Integration Contracts and Asset Complementarity: Theory and Evidence from US Data[⋆]

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Abstract

Firms sign integration contracts to increase profits from trade and competition with third parties. An integration contract can improve complementarity among partners (productivity effect) and increase their power in the marketplace (strategic effect). We investigate three bilateral contracts: M&A, Minority Stake purchase, and Joint Venture. Using a cooperative game approach, we characterize quite general profitability conditions. To estimate them, we adopt a novel complementarity index. It shows that for any kind of contract, a significant share of the integration profits is due to the "strategic" effect of increased market power. In most cases productivity gains are relatively less important.

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1. Introduction

In the last fifteen years AT&T corporation, the largest provider of fixed telephone and broadband television services in the US, has also become the second largest provider of mobile telephone. This position was achieved through a certain number and variety of integration contracts. For instance, in 2000 AT&T spent $US1.4 billion to buy a 32% share of Net2Phone, a software/services company principally specialized in SIP-based and PacketCable-based VoIP networks. Despite the integration did not lead to the full control of Net2Phone, thereafter AT&T was able to influence strategically Net2Phone's business with other firms in the telecommunication industry.

In 2003, AT&T Wireless and Cingular Wireless formed a joint venture (JV) to expand their GSM/GPRS wireless technology along 3,000 miles of interstate highways in Midwestern and Western states which were not covered yet. The two partners had a fifty-fifty control over the JV. At the time, AT&T and Cingular provided substitutable wireless services. Thus the JV served to reduce detrimental competition among them, and it also reduced strategically the need for further alliances with other competitors.

As suggested by these two anecdotes, firms often engage in JVs or minority stakes integration to pursue strategic objective, beyond the mere exploitation of internal synergies. In many cases, this happens even when the acquisition of full control is a viable option. The questions that this article attempts to answer are the following. Which are the general conditions that make a JV or a minority stakes acquisition a profitable alternative to the full control? Which kind of effects are more likely to occur when less than the full control is transferred? Is there any general evidence of such effects?

An integration contract yields two types of effects. First, a *productivity effect*, which consists in the improvement of the partners' production function, and occurs if there is some complementarity among their resources (e.g. synergies, better organization, economies of scale, etc.). Second, a *strategic effect*, that is due to a change in the partners' market power against competitors, customers, upstream suppliers and other trading parties. This second effect, however, could be negative, as integration may increase the third parties' ability to hold up the partners, leading to a decrease in their market power. Then it is not obvious that an integration contract guarantees higher profits to the partners, even in the presence of resource complementarity.

Using the approach of cooperative games, Segal (2003) is able to provide quite general conditions for the profitability of an M&A contract. This contract gives one partner the control over the 100% of the other partner's resources. His seminal model, however, is not able to explain why firms often engage in integration contracts and alliances that transfer less than 100% control over resources. We extend his model in this direction, allowing for minority stake integration (MS) and JV. Adopting the same cooperative approach we characterize profitability conditions for these forms of integration. We show that in many cases, less than 100% control is more profitable than the full control over the partner's resources.

Let us illustrate the intuition with an example. Consider three firms in the telecommunication business, i, j and k. Firm i provides mobile telephone services using an infrastructure owned by k. Firm j develops and supplies two types of software, A and B. Software A is sold to k and to other users, but it is essential to k's business. Software B is sold to k only, but it is not essential for k. Suppose i acquires 100% control of j: the latter cannot sell software without j's permission. There is a productivity effect, due to complementarities between i and j. But there are also two strategic hold-up effects at work. The first one is positive for the integrating partners: j cannot sell software A to k before i hasn't agreed to rent the infrastructure from k. This effect increases firm i's ability to hold up k. The second strategic effect is negative: k can threat i not to buy software B if the price paid by i to rent the infrastructure is too low. This second effect increases k's ability to hold up i. The profitability of the acquisition depends on the relative strength of these two effects. However, the two partners can do better than the full acquisition. Suppose i and j sign an MS contract which gives the former the control over software A only. Thus, j can sell software B independently of i, with the consequence that k's ability to hold up i does not increase. It is apparent that the MS allows the partners to make more profits than the full acquisition.

Segal (2003) shows that a contract that assigns partner i the full control over j's resources is profitable if it decreases the complementarity of third parties with the two partners' resources. The reason is that lower complementarity yields lower hold up power. We call M&A this type of contract. The theoretical model in this article reformulates Segal's condition, saying that the contract is profitable if the complementarity of third parties with the joint resources of i and j is lower than the sum of third parties' complementarity with i and j, separately.

The empirical part introduces a complementarity index that tests this prediction. It shows that the return on assets increases on average by 0.34 percentage points if firms engage in an M&A. This rise in profits is the "strategic effect" due to a decrease in the third parties' holdup power.

Interestingly, we show that a profitable "strategic effect" may arise not only from well-defined profitability conditions, like in Segal's work, but also from independent variations in complementarity between partners (either jointly or separately) and third parties. These changes contribute to enhance the partners' holdup power against third parties and therefore they provide additional gains from integrations. The cumulative gains from both profitability conditions and complementarities with third parties potentially make the strategic effect more effective than the productivity effect, that works only through the complementarity between the two partners.

For instance, in an M&A profits increase on average by 0.41 percentage points for a decrease in the complementarity between acquiror and third parties and by 0.37 percentage points in the case of complementarity between target and third parties. Other 0.28 points the average gains in case of complementarity between third parties and partners' joint resources. Looking at the productivity effect, data show that return on assets falls down by

12 percentage points if the integration is associated with an increase in the complementarity index between the partners. Thus gains in productivity are negative when controlling for strategic relationships with third parties. As a consequence, M&As are mostly motivated by the objective of strategically gaining market power rather than gaining productivity.

The highest return from profitability conditions is in the case of a minority stakes contract. An MS gives partner i the ability to control a share λ of j's resources ($\lambda < 1/2$). Data show that profits increase on average by 1.14 percentage points from a minority partnership. Other 0.14 percentage points come out for each decrease in the acquiror's complementarity with third parties. A firm may cumulate strategic gains from a variety of minority partnerships that increase its overall market power. Altogether, the net effect may exceed the positive impact from complementarity with the acquired resources, which is positive for MS contracts (+4.5 percentage points). Further, the model shows that ceteris paribus an MS can be much preferable to an M&A. It happens if the complementarity of third parties with i and the controlled share of j's resources is smaller than the complementarity in the presence of j's resources as a whole. In this case, the average performance from an MS is 3.72 percentage points higher than in case of M&A.

A JV gives rise to a new independent entity, endowed with an amount of resources conferred by the partners on the basis of equity shares. The model predicts that a JV is profitable if the complementarity of third parties with the new entity is lower than their complementarity with the conferred resources separately. In other words, a JV is profitable if allowing the JV to control the conferred resources as a whole implies that the third parties lose part of their hold up power. Data show that the "strategic effect" from profitability condition is an average increase of 0.8 percentage points in return on assets, lower than in case of an MS but higher than an M&A. A much higher impact on the performance comes from strategic changes in complementarity with third parties. Lowering the third parties' complementarity with one of the two partners yields on average 17 percentage points in returns, which is the same impact of the productivity effect. Ceteris paribus, if the contract reduces the holdup power of third parties towards each partner then the strategic effect is much higher than the productivity effect, and even more if the profitability condition for JV is satisfied.

Overall, the average strategic effect of profitability conditions is a boost in profits in the first two years post-integration. The highest impact occurs in the first year (more than 2 percentage points), and it lowers in the second year (1.22).

These empirical findings suggest two general results. First, contracts which transfer less than full control of a partner's resources on average have a larger positive impact on the partners' joint profits. Second, the relative importance of the strategic effect is larger for this kind of contracts. Indeed firms can increase market power through a variety of partial integrations which are much more easily manageable than full acquisitions.

An additional contribution of this article is the definition of an index to measure resource complementarity among firms. It addresses a measurement complexity arising from the fact that firms are usually involved in different businesses, each of them belonging to different sectors. In addition, the index addresses a dynamic complexity, due to the fact that complementarity between pairs of industrial sectors changes over time as a result of new products and/or technologies.

The cooperative game approach to integration contracts dates back to the seminal works of Grossman and Hart (1986) and Hart and Moore (1990), who, in contrast to the Coasian logic, focussed on limits to contractibility. They showed that changing the ownership of a collection of assets affects bargaining power, and then the distribution of surplus. This yields two effects. First, given ex-post efficiency, the owners can capture a larger share of ex-post surplus. Second, the prospect of a larger share leads the agents to undertake non-contractible actions ex-ante, which in turn may prompt ex-post efficiency. Of course, these two effects are strictly related to each other. However, the enormous literature originated by Grossman and Hart's works can be split in two big strands. The first one studies how ownership structures provide appropriate incentives to ex-ante investments that enhance efficiency.[1] The present article belongs to a second strand, that is mainly focused on exploring how integration contracts or partnerships occurring prior to production, affect final allocations resulting from bargaining with common third parties (e.g. Horn and Wolinsky, 1988; Davidson, 1988; Stole and Zwiebel, 2008; Chipty and Snyder, 1999; Elliott, 2015). The most related work is Segal (2003). In order to pin down the "bargaining externalities" arising from a series of integration contracts, Segal departs from efficiency effects. He provides a very general framework to study how substitutability/complementarity of integrating partners affects their ability to hold-up third parties. Thus he is able to provide quite general profitability conditions for a set of integration contracts. As mentioned earlier, he only considers contracts that transfer full control of a partner's resources. We build on his work, allowing for collusion contracts that transfer less than full control. Then we try to find empirical evidence of our results.[2] We follow Segal (2003) - and much of the above-mentioned literature - in adopting a cooperative bargaining solution. Indeed, we think that the cooperative approach better fits our large-sample empirical investigation.

The idea that partners that acquire a minority stake can exert some degree of influence on the target firm ties our work to the corporate finance literature that studies the power of minority shareholding. Bhagat and Brickley (1984) show that minorities are able to influence the election of some board members even if the majority opposes their election.[3] Butz (1994) points to the fact that minorities are influential because they can threat the CEO to purchase more shares in order to acquire majority control. Ciccotello and Hornyak (2000) study the minority's power in joint ventures. Elfenbein and Lerner (2003; 2012) show that the allocation of property rights is chosen according to the relative bargaining

[1] This strand of literature is quite large. For a recent and comprehensive survey, see Legros and Newman (2014).

[2] A related work is Platz and Østerdal (2013), who study allocation rules that dissuade partners from manipulating partnerships.

[3] Very often minorities vote on key managerial decisions such as mergers and acquisitions (Bethel et al., 2009), thus investors may acquire voting rights just to influence the outcome of M&A proposals (Hu and Black, 2007).

power, and how it may lead to increased performance of the partners. These contributions belong to a wider mainstream literature exploring how the allocation of ownership rights influences the performance of the alliances (see Kloyer, 2011; Bodnaruk et al., 2013; Haeussler and Higgins, 2014; Prange and Mayrhofer, 2015 for an overview). Differently from us, this literature focusses on the minority-majority relationship within the firm. We study minority shareholdings' effects outside the firm, namely, the effects on "horizontal" competition with other firms, and the effect on "vertical" trade with suppliers and customers.

The article is organized as follows. Section 2 presents the cooperative game model to study integration contracts, and characterizes profitability conditions. Section 3 introduces the complementarity index. Based on this index, Section 4 tests theoretical predictions. Section 5 concludes.

2. Model

Let $N = \{1, \ldots, n\}$ be a set of agents in the game. Agents can be firms competing in the same sector, firms in the upstream or downstream sectors, and customers. Agents own perfectly divisible assets $A = \{a_1, ..., a_n\}$ with control structure $A(S) : 2^N \to \mathbb{R}^{|S|}$. The set function $A(S)$ defines the amount of assets controlled by the subset S of agents. We will refer sometimes to S as a coalitions of agents.

Let (N, v) be a game with characteristic function $v(S, A(S)) : N \otimes \mathbb{R}^{|S|} \to \mathbb{R}$, for any coalition $S \subseteq N$. An integration contract has the effect of changing the control structure of the game, in a way we will define later. The timing of events is then the following. At period 0 two players, i and j, sign an integration contract. At period 1 all players play the game and split total payoffs according to the following solution.

Let $p^i(S)$ be the probability of any coalition S not containing i,

Definition 1. *(Weber, 1988) A solution $\varphi = \{\varphi_1, .., \varphi_n\}$ is a probabilistic value if for all i and any collection of v,*

(1) $$\phi_i(v) = \sum_{S \in 2^{N \setminus i}} p^i(S) \Delta_i v(S, A(S))$$

with $\Delta_i v(S, A(S)) = [v(S \cup i, A(S \cup i)) - v(S, A(S))]$.

The idea is that each player enters the negotiation arena at random with the scope of forming a coalition. Producing, and exchanging with other players implies forming a coalition with them. A coalition S is random because players are supposed to enter a coalition at random. The probability of any coalition S not containing i is $p^i(S)$ and it can be derived from the entry probability distributions of all players.[4] A probabilistic value assigns each player her/his expected marginal contribution to the random coalition S. If for instance the value of coalition S increases by $\Delta_i v(S, A(S)) = \$5$ when player i joins that coalition, and the probability of forming that coalition is $p^i(S) = 25\%$, then player i expects to be rewarded by \$1.25. By randomizing over all coalitions one obtains total expected rewards of player i, i.e. $\phi_i(v)$.

We assume that $p^i(S \cup i) = p^j(S \cup j)$, for any $S \subseteq N \setminus i \setminus j$. This amounts to saying that i and j behave symmetrically during negotiations. To save notation, let $v(S, A(S)) = v(S)$. Ichiishi (1993) uses the second order difference operator, $\Delta^2_{ki} v(S) = \Delta_k v(S \cup i) - \Delta_k v(S)$, to measure complementarity between i's and k's assets. Throughout the article we will need to measure complementarity of k's assets to those under the control of a generic coalition G. Thus we define:

Definition 2. $\Delta^2_{kG} v(S)$ *represents the complementarity between player* k *and the members of coalition* G*, where* $\Delta^2_{kG} v(S) \equiv \Delta_k v(S \cup G) - \Delta_k v(S)$*, (with* $k \in N$*,* $G, S \subseteq N \setminus k$ *and* $S \cap G = \emptyset$*).*[5]

[4] Specifically, call $x_j(t)$ the probability that player j has entered by time $t \in [0, 1]$, ($j \in N$). The probability that player i joins a coalition $S \subseteq N \setminus i$, at time t, is:

$$\prod_{\substack{j \in S \\ S \subseteq N \setminus i}} x_j(t) \prod_{\substack{j \notin S \\ S \subseteq N \setminus i}} (1 - x_j(t)) \cdot x_i'(t)$$

and player i expects to join coalition S with probability:

$$p^i(S) = \int_0^1 \prod_{\substack{j \in S \\ S \subseteq N \setminus i}} x_j(t) \prod_{\substack{j \notin S \\ S \subseteq N \setminus i}} (1 - x_j(t)) dx_i(t)$$

.

[5] Specifically, player k is complementary (substitutable) to G if $\Delta^2_{kG} v(S) > 0$ ($\Delta^2_{kG} v(S) < 0$).

Roughly speaking, k is complementary to the members of G if k's resources are more valuable whenever also G's resources are used. Complementarity goes in both directions. It also implies that the value jointly added by members of G to any other coalition S is higher in the presence of player k. If instead the value added by k decreases when G's resources are already in, then we say that k is substitute of G.

We can now define a contract.

Definition 3. *$C(\lambda)$ is an integration contract between i and j if*

$$A^{C(\lambda)} = \{a_1, .., a_i + \lambda a_j, .., (1 - \lambda)a_j, .., a_n\}$$

and $v^{C(\lambda)}(S) = v(S, A^{C(\lambda)}(S))$.

An integration contract changes the control structure over resources, giving i the control of a share $\lambda \in (0, 1]$ of j's resource a_j. Differently from Segal [2003], the above definition can describe situations in which partner i acquires less than the full control of j's resource, a situation that typically occurs in minority stake contracts. If $\lambda = 1$, our definition coincides with Segal's. As in his model, an integration contract is profitable if it reduces all other players' expected payoffs:

$$\phi_k\left(v^{C(\lambda)}\right) - \phi_k(v) < 0 \qquad (2)$$

for any $k \neq i, j$.

2.1. M&A contracts

An M&A is a contract that assigns firm i the total control of j's resources. Through an M&A, player i can manage j's resources even in the absence of j. The complete acquisition of Leap (the target j) by AT&T (the acquiror i) is an example of M&A. As pointed out earlier, this is the collusion contract studied by Segal. Here we re-state his general profitability condition (Segal, 2003, p. 450), in order to get an empirically testable statement.

Proposition 1. *An M&A between i and j is profitable if it makes all third parties k less complementary to $G = \{i, j\}$ than to j and i, separately: $\Delta^2_{k\{i,j\}}v(S) < \Delta^2_{ki}v(S) + \Delta^2_{kj}v(S)$, for all k.*

Proof. An M&A contract affects the worth of those coalitions that contain only one of the integrating parties. As regards players' marginal contributions, they are affected in the following way:

1. Firm j becomes a null player in all coalitions.
2. Firm i contributes more than before to all coalitions, because it brings j's resources.
3. Player k's marginal contributions are the following:

$$\Delta_k v^{M\&A}(S) = \begin{cases} \Delta_k v(S \setminus j) & \text{for any } S \subseteq N \setminus i \cup j \\ \Delta_k v(S \cup j) & \text{for any } S \subseteq N \setminus j \cup i \\ \Delta_k v(S) & \text{otherwise} \end{cases}$$

Thus we can write the variations in player k's marginal contributions:

$$\Delta_k v^{M\&A}(S) - \Delta_k v(S) = \begin{cases} -\Delta^2_{kj} v(S) & \text{for any } S \subseteq N \setminus i \cup j \\ \Delta^2_{kj} v(S \cup i) & \text{for any } S \subseteq N \setminus j \cup i \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

The first line in the RHS of (3) is a positive effect for i and j. Suppose that k and j are complementary ($\Delta^2_{kj} v(S) > 0$). It tells us that k's marginal contributions to coalitions that include j (and not i) decrease because now k has to "wait for i". The second line is a negative effect for i and j. It tells that k's marginal contributions to coalitions that include i (and not j) increase, because now i has already brought j's resource. Thus k's contribution is larger. The M&A is profitable if the first effect is larger than the second one, for all k and all S:

$$\Delta^2_{kj} v(S \cup i) - \Delta^2_{kj} v(S) > 0 \tag{4}$$

In this case, (2) is satisfied for all k ($\lambda = 1$). Let us re-write (4) as

$$\Delta_k v(S \cup \{i, j\}) - \Delta_k v(S \cup j) - [\Delta_k v(S \cup i) - \Delta_k v(S)] < 0$$

Adding the zero-sum term $\Delta_k v(S) - \Delta_k v(S)$ and rearranging, yields

$$\Delta^2_{k\{i,j\}} v(S) < \left[\Delta^2_{ki} v(S) + \Delta^2_{kj} v(S)\right] \tag{5}$$

which must be true for any $k \neq i, j$ and all $S \subseteq N \setminus i \setminus j \setminus k$. ■

The complementarity between i and j is not sufficient to ensure profitability of an M&A contract. A sufficient condition is that (5) is satisfied for all k. To see the intuition, suppose the two partners are complementary. They are more efficient when they merge (i.e. the productivity effect is positive). However, it is perfectly possible that the complementarity of k's resource increases, giving k a larger hold-up power. In other words, it is possible that k's resource becomes more "essential" to the partners. If this occurs for all k, an M&A results in a loss of market power that may jeopardize the benefits of integration.

2.2. Minority stakes contracts

Through an integration contract, firm i acquires the control of a share λa_j of j's assets ($\lambda \leq 1$). If $0 < \lambda \leq 0.5$, we say that the contract consists in a minority stakes integration. This typically occurs when i is a minority shareholder of j, as in the case of AT&T buying 32% of Net2Phone in 2000. As pointed out earlier, minority shareholders exert a certain amount of influence on the target's decision. With a high level of generality, we parametrize i's decisional influence through the probability, σ, that i brings all j's resource with him when he enters any coalition S. More precisely, suppose i enters a coalition $S \subseteq N \setminus i \setminus j$. With probability σ, he adds $\{a_i, a_j\}$ to all resources available to that coalition, whereas with probability $1 - \sigma$ he adds "only" $\{a_i, \lambda a_j\}$. Realistically, the amount of influence σ that a minority shareholder exerts on target j positively depends on the share size, λ.[6]

Suppose that condition (5) holds, that is a firm i may choose to merge with a firm j and achieve positive profits. Proposition 2 below says that a minority stakes contract is also

[6] Of course, i's decisional influence can also depend on other factors, such as the level of fractionalization of the other shareholders, or the credibility of i's threat to sell λa_j to some opponent of j's majority shareholder (cf. Butz, 1994 and Hubbard and Palia, 1995).

profitable whenever it lowers the complementarity of third parties' resources with λa_j. In this case, the strategic effect of an MS integration is positive, because it makes third parties less essential to the partners.

Proposition 2. *A minority stakes contract between i and j is profitable if it makes any third party's resource a_k less complementary to $\{a_i, \lambda a_j\}$ than to a_i and λa_j, separately.*

Proof. By MS, the k's expected contributions become

$$\begin{cases} \Delta_k v^{MS}(S) = \sigma \Delta_k v(S \cup i \cup j) + (1-\sigma)\Delta_k v(S \cup i \cup j^{\lambda}) & \text{with } S \cup i \\ \Delta_k v^{MS}(S) = \sigma \Delta_k v(S) + (1-\sigma)\Delta_k v(S \cup j^{1-\lambda}) & \text{with } S \cup j \end{cases}$$

for any $S \subseteq N \setminus i \setminus j \setminus k$, where $S \cup i \cup j^{\lambda}$ is a coalition S in which i brings also λa_j, and $S \cup j^{1-\lambda}$ is a coalition S in which j brings only the share $(1-\lambda)a_j$ of his own resources. The expected variation in k's payoff is

$$\begin{aligned} &\sigma \left[\Delta_k v(S \cup i \cup j) - \Delta_k v(S \cup i)\right] + (1-\sigma)\left[\Delta_k v(S \cup i \cup j^{\lambda}) - \Delta_k v(S \cup i)\right] \\ &\quad + \sigma \left[\Delta_k v(S \setminus j) - \Delta_k v(S \cup j)\right] + (1-\sigma)\left[\Delta_k v(S \cup j^{1-\lambda}) - \Delta_k v(S \cup j)\right] \\ &\qquad = \sigma \left[\Delta^2_{kj} v(S \cup i) - \Delta^2_{kj} v(S)\right] + (1-\sigma)\left[\Delta^2_{kj^{\lambda}} v(S \cup i) - \Delta^2_{kj^{\lambda}} v(S \cup j^{1-\lambda})\right] \end{aligned}$$

■ Replacing the difference $\Delta^2_{kj} v(S \cup i) - \Delta^2_{kj} v(S)$ with the terms in (5) and requiring (2), we get:

$$\Delta^2_{kj^{\lambda}} v(S \cup i) - \Delta^2_{kj^{\lambda}} v(S \cup j^{1-\lambda}) < \frac{\sigma}{\sigma - 1}\left[\Delta^2_{k\{i,j\}} v(S) - \Delta^2_{ki} v(S) - \Delta^2_{kj} v(S)\right] \tag{6}$$

for all $S \subseteq N \setminus i \setminus j \setminus k$ and any $k \in N \setminus i \setminus j$. Let us denote the LHS of (6) by y and the difference in square brackets of RHS by x. The MS contract is profitable if

$$y < \frac{\sigma}{\sigma - 1} x \tag{7}$$

Since $x < 0$ and $\frac{\sigma}{\sigma-1} < 0$ by hypothesis, a sufficient condition for (7) is $y \leq 0$, that is

$$\Delta^2_{kj^\lambda} v(S \cup i) \leq \Delta^2_{kj^\lambda} v(S \cup j^{1-\lambda}) \tag{8}$$

By Proposition 2, the profitability of an MS contract (i.e. the possible increase in profits) is independent of i's decisional influence, σ. Eventually, σ affects the size of profits change, but not the sign of that change. The profitability of an MS is linked to the reduction of third parties' complementarity with the acquired share λa_j, when the latter is used jointly with a_i. The reason is that third parties become less essential, leading to a strategic increase of partners' market power.

It is perfectly plausible that third parties become less essential when i acquires the share λa_j, whereas they would become more essential should i acquire the whole a_j. In general, an MS contract can be more profitable than an M&A because it allows to integrate those assets that yield a larger "strategic" reduction of k's complementarity with the partners. The following proposition makes this point, formally.

Proposition 3. *An MS contract between i and j is more profitable than an M&A contract if complementarity between k's assets and $\{a_i, \lambda a_j\}$ is lower in the absence of j's non-integrated resources, $(1-\lambda)a_j$, than in the presence of these resources.*

Proof. Consider x, y in (7) and let $x < 0$ (an M&A would be profitable). Then, an MS contract is preferable if the externality that it yields on any k is larger than the externality produced by M&A, which yields

$$(1-\sigma)y + \sigma \cdot x < x \Longrightarrow y < x < 0 \tag{9}$$

Inequality (9) implies

$$\Delta^2_{kj^\lambda} v(S \cup i) - \Delta^2_{kj^\lambda} v(S \cup j^{1-\lambda}) < \Delta^2_{k\{i,j\}} v(S) - \Delta^2_{ki} v(S) - \Delta^2_{kj} v(S)$$

or equivalently

$$\Delta_k v(S \cup i \cup j^{\lambda}) - \Delta_k v(S \cup i) + \Delta_k v(S \cup j^{1-\lambda}) - \Delta_k v(S \cup j)$$
$$< \Delta_k v(S \cup \{i, j\}) - \Delta_k v(S) - \Delta_k v(S \cup i) + \Delta_k v(S) + \Delta_k v(S) - \Delta_k v(S \cup j)$$

Then

$$\Delta^2_{k\{i,j^{\lambda}\}} v(S) < \Delta^2_{k\{i,j^{\lambda}\}} v(S \cup j^{1-\lambda}) \tag{10}$$

for all $k \in N \setminus i \setminus j$ and $S \subseteq N \setminus i \setminus j \setminus k$. ■

Proposition 3 provides a theoretical explanation of our empirical result that MS contracts have on average a larger positive impact on profits than M&A contracts.

2.3. JVs with joint ownership

Suppose two parent firms, i and j, confer an equal share λ of their resources to form a JV. The latter becomes the $(n+1)th$ player in the game. The asset vector is then

$$A^{JV(\lambda)} = \{a_1, .., a_i(1-\lambda), .., (1-\lambda)a_j, .., a_n, \lambda(a_i + a_j)\}$$

We assume that the control of the JV's resource is assigned to i or j with equal probability. This reflects the idea that each player has a fifty-fifty influence on JV's decisions. The strategic effect of a JV consists in reducing third parties' ability to hold-up any of the two parents. This is the case if third partners' resources become less essential when any of the two parent firms can control her own resources plus the other parent's conferred resources. More formally,

Proposition 4. *A JV contract between i and j is profitable if it lowers third parties' complementarity with $(a_l + \lambda a_m)$, where $l, m = i, j$ and $l \neq m$.*

Proof. By the JV contract, the k's expected contributions are

$$\begin{cases} \Delta_k v^{JV}(S) = \left[\Delta_k v(S \cup i \cup j^{\lambda}) + \Delta_k v(S \cup i^{1-\lambda})\right]/2 & \text{with } S \cup i \\ \Delta_k v^{JV}(S) = \left[\Delta_k v(S \cup j \cup i^{\lambda}) + \Delta_k v(S \cup j^{1-\lambda})\right]/2 & \text{with } S \cup j \end{cases}$$

where player $j^{1-\lambda}$ is endowed with $(1-\lambda)a_j$ and player j^{λ} is endowed with λa_j (similarly for player i). The JV is profitable if

$$\begin{aligned} &\Delta_k v(S \cup i^{1-\lambda} \cup \{i^{\lambda}, j^{\lambda}\}) + \Delta_k v(S \cup j^{1-\lambda} \cup \{i^{\lambda}, j^{\lambda}\}) \\ &+\Delta_k v(S \cup i^{1-\lambda}) + \Delta_k v(S \cup j^{1-\lambda}) - 2\Delta_k v(S \cup i) - 2\Delta_k v(S \cup j) < 0 \end{aligned} \tag{11}$$

Adding the zero-sum term

$$-\Delta_k v(S \cup i^{1-\lambda}) + \Delta_k v(S \cup i^{1-\lambda}) - \Delta_k v(S \cup j^{1-\lambda}) + \Delta_k v(S \cup j^{1-\lambda})$$

Inequality (11) implies

$$\Delta^2_{ki^{\lambda}} v(S \cup i^{1-\lambda}) + \Delta^2_{kj^{\lambda}} v(S \cup j^{1-\lambda}) > \Delta^2_{k\{i^{\lambda}, j^{\lambda}\}} v(S \cup i^{1-\lambda}) + \Delta^2_{k\{i^{\lambda}, j^{\lambda}\}} v(S \cup j^{1-\lambda}) \tag{12}$$

for all $k \in N \setminus i \setminus j$ and $S \subseteq N \setminus i \setminus j \setminus k$. ■

This Proposition tells us that, apart from productivity effects, gains in a JV may be due to consistent increases in the market power of parent firms.

3. A measure of asset complementarity

Measuring complementarity implies assessing how industries and firms are related. This is notably a quite difficult task. Most existing complementarity measures use industry codes, which provide only qualitative assessments. These kinds of indexes are based only on sector classification (the most common one is 4-digit SIC classification). They are commonly used to investigate the correlation between firms' sectors, the occurrence of integration contracts, and firms' profits (Gort, 1962; Hassid, 1975; Berry, 1974; Jacquemin and Berry, 1979). Later works provide more sophisticated measures, such as concentric indexes (Caves et al., 1980 and Wernerfelt and Montgomery, 1988) and entropy indexes (Palepu, 1985). These measures have been used to study diversification (e.g. Morck et al., 1990; Berger and Ofek, 1995) according to some sales-related requirements or other accounting data that are available by segment.[7]

For our purpose, these measures are unsatisfactory because they are mainly based on the similarity in industry codes and therefore they are ineffective in identifying complementarities among industries. Some vertically related industrial sectors are classified as "unrelated" according to their three-digit NAICS code. However, complementarity may occur between firms belonging to such sectors. For instance, this is the case of the oils-refining business (NAICS six-digit code: 311225) and the petrochemical business (NAICS six-digit code: 325110).

3.1. Complementarity index for two multi-industry firms

More recently, Fan and Lang (2000) proposed a quantitative complementarity index based on Input-Output (I-O) tables. According to them, the complementarity between industries l and m is an average of the degree of correlation between their input and output flows from/to other industries:

$$COMP(l,m) = \frac{corr(r_{bl}, r_{bm}) + corr(c_{bl}, c_{bm})}{2} \tag{13}$$

where r_{bl} and r_{bm} is the percentage of sector b's output required to produce one dollar of output in industries l and m, and c_{bl} and c_{bm} are the percentages of l and m's output used by b (with $b \neq l, m$).

Index (13) is quite appealing. However, it measures the complementarity between pairs

[7] In most cases these indexes consider the number of industries in which firms are active and the share of their activities not belonging to the primary industry. Then the Herfindhal index of concentration is applied in some way.

of firms belonging to one industry only. In fact, almost every firm in our sample produces a variety of goods and/or services belonging to different industries. Each of them is characterized by a specific level of complementarity with other industries. For this reason, we need to extend the work of Fan and Lang in order to measure complementarity between multi-industry firms.

Consider two firms i and j. Their products are included in a number of industries: $l = 1, ..., L$ and $m = 1, ..., M$, respectively. Let i_l be the output of firm i in sector l and j_m the output of firm j in sector m. The complementarity index between multi-industry firms i and j is:

$$COMP_{i,j} = \sum_{l=1}^{L} \sum_{m=1}^{M} (R_i \cdot R_j) COMP(i_l, j_m) \tag{14}$$

where $COMP(i_l, j_m)$ is defined by (13), and R_i and R_j are the i's and j's shares of the total operating revenues turnover. Notice that this index is time-varying (I-O tables for US are updated yearly). It detects variations in complementarity that may result from technological changes, or firms' strategic choices (e.g. the launch of a new product or the desertion of an old one).

3.2. Complementarity in the presence of third parties

The model of Section 2 points out that benefits from an integration contract are due not only to possible changes in complementarity between i and j, but also to possible changes in complementarity between each of them and any third party, k. To evaluate empirically the effects of integrations, we build complementarity indexes based on a weighted average of i's (or j's) complementarity degrees with any third party k which might belong to a random coalition S. Thus the complementarity between i and a third partner k is

$$Cki = \sum_{K} R_k COMP_{k,i} \tag{15}$$

The weights R_k assess the relative importance of third parties in our sample. Specifically, R_k is the share of the total operating revenue turnover of k, and K is the set of all third parties $k \neq i, j$. Index Cki is a proxy of the difference operator $\Delta^2_{ki} v(S)$. Similarly, we also define Ckj, proxy of $\Delta^2_{kj} v(S)$.[8] Using indexes $COMP_{k,i}$, $COMP_{k,j}$ and $COMP_{i,j}$, we build index $Ckij$, that represents the complementarity between partners, taken together, and third parties:

$$Ckij = \sum_K R_k COMP_{k,i} \cdot COMP_{i,j} + \sum_K R_k COMP_{k,j} \cdot COMP_{i,j} \tag{16}$$

Index $Ckij$ is a proxy of $\Delta^2_{k\{i,j\}} v(S)$, the post-integration complementarity.

Following the same steps we define complementarity indexes for MS and JV contracts. Suppose i acquires a minority share λ of j's resources. Index (15) now becomes:

$$Cki^{\lambda} = \sum_{K \cup j} R_k COMP_{ki^{\lambda}} \tag{17}$$

Observe that in the case of MS or JV, the target firm j controls resource $(1-\lambda)a_j$ independently of i. This the reason why index (17) includes j in coalition S.

All above belong to the interval $[-1, 1]$. They are time varying, because I-O tables are updated yearly. This solution allows to consider also the changes of our firms' business lines over time.

4. Empirical evidence

In this Section we use panel data to provide empirical evidence of Propositions in Section 2. Specifically, we want to test if the profitability conditions derived in Section 2 exert a positive and significant impact on firms' performance, in case of integration. Moreover, we

[8] Specifically,

$$Ckj = \sum_K R_k COMP_{k,j}$$

.

want to test if performance is more reactive to changes in complementarity with third parties than to changes in complementarity between partners. This would prove that the "strategic" effect of integration is larger than the "productivity" effect.

Data come from databases Orbis and Zephyr (Bureau Van Dijk) and refer to $8,106$ US listed companies that signed a bilateral contract of M&A (416 units), MS $(6,495)$ or JV $(1,195)$ in the period 2002-2007. Table 1 provides a classification of integration contracts based on the completion year.

Place Table 1 approximately here.

The subset of M&As includes all the cases of majority stake acquisition, irrespective of the fact it occurred through the acquisition of a majority or a minority share of the target firm. Data available on companies' performance and characteristics range from 1999 to 2010. NAICS 6-digit classification includes 90 different primary industrial sectors. All companies in our sample are multi-industry firms. If we consider all secondary firm activities, then the M&A and MS contracts (including target companies) cover 105 different industrial sectors, whereas the JVs cover 58 sectors. For each company, we take into account up to 8 different business lines ranked by relevance in terms of revenues. Using the Input-Output Accounts Data available from the U.S. Bureau of Economic Analysis (BEA), we measure all complementarity relationships defined in Section 3.

Firm profitability is measured by ROA (Returns on Assets), the percentage ratio between a company's annual earnings and its total assets. As contracts have important implications on some characteristics of the firms (e.g. size, efficiency, productivity,...) we use a dynamic model for panel data which takes into account autocorrelation in the variable measuring firm performance. Because of dynamic effects and endogeneity problem, we adopt the dynamic GMM proposed by Blundell and Bond (1998), where variables are instrumented by using their lagged and non-lagged first-differences.[9] For each company i we set a time-varying

[9] For predetermined and endogenous variables, two is the maximum number of lags used as instruments.

dummy T_{it} whose value changes from 0 to 1 starting from the generic year t in which integration occurs.

The model is:

$$(18) \qquad ROA_{it} = \alpha ROA_{it-1} + \delta_{\mathbf{1}}\mathbf{SIZE}_{it} + \delta_2 T_{it} \times PC_{it} + \delta_{\mathbf{3}}\mathbf{TC}_{it} + \mu_i + y_t + \epsilon_{it}$$

The row vector $SIZE_{it}$ includes variables $SALES_{it}$ (net sales, in natural log), $EMPL_{it}$ (number of employees, in natural log) and their first order lags.

As first step, we use model (18) to test the general profitability requirements from Propositions 1, 2 and 4 in Section 2. Afterwards, in Section 4.1, we implement the ANOVA technique to check whether an MS contract is really more profitable than M&A when condition (10) holds, that is the content of Proposition 3.

To test our theoretical findings we use the interaction term $T_{it} \times PC_{it}$, where PC_{it} is a dummy indicating whether the profitability condition associated with contract T_{it} is satisfied or not in year t. For example, consider an M&A contract. Inequality (5) says that a sufficient profitability condition is that the M&A reduces the partners' complementarity with all third parties. Using indexes defined in Section 3, this condition implies $Ckij < Cki + Ckj$. If this inequality holds, then the dummy variable PC_{it} takes value 1. Hence, the interaction term $T_{it} \times PC_{it}$ evaluates the M&A impact on post-integration profits.

For each company i, and any period t, vector TC_{it} in (18) is composed of interactions of T_{it} with the following four complementarity indexes. First, Cki measures pre-integration complementarity between partner i and all third parties, k. Specifically, for year t, the complementarity index Cki is defined by (15) and, in case of MS and JV, by (17). Second, index Ckj is defined in the same way for $i = j$. Third, index $Ckij$ is defined by (16). It measures post-integration complementarity between partners and competitors. The forth index, $COMP_{i,j}$ defined by (14), represents complementarity between i and j. It assesses mutual benefits eventually arising from merging partners' assets (the so-called productivity effect), without taking into account any possible effect due to changes in the complementarity with third parties (i.e. the strategic effect). All these four complementarity indexes are time varying. Finally, μ and y in (18) represent firm and time specific effects; ϵ is the usual disturbance term.

Columns (1)-(3) in Table 2 show results for M&A, MS and JV contracts, respectively. To save notation, hereafter we omit subscripts i and t for variables referring to panel data.

For each contract, we disentangle the productivity and strategic effect in order to assess their relative importance. The productivity effect is captured only by the interaction term $T \times COMP_{i,j}$, while the strategic effect works through the four interactions of variable T with dummy variable PC and the complementarity indexes Cki, Ckj and $Ckij$. Substantially, the impact of the strategic effect can be cumulated across four possible strategic variations in the complementarity between partners and third parties.

There is evidence that when our theoretical profitability conditions are satisfied, post-integration profits are higher. The variable of interest is $T \times PC$: interaction between two dummies for treatment and profitability conditions. Coefficients associated with this variable show that in case of MS integration, $T \times PC$ has the strongest impact on profits: the acquiror's returns grow by 1.14 percentage points on average. The weakest impact occurs in the case of M&As, where profits increase on average by 0.34 percentage points.

These results confirm the intuition that if a contract allocates ownership rights over resources in such a way that the complementarity relationships satisfy a given condition, then this is sufficient to guarantee a boost in profits. This is a first way to capture the strategic effect from contracting. However strategic gains also stem from changes in the complementarity between each partner and third parties. The impact is measured by variables $T \times Cki$ and $T \times Ckj$.

In an M&A profits increase on average by 0.41 percentage points for every decrease of the complementarity between the acquiror i and third parties, measured by variable $T \times Cki$ (the coefficient value is significant at 1%), and by 0.37 percentage in case of complementarity between the target and third parties ($T \times Ckj$). A further boost effect comes out from the interaction term $T \times Ckij$. It shows how the changes in complementarity between competitors and partners' joint resources due to the integration impact on performance. The coefficient value for M&A is 0.28 (significant at 1%), meaning that on average the integration provides 0.28 percentage points in returns for every increase of $Ckij$. These gains possibly sum up to those from other interactions. The "productivity effect" is the effect of integration on partners' complementarity, as measured by $T \times COMP_{i,j}$. For M&A contracts, the impact is strongly negative when controlling for the strategic effect: about 12 percentage points less for every increase of $COMP_{i,j}$. Thus any positive changes in the performance are mainly due to the strategic interactions among firms rather than productivity issues.

In the case of MS contracts the largest impact from strategic effect is related to the profitability condition PC, which guarantees the highest increase in returns across the contracts (the coefficient value is 1.14 and significant at 1% level). Additional gains of 0.14 points occurs for every change of the complementarity with third parties (see the negative coefficient value for $T \times Cki$ in column 2). Although the productivity effect is quite large for this contract (a value of 4.47 for variable $T \times COMP_{i,j}$), these findings suggest that a minority stake purchase must not be necessarily motivated by issues of synergy. Profits may increase substantially due to the strategic interactions in the market. That is the reason why firms can engages in a wide variety of minority stakeholdings.

Column 3 in Table 2 shows that this strategic motivations are particularly relevant in JV contracts. Here the complementarity between partners has a strong and positive effect on the post-integration performance (coefficient value for $T \times COMP_{i,j}$ is about +17) but more importantly the gains can increase by other 17 points for every decrease of complementarity between one of the two partners and third parties. Thus the strategic effect is potentially double the productivity effect.

Place Table 2 approximately here.

4.1. Average effect of profitability conditions

To provide further evidence of our results, we estimate the average impact of profitability conditions on post-integration performance. Within the sample of firms that signed an integration contract in the period $2002-2007$ we distinguish between treated and controls. A "treated" firm satisfies the corresponding profitability requirement, therefore the treatment group includes all firms such that both dummy variables T and PC take value 1 starting from the year of integration. The control group includes firms which do not satisfy profitability conditions: for these firms, treatment variable T takes value 1 but dummy variable PC takes value 0.

Then we estimate the Average Treatment Effect (ATE), that requires finding matches for both the treated and control units, and the Average Treatment Effect on the Treated ($ATET$), that only requires finding matches for the treated. Controls and treated are similar based on a propensity score (Rosenbaum and Rubin, 1983) that we calculate by a logit on a vector $\mathbf{X}$ of pre-treatment characteristics. In vector $\mathbf{X}$ we include former variables $EMPL$ and $SALES$, as proxies for dimensionality, and the new variables RSF (return on shareholders funds) and EV (enterprise value), as proxies for profitability. Finally, we compute the average effect of treatment based on the nearest neighbor matching. The post-integration period includes the three years after the contract completion date.

Results in Table 3 support theoretical predictions. When profitability conditions are satisfied, a significant increase in the rate of return occurs. The ATE is $+2.12$ percentage points in the first post-integration year, and $+1.24$ in the second. This boost effect disappears in the third year. Matching treated and control only on the treated ($ATET$), the impact is limited to the first year but it is higher ($+2.34$ percentage points). On average, the returns after integration grow by $+1.02\%$.

Finally, we test whether the choice of buying only a share of the partner's resources is preferable to an M&A when the MS contract strongly reduces the complementarity between acquiror and third parties, according to condition (10) (see Proposition 3). For this purpose, we consider a subsample of firms that satisfy both profitability conditions (5) and (10) in the year of integration, that is all firms that might find an M&A contract also profitable. Then we use the analysis of variance (ANOVA) to compare the average performance for firms choosing different contracts. Table 4 shows the results. The one-way ANOVA highlights a boost effect from MS. The probability (p-value) associated with the differences between groups is less than 0.01 (see Sig. level in table 4), therefore differences among the contracts are valid and statistically significant at 1%. When firms choose an MS contract the average ROA is much higher: 3.72 percentage points more than M&A. Interestingly, this boost effect still amounts to about 2.67 percentage points for firms choosing a JV contract. These findings provide further evidence that on average partial integrations are more profitable than complete integration contracts.

Place Tables 3 and 4 approximately here.

5. Conclusions

This article adopts the approach of cooperative game theory to study integration contracts. This approach is quite general, therefore it yields widely applicable predictions that do not depend on the context in which integration takes place. This article builds on the work of Segal (2003), who studied integration contracts using the same approach. He only considered cases in which firms pool 100% of their resources. This article extends his analysis in two directions. First, it considers integration contracts that pool less than 100% of partner's resources. Second, it provides empirical evidence of theoretical predictions.

Theoretically, integration yields two effects. It may enhance efficiency, by increasing complementarity between partners' resources (the efficiency effect). It may increase partners' market power, by making competitors' and other parties' resources less essential. The model shows that a minority stakeholding or a JV can be more profitable than an M&A. The reason is that pooling less than 100% resource may yield a larger strategic effect, compared to full integration. It can allow partners to decrease third parties complementarity by a larger amount, making them less essential than in the case of an M&A.

These theoretical predictions are fully corroborated by empirical evidence. We use a large sample of US quoted companies. In order to measure firms' asset complementarities we develop an index based on the I-O coefficients. Our measure is time varying and most importantly it applies to multi-product firms. Data show that profits increase when theoretical profitability conditions are satisfied and changes in partners' complementarity with third parties occur. These strategic gains may represent the main source of profits because they work in several ways. Productivity gains due to enhanced efficiency still matter but they may reveal less relevant, because they are associated only with variations in the complementarity between partners. On the contrary, firms can accumulate strategic gains from a variety of strategic interactions.

The main empirical result in this article is that partial integrations may yield consistent increase in profits, even in the presence of limited efficiency gains. The reason is that minority stake contracts and JVs often lead to large accumulation of market power. On average, MS contracts show the highest return from our profitability conditions.

From a normative viewpoint, this implies that the acquisition of non-controlling minority shareholding (and the strategic alliances as well) may harm competition and then consumers. However, antitrust legislation is quite heterogeneous across countries on this issue. In some countries (e.g. the US, Japan, UK or Germany), the Competition Authorities are given the competence to review any kind of minority acquisitions. In some other jurisdictions (e.g. the European Commission or some EU members), the authorities cannot investigate minority shareholdings which do not lead to the acquisition of full control. There is not much consensus about the potential harms of minority shareholding. Perhaps the theoretical framework and the empirical findings of this article help shed light on these important normative issues.

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Table 1: Sample decomposition by year of integration.

Completion year	2002	2003	2004	2005	2006	2007	Total
M&A	24	43	49	118	99	83	416
MS	519	766	690	1334	2887	299	6495
JV	120	167	245	199	207	257	1195
Total	663	976	984	1651	3193	639	8106

Table 2: Complementarity and post-integration performance.
Dynamic GMM (Blundell-Bond [1998]) estimators.

	(1)	(2)	(3)
Dep. ROA	$M\&A$	MS	JV
$ROA(t-1)$	0.0928***	0.2018***	0.1667***
	(0.0011)	(0.0058)	(0.0051)
$SALES$	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)
$SALES(t-1)$	0.0005***	−0.0000***	−0.0000***
	(0.0000)	(0.0000)	(0.0000)
$EMPL$	0.0000	0.0000*	−0.0002***
	(0.0000)	(0.0000)	(0.0000)
$EMPL(t-1)$	−0.1883***	0.0001***	0.0000***
	(0.0018)	(0.0000)	(0.0000)
$T \times PC$	0.3434***	1.1441***	0.7827**
	(0.1142)	(0.2939)	(0.3186)
$T \times COMP_{i,j}$	−12.3471***	4.4690***	17.4311***
	(0.9335)	(0.2679)	(0.5883)
$T \times Cki$	−0.4101***	−0.1386*	−17.3905***
	(0.0555)	(0.0730)	(0.5963)
$T \times Ckj$	−0.3668***	−0.0511	−17.1785***
	(0.0650)	(0.1135)	(0.5970)
$T \times Ckij$	0.2773***	.0005	
	(0.0292)	(.0454)	
$Const.$	0.2457	3.0309***	2.1606***
	(0.2438)	(0.1995)	(0.1639)
N	1436	27662	6910

Notes. Standard errors in parentheses; *** p <0.01, ** $p < 0.05$, * $p < 0.1$.

Data for complementarity indexes are ×100. All regressions include firm and time fixed effects.

Table 3: Average Treatment Effect (ATE) and Average Treatment Effect on Treated (ATET) from integration Profitability Conditions.

Dep. ROA	*ATE*			
Post-integration years:	*All*	$t+1$	$t+2$	$t+3$
	1.018***	2.119**	1.243*	1.034
	(0.002)	(0.010)	(0.080)	(0.127)
	ATET			
	1.018***	2.339**	1.270	0.714
	(0.002)	(0.013)	(0.108)	(0.361)
N	8995	2254	2254	2246

Notes. Treated: $T = 1, PC = 1$; Controls: $T = 1, PC = 0$.

*** $p< 0.01$, ** $p< 0.05$, * $p< 0.1$; p-values in parentheses.

Table 4: ANOVA for post-integration performance.

	Sum of squares	df	Mean square	F	Sig.
Between groups	10396.0441	2	5198.0220	36.76	0.0000
Within groups	2466364.22	17441	141.41186		
Pairwise comparisons of the means (Bonferroni's method):					
M&A	0 (base)				
MS	+3.630***				
JV	+2.618***				

Notes. Treatment variable includes three categories: M&A, MS and JV.

The subsample includes firms that satisfy profitability conditions (5) and (8) for M&A and MS.

Standard errors in parentheses; *** $p <0.01$, ** $p < 0.05$, * $p < 0.1$.