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Author(s): Adolfo de Motta
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Managerial Incentives and Internal Capital Markets

ADOLFO DE MOTTA *

ABSTRACT

Capital budgeting in multidivisional firms depends on the external assessment of the whole firm, as well as on headquarters' assessment of the divisions. While corporate headquarters may create value by directly monitoring divisions, the external assessment of the firm is a public good for division managers who, consequently, are tempted to free ride. As the number of divisions increases, the free-rider problem is aggravated, and internal capital markets substitute for external capital markets in the provision of managerial incentives. The analysis relates the value of diversification to characteristics of the firm, the industry, and the capital market.

RECENT LITERATURE SUGGESTS that corporate diversification is out of style. However, the fact remains that many corporations are remarkably diversified: In 1992, 87 percent of the 500 largest U.S. public companies operated in more than one SIC code (Montgomery (1994)). Since most large firms are multidivisional, their internal capital markets play an important role in the investment decisions of the economy. I study the process by which internal capital markets channel funds within corporations, focusing on the following effects. Corporate headquarters can create value in a multidivisional firm by monitoring division managers and efficiently allocating funds across divisions. On the other hand, each division manager in a multidivisional firm takes the external perception of the whole firm as a public good, and is tempted to free ride on this perception.

In the model, division managers can take costly, unobserved actions that increase divisional profits. Divisional profits also increase with divisions' efficiency levels, which are unknown *ex ante*. External investors and corporate headquarters draw inferences about efficiency from profits, while corporate headquarters has access to inside information that can also be used to draw infer-

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ences about efficiency. This information may be acquired through the interaction that it has with the divisions within the corporation. Investment in each period is based on expected profits, which depend on assessed efficiency. Finally, both headquarters and division managers are empire builders seeking to maximize the amount of resources under their control.

Consider, first, the case of a stand-alone firm, that is, a firm with a single line of business or division. The division manager of this firm has the incentive to influence the investors' learning process, and hence future investment, by taking unobserved actions that increase divisional profits. The greater the realized profits, the greater the external assessment of efficiency, and, subsequently, more funds are allocated to the firm and, hence, to the division.

Now consider a multidivisional firm, where actions by division managers have two effects. First, they increase the firm's profits, and thus attract external funds to the firm (this is similar to the stand-alone case). Second, they increase the division's profits, and thus attract internally allocated funds to the division.

The first effect gives rise to a free-rider problem, as future funds are shared among all the divisions within the corporation. As the number of divisions increases, the free-rider problem is aggravated, and internal capital markets substitute for external capital markets in the provision of managerial incentives.

The second effect generates the benefits of multidivisional firms: The division manager may have stronger incentives to increase current profits when monitored by headquarters than when monitored by external investors.

The trade-off between these two effects is influenced by the quality of information available to external investors and to headquarters. If external investors cannot extract much information about efficiency from profits, they provide division managers with weak incentives to increase these profits, and, hence, the multidivisional structure is better than the stand-alone. If, however, headquarters has precise inside information about efficiency, division managers can hardly influence headquarters' assessment by increasing current profits. Thus, in this case, the stand-alone structure provides stronger managerial incentives than the multidivisional structure.

Based on the previous considerations, this analysis yields several testable implications. First, as just discussed, if external investors are inefficient at extracting information from profits, the multidivisional structure is better than the stand-alone. To the extent that less developed capital markets are characterized by relatively unskilled investors, this suggests a negative relation between the development of the external capital market and the value of multidivisional (i.e., diversified) firms relative to the value of stand-alone ones.[1] This is consistent with available empirical evidence. Recent empirical work shows that U.S. capital markets discounted diversified corporations during the 1980s by as much as 13 to

[1] The relation between the development of the external capital market and the value of diversification could be viewed as two interdependent outcomes. While an underdeveloped external capital market induces firms to create internal capital markets, the creation of internal capital markets could, as well, prevent the development of the external capital market.

15 percent (Berger and Ofek (1995)). However, in countries where external capital markets were less developed, diversification increased value (Fauer, Houston, and Naranjo (1998)).

Second, the stand-alone structure provides stronger incentives than the multidivisional structure in new and high-growth industries and in younger firms. These industries and firms are characterized by high *ex ante* uncertainty (i.e., diffuse priors about efficiency), which increases the impact that new information has on the assessment of efficiency. Headquarters relies relatively more than external investors on nonprofit related information, which does not provide division managers with incentives to increase current profits, and therefore, in these industries, external capital markets are a stronger source of incentives than internal capital markets.

This paper is methodologically inspired by Holmstrom's (1999) career concerns model. In the spirit of the career concerns literature, division managers have incentive to influence the learning process, and, hence, future investment, by taking unobserved actions that increase current profits.

Other papers have studied internal capital markets. For a complete view of the literature on internal capital markets, see Stein (2001) and the references therein. As in this paper, Stein (1997) models corporate headquarters as an intermediary between external investors and division managers. Corporate headquarters creates value by efficiently allocating funds across divisions. However, in Stein (1997), division managers are passive agents that have no effect on divisional profits.

Stein (2002) introduces "active" division managers and studies their research incentives. He shows that headquarters' and division managers' research effort can be strategic complements or substitutes depending on the nature of the information. This paper also introduces "active" division managers and studies their incentives; however, it does not focus on information production. Furthermore, in this paper, unlike in Stein (2002), both external investors and headquarters provide division managers with incentives to increase profits.

Rajan, Servaes, and Zingales (2000) and Scharfstein and Stein (2000) study the effect of bargaining power and influence activities on the allocation of resources by internal capital markets. They both conclude that multidivisional firms might decrease value because corporate headquarters are likely to cross-subsidize divisions. This paper abstracts from allocation problems and studies the effect that a well-functioning internal capital market has on managerial incentives.

Gertner, Scharfstein and Stein (1994) show that internal capital markets reduce managerial incentives because, unlike external financing, (division) managers do not have control rights and might be subject to *ex post* opportunistic behavior. They identify headquarters with owner-investors, and in doing so, leave aside agency problems at the headquarters level. Furthermore, their article does not focus on competition for corporate funds, which is one of the characteristics of internal capital markets addressed in this paper.

The rest of the paper is structured as follows. In Section I, I present the main model. Section II solves the model and gives the main results. Section III studies the implications of allowing for the provision of explicit incentives. Finally, Section IV offers concluding remarks.

I. Model

I consider a two-period model ($t = 1,2$) with no discounting and three stages in each period. In stage 1, external capital markets (i.e., external investors) provide funds to the firm. In stage 2, corporate headquarters allocates these funds across the divisions of the corporation. Finally, in stage 3, profits are realized. Furthermore, in period 1, between stages 2 and 3, division managers choose unobserved actions that increase divisional profits.

A. Agents

There are three risk-neutral agents: (1) external capital markets/external investors, (2) corporate headquarters, and (3) division managers.

External capital markets/External investors own the corporation and provide the necessary funds for investment. Specifically, external investors provide F_t funds to the firm in period t. External investors choose the amount of funds that maximizes expected profits.

Corporate headquarters allocates the funds provided by external investors across the divisions. Corporate headquarters has monitoring skills that allow it to acquire inside information about the divisions and to potentially improve the allocation of resources inside the firm. However, corporate headquarters is an empire builder that derives private benefits in direct proportion to the investment in the firm, and whose objective is to maximize expected investment.[2] When headquarters is indifferent to the allocation of funds, it will maximize expected profits.

Division managers, like headquarters, are empire builders, but they only derive private benefits from investment in their divisions. Division managers may take unobserved actions that are costly to them but that increase divisional profits in period 1. They only take these actions if an increase in divisional profits improves external investors', as well as headquarters', assessment of their divisions and raises future funding. Division manager i has the following utility function:

$$u_i = I_{i1} + I_{i2} - g(a_{i1}) \tag{1}$$

where I_{it} is investment in division i in period t and a_{i1} is the action taken by division manager i in period 1. The cost function $g(.)$ is increasing and convex, and $g'(0)=0$.[3]

[2] This assumption may be interpreted in several ways. First, it captures managerial career concerns. Empirical evidence on managerial compensation shows that there is a high correlation between the level of compensation and firm size (Hall and Liebman (1998)). To the extent that managers perceive this relation, they may try to increase the level of investment, and hence the size of their corporation. Alternatively, it represents benefits, such as social status and power, that managers derive from running a large organization.

[3] Implicit in this setup is the assumption that division managers' participation constraints are not binding. In the model, division managers take costly actions but are not rewarded for them in equilibrium; external investors and headquarters anticipate managers' actions and, therefore, these actions do not influence their assessments. I will revisit this assumption in Section III, which considers explicit incentives.

B. Organization and Technology

While stand-alone firms have only one division, multidivisional firms consist of N ($N>1$) divisions. Every division i is characterized by a parameter η_i that represents its efficiency level. This parameter, η_i, is constant over time and sums up all technological and organizational factors that influence division i's performance. Division i is also subject to a transitory shock ε_{it} that affects divisional profits in period t. Shocks are independent across divisions and across time, and have zero expectation. Finally, the profits of division i in period 1 increase with a_{i1}(the action taken by division manager i).

Division i's profits in periods 1 and 2 are given by the following expressions:[4]

$$\pi_{i1} = (\eta_i + a_{i1} + \varepsilon_{i1})I_{i1} - \frac{1}{2}I_{i1}^2 \tag{2}$$

$$\pi_{i2} = (\eta_i + \varepsilon_{i2})I_{i2} - \frac{1}{2}I_{i2}^2 \tag{3}$$

C. Information

The following assumptions regarding information are made:

(A1) At the beginning of period 1, all agents have the same prior, denoted by Ω_1 about the divisions' efficiency levels, $\{\eta_i\}$.[5]

(A2) At the beginning of period 2, headquarters and division managers have an informational advantage over external investors with respect to the efficiency of the divisions. I denote by $\Omega_2^{Mkt}, \Omega_2^{HQ}, \Omega_2^{Mng}$ the information of external investors (i.e., external capital markets), of headquarters, and of division managers, respectively, at the beginning of period 2.

$$\Omega_2^{Mkt} \subset \Omega_2^{Mng} \subseteq \Omega_2^{HQ}. \tag{4}$$

Finally, I assume that external investors and corporate headquarters cannot commit to financing decisions that are *ex post* inefficient. In practice, there is an important part of the information that determines the optimal level of investment (e.g., industry prospects, the firm's characteristics, etc.) on which one cannot fully contract. Ignoring this information and contracting *ex ante* is likely to be prohibitively expensive. Furthermore, it is not credible to commit to an investment plan that sometimes results in *ex post* underinvestment, since all interested parties—external investors, headquarters, and division managers—would have incentives to increase *ex post* the level of investment.

The sequence of events in each period t is illustrated in Figure 1.

[4] Profits are net of investment cost.

[5] This assumption allows me to abstract from strategic revelation of information in the allocation of funds. If headquarters had an informational advantage in period 1, its allocation of funds might convey information to investors, and, hence, headquarters could distort that allocation to influence future investment. This is not the case in period 2; when headquarters makes the allocation of funds in period 2, investors have already made all their funding decisions.

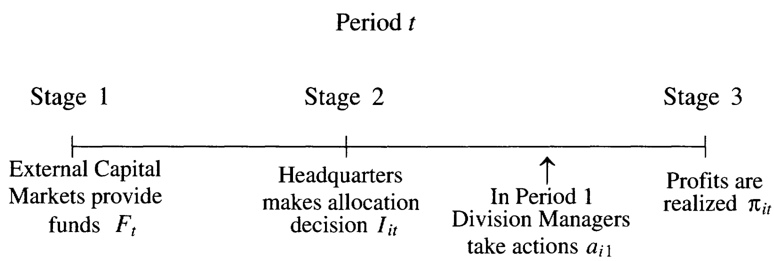

Figure 1. Stages in period *t*.

II. Analysis

First, I characterize the first-best solution. Then, I solve the model for stand-alone firms and for multidivisional firms. Finally, I explore a richer set of assumptions about the learning process that allows me to derive additional implications. Proofs are provided in the Appendix.

A. First-best

The first-best investment, I_{i1}^{FB}, and action, a_{i1}^{FB}, for division i in period 1 is the solution to the following optimization problem:

$$\max_{I_{i1},a_{i1}} E(\pi_{i1}|\Omega_1) + 2I_{i1} - g(a_{i1}) \tag{5}$$

where $2I_{i1}$ is the sum of the utility that corporate headquarters and division manager i obtain from an investment I_{i1} in the division.

Assuming that this is a concave problem,[6] the following first order conditions (f.o.c.) characterize the first-best:

$$g'\left(a_{i1}^{FB}\right) = I_{i1} \tag{6a}$$

$$I_{i1}^{FB} = 2+E(\eta_i|\Omega_1) + a_{i1}. \tag{6b}$$

Notice that the first f.o.c. characterizes the first-best action a_{i1}^{FB} for a *given* level of investment I_{i1}. In particular, a_{i1}^{FB} increases with I_{i1}.

The second f.o.c. characterizes the first-best investment I_{i1}^{FB} for a *given* managerial action a_{i1} Specifically, I_{i1}^{FB} increases with the expected efficiency of the division and with the managerial action.

Following the same steps, the next equation characterizes the first-best investment I_{i2}^{FB} for division i in period 2:

$$I_{i2}^{FB} = 2 + E\left(\eta_i|\Omega_2^{HQ}\right). \tag{7}$$

[6] For example, in the case of a quadratic cost function $g(a) = ca^2$concavity implies $c > \frac{1}{2}$.

B. Stand-alone Firms

This section solves the model for a stand-alone firm. To simplify notation, I drop the subindex i for the only division in a stand-alone firm. The model is solved by backwards induction.

Period 2

In stage 2, since headquarters seeks to maximize investment, it channels all available funds to the only division in the firm$\left(I_2^{SF} = F_2^{SF}\right)$. *In stage 1,* external investors choose the amount of funds that maximizes expected profits. Because headquarters would have a tendency to overstate the investment needs of the firm, outside investors do not rely on headquarters' information in their funding decision (Sec. III addresses the possibility of using an incentive scheme to elicit headquarters' information):

$$\max_{\{F_2 \text{ s.t. } I_2^{SF} = F_2\}} E\left[(\eta + \varepsilon_2)\,|\Omega_2^{Mkt}\right] I_2^{SF} - \frac{1}{2}\left(I_2^{SF}\right)^2. \tag{8}$$

The level of funding F_2^{SF} is given by the expected efficiency of the firm's division conditional on the external capital markets' (i.e., external investors') information:

$$F_2^{SF} = I_2^{SF} = E\left[\eta|\Omega_2^{Mkt}\right]. \tag{9}$$

Period 1

The division manager realizes that the investment in period 2 depends on the external assessment of the firm. She tries to improve this assessment by taking an unobserved action, a_1^{SF}, which increases first-period profits. Since there is no private information at the time of taking the action, investors are able to infer a_1^{SF} in equilibrium. Specifically, the division manager takes action a_1^{SF} that maximizes her expected utility $E\left[u|\Omega_1, a_1^{SF}\right]$. Solving for the managerial action, the following f.o.c. is obtained:

$$g'\left(a_1^{SF}\right) = \frac{\partial E\left[E\left[\eta|\Omega_2^{Mkt}\right]|\Omega_1, a_1^{SF}\right]}{\partial a_1}. \tag{10}$$

This condition shows that the division manager has strong incentives to increase profits (i.e., higher a_1^{SF}) when her action has a large marginal effect on the external assessment of the firm.

In stage 2, headquarters channels all available funds to the division$\left(I_1^{SF} = F_1^{SF}\right)$. Finally, *in stage 1,* external investors provide funds to the firm. The level of funding F_1^{SF} is given by the expected efficiency of the firm's division plus the inferred managerial action:[7]

$$F_1^{SF} = I_1^{SF} = E(\eta|\Omega_1) + a_1^{SF}. \tag{11}$$

[7] I am implicitly assuming that investment decisions do not affect the learning process (i.e., that I_1 does not affect Ω_2^{Mkt} or Ω_2^{HQ}).

C. Multidivisional Firms

Period 2

In stage 2, because headquarters is concerned with the total investment in the firm, it allocates funds to maximize expected profits *subject to* investing all available funds, F_2:

$$\max_{\left\{I_{i2}\, s.t. \sum_{i=1}^{N} I_{i2}=F_2\right\}} E\left[\sum_{i=1}^{N}\left[(\eta_i+\varepsilon_{i2})I_{i2}-\frac{1}{2}I_{i2}^2\right]|\Omega_2^{HQ}\right]. \tag{12}$$

Assuming an interior solution, the following level of investment is obtained for division i:

$$I_{i2}^{MF}=\frac{F_2}{\mathrm{N}}+\frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right)-\frac{1}{N-1}\sum_{j\neq i}E\left(\eta_j|\Omega_2^{HQ}\right)\right\}. \tag{13}$$

In the solution, a marginal increase in the level of funding F_2 is divided equally among the N divisions of the corporation. This characteristic is specific to the model since all divisions have a profit function with the same degree of concavity. More generally, division managers do not receive the full marginal returns of their actions in the form of increased funding for their divisions. The external assessment of the firm is a public good for division managers because an increase in funding is shared among all the divisions. As a public good, its provision is subject to a free-rider problem that reduces the role of external capital markets in the provision of managerial incentives.

In stage 1, external investors take into account how headquarters allocates funds across divisions (i.e., $\{I_{i2}^{MF}\}$ as defined above). In particular, they maximize expected profits:

$$\max_{F_2} E\left[\sum_{i=1}^{N}\left[(\eta_i+\varepsilon_{i2})I_{i2}^{MF}-\frac{1}{2}\left(I_{i2}^{MF}\right)^2\right]|\Omega_2^{Mkt}\right]. \tag{14}$$

Solving the problem, the amount of funds provided to the multidivisional firm F_2^{MF} is the sum of the expected efficiency of the divisions of the firm:

$$F_2^{MF}=\sum_{i=1}^{N}E\left(\eta_i|\Omega_2^{Mkt}\right). \tag{15}$$

A multidivisional firm receives the same amount of funds as an equivalent portfolio of stand-alone firms. This result occurs despite headquarters' superior information.[8]

[8] In a more general setting, the amount of funds that a multidivisional firm is able to raise might be larger or smaller than the funds raised by a portfolio of comparable stand-alone firms. Assume, for example, that each of the N divisions attracts F funds as stand-alone firms. Now consider a multidivisional firm with these N divisions. The marginal return of the NFth unit could be larger or smaller than the opportunity cost of capital, and, therefore, the amount of funds raised by the multidivisional firm may be larger or smaller than NF. However, what is important for incentives is not the total level of funding but the marginal effect of the manager's action on the level of funding.

Period 1

Division managers try to influence external investors' and headquarters' assessments of their divisions by boosting first-period profits. In particular, division manager i chooses action a_{i1}^{MF} that maximizes her expected utility, $E\left[u_i|\Omega_1, a_{i1}^{MF}\right]$. The following f.o.c. characterizes action a_{i1}^{MF}:

$$\begin{aligned} g'\left(a_{i1}^{MF}\right) &= \frac{1}{N}\frac{\partial E\left[(N-1)E\left(\eta_i|\Omega_2^{HQ}\right) - \sum_{j\neq 1} E\left(\eta_j|\Omega_2^{HQ}\right)|\Omega_1, a_{i1}^{MF}\right]}{\partial a_{i1}} \\ &\quad + \frac{1}{N}\sum_{j=1}^{N}\frac{\partial\left\{E\left[E\left(\eta_j|\Omega_2^{Mkt}\right)|\Omega_1, a_{i1}^{MF}\right]\right\}}{\partial a_{i1}}. \end{aligned} \tag{16}$$

This equation identifies the different sources of managerial incentives. The first term captures the incentives provided by the internal capital market: A division manager tries to influence headquarters' assessment, and, hence, the allocation of resources inside the firm. The second term captures the incentives provided by external capital markets: A division manager also tries to influence external investors' assessment in order to increase the total funds available to the firm.

The equation also identifies the possible interactions among divisions in the learning process as managers may try to influence the assessed efficiency of the other divisions in the firm. In the spirit of the internal capital markets literature (i.e., pure diversification), I assume that division managers do not influence the assessment of the other divisions in the firm:

$$\frac{\partial E\left[E\left(\eta_j|\Omega_2^{h}\right)|\Omega_1, a_{i1}\right]}{\partial a_{i1}} = 0 \qquad h = \{Mkt, HQ\} \quad \text{and} \quad i \neq j. \tag{17}$$

Under (17), managerial incentives boil down to the following equation, where both sources of managerial incentives (internal and external) are still present:

$$g'\left(a_{i1}^{MF}\right) = \frac{1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{Mkt}\right)|\Omega_1, a_{i1}^{MF}\right]}{\partial a_{i1}} + \frac{N-1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{HQ}\right)|\Omega_1, a_{i1}^{MF}\right]}{\partial a_{i1}}. \tag{18}$$

PROPOSITION 1: *As the number of divisions increases, internal capital markets substitute for external capital markets in the provision of managerial incentives.*

The level of managerial incentives is a weighted average of the incentives provided by internal and external capital markets. As the number of divisions increases, the weight shifts towards the internal capital market. While an increase in the number of divisions aggravates the free-rider problem, it increases the importance of headquarters' assessment on the marginal funding received by the division.

LEMMA 1: *If headquarters has no informational advantage with respect to external capital markets ($\Omega_2^{Mkt} \equiv \Omega_2^{HQ}$), investment and managerial incentives in each division are independent of the organizational structure.*

Lemma 1 stresses the importance of headquarters' informational advantage. If headquarters has no informational advantage, the level of incentives does not depend on the number of divisions. The literature on internal capital markets has identified headquarters' informational advantage as one of the main sources for creating value in multidivisional firms (e.g., Stein (1997)). In the model, this is captured by higher expected profits in period 2 for multidivisional firms. However, headquarters' superior information also affects managerial incentives in period 1, which may increase or decrease the value of multidivisional firms.

PROPOSITION 2: *Multidivisional firms provide stronger (weaker) incentives than stand-alone firms if managerial actions have a greater (smaller) marginal effect on headquarters' evaluation process than on external investors' evaluation process:*

$$a_{i1}^{MF} > a_{i1}^{SF} \quad \textit{if} \quad \frac{\partial E[E\left(\eta_i|\Omega_2^{HQ}\right)|\Omega_1, a_{i1}]}{\partial a_{i1}} > \frac{\partial E\left[E(\eta_i|\Omega_2^{Mkt})|\Omega_1, a_{i1}\right]}{\partial a_{i1}}. \tag{19}$$

Headquarters' informational advantage may have positive or negative consequences for managerial incentives. Internal capital markets provide strong managerial incentives when managerial actions have a large marginal effect on headquarters' assessment of the divisions, which in turn depends on the weight given to first-period profits in this assessment. A richer set of assumptions about the learning process is necessary to determine whether headquarters' informational advantage increases or decreases managerial incentives.

In stage 2, headquarters' investment maximizes expected profits subject to investing all available funds F_1:

$$I_{i1}^{MF} = \frac{F_1}{N} + \frac{1}{N}\left\{\{(N-1)\left[E(\eta_i|\Omega_1) + a_{i1}^{MF}\right]\} - \sum_{j\neq i}\left[E\left(\eta_j|\Omega_1\right) + a_{j1}^{MF}\right]\right\}. \tag{20}$$

In stage 1, the level of funding in period *1* is the sum of the expected efficiency of the divisions plus the inferred managerial actions:

$$F_1^{MF} = \sum_{i=1}^{N}\left[E(\eta_i|\Omega_1) + a_{i1}^{MF}\right]. \tag{21}$$

Notice that the investment, $I_{i1}^{MF} = E(\eta_i|\Omega_1) + a_{i1}$, is smaller than the first-best investment *given* the managerial action, $I_{i1}^{FB}(a_{i1}) = 2 + E(\eta_i|\Omega_1) + a_{i1}$. External investors do not take into account the private benefits that division managers and corporate headquarters derive from the investment. Nevertheless, managerial incentives are independent of the level of investment in period 1.

A question remains whether the constrained optimal action a_{i1}^{MF} is higher or lower than the first-best a_{i1}^{FB}. The first-best action for *the given* level of investment,

$I_{i1}^{MF} = E(\eta_i|\Omega_1) + a_{i1}^{MF}$, is defined by

$$g'\left(a_{i1}^{FB}\right) = I_{i1}^{MF} = E(\eta_i|\Omega_1) + a_{i1}^{MF} \tag{22}$$

and a_{i1}^{MF} is defined by

$$g'\left(a_{i1}^{MF}\right) = \frac{1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{Mkt}\right)|\Omega_1, a_{i1}^{MF}\right]}{\partial a_{i1}} + \frac{N-1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{HQ}\right)|\Omega_1, a_{i1}^{MF}\right]}{\partial a_{i1}}. \tag{23}$$

In the spirit of the career concerns literature (Holmstrom (1999)), there is a fundamental incongruity in preferences: While division managers are concerned with the return of their actions in terms of future funding, investors are concerned with financial returns. Although, as is typical of the career concerns models, theoretically there is no clear relation between a_{i1}^{MF} and a_{i1}^{FB} empirical evidence suggests that $a_{i1}^{MF} < a_{i1}^{FB}$. For example, Gibbons and Murphy (1992) show that in the presence of both explicit and implicit incentives, compensation schemes will optimize total incentives. The fact that most compensation schemes have a positive pay-for-performance relation indicates that $a_{i1}^{MF} < a_{i1}^{FB}$. From this point, the following assumption, which guarantees that $a_{i1}^{MF} < a_{i1}^{FB}$, is made:

$$E(\eta_i|\Omega_1) > \frac{1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{Mkt}\right)|\Omega_1, a_{i1}\right]}{\partial a_{i1}} + \frac{N-1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{HQ}\right)|\Omega_1, a_{i1}\right]}{\partial a_{i1}}. \tag{24}$$

Under this assumption, stronger managerial incentives not only increase profits but also approach the solution, a_{i1}^{MF}, to the first-best.

LEMMA 2: *Stronger managerial incentives increase profits and cause a_{i1}^{MF} to approach the first-best.*

D. More Structure

To make finer predictions, I explicitly model the learning process by making the following assumptions:

(1) $\varepsilon_{it} = \varepsilon_{1it} + \varepsilon_{2it}$
(2) ε_{1it} and ε_{2it} are distributed $N\left(0, \sigma_{\varepsilon 1}^2\right)$ and $N\left(0, \sigma_{\varepsilon 2}^2\right)$ respectively
(3) The prior of the efficiency parameter η_i is distributed $N\left(m_i, \sigma_\eta^2\right)$
(4) All distributions are common knowledge and independent
(5) External investors observe $\{\pi_{it}, I_{it}\,; \forall i, t\}$
(6) Corporate headquarters observe $\{\pi_{it}, I_{it}, \varepsilon_{2it}, S_{it}\,; \forall i, t\}$ where $S_{it} \equiv \eta_i + u_{it}$ and u_{it} is distributed $N\left(0, \sigma_u^2\right)$.[9]

[9] Division managers' information at the beginning of period 2 does not affect our analysis. Division managers do not take any actions in period 2.

Assumptions 1 to 4 are made for convenience, since the updating process of the normal distribution is well understood. Assumptions 5 and 6 reflect headquarters' informational advantage over external investors. On one hand, headquarters is able to make judgments on efficiency beyond profit-related information. In particular, headquarters observes a signal S_{it}, which reduces the weight given to first-period profits in the updating process, and, hence, decreases managerial incentives towards boosting these profits. On the other hand, headquarters is also in a better position to determine the extent to which first-period profits are the result of some transitory shock. This is captured by the assumption that headquarters, unlike external investors, is able to observe ε_{2it}. This type of informational advantage, by increasing the weight given to first-period profits in headquarters' assessment of the division, makes internal capital markets a strong source of managerial incentives.

Lemma A.1 in the Appendix characterizes the updating process. Under this richer set of assumptions, the next proposition follows.

PROPOSITION 3: *(i) When external capital markets are inefficient relative to internal capital markets (when $\sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2$ is large), multidivisional firms provide stronger incentives than stand-alone firms. (ii) When the prior of efficiency is very diffuse (when σ_η^2 is large), stand-alone firms provide stronger incentives than multidivisional firms. (iii) When corporate headquarters accurately observes divisions' efficiency levels (when σ_u^2 is small), stand-alone firms provide stronger incentives than multidivisional firms:*

$$\text{For } \sigma_\eta^2 > 0, a_{i1}^{MF} > a_{i1}^{SF} \quad \text{iff} \quad \sigma_u^2 \frac{\sigma_{\varepsilon 2}^2}{\sigma_{\varepsilon 1}^2} > \sigma_\eta^2. \tag{25}$$

This result deserves some comments:

(i) When external investors are relatively inefficient at processing the information contained in divisional profits (when $\sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2$ is very large), they give little weight to first-period profits in their assessment.[10] Hence, external capital markets do not provide strong managerial incentives. This problem particularly affects stand-alone firms because external capital markets are their only source of incentives, whereas multidivisional firms also rely on their internal capital markets.

The following quote about India from Ghemawat and Khanna (1998, p. 46) describes the kind of problems associated with less developed capital markets studied in this paper:

> "Domestic institutional investors are only gradually acquiring the skills necessary for monitoring investments while foreign institutional investors are typically unfamiliar enough with the Indian business scene to provide adequate monitoring services."

[10] The total variance of the noise that external capital markets face is $\sigma_{\varepsilon 1}^2 + \sigma_{\varepsilon 2}^2$. The ratio $1 + \sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2$ measures the relative variance of the noise faced by external investors and headquarters. When $\sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2 = 0$, external investors can sort out as much noise as headquarters. When $\sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2$ is very large, it means that external investors can sort out a relatively small part of the noise.

Proposition 3 suggests a negative relation between the value of diversification and the development of external capital markets. This relation is consistent with available empirical evidence; while the U.S. market discounts diversified firms by as much as 13 percent, Fauer et al. (1998) show that in countries where firms have difficult access to external financing, diversification increases value. The allocation effect (headquarters' allocation of resources) reinforces the negative relation between the development of external capital markets and the value of diversification. However, if internal capital markets always improve the allocation of funds, the allocation effect alone cannot explain the observed diversification discount.

Further, the result suggests that as external capital markets develop, stand-alone firms become relatively more profitable (compared to divisions in multidivisional firms). Consistent with this, Berger and Ofek (1995) find that in the United States, stand-alone firms have higher margins and profitability than similar divisions in multidivisional firms. Notice that while the allocation effect may explain why multidivisional firms are more profitable than a portfolio of comparable stand-alone firms, it does not have clear implications for profitability at the divisional level.

So far, I have made comparisons between multidivisional firms and *all-else-being-equal* portfolios of stand-alone firms. Firms, however, may change their degree of diversification. As external capital markets develop, and investors can sort out a greater part of the noise (lower $\sigma^2_{\varepsilon 2}$), they become a more powerful source of incentives and the value of diversification decreases.[11] This suggests that as external capital markets develop (lower $\sigma^2_{\varepsilon 2}$), firms should go through a focusing process. For example, Habib, Johnsen, and Naik (1997) show that spin-off announcements in the United States have generally been accompanied by an increase in the firm's value.

Corollary 1 summarizes the implications derived from part (*i*) in the previous proposition.

COROLLARY 1 *As external capital markets develop (lower $\sigma^2_{\varepsilon 2}$): (1) the value of diversification decreases, (2) stand-alone firms become more profitable than divisions in multidivisional firms, and (3) firms become less diversified.*

(ii) When the prior of efficiency is diffuse (high σ^2_{η}), new information will be weighted heavily in the updating process. While for stand-alone firms, all new information comes from profits that division managers can increase with their actions, in multidivisional firms, part of the new information comes from direct signals on efficiency (S_{it}) that the managers cannot influence. Firms in new and high-growth industries and younger firms are likely to have high *ex ante* uncertainty about their efficiency (high σ^2_{η}), which suggests the following corollary.

[11] I am implicitly assuming that, as external capital markets develop, the gap in information between internal and external capital markets narrows for profit-related measures. Direct signals (like S_{it}), which might be derived from working within the organization, are less sensitive to market development.

COROLLARY 2 *Compared to multidivisional firms, stand-alone structures provide stronger incentives (1) in new and high-growth industries and (2) in younger firms.*

In this case, the allocation effect may go in the opposite direction: As σ_η^2 increases, the information of headquarters becomes more valuable in the allocation of resources and, hence, causes the value of diversification to increase. The empirical implications depend on which of these two effects dominate. If the incentive effect (the impact that the number of divisions has on managerial incentives and, hence, on profits) is stronger than the allocation effect, then: (1) the diversification discount should be higher for firms in new and high-growth industries; (2) new and high-growth industries, unlike more mature industries, should be characterized by stand-alone firms;[12] (3) the diversification discount should be higher for younger firms; and (4) the age of a division should be negatively correlated with the probability of being a stand-alone firm.

(iii) Finally, Proposition 3 states that managerial incentives in multidivisional firms decrease with σ_u^2. This result captures the dark side of information (e.g., Cremer (1995)). When signal S_{it} is very precise, headquarters does not rely as much on current profits, which decreases managerial incentives to boost these profits. Optimal organizational design should take into account this effect. For example, Baker (1992) illustrates the story of Beatrice. This conglomerate created value while top management maintained an arm's-length relation with the divisions. When the company changed management, however, the new management became more involved in operational issues and Beatrice started to lose value.

III. Explicit Incentives

This section analyzes the robustness of the effects described so far to the introduction of explicit incentives. The analysis proceeds in two steps. First, I consider the possibility that division managers are given explicit incentives in addition to their implicit incentives. Second, I consider the possibility that an incentive scheme can be used to elicit headquarters' information at the beginning of period 2.

A. Explicit Incentives for Division Managers

So far, the paper has viewed division managers as empire builders who seek to maximize the size of their divisions. This subsection evaluates whether implicit incentives (i.e., the incentives derived from the link between current profits and future investment) remain important in the presence of monetary payoffs and direct compensation.

[12] In new and high-growth industries, profits are also likely to be a noisier signal of efficiency (higher $\sigma_{\varepsilon 1}^2$ and $\sigma_{\varepsilon 2}^2$). Nevertheless, what matters for us is not the noisiness of the signal, but the relative efficiency of the internal and external capital markets at processing the information $\sigma_{\varepsilon 2}^2/\sigma_{\varepsilon 1}^2$

I consider the following utility function for division manager i:

$$u_i = v(w_{i1} + w_{i2}) + I_{i1} + I_{i2} - g(a_{i1}) \tag{26}$$

where w_{it} is the wage received by division manager i in period t, $v' > 0$ and $v'' < 0$. Risk aversion is necessary to make the provision of explicit incentives costly for the firm and, as I will show, make implicit incentives valuable.

The wage of division manager i in period t (w_{it}) can be any function of the divisional profits in period t ($\{\pi_{jt}\}$) and in past periods $\left(\{\pi_{jt'}\}_{t'<t}\right)$. Furthermore, I assume that division managers could receive a per period salary $\bar{w}$ somewhere else.[13]

The timing of the game is the same as shown in Figure 1, except that now in stage 2 of period 1, corporate headquarters allocates the funds across the divisions and designs a compensation scheme for the division managers. I require that the parties do not have incentives to renegotiate the contract after investment in period 2.[14]

LEMMA 3: *In any renegotiation-proof contract, the wage in period 2 (w_{i2}) is independent of the profits in that period ($\{\pi_{j2}\}$).*

LEMMA 4: *If information is independent across divisions, in any renegotiation-proof contract, the wage of a division manager does not depend on the profits of the other divisions in the firm.*

The intuition for these lemmas follows. Since division managers are risk averse, any renegotiation-proof contract must pay the division managers a deterministic wage (from the point of view of period 2). Furthermore, since information is independent across divisions and there is no information asymmetry in period 1, the profits of the other divisions do not contain any information about the action of the division manager.

Given that the wage in period 2 is constant (i.e., independent of $\{\pi_{j2}\}$), the optimal level of investment I_{i2} is the same as in Section II:

$$I_{i2} = \frac{1}{N}\sum_{j=1}^{N} E(\eta_j|\Omega_2^{Mkt}) + \frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right) - \frac{1}{N-1}\sum_{j\neq i} E\left(\eta_j|\Omega_2^{HQ}\right)\right\}. \tag{27}$$

[13] This defines the reservation utility of the division managers. Notice that the learning process does not affect the reservation utility of the division managers, that is, the learning is firm specific. Otherwise, there would be an additional source of managerial incentives.

[14] Technically, this assumption has the role of making the moral hazard a one-period problem (see the following lemma). Nevertheless, the possibility of signing long-term contracts is important because it allows corporate headquarters to commit to not extracting *ex post* the private benefits that division managers obtain from running their divisions (corporate headquarters can extract those rents *ex ante* without destroying implicit incentives). Alternative settings with limited liability or *ex post* bilateral monopoly (i.e., hold-up) would also prevent *ex post* extraction of private benefits.

In other words, as the number of divisions increases, internal capital markets substitute for external capital markets in the provision of managerial (implicit) incentives.

The two previous lemmas imply that corporate headquarters in stage 2 of period 1 solves the following optimization problem:

$$\max_{\{\{w_{i1}(\pi_{i1})\},\{w_{i2}(\pi_{i1})\},\{I_{i1}\},\{a_{i1}\}\}} \sum_{i=1}^{N} E(\pi_{i1} + \pi_{i2} - w_{i1} - w_{i2}|\Omega_1, a_{i1}) \tag{28}$$

s.t.

$$a_{i1}^{*} = \arg\max_{a_{i1}} E(v(w_{i1} + w_{i2})|\Omega_1, a_{i1}) + E(I_{i2}|\Omega_1, a_{i1}) - g(a_{i1})\, \forall i \tag{29}$$

$$I_{i1} + E(v(w_{i1} + w_{i2})|\Omega_1, a_{i1}) + E(I_{i2}|\Omega_1, a_{i1}) - g(a_{i1}) \geq v(\overline{w} + \overline{w})\, \forall i \tag{30}$$

$$I_{i2} + v(w_{i1} + w_{i2}) \geq v(w_{i1} + \overline{w})\, \forall i \tag{31}$$

$$I_{i2} = \frac{1}{N}\sum_{j=1}^{N} E\left(\eta_j|\Omega_2^{Mkt}\right) + \frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right) - \frac{1}{N-1}\sum_{j\neq i} E\left(\eta_j|\Omega_2^{HQ}\right)\right\} \forall i \tag{32}$$

$$\sum_{j=1}^{N} I_{j1} = F_1. \tag{33}$$

The objective function is the profits of the divisions (after managers' wages). The first set of constraints is the incentive compatibility conditions of the division managers. The second set of constraints is the individual rationality conditions in period 1. The third set of constraints is the individual rationality conditions in period 2. The fourth set of constraints is the investment conditions in period 2. Finally, the last set of constraints guarantee that headquarters does not invest more than the total funds available.

Using the first-order approach to principal–agent problems (Rogerson (1985)) the next proposition follows:[15]

PROPOSITION 4: *The profits of the firm increase with implicit incentives.*

This proposition links profits and level of implicit incentives, the latter of which is defined by each division manager's ability to influence investment in period 2 by taking unobserved action a_{i1} (*i.e.*, $\partial E(I_{i2}|\Omega_1, a_{i1})/\partial a_{i1}$). Proposition 4 implies that even when it is possible to provide division managers with explicit incentives, implicit incentives are still valuable.[16] The provision of explicit incentives

[15] This implies a monotone likelihood ratio condition and convexity of the distribution function.

[16] Underlying this proposition is the assumption, made in Section II, that in the absence of explicit incentives, a_{i1}^{MF} is smaller than the first-best.

induces the risk-averse division managers to bear some risk. This is costly for the firm because it must compensate the division managers for bearing that risk.

In period 1, since corporate headquarters has no informational advantage, and divisions are independent (i.e., there are no learning externalities across divisions), corporate headquarters solves the same explicit incentives problem regardless of the number of divisions, implicit incentives aside. In other words, the number of divisions only affects the level of implicit incentives, but otherwise does not help or obstruct the provision of explicit incentives. Therefore, if an increase in the number of divisions increases implicit incentives, then it also increases first-period profits. The following corollary summarizes this discussion.

COROLLARY 3: *If an increase in the number of divisions increases implicit incentives, that is, the internal capital markets provide stronger incentives than the external capital markets, then it also increases first-period profits.*

Previous literature has suggested that the optimal compensation contract optimizes total incentives. For example, Gibbons and Murphy (1992) document that pay for performance is stronger in years preceding retirement (i.e., when career concerns are weaker). To the extent that this is a model of managerial incentives at the divisional level (i.e., middle managers), career concern considerations are likely to play an important role in the incentive system.[17]

B. Headquarters and the Revelation of Information

So far, the paper has viewed corporate headquarters as an empire builder that seeks to maximize investment. This subsection evaluates the role of corporate headquarters in the presence of monetary payoffs, raising the question of whether an incentive scheme can be used to elicit corporate headquarters' information at the beginning of period 2.

In particular, I assume that corporate headquarters has the following utility function:

$$V^{HQ} = F_1 + F_2 + p \tag{34}$$

where p is the payment received by corporate headquarters, which has no resources of its own (i.e., $p \geq 0$).

The timing of the game is the same as shown in Figure 1, except that now in period 2, there is an initial stage 0 when a revelation game is played. Specifically, corporate headquarters reports its assessed efficiency of the divisions, $\{E(\eta_j|\Omega_2^{HQ})\}$ and is given incentives to report truthfully.

The choice variables in the revelation game are the payment received by corporate headquarters, p, and the amount of funds invested in the firm, F_2. Both p and

[17] It can be argued that as time passes and divisions' types are revealed, implicit incentives will tend to be weaker and explicit incentives stronger. Nevertheless, divisions' types may change over time. For example, the division manager might be promoted (and therefore replaced) or divisional changes might be necessary in order to adjust to transformations in the environment (e.g., the industry).

F_2 are a function of corporate headquarters' report, R.[18] The assumption that external investors can commit to certain investment and payment schedules as a function of the report (even when it is *ex post* optimal for both parties to implement a different level of investment) is intended to give the revelation scheme the greatest possibility of success. A failure to commit would increase the cost of inducing corporate headquarters to report truthfully.[19]

External investors solve the following problem in stage 0 of period 2:

$$\mathrm{Max}_{\{p(R),F_2(R)\}} E\left[\sum_{i=1}^{N} \pi_{i2}\left(F_2(R), \left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) - p(R)|\Omega_2^{Mkt}\right] \tag{35}$$

s.t.

$$F_2\left(\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) + p\left(\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) \geq F_2(R) + p(R)\ \forall\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}, R \tag{36}$$

$$F_2\left(\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) + p\left(\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) \geq 0\ \forall\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\} \tag{37}$$

$$P(R) \geq 0\ \forall R \tag{38}$$

$$F_2(R) \geq 0\ \forall R. \tag{39}$$

The objective function is the expected profits of the firm (after the payment to corporate headquarters) in period 2. In particular, function $\pi_{i2}(F_2(R), \{E(\eta_j|\Omega_2^{HQ})\})$ is the profits of division i in period 2 when $F_2(R)$ funds are provided to the firm and the firm's divisions have expected efficiencies $\{E(\eta_j|\Omega_2^{HQ})\}$. The first set of constraints is the incentive compatibility conditions that guarantee a truthful report. The second set of constraints is the individual rationality conditions. For convenience, corporate headquarters' reservation utility is set to zero. The two last sets of constraints guarantee that the payment received by corporate headquarters and the amount of funds invested in the firm are nonnegative.

PROPOSITION 5: *The solution of the revelation game takes one of the following forms: (i) No revelation: The level of funding provided to the firm is the sum of the assessed efficiency of the firm's divisions by external capital markets:*

$$F_2 = \sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{Mkt}\right). \tag{40}$$

[18] R is a vector with N elements, one for each divisions' efficiency.

[19] This assumption is common for this type of model. For example, Harris and Raviv (1996) make a similar assumption and justify it in terms of reputation considerations (not explicitly modeled).

(ii) Partial revelation: The level of funding provided to the firm depends on the sum of the assessed efficiency of the firm's divisions by corporate headquarters up to a limit, $\bar{F}_2$.

$$F_2 = \min\left[\sum_{i=1}^{N}\left(E\left(\eta_i|\Omega_2^{HQ}\right)+1\right),\ \bar{F}_2\right]. \tag{41}$$

In the first solution, inducing truthful revelation by corporate headquarters is so expensive (or the gains are so small) that external investors find it optimal to ignore headquarters' information in deciding the amount of funds to provide to the firm.

In the second solution, external investors set an upper limit for the funds invested in the firm. This allows the partial use of corporate headquarters' information in the funding decision while limiting the cost of inducing truthful revelation by headquarters.

COROLLARY 4: *A first order stochastic increase in external investors' perceived efficiency of the divisions increases the upper limit of the amount invested in the firm $\bar{F}_2$.*

In other words, an increase in the assessed efficiency of the divisions by external investors increases the cost of lowering $\bar{F}_2$, and hence also increases the expected level of investment.

Whether the solution to the revelation game takes the form of no revelation or partial revelation depends, among other things, on the information of external investors, Ω_2^{Mkt}. Nevertheless, what is important is that in both solutions, the expected amount of funds provided to the firm increases with the assessed efficiency of the firm's divisions by external investors.

The expected level of funding F_2 is given by the following expression, where Γ is the set of information sets that results in a no-revelation solution in the revelation game:

$$\begin{aligned} E(F_2|\Omega_1,a_{i1}) &= E\left[\Pr(\Omega_2^{Mkt}\in\Gamma)\sum_{j=1}^{N}E(\eta_j|\Omega_2^{Mkt})|\Omega_1,a_{i1}\right] \\ &\quad +E\left[(1-\Pr(\Omega_2^{Mkt}\in\Gamma))\min\left[\sum_{j=1}^{N}\left(E\left(\eta_j|\Omega_2^{HQ}\right)+1\right),\ \bar{F}_2(\Omega_2^{Mkt})\right]|\Omega_1,a_{i1}\right]. \end{aligned} \tag{42}$$

Managerial incentives are given by the following f.o.c.:

$$g'(a_{i1}) = \frac{1}{N}\frac{\partial E(F_2|\Omega_1,a_{i1})}{\partial a_{i1}} + \frac{N-1}{N}\frac{\partial E\left[E\left(\eta_i|\Omega_2^{HQ}\right)|\Omega_1,a_{i1}^{MF}\right]}{\partial a_{i1}} \tag{43}$$

where $E(F_2|\Omega_1,a_{i1})$ is defined above.

As in Section II, the level of managerial incentives is a weighted average of the incentives provided by the external investors' funding decision (the first term on the right-hand side (RHS)) and the headquarters' allocation decision (the second term on the RHS).

The external investors' funding decision depends on both external investors' and headquarters' assessments of the divisions. In other words, even if an incentive scheme is used to elicit headquarters' information, external investors' information is still an important determinant of the funding decision, and, hence, of managerial incentives.[20]

IV. Conclusion

This paper shows that corporate headquarters' informational advantage, while improving the allocation of resources, might have adverse consequences for managerial incentives. In particular, in multidivisional firms each division manager takes the external perception of the whole firm as a public good and is tempted to free ride. This analysis has produced several testable implications. First, there is a negative relation between the development of external capital markets and the value of diversification. Second, as external capital markets develop, we should observe a decrease in diversification. Finally, external capital markets provide stronger incentives in new and high-growth industries, as well as in newer firms within an industry.

Let me conclude by suggesting a few avenues for future research. Throughout this paper, headquarters has used its informational advantage to improve the external capital markets' allocation of resources. More generally, headquarters' investment decisions might convey information to external investors and to division managers. Headquarters could act strategically by distorting investment to increase future funding. It would be interesting to study these possible distortions and their implications for managerial incentives and firm value.

This framework is also well suited for the study of issues related to organizational design. For example, in some organizations, resources are allocated using multiple layers. The specific organizational structure would determine the extent to which any two divisions within the organization are in direct competition for corporate resources. Inducing cooperation between certain divisions may imply reducing the degree of divisional competition for corporate resources.

Appendix

LEMMA A.1. *Under assumptions (1) to (6), the updating process takes the following form (where $\hat{a}_{i1}$ is the conjectured action, which is equal to the actual action in equilibrium):*

$$E\left(\eta_i|\Omega_2^{Mkt}\right) = \alpha m_i + (1-\alpha)(\eta_i + \varepsilon_{1i1} + \varepsilon_{2i1} + a_{i1} - \hat{a}_{i1}) \tag{A1}$$

$$\textit{where} \quad \alpha \equiv \frac{\sigma_{\varepsilon 1}^2 + \sigma_{\varepsilon 2}^2}{\sigma_\eta^2 + \sigma_{\varepsilon 1}^2 + \sigma_{\varepsilon 2}^2}$$

[20] In period 1, the solution to stages 1 and 2 is similar to the solution in Section II.

$$E\left(\eta_i|\Omega_2^{HQ}\right) = \beta m_i + \gamma(\eta_i + \varepsilon_{1i1} + a_{i1} - \hat{a}_{i1}) + (1-\beta-\gamma)S_{i1} \tag{A2}$$

$$\textit{where} \quad \beta \equiv \frac{\sigma_{\varepsilon 1}^2\sigma_u^2}{\sigma_u^2\sigma_\eta^2 + \left(\sigma_u^2+\sigma_\eta^2\right)\sigma_{\varepsilon 1}^2} \quad \textit{and} \quad \gamma \equiv \frac{\sigma_\eta^2\sigma_u^2}{\sigma_u^2\sigma_\eta^2 + \left(\sigma_u^2+\sigma_\eta^2\right)\sigma_{\varepsilon 1}^2}.$$

Proof of Proposition 3: Under assumptions (1) to (6), and using Lemma A.1, managerial incentives in stand-alone and multidivisional firms are given by the following two expressions:

$$g'\left(a_{i1}^{SF}\right) = \frac{\sigma_\eta^2}{\sigma_\eta^2+\sigma_{\varepsilon 1}^2+\sigma_{\varepsilon 2}^2} \tag{A3}$$

$$g'\left(a_{i1}^{MF}\right) = \frac{1}{N}\frac{\sigma_\eta^2}{\sigma_\eta^2+\sigma_{\varepsilon 1}^2+\sigma_{\varepsilon 2}^2} + \frac{N-1}{N}\frac{\sigma_\eta^2\sigma_u^2}{\sigma_u^2\sigma_\eta^2 + \left(\sigma_u^2+\sigma_\eta^2\right)\sigma_{\varepsilon 1}^2}. \tag{A4}$$

$$\text{Combining the two expressions:} \quad \text{For } \sigma_\eta^2>0, \quad a_{i1}^{MF}>a_{i1}^{SF} \quad \text{iff} \quad \sigma_u^2\frac{\sigma_{\varepsilon 2}^2}{\sigma_{\varepsilon 1}^2}>\sigma_\eta^2. \tag{A5}$$

Proof of Lemma 4: Given that in any renegotiation-proof contract w_{i2} is independent of $(\{\pi_{j2}\})$ and that there is no information asymmetry in period 1, i.e., $\Omega_1^{HQ} = \Omega_1^{Mkt} = \Omega_1^{Mkt}$, the profits of the other divisions in period 1, i.e., $\{\pi_{j1}\}_{j\neq i}$, do not contain any information about a_{i1}. Therefore, it will not be optimal to make the wage of a division manager depend on the profits of the other divisions in the firm.

LEMMA A.2. *Corporate headquarters can restrict its attention to contracts that pay a constant wage $w_{i2} = \bar{w}$ in period 2.*

Proof. Suppose that the optimal renegotiation-proof contract is $\{w_{i1}^*(\pi_{i1}), w_{i2}^*(\pi_{i1})\}$ Then, given the additive structure of the utility function $(v(w_{i1}+w_{i2}))$, $\{w_{i1}^{**} = w_{i1}^*(\pi_{i1}) + w_{i2}^*(\pi_{i1}) - \bar{w}, w_{i2}^{**} = \bar{w}\}$ is also renegotiation-proof and provides the same level of incentives at the same cost for the firm.

Proof of Proposition 4: Throughout this proof, I make use of the assumption, made in Section II, that implicit incentives are smaller than the first-best level of incentives.

Lemma A.2 implies that headquarters' problem can be rewritten as follows:

$$\max_{\{\{w_{i1}(\pi_{i1})\},\{I_{i1}\},\{a_{i1}\}\}} \sum_{i=1}^{N} E(\pi_{i1} - w_{i1}|\Omega_1, a_{i1}) \tag{A6}$$

s.t.

$$a_{i1}^{*} = \arg\max_{a_{i1}} E(v(w_{i1} + \bar{w})|\Omega_1, a_{i1}) + E(I_{i2}|\Omega_1, a_{i1}) - g(a_{i1})\,\forall i \tag{A7}$$

$$I_{i1} + E(v(w_{i1} + \bar{w})|\Omega_1, a_{i1}) + E(I_{i2}|\Omega_1, a_{i1}) - g(a_{i1}) \geq v(\overline{w} + \overline{w})\,\forall i \tag{A8}$$

$$I_{i2} + v(w_{i1} + \bar{w}) \geq v(w_{i1} + \bar{w})\,\forall i \tag{A9}$$

$$I_{i2} = \frac{1}{N}\sum_{j=1}^{N} E(\eta_j|\Omega_2^{Mkt}) + \frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right) - \frac{1}{N-1}\sum_{j\neq i}^{N} E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\forall i \tag{A10}$$

$$\sum_{j=1}^{N} I_{j1} = F_1. \tag{A11}$$

For each division, there are two possible solutions to this optimization problem. First, we can have a corner solution where no explicit incentives are provided (i.e., the division manager is given a constant wage). In this case, an increase in managerial implicit incentives will approach the level of incentives to the first-best and, therefore, will increase the firm's profits.

Second, we can have a solution where explicit incentives are provided on top of implicit incentives. Assuming that the first-order approach (FOA) is valid, the incentive compatibility constraints imply (in an interior optimum) that

$$E\left[v(w_{i1} + \bar{w})\frac{f_a(\pi_{i1}, a_{i1})}{f(\pi_{i1}, a_{i1})}|\Omega_1, a_{i1}\right] + \left[\frac{\partial E(I_{i2}|\Omega_1, a_{i1})}{\partial a_{i1}}\right]_{a_{i1}=\hat{a}_{i1}} = g'(a_{i1})\,\forall i \tag{A12}$$

where $f(\pi_{i1},a_{i1})$ is the density function of profits under action a_{i1}, and f_a is its first derivative w.r.t. a_{i1}, (since at $t=1$ there is symmetric information, in equilibrium, the action is equal to the conjectured action, $\hat{a}_{i1}$, i.e., $a_{i1} = \hat{a}_{i1}$). $\Phi_{i1} \equiv \left[\frac{\partial E(I_{i2}|\Omega_1, a_{i1})}{\partial a_{i1}}\right]_{a_{i1}=\hat{a}_{i1}}$ gives the level of implicit incentives.

Notice that in both the incentive compatibility conditions (IC), and the individual rationality conditions in period 1 (IR1), we have $E(I_{i2}|\Omega_1,a_{i1})$. The interaction between a_{i1} and I_{i2} is through the learning process of the external investors and of corporate headquarters. In equilibrium, however, the actual action is equal to the conjectured action $a_{i1} = \hat{a}_{i1}$, and the action does not affect the level of investment, I_{i2}. Therefore, *ex ante*, when the division manager decides whether to join the firm (IR1), she will expect the following private benefits in period 2 (which are independent of her action): $[E(I_{i2}|\Omega_1, a_{i1})]_{a_{i1}=\hat{a}_{i1}} = E(\eta_i|\Omega_1)$. Nevertheless, when the division manager decides which action to take (IC), she will intend to increase I_{i2} with her action (even though she will not accomplish it). In particular, implicit incentives will be given by $\left[\frac{\partial E(I_{i2}|\Omega_1, a_{i1})}{\partial a_{i1}}\right]_{a_{i1}=\hat{a}_{i1}}$.

The Lagrangian of the FOA program is:

$$
\begin{aligned}
L = & \sum_{i=1}^{N} E(\pi_{i1} - w_{i1}|\Omega_1, a_{i1}) \\
& + \sum_{i=1}^{N} \lambda_i \{ I_{i1} + E(v(w_{i1} + \bar{w})|\Omega_1, a_{i1}) + E(\eta_i|\Omega_1) - g(a_{i1}) - v(\bar{w} + \bar{w}) \} \\
& + \sum_{i=1}^{N} \mu_i \left\{ E\left[v(w_{i1} + \bar{w}) \frac{f_a(\pi_{i1}, a_{i1})}{f(\pi_{i1}, a_{i1})} |\Omega_1, a_{i1} \right] + \Phi_{i1} - g'(a_{i1}) \right\} \\
& + \gamma \left\{ F_1 - \sum_{j=1}^{N} I_{j1} \right\}
\end{aligned} \tag{A13}
$$

(Note: In the (IR1), I have used that $[E(I_{i2}|\Omega_1, a_{i1})]_{a_1 = \hat{a}_1} = E(\eta_i|\Omega_1)$; since I_{i2} is non-negative, (IR2) can be ignored; The equation for I_{i2} has been plugged in Φ_{i1}.)

Let z_i be a parameter that only affects the level of implicit incentives $\Phi_{i1}(z_i)$. For example, Φ_{i1} depends on, among other things, the number of divisions N. A change in the number of divisions will change implicit incentives and will not affect the level of investment or explicit incentives (except from the effect through implicit incentives). Another example could be a change in the precision of the signals observed by corporate headquarters.

Differentiating the Lagrangian w.r.t. z_i and using the envelope theorem, we obtain that the effect of a change in implicit incentives on the amount of profits (after wages) is given by the Lagrange multiplier of the IC constraint (μ_i^*):

$$
\frac{\partial L(a_1^*, w_1^*, I_1^*, \lambda^*, \mu^*, \ \gamma^*)}{\partial z_i} = \frac{\partial \sum_{i=1}^{N} E(\pi_{i1}^* - w_{i1}^*|\Omega_1, a_{i1})}{\partial z_i} = \frac{\partial \Phi_{i1}(z_i)}{\partial z_i} \mu_i^*. \tag{A14}
$$

The next lemma (Lemma A.3) proves that in an interior solution $\mu_i^* > 0$. Therefore an increase in implicit incentives (i.e., $\frac{\partial \Phi_{i1}(z_i)}{\partial z_i} > 0$) increases profits.

LEMMA A.3: *(Based on Rogerson (1985, note 8.) In any interior solution when explicit incentives are provided on top of implicit incentives (i.e., $a_{i1}^* > a_{i1}^I$ where a_{i1}^I is defined by $g'(a_{i1}^I) = \Phi_{i1}$), the Lagrange multiplier of the IC constraint is positive, (i.e., $\mu_i > 0$).*
Proof: The f.o.c. of the Lagrangian with respect to w_{i1} is:

$$
\frac{1}{v'(w_{i1}(\pi_{i1}) + \bar{w})} = \lambda_i + \mu_i \frac{f_a(\pi_{i1}, a_{i1})}{f(\pi_{i1}, a_{i1})}. \tag{A15}
$$

Given the Maximum Likelihood Ratio Property (needed for the FOA), if $\mu_i \leq 0$, then the f.o.c. implies that $w_{i1}(\pi_{i1})$ is nonincreasing in profits. By first-order stochastic dominance (notice that an increase in a_{i1} shifts the distribution function of profits (π_{i1}) to the right) the division manager would choose $a_{i1}^* \leq a_{i1}^I$. Therefore for $a_{i1}^* > a_{i1}^I$, μ_i, must be positive.

Proof of Proposition 5: The set of incentive compatibility conditions can be rewritten as follows:

$$F_2(R) + p(R) = K \quad \forall R \tag{A16}$$

where K is some positive constant. In other words, corporate headquarters' utility must be constant (independent of its report R) in order to guarantee that corporate headquarters has no incentive to report falsely.

Substituting the incentive compatibility conditions in the objective function, the problem becomes:

$$\max_{\substack{\{F_2(R),\, K \text{ s.t.} \\ K \geq F_2(R) \geq 0 \ \ \forall R\}}} E\left[\sum_{i=1}^{N} \pi_{i2}\left(F_2(R), \left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) - K + F_2(R)|\Omega_2^{Mkt}\right]. \tag{A17}$$

From Section II in the main text, the investment in division i in stage 2 is

$$I_{i2} = \frac{F_2}{N} + \frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right) - \frac{1}{N-1}\sum_{j \neq i} E\left(\eta_j|\Omega_2^{HQ}\right)\right\}. \tag{A18}$$

Therefore, the profits of division i in period 2 are given by the following expression which is a function of F_2 and $\{E(\eta_j|\Omega_2^{HQ})\}$:

$$\begin{aligned} E\left[\pi_{i2}|\Omega_2^{HQ}\right] &= E\left(\eta_i|\Omega_2^{HQ}\right) I_{i2} - \frac{I_{i2}^2}{2} = \\ &= E\left(\eta_i|\Omega_2^{HQ}\right)\left(\frac{F_2}{N} + A_i\right) - \frac{\left(\frac{F_2}{N}\right)^2 + A_i^2 + 2\frac{F_2}{N}A_i}{2} \end{aligned} \tag{A19}$$

where

$$A_i \equiv \frac{N-1}{N}\left\{E\left(\eta_i|\Omega_2^{HQ}\right) - \frac{1}{N-1}\sum_{j \neq i} E\left(\eta_j|\Omega_2^{HQ}\right)\right\} \quad \text{and} \quad \sum_{i=1}^{N} A_i = 0 \tag{A20}$$

$$\begin{aligned} \sum_{i=1}^{N} E\left[\pi_{i2}|\Omega_2^{HQ}\right] &= \sum_{i=1}^{N}\left[E\left(\eta_i|\Omega_2^{HQ}\right)\left(\frac{F_2}{N} + A_i\right) - \frac{\left(\frac{F_2}{N}\right)^2 + A_i^2}{2}\right] \\ &= \sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{HQ}\right)\frac{F_2}{N} - \frac{F_2^2}{2N} + \psi\left(\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right) \end{aligned} \tag{A21}$$

where ψ $(\{E(\eta_j|\Omega_2^{HQ})\})$ is a function of the expected efficiencies of the divisions and does not depend on the amount of funds provided to the firm, F_2. Using the above expression, the program can be rewritten as follows:

$$\max_{\substack{\{F_2(R),\, K \text{ s.t.} \\ K \geq F_2(R) \geq 0 \ \ \forall R\}}} E\left[\sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{HQ}\right)\frac{F_2}{N} - \frac{F_2^2}{2N} + \psi - K + F_2|\Omega_2^{Mkt}\right] \tag{A22}$$

since $\psi(\{E(\eta_i|\Omega_2^{HQ})\})$ is independent of F_2 and K, then the problem can be rewritten as:

$$\max_{\substack{\{F_2(R)\,K\,\text{s.t.}\\ K\geq F_2(R)\geq 0\ \ \forall R\}}} E\left[\sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{HQ}\right)\frac{F_2}{N} - \frac{F_2^2}{2N} - K + F_2|\Omega_2^{Mkt}\right]. \tag{A23}$$

There are two possible solutions for K: (i) If F_2 is constant (independent of the report R), then $K = F_2$ (and therefore $p(R) = 0$). (ii) If F_2 is not constant (depends on the report R), then $K = \max_{R'\in\Theta}\{F_2(R')\}$ (and therefore), $p(R) = \max_{R'\in\Theta}\{F_2(R')\} - F_2(R)$), where Θ is the set of feasible reports. Let us characterize these two possible solutions:

Case (i): When F_2 is constant and $K = F_2$, the program becomes:

$$\max_{\{F_2\,\text{s.t.}\ F_2\geq 0\}} E\left[\sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{HQ}\right)F_2 - \frac{F_2^2}{2}|\Omega_2^{Mkt}\right]. \tag{A24}$$

Assuming an interior solution, then:

$$F_2 = \sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{Mkt}\right). \tag{A25}$$

In this solution, external investors obtain the following expected profits:

$$E\left[\sum_{i=1}^{N}\left[\pi_{i2}\left(\sum_{j=1}^{N} E\left(\eta_j|\Omega_2^{Mkt}\right),\left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right)\right]|\Omega_2^{Mkt}\right]. \tag{A26}$$

Case (ii): When $F_2(R)$ is not constant and $K = \max_{R'\in\Theta}\{F_2(R')\}$, the program becomes:

$$\max_{\substack{\{F_2(R),\,\text{s.t.}\\ F_2(R)\geq 0\}}} E\left[\sum_{i=1}^{N} E\left(\eta_i|\Omega_2^{HQ}\right)\frac{F_2(R)}{N} - \frac{F_2^2(R)}{2N} - \max_{R'\in\Theta} F_2(R') + F_2(R)|\Omega_2^{Mkt}\right]. \tag{A27}$$

I solve the problem in two stages: first, I set an arbitrary upper limit $\bar{F}_2$ and solve for the optimal scheme given that limit; second, I solve for the optimal upper limit $\bar{F}_2$.

For an arbitrary upper limit $\bar{F}_2$, the problem can be written as follows:

$$\max_{\substack{\{F_2(R),\,\text{s.t.}\\ \bar{F}\geq F_2(R)\geq 0\}}} E\left[\sum_{i=1}^{N}\left(E\left(\eta_i|\Omega_2^{HQ}\right)+1\right)F_2(R) - \frac{F_2^2(R)}{2} - N\bar{F}_2|\Omega_2^{Mkt}\right]. \tag{A28}$$

The solution to the problem is:

$$F_2^*\left(\left\{E\left(\eta_i|\Omega_2^{HQ}\right)\right\}\right) = \min\left[\sum_{i=1}^{N}\left(E\left(\eta_i|\Omega_2^{HQ}\right)+1\right), \bar{F}_2\right]. \tag{A29}$$

The optimal upper limit $\bar{F}_2$ is the solution to the following program:

$$\max_{\bar{F}_2} E\left[\sum_{i=1}^{N}\left(E\left(\eta_i|\Omega_2^{HQ}\right)+1\right)F_2^* - \frac{\left(F_2^*\right)^2}{2} - N\bar{F}_2|\Omega_2^{Mkt}\right] \tag{A30}$$

where F_2^* is defined above. Let us define $y\left(\Omega_2^{HQ}\right)$ as follows:

$$y\left(\Omega_2^{HQ}\right) \equiv \sum_{i=1}^{N}\left(E\left(\eta_i|\Omega_2^{HQ}\right)+1\right). \tag{A31}$$

Then, the program can be rewritten as:

$$\max_{\bar{F}_2} E\left[y(\Omega_2^{HQ})\ \min\left[y\left(\Omega_2^{HQ}\right), \bar{F}_2\right]\frac{-(\min[y(\Omega_2^{HQ}), \bar{F}_2])^2}{2} - N\bar{F}_2|\Omega_2^{Mkt}\right] \tag{A32}$$

which in turn can be rewritten as:

$$\max_{\bar{F}_2} \int_{-\infty}^{\bar{F}_2}\frac{1}{2}(y)^2 f(y|\Omega_2^{Mkt})dy + \int_{\bar{F}_2}^{\infty}\left[y\bar{F}_2 - \frac{1}{2}\left(\bar{F}_2\right)^2\right]f(y|\Omega_2^{Mkt})dy - N\bar{F}_2 \tag{A33}$$

where $f\left(y|\Omega_2^{Mkt}\right)$ is the density function of y conditional on the information of external investors, Ω_2^{Mkt}.

In an interior solution, the optimal upper limit $\bar{F}_2$ is given by the following f.o.c.:

$$\int_{\bar{F}_2}^{\infty}[y-\bar{F}_2]f(y|\Omega_2^{Mkt})dy - N = 0. \tag{A34}$$

The s.o.c. guarantees that the f.o.c. gives a maximum:

$$-\Pr\left[y > \bar{F}_2|\Omega_2^{Mkt}\right] < 0. \tag{A35}$$

In this solution, external investors obtain the following expected profits:

$$E\left[\sum_{i=1}^{N}\left[\pi_{i2}\left(\min\left[y\left(\Omega_2^{HQ}\right), \bar{F}_2\right], \left\{E\left(\eta_j|\Omega_2^{HQ}\right)\right\}\right)\right] - \bar{F}_2 + \min\left[y\left(\Omega_2^{HQ}\right), \bar{F}_2\right]|\Omega_2^{Mkt}\right] \tag{A36}$$

where $\bar{F}_2$ is given by the f.o.c.

$$\int_{\bar{F}_2}^{\infty}[y-\bar{F}_2]f(y|\Omega_2^{Mkt})dy - N = 0. \tag{A37}$$

Proof of Corollary 4: I differentiate the f.o.c. for $\bar{F}_2$ with respect to $\bar{F}_2$ and Ω_2^{Mkt}. (This is an abuse of notation. The idea is that in period 1, external investors would receive a set of signals $\{s_j^{Mkt}\}$ about the efficiency of divisions. I am implicitly assuming that the f.o.c. is a continuous and differentiable function of those signals.)

$$-\Pr\left[y > \bar{F}_2 | \Omega_2^{Mkt}\right] d\bar{F}_2 + \left[\int_{\bar{F}_2}^{\infty} \left(y - \bar{F}_2\right) \frac{\partial f\left(y | \Omega_2^{Mkt}\right)}{\partial \Omega_2^{Mkt}}\, dy\right] d\Omega_2^{Mkt} = 0 \tag{A38}$$

which can be rewritten as:

$$\frac{d\bar{F}_2}{d\Omega_2^{Mkt}} = \frac{\int_{\bar{F}_2}^{\infty} \left(y - \bar{F}_2\right) \frac{\partial f\left(y|\Omega_2^{Mkt}\right)}{\partial \Omega_2^{Mkt}}\, dy}{\Pr\left[y > \bar{F}_2 | \Omega_2^{Mkt}\right]}. \tag{A39}$$

If an increase in Ω_2^{Mkt} produces a first-order stochastic dominant shift in $f\left(y|\Omega_2^{Mkt}\right)$ (remember that $y \equiv \sum_{i=1}^{N} \left(E(\eta_i | \Omega_2^{HQ}) + 1\right)$) then:

$$\int_{\bar{F}_2}^{\infty} \left(y - \bar{F}_2\right) \frac{\partial f\left(y|\Omega_2^{Mkt}\right)}{\partial \Omega_2^{Mkt}} dy \geq 0 \quad \text{and it follows that} \quad \frac{d\bar{F}_2}{d\Omega_2^{Mkt}} \geq 0. \tag{A40}$$

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