Integration Contracts and Asset Complementarity: Theory and Evidence from US Data

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Integration Contracts and Asset Complementarity: Theory and Evidence from US Data

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Abstract

Firms sign an integration contract with the purpose of increasing their expected profits from trade and competition with third parties. Gains depend on how the contract improves the partners' production function (e.g. better synergies, organization, etc.), and how it increases their power in the marketplace.

We investigate three bilateral integration contracts under different ownership allocations over resources: M&A, Minority Stake purchase and Joint Venture. We study them theoretically with a cooperative game approach. We derive some profitability conditions that we test empirically on a sample of about 9000 US firms. In order to estimate the link between ownership, asset complementarity and profits over time, we propose a novel multiproduct and time-varying complementarity index. Empirical results fully support our theoretical predictions.

JEL classification: C22; C71; G34

Keywords: Cooperative Games; Merger; Acquisition; Joint venture; Complementarity

1. Introduction

An integration contract among a group of firms, not only may improve the joint production function (e.g. better synergies, organization, etc.), it may also increase joint power towards competitors and trading parties. Profits can either increase or decrease after integration. In this paper, we analyze how partners' joint profits from the contract depend on the type of assets they integrate and, specifically, on the complementarity of integrated assets with third parties' assets.

Suppose that at time 0 a subset of players sign an integration contract. They choose which part of their assets to integrate. At time 1 all players bargain over the division of the payoffs from production or trade. The contract signed at time 0 changes the control over

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resources, and then affects bargaining at time 1. For instance, an M&A will give the acquiror the full control over the target's resources. If thanks to the contract the complementarity of the integrating partners with third players decreases, then integration is profitable. The idea is that in this case at time 1 third players can enjoy a weaker holdup ability towards partners, which is the reason why partners have more leverage in bargaining. But then the partners at time 0 can strategically choose which kind of asset to integrate in order to increase the gains from integration.

We use a cooperative-game approach, which yields very general implications about the effects of integrations on bargaining. First, we consider complete integration contracts (e.g. Merger and Acquisition (M&A)). This is the class of contracts introduced by Segal (2003), but we restate his results in order to have testable predictions. Then we consider two different partial integration contracts. The first one is the Minority Stake (MS) purchase, by which a firm gets the control over a maximum of 50% of another company's assets. For this contract we introduce a measure of the decisional influence that a minority stakeholder can exert on vendor. When only a minority stake is acquired, the acquiror may still exert some influence and affect profits. These profits depend on the kind of assets that are acquired. We study how the advantages of being minority stakeholders are affected by the integrated assets (complementary or substitutable) and who controls them. The second partial integration contract is the Joint Venture (JV), where for simplicity we assume that two firms confer an equal share of their assets to a common activity with fifthy-fifthy control.

Our theoretical results are the following. First, an M&A that gives partner i the full control over partner j's resources is always profitable if it makes competitors less complementary (hence, less indispensable) to partner i. In this case the integrating parties' ability to holdup third parties is relatively strong.

Second, Minority Stake (MS) purchase is more profitable than an M&A if partner i can acquire the resources of partner j that make third parties more indispensable to i than to j.

Third, when partners form a JV and they exert a joint control over common resources, the profits increase if third parties are less complementary to the JV's resources, rather than to partners' resources separately.

The above theoretical predictions yield some testable profitability conditions. Data show that when these conditions are satisfied, profits increase. Specifically, the return on assets increases on average by 1.44 percentage points if firms engage in an M&A, they increase by 1.60 percentage points in case of a Minority Stake integration, and by 0.77 in case firms form a Joint Venture. Considering all contracts together, the return on assets increases on average by 1.16 percentage points in the first year and by 1.40 points in the second year. This boost effect on profits decreases in the third year and then disappears.

Segal (2003) studies integrations theoretically. But he assumes that the partners can only integrate 100% of their assets. We remove this assumption, study the role of minority stakes, and test our theoretical predictions. Allowing partners to integrate less than 100% of their assets has some important implications and it is consistent with recent developments in the literature about the incentives and the power of minority stakeholders. For instance, minority shareholders can influence the election of some board members even if the majority opposes their election. They may cumulate their votes in order to elect a certain number of directors (Bhagat and Brickley, 1984). Not only. Butz (1994) shows that minority shareholders have influence on the chief executive officer (CEO) because they use threats to take majority control by purchasing more shares. Indeed, the power of minorities can be expressed by selling and buying shares (see also Admati and Pfleiderer, 2009 and Edmans, 2009). Moreover, often the minorities vote on key managerial decisions such as mergers and acquisitions (Bethel et al., 2009). As a consequence, investors may acquire voting rights just to influence the outcome of M&A proposals (Hu and Black, 2007), because their preferences in voting give them some power, and the ability in affecting board composition is proportional to the minorities protection rights ensured by the legal environment (Kim et al., 2007). Hubbard and Palia (1995) show that the acquisition of minority stakes increases the acquiror's profits as soon as the managerial ownership is sufficiently high, otherwise the agency costs of equity would reduce the acquiror's private benefits of control. In other contexts, such as the JV formation, the minorities' holdup ability may be affected also by the nature of the assets and the choice of sharing a joint product or just informations (Ciccotello and Hornyak, 2000).

As for our empirical test, the main issue is measuring asset complementarity. The empirical problem arises because firms are usually involved in different businesses, each of them belonging to a specific sectoral activity. Not only. The complementarity relationships between each pair of industrial sectors may change over time because of the entry of new products and/or technologies, and this makes complementarity a dynamic factor. To solve this problem, we develop a novel complementarity index for multiproduct firms which is also time varying. Using this index, we find empirical evidence of our theoretical predictions.

Further, we show that the asset complementarities between partners and competitors has a much stronger impact on profits than complementarity among the partners themselves. For instance, any increase in the complementarity index between partners yields on average an increase in profits of 27% of that change, whereas this impact grows to 94% in the case of complementarity index between partner i and competitors. Looking at the contracts individually, the largest gap between the effects of the two complementarity indices occurs in the case of MS purchases: 20.6% from partners' complementarity versus 119% from complementarity between partner i and competitors. This finding confirms the main idea of our model that gains from integration are not only due to an improvement in the production function of the integrating partners, but also, and most importantly, they are due to an increase in their power within the marketplace.

The paper is organized in four Sections. Section 2 describes the bargaining model for integrations and provides few specific profitability conditions. In Section 3 we introduce the complementarity index for sectoral activities. This measure of asset relationships is crucial for Section 4, where we test our findings. Section 5 concludes.

2. Model

A set of players $N = \{1, \dots, n\}$ own divisible assets $A = \{a_1, ..., a_n\}$ with control structure $A(S) : 2^N \to \mathbb{R}^{|S|}$, where $A(S)$ is the subset of A controlled by a given coalition S. For any $T \subset S$ it is true that $A(T) \subseteq A(S)$. Contracts have the effect of changing the control structure over assets. Note that with this specification assets are divisible and each player may transfer the control also over a part of his assets. At period 0 two players, i and j, sign an integration contract, then at period 1 all players play a TU cooperative game and split total payoffs according to the probabilistic value defined below.

Let (N, v) be a game with characteristic function $v(S, A(S)) : N \otimes \mathbb{R}^{|S|} \to \mathbb{R}$, for any coalition $S \subseteq N$. Let p^i be a probability measure over $2^{N \setminus i}$, e.g. a probability distribution over the finite collection of coalitions 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,*

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

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. A probabilistic value gives each player his expected marginal contribution to the random coalition $S \in 2^{N \setminus i}$, according to $p^i(S) = \Pr[S]$.

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 $v(S, A(S)) = v(S)$. Using a second order difference operator $\Delta^2_{ki} v(S) = \Delta_k v(S \cup i) - \Delta_k v(S)$ (Ichiishi, 1993), we can define a measure of complementarity that we will use below.

Definition 2. *i) Let* $\Delta^2_{kG}v(S) = \Delta_k v(S \cup G) - \Delta_k v(S)$, *with* $G, S \subseteq N \setminus k$ *and* $S \cap G = \emptyset$. *The complementarity degree between any player* $k \in N$, *and any subset of players,* G *is* $\Delta^2_{kG}v(S)$.[1]

Finally,

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 full control of a share $\lambda \in (0, 1]$ of j's assets a_j. As in Segal (2003), the integration is advantageous to the partners if it reduces all competitors' expected payoff:

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

for any $k \neq i, j$.

2.1. M&A contracts

An M&A contract occurs when a firm i gets the majority of j's shares. Then the full control over all j's resources goes to i, e.g. $\lambda = 1$. Thus an M&A contract is defined as $v^{M\&A}(S) = v^{C(1)}(S)$. Now player i can manage j's resources even in his absence. Player j becomes a dummy and the externality on a third player k participating coalition S is

$$\Delta^2_{kj}v(S \cup i) - \Delta^2_{kj}v(S) \tag{3}$$

The M&A is profitable if it causes a negative externality on all third players; e.g. if (3) is negative for all k and any S. A general profitability condition for these collusive contracts is provided by Segal (2003, p. 450), but Proposition 1 below restates the Segal's result as function of pre- and post- integration players' complementarities in order to get an empirically testable statement.

Proposition 1. *An M&A contract between* i *and* j *is profitable if it reduces their complementarity with third parties.*

[1] In more detail, a player k is complementary (substitutable) to players in G if $\Delta^2_{kG}v(S) > 0$ ($\Delta^2_{kG}v(S) < 0$).

Proof. Assume that (3) is negative and rewrite it as

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

where $\{i,j\}$ replaces $(i \cup j)$ and denotes the merged entity after integration. Adding the zero-sum term $\Delta_k v(S) - \Delta_k v(S)$ and rearranging, yields

$$\Delta^2_{k\{i,j\}} v(S) < \left[\Delta^2_{ki} v(S) + \Delta^2_{kj} v(S)\right] \tag{4}$$

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

The general idea is that an M&A has two contrasting effects: first, it increases player i's holdup power on k because j's contribution is "delayed" until i joins the coalition S; second, it increases the third players' ability to holdup i, since j's contribution is put forward in those coalitions that i is already in. Proposition 1 claims that the first positive effect prevails if the contract makes third parties less complementary (hence, less indispensable) to the partners.

2.2. Minority stakes

By a Minority Stake (MS) purchase a firm i gets a share $0 < \lambda \leq 0.5$ of j's assets. We assume that i can exert a certain influence on j's decisions even if i is a minority stakeholder.[2] In some cases this influence may be so strong to give i full decisional power over j's assets, as in M&A contracts. Let σ parametrize i's influence on j. Specifically, σ is the probability that i acquires the full control over j's resources. Conversely, $(1-\sigma)$ is the probability that i only controls the minority share λ of j. Formally, because of the contract any coalition $S \cup i \setminus j$ yields $v^{C(1)}(S)$ with probability σ, and it yields $v^{C(\lambda)}(S)$ with probability $(1-\sigma)$.

As pointed out in the Introduction, the idea that minorities may exert some degree of influence in boards is common in the literature on corporate governance. This influence is strongly related to the purchased stake λ, but it depends also on other factors, such as the acquiror's threatening ability, the level of his managerial ownership or how much the control over share $(1-\lambda)$ is unanimous (cf. Butz, 1994 and Hubbard and Palia, 1995).

Thus for any share λ of acquired resources, the parameter σ measures the acquiror's decisional power. Below, Proposition 2 says that if some complementarity conditions are satisfied, then both M&A and MS may be advantageous at the same time, whereas Proposition 3 shows in which case the MS guarantees higher profits than M&A.

Proposition 2. *If an M&A contract is profitable and if the presence of i reduces the third parties' complementarity with λa_j, then for any σ an MS contract is profitable too.*

[2] Although i does not fully control j's resources, he can always use the fraction λ of j's assets to exert a threatening power against him (e.g. i could sell assets λa_j to some j's opponent).

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 $S \cup i \cup j^{1-\lambda}$ 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

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

Replacing the difference $\Delta^2_{kj} v(S \cup i) - \Delta^2_{kj} v(S)$ with the terms in (4) and requiring (2), we get:

$$\Delta^2_{kj^{\lambda}} v(S \cup i) - \Delta^2_{kj^{\lambda}} v(S \cup j^{1-\lambda}) < \frac{\sigma}{\sigma - 1}\left[\Delta^2_{k\{i,j\}} v(S) - \Delta^2_{ki} v(S) - \Delta^2_{kj} v(S)\right] \tag{5}$$

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 (5) by y and the difference in square brackets of RHS by x. The MS contract is profitable if

$$y < \frac{\sigma}{\sigma - 1} x \tag{6}$$

Since $x < 0$ and $\frac{\sigma}{\sigma-1} < 0$ by hypothesis, a sufficient condition for (6) is $y \leq 0$, that is

$$\Delta^2_{kj^{\lambda}} v(S \cup i) \leq \Delta^2_{kj^{\lambda}} v(S \cup j^{1-\lambda}) \tag{7}$$

■

Broadly speaking, Proposition 2 states that if an M&A is profitable, this does not imply that playing a minority role through an MS contract would be unprofitable. Interestingly, Proposition 3 below shows that the gains from an MS integration might be even larger.

Proposition 3. *An MS contract is preferred to an M&A if it makes third parties more complementary with i rather than j.*

Proof. Consider x, y in (6) and let $x < 0$ (profitable M&A) and $y < 0$ (profitable MS). An MS contract is more profitable if the externality that it produces on any k is larger than the externality produced by M&A, which yields

$$(1-\sigma)y+\sigma\cdot x<x\Longrightarrow y<x \tag{8}$$

The (8) implies

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

or equivalently

$$\begin{aligned}&\Delta_k v(S\cup i\cup j^\lambda)-\Delta_k v(S\cup i)+\Delta_k v(S\cup j^{1-\lambda})-\Delta_k v(S\cup j)\\&\qquad>\Delta_k v(S\cup\{i,j\})-\Delta_k v(S)-\Delta_k v(S\cup i)+\Delta_k v(S)+\Delta_k v(S)-\Delta_k v(S\cup j)\end{aligned}$$

and finally

$$\Delta^2_{k\left\{i,j^\lambda\right\}}v(S)>\Delta^2_{k\left\{i,j^\lambda\right\}}v(S\cup j^{1-\lambda}) \tag{9}$$

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

The main intuition behind Proposition 3 is that any acquiror i can strategically choose that part of j's assets making him more indispensable to third parties, in order to increase his holdup power in bargaining.

Corollary 1. *Suppose that an M&A is unprofitable. With $\sigma\le 0.5$, the MS contract is always profitable if condition (9) holds.*

Proof. By (6) the MS integration is profitable if $y<0$ and $|y|>\sigma\cdot x$. If $\sigma\le 0.5$ the (6) immediately implies $|y|>x$, or equivalently the (9). ■

According to Corollary 1, a player i who does not find convenient a complete integration with j can still advantageously buy a minority share λa_j even if his decisional influence on j is low. For instance, a partial integration with j may still be profitable if the acquired assets λa_j are strongly complementary to those of third parties ks.

2.3. JVs with joint ownership

When two firms form a JV they give rise to a new player which enters the market. We model this new player as one which is able to influence competition as much as the other players and, of course, according to the amount of asset it is devoted to. Therefore the new control structure is

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

The JV is a fictitious new player endowed with $\lambda(a_i + a_j)$. We assume that the control of the JV is assigned to i or j with equal probability. This reflects the idea that each player participates in the JV at 50%.

Proposition 4. *Suppose that players i and j form a JV with common assets $\lambda(a_i + a_j)$. This contract is profitable if it reduces the complementarity of third parties with the JV assets.*

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

$$\begin{gathered} \Delta_k v(S \cup i^{1-\lambda} \cup \{i^\lambda, j^\lambda\}) + \Delta_k v(S \cup j^{1-\lambda} \cup \{i^\lambda, j^\lambda\}) \\ +\Delta_k v(S \cup i^{1-\lambda}) + \Delta_k v(S \cup j^{1-\lambda}) - 2\Delta_k v(S \cup i) - 2\Delta_k v(S \cup j) < 0 \end{gathered} \tag{10}$$

Adding the zero-sum terms

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

the (10) implies

$$\Delta^2_{ki^\lambda} v(S \cup i^{1-\lambda}) + \Delta^2_{kj^\lambda} v(S \cup j^{1-\lambda}) > \Delta^2_{k\{i^\lambda, j^\lambda\}} v(S \cup i^{1-\lambda}) + \Delta^2_{k\{i^\lambda, j^\lambda\}} v(S \cup j^{1-\lambda}) \tag{11}$$

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

The LHS and RHS of (11) represent the k's complementarity with the JVs assets λa_i and λa_j before and after integration respectively. If the contract reduces this complementarity degree, then the partners' profits increase.

3. Complementarity index

Measuring how industries, firms, or segments within firms are related is often a quite difficult task. Existing measures use industry codes, which give qualitative measures of the asset relationships. These measures are based on the number and the sectoral classification of firm's assets (the most diffused is the 4-digit SIC classification) and they are often used to find a significant correlation with the merging opportunity (Gort, 1962; Berry, 1974; Hassid, 1975 and Jacquemin and Berry, 1979). More sophisticated diversification measures, based on industry codes, are the concentric index (Caves et al., 1980 and Wernerfelt and Montgomery,

1988) and the entropy measure (Berry, 1974; Jacquemin and Berry, 1979 and Palepu, 1985), that have been used in many empirical works on diversification (e.g. Morck et al., 1990 and Berger and Ofek, 1995).

Nevertheless, it has been recognized that these measures are unsatisfactory in various aspects. First, they are not able to reveal the true type of relatedness among the firms' activities. Two businesses are classified as unrelated whenever they do not share the same two-, three-, or four-digit code, but this is not effective. Some industrial sectors might be classified as unrelated according to their three-digit NAICS code, but in fact they are vertically related. This is the case, for example, of the oils-refining business (NAICS six-digit code: 311225) and the petrochemical business (NAICS six-digit code: 325110).

Second, they are discrete measures and therefore do not allow for any quantitative ranking of relatedness. We might be interested in evaluating the impact of market relatedness on the performance of two RJVs where partners are horizontally related. In such case we would not be able to distinguish which couple of parents are more related, thus no correlation with the performance could be established. Third, they are not exempt from classification errors. For these reasons some authors have recently looked for quantitative measures of diversity based on the Input-Output (I-O) tables. One of the first applications is given by Lemelin (1982), whose approach is followed about twenty years later by Fan and Lang (2000) to explore the effect of asset relationships on the firms' performance. These authors define the complementarity between two sectors l, m as a simple average of the degrees to which the two industries share their inputs and output. Based on I-O Tables, for each pair of sectors l and m the coefficients r_{bl} (for all $b \neq l$) and r_{bm} (for all $b \neq m$) define the values of b's output required to produce 1\$ output in industries l and m, respectively, while the coefficients c_{bl} and c_{bm} are the percentages of l's and m's output used by any intermediate industry b, except l, m. Finally, the Fan and Lang's (2000) complementarity index between two single-product firms producing l and m is

$$COMP(l,m) = \frac{corr(r_{bl}, r_{bm}) + corr(c_{bl}, c_{bm})}{2} \tag{12}$$

As pointed out in the Introduction, we identify two main problems related to index (12). First, firms are usually involved in many different sectoral activities, each of them showing a specific complementarity degree with the industrial sectors of any random partner. Second, the complementarity among firms may change over time according to their business strategies (e.g. the launch of new products, or the adoption of new technologies).

Starting from the general idea of Fan and Lang (2000), we propose a new index that allows to examine complementarity among multiproduct firms. Moreover, this index is based on

I-O tables which are updated yearly, and therefore it is time varying.

Consider two firms, i and j, involved in a number of sectors $l = 1, ..., L$ and $m = 1, ..., M$ respectively. Vectors $\{i_1, ..., i_L\}$ and $\{j_1, ..., j_M\}$ define the set of i and j's business lines i_l and j_m. Using (12), we measure the complementarity index between multiproduct firms i and j by

$$COMP_{i,j} = \sum_{l=1}^{L} \sum_{m=1}^{M} (s_{i_l} \cdot s_{j_m}) COMP(i_l, j_m) \tag{13}$$

where weights $s_i = (s_{i_1}, ..., s_{i_L})$ and $s_j = (s_{j_1}, ..., s_{j_M})$ are the shares of the market operating revenue turnover that i and j draw from their sectoral businesses.

We also define the i and j's complementarity in the presence of a group S of competitors. In this case, (13) is averaged with the mean complementarity degree between any $k \in S$ and i or j considered individually:

$$COMP^{S}_{i,j} = (R_i + R_j)\, COMP_{i,j} + \sum_{k \in S} R_k \left[(COMP_{i,k} + COMP_{j,k}) / 2 \right] \tag{14}$$

Weights R_i, R_j, R_k are the firms' shares of total operating revenue turnover. All indices above belong to the interval $[-1, 1]$. Applying (13) and (14) period by period, we explore how firms' business lines change over time and how this changes affect their complementarity relationships.

4. Empirical evidence

4.1. Asset complementarities and integration profitability

We apply two different empirical strategies on a sample of 8866 US firms that signed a bilateral contract of M&A (439 units), MS (6922) or JV (1505) in period 2002-2007. First, we run regressions to test theoretical profitability conditions, (4), (7) or (11). Since contracts have important implications both on the size and other firm's characteristics (e.g. efficiency, productivity,...) we use a dynamic model that takes into account the autocorrelation in the variable that measures performance.

Because of dynamic effects and endogeneity problem, we adopt a dynamic GMM proposed by Blundell and Bond (1998), where variables are instrumented by using their lagged and non-lagged first-differences. The basic model is

$$ROA_{it} = \alpha ROA_{it-1} + \delta_{\mathbf{1}} \mathbf{SIZE}_{it} + \delta_2 T_i + \delta_3 T_i \times PC_{it} + \delta_{\mathbf{4}} \mathbf{TC}_{it} + \mu_i + y_t + \epsilon_{it} \tag{15}$$

where the treatment dummy variable T_i captures the existence of an integration contract for firm i and the dependent variable ROA_{it} (return on assets) measures his financial performance in every year t.

The row vector $\mathbf{SIZE}_{it}$ incudes variables $SALES_{it}$ (net sales, in natural log), $EMPL_{it}$ (number of employees, in natural log) and their first order lags. We model $SALES$ and $EMPL$ as endogenous variables and instrument them with their lagged levels. The remaining variables are predetermined, as unforecastable errors in a period might affect future changes in other covariates, and this prevents strict exogeneity.

We test the theoretical profitability conditions by the interaction terms $T_i \times PC_{it}$, where PC_{it} is a dummy indicating whether the profitability condition associated with contract T_i is satisfied or not.

Vector $\mathbf{TC}_{it}$ in (15) is composed of interactions of T_i with the following four complementarity indices. The first two indices are Cik_{it} and Cjk_{it}, and they measure the complementarity degree between each single partner (i or j) and all competitors ks. The third index, Cij_{it}, gives the complementarity between each pair of partners. The fourth index, $Cijk_{it}$, represents the average level of complementarity within the market. We compute them following the procedure described in Section 3. By construction, they are time varying. Finally, μ and y in (15) represent the firm and time specific effects, and ϵ the usual disturbance term.

Columns (1)-(3) in Table 1 show the results for M&A, MS and JV contracts, respectively. There is evidence that when profitability conditions (4), (7) or (11) hold then post-integration profits are higher. The variable of interest is $T \times PC$, the interaction between the two dummies for treatment and for profitability conditions. Coefficients associated with this variable show that in case of MS purchases the profitability condition has the strongest impact on profits (the value is 1.595, and it is significant at 1%). This means that, for instance, provided condition (7) is satisfied, an MS purchase increases the acquiror's returns by 1.595 percentage points on average. The lowest impact of profitability conditions occurs in the case of a JV, but still profits increase by 0.77 percentage points (and significant at 1%). These results confirm our theoretical prediction that contracts increase profits because they affect the technological relationships among firms, and ultimately their power in the marketplace.

The effect of partners' complementarity on the post-agreement performance is measured by interaction $T \times Cij$. For any increase in Cij, the impact on profits is 11% of this change if the contract is an M&A, almost 27% in case of MS and 49% in case of JV.

We compare this impact of partners' complementarity with the impact of complementarity between a contracting firm and its competitors, as measured by the interaction of treatment variable T with complementarity index Cik. Coefficients for $T \times Cik$ span from 1.058 (in case of an M&A) to 1.378 (in case of a JV), at a level of significance 1%, and they point out that for any contract the influence exerted on profits is much stronger than that of complementarity between partners. Instead, looking at the average impact across the three contracts, for any increase in the complementarity index between partners the impact on profits is 27% of that change, whereas it is 94% in the case of complementarity between partner i and competitors.

This stronger impact of complementarity between integrating partner and competitors reflects the central idea in our theoretical model that gains from integration are mainly due to the fact that integration increases integrating partners' power towards competitors and trading parties. The effects of integration on the production function (e.g. better synergies, organization, etc.) are positive, relevant, but quantitatively less important.

Additional support to this idea comes from other two interactions, $T \times Cjk$ and $T \times Cijk$ (cf. Table 1). The former measures the impact of complementarity between target j and competitors, which turns out not to have the same sign for all contracts. There is a positive effect on performance in the case of JV (the coefficient takes value 0.591), but a negative effect in case of M&A (-0.301) and MS (-1.426). Notice that all coefficients are significant at 1%.

The second interaction, $T \times Cijk$, refers to the effect of complementarity amongst all firms in our sample, which is measured by $Cijk$. When the value of this index is high, third parties have a higher chance to find good trading alternatives to the integrated firm. For all contracts, Table 1 shows that the higher the complementarity amongst all firms the lower the performance from integration. This result is consistent with the idea that integration contracts are less profitable if competitors can easily find good alternative trading parties, with respect to i and j.

Finally, in order to check the model specification, we test the null hypothesis of no serial correlation in the first-differenced errors, at order two. The hypothesis is not rejected (see AR(2) test in Table 1), thus the moment conditions used here are valid. Notice also that, for all regressions, the Sargan test does not reject the overidentification restrictions (see last row of Table 1).

Table 1: Complementarity and post-integration performance.
Dynamic GMM (Blundell-Bond, 1998) estimators.

	(1)	(2)	(3)
Dep. ROA	M&A	MS	JV
$ROA(t-1)$	0.180***	0.172***	0.188***
	(0.000)	(0.000)	(0.000)
$SALES$	0.132***	0.010***	0.023***
	(0.000)	(0.000)	(0.000)
$SALES(t-1)$	0.079***	−0.007***	−0.145***
	(0.000)	(0.000)	(0.000)
$EMPL$	0.008***	−0.003***	0.009***
	(0.000)	(0.000)	(0.000)
$EMPL(t-1)$	−0.004***	0.001***	0.006***
	(0.000)	(0.000)	(0.009)
T	1.191**	1.867***	1.520***
	(0.018)	(0.000)	(0.000)
$T \times PC$	1.440*	1.595***	0.771***
	(0.078)	(0.000)	(0.000)
$T \times Cij$	0.111**	0.206***	0.490***
	(0.041)	(0.061)	(0.000)
$T \times Cik$	1.058***	1.194***	1.378***
	(0.000)	(0.000)	(0.000)
$T \times Cjk$	−0.301***	−1.426***	0.591***
	(0.000)	(0.000)	(0.000)
$T \times Cijk$	−0.443***	−1.444***	−0.591***
	(0.000)	(0.000)	(0.000)
AR(1) test (p-value)	0.000	0.000	0.000
AR(2) test (p-value)	0.167	0.206	0.132
Sargan (p-value)	0.101	0.120	0.257

Notes: p-values in parentheses; *** p <0.01, ** $p < 0.05$, * $p < 0.1$.
All regressions include time fixed effects.

4.2. Average effect of profitability conditions

In order to provide further supporting evidence to our predictions, we estimate the average impact of profitability conditions on post-integration performance. We apply the ATT (Average Treatment effect on Treated) technique to the group of integrated firms. In order to have a sufficiently large sample, we do not differentiate by the type of integration (e.g. M&A, MS and JV are considered the same). Within the group, we distinguish between treated and control firms. A firm is defined "treated" if satisfies the corresponding profitability requirement in all the four post-integration years. Therefore the treatment group includes all companies such that both dummy variables T and PC take value 1 starting from the year of integration.

The second group is the counterfactual group of controls. This group includes companies which do not satisfy our profitability condition in the four post-integration years: for these companies the treatment variable T takes value 1 but dummy variable PC takes value 0.

Controls and treated are grouped according to their similarity based on a propensity score (Rosenbaum and Rubin, 1983). This score is computed by a probit 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. Then we compute the average effect of treatment based on the nearest neighbor matching.

Table 2 shows the results. On average, the impact of our profitability conditions on rate of return is a significant increase of 1.16 percentage points in the first year, and 1.40 in the second year. This boost effect decreases in the third year and then disappears.

These findings provide additional support to our model.

Table 2: Average Treatment Effect (ATT) from contract profitability conditions. Post-estimation window: 2003-2009.

	$t+1$	$t+2$	$t+3$	$t+4$
ATT	1.159**	1.402*	0.499**	−1.221
Treated $(T=1, PC=1)$	1116	1120	1176	1072
Controls $(T=1, PC=0)$	1193	1126	1078	920

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5. Conclusions

In this paper we investigate three forms of integration contracts, which have the effect of changing the control over partners' resources. Our theoretical model accounts not only for the improvement in the joint production function of the integrating partners, but also for the increase in their power within the marketplace.

Our reference model is the work of Segal (2003), who studies integration contracts when players integrate 100 per cent of their resources. We consider contracts in which two players may integrate less than 100 per cent of their assets, and possibly exert minority control. The model shows that being a minority stakeholder can increase profits compared to full control, for instance when the purchased minority assets are highly complementary to third parties. The reason is that this kind of integration yields a major increase in the power to holdup trading parties. A JV is highly profitable if it allows the partners to profit from their complementarities and, at the same time, if it makes third parties less indispensable.

We provide empirical evidence of our results using a sample of US quoted companies. To measure firms' asset complementarities we develop a measure based on the I-O coefficients. Our measure is time varying and most importantly it applies to multiproduct firms.

Data show that profits increase by a substantial amount when the theoretical profitability conditions are satisfied. This supports the main idea of our theoretical approach, based on cooperative games: profits from integration are not only due to efficiency gains at the production stage, but also to higher bargaining power in the marketplace.

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