay high managerial pay is likely to reduce managerial pay. Higher taxes on managerial pay in publicly held

corporations with widely diversified shareownership[26] in excess of a certain threshold, reporting requirements on proxy statements of total managerial compensation, and publicity campaigns explaining how stock options impose costs on other shareholders through dilution might all have positive effects.

Secondly, the government can affect the extent of competition in the market for managers; to a large extent, rents are a result of limitations on competition. Thus, the restrictions on poison pills and other management techniques which make it more difficult to replace management have been criticized on the grounds that by weakening the market for management, they enable resources to be managed by less efficient management. Critics of these take-over mechanisms have countered with the contention that evidence that take-overs result in improved management is, at best, weak. Our analysis has provided another argument against the anti-takeover tactics (and legislation which facilitates, or does not prohibit them): the reduced managerial competition not only increases the scope for managerial rents, but increases the scope and incentives for distortionary behavior designed at enhancing managerial rents.

Thirdly, and perhaps most problematical, the

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[26]When share ownership is concentrated, there is a stronger presumption that the owners can exercise effective control.

government can affect the structure of the capital market, and the relationship of the capital market to corporate behavior. Here, our comments are perhaps even more tentative than our earlier suggestions.

One needs to ask, is it just an accident that Japan and Germany have a markedly different system of capital markets and that the levels of managerial rents in those countries are apparently much lower? As we noted in the introduction, it has long been recognized that in widely diversified firms, shareholders do not exert effective control partially because the free rider problem gives no shareholder the incentive to invest much in obtaining the requisite information. Banks, in providing credit, have both the ability (through the withdrawal of credit) and incentives to do so, and thus can exercise more effective control (Berle [1926], Stiglitz [1985]). The Japanese and German banking systems may facilitate that exercise of control, thus providing a check on the manager's ability to extract rents, and so on her rent seeking behavior. These systems, to be sure, come with other advantages (such as their behavior in response to cyclical variability) and disadvantages, particularly their potential for concentration of economic power and loss of competition; within this broader perspective, concerns about managerial rent seeking may be only a second order consideration.

Still, while anecdotes do not prove a case, we may usefully ask whether the abuses of managerial discretion

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that were uncovered in the take-over and merger frenzy of the 1980s and discussed in such popular classics as Barbarians at the Gate are truly unrepresentative, drawing our attention because they were so atypical? Or do they represent the tip of an iceberg? By their very nature, the distortionary behavior we have discussed is hard to detect; it is only when the abuses become so large that they can no longer be ignored that we can be sure that they have in fact occurred.[27] It is likely that more subtle abuses occur daily in thousands of

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[27]Two analogies may be useful. Samuelson's so called neoclassical synthesis argued that once the government had intervened to ensure full employment, standard classical propositions concerning the efficiency of the market obtained; while many modern theories claim that the kinds of resource misallocations associated with the Great Depression and other recessions are but the tip of an iceberg: why should we believe that economic forces could allow such massive inefficiencies in resource allocation, but not allow, at the same time, smaller (and therefore harder to detect) inefficiencies.

While it is hard for economists to assess how efficient firms are (since they are not privy to the details of the technology), there is one aspect of their behavior where it is relatively easy to assess efficiency--that concerning taxation. There are, by now, a large number of so-called tax paradoxes (Stiglitz [1982] (involving the treatment of inventories, accelerated depreciation, executive compensation, dividends); in these instances, firms could have reduced their tax liabilities, without adversely affecting any other objective of the firm. Should we assume that these well documented failures are isolated, aberrations, or that they are representative of a wider class of non-maximizing behaviors?

firms; and while each of them may be relatively small in magnitude, when added together, they may amount to a significant distortion in economic behavior. As economists, it is hard not to take seriously the possibility that managers do in fact respond to the economic incentives which they face. We have argued that these economic incentives are likely to lead them to rent seeking behavior, not all of which is to the benefit either of the firm for which they work or the economy as a whole.

We here prove a simple statistical lemma necessary to derive the conditional expectations $E[C_1 + C_2 \mid Y_1, Y_2]$ and variances $V[C_1 + C_2 \mid Y_1, Y_2]$ given in the paper.

Lemma 2. If x,y are independent normal variables and $x \sim N(0, \sigma^2)$ $y \sim N(0, w^2)$, then $x \mid x + y = s \sim$

$$N\left(s \ \frac{\sigma^2}{\sigma^2+w^2}, \ \frac{\sigma^2 w^2}{\sigma^2+w^2}\right).$$

Proof: The conditional density of x can be written

$$f(x \mid x + y = s) = \frac{f(x, x+y=s)}{f(x+y)}$$

$$= \frac{\dfrac{1}{2\pi\sigma w} \exp\left(-\dfrac{x^2}{2\sigma^2}\right) \exp\left(-\dfrac{(s-x)^2}{2w^2}\right)}{\dfrac{1}{\sqrt{2\pi}\sqrt{\sigma^2+w^2}} \exp\left(\dfrac{-s^2}{2(\sigma^2+w^2)}\right)}$$

$$=$$

$$\frac{\sqrt{\sigma^2+w^2}}{\sqrt{2\pi}\,\sigma w} \exp\left[\frac{-x^2(\sigma^2+w^2)}{2\sigma^2 w^2} + \frac{xs}{w^2} - \frac{s^2}{2w^2} + \frac{s^2}{2(\sigma^2+w^2)}\right.$$

$$=$$

$$\frac{\sqrt{\sigma^2+w^2}}{\sqrt{2\pi}\,\sigma w}\,\exp\left[-\frac{\sigma^2+w^2}{2\sigma^2 w^2}\left(x^2 - 2x\,\frac{\sigma^2}{\sigma^2+w^2} + \frac{s^2(\sigma^2)}{(\sigma^2+w^2)}\right)\right.$$

$$=$$

$$\frac{\sqrt{\sigma^2+w^2}}{\sqrt{2\pi}\,\sigma w}\,\exp\left[-\frac{\sigma^2+w^2}{2\sigma^2 w^2}\left(x - s\,\frac{\sigma^2}{\sigma^2+w^2}\right)^2\right]$$

Thus, $(x,\ x + y = s) \sim N\left(s\,\dfrac{\sigma^2}{\sigma^2+w^2},\ \dfrac{\sigma^2 w^2}{\sigma^2+w^2}\right)$. Q.E.D.

Given lemma 2, it is easy to see that $E[C_1 + C_2 \mid Y_1, Y_2]$ and $V[C_1 + C_2 \mid Y_1, Y_2]$ are as given in the paper. Since the investment levels are known,

$$E[C_1 + C_2 \mid Y_1, Y_2] = F_1(I_1) + F_2(I_2) + E[\theta_1 \mid e_1$$
$$+ \theta_1 = Y_1 - F_1(I_1)] + E[(\theta_2 \mid e_2 + \theta_2 = Y_2 - F_2(I_2))]$$

and by lemma 2 this equals,

$$F_1(I_1) + F_2(I_2) + \beta_1\,(Y_1 - F_1(I_1))$$
$$+ \beta_2\,(Y_2 - F_2(I_2))$$

where

$$\beta_i = \frac{\sigma_i^2 I_i^2}{(\sigma_i^2 + w_1^2)\,I_i^2} = \frac{\sigma_i^2}{\sigma_i^2 + w_i^2}\ .$$

Choosing $\beta_0 = F_1(I_1)[1-\beta_1] + F_2(I_2)[1-\beta_2]$, we get the formula in the text for $E[C_1 + C_2 \mid Y_1,\ Y_2]$.
It can also be seen that

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$$V(C_1 + C_2 \mid Y_1, Y_2) = V[\theta_1 \mid e_1 + \theta_1 - Y_1$$
$$- F_1(I_1)] + V[\theta_2 \mid e_2 + \theta_2 - Y_2 - F_2(I_2)]$$

By lemma 2 this equals half the sum of the harmonic means of $I_1^2\sigma_1^2$ and $I_1^2 w_1^2$ and of $I_2^2\sigma_2^2$ and $I_2^2 w_2^2$, as written in the text:

$$\frac{I_1^2\sigma_1^2 w_1^2}{\sigma_1^2 + w_1^2} + \frac{I_2^2\sigma_2^2 w_2^2}{\sigma_2^2 + w_2^2}$$

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