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Maria Rosa Battaggion, Vittoria Cerasi and Gulen Karakoc

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The Value of Interlocking Directorates in Vertical Contracting*

Maria Rosa Battaggion† Vittoria Cerasi‡
Gülen Karakoç§

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Abstract

This study analyzes the choice to interlock between two competing companies when their privately known marginal costs are correlated. The two rivals are organized into different business models: one delegates its production to a subcontractor, while the other is vertically integrated and carries its production in-house. By accepting the interlock, the hosting company discloses its marginal cost to the rival. The two companies decide ex-ante whether to commit to interlock. In a Perfect Bayesian Equilibrium, the vertically separated company gains more from interlocking than the rival because it saves on internal agency costs and gains market power, otherwise unbalanced toward the competitor. Interestingly, we show the following: for high cost correlation allowing a unilateral interlock benefits consumers. Hence, our results provide reasons for approving horizontal interlocking in markets where companies have asymmetric business models, and the interlocking company outsources its production.

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Keywords: Interlocking directorates; Agency costs; Vertical hierarchy.

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†University of Bergamo, Department of Economics, Via dei Caniana 2, 24127, Bergamo, Italy; e-mail: maria-rosa.battaggion@unibg.it

‡University of Milan-Bicocca, Department of Economics, Management and Statistics (DEMS) and Center for European Studies (CefES), Piazza dell'Ateneo Nuovo 1, 20126, Milano, Italy; e-mail: vittoria.cerasi@unimib.it

§University of Milan-Bicocca, Department of Economics, Management and Statistics (DEMS) and Center for European Studies (CefES), Piazza dell'Ateneo Nuovo 1, 20126, Milano, Italy; e-mail: gulen.karakocpalminteri@unimib.it

1 Introduction

Interlocking occurs when one company's director, having received an invitation, sits on the board of another company and acquires strategic information about the hosting company (e.g., Lamb and Roundy, 2016). Therefore, exchanging information with interlocking directorates (ID) at the board level may effectively influence the two involved companies' decision-making. Khanna and Thomas (2009) provide evidence of more significant stock price commonality between companies sharing ID than other forms of ties, such as minority shareholdings. The ID form stable links between companies. For this reason, the antitrust authority fears that interlocks between two rivals in the product market, horizontal ID, endanger competition. The antitrust treatment of horizontal interlocks varies across countries. While banned in the US, countries like Japan, South Korea, and Indonesia have permitted them. The European Union (EU) Competition Law applies the same treatment to interlock as minority shareholdings leaving the EU commission to intervene to prevent interlocks on specific occasions (see Petersen, 2016, for a detailed discussion of the EU approach).

In this paper, we analyze the companies' incentives to exchange information through horizontal ID. To unveil the pro-competitive aspects of ID, we depart from Battaggion and Cerasi (2020) and consider rival companies with different levels of integration in their production. Many competing companies have a rather complex organization. Indeed, in several industries, it is common to observe some companies delegating a large set of their activities, ranging from production to distribution and after-sales service. "Some firms have gone so far as to become virtual manufacturers, owning designs for many products but making almost nothing themselves" (Grossman and Helpmann, 2005, p.135). This phenomenon is even more important in Europe, where large companies delegate part of their production to small and medium-sized enterprises (SMEs). In fact, about 3.7 million SMEs in the EU are engaged as subcontractors, representing 17% of all SMEs in the EU (see EIM Business & Policy Research report, 2009). Delegation implies the loss of information on essential aspects of the production chain. For instance, the subcontractor may retain private information on several aspects of the production technology. However, it is up to the outsourcing companies to compete for clients in the product market. In this setting, exchanging information between outsourcing companies through ID has novel implications for market competition.

To address this issue, we consider a setting where two manufacturers compete to sell a homogeneous good. One of the rivals delegates its production to a subcontractor privately informed about the cost of production, while the other is an integrated producer. Within the vertically separated organization, the information about the cost of production must be obtained by designing an incentive-compatible contract.[1] We assume that the level of

[1]There exists rich literature on the strategic decisions of outsourcing (e.g., Shy and Stenbacka, 2003; Groosman and Helpman, 2005) and its effects on the global economy (Feenstra 1998; McLaren 2000). However, we consider the subcontracting decision as exogenous.

efficiency of the two competing companies operating in the same sector is correlated.[2]

We model interlocking as the outcome of a strategic choice. Specifically, at the onset of the game, each firm simultaneously and non-cooperatively chooses whether to invite the executive of the rival company to sit on its board meeting, and by doing so, it discloses sensitive information. Unlike in the usual information-sharing model (see the survey in Vives, 2006), we consider an environment in which companies can observe their rival's private information only when invited and once accepted. Therefore, in our model, ID implies a more significant commitment than the current information-sharing literature.

When ID is permitted, we show that both companies prefer to interlock regardless of the rival's decision, thus forming a bilateral interlocking tie, the unique equilibrium of the game. On the one hand, each firm, by inviting the director of the rival to sit on its board, discloses its marginal cost to them, thus reducing the uncertainty about the quantity supplied, that is, the *competition effect*. This effect is at play in both firms, regardless of who interlocks, and it helps to soften competition. On the other hand, the outsourcing company, by observing the marginal cost of the rival, given that costs are correlated, saves on internal agency costs when eliciting private information from the subcontractor, that is, the *indirect agency effect*. This effect is at play only for the outsourcing company. Which of these two contrasting effects dominates depends on the degree of cost correlation. Specifically, the outsourcing company gains more by interlocking than the vertically integrated rival for sufficiently correlated costs. The reason is twofold. First, due to in-house production, the informative advantage of the integrated company vanishes when the vertically separated rival is allowed to interlock. Hence, this specific case of unilateral interlocking balances the competition between the two companies. Second, the internal agency cost fades away as cost correlation increases. Without ID, instead, the integrated company not facing any internal agency problem exploits this informative advantage by competing more aggressively.

For a given cost correlation, consumers prefer the equilibrium without interlocking since competition is fiercer. Interestingly, for a sufficiently high-cost correlation, if only the outsourcing company were allowed to interlock, consumers may benefit from such unilateral interlocking. The intuition is the following: on the one hand, the rent paid to the subcontractor decreases as cost correlation increases; on the other hand, competition between the two asymmetric companies becomes more balanced. Hence, allowing only the outsourcing company that suffers from an internal agency problem to interlock can be a way to protect consumers. This argument introduces an important exception for the treatment of ID within the EU competition law.

We depart from the literature on information sharing where competitors have symmetric business models (e.g., Raith, 1996; Piccolo and Pagnozzi, 2013) by analyzing two asymmetric

[2] Cost correlation is typical in mature industries in which cost advantages are matched by competitors (Bush and Sinclair, 1992), but also in technologically dynamic industries due to knowledge spillovers among firms or R&D investment in patent races.

organizations, where only one is vertically integrated. In this framework, we investigate the interplay between two channels: the *external* communication channel, occurring through interlocking between the two competitors, and the *internal* communication channel, taking place through the revelation mechanism inside the vertically separated company. Moreover, following Battaggion and Cerasi (2020), we study the incentives of two asymmetric business organizations to enter an ID in a setting where production costs are correlated. We show that when the cost correlation is sufficiently high: i) the vertically separated company benefits more from interlocking than the rival, and ii) the consumer surplus is greater when the vertically separated company interlocks rather than a situation in which interlocking is not allowed.

2 The Model

Players and Environment. Consider two competing companies, indexed by $i = 1, 2$. We consider a one-sided hierarchy model: only one company, say company 1, is vertically separated and composed of a (female) manufacturer M_1 and a (male) subcontractor S_1. This may occur, for instance, if M_1 lacks in-house production capacity and, therefore, delegates her production to an exclusive subcontractor S_1. Instead, we assume that the rival company, say company 2, is vertically integrated, so that manufacturer M_2 carries out in-house production.[3] Hence, the two companies exhibit asymmetry in terms of their organizational structures. Players are risk-neutral. M_1 and M_2 engage in quantity competition, and their payoffs are given by

$$\mathcal{V}_i(\cdot) \triangleq \mathcal{S}_i(q_i, q_j) - \mathbb{I}t_i - (1-\mathbb{I})\,\theta_i q_i, \quad i = 1, 2 \text{ and } i \neq j,$$

where $\mathcal{S}_i(q_i, q_j) \triangleq \kappa q_i - q_i^2 - q_i q_j$ denotes the company i's (quadratic) surplus from production. The marginal cost of production is given by $\theta_i \in \Theta \triangleq \left\{\underline{\theta}, \overline{\theta}\right\}$ and is private information of each producer. The indicator function $\mathbb{I} \in \{0, 1\}$ takes value 1 if the company is vertically separated so that M_1 outsources production and pays a transfer t_1 to S_1 to produce on her behalf. If, instead, the company features vertical integration the indicator function $\mathbb{I}$ takes value 0 as M_2 undertakes in-house production, incurring a marginal cost of production denoted by θ_2.[4] Since S_1 produces on behalf of M_1, his utility is given by

$$\mathcal{U}_1(\cdot) \triangleq t_1 - \theta_1 q_1,$$

[3] There are multiple reasons why a company decides to outsource its production, including cost-cutting strategies and access to external technology, however in the present model, we consider the outsourcing decision as exogenous.

[4] In the paper, we use indifferently the terms outsourcing/sub-contracting to indicate the case when the manufacturer delegates the production to an independent supplier.

where θ_1 is S_1's marginal cost of production. Moreover, we assume that S_1 is protected by limited liability.

Information. As mentioned above, the parameter $\theta_i \in \Theta \triangleq \{\underline{\theta}, \overline{\theta}\}$, with $\Delta\theta \triangleq \overline{\theta} - \underline{\theta}$, is private information of each production entity. Specifically, within company 1, since the production is outsourced to an independent subcontractor, marginal cost of production θ_1 is private information to S_1; the manufacturer M_1 can learn it only through a revelation mechanism. By the same token, the parameter $\theta_2 \in \Theta$ is private information to M_2.

The marginal costs are correlated across companies. Following the literature (See, e.g., Sharpe 1990), we assume that $\Pr(\theta_i = \underline{\theta}) = \frac{1}{2}$ and

$$\Pr\left(\theta_i = \overline{\theta} | \theta_j = \overline{\theta}\right) = \Pr\left(\theta_i = \underline{\theta} | \theta_j = \underline{\theta}\right) = \frac{1+\alpha}{2}, \quad i, j = 1, 2,$$

where $\alpha > 0$ measures the degree of cost correlation: a higher α makes it more likely that the subcontractor S_1 and the integrated entity M_2 have the same cost of production, and vice versa.

Contract and Communication. As M_1 outsources production to S_1, she designs an incentive-compatible contract to elicit information about θ_1 from S_1. We assume that the contract between M_1 and S_1 is secret; that is, the information obtained by M_1 from S_1 cannot be observed by the integrated rival M_2. However, M_1 may decide to interlock with M_2 and share her private information or vice versa. Specifically, we model interlocking as an *invitation-only* process. The owners of the property rights on information within each company, M_1 and M_2, may invite other directors to participate in their respective board meetings. Only when their invitation is accepted, the interlocking tie is established. Moreover, we assume that M_1 and M_2 commit ex-ante to interlock. Hence, once interlocking has been announced, it cannot be renegotiated. Following Raith (1996), among many others, we consider an "all-or-nothing" disclosure policy: either the marginal cost is fully disclosed to the rival ($d_i = I$), or it remains private within each firm ($d_i = N$).[5] Hence, we have four possible cases to consider:

- Bilateral Interlocking ($d_1 = I, d_2 = I$) in which the marginal costs are common knowledge.
- No Interlocking ($d_1 = N, d_2 = N$) in which the marginal costs remain private information, and

[5] Notice that, as in Battaggion and Cerasi (2020), for brevity, we use the notation $d_i = I$, which captures only the case in which the inviting company sends the invitation to interlock to the receiving company to be accepted. In contrast, we use $d_i = N$ to capture the cases where marginal cost remains private information, which happens when either (i) M_i invites rival to interlock while the rival does not accept the invitation, or (ii) M_i does not send an invitation to interlock.

- Unilateral Interlocking ($d_1 = I, d_2 = N$) or ($d_1 = N, d_2 = I$): one of the two companies observes the marginal cost of the rival, but not vice versa.[6]

Given that M_1 commits to a deterministic interlocking regime before contracting with the subcontractor S_1, we can use the revelation principle and consider a direct mechanism in which S_1 sends a private message $m_1 \in \Theta$ about his cost to M_1. Therefore, for any $d_1 \in \{I, N\}$, we define the contract as a menu

$$\begin{cases} \mathcal{M}^N = \{t_1(m_1), q_1(m_1)\}_{m_1 \in \Theta}, & \text{if } d_1 = N, \\ \mathcal{M}^I \triangleq \{t_1(m_1, m_2), q_1(m_1, m_2)\}_{(m_i, m_2) \in \Theta}, & \text{if } d_1 = I, \end{cases}$$

where, without ID, the output $q_1(\cdot)$ produced by S_1 and the transfer $t_1(\cdot)$ paid by M_1 to S_1 is contingent only on m_1. Instead, with ID, the contract can also be conditioned on the hard (verifiable) information $m_2 = \theta_2 \in \Theta$ (in equilibrium) revealed by the integrated manufacturer M_2.

Timing. The timing is as follows:

1. M_1 and M_2 simultaneously and publicly announce whether they are willing to interlock with each other (provided that interlocking is allowed).
2. S_1 privately observes θ_1, while M_2 privately observes θ_2.
3. M_1 offers a contract to S_1: if S_1 accepts, he report m_1 to M_1.
4. Interlocking takes place if they committed to do so.
5. Production occurs, and t_1 is paid.

The equilibrium concept is Perfect Bayesian Equilibrium. We impose passive beliefs.

Finally, the following assumption guarantees that quantities are always positive in the equilibrium– i.e., there is never shut down of production.

Assumption 1. The difference between the two possible values of the production cost is not too large — i.e.,

$$\Delta\theta \leqslant \overline{\Delta\theta} \triangleq (1-\alpha)\frac{(\kappa-\theta)}{4}.$$

3 Equilibrium Analysis

In this section, we first develop the analysis when (horizontal) interlocks are allowed, then we briefly review the model's logic in the case where they are banned. In Section 4, we

[6]For instance, when ($d_1 = I$,$d_2 = N$), the director of the vertical hierarchy is hosted on the board of the integrated firm. Hence, M_1 interlocks and learns the marginal cost of M_2, but not vice versa.

compare players' ex-ante expected profits and consumer surplus across different interlocking regimes.

Horizontal interlocks are allowed. Consider first the case where the vertically separated manufacturer M_1 sends an invitation to the integrated rival M_2 to interlock, and the rival accepts this invitation, so that $d_2 = I$.

In this case, integrated company learns θ_1 and solves

$$\max_{q_2 \geqslant 0} \left\{ \mathcal{S}_2 \left(q_1^{d_1}, q_2 (\theta_1, \theta_2) \right) - \theta_2 q_2 (\theta_1, \theta_2) \right\}, \tag{1}$$

which solution depends on S_1's production

$$q_2 (\theta_1, \theta_2) = \frac{\kappa - q_1^{d_1} - \theta_2}{2}, \quad d_1 \in \{I, N\}.$$

Suppose now that M_1 sends an invitation to M_2 to interlock and her invitation is not accepted by the integrated rival — i.e., such that $d_2 = N$. In that case, using Bayes' rule, the integrated manufacturer M_2 forms beliefs about θ_1 (which corresponds to m_1 in equilibrium), given her own cost θ_2 and solves

$$\max_{q_2 \geqslant 0} \mathbb{E} \left[\mathcal{S}_2 \left(q_1^{d_1}, q_2 (\theta_2) \right) - \theta_2 q_2 (\theta_2) \right], \tag{2}$$

which solution depends on S_1's expected production

$$q_2 (\theta_2) = \frac{\kappa - \sum_{\theta_1} \Pr [\theta_1 | \theta_2] \, q_1^{d_1} - \theta_2}{2}, \quad d_1 \in \{I, N\}.$$

The slope of this function depends on the degree of cost correlation: the higher is the correlation, the more *accurate* is M_2's inference on θ_1 given θ_2, and its estimate of S_1's production.

Instead, suppose that integrated entity M_2 sends an invitation to the vertically separated rival M_1 and the invitation is accepted. Before an eventual interlocking tie is established, M_1 must elicit information about θ_1 from her subcontractor S_1 through costly contracting, giving up an informational rent to screen types. To minimize this rent, M_1 distorts output away from the efficient production level, which in turn affects the strategic interaction between companies.

As usual, only the incentive constraint of the efficient type and the participation constraint of the inefficient type matter (see, e.g., Laffont and Martimort, 2002). Hence, letting $q_2^{d_2}$ be the integrated entity M_2's output in equilibrium for $d_2 \in \{I, N\}$, in order to maximize her profit M_1 solves

$$\max_{\{q_1(\cdot,\cdot), t_1(\cdot,\cdot)\}} \sum_{\theta_1} \Pr (\theta_1) \sum_{\theta_2} \Pr (\theta_2 | \theta_1) \left[\mathcal{S}_1 \left(q_1 (\theta_1, \theta_2), q_2^{d_2} \right) - t_1 (\theta_1, \theta_2) \right], \qquad d_2 \in \{I, N\},$$

subject to

$$\begin{cases} \text{PC}: \sum_{\theta_2} \Pr\left(\theta_2|\overline{\theta}\right) \mathcal{U}_1\left(\overline{\theta},\theta_2\right) \geqslant 0, & \forall\theta_2 \in \Theta, \\ \text{IC}: \sum_{\theta_2} \Pr\left(\theta_2|\underline{\theta}\right) \mathcal{U}_1\left(\underline{\theta},\theta_2\right) \geqslant \sum_{\theta_2} \Pr\left(\theta_2|\underline{\theta}\right) \left[t_1\left(\overline{\theta},\theta_2\right) - \underline{\theta} q_1\left(\overline{\theta},\theta_2\right)\right], & \forall\theta_2 \in \Theta. \end{cases}$$

After a standard change of variables, M_1's relaxed maximization problem is

$$\max_{q_1(\cdot,\cdot)} \left\{ \mathbb{E}\left[\mathcal{S}_1\left(q_1\left(\theta_1,\theta_2\right), q_2^{d_2}\right) - \theta_1 q_1\left(\theta_1,\theta_2\right)\right] - \frac{1}{2}\Delta\theta \sum\nolimits_{\theta_2} \Pr\left(\theta_2|\underline{\theta}\right) q_1\left(\overline{\theta},\theta_2\right) \right\}. \tag{3}$$

Hence, when interlocks are allowed, by accepting M_2's invitation to interlock, M_1 can condition the contractual terms also on θ_2. Consequently, for a given cost correlation, this allows M_1 to save on the informational rent left to the low-cost supplier, as the contract offered to S_1 is now contingent on the cost of the integrated rival.

Suppose now that although interlocks are allowed, M_1 declines the invitation: then M_1 deals with S_1 behind the veil of ignorance. In this case S_1 does not know M_2's cost when he reports his own cost to M_1, the relevant incentive and participation constraints are

$$\begin{cases} \text{PC}: \mathcal{U}_1\left(\overline{\theta}\right) \geqslant 0, & \forall\theta_2 \in \Theta, \\ \text{IC}: \mathcal{U}_1\left(\underline{\theta}\right) \geqslant \mathcal{U}_1\left(\overline{\theta}\right) + \Delta\theta q_1\left(\overline{\theta}\right), & \forall\theta_2 \in \Theta. \end{cases}$$

Since at the optimum both constraints are binding, M_1's relaxed maximization program is

$$\max_{q_1(\cdot,\cdot)} \left\{ \mathbb{E}\left[\mathcal{S}_1\left(q_1\left(\theta_1\right), q_2^{d_2}\right) - \theta_1 q_1\left(\theta_1\right)\right] - \frac{1}{2}\Delta\theta q_1\left(\overline{\theta}\right) \right\}. \tag{4}$$

Unlike before, by declining M_2's invitation to interlock, M_1 must now grant an informational rent $\Delta\theta q_1\left(\overline{\theta}\right)$ to the low-cost type S_1 to induce him to reveal his private information, which does not depend on the rival's production cost. That is, by declining the invitation to interlock, M_1 deals with S_1 behind the veil of ignorance.

Notice that the low-cost supplier's output is chosen efficiently regardless of M_1's decision to accept the integrated rival's invitation to interlock. Moreover, M_1 induces a high-cost supplier to produce an inefficiently low output to reduce the informational rent. However, as companies' expected outcome is the same with and without interlocking, interlocking only induces competing manufacturers to reallocate output distortions across different states. Notably, the magnitude of these distortions depends on the information available to M_1.

Hence, when interlocks are permitted, there are three candidate equilibria: (i) bilateral interlocking $(d_1 = I, d_2 = I)$ in which each company invites the rival and accepts the invitation by the rival, or (ii) two unilateral interlocking cases $(d_1 = I, d_2 = N)$ and $(d_1 = N, d_2 = I)$, where one company declines the invitation to interlock while the other accepts it. In Table 1 (see the Appendix), we report the quantities that may emerge in these candidate equilibria. Given the resulting profits, we now solve the game in which the two manufacturers decide simultaneously and without any coordination whether to form an interlocking tie. We obtain the following result.

Proposition 1 *When both companies are allowed to interlock, bilateral interlocking ($d_1 = I, d_2 = I$) is the unique equilibrium in dominant strategies regardless of the degree of cost correlation. Moreover, integrated manufacturer M_2, on average, produces more than the vertically separated rival M_1.*

Companies' incentives to interlock often depend on the disclosure of information's impact on the rival's equilibrium output. Since goods are substitutes, interlocking induces rivals to cut back output in the most likely states, making communication valuable. Specifically, the vertically integrated entity M_2 benefits from interlocking since, as mentioned above, disclosing θ_2 enables M_1 to condition the contractual terms offered to S_1 on θ_2. This allows M_2, which produces in-house, to increase profit. Simultaneously, by interlocking, M_1 can offer a contract to S_1, which depends on information about the rival's cost. As a result, since the marginal costs are positively correlated, when M_2's cost is high, this implies that M_1 distorts (downward) more output in the state where S_1's cost is also high. However, this correlation relaxes the supplier's incentive compatibility and makes it less costly for M_1 to elicit S_1's private information. Eventually, bilateral interlocking mutually benefits both firms because it helps them resolve cost uncertainty. Moreover, the integrated entity M_2 is (on average) more aggressive and produces more than the vertically separated rival M_1 not facing agency costs. Consequently, the joint entity M_1 and S_1 obtains a lower joint surplus compared to the integrated rival M_2.

Horizontal interlocks are banned. We now examine the case in which the competing manufacturers M_1 and M_2 are not allowed to interlock, that is, ($d_1 = N, d_2 = N$). In this case, the M_1's maximization problem is identical to (2) and M_2's maximization problem is the same as that in (4). Moreover, the companies' expected outputs are equivalent to when, although firms are allowed to interlock, they do not communicate due to the linearity of outputs with respect to costs (as in Shapiro, 1986). Hence, given that firms are not allowed to interlock, and marginal costs remain private information, each firm produces *behind the veil of ignorance.*

4 Strategic Gains from Interlocking

In this section, we analyze each firm's strategic gain from establishing bilateral ID. Given that firms differ in their organizational structures, we first compare each player's ex-ante expected profits with and without ID. We obtain the following result.

Proposition 2 *The ex-ante profits of M_1 and M_2 are higher with bilateral ID rather than without ID; S_1's expected rent is higher without ID. Moreover, there exists a threshold $\widehat{\alpha}$ such that M_1's strategic gain from bilateral ID is higher compared to that of the integrated rival M_2 only if $\alpha > \widehat{\alpha}$.*

M_1 and S_1 have opposing preferences regarding ID, whereas ID helps M_1 to reduce S_1's informational rent; by interlocking, M_1 always harms S_1. The strategic gains from bilateral ID depend on the degree of the cost correlation and the companies' organizational structure. Specifically, when cost correlation is high, M_1 gains from reducing uncertainty through bilateral ID, and this benefit dominates the gain of the integrated rival M_2. The reason is that, in principle, bilateral ID has two opposing effects (see Figure 1). First, there is a *competition effect* that arises from the effect on product market competition. The *indirect agency effect* arises from the output distortion to elicit private information from S_1. This effect matters only for the vertical hierarchy as interlocking enables M_1 to save on agency costs.

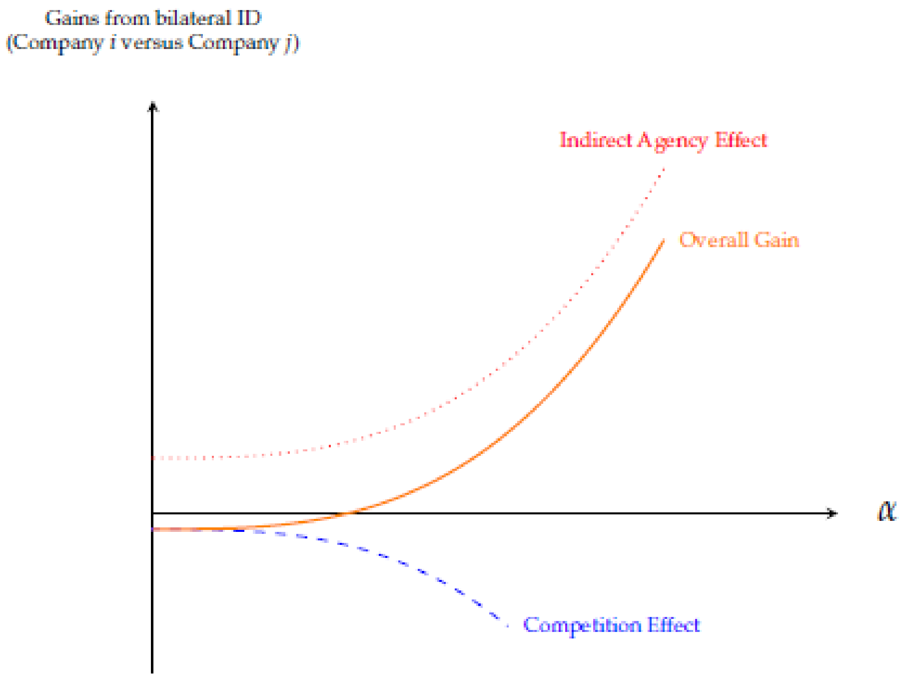

Figure 1: Separated company *i*'s gain from bilateral relative to integrated company *j*

The competition effect benefits the integrated company M_2 since it faces no agency costs and thus produces more on average than the rival. Conversely, the indirect agency effect increases with correlation. As for cost correlation increases, interlocking reduces the rent and makes it less costly for M_1 to elicit private information of S_1. As we shall see below, these savings overcome the indirect cost of interlocking that consumers face due to the restriction of quantities.

We can now study the effect of interlocking on consumer surplus. We obtain the following result.

Proposition 3 *There exists a threshold α^C such that when $\alpha > \alpha^C$ consumer surplus is maximized under a unilateral interlocking ($d_1 = I, d_2 = N$) in which only the vertically separated firm interlocks. Otherwise, consumer surplus is maximized under no interlocking ($d_1 = N, d_2 = N$).*

Surprisingly, interlocking may not necessarily harm consumers. In fact, for a sufficiently high-cost correlation, consumers may benefit from a unilateral interlocking when the outsourcing company is allowed to interlock, while the vertically integrated competitor is not.

This counter-intuitive result is based on the fact that allowing only the vertically separated company to interlock has two opposing effects on consumer surplus. On the one hand, when M_1 is permitted to interlock, from Proposition 1, we know that she prefers to interlock. By doing so, M_1 reduces the indirect costs of outsourcing production to an independent subcontractor S_1. At the same time, since the vertically integrated company is not permitted to interlock, forming such a unilateral interlocking tie balances the production between the two rival companies and softens the competitive advantage of M_2, which produces in-house. Therefore, unilateral interlocking may result in a positive effect on the consumer surplus. On the other hand, due to cost correlation, interlocking may increase (resp. decrease) M_1's profit (resp. consumer surplus) because output adjustments of the integrated competitor increase M_1's output dispersion. In that case, forming such a unilateral interlocking tie may harm consumer surplus. However, the more correlated are the companies' costs, the less important is this effect. When the degree of cost correlation is sufficiently high, the former effect dominates the latter, and hence, unilateral interlocking in which only the vertically separated company interlocks benefits consumers.

Hence, when the market is composed of companies with asymmetric organizational structures, but the marginal costs are imperfectly correlated, the antitrust authority's choice (between allowing and banning interlocking) should depend on the trade-off between these two conflicting effects. As we highlighted above, the second effect may outweigh the first when the degree of cost correlation is sufficiently high. As a result, unilateral interlocking in which only the company that outsources production to an independent subcontractor interlock can be a way to protect consumers. This argument introduces an important exception for the treatment of ID within the EU competition law.

5 Conclusion

In this paper, we analyze a setting where two companies, one vertically integrated while the other delegating its production to a subcontractor, competing on quantities and correlated costs, may interlock. Although both companies benefit from reducing the uncertainty due to interlocking, the vertically separated company benefits more, proportionally, as it saves on agency costs, compared to the integrated company: this effect is stronger the higher the cost correlation. Our paper shows that interlocking by vertically separated companies may discipline the exclusive agent, reduce agency costs and thus, benefit consumers.

Given that antitrust typically prohibits these horizontal ties, we suggest scrutinizing interlocking agreements not only for sector and company size but also for the business model of the involved companies.

References

[1] Battaggion, M.R., Cerasi. V.,(2020), "Strategic interlocking directorates." *Journal of Economic Behavior and Organization,* 178, 85-101.

[2] Bush R.J., Sinclair S.A., (1992), "Changing strategies in mature industries: a case study", *Journal of Business & Industrial Marketing*, 7, 63-72.

[3] EIM Business & Policy Research report, (2009), EU SMEs and subcontracting - European Commission. Available at: *https://ec.europa.eu/growth/sites/default/files/docs/body/eu-smes-subcontracting-final-report_en.pdf.*

[4] Feenstra R.C., (1998), "Integration of Trade and Disintegration of Production in the Global Economy", *Journal of Economic Perspectives,*12, 31–50.

[5] Grossman G.M., Helpman E., (2005), "Outsourcing in a Global Economy", *Review of Economic Studies,* 72, 135–159.

[6] Khanna T., Thomas C., (2009), "Synchronicity and firm interlocks in an emerging market", *Journal of Financial Economics*, 92, 182-204.

[7] Laffont, J.-J., Martimort D., (2002), *The Theory of Incentives: The Principal-Agent Model*, Princeton University Press, Princeton.

[8] Lamb, N., Roundy P., (2016), "The 'ties that bind' board interlocks research: a systematic review", *Management Research Review,* 39, 1516–1542 .

[9] McLaren J.,(2000), "Globalization" and Vertical Structure", *The American Economic Review,* 90, 1239-1254.

[10] Petersen, V., (2016), "Interlocking Directorates in the European Union: An argument for their restriction", *European Business Law Review,* 6 , 821-864 .

[11] Piccolo, S., Pagnozzi M., (2013), "Information sharing between vertical hierarchies", *Games and Economic Behavior*, 79, 201-222.

[12] Raith M., (1996), "A General Model of Information Sharing in Oligopoly", *Journal of Economic Theory,* 71, 260-288.

[13] Shapiro, C., (1986), "Exchange of Cost Information in Oligopoly", *Review of Economic Studies,* 53, 433-446.

[14] Sharpe S., (1990), "Asymmetric Information, Bank Lending, and Implicit Contracts: A Stylized Model of Customer Relationships." *Journal of Finance,* 45, 1069-1087.

[15] Shy O., Stenbacka R., (2003), "Strategic outsourcing", *Journal of Economic Behavior & Organization,* 50, 203–2.

[16] Vives X., (2006), "Information sharing among firms", *The New Palgrave Dictionary of Economics*, 1-8.

A Appendix

Proof of Proposition 1. Let $\mathcal{V}_1^{d_1,d_2}$ $(d_1,d_2)\in\{I,N\}\times\{I,N\}$ be the M_1's ex-ante profit and $\mathcal{V}_2^{d_1,d_2}$ be M_2's ex-ante profit. For any interlocking regime (d_1,d_2), their expected profits are given by

$$\mathcal{V}_i^{d_i,d_j}=\sum_{\theta_i\in\Theta}\Pr(\theta_i)\sum_{\theta_j\in\Theta}\Pr(\theta_j|\theta_i)\left(q_i^{d_i,d_j}\right)^2,\qquad i,j=1,2.$$

Using the equilibrium quantities from Table 1, we have

$$\begin{aligned}\mathcal{V}_1^{I,I}-\mathcal{V}_1^{N,I}&=\frac{\alpha^4-8\alpha^3+30\alpha^2+8\alpha+1}{36(1-\alpha)(1+\alpha)}\Delta\theta^2>0,\\ \mathcal{V}_1^{I,N}-\mathcal{V}_1^{N,N}&=\frac{72\alpha+183\alpha^2-72\alpha^3-45\alpha^4+8\alpha^6+16}{36(1-\alpha)(1+\alpha)(2-\alpha)^2(2+\alpha)^2}\Delta\theta^2>0,\end{aligned}$$

which are positive for all $\alpha\geqslant 0$. Hence, M_1 strictly prefers to interlock.

Similarly, also M_2 strictly prefers to interlock since using the equilibrium quantities from Table 1, we have

$$\begin{aligned}\mathcal{V}_2^{I,I}-\mathcal{V}_2^{I,N}&=\frac{1+\alpha^2}{9(1-\alpha^2)}\Delta\theta^2>0,\\ \mathcal{V}_2^{N,I}-\mathcal{V}_2^{N,N}&=\frac{(1-\alpha^2)(4-\alpha)(7\alpha^3-4\alpha^2-40\alpha+6)}{144(2-\alpha)^2(2+\alpha)^2}\Delta\theta^2>0,\end{aligned}$$

for all $\alpha\geqslant 0$.

Therefore, both M_1 and M_2 strictly prefers to interlock regardless of the opponent's interlocking decision and hence, making bilateral interlocking is the unique equilibrium in dominant strategies.

Finally we show that M_2 is on average, produces more than the separated rival M_1. To show the result, notice that

$$\begin{aligned}\mathbb{E}\left[q_2^{I,I}(\theta_1,\theta_2)\right]&=\sum\nolimits_{\theta_2}\Pr\left[\overline{\theta}\right]\sum\nolimits_{\theta_1}\Pr\left[\theta_1|\overline{\theta}\right]q_2^{I,I}\left(\theta_1,\overline{\theta}\right)+\sum\nolimits_{\theta_2}\Pr\left[\underline{\theta}\right]\sum\nolimits_{\theta_1}\Pr\left[\theta_1|\underline{\theta}\right]q_2^{I,I}\left(\theta_1,\underline{\theta}\right)\\&=\frac{\kappa-\underline{\theta}}{3}\end{aligned}$$

and

$$\begin{aligned}\mathbb{E}\left[q_1^{I,I}(\theta_1,\theta_2)\right]&=\sum\nolimits_{\theta_1}\Pr\left[\overline{\theta}\right]\sum\nolimits_{\theta_2}\Pr\left[\theta_2|\overline{\theta}\right]q_1^{I,I}\left(\overline{\theta},\theta_1\right)+\sum\nolimits_{\theta_1}\Pr\left[\underline{\theta}\right]\sum\nolimits_{\theta_2}\Pr\left[\theta_2|\underline{\theta}\right]q_1^{I,I}\left(\underline{\theta},\theta_2\right)\\&=\frac{\kappa-\underline{\theta}}{3}-\frac{\Delta\theta}{2}.\end{aligned}$$

Hence, it is straightforward to see that

$$\mathbb{E}\left[q_2^{I,I}(\theta_1,\theta_2)\right]-\mathbb{E}\left[q_1^{I,I}(\theta_1,\theta_2)\right]=\frac{\Delta\theta}{2}>0.\qquad\blacksquare$$

Proof of Proposition 2 Using the M_1's expected profit from the proof of Proposition **1,**

Table 1: Solving the corresponding maximization problems embedded into main text, this table reports the quantities produced by the two company across different interlocking regimes.

Interlocking Regime	**Vertically Separated Company** 1
Bilateral ID ($d_1 = I, d_2 = I$)	$q_1^{I,I}\left(\underline{\theta},\overline{\theta}\right) = q^* + \frac{\Delta\theta}{3} > q_1^{I,I}\left(\underline{\theta},\underline{\theta}\right) = q^* > q_1^{I,I}\left(\overline{\theta},\overline{\theta}\right) = q^* - \frac{(3-\alpha)\Delta\theta}{3(1+\alpha)} > q_1^{I,I}\left(\overline{\theta},\underline{\theta}\right) = q^* - \frac{4\Delta\theta}{3(1-\alpha)}$
No ID ($d_1 = N, d_2 = N$)	$q^* > q_1^{N,N}\left(\underline{\theta}\right) = q^* - \frac{\alpha(1-\alpha)\Delta\theta}{2(4-\alpha^2)} > q_1^{N,N}\left(\overline{\theta}\right) = q^* - \frac{\left(8-\alpha-\alpha^2\right)\Delta\theta}{2(4-\alpha^2)}$
Unilateral ID ($d_1 = I, d_2 = N$)	$q_1^{I,N}\left(\underline{\theta},\overline{\theta}\right) = q^* + \frac{\Delta\theta}{6} > q_1^{I,N}\left(\underline{\theta},\underline{\theta}\right) = q^* - \frac{\Delta\theta}{6} > q_1^{I,N}\left(\overline{\theta},\overline{\theta}\right) = q^* - \frac{(5-\alpha)\Delta\theta}{6(1+\alpha)} > q_1^{I,N}\left(\overline{\theta},\underline{\theta}\right) = q^* - \frac{(7-\alpha)\Delta\theta}{6(1-\alpha)}$
Unilateral ID ($d_1 = N, d_2 = I$)	$q_1^{N,I}\left(\underline{\theta}\right) = q^* + \frac{(1-\alpha)\Delta\theta}{6} > q^* > q_1^{N,I}\left(\overline{\theta}\right) = q^* - \frac{(7-\alpha)\Delta\theta}{6}$

where $q^* \triangleq \frac{\kappa-\theta}{3}$ is the efficient Cournot outcome.

Interlocking Regime	**Vertically Integrated Company** 2
Bilateral ID ($d_1 = I, d_2 = I$)	$q_2^{I,I}\left(\overline{\theta},\underline{\theta}\right) = q^* + \frac{2\Delta\theta}{3(1-\alpha)} > q_2^{I,I}\left(\underline{\theta},\underline{\theta}\right) = q^* > q_2^{I,I}\left(\overline{\theta},\overline{\theta}\right) = q^* - \frac{2\alpha\Delta\theta}{3(1+\alpha)} > q_2^{I,I}\left(\underline{\theta},\overline{\theta}\right) = q^* - \frac{2\Delta\theta}{3}$
No ID ($d_1 = N, d_2 = N$)	$q_2^{N,N}\left(\underline{\theta}\right) = q^* + \frac{(1-\alpha)\Delta\theta}{4-\alpha^2} > q^* > q_2^{N,N}\left(\overline{\theta}\right) = q^* - \frac{(1-\alpha)\Delta\theta}{4-\alpha^2}$
Unilateral ID ($d_1 = I, d_2 = N$)	$q_2^{I,N}\left(\underline{\theta}\right) = q^* + \frac{\Delta\theta}{3} > q^* > q_2^{I,N}\left(\overline{\theta}\right) = q^* - \frac{\Delta\theta}{3}$
Unilateral ID ($d_1 = N, d_2 = I$)	$q_2^{N,I}\left(\overline{\theta},\underline{\theta}\right) = q^* + \frac{(7-\alpha)\Delta\theta}{12} > q_2^{N,I}\left(\overline{\theta},\overline{\theta}\right) = q^* + \frac{(1-\alpha)\Delta\theta}{12} > q_2^{N,I}\left(\underline{\theta},\underline{\theta}\right) = q^* - \frac{(1-\alpha)\Delta\theta}{12} > q_2^{N,I}\left(\underline{\theta},\overline{\theta}\right) = q^* - \frac{(7-\alpha)\Delta\theta}{12}$

where $q^* \triangleq \frac{\kappa-\theta}{3}$ is the efficient Cournot outcome.

M_1's gain from bilateral interlocking given the interlocking decision of M_2 can be found as follows:

$$\mathcal{V}_1^{I,I} - \mathcal{V}_1^{N,I} = \frac{\alpha^4 - 8\alpha^3 + 30\alpha^2 + 8\alpha + 1}{36\,(1-\alpha)\,(1+\alpha)}\Delta\theta^2 > 0.$$

Similarly, M_2's gain from bilateral interlocking given the interlocking decision of M_1 is

$$\mathcal{V}_2^{I,I} - \mathcal{V}_2^{I,N} = \frac{1+\alpha^2}{9\,(1-\alpha^2)}\Delta\theta^2 > 0.$$

Hence, comparing these two expressions, we have

$$\left[\mathcal{V}_1^{I,I} - \mathcal{V}_1^{N,I}\right] - \left[\mathcal{V}_2^{I,I} - \mathcal{V}_2^{I,N}\right] = \frac{8\alpha + 26\alpha^2 - 8\alpha^3 + \alpha^4 - 3}{36\,(1-\alpha)\,(1+\alpha)}\Delta\theta^2.$$

The sign of this expression depends on the sign of the numerator

$$\tau(\alpha) \triangleq \alpha^4 - 8\alpha^3 + 26\alpha^2 + 8\alpha - 3 = 0.$$

Notice that

$$\tau(\alpha = 0) = -3 < 0,$$

and

$$\tau(\alpha = 1) = 24 > 0.$$

Moreover,

$$\frac{d\tau(\alpha)}{d\alpha} = 4\alpha^3 - 24\alpha^2 + 52\alpha + 8 > 0.$$

Hence, by intermediate value theorem there exists a unique $\widehat{\alpha} \triangleq 0.23$ such that $\tau(\alpha) > 0$ (so that the principal of the vertically separated company i's gain from bilateral interlocking is higher than her integrated rival) if and only if $\alpha > \widehat{\alpha}$.

We now compare S_1's rent across different interlocking regimes. Let $\mathcal{R}^{d_i,d_j}$ be the supplier's ex ante rent for any interlocking regime $(d_1, d_2) \in \{I, N\} \times \{I, N\}$. When M_1 does not interlock — i.e., such that $d_1 = N$ — S_1's expected rent is

$$\mathcal{R}^{N,d_2}(\theta_i) = \sum_{\theta_i} \Pr(\theta_i)\, q_i^{N,d_2}\left(\overline{\theta}\right)\Delta\theta, \qquad d_2 \in \{I, N\}.$$

Instead when M_1 interlocks with the rival company — i.e., such that $d_1 = I$ — S_1's expected rent is

$$\mathcal{R}^{I,d_2}(\theta_i, \theta_j) = \sum_{\theta_i} \Pr(\theta_i) \sum_{\theta_j} \Pr(\theta_j|\underline{\theta})\, q_i^{I,d_2}\left(\overline{\theta}, \theta_j\right)\Delta\theta, \qquad d_2 \in \{I, N\}.$$

Using the corresponding outputs from Table 1, we immediately have

$$\begin{aligned}
\mathcal{R}^{N,N}(\theta_i) - \mathcal{R}^{N,I}(\theta_i) &= \frac{(1-\alpha^2)(4-\alpha)}{12(4-\alpha^2)}\Delta\theta^2 > 0, \\
\mathcal{R}^{N,N}(\theta_i) - \mathcal{R}^{I,I}(\theta_i,\theta_j) &= \frac{\alpha^5 - 12\alpha^4 - 8\alpha^3 + 56\alpha^2 + 7\alpha + 4}{12(1-\alpha^2)(4-\alpha^2)}\Delta\theta^2 > 0, \\
\mathcal{R}^{N,N}(\theta_i) - \mathcal{R}^{I,N}(\theta_i,\theta_j) &= \frac{\alpha^5 - 9\alpha^4 - 8\alpha^3 + 45\alpha^2 + 7\alpha}{12(1-\alpha^2)(4-\alpha^2)}\Delta\theta^2 > 0.
\end{aligned}$$

Therefore, for any $\alpha \geqslant 0$, S_i's rent is higher without interlocking (N,N) than under any other interlocking regime. ■

Proof of Proposition 3 Since the two companies produce homogenous products, and since the inverse demand is linear, for any interlocking decision $(d_1,d_2) \in \{I,N\} \times \{I,N\}$, the expected consumer surplus can be written as follows

$$CS^{d_1,d_2} = \sum_{\theta_1} \Pr(\theta_1) \sum_{\theta_2} \Pr(\theta_1|\theta_2) \left(q_1^{d_1,d_2} + q_2^{d_1,d_2}\right)^2.$$

Using the equilibrium outputs from Table 1, first notice that

$$\begin{aligned}
CS^{I,N} - CS^{I,I} &= \frac{5(1+\alpha^2)}{36(1-\alpha^2)}\Delta\theta^2 > 0, \\
CS^{I,N} - CS^{N,I} &= \frac{-16\alpha + 62\alpha^2 + 16\alpha^3 - 5\alpha^4 + 15}{144(1-\alpha^2)}\Delta\theta^2 > 0.
\end{aligned}$$

It follows that $CS^{I,N} > \max\left\{C^{I,I}, C^{N,I}\right\}$ for all $\alpha \geqslant 0$.
Notice further that

$$CS^{N,N} - CS^{I,N} = \frac{189\alpha^4 - 36\alpha^5 - 8\alpha^6 + 36\alpha^3 - 363\alpha^2 + 20}{36(1-\alpha^2)(1+\alpha)(2-\alpha)^2(2+\alpha)^2}\Delta\theta^2.$$

The sign of this expression depends on the sign of the numerator

$$\nu(\alpha) = 189\alpha^4 - 36\alpha^5 - 8\alpha^6 + 36\alpha^3 - 363\alpha^2 + 20,$$

with

$$\frac{d\nu(\alpha)}{d\alpha} = 756\alpha^3 - 180\alpha^4 - 48\alpha^5 + 108\alpha^2 - 726\alpha < 0.$$

Since,

$$\nu(\alpha = 0) = 20 > 0,$$

and

$$\nu(\alpha = 1) = -162 < 0,$$

by intermediate value theorem there exists a unique $\alpha^C \triangleq 0.24$ such that $\tau(\alpha) < 0$ so that the consumer surplus without interlocking (N,N) is lower than the unilateral interlocking (I,N) if and only if $\alpha > \alpha^C$. ■