Strategic Management Journal
Strat. Mgmt. J., **37**: 1379–1394 (2016)
Published online EarlyView 17 June 2015 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/smj.2392
Received 5 September 2013; *Final revision received 2 April 2015*

EQUITY-BASED INCENTIVES AND COLLABORATION IN THE MODERN MULTIBUSINESS FIRM

JOANNE OXLEY[1] and GURUPDESH PANDHER[2]*
[1] *Rotman School of Management, University of Toronto, Toronto, Ontario, Canada*
[2] *Odette School of Business, University of Windsor, Windsor, Ontario, Canada*

Research summary: *This paper examines the role of equity-based incentives in fostering cross-business-unit collaboration in multibusiness firms. We develop a formal agency model in which headquarters offers equity and profit incentives to business-unit managers with the objective of maximizing total expected firm returns. The resulting compensation contract provides a rich mechanism for aggregating value from collaborative interactions across business units, aligning managers' efforts with the firm's growth prospects and organization structure and managing the dual risks in profits and firm market value. The inclusion of equity incentives elicits higher levels of own-unit and collaborative efforts over the profits-only contract. Our results suggest that equity-based incentives are most beneficial when profitability is uncertain relative to long-term growth prospects, in firms pursuing related diversification strategies, and in periods of rising equity markets.*

Managerial summary: *Equity-based compensation such as restricted stock grants and options are increasingly common, not only for CEOs and other top executives, but also for business unit managers and other non-C-suite employees. The paper studies the role of such "global" incentives in enabling multibusiness firms to benefit from cross-unit collaboration. Results from our model show that managerial contracts that include appropriate levels of equity incentives, in addition to profit-based incentives, generate higher own-unit and collaborative efforts. We also find that equity incentives are likely to be most beneficial for large firms in high-growth sectors, for firms pursuing a related diversification strategy, and in periods of rising stock markets. The model can also provide useful guidance on designing return-maximizing compensation contracts for business unit managers in different firm, organizational, and industry contexts.* Copyright © 2015 John Wiley & Sons, Ltd.

INTRODUCTION

One of the most significant changes in management incentive systems in the late twentieth century was the dramatic rise in the use of equity-based compensation such as restricted stock grants and options (Ofek and Yermack, 2000). Morgenson (1998), for example, notes that the 200 largest U.S. companies reserved more than 13 percent of their common shares for compensation awards to managers in 1997, doubling the amount set aside for that purpose at the beginning of the decade. Moreover, while equity-based compensation is traditionally associated with CEOs or other "C-suite" executives, by the late 1990s more than 75 percent of stock options granted by S&P 500 firms went to executives and employees below the top five highest-paid executives (Murphy, 2003: 134).

Prior research in finance and economics traces the benefits of equity-based compensation at the executive level to the reduction of agency costs and alignment of managerial incentives with shareholder concerns (Holmstrom, 1979; Jensen and

Keywords: multibusiness firms; collaboration; equity and profit incentives; organizational design; total firm returns
*Correspondence to: Gurupdesh Pandher, Odette School of Business, University of Windsor, 401 Sunset Avenue, Windsor, Ontario N9B 3P4, Canada. E-mail: gpandher@uwindsor.ca

Copyright © 2015 John Wiley & Sons, Ltd.

Meckling, 1976). These benefits are particularly relevant in situations where the forward-looking nature of stock prices makes equity value a more appropriate benchmark for managerial performance than accounting profits, for example in so-called "new economy"[1] firms (Anderson, Banker, and Ravindran, 2014; Ittner, Lambert, and Larcker, 2003) and firms in other industries where long-term investments are important sources of value (Fama and Miller, 1972; Jensen and Murphy, 1990).

In addition to incentive alignment considerations, the literature has also illuminated the potential role played by strategic, social and organizational factors in shaping executive compensation schemes (Finkelstein and Hambrick, 1988; Nyberg *et al.,* 2010; Westphal and Zajac, 1998). Zajac and Westphal (1994), for example, find that while long-term incentives involving firm equity have become expected components of CEO compensation, they are more costly and less effective for firms facing high levels of risk. On social aspects, Westphal and Stern (2006) find that top managers engaged in high levels of flattery and opinion conformity toward the CEO were more likely to receive board appointments. Focusing on individual traits, Wowak and Hambrick (2010) develop a theoretical model that highlights how CEO characteristics may interact with equity-based pay (stock options) to affect risk taking and subsequent firm performance. Pandher and Currie (2013) consider an alternative framework where CEOs and other firm stakeholders vie over firm rents from its resource advantage and find that CEO pay is inherently tied to corporate strategy and will tend to be highly variable even for similar firms.

Press reporting on the extension of equity-based incentives to non-C-suite executives points to another possibly significant benefit of equity compensation that has heretofore received scant attention from researchers, however: increasing collaboration or teamwork. Following a major corporate reorganization, for example, communications company Hughes Electronics Corporation announced that it was awarding stock options to select managers and employees "to promote teamwork" (*Los Angeles Times*, 1998). And Jeff Bezos, CEO of online retailing giant Amazon, proudly asserted in a 2012 interview, "We pay very low cash compensation relative to most companies. … We also have no [profit-based] incentive compensation of any kind. And the reason we don't is because *it is detrimental to teamwork*" (Lashinsky, 2012; emphasis added). This statement is particularly noteworthy since Amazon is often cited as having one of the most equity-heavy management compensation packages in the industry.[2]

In this paper we address the emerging gap between research and practice in this area by developing a formal agency model of equity-based incentives and collaboration in a multibusiness firm. We believe that this approach is particularly relevant to today's business environment, where long investment horizons and diversification strategies often go hand in hand, and coordination among decentralized business units is a key problem facing headquarters' managers of large corporations. Even in new economy firms with roots in a single business, diversification strategies are becoming increasingly common. For example, Google's businesses now include Google+, Android, Google Glass and, most recently, self-driving cars. And for its part, Amazon has been "pushing into everything from couture retailing and feature-film production to iPad-worthy tablet manufacturing" (Lashinsky, 2012). In this context, teamwork—and in particular, collaboration across business units—undoubtedly becomes a far more salient concern.

Our model builds on and contributes to a rich body of research in organizational economics addressing the need to balance local effort and cross–business-unit collaboration in decentralized multibusiness firms (Chandler, 1962, 1977; Milgrom and Roberts, 1992; Williamson, 1975, 1985). A central focus of work in this tradition has been the design of contracts and governance structures to overcome agency problems associated with information asymmetries and incentive misalignment; left unchecked, such problems can reduce managerial effort, undermine collaboration, and significantly reduce firm performance (e.g., Holmstrom, 1979; Holmstrom and Milgrom, 1991; Teece, 1982).

[1] New economy firms are generally defined as "companies competing in the computer, software, internet, telecommunications, or networking fields," (Murphy, 2003: 131–132).

[2] A 2012 online article "Working at Amazon," for example, asks rhetorically: "How low are the base salaries? The second highest paid employee at the company, Jeff Wilke, who runs the North American consumer business, has a base salary of $165,000 per year. Why does he stick around then? Well … employees can get big compensation packages from restricted stock units. Wilke may have a low salary, but he's got $20 million in stock … So, the pay might be low, but it's not like people are going poor at Amazon." (Yarow, 2012)

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Strategy scholars have also made significant contributions to knowledge in this area, exploring the design of incentive systems to optimize collaboration and coordination among business units in diversified firms (Gupta and Govindarajan, 1986; Kretschmer and Puranam, 2008; Rivkin and Siggelkow, 2003, 2006). A basic premise of this work is that basing managerial compensation, at least in part, on "global" (firm-wide) profits encourages collaboration and enhances firm performance when there is significant interdependence among business units. At the same time, it is argued that firm-wide profit incentives can potentially dampen "local" effort and performance if interdependence among business units is actually low (Helfat and Eisenhardt, 2004; Hill, Hitt, and Hoskisson, 1992; Kretschmer and Puranam, 2008). As a result, firms are well-advised to match managerial incentive structures to the strategic and organizational environment in which they operate (Aggarwal and Samwick, 2003; Hill and Hoskisson, 1987).

We build on this prior work by exploring the role of equity-based compensation in encouraging collaboration in a multibusiness context. More specifically, we develop a formal agency model in which headquarters provides equity and profit incentives (unit-level and firm-wide) to business-unit managers, with the objective of maximizing total expected firm returns; i.e., current profits plus gains in the value of the firm over the contracting period. Results from the model resonate with previous findings that business-wide incentives foster cross–business-unit collaboration and, in an important advance on prior work, we show that including equity in managerial incentive contracts provides a particularly effective mechanism for balancing collaborative and "local" incentives: the optimum contract in our model elicits higher own-unit and collaborative effort from business-unit managers than is achievable with a restricted (profit-only) incentive contract. Our results also provide insights into how the optimal mix of equity and profit incentives is shaped by various individual, organizational, and industry environment characteristics. In particular, we show that equity incentives are most useful when current profitability is uncertain relative to long-term growth prospects (e.g., in new economy firms), in firms pursuing related diversification strategies, and in periods of rapidly increasing stock market values.

The remainder of the paper proceeds as follows: Immediately below we describe the central managerial incentive problems common to multibusiness firms and summarize relevant findings from prior research. This lays the groundwork for our theoretical work, introduced in the next section, where we present the formal model and provide an intuitive description of the mechanisms driving the main results. In the final sections of the paper we draw out implications of our results for organizational design and managerial compensation in new economy firms and a variety of other contexts. We also note limitations of our approach and identify promising avenues for future work.

INCENTIVES IN MULTIBUSINESS FIRMS

At least since the pioneering work of Edith Penrose in the 1950s, there has been general agreement on the potential for diversification strategies to increase the value generated by firm-specific resources in the presence of imperfect factor markets (Barney, 1988; Penrose, 1959; Rumelt, 1974). Where agreement breaks down, however, is on whether (and to what extent) the potential benefits of diversification are actually realized in practice: while several studies have demonstrated a positive correlation between diversification—particularly related diversification—and firm performance (Montgomery, 1982; Palepu, 1985; Rumelt, 1982), others have produced evidence of a negative impact (e.g., Berger and Ofek, 1995; Schoar, 2002) or an insignificant relationship between diversification and firm value (Villalonga, 2004a).[3]

One of the most common explanations for the equivocal link between diversification and performance is implementation failure: as Hill, *et al.* (1992: 501) assert,

> … almost 30 years ago, Chandler (1962) noted that the success of a diversification strategy depends on how it is implemented. Diversification alone will not produce superior performance; the firm must also adopt the appropriate internal organizational arrangements.

[3] But see Villalonga (2004b) for a reappraisal of these results, suggesting that empirical findings of a diversification discount may be an artifact of the COMPUSTAT segment data used in most prior studies.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Hill, *et al.,* go on to highlight a theme that has permeated subsequent work on the implementation challenges associated with diversification; i.e., the need to create organizational structures and managerial incentives that promote cooperation and collaboration across the different businesses in which the firm operates. In this view, cross–business-unit collaboration is crucial if the company is to benefit from the synergies, or economies of scope, that lie at the heart of diversification strategies.

A basic premise shared by a diverse set of management and economics scholars exploring the role of managerial incentives in fostering collaboration and coordination is that basing managerial compensation, at least in part, on "global" (firm-wide) profits increases firm performance when there is significant interdependence among business units (see Gupta and Govindarajan [1986] for an insightful early discussion of this issue). Some scholars nonetheless note that firm-wide profit incentives can potentially dampen "local" effort, and thus performance, if interdependence among business units is actually low (Helfat and Eisenhardt, 2004; Hill *et al.,* 1992; Kretschmer and Puranam, 2008); others note that firm-wide profit incentives force managers to bear financial risks associated not only with their own performance but also with that of others (Baker, 2002). These are important considerations if managers are both effort-averse and risk-averse, as is commonly acknowledged to be the case.

Formal modeling efforts—and in particular applications of principal-agent theory—have proved to be particularly useful in probing and delineating the inherent trade-offs involved in the design of incentive systems in multibusiness firms. Principal–agent theory recognizes that business owners (principals), or headquarters managers acting on their behalf, are unable to observe all the actions or beliefs of business-unit managers (agents) as they make decisions that directly influence firm performance. In addition, the interests of business-unit managers frequently diverge from those of headquarters in terms of both the overall level and focus of effort exerted. Moreover, observed performance measures used to provide incentives are noisy outcomes of actions taken by managers across business units and, as such, efforts to align manager and firm incentives inevitably involve second-best solutions. Thus, for example, in their seminal paper, Holmstrom and Milgrom (1991) demonstrate that an increase in an agent's compensation in one task causes reallocation of attention away from other tasks, suggesting that an increase in firm-wide profit incentives inevitably reduces attention devoted to own-unit operations, all else equal. Kretschmer and Puranam (2008) also develop a formal model that confirms the intuition that the benefit of incorporating firm–wide profits in business-unit managers' compensation is increasing in the level of interdependency among business units; in their model, this benefit is particularly pronounced under conditions of uncertainty and asymmetry in collaborative benefits. The authors also derive threshold levels of interdependency below which compensation schemes to induce collaboration actually reduce firm performance (Kretschmer and Puranam, 2008: 860).

A similar conclusion regarding the trade-off between local and firm-wide incentives emerges from a distinct stream of research using agent-based simulation to model organizational design decisions in complex organizations (Rivkin and Siggelkow, 2003, 2006). In contrast to the formulation in multi-task principal–agent models, there is no explicit cross–business-unit collaboration here, in that managers' efforts are all directed to own-business-unit tasks.[4] There is nonetheless a role for firm-wide incentives in the presence of interdependencies among business units, as they encourage managers to consider the impact on overall firm profits when making decisions about own-unit tasks. Rivkin and Siggelkow (2003) show that, here again, firm-wide incentives may, in some circumstances, restrict search and potentially lower firm performance, particularly in the presence of a "passive" CEO who essentially rubberstamps proposals proposed by subordinate managers.

As noted in the introduction, managerial compensation packages in the modern multibusiness firm increasingly incorporate a significant equity component in addition to profit-based incentives. Theory is lagging practice in this regard however, as none of the existing models of managerial incentives in the multibusiness firm have explicitly considered the role that equity-based incentives may play in balancing collaborative and "local"

[4] The role of the hierarchy in Rivkin and Siggelkow's (2003) model is to review proposals from subordinates who search for high-value points on a landscape; their conceptualization of the central organizational design problem in multibusiness firms thus sits "between" principal–agent multi-tasking models focused on designing collaborative incentives and "information revelation" models focused on resource allocation across independent business units (e.g., Friebel and Raith, 2010; Levinthal and Wu, 2010).

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

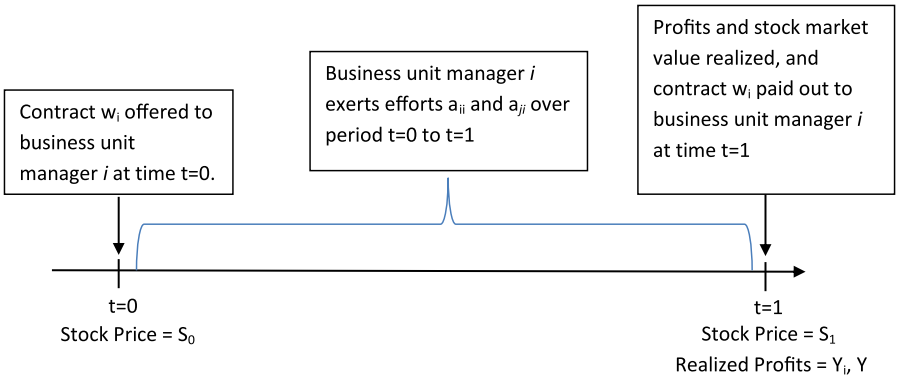

Figure 1. Timeline of actions and outcomes in the model

effort by business-unit managers. The model below addresses this gap.

THEORETICAL MODEL

We develop a model in which headquarters (the principal) of a multibusiness firm offers its business-unit managers (agents) an incentive contract based on firm equity, business-unit profits, and total firm profits, with the goal of maximizing total firm returns over the contracting period. For ease of exposition, we consider a multibusiness firm comprised of two symmetric business units.[5] As in standard agency models (e.g., Holmstrom and Milgrom, 1991), we assume that the principal is risk-neutral and that agents are both risk-averse and effort-averse.[6] Moreover, the agents' actions and effort are not observable to the principal; as such, the contract cannot be formulated as a function of effort but instead must depend on observed profits and, here, stock market value. Further, while the contract is for one period, the firm is viewed as a going concern existing over multiple periods.

Timeline of actions and outcomes

The basic timing of actions and outcomes related to the contracting problem in our model is as follows: At time $t = 0$ (the beginning of the contracting period), headquarters (HQ) offers the manager of each business unit i $(i = 1, 2)$ a compensation contract w_i $(i = 1, 2)$ with incentives based on shares of end-of-period business-unit profits, firm-wide profits, and firm equity value (see below for details of the contract form). Business-unit manager i responds to this incentive contract and exerts own-business-unit effort a_{ii} $(i = 1, 2)$[7] and cross–business-unit collaborative effort a_{ji} $(j = 1, 2$ and $j \neq i)$ over the contracting period. At the end of the period (time t = 1), profits and equity (stock) market value are realized, and managers are paid according to the incentive contract. Figure 1 summarizes these actions and the timing of the model.

Total firm returns and managerial effort

We denote the profits of each business unit over the contracting period by Y_i $(i = 1, 2)$ and the firm's total equity market value at the end of the period by S_1; firm value at the start of the contracting period is S_0. Then, the total firm return over the contracting period which headquarters (HQ) seeks to maximize is given by

$$r_s = \frac{(S_1 + Y - w) - S_0}{S_0}. \qquad (1)$$

where $Y = \sum_{i=1}^{2} Y_i$ is total firm profits (gross of managers' compensation) and $w = \sum_{i=1}^{2} w_i$ is the

[5] While this is clearly a simplification, incorporating asymmetries in the benefits of collaborative effort across business units is quite straightforward, and generalization to n business units also yields qualitatively similar results (available from the authors on request).

[6] As is common in the organization design literature (e.g., Friebel and Raith, 2010), we abstract away from agency issues between the HQ manager and the owners of the firm in order to focus attention on aligning business-unit managers' incentives with firm objectives.

[7] This and all other terms in the model follow the following notation convention: the first subscript refers to the business unit that is the target of the managers' effort; the second subscript refers to the "home" business unit of the manager.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

total compensation paid to the business-unit managers. To simplify our notation further, in the following we refer to the end-of-period stock market value of the firm, S_1, simply as S, so that (1) can then be expressed as $r_s = \frac{1}{S_0}(S + Y - w) - 1$.[8]

The profits Y_i of business unit i are related to business-unit managers' efforts as follows:

$$Y_i = \mu_i + \beta_{ii}a_{ii} + \sum_{j \neq i} \beta_{ij}a_{ij} + \varepsilon_i, \quad \varepsilon_i \sim N\left(0, \sigma^2_{Y_i}\right) \tag{2}$$

where μ_i is the mean level of profits in business unit i with zero managerial effort; $\beta_{ii}a_{ii}$ captures the effect of manager i's effort on own-business-unit profits; $\sum_{j \neq i} \beta_{ij}a_{ij}$ represents the contribution of cross–business-unit collaborative effort by the other business-unit manager(s) j to the profits of business unit i; and ε_i is the idiosyncratic Gaussian shock to business-unit profits over the period (variance $\sigma^2_{Y_i}$). The total effort exerted by the manager of business unit i is thus equal to $a_i = (a_{ii}, a_{ji})$; β_{ii} and β_{ji} capture the productivity of these efforts in terms of own-business-unit operations and cross–business-unit collaboration respectively.

We assume that the firm's stock market value is a stochastic function of the present value of expected earnings, as evaluated by shareholders. In our one-period model we capture this assumption by setting

$$S = \theta E(Y) + \eta, \quad \eta \sim N\left(0, \sigma^2_S\right) \tag{3}$$

where $E(Y)$ is expected period firm profits, θ is a market valuation parameter, and η is a Gaussian shock generating random deviations in firm market value from the expected value based on earnings (firm variance σ^2_S). In this sense, S is a stochastic representation of firm value in terms of the present value of expected earnings to shareholders, consistent with the principle of fundamental valuation, which represents firm value in terms of future expected earnings.[9] Accordingly, the valuation parameter θ can be interpreted as the growth–perpetuity value of expected firm earnings[10] or, equivalently, the firm's forward price-to-earnings ratio (Ang and Zhang, 2011) and (3) is a representation of how the equity market converts information on firm earnings into asset values.

We can also see from this formulation that if collaborative productivity is high for business-unit manager i (high β_{ji}), then effort by this manager will have a large effect on total firm return (1) since both total profits Y and firm market value S contribute to the return r_s over the contracting period.

The contracting problem

The compensation contract that HQ offers to each business-unit manager, w_i $(i = 1, 2)$ is given by

$$w_i = s_i + b_iY_i + c_iY + m_iS \tag{4}$$

where s_i is a fixed salary, b_i is the manager's share of business unit i' profits Y_i, c_i is the manager's share of total firm-wide profits Y, and m_i is the manager's share of firm equity S.

To connect to prior work and understand better the precise role that equity incentives play in eliciting business managers' efforts, we also compare the contract (4) with a "profit-only" incentive contract that includes a fixed salary, plus incentives based on business-unit profits and firm-level profits.[11] This profit-only incentive contract can be expressed in our notation as

$$w_i = s_i + b_iY_i + n_iY. \tag{5}$$

In representing manager preferences over compensation, we follow common practice in the literature and use an exponential utility specification (e.g., Gao, 2010; Garen, 1994; Jensen

[8] This formulation is consistent with a one-period-ahead stock valuation model in corporate finance. Here, the current value of the stock price S_0 is equal to the present value of expected next-period earnings E_1 plus the present value of the next-period stock price, S_1: i.e., $S_0 = \frac{E_1}{1+r_s} + \frac{S_1}{1+r_s}$ where r_s is the shareholders' required return. Solving this expression for r_s and keeping in mind that in our case $E_1 = Y - w$ directly leads to the expression for firm returns in (1).

[9] Note that this includes "new economy" or other very high-growth firms: although these firms may have low earnings presently, investors are willing to pay a high price relative to current earnings (i.e., high θ) in recognition of higher expected earnings in the future.

[10] The growth perpetuity value of the firm $\theta = 1/(k - g)$ represents the present value of expected firm earnings $E(Y)$ with growth rate g and discount rate k.

[11] For example, Kretschmer and Puranam (2008) analyze an incentive contract based on business-unit profits and total firm profits, where HQ maximizes total firm profits.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

and Murphy, 1990). This utility function exhibits constant absolute risk aversion (CARA) and yields tractable expressions for incentives and effort that are independent of managers' initial wealth. More specifically, manager i's utility (U_i) is related to total compensation (w_i) and efforts ($a_i = (a_{ii}, a_{ji})$) as follows:

$$U_i\left(w_i, a_i\right) = -\exp\left(-\alpha\left(w_i - \frac{1}{2}g_i\sum_{j=1}^{2}a_{ji}^2\right)\right)$$

here, α is the manager's coefficient of risk aversion and g_i represents his/her aversion to effort (we assume this to be the same for managers). Manager i selects effort levels a_i to maximize utility and will accept a contract (s_i, b_i, c_i, m_i) if it provides at least the same utility as the manager's outside option $\bar{U}_i$, where $\overline{U}_i = -\exp\left(-\alpha_i\overline{w}_i\right)$ and $\overline{w}_i$ is the corresponding outside certainty reservation pay.

HQ's contracting problem in our model thus involves the design of an incentive contract for business unit managers that maximizes total expected firm return $E\left(r_s\right) = \frac{1}{S_0}E\left(S + Y - w\right) - 1$, subject to business managers' incentive compatibility and participation constraints[12]:

For $i = 1, \ldots, I = 2$

$$\underset{\{s_i,b_i,c_i,m_i\}}{\text{Max}}\ \frac{1}{S_0}E\left(S + Y - \sum_{i=1}^{I=2} w_i\left(s_i, b_i, c_i, m_i\right)\right)$$

$$= \underset{\{s_i,b_i,c_i,m_i\}}{\text{Max}}\ \frac{1}{S_0}E\left(S + \sum_{i=1}^{I=2} Y_i - \sum_{i=1}^{I=2}(s_i + b_iY_i + c_iY + m_iS)\right) \quad (6)$$

subject to

$$\underset{\{a_{ii},a_{ji}\}}{\text{Max}}\ E\left\{-\exp\left(-\alpha\left(w_i\left(s_i, b_i, c_i, m_i\right) - \frac{1}{2}g_i\sum_{j=1}^{I=2}a_{ji}^2\right)\right)\right\}, i = 1, \ldots, I \quad (7)$$

$$E\left\{-\exp\left(-\alpha\left(w_i\left(s_i, b_i, c_i, m_i\right) - \frac{1}{2}g_i\sum_{j=1}^{I}a_{ji}^2\right)\right)\right\} \geq \overline{U}_i, i = 1, \ldots, I \quad (8)$$

Note that with this model formulation HQ managers take into account the total impact of collaboration on *both* total profits and firm value in determining how much weight to give to business-unit profits (Y_i), total profits (Y), and firm equity (S) incentives in the return-maximizing contract. Similarly, heterogeneity in other divisional and firm characteristics such as manager's own-division productivity β_{ii}, firm growth prospects θ, divisional profit uncertainty $\sigma_{Y_i}^2$, firm value uncertainty σ_S^2 will be taken into account in determining the optimal incentives.

To obtain the solution to this problem we follow common practice and proceed in two steps: First, given a general incentive contract $(w_i = s_i + b_iY_i + c_iY + m_iS)$, we examine manager i's utility maximization problem (7 and 8) and obtain his/her best-response effort vector $a_i = (a_{ii}, a_{ji})$. Second, we solve for the principal's choice of contract (s_i, b_i, c_i, m_i) by maximizing (6) subject to the constraints implied by the business-unit managers' best-response effort vectors. Details of the solution are provided in Appendix 1, and key results are reported below.

The optimal contract

Business-unit managers' best-response effort vectors for the general incentive contract $w_i = s_i + b_iY_i + c_iY + m_iS$ are derived from the first order conditions of the incentive compatibility and participation constraints (7 and 8), yielding the following values:

$$a_{ii} = \frac{\beta_{ii}\left(b_i + c_i + \theta m_i\right)}{g_i}, \quad a_{ji} = \frac{\beta_{ji}\left(c_i + \theta m_i\right)}{g_i}. \quad (9)$$

Substituting these values into (6–8) and solving HQ's constrained optimization problem produces the following incentive terms:

$$b_i = \frac{(1+\theta)\,\sigma_S^2 g\alpha\left(\beta_{ii}^2\sigma_{Y_j}^2 - \beta_{ji}^2\sigma_{Y_i}^2\right)}{D_i} \quad (10)$$

[12] To maintain analytical tractability we do not introduce a separate constraint on individual manager's incentives, but it can be shown that under the optimal contract the total compensation paid out to business-unit managers always falls below the limit of 100 percent of total firm returns (proofs available from authors on request). See Footnotes 13 and 14 for more on total managerial compensation in the optimum contract.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

$$c_i = \frac{(1+\theta)\,\beta_{ji}^2\sigma_S^2\left(\beta_{ii}^2 + g\alpha\sigma_{Y_i}^2\right)}{D_i} \tag{11}$$

$$m_i = \frac{\theta\,(1+\theta)\left[\beta_{ii}^2\beta_{ji}^2\left(\sigma_{Y_i}^2+\sigma_{Y_j}^2\right) + \alpha g\sigma_{Y_i}^2\sigma_{Y_j}^2\left(\beta_{ii}^2+\beta_{ji}^2\right)\right]}{D_i} \tag{12}$$

where $D_i = \theta^2\left[\beta_{ii}^2\beta_{ji}^2\left(\sigma_{Y_i}^2+\sigma_{Y_j}^2\right) + \alpha g\sigma_{Y_i}^2\sigma_{Y_j}^2\left(\beta_{ii}^2+\beta_{ji}^2\right)\right] + \sigma_S^2\left[\beta_{ii}^2\beta_{ji}^2 + \alpha g\left(\beta_{ii}^2\sigma_{Y_j}^2 + \beta_{ji}^2\sigma_{Y_1}^2\right) + \alpha^2 g^2\sigma_{Y_i}^2\sigma_{Y_j}^2\right]$.

Note that in the optimal contract, c_i and m_i are always positive and b_i is positive for reasonable values of productivity and uncertainty parameters.[13,14]

Below, we examine the sensitivity of the optimal contract terms to different productivity, uncertainty, and growth parameters, to probe the conditions under which we are most likely to see different types of incentive contracts. Before turning to that analysis, however, we first compare managerial effort under the optimal contract identified above with effort under a contract that does not include any equity incentive. This allows us to assess the impact of equity incentives on business-unit managers' behavior and, in particular, on their incentives to collaborate across business units.

Impact of equity incentives on business-unit manager effort

To compare managers' efforts under the optimal contract described above with one that does not allow for equity incentives (5), we impose the restriction $m_i = 0$ in (6–8) above and solve as before (see Appendix S1 for details). Denoting the original contract as C1, and the no-equity ($m_i = 0$) contract as C2 we can show that

$$a_{ii}^{C1} - a_{ii}^{C2} = \frac{\theta^2\,(1+\theta)\,\beta_{ii}^2\alpha\sigma_{Y_i}^2\left(\beta_{ii}^2\beta_{ji}^2\left(\sigma_{Y_i}^2+\sigma_{Y_j}^2\right) + \alpha g\sigma_{Y_i}^2\sigma_{Y_j}^2\left(\beta_{ii}^2+\beta_{ji}^2\right)\right)}{\left(\beta_{ii}^2 + \sigma_{Y_i}^2\alpha g\right)D^{C1}} > 0 \tag{13}$$

$$a_{ji}^{C1} - a_{ji}^{C2} = \frac{\theta^2\,(1+\theta)\,\beta_{ji}^2\alpha\sigma_{Y_j}^2\left(\beta_{ii}^2\beta_{ji}^2\left(\sigma_{Y_i}^2+\sigma_{Y_j}^2\right) + \alpha g\sigma_{Y_i}^2\sigma_{Y_j}^2\left(\beta_{ii}^2+\beta_{ji}^2\right)\right)}{\left(\beta_{ji}^2 + \sigma_{Y_j}^2\alpha g\right)D^{C1}} > 0 \tag{14}$$

These expressions show that managerial effort is higher under the contract that includes an equity incentive component for all values of productivity, growth, and uncertainty parameters. Moreover, *the increase in effort is for both own-unit effort (a_{ii}) and cross–business-unit collaborative effort (a_{ji})*. The intuition behind this result is that inclusion of the equity incentive more closely aligns the managers' incentives with the firm's objective function and thus generates the optimal level of own–division- and cross–division-collaborative effort needed to maximize expected firm returns.

This result naturally raises the question "why are equity incentives not ubiquitous features of business-unit managers' compensation packages in North America and elsewhere if they always improve performance?" One plausible answer may be simply that there is a process of discovery and diffusion in recognizing the value of equity incentives for non-C-suite executives (Strang and Soule, 1998). In this view, we should expect to see a continuation in the recent trend of increasing use of equity incentives for business-unit managers in multibusiness firms. Another plausible answer, however, may

[13] In particular, b_i is positive as long as $\beta_{ii} > \beta_{ji}\left(\sigma_{Y_i}/\sigma_{Y_j}\right)$. It is reasonable to expect that the productivity of own-unit effort is in general significantly higher than cross-unit collaborative effort (Camerer and Knez, 1997; Kretschmer and Puranam, 2008), such that the only plausible situation leading to violation of this condition is if the variance of manager i' divisional profits is extremely high relative to the variance of division j profits. In this case, where divisional profit incentives become negative, HQ will optimally set $b_i = 0$, thus focusing all of the business-unit managers' incentive pay on global profits and equity value.

[14] Managers' combined equity grants in the optimal incentive contract represent a small fraction of total firm equity for model parameter values that are "reasonable," in the sense that they are consistent with empirical observation (e.g., for relative profit and equity variance, productivity of own– versus cross–business-unit productivity, etc.). Although mathematical results exist for any parameterization of the model, some of which may imply significantly higher incentives, internal consistency among parameter values is required so that model results have a meaningful economic interpretation. Empirical calibration of the model and exploration of possible boundary conditions nonetheless represents a potentially useful avenue for future work.

Copyright © 2015 John Wiley & Sons, Ltd.

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

be that there are additional organizational or financial costs associated with the use of equity incentives that are not captured in our model.[15] While analysis of the impact of such "frictions" in the use of equity incentives is beyond the scope of our model (and our paper) it prompts us to examine the conditions under which the model predicts more intensive use of equity incentives relative to different profit-based incentives. In this way we can understand where firms are likely to derive the *most* benefit from the use of equity incentives in eliciting additional effort from their business-unit managers.

When are equity incentives most useful?

Table 1 displays the signs of partial derivatives with respect to the main model parameters for each of the contract incentives, b_i, c_i, m_i, as well as for pairwise ratios of these incentives, m_i/c_i, m_i/b_i, and c_i/b_i, for managers' own–business-unit and cross–business-unit collaborative efforts, $a_i = (a_{ii}, a_{ji})$, and also for the increase in effort associated with the optimal contract versus a restricted ($m_i = 0$) contract.[16] Examination of these partial derivatives allows us to assess the relative merits of equity incentives versus firm-wide and local profit incentives in inducing business-unit managers' efforts and increasing performance in a variety of contexts.[17]

Table 1. Assessing the merits of equity incentives: signs of partial derivatives

	θ	σ_S	σ_{Y_i}	β_{ii}	β_{ji}
b_i	−	+	−	+	−
c_i	−[a]	+	−	+	+
m_i	+[b]	−	+	+	+
c_i/b_i	0	0	+	−	+
m_i/b_i	+	−	+	−	+
m_i/c_i	+	−	+	+	−
a_{ii}	+	−	−	+	+
a_{ji}	+	−	+	+	+
$a_{ii}^{C1} - a_{ii}^{C2}$	+	−	+	?[c]	+
$a_{ji}^{C1} - a_{ji}^{C2}$	+	−	+	+	?[c]

[a] This value is negative as long as θ is not "too small."
[b] This value is positive as long as θ is not "too large."
[c] The large number of opposing terms in these expressions making signing of the net effect impossible without imposing multiple parameter restrictions.
The above table displays the signs of the partial derivatives for different optimum incentive contract terms and realized efforts (listed in the left hand column) with respect to various model parameters (identified in column headings).

These results highlight some important nuances related to the use of equity incentives for business-unit managers. Looking first at Columns 1 and 2, we see that the utility of equity incentives is in general increasing in the valuation parameter (forward price–earnings ratio) θ and decreasing in the volatility of stock market values, σ_S: as θ increases or σ_S decreases, the optimum compensation contract for business-unit managers shifts toward equity incentives, and there is a concomitant decrease in profit-based incentives.[18] Moreover, with this shift toward equity compensation, both own–unit- and cross–business-unit collaborative effort are increased, as is the effort that is foregone if a firm's compensation policies do not allow for equity incentives.

[15] One possibility is that the "risk premium" associated with equity compensation is larger for non-C-suite executives because they have on average lower wealth than their more senior counterparts. If this is the case, then equity compensation becomes relatively more "expensive" in comparison to fixed or profit-based compensation (Core, Guay, and Larcker, 2003). While the results in our model certainly take into account the riskiness of equity compensation and factor this into the firm's optimization problem, we nonetheless assume constant absolute risk aversion and therefore abstract away from manager wealth effects. Another possibility is that stock options and grants are a particularly visible form of compensation and, as such, are more likely to generate social comparison costs (Nickerson and Zenger, 2008). Finally, there is some evidence that (at least for CEOs) restricted stock holdings actually reduce executives' willingness to make strategically risky (but positive NPV) investments, so imposing additional costs on the organization (Devers *et al.,* 2008; see also Wright *et al.,* 2007).

[16] The expressions for the partial derivatives are quite complex. See Appendix S2 for some of the simpler examples of these expressions, for partial derivatives of the pairwise ratios of contract terms.

[17] Note that there is variation in the total expected value of the compensation package for different combinations of equity and profit incentives. This is because of differences in the variability of managers' compensation derived from profits and equity shares and thus differences in the expected value of the compensation package needed to match the utility of the risk-averse managers' outside certainty reservation pay $\overline{w}_i$. This difference in total expected cost is factored into HQ's optimization problem. Note also that for the purposes of this analysis we assume that $\beta_{ii} > \beta_{ji}\left(\sigma_{Y_i}/\sigma_{Y_j}\right)$ (see Footnote 14 for more on this).

[18] This result may not hold if equity incentives are comprised of stock options rather than stock grants (see page 12 regarding opportunities for further research). To maintain tractability, theoretical contracting models including equity into managerial contracts do not distinguish between stock grants and stock options (e.g., Dutta and Reichelstein, 2005; Feltham and Wu, 2000). This may be partially justified by the practice in empirical work on CEO compensation to convert stock options to their equity equivalent using the option's delta (sensitivity of call option to stock price) (e.g., Core *et al.,* 2003; Garvey and Milbourn, 2003).

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Column 3 shows that the importance of equity incentives also increases when the variability of business-unit profits σ_{Y_i} increases (all else equal). In this case, optimal profit-based incentives again decline, but this happens more markedly for business-unit profits than for firm-wide profits (c_i/b_i increases) and; as before, the "lost" effort associated with restricted (no-equity) compensation contracts is increasing in σ_{Y_i}.

Finally, Columns 4 and 5 indicate that, as one should expect, the balance of global (firm-wide) to local incentives is increasing in the productivity of cross-unit collaborative effort and decreasing in the productivity of own–business-unit effort: both c_i/b_i and m_i/b_i decrease (increase) as β_{ii} (β_{ji}) increases. Perhaps more surprisingly, these results also show that an increase in cross–business-unit collaborative productivity increases both collaborative effort *and* own–business-unit effort. The intuition behind this result is that increasing β_{ji} leads to higher equity incentives in the optimum contract; and, even though own-division profit share (b_i) may go down (which would usually divert effort away from own-division tasks), the greater reward for contributions to firm value in the return-maximizing contract more than offsets this effect and leads to higher own-division effort. The same is true for increases in β_{ii}; again we see increases in both own–business-unit and cross–business-unit collaborative effort. This again illustrates how the use of equity incentives facilitates a more fine-grained balancing of own-division and cross-unit collaborative effort than is feasible with a profit-only incentive contract when headquarters seeks to maximize total firm returns.

DISCUSSION & IMPLICATIONS

In the previous section, we identified equity and profit-based incentives for business-unit managers that maximize total expected firm returns when managers have the potential to affect the performance of other business units through collaboration. We now consider implications of these results for the management of multibusiness firms in different contexts and for our understanding and interpretation of recent anecdotal and empirical evidence on the use of equity-based incentives. In the final section we note some important limitations of our work and conclude with a discussion of useful avenues for future research.

Equity incentives in new economy firms

Our model results align well with observations on the more intensive use of equity-based compensation for managers of "new economy" firms (Murphy, 2003) and shed new light on the potential link between equity incentives and collaboration intimated by Amazon CEO Jeff Bezos. Like many other new economy firms, Amazon is generally perceived to have strong and reliable growth prospects. At the same time, current profitability is highly uncertain, as the following observation suggests:

> Why does Amazon's stock keep hitting new highs while the company (as critics love to point out) continues to generate almost no profit?
>
> Because Amazon's management has stated very clearly that the company is going to invest aggressively in the long-term future instead of worrying about near-term profits. And Amazon's management has demonstrated, again and again, that it can make smart-enough investments that, over the long haul, the investments can produce even greater returns (Blodget, 2013).

High firm growth prospects combined with low and uncertain current profitability are captured in our model by elevated values on both the valuation parameter θ and business-unit profit uncertainty parameter σ_{Y_i}. As the results in Table 1 show, increases in either of these parameters leads to a higher weighting on equity incentives in the optimal contract (m_i, m_i/c_i, and m_i/b_i all increase) as well as an increase in cross–business-unit collaborative effort (a_{ji}); the net effect on own–business-unit effort is difficult to sign, as the partial derivatives on a_{ii} go in opposite directions for the two parameter changes; but note that the inclusion of equity incentives in the contract significantly increases *both* own–business-unit effort *and* cross–business-unit collaborative effort relative to an otherwise-optimal non-equity contract ($a_{ii}^{C1} - a_{ii}^{C2} > 0$ and $a_{ji}^{C1} - a_{ji}^{C2} > 0$). In other words, equity incentives provide a particularly useful mechanism for balancing the need for local effort (e.g., for innovation within the business unit) and firm-wide teamwork among business-unit managers—something that is of particular interest as new economy firms expand into an increasingly diverse array of related businesses.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Equity incentives and stock market dynamics

The results of our model also have implications for the extent of equity-based compensation that we should expect to see during periods of stock market rallies or declines. As noted earlier, the use of equity-based compensation (particularly for non-C-suite executives) really took off during the 1990s. This period coincided with a prolonged bull market in the U.S., when companies experienced massive growth in equity values and price–earnings ratios (Ang and Zhang, 2011).[19] The timing of the increase in equity-based compensation is thus consistent with the predictions of our model, as an increase in the valuation parameter θ leads to an increase in the optimum equity-to-profit incentives ratio in managers' compensation contracts.

Our model further predicts that the shift toward equity compensation will be higher for firms with lower market value uncertainty (σ_S), which is consistent with the observation that the increases in equity-based compensation during the late 1990s were particularly dramatic for executives of the largest S&P500 firms (which tend to have lower stock market volatility).[20] Moreover, during periods of lower growth, our model predicts that equity incentives will fall relative to profit-based incentives, something that we have also seen in the more recent period, in the aftermath of the global financial crisis.[21]

Related diversification & organization form

In addition to illuminating these current trends in the use of equity-based compensation, our analysis yields several additional insights and predictions on the relationship between the organizational form of multibusiness firms and the return-maximizing incentive contract. For example, our model points to a positive link between cross–business-unit collaborative productivity (β_{ij}) and the optimum level of equity in business-unit managers' compensation package. This finding has implications for the benefits of equity-based compensation for firms pursuing related versus unrelated (conglomerate) diversification: to the extent that the presence of greater potential synergies in related diversification implies higher cross–business-unit collaborative productivity (higher β_{ji}), we should expect to see greater use of equity-based compensation relative to that in otherwise similar conglomerate firms whose business units are engaged in fewer overlapping/complementary activities. This result is consistent with prior findings that increasing the share of "global" (firm-wide) profits in managerial compensation packages encourages collaboration and enhances firm performance when there is significant interdependence among business units (Gupta and Govindarajan, 1986; Kretschmer and Puranam, 2008; Rivkin and Siggelkow, 2003, 2006). Our model adds an additional important insight, however, as it highlights the unique role of equity-based compensation in balancing the need for local effort and firm-wide collaboration, leading to higher levels of effort by business-unit managers overall, as discussed above.

Our model can also generate insights into the potential for *selective* use of equity-based incentives in different parts of the firm in cases where there is heterogeneity and asymmetry in the benefits of collaboration across business units (e.g., $\beta_{ij} > \beta_{ji}$). One might conjecture, for example, that in vertically integrated firms in technology-intensive industries such as pharmaceuticals or biotechnology the benefits of cross–business-unit collaboration are greatest in "upstream" business units devoted to R&D operations. If this is the case, then the results of our model imply that we should see a greater reliance on equity-based incentives for R&D managers, relative to managers of "downstream" divisions (e.g., sales) where cross–business-collaborative productivity is lower. And indeed, there is some suggestive empirical evidence consistent with this conjecture: in their study of equity-based pay in new economy firms, Ittner *et al.* (2003) note that compensation packages for technical managers tend to be more heavily weighted toward equity than those for managers in other areas, all else equal.[22] To be sure, there may

[19] Ang and Zhang note that P/E ratios for S&P 500 firms were very high during the late 1990s and early 2000s, well above their historical average of 18.5 (2011: 134)

[20] In cross-sectional analysis, Frye (2004) also finds evidence of a positive link between equity-based compensation and firm size, growth opportunities, and industry performance in the late 1990s.

[21] We recognize that this shift reflects not only the decline in P/E ratios since the financial crisis, but also a shift in public opinion regarding equity-based compensation, given some of the excesses associated with the crisis.

[22] It is important to acknowledge that there are plausible alternative explanations or this result, including the one emphasized by Ittner *et al*, that "employees working in technical areas (such as engineering, information technology and research and development) have a stronger ability to impact stock price in these firms, leading to greater use of stock options in these functions." (Ittner *et al.,* 2003: 95). In our model this mechanism would show up as

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

be binding constraints on intra-firm variance in the types of compensation packages offered to managers, due to social comparison costs and concerns about fairness (Nickerson and Zenger, 2008; Pfeffer and Langton, 1993). Further exploration of this issue could nonetheless be a particularly interesting avenue for future research.

CONCLUSIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

Agency issues and information asymmetries generate frictions that can prevent multibusiness firms from fully realizing value from collaborative efforts across business units. As such, an incentive mechanism that can elicit the appropriate mix of "local" and "global" or firm-wide efforts from business-unit managers is a strategic priority. We contribute to understanding of this important strategic management problem by developing a formal model of collaborative incentives in a multibusiness firm in which headquarters maximizes total expected firm returns by providing equity and profit incentives to business-unit managers. The model enables us to make precise predictions on how the optimal composition of equity and profit incentives, as well as business-unit managers' collaborative and own-division efforts, is influenced by various firm and organizational characteristics. This would not be possible through informal reasoning, given the complex relationships involved. Our modeling efforts provide a number of new insights and predictions that can inform future research and management practice.

We find that the inclusion of equity incentives in business-unit managers' compensation contracts generates higher collaborative and "local" efforts from business-unit managers than would be achievable through a profit-only incentive contract. The return-maximizing contract provides a rich mechanism for aggregating value from collaborative interactions across business units, more effectively aligning manager activities with the firm's growth prospects and managing the dual risks in divisional profits and firm market value faced by multibusiness firms. It also generates alignment of manager incentives to organizational characteristics and structure (e.g., related versus unrelated diversification). Results of the model indicate that the optimal ratio of equity-to-profit incentives for business-unit managers is higher for high-growth firms, larger and less volatile firms (e.g., S&P 500), for firms pursuing related diversification, and during "bull market" periods. We believe that these and other model predictions summarized in Table 1 are susceptible to empirical evaluation given appropriate data on business-unit performance, managerial compensation, and firm equity returns. Our model results may also prove useful in guiding the design and evaluation of optimal profit and equity incentive contracts for business-unit managers in different organizational and industry contexts.

Of course, as with all formal modeling efforts, we are forced to make several simplifying assumptions in order to generate an analytically tractable model. While we believe that our approach yields a rigorous basis for improving our understanding of equity-based incentives and collaboration in multibusiness firms, there are several theoretical extensions and refinements that would be useful to incorporate in future work. One important assumption we make is that expectations about the firm's future growth prospects (the valuation parameter) is exogenously given and constant over the contracting period. We believe that this is a reasonable simplification: although valuation (price-to-earnings) ratios do change over time, they tend to do so slowly and can reasonably be assumed to be fixed over shorter contracting horizons. Extension of the model to allow for a stochastic valuation parameter or to allow this parameter to be shaped by managers' actions (for example by expanding our multitasking model to consider choices in the temporal dimension) is a challenging enterprise but nonetheless one that may generate interesting additional insights.

Another challenging but useful model extension could be to incorporate stock options as a separate item in the incentive contract. The asymmetric feature of stock options in the incentive contract would almost certainly preclude finding a closed-form solution—one reason why related prior theoretical contracting models including equity into managerial contracts do not distinguish between stock grants and stock options (e.g., Dutta and Reichelstein, 2005; Feltham and Wu, 2000). One reasonable simplification commonly adopted in empirical work on CEO compensation (e.g., Core, Guay, and

increased own-business-unit productivity, β_{ii}, something that also leads to increased equity in the optimal incentive contract.

Copyright © 2015 John Wiley & Sons, Ltd.

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Verrecchia, 2003; Gao, 2010; Garvey and Milbourn, 2003) is to convert stock options to their equity equivalent using the option's delta (sensitivity of call option to stock price). Analysis based on this extension can introduce some additional complexity in how stock price uncertainty affects the incentives related to stock options.

One potential application deserving of additional exploration is the design of incentive contracts for firms pursuing diversification strategies based on the sharing of centrally developed scale-free resources across relatively independent business units, for example in the case of Disney's characters and themes, or General Electric's revered management development process. If, as one might suspect, this type of diversification requires less collaborative effort by business-unit managers then, according to our model, we should expect to see fewer equity incentives employed, all else equal. More generally, lower powered incentives for business-unit managers may facilitate HQ's ability to exercise "fiat" in deployment of centrally developed resources (Williamson, 1985). Nonetheless, as pointed out in a recent article by Zhou (2011), "Sharing common inputs creates interdependencies between business lines. It requires joint designing, joint scheduling, and mutual adjustments. … Interdependent business lines must engage in ongoing communication to understand the factors affecting each other's decisions and to track the decisions that are made, particularly where multiple equilibria exist." (Zhou, 2011: 626). This observation suggests that different, and potentially complex, combinations of vertical and horizontal coordination mechanisms may be required for different types of diversification. Mapping differentiation strategies onto coordination and incentive mechanisms thus represents an interesting opportunity for future work.

Despite the fact that the unbounded enthusiasm for stock grants, options, and other high-powered managerial performance incentives has cooled in the aftermath of the 2008/2009 financial crisis, it appears that equity-based compensation is here to stay (Anderson *et al.,* 2014; Hochberg and Lindsey, 2010). We believe that our paper has taken an important first step toward a better understanding of the positive role that equity- and profit-based incentives can jointly play in fostering collaboration in multibusiness firms and hope that it stimulates additional research on this important topic.

ACKNOWLEDGEMENTS

This research was supported by the Canadian Social Science & Humanities Research Council (SSHRC Grant #: 430-2012-0359). The authors thank the Co-Editor Constance Helfat and two anonymous reviewers for their very useful and constructive comments and suggestions in the finalization of this paper.

REFERENCES

Aggarwal RK, Samwick AA. 2003. Performance incentives within firms: the effect of managerial responsibility. *Journal of Finance* **58**(4): 1613–1649.

Anderson MC, Banker RD, Ravindran S. 2014. Executive compensation in the information technology industry. *Management Science* **46**(4): 530–547.

Ang A, Zhang X. 2011. Price-earnings ratios: growth and discount rates. In *Rethinking the Equity Risk Premium*, Hammond PB, Leibowitz ML, Siegel LB (eds). Research Foundation of the CFA Institute; 130–142. Available at: http://www.cfainstitute.org/learning/products/publications/contributed/Pages/rethinking_the_equity_risk_premium.aspx.

Baker G. 2002. Distortion and risk in optimal incentive contracts. *Journal of Human Resources* **37**(4): 728–751.

Barney JB. 1988. Returns to bidding firms in mergers and acquisitions: reconsidering the relatedness hypothesis. *Strategic Management Journal* **9**: 71–78.

Berger PG, Ofek E. 1995. Diversification's effect on firm value. *Journal of Financial Economics* **37**: 39–65.

Blodget H. 2013. Yes, Virginia, you can have great stock performance while forgoing near–term profit. *Business Insider* 1 August. Available at: http://www.businessinsider.com/profits-and-stock-prices-2013-8 (accessed 24 March 2014).

Camerer CM, Knez M. 1997. Coordination in organizations: a game theoretic perspective. In *Organizational Decision Making*, Shapira Z (ed). Cambridge University Press: Cambridge, UK; 158–190.

Chandler A. 1962. *Strategy and Structure*. Doubleday & Company: New York.

Chandler A. 1977. *The Visible Hand: The Managerial Revolution in American Business*. Harvard University Press: Cambridge, MA.

Core JE, Guay WR, Larcker DF. 2003. Executive equity compensation and incentives: a survey. *Economic Policy Review* **9**(1): 27–50.

Core JE, Guay WR, Verrecchia RE. 2003. Price versus non-price performance measures in optimal CEO compensation contracts. *Accounting Review* **78**(4): 957–981.

Devers CE, McNamara G, Wiseman RM, Arrfelt M. 2008. Moving closer to the action: examining compensation design effects on firm risk. *Organization Science* **19**(4): 548–566.

Copyright © 2015 John Wiley & Sons, Ltd.

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Dutta S, Reichelstein SJ. 2005. Stock price, earnings and book value in managerial performance measurement. *Accounting Review* **80**(4): 1069–1100.

Fama EF, Miller MH. 1972. *The Theory of Finance*. Dryden Press: Hinsdale, IL.

Feltham GA, Wu MG. 2000. Public reports, information acquisition by investors, and management incentives. *Review of Accounting Studies* **5**(2): 155–190.

Finkelstein S, Hambrick DC. 1988. Chief executive compensation: a synthesis and reconciliation. *Strategic Management Journal* **9**: 543–558.

Friebel G, Raith M. 2010. Resource allocation and organizational form. *American Economic Review* **2**(2): 1–33.

Frye MB. 2004. Equity-based compensation for employees: firm performance and determinants. *Journal of Financial Research* **27**(1): 31–54.

Gao H. 2010. Optimal compensation contracts when managers can hedge. *Journal of Financial Economics* **97**(2): 218–238.

Garen JE. 1994. Executive compensation and principal-agent theory. *Journal of Political Economy* **102**(6): 1175–1199.

Garvey G, Milbourn T. 2003. Incentive compensation when executives can hedge the market: evidence of relative performance evaluation in the cross-section. *Journal of Finance* **58**: 1557–1582.

Gupta AK, Govindarajan V. 1986. Resource sharing among SBUs: strategic antecedents and administrative implications. *Academy of Management Journal* **29**(4): 695–714.

Helfat CE, Eisenhardt KM. 2004. Inter–temporal economies of scope, organizational modularity, and the dynamics of diversification. *Strategic Management Journal* **25**: 1217–1232.

Hill CWL, Hitt MA, Hoskisson RD. 1992. Cooperative versus competitive structures in related and unrelated diversified firms. *Organization Science* **3**(4): 501–521.

Hill CWL, Hoskisson RD. 1987. Strategy and structure in the multiproduct firm. *Academy of Management Review* **12**(2): 331–341.

Hochberg YV, Lindsey L. 2010. Incentives, targeting and firm performance: an analysis of non–executive stock options. *Review of Financial Studies* **23**(11): 4148–4186.

Holmstrom B. 1979. Moral hazard and observability. *Bell Journal of Economics* **10**: 74–91.

Holmstrom B, Milgrom P. 1991. Multi-task principal agent analysis: linear contracts, asset owner ship and job design. *Journal of Law, Economics, and Organization* **7**: 24–52.

Ittner CD, Lambert RA, Larcker DF. 2003. The structure and performance consequences of equity grants to employees of new economy firms. *Journal of Accounting and Economics* **34**: 89–127.

Jensen M, Meckling WH. 1976. Theory of the firm: managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics* **3**: 305–360.

Jensen M, Murphy K. 1990. Performance pay and top management incentives. *Journal of Political Economy* **98**: 225–264.

Kretschmer T, Puranam P. 2008. Integration through incentives within differentiated organizations. *Organization Science* **19**(6): 860–875.

Lashinsky A. 2012. Jeff Bezos: the ultimate disrupter. *Fortune Magazine* 3 December: 166.

Levinthal DA, Wu B. 2010. Opportunity costs and non–scale free capabilities: profit maximization, corporate scope and profit margins. *Strategic Management Journal* **31**: 780–801.

Los Angeles Times. 1998. Hughes offering stock options to employees. 7 August. Available at: http://articles.latimes.com/keyword/stock-options/featured/2 (accessed 29 October 2014).

Milgrom P, Roberts J. 1992. *Economics, Organization, and Management*. Prentice Hall: Englewood Cliffs, NJ.

Montgomery CA. 1982. The measurement of firm diversification: some new empirical evidence. *Strategic Management Journal* **25**(2): 299–307.

Morgenson G. 1998. Stock options are not a free lunch. *Forbes* 18 May: 212–217.

Murphy KJ. 2003. Stock–based pay in new economy firms. *Journal of Accounting and Economics* **34**: 129–147.

Nickerson JA, Zenger T. 2008. Envy, comparison costs, and the economic theory of the firm. *Strategic Management Journal* **29**: 1429–1450.

Nyberg AJ, Fulmer IS, Gerhart B, Carpenter MA. 2010. Agency theory revisited: CEO return and shareholder interest alignment. *Academy of Management Journal* **53**: 1029–1049.

Ofek E, Yermack D. 2000. Taking stock: equity-based compensation and the evolution of managerial ownership. *Journal of Finance* **55**(3): 1367–1384.

Palepu K. 1985. Diversification strategy, profit performance and the entropy measure. *Strategic Management Journal* **6**: 239–255.

Pandher GS, Currie R. 2013. CEO compensation: a resource advantage and stakeholder-bargaining perspective. *Strategic Management Journal* **34**: 22–41.

Penrose ET. 1959. *The Theory of the Growth of the Firm*. John Wiley: New York.

Pfeffer J, Langton N. 1993. The effect of wage dispersion on satisfaction, productivity, and working collaboratively: evidence from college and university faculty. *Administrative Science Quarterly* **38**(3): 382–407.

Rivkin JW, Siggelkow N. 2003. Balancing search and stability: interdependencies among elements of organizational design. *Management Science* **49**(3): 290–311.

Rivkin JW, Siggelkow N. 2006. Organizing to strategize in the face of interactions: preventing premature lock–in. *Long Range Planning* **39**: 591–614.

Rumelt RP. 1974. *Strategy, Structure and Economic Performance*. Harvard University Press: Cambridge, MA.

Rumelt RP. 1982. Diversification strategy and profitability. *Strategic Management Journal* **3**: 359–369.

Schoar A. 2002. Effects of corporate diversification on productivity. *Journal of Finance* **57**(6): 2379–2403.

Strang D, Soule SA. 1998. Diffusion in organizations and social movements: from hybrid corn to poison pills. *Annual Review of Sociology* **24**: 265–290.

Copyright © 2015 John Wiley & Sons, Ltd.

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Teece D. 1982. Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior and Organization* **3**(1): 39–63.
Villalonga B. 2004a. Diversification discount or premium? New evidence from the business information tracking series. *Journal of Finance* **59**: 479–506.
Villalonga B. 2004b. Does diversification cause the 'diversification discount'? *Financial Management* **33**(2): 5–27.
Westphal JD, Stern I. 2006. The other pathway to the boardroom: how interpersonal influence behavior can substitute for elite credentials and demographic majority status in gaining access to board appointments. *Administrative Science Quarterly* **51**: 169–204.
Westphal JD, Zajac EJ. 1998. The symbolic management of stockholders: corporate governance reforms and shareholder reactions. *Administrative Science Quarterly* **43**(1): 127–153.
Williamson OE. 1975. *Markets and Hierarchies*. Free Press: New York.
Williamson OE. 1985. *The Economic Institutions of Capitalism*. Free Press: New York.
Wowak AJ, Hambrick DC. 2010. A model of person-pay interaction: how executives vary in their responses to compensation arrangements. *Strategic Management Journal* **31**: 803–821.
Wright P, Kroll M, Krug JA, Pettus M. 2007. Influences of top management team incentives on firm risk taking. *Strategic Management Journal* **28**: 81–89.
Yarow J. 2012. Working at Amazon: no free food, and a low salary. *Business Insider* 16 November. Available at: http://www.businessinsider.com/working-at-amazon-no-free-food-and-a-low-salary-2012-11 (accessed 24 March 2014).
Zajac EJ, Westphal JD. 1994. The costs and benefits of managerial incentives and monitoring in large US corporations: when is more not better? *Strategic Management Journal* **15**: 121–142.
Zhou YM. 2011. Synergy, coordination costs, and diversification choices. *Strategic Management Journal* **32**: 624–639.

APPENDIX 1: MODEL SOLUTION

Business managers' best effort response vector

The best effort response for manager of business-unit i to the incentive contract $w_i = s_i + b_i Y_i + c_i Y + m_i S$ is determined as follows:

Combining (2 and 4) in the paper to $E(w_i) = s_i + b_i E(Y_i) + c_i E(Y) + m_i E(S) = s_i + b_i \left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right) + \left(c_i + \theta m_i\right) \left\{\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right)\right\}$ and $Var\left(w_i\right) = b_i^2\sigma_{Y_i}^2 + c_i^2\left(\sigma_{Y_i}^2 + \sigma_{Y_j}^2\right) + 2b_i c_i \sigma_{Y_i}^2 + m_i^2\sigma_S^2$).[23]

This allows (8) to be written as

$$\underset{\{a_i\}}{\text{Max}} -\exp\left(-\alpha_i\left(\begin{array}{l} s_i + b_i\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right) + \left(c_i + \theta m_i\right) \\ \times\left\{\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right)\right\} \\ -\frac{1}{2}\alpha_i\left\{b_i^2\sigma_{Y_i}^2 + c_i^2\left(\sigma_{Y_i}^2 + \sigma_{Y_j}^2\right)\right. \\ \left.+2b_i c_i\sigma_{Y_i}^2 + m_i^2\sigma_S^2)\right\} - \frac{1}{2}g_i\sum_{k=1}^{I=2}a_{ki}^2 \end{array}\right)\right). \quad \text{(A1)}$$

By monotonicity of the utility function and normality of w, (A1) is equivalent to maximizing

$$\begin{aligned} & s_i + b_i\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right) + \left(c_i + \theta m_i\right) \\ & \times\left\{\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right)\right\} \\ & -\frac{1}{2}\alpha_i\left\{b_i^2\sigma_{Y_i}^2 + c_i^2\left(\sigma_{Y_i}^2 + \sigma_{Y_j}^2\right)\right. \\ & \left.+2b_i c_i\sigma_{Y_i}^2 + m_i^2\sigma_S^2)\right\} - \frac{1}{2}g_i\sum_{k=1}^{I=2}a_{ki}^2 \end{aligned} \quad \text{(A2)}$$

The first-order conditions for optimal managerial efforts follow from differentiating (A2) with respect to efforts a_{ii} and a_{ji},:

$$b_i\beta_{ii} + \left(c_i + \theta m_i\right)\beta_{ii} - g_i a_{ii} = 0 \quad \text{(A3)}$$

$$\left(c_i + \theta m_i\right)\beta_{ji} - g_i a_{ji} = 0 \quad \text{(A4)}$$

It follows that divisional managers' effort responses to profit and equity incentives (b_i, c, m_i),

[23] For tractability, we assume that idiosyncratic shocks among business-unit profits are independent, such that ε_i and ε_j are independently distributed with variances $\sigma_{Y_i}^2$ and σ_{Yj}^2, respectively. A model solution with non-zero correlations (available from the authors on request) yields expressions that are analytically quite cumbersome, but the central results remain unchanged. In addition we assume that η is independent of unanticipated shocks to business-unit profits (ε_i and ε_j): η represent shocks to firm value that are unrelated to changes in expected profits $E(Y)$ and, since these shocks occur separately in equity and product markets, there is no a priori reason to believe that they are correlated. This parallels the assumption in the Capital Asset Pricing Model (CAPM), where idiosyncratic risk in an individual company's stock return is independent of market risk.

Copyright © 2015 John Wiley & Sons, Ltd.

DOI: 10.1002/smj

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

$i = 1, 2$, are given by

$$a_{ii} = \frac{\beta_{ii}\left(b_i + c_i + \theta m_i\right)}{g_i}, \quad a_{ji} = \frac{\beta_{ji}\left(c_i + \theta m_i\right)}{g_i} \tag{A5}$$

The optimal contract

Equity and profit incentives in the optimal contract are determined by maximizing total expected firm returns (6) subject to business-unit manager participation and incentive compatibility constraints (7) and (8). Since shareholder returns decline if compensation is increased beyond $\overline{w}_i$, the constraint (8) holds with equality leading to

$$\begin{aligned} &-\exp\left(-\alpha\left(\begin{array}{l} s_i + b_i\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right) \\ \quad + \left(c_i + \theta m_i\right) \\ \quad \times\left\{\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right)\right\} \\ \quad -\frac{1}{2}\alpha_i\left\{b_i^2\sigma_{Y_i}^2 + c_i^2\left(\sigma_{Y_i}^2 + \sigma_{Y_j}^2\right)\right. \\ \quad \left.+2b_ic_i\sigma_{Y_i}^2 + m_i^2\sigma_S^2\right\} - \frac{1}{2}g_i\sum_{k=1}^{I=2}a_{ki}^2 \end{array}\right)\right) \\ &= -\exp\left(-\alpha_i\overline{w}_i\right) \end{aligned} \tag{A6}$$

or

$$\begin{aligned} s_i = {} & \overline{w}_i - b_i\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right) \\ & - \left(c_i + \theta m_i\right)\left\{\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}\beta_{ij}a_{ij}\right)\right\} \\ & + \frac{1}{2}\left\{b_i^2\sigma_{Y_i}^2 + c_i^2\left(\sigma_{Y_i}^2 + \sigma_{Y_j}^2\right) + 2b_ic_i\sigma_{Y_i}^2\right. \\ & \left. + m_i^2\sigma_S^2\right\} + \frac{1}{2}g_i\sum_{k=1}^{I=2}a_{ki}^2 \end{aligned} \tag{A7}$$

Substituting (A7) in (6) expresses the headquarters' objective in terms of three variables:

$$\begin{aligned} \underset{\{b_i,n_i,m_i\}}{\text{Max}}\ \frac{1}{\text{S}_0}\left(\begin{array}{l} (1+\theta)\sum_{i=1}^{I=2}\left(\mu_i + \beta_{ii}a_{ii} + \sum_{j\neq i}^{I=2}\beta_{ij}a_{ij}\right) \\ -\left\{\overline{w} + \frac{1}{2}\sum_{i=1}^{I=2}\left(b_i^2\sigma_{Y_i}^2 + c_i^2\sum_{k=1}^{I=2}\sigma_{Y_k}^2\right.\right. \\ \left.\left.+2b_ic_i\sigma_{Y_i}^2 + m_i^2\sigma_S^2\right) + \frac{1}{2}g_i\sum_{k=1}^{I=2}a_{ki}^2\right)\right\} \end{array}\right). \end{aligned} \tag{A8}$$

The first-order conditions determining the return-maximizing levels of equity incentives b_i, firm-wide profit incentives n_i, and equity incentives m_i are, respectively:

$$\begin{aligned} &(1+\theta)\left(\beta_{ii}\frac{\partial a_{ii}}{\partial b_i} + \sum_{j\neq i}^{I=2}\beta_{ij}\frac{\partial a_{ij}}{\partial b_i}\right) \\ &-\left\{\alpha_ib_i\sigma_{Y_i}^2 + 2c_i\sigma_{Y_i}^2 + g_i\sum_{k=1}^{I=2}a_{ki}\frac{\partial a_{ki}}{\partial b_i}\right\} = 0 \end{aligned} \tag{A9}$$

$$\begin{aligned} &(1+\theta)\left(\beta_{ii}\frac{\partial a_{ii}}{\partial c_i} + \sum_{j\neq i}^{I=2}\beta_{ij}\frac{\partial a_{ij}}{\partial c_i}\right) \\ &-\left\{c_i\sum_{k=1}^{I=2}\sigma_{Y_k}^2 + b_i\sigma_{Y_i}^2 + g_i\sum_{k=1}^{I=2}a_{ki}\frac{\partial a_{ki}}{\partial c_i}\right\} = 0 \end{aligned} \tag{A10}$$

$$\begin{aligned} &(1+\theta)\left(\beta_{ii}\frac{\partial a_{ii}}{\partial m_i} + \sum_{j\neq i}^{I=2}\beta_{ij}\frac{\partial a_{ij}}{\partial m_i}\right) \\ &-\left\{\alpha_im_i\sigma_S^2 + g_i\sum_{k=1}^{I=2}a_{ki}\frac{\partial a_{ki}}{\partial m_i}\right\} = 0. \end{aligned} \tag{A11}$$

From (A5), the partial derivatives for managerial effort are as follows:

$$\begin{aligned} &\frac{\partial a_{ii}}{\partial b_i} = \frac{\beta_{ii}}{g_i}, \quad \frac{\partial a_{ii}}{\partial c_i} = \frac{\beta_{ii}}{g_i}, \quad \frac{\partial a_{ii}}{\partial m_i} = \frac{\theta\beta_{ii}}{g_i}, \\ &\frac{\partial a_{ji}}{\partial b_i} = 0, \quad \frac{\partial a_{ji}}{\partial c_i} = \frac{\beta_{ji}}{g_i}, \quad \frac{\partial a_{ji}}{\partial m_i} = \frac{\theta\beta_{ji}}{g_i} \end{aligned} \tag{A12}$$

The solution for equity incentives, business-unit profit incentives, and firm-wide profit incentives (10–12) follow from substituting the expressions in (A12) into in (A9–A11) and solving for the three incentives (detailed calculations available from authors).

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix S1. Managerial effort with equity and non-equity incentive contracts.
Appendix S2. Partial derivatives for ratios of optimal contract terms.

Copyright © 2015 John Wiley & Sons, Ltd.

10970266, 2016, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/smj.2392 by Texas A&M International, Wiley Online Library on [12/03/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License