Synergistic Mergers in an Agency Context: An Illustration of the Interaction of the Observability Problem and Synergistic Merger

Tim S. Campbell[1] and Anthony M. Marino[2]*

[1] Department of Finance and Business Economics, Marshall School of Business, University of Southern California tcampbell@marshall.usc.edu
[2] Department of Finance and Business Economics, Marshall School of Business, University of Southern California amarino@marshall.usc.edu

Summary. This paper formulates a simple agency problem in a single division firm and has that firm merge with another firm having the same agency problem. The merger creates synergy, but it also causes the principal to lose information in observing the agent's performance. We call the latter problem the observability problem associated with merger. We focus on the interaction of these two by-products of merger and study their effects on the firm's agency contract and profit. A key point is that many of the beneficial effects that we would associate with the presence of synergy can be undone by the observability problem, so that the synergistic benefits of merger can be misgauged, if the observability problem is ignored. Two empirically testable implications arise. First, if the post merger contract is less sensitive, then the observability problem is essentially nonexistent and the merger is profitable. Second, if the post merger contract is very sensitive, then synergy is swamping the observability problem and the merger is profitable.

1 Introduction

The economics literature has provided a variety of motivations for mergers. A first key motive in horizontal mergers is the creation of market power and the associated value that comes along with such power. (See Stigler (1950) for an early discussion.) A second related set of motives might be called technological in nature. The merger of two firms can create cost savings through a variety of sources. Merger can eliminate redundant facilities such as overlapping bank ATM's. It can also induce more efficient use of support functions, such as accounting and marketing, and more efficient use of fixed inputs (e.g., common pooling of fixed inputs and elimination of redundancy.) The merger

* The authors benefited from discussions with Tom Gilligan, Tracy Lewis, John Matsusaka, and Jan Zabojnik. An anonymous referee gave beneficial comments. This research was supported by the Marshall General Research Fund.

of two firms can lead to sharing of previously private information and ideas. Learning might take place among the employees of one merged firm as they associate with their counterparts from the other merged firm. A third key set of motivations given for merger is founded on the notion that a manager's incentive to maximize his own well being may not lead to value maximization for the firm's shareholders. The manager may derive utility from pure empire building. (See, for example, Baumol (1967) and Mueller (1969)). Alternatively, more acquisitions might allow the manager to invest in assets whose returns are dependent on the manager's private information so as to entrench himself within the company. (Shleifer and Vishney, 1989). Further, the tendency for managers to overestimate their own ability can lead them to over estimate the future performance of acquired firms (Roll, 1986).

We focus on the first two motives and term these rationalizations for merger as general "synergy". While many merger and acquisition decisions are justified based on the synergy they are expected to generate, curiously, subsequent divestitures of businesses are also often justified on the basis that they did not generate sufficient synergy.[3] Moreover, the frequency of divestitures of initial acquisitions is quite large. Kaplan and Weisbach (1992) report that, for a sample of large acquisitions between 1971 and 1982, almost 44% of the acquirers had divested their previous target by 1989. In addition, a now extensive applied management literature emphasizes the need for a systematic process for generating synergies.[4] A failure to implement such a process effectively can undermine the anticipated synergies in an acquisition and ultimately lead to divestiture. Clearly, synergy is sufficiently hard to estimate, ex ante, and hard to deliver, ex post, that the search for synergy in the business community appears to involve a fair amount of experimentation. Errors in this synergy prediction and implementation process could account for the large number of failed mergers, or it could be that one of the above self-interest motives for merger is the reason that a merger turned out to be unprofitable. We want to examine a different problem arising in the process of synergy prediction and implementation.

A potential stumbling block which could make the successful realization and correct prediction of synergy difficult is that seemingly simple forms of synergy; arising from enhanced revenues, reduced redundancy, and lower costs; must be realized in an agency context. The common pooling and intermeshing of two firm's resources which create synergy under merger, can also make it more difficult for the principal of a firm to observe the separate performances of the agents in the merged organization. We call the latter problem the performance observability problem created by mergers.

This paper will focus on the interaction of the performance observability problem and the creation of synergy as a result of merger, and it will study the effects of this interaction on the endogenously optimal agency contact

[3] See Cusatis et al. (1993).
[4] See, for example, Goold and Campbell (1998).

before and after merger. Our goal will be to outline the effects of synergy, the observability problem and the joint presence of both phenomena on the optimal agency contract and the equilibrium of the firm. We will show that many of the beneficial effects resulting from synergy may be undone by the observability problem and we will develop testable implications regarding the contract sensitivity (the gradient of the pay-performance relationship) and the expected compensation of the agent in the post merger contract.

The idea that the performance of individual business units may be difficult to measure in a multi-divisional business firm and that this measurement problem may stem from the organization of the firm is not new. Williamson (1985) emphasized the importance of the "power of incentives" in explaining organizational structure of firms. In particular, that merger might result in lower powered incentives. In addition, Hermalin and Katz (1996) distinguish between the risk reduction effects and the informational effects of diversification. They argue that the value of diversification in an agency setting derives from its effects on the principal's information concerning the agent's actions, rather than solely from its effects on risk. They demonstrate that diversification can endogenously increase or decrease the principal's information about the agent's actions, thus, diversification can raise or lower agency cost.[5] By assuming that merger eliminates some of the principal's information, our analysis is similar in spirit to that of Hermalin and Katz.

We specify a simple discrete-outcome agency model where an agent exerts unobservable effort to increase the probability of a high return. The agency cost derives from a limited liability constraint on the agent. Synergistic gains from merger of two firms arise because effort exerted by the agent in each of two firms is assumed to proportionally increase the probability of generating a high return in the other firm. When two firms with similar agency problems merge to achieve synergy, information on the returns on the individual businesses is assumed to be lost in that the principal is able to observe only aggregate performance as opposed to individual performance after merger.

After presenting the model in Section 2a, we consider the observability problem without synergy in Section 2.b. We find that merger with the observability problem (but without synergy) increases the optimal contract's marginal compensation for good performance, but at the same time reduces the probability the agent will be rewarded for a good performance, thus making changes in the agent's expected compensation indeterminate. Merger with the observability problem always increases the sensitivity of the agency contract, decreases the firm's value and decreases the equilibrium effort of the agent. Section 3a considers merger with synergy but without the observability

[5] Their analysis is addressed to the literature that argues that agency considerations can lead to firm diversification. Diamond and Verrecchia (1982), Marshall (1984), and Aron (1988) each has a different model of the beneficial effects of diversification and the resultant risk reduction in the agency problem.

problem, and we find that the effects on the agency contract; effort and profit are exactly the opposite of those of the observability problem, except that with synergy alone, the expected payment to the agent must rise. In Section 3.b we study the effects of the opposing forces of synergy and the observability problem on the incentive contract. We find that the magnitude of synergy must be greater than a certain positive threshold so as to swamp the observability problem and make merger profitable. In this case, merger results in a more sensitive agency contract. However, the impact on expected costs, the agent's effort and expected profit depend on the trade-off between the level of synergy and the observability problem.

An empirically testable implication of this analysis is that if, after merger, the agent's contract becomes less sensitive, then the observability problem is essentially nonexistent and we would expect the merger to be profitable. The lesser is the degree of sensitivity of the post merger contract the greater is the degree of profitability of the merged firms. A further empirical implication is that if the contract, after merger, is more sensitive and the expected compensation of the agent is greater, then synergy is swamping the observability problem and the merger is profitable. A general implication is that any ex ante quantification of potential synergies or post-merger attempts to deliver synergies should take into account the agency costs and contracting implications of any observability problem created by the merger.

2 The Agency and the Observability Problems

2.1 The Single Division Agency Problem

Consider a hidden action agency problem, where a principal has control over a firm, but the firm requires the services of an agent whose effort is unobservable. Let e denote the agent's effort and its cost to the agent, and suppose that there are three possible cash flows for the firm:

$$H > M > L, \text{ where } \mathrm{Prob}(H) \equiv r,\ \mathrm{Prob}(M) \equiv p(e), \text{ and } \mathrm{Prob}(L) \equiv 1-r-p(e).$$

The high cash flow occurs with an exogenous probability and the probabilities of the medium and the low cash flows are functions of the agent's effort.[6] Greater effort by the agent increases the probability of the medium cash flow and decreases the probability of the low cash flow. We assume

$$\text{A.1. } p' > 0,\ p'' < 0.$$

[6] We did not use the more convenient two-outcome model, where performance can take on the values H or L, because the performance observability problem unravels in this version. The principal can attain the same second best as in the single division problem by making a positive payment in the event of the outcome H for each division.

The principal designs a contingent payment scheme for the agent, under the assumption that the agent and the principal are risk neutral. In the event of a performance $i \in \{H, M, L\}$, the principal pays C^i. Also, assume that the agent has limited liability, so that the principal can not issue negative contingent payments. In the present risk neutral environment, there is no agency problem and the principal can implement the first best when there are no lower bounds on the C^i. Let the agent have a market wage of w. The agent's expected payoff is given by

$$rC^H + pC^M + (1 - r - p)C^L - e.$$

Given a compensation vector from the principal, the agent's optimal effort is determined by solving

$$p'(e)(C^M - C^L) - 1 = 0. \tag{1}$$

Employment will be desirable to an agent with reservation wage w if

$$rC^H + pC^M + (1 - r - p)C^L - e - w \geq 0. \tag{2}$$

Equations 1 and 2 are the incentive compatibility (IC) and participation constraints, and these along with the limited liability constraints $C^i \geq 0$ define the constraints for the principal's maximization problem. In the present risk neutral environment, there is no agency problem and the principal can implement the first best when there are no lower bounds on the C^i through limited liability. This is critical for a second best in that the principal could generate first best effort through the (IC) constraint by raising C^M and lowering say C^H sufficiently to meet the participation constraint with equality. That is, if the participation constraint is binding and the limited liability constraints are not, the principal keeps the entire surplus (the agent retains no rent) and achieves the first best. If the participation constraint is binding (the agent has no rent) and some of the limited liability constraints are binding and some are not, then we have a knife edge solution which may or may not be the first best. We then want to only consider second best solutions where at least one limited liability constraint is binding and the participation constraint is nonbinding (the agent keeps some rent). We posit a fairly standard sufficiency condition to guarantee that the latter is true. Note that through the (IC), $C^M = 1/p'(e) + C^L \geq 1/p'(e)$, so that $p(e)C^M \geq p(e)/p'(e)$. It follows that the participation constraint is nonbinding if $p(0)/p'(0) > w$, by $p(e)C^M - e \geq p(e)/p'(e) - e$, the fact that the function $(p/p' - e)$ is increasing, and that $rC^H, (1 - r - p)C^L \geq 0$. That is, the lowest level of effort generates a large enough expected net return to exceed the outside wage.[7] We assume the analogue to this assumption in all of the problems to follow. Under this assumption, the principal's optimum is characterized as in the following (All proofs are provided in the Appendix).

[7] See Levitt and Synder (1997) for an identical assumption.

Lemma 1. *In equilibrium, only* C^M *is positive. Expected cost is given by* $pC^M = p/p'$ *and equilibrium effort is defined by*

$$p'(e^s)(M - L) = 1 - p''(e^s)p(e^s)/(p'(e^s))^2 \equiv z(e) > 1. \tag{3}$$

In what follows we will think of the function p/p' as the firm's equilibrium cost function and define marginal cost as

$$z(e) = 1 - p''p/(p')^2.$$

We will assume that marginal cost is increasing in e

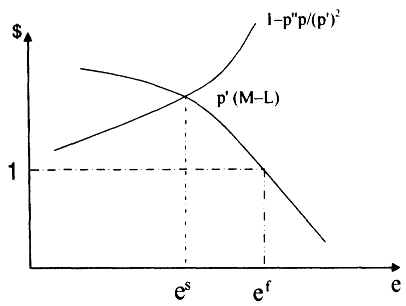
$$\text{A.2} z'(e) = -\{(p'''p + p'p'')(p')^2 - 2(p')(p'')(p''p)\}/(p')^4 > 0.$$

For A.2 to be true, it suffices that $p''' \geq 0$, although this is not a necessary condition.

As expected, only the highest discretionary performance receives a positive payment in equilibrium. Condition 3 equates the marginal benefit of effort with its marginal cost. We note that marginal cost is greater than unity, and the first best marginal cost is equal to unity. Using the results of Lemma 1, we can rewrite the principal's problem as

$$\underset{\{e\}}{Max}\ rH + pM + (1 - r - p)L - p/p'. \tag{4}$$

Problem 4 has a first order condition identical to 3. Let $\pi(e) \equiv rH + pM + (1 - r - p)L - p/p'$. The equilibrium is illustrated in Figure 1, where we also illustrate the first best effort as e^f defined by $p'(e^f)(M - L) = 1$. It is clear that $e^f > e^s$.



2.2 The Observability Problem in a Multidivisional Firm

Next, let the single division firm merge with another identical firm. The merger creates a new firm with two agents and one principal. Initially, we assume that there is no synergy. The merger is costly due to the fact that the principal is not as well informed about the individual performance of the agents in the two separate divisions. This section isolates the cost associated with the performance observability problem. Let us take the simplest version of such a story and assume that, as a result of the merger, the principal can no longer observe a single agent's performance, but, instead, can only observe aggregate performance.[8] We assume

$$\text{A.3. } 2M = H + L.$$

Assumption A.3 makes it impossible for the principal to distinguish between two middle outputs and a high and a low output. Table 1 summarizes the outcomes that can be observed by the principal and the associated contingent payments.

Set of Outcomes	Payment
HL, LH, or MM	C^*
MH or HM	$C^{M,H}$
LM or ML	$C^{L,M}$
HH	C^H
LL	C^L

We wish to formulate and solve the new agency problem with merger and unobservability.

Let p_i denote $p(e_i)$. Then a single agent's welfare can be written as

$$\begin{aligned} C = rrC^H + (1-r-p_1)(1-r-p_2)C^L + (rp_1 + rp_2)C^{M,H} + [(1-r-p_1)p_2 \\ +(1-r-p_2)p_1]C^{L,M} + [r(1-r-p_2) + (1-r-p_1)r + p_1p_2]C^* - e_i. \quad (5)\end{aligned}$$

If each agent acts as a Nash player, then he will maximize welfare over a choice of e_i, assuming that the other agent's effort is given. For example, agent 1 has the incentive compatibility constraint

$$\begin{aligned} \partial C/\partial e_1 = -p_1'(1-r-p_2)C^L + p_1'rC^{M,H} + [-p_1'p_2 + p_1'(1-r-p_2)]C^{L,M} \\ +[-p_1'r + p_1'p_2]C^* - 1 = 0. \quad (6)\end{aligned}$$

If we again assume that the relevant participation constraint is nonbinding, then we can summarize the solution to the principal's problem in

[8] The most reasonable justification for this assumption relies on an additional assumption that the return generated by a division is, in part, the current cash flow and, in part, the expectation of future cash flows. Then, even if current cash flows can be observed at the level of each division, the only objective measure of the current value of future cash flows is the firm's current stock price. However, the merged firm only has one stock price pertaining to future cash flows from both divisions. Hence, a measure of present value of future cash flows is not directly observable at the level of the individual division.

Lemma 2. *Only one of* C^* *and* $C^{M,H}$ *can be optimally positive in equilibrium, with* Prob$(C^*) \bullet C^* = [2r(1\text{-}r\text{-}p) + p^2]/[(p\text{-}r)p']$ *and* Prob$(C^{M,H}) \bullet C^{M,H} = 2p/p'$. *The optimal positive payment is the* $\min\{2p/p', [2r(1\text{-}r\text{-}p) + p^2] / [(p - r)p']\}$.

Depending on parameter values, either payment contingency presented in Lemma 2 can be optimal. However, we wish to focus on the payment $C^{M,H}$ because of its simplicity. In what follows, we assume that the parameters of the model are such that $C^{M,H}$ is optimal. A sufficiency condition for $C^{M,H}$ to be optimal is

$$\text{A.4 } [2(r - r^2)]^{1/2} > p(e), \text{ for all } e.$$

The principal's problem can now be written in a very simple reduced form. Define

$$\pi(e_1, e_2) = 2rH + \Sigma p_i M + \Sigma(1 - r - p_i)L - (p_1 + p_2)/p_1' - -(p_1 + p_2)/p_2'. \tag{7}$$

Then the principal's problem is to $\underset{\{e_1,e_2\}}{Max}\ \pi(e_1,e_2)$, and the first order condition for e_1 is

$$\partial\pi/\partial e_1 = p_1'(M - L) - [(p_1')^2 - p_1''(p_2 + p_1)]/(p_1')^2 - p_1'/p_2' = 0. \tag{8}$$

The first order condition for e_2 is symmetric. Equalizing the e_i, we have that

$$p'(e^m)(M - L) = 2[1 - p(e^m)p''(e^m)/(p'(e^m))^2] = 2z(e^m) \tag{9}$$

describes the optimal e_i for each division.

The effect of merging the two firms and introducing the observability problem is apparent from equations (3) and (9). The observability problem has forced the optimal incentive contract to lump the reward for good performance into a public good performance versus a private one. In this sense, it has lowered the power of the incentive contract. The effect is to double both the total and the marginal costs of eliciting effort, at a given effort level. It is clear that equilibrium effort is less in each division of the merged firm, due to this fact. That is, $e^s > e^m$. Further, it is clear that the profit of a single division of the merged firm, $.5\pi(e, e)$, is strictly less than that of a single division firm for all levels of e. Let $.5\pi(e, e) \equiv \pi^m(e)$. We have

$$\begin{aligned}\pi^m(e) &= rH + pM + (1 - r - p)L - 2p/p' \\ &< rH + pM + (1 - r - p)L - p/p' = \pi(e), \text{ for all } e.\end{aligned}$$

It follows that by $e^s > e^m$ and each of $\pi^m(e,)$ and $\pi(e)$ strictly concave, $\pi^m(e^m) < \pi(e^s)$. Thus, as one would expect, it is not optimal for the firms to merge, if there is an observability problem without compensating synergy. We consider this as a benchmark case only.

We want to examine how the optimal agency contract has changed as the result of merger and the unobservability problem. First consider the magnitude of the probability of a good performance at a given effort level. In a single division firm, the probability of a good performance is p, whereas in a merged firm, this probability is 2rp. For feasibility we require that $2rp < 1$ for all e. Therefore, we must assume

$$\text{A.5 } r < 1/2.$$

Under A.5, $p > 2rp$, for all e, and, in particular, $e^s > e^m$, implies $p(e^s) > 2rp(e^m)$. The effect of the observability problem is to lower the equilibrium probability of a good performance.

Next, define the *sensitivity* of the incentive contract as the magnitude of the payment for a good (discretionary) performance, in equilibrium. In this model, sensitivity is a measure of the "gradient" of the contact, because the difference between the optimal positive payment (C^M or $C^{M,H}$) and zero is the incremental benefit for a good performance. Intuition would suggest that merger would dictate that the incentive contract become more sensitive in the presence of lower powered incentives. However, this simple logic presumes a constant level of equilibrium effort and effort is of course endogenous to the contract. The unobservability problem has in fact lowered equilibrium effort by raising its marginal cost. From the above analysis, our question is formalized as

$$C^{M,H} \gtreqless C^M \text{ if } p'(e^s)/p'(e^{m*}) \gtreqless r, \text{ where } p'(e^s)/p'(e^{m*}) \in (0,1). \tag{10}$$

Proposition 1 summarizes our results.

Proposition 1. *In the presence of the observability problem, merger always results in a more sensitive incentive contract, which has a lower probability of a good performance by the agent. The agent's expected compensation before and after merger can rise or fall. The principal's profit must fall after merger, as does the agent's effort level.*

Proposition 1 confirms our intuition that merger with the unobservability problem results in an optimal contract with a greater incremental benefit for a good performance. However, because the equilibrium probability of a good performance must fall, the effect on the agent's expected payment is indeterminate.

3 Synergy in an Agency Context

In this section, we introduce synergy into the two-division agency model. We modify the model so that probability of the return M in the i^{th} division is equal to $sp(e_i)$, where $s > 1$ is a parameter reflecting the amount of external synergy for division i, emanating from the other division, $j \neq i$. That is $s > 1$, if $e_{j \neq i} > 0$.[9] Because firms and divisions are assumed to be identical, s is the same across divisions. To better understand the impact of synergy, we will first consider the effect of synergy alone on the incentive contract. That is, will begin by assuming that the observability problem does not exist.

3.1 Merger with Synergy Alone

Without the observability problem, the single division firm and a single division of the merged firms have identical incentive contracts, in the sense that an agent is paid when performance M is observed. Let C^{M*} be the payment to an agent in a single division of the merged firms. In equilibrium, this payment is given by $C^{M*} = 1/sp'$ and expected cost is $sp/sp' = p/p'$. The equilibrium profit of a single division of the merged firms is

$$\pi^m(e) = rH + (1-r)L + sp(M-L) - p/p',$$

so that equilibrium effort in each division is given by the condition

$$sp'(e^m)(M-L) = z(e^m). \tag{11}$$

To economize on notation, we have used the same symbol for equilibrium effort and profit of a division of the merged firm. Comparing (11) and (3), it is immediate that $e^s < e^m$. Synergy has raised the benefit of effort without affecting its cost. Thus, equilibrium effort use increases. Because $e^m > e^s$ and each of $\pi^m(e)$ and $\pi(e)$ is strictly concave in e, it is clear that merger with synergy increases equilibrium profit, $\pi^m(e^m) > \pi(e^s)$. Further, because the expected cost function is the same before and after merger and effort after merger is greater, expected costs rise.

The probability of payment $C^{M*}$is sp, so that, by $s > 1, sp > p$, for all e. In particular, because $e^m > e^s$, $sp(e^m) > p(e^s)$. Merger with synergy raises the probability of a good performance in equilibrium.

Finally, let us consider the sensitivity of the contract before and after merger. We must compare $C^{M*} = 1/sp'(e^m)$ with $C^M = 1/p'(e^s)$. Clearly,

$$C^{M*} \begin{matrix} > \\ = \\ < \end{matrix} C^M \text{ as } \frac{p'(e^s)}{p'(e^m)} \begin{matrix} > \\ = \\ < \end{matrix} s, \tag{12}$$

where $p'(e^s)/p'(e^m) > 1$, by p' decreasing and $e^m > e^s$. We have

[9] This is a simple formulation of a beneficial externality between divisions. More general formulations are of course possible, but our intent is to present a simple and tractable illustration of the interaction of synergy and the observability problem.

Proposition 2. *Merger with synergy and without the observability problem always results in a less sensitive incentive contract, which has a greater probability of a good performance by the agent in equilibrium. The sensitivity of the optimal contract is decreasing in the synergy parameter. The principal's expected profit, the expected compensation to the agent and the agent's effort all rise after merger.*

Synergy alone has the opposite effects on the incentive contract as does the observability problem. The exception is that synergy with merger raises the agent's expected compensation whereas this effect is uncertain under the observability problem alone.

3.2 Merger with Synergy and the Observability Problem

Let us begin by considering a single representative agent's compensation under the observability problem and synergy. This is given by

$$\begin{aligned} C = rrC^H &+ (1-r-sp_1)(1-r-sp_2)C^L + [r(sp_1)+r(sp_2)]C^{M,H} \\ &+[(1-r-sp_1)(sp_2)+(1-r-sp_2)(sp_1)]C^{L,M} \\ &+[r(1-r-sp_2)+r(1-r-sp_1)+(sp_1)(sp_2)]C^* - e_i. \quad (13) \end{aligned}$$

Using the same logic as in the model without synergy, we have that all payments except for $C^{M,H}$ and C^* must be zero in equilibrium. However, we again assume that the parameters are such that only $C^{M,H}$ can be positive. It suffices that

$$\text{A.6 } (s)^{-1}[2(r-r^2)]^{1/2} > p(e), \text{ for all } e,$$

hold. It is clear that A.6 implies A.4, given s > 1. For agent one, the reduced form incentive compatibility constraint now reads

$$rsp_1'C^{M,H} - 1 = 0. \quad (14)$$

The expected payment to agent one is then $[r(sp_1)+r(sp_2)]/(rsp_1') = (p_1+p_2)\ /(p_1')$. Agent two's expected payment is symmetric. Using the same logic as in the problem without synergy, we can write the principal's problem as

$$\pi(e_1,e_2) = 2rH + 2(1-r)L + \Sigma(sp_i)(M-L) - \Sigma(p_1+p_2)/(p_i'). \quad (15)$$

The principal then sets

$$\begin{aligned} \partial\pi/\partial e_1 = (sp_1')(M-L) - \{[(p_1')^2 - (p_1'')(p_1+p_2)]/(p_1')^2\} \\ + (p_1')/(p_2') = 0. \quad (16) \end{aligned}$$

The first order condition for e_2 is symmetric. Equalizing the e_i, we can write this condition as

$$sp'(e^m)(M - L) - 2z(e^m) = 0. \tag{17}$$

Equation (17) describes the optimal effort choice for each division, denoted e^m.

Synergy has changed the firm's reduced form profit function in a way that it increases the net benefit of effort in each division. Equalizing the e_i, we can write the reduced form profit of a single division and compare this to the case of no synergy as follows:

$$\pi^m(e) = rH + spM + (1 - r - p)L - 2p/p' > rH + pM + (1 - r - p)L - 2p/p',$$

for all e. The new marginal benefit of effort is increased due to synergy as shown in (14) or alternatively the effective marginal cost of effort has been reduced. The observability problem has then been dampened.

The equilibrium amount of effort chosen by a division of a merged firm with synergy can be compared to that of a single division firm. Whether effort under unobservability and synergy is less or greater depends on the magnitude of that synergy. From (17), the marginal benefit of effort can be written as p'(e)(M-L) and its effective marginal cost is $(2/s)z(e^m)$. The observability problem has doubled effort's marginal cost and synergy reduces this effect. Whether effort's effective marginal cost is greater or less after merger as opposed to pre-merger, depends on whether s is less or greater than 2. Because the above marginal benefit of effort is the same before and after merger, we have

$$e^m \begin{smallmatrix} > \\ - \\ < \end{smallmatrix} e^s \text{ if } s \begin{smallmatrix} > \\ - \\ < \end{smallmatrix} 2, \text{ where } s > 1. \tag{18}$$

Next, consider how merger with synergy affects the sensitivity and the probability of a good performance by the agent. The effect on sensitivity of the contract is described by the condition

$$C^{M,H} \begin{smallmatrix} > \\ - \\ < \end{smallmatrix} C^M \text{ if } p'(e^s)/p'(e^m) \begin{smallmatrix} > \\ - \\ < \end{smallmatrix} sr. \tag{19}$$

The probability of the payment $C^{M,H}$is 2rsp. For the latter to be less than unity for all e, we assume, for feasibility,

A.7 2 sr < 1.

Given that $s > 1$, A.7 implies that $r < 1/2$. For feasible parameter values, the combination of the observability problem and synergy results in $2rsp < p$, for all e. If $s \in (1, 2]$, then we saw, from (18), that $e^s \geq e^m$. For this case, it follows that $2rsp(e^m) < p(e^s)$, and the probability of good performance by the agent is decreased by merger. On the other hand, using the same logic, if $s > 2$, then $e^m > e^s, p(e^m) > p(e^s)$, and it is unclear whether the probability of a good performance by the agent is increased or decreased by merger. We have

Proposition 3. *(i) In the presence of the observability problem, merger always results in a more sensitive incentive contract, regardless of the level of synergy.*

(ii) The equilibrium probability of a good performance by the agent is less after merger, if synergy does not swamp the unobservability problem ($s \in (1,2]$). In this case, the equilibrium effort of the agent satisfies $e^m \leq e^s$ as s is ≤ 2, and the expected compensation to the agent can rise or fall after merger.

(iii) The effect of merger on the probability of a good performance by the agent is indeterminate, if the level of synergy is sufficient to swamp the observability problem ($s > 2$). For $s > 2$, merger results in an increase in the agent's effort and his expected compensation, and each of these equilibrium values as well as the sensitivity of the optimal contract is increasing in the synergy parameter.

Our final result is concerned with the profitability of merger for the case where the observability problem and synergy coexist.

Proposition 4. *If the observability problem is present, there exists a feasible value of the synergy parameter $s^m \in (1,2)$ for which merger is minimally profitable. That is, $\pi^m(e^m) \geq \pi(e^s)$ for $s \geq s^m$ and conversely for $s < s^m$.*

Concluding Remarks

Synergistic merger has the effects of increasing profit, increasing the agent's expected compensation, increasing the agent's effort, and decreasing the sensitivity of the optimal incentive contract. However, the observability problem reverses all but one of these effects (The impact on the agent's expected compensation is uncertain.) When we combine synergistic merger with the observability problem, we place greater requirements on the level of synergy for there to be profitable merger. Many of the above intuitive effects of synergistic merger are dampened. For synergistic merger to raise profit, increase the agent's effort and increase the agent's expected compensation, synergy must be of sufficient magnitude to overcome the observability problem. Ignoring the latter problem can lead to an over estimate of the benefits of merger.

Finally, Propositions 1 through 3 can be used to arrive at two empirically testable predictions. First, if the post merger contract is less sensitive, then the observability problem is essentially nonexistent and we would expect the merger to be profitable. A second empirical implication is that if the contract after merger is more sensitive and the expected compensation of the agent is greater, then synergy is overcoming the observability problem and the merger should be a profitable one.

Appendix

Proof of Lemma 1: Since equal contingent payments apply to both agents, in equilibrium $e_1 = e_2$. Then, the first order conditions for the principal's choice of contingent payments are as follows:

$$-r + \gamma^H = 0 \Rightarrow \gamma^H > 0 \text{ and } C^H = 0. \tag{i}$$

$$-(1 - r - p) - \mu p' - \gamma^L = 0. \tag{ii}$$

$$-p + \mu p' + \gamma^M = 0. \tag{iii}$$

We know that from the incentive compatibility constraint, it must be that $C^M > C^L = 0$. Thus, from (iii), $\gamma^M = 0$ and $\mu = p/p' > 0$. Whence, (ii) implies that $C^L = 0$. From the incentive compatibility constraint, $C^M = 1/p'$, so that the principal's expected cost is p/p'. The principal's first order condition for effort is $p'(M - L) - p'C^M + \mu p''C^M = 0$. Substituting $\mu = p/p'$ and $p'C^m = 1$ from the incentive compatibility constraint, we have that the equilibrium e is defined by $p'(M - L) = 1 - p''p/(p')^2 > 1.$||

Proof of Lemma 2: Because both divisions are identical, we can consider the first order conditions for agent one and use symmetry to determine those of agent two.

$$C^H : -rr + \gamma^H = 0 \Rightarrow \gamma^H > 0 \text{ and } C^H = 0.$$

$$C^L : -(1 - r - p_1)(1 - r - p_2) - p_1'(1 - r - p_2) + \gamma^L = 0 \Rightarrow \gamma^L > 0 \text{ and } C^L = 0.$$

$$C^{L,M} : -[(1 - r - p_1)p_2 + p_1(1 - r - p_2)] + \mu_1 p_1'(1 - r - 2p_2) + \gamma^{L,M} = 0.$$

$$C^* : -[r(1 - r - p_2) + (1 - r - p_1)r + p_1 p_2] + \mu_1 p_1'(p_2 - r) + \gamma^* = 0.$$

$$C^{M,H} : -(rp_1 + rp_2) + \mu p_1' r + \gamma^{M,H} = 0.$$

Above, we have shown that C^H and C^L are optimally zero. Next, we consider the remaining payments. First consider $C^{L,M}$. If $(1 - r - 2p_2) \leq 0$ then from the above first order condition $\gamma^{L,M} \sim> 0$ and $C^{L,M} = 0$. Next suppose that $(1 - r - 2p_2) > 0$. Then we have that

$$[(1 - r - p_1)p_2 + p_1(1 - r - p_2)]/[p_1'(1 - r - 2p_2)] \geq \mu/(1 - \lambda).$$

Noting that in equilibrium $p_1 = p_2$ this condition can be written as

$$2p(1 - r - p)/[p'(1 - r - 2p)] \geq \mu/(1 - \lambda).$$

From the first order condition for $C^{M,H}$ we have

$$2p/p' \geq \mu/(1 - \lambda).$$

However,

$(1-r-p)/[(1-r-2p)] > 1$, so that $2p(1-r-p)/[p'(1-r-2p)] > \mu/(1-\lambda)$.

It follows that $C^{L,M} = 0$. We can conclude that only C^* and $C^{M,H}$ can be positive.

Let us focus on the possible positive payments. The first order conditions for these payments can be written as

$$C* : [2r(1-r-p)+p^2]/[(p-r)p'] \geq \mu/(1-\lambda)$$

with strict inequality implying $C^* = 0$.

$$C^{M,H} : 2p/p' \geq \mu/(1-\lambda) \text{ with strict inequality implying } C^{M,H} = 0.$$

It follows that the positive payment is the $\min\{2p/p', [2r(1-r-p)+p^2]/[(p-r)p']\}$.||

Proof of Proposition 1: From (10) we need to show that $p'(e^s)/p'(e^m) > r$. Using the FOC to optimal effort choice, we can rewrite this condition as *TRIALRESTRICTION* We have that $e^s > e^m$ and that z is nondecreasing. Further, from feasibility, $r < 1/2$. We have *TRIALRESTRICTION* Whence, $C^{M,H} > C^M$.

All that remains to be shown is that the principal's expected payment can rise or fall under merger. To see this, consider an example. Let $p = 1-\exp(-e)$ and define $(M-L) \equiv \Delta$. Before merger, expected compensation is $p(e^s)/p'(e^s) = \exp(e^s)-1$, where $e^s = .5(\ln \Delta)$. After merger, expected compensation is $p(e^m)/p'(e^m) = 2[\exp(e^m) - 1]$, where $e^m = .5\ln(\Delta/2)$. Thus, we compare pre-merger expected cost $\exp(.5(\ln\Delta)) - 1$ to post merger expected cost $2[\exp(.5\ln(\Delta/2)) - 1]$. If $\Delta = 6$, then post-merger expected cost is greater. If $\Delta = 5$, then the opposite is true. In each of these cases if $r = .3$, then all of our assumptions are met. ||

Proof of Proposition 2: Using condition (12), we need to show $p'(e^s)/sp'(e^m) < 1$. Substituting from condition (11), this becomes $z(e^s)/z(e^m) < 1$. Given A.2, z is increasing in e. Further, $e^s < e^m$. It follows that $z(e^s)/z(e^m) < 1$, and that this ratio is decreasing in s. Because p/p' is an increasing function, $e^m > e^s$ implies that the expected compensation to the agent is greater after merger. ||

Proof of Proposition 3: First suppose that $s \in (1,2)$. Using condition (17) and condition (19), $C^{M,H} > C^M$ if $z(e^s)/2z(e^m) > r$. Because $e^s > e^m$ and z is increasing, $z(e^s) > z(e^m)$. Thus, $z(e^s)/2z(e^m) > 1/2 > r$.

Next, suppose that $s \geq 2$. From (18), $e^m \geq e^s$. Using (19), $C^{M,H} > C^M$, if $p'(e^s)/p'(e^m) > sr$. If $e^m \geq e^s$, then because p' is positive and decreasing, $p'(e^s)/p'(e^m) \geq 1 > sr$. The ratio $p'(e^s)/p'(e^m)$ is increasing in s. Thus, sensitivity and effort in the merged firm become greater as s increases.

All that remains to be considered is the impact of merger on expected costs of the principal. If $s \leq 2$, then while sensitivity increases with merger, effort and the probability of a good performance decrease. We can use the example used in the proof of Proposition 1, to show that the expected payment to the principal can rise or fall. With synergy, expected cost before merger is $\exp(.5(\ln \Delta)) - 1$ and expected cost after merger is $2[\exp(.5\ln(s\Delta/2)) - 1]$. For $s = 1.1$, post merger expected cost is less if $\Delta = 3$, but it is greater if $\Delta = 5$. In each of these cases, if $r = .4$, the assumptions of our model hold. If $s > 2$, then expected cost in the merged firm is greater after merger, because $s > 2$ implies that $e^m > e^s$. By $2p/p' > p/p'$, for all e, and by p/p' increasing, it follows that $2p(e^m)/p'(e^m) > p(e^s)/p'(e^s)$. Further, it is clear that as synergy increases expected costs become greater in the merged firm.||

Proof of Proposition 4: Using the envelope theorem, we find that $d\pi^m(e^m(s))/ds = p(e^m)(M - L) > 0$. The function $\pi^m(e^m(s))$ is then increasing and continuous in s, while $\pi(e^s)$ is invariant with respect to s. If we can show that $\exists$ a feasible s at which $\pi^m(e^m(s)) < \pi(e^s)$ and a feasible s at which the converse holds, then, by the intermediate value theorem for continuous functions, there is an s* such that $\pi^m(e^m(s*)) = \pi(e^s)$. Further, for $s < s*$, it would be true that $\pi^m(e^m(s)) < \pi(e^s)$, while, for s $> s*$, we would have that $\pi^m(e^m(s)) > \pi(e^s)$.

Set $s = 1$ in the merged firm. Then $\pi^m(e) > \pi(e)$, for all e. It is further true that $e^s > e^m$ and each of these functions is strictly concave in e. Thus, for $e \in [e^m, e^s]$, $\pi^m(e)$ is decreasing in e, while $\pi(e)$ is increasing in e. It follows that $\pi^m(e^m(s)) < \pi(e^s)$.

For each e, take the difference $\pi^m(e) - \pi(e) = p(e)(s-1) - p/p'$. Let $\hat{e}$ be the e which sets this differences to zero. We have $(s - 1)(M - L) = 1/p'(\hat{e})$. the function $1/p'(e)$ is strictly increasing in e. Thus, for $e > \hat{e}, \pi^m(e) < \pi(e)$, and, for $e < \hat{e}, \pi^m(e) > \pi(e)$.

Set $s = 2$, Then $e^m = e^s$. $e^s = e^m$ is defined by $(M - L) = z(1/p')$, with $z > 1$, for all e. $e\hat{}$ is defined by $(M - L) = 1/p'$, in this case. By $z > 1$ and $1/p'$ increasing, e$\hat{}$ $> e^s = e^m$. Thus, it follows that $\pi^m(\mathrm{e}^m(\mathrm{s})) > \pi(\mathrm{e}^s)$. The point s* then exists and the result holds. ||

References

Aron, D. J., "Ability, Moral Hazard, Firm Size, and Diversification", *Rand Journal of Economics*, **19**(1) (1988), 72–87.

Baumol, W. J., *Business Behavior, Value and Growth.* New York: Harcourt, Brace and World, 1967.

Cusatis, P. J., J. A. Miles and J. R. Woolridge , "Restructuring through Spin-offs", *Journal of Financial Economics*, **33**(3) (1993), 293–311.

Diamond, D. W. and R. E. Verrecchia, "Optimal Managerial Contracts and Equilibrium Security Prices", *The Journal of Finance*, **37** (1982), 275–288.

Michael Goold and Andrew Campbell, "Desperately Seeking Synergy," *Harvard Business Review*, **76**(5) (1998), 130–143.

B.E. Hermalin and M.L. Katz, Corporate Diverisification and Agency, September 1996.

Kaplan, S. N. and M. S. Weisbach, "The Success of Acquisitions: Evidence from Divestitures", Journal of Finance, **47**(1) (1992), 107,138.

Levitt, S. D. and C. M. Synder, "Is NoNews Bad News? Information Transmission and the Role of Early Warning in the Principal-Agent Model", *Rand Journal of Economics*, **28**(4) (1997), 641–661.

Marshall, W. J., J.B. Yawitz and E. Greenberg, "Incentives for Diversification and the Structure of the Conglomerate Firm", *Southern Economic Journal*, **51** (1985), 1–23.

R. H. McGuckin and S.V. Nguyen, On Productivity and Plant Ownership Change: New Evidence from the Longitudinal Research Database, *Rand Journal of Economics*, **26**(2) (1995), 257–276.

Mueller, D. C., "A Theory of Competitive Mergers", *Quarterly Journal of Economics*, **83** (1969), 643–659.

Roll, R., "The Hubris Hypothesis of Corporate Takeovers", *Journal of Business*, **59** (1986), 197–216.

Shleifer, A. and Vishny, R. W., "Management Entrenchment: The Case of Manager Specific Investments," *Journal of Financial Economics*, **25** (1989), 123–139.

Stigler, G. J., "Monopoly and Oligopoly by Merger," *American Economic Review*, **40** (1950), 23–34.

Williamson, O. E., *The Economic Institutions of Capitalism.* New York: The Free Press, 1985.