Outsourcing without Cost Advantages

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Abstract

This paper explores the incentives of two competing firms to outsource to an external supplier without a cost advantage in input production. We show that both firms outsource although outsourcing does not necessarily reduce their costs. They outsource because the supplier, through its contracts terms, allows them to commit to input costs that transform competition from Cournot to Stackelberg. The use of non-linear contracts and sequential contracting is crucial for this commitment mechanism to work. The supplier purposefully avoids industry profit maximization to enlarge its profits share. Both consumers and welfare benefit from the presence of an otherwise redundant supplier in the market.

Keywords: outsourcing; strategic outsourcing; make-or-buy; two-part tariffs; common supplier; sequential contracting; Stackelberg
JEL classification: D43; L11; L21; L22; L23

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1 Introduction

Nowadays, it is rare to find a firm that does not outsource part of its production.[1] The most obvious and extensively studied motive for outsourcing is cost-reduction, typically due to the external suppliers' cost advantages in input production.[2] This is consistent with many instances of outsourcing to suppliers located in countries with low labor or material costs, such as China and India (Deloitte, 2016). Not all firms, however, outsource to suppliers with lower costs. Boeing, for example, outsources the production of a significant percentage of its aircraft fuselage to a Japanese consortium, although neither labor costs nor other costs in the Japanese aircraft industry are known to be lower than in the US.[3] In fact, wages in Japan as well as in several other countries where key Boeing suppliers hang their hats, such as Germany and France, are high.[4] Furthermore, with the cost advantages of suppliers from Asian countries steadily deteriorating, many US firms recently reshore and outsource domestically; they procure inputs from suppliers with access to the same production factors as them.[5] In line with this trend, input suppliers, such as Dow Chemicals and Flex n Gate, open or expand their production plants in the US.

Widespread outsourcing is accompanied by the emergence of large input suppliers – contract manufacturers – that often serve competing firms.[6] For instance, both Boeing and Airbus source jet engine components from Ishikawajima Harima Heavy Industries, Apple and Samsung procure ceramic capacitors from Murata, Ford Motors and General Motors purchase automotive electronics from Visteon and exterior automotive components from Flex n Gate, Mercedes-Benz and BMW assign their cars assembly to Magna, Cisco and HP contract out the design engineering of their network hardware to Jabil.

This paper explores the incentives of competing firms to outsource to a common supplier without a cost advantage in input production rather than to undertake input production in-house. We abstract from the cost-reduction rationale of outsourcing to focus on how contracting can influence the emerging input production patterns and their efficiency. We

[1] For information on the extent of outsourcing, see e.g., outsourcing reports by Statista.

[2] Another well recognized motive for outsourcing is firms' intention to focus on their core activities, such as product design, innovation, and marketing.

[3] See Chen et al. (2011) for details.

[4] Similarly, Ford Motors sources automotive electronics from its spin-off, Visteon. As Grahovac et al. (2015) argue, Visteon maintains high-wage unionized operations, and thus, Ford's decison to source inputs from Visteon is not driven by Visteon's access to cheaper production factors.

[5] This phenomenon is mainly due to increases in local wages in China and India as well as increases in transportation costs and/or tariffs on imports from these countries. For evidence of this trend, see e.g., Pearce (2014), Why 'Nearshoring' Is Replacing 'Outsourcing', *The Wall Street Journal* (June 4, 2014), Local Outsourcing on Rise in US, *The Economic Times* (August 4, 2012), Outsourcing and Offshoring: Here, There and Everywhere (special report), *The Economis*t (January 19, 2013), and 'Made in China' Isn't so Cheap Anymore and that could Spell Headache for Beijing, *CNBC* (February 27, 2017). For case studies, visit: http://www.reshorenow.org.

[6] In the electronics sector, the Chinese Foxconn is the largest contract manufacturer reporting more that $138 billion profits in 2017. In the biotechnology sector, the profits of the US contract manufacturer Freudenberg Medical exceeded $1 million in 2016.

show that an external common supplier can, through its contract offers, alter competition between the incumbents from Cournot to Stackelberg. The role that the external supplier, and thus, outsourcing, can play is to provide a mechanism by which competing firms can credibly commit to input costs that generate Stackelberg competition, without reducing the competitiveness of the industry.

In our main framework, there are two firms which produce perfect substitutes using an input that they produce in-house or source from a monopolistic external supplier which faces the same input production cost. The supplier makes sequential two-part tariff offers to the firms that compete in quantities. A firm outsources when it accepts the supplier's offer.

Both firms outsource in equilibrium. The emergence of outsourcing hinges on the external supplier's ability to manipulate the input cost of its customers and generate cost asymmetry between them. Two-part tariffs grant such flexibility; they allow the supplier to charge a wholesale price in order to favor or not a customer and, in turn, use the fixed fee to recuperate or compensate. In equilibrium, the supplier sets a positive mark-up to the firm with which it trades first and subsidizes the second firm. Doing so, it transforms the latter into a Stackelberg leader. This reveals a novel motive for outsourcing: Firms outsource not due to the lower input costs that an external supplier with more efficient production technology can offer, but to transform the competition between them from Cournot to Stackelberg.

Interestingly, the supplier serves both firms not to enjoy higher input demand, but to increase the profits that it makes and extracts from the second firm. Industry profits would be maximized if a firm was fully foreclosed from the market. The supplier keeps both firms active not because of its inability to commit to a non-opportunistic behavior, but because foreclosure reinforces its preferred customer's – the second firm's – outside option of in-house production. Stated differently, the supplier incorporates both the rent generation and the distributional effects of contracting.

Outsourcing is beneficial for consumers and welfare. This result arises from firm's subsidization, via the wholesale price, that leads to a lower retail price. It follows that the presence of a large contract manufacturer in the market – even when it is redundant and not more efficient than original brand manufacturers – can be socially efficient.

These conclusions, carry over to other non-linear contractual forms, but not to linear wholesale price contracts. Therefore, the ability and the incentives of the supplier to induce outsourcing can be contract dependent. With wholesale price contracts, a supplier without a cost advantage is unable to generate downstream asymmetry and rents for itself. Because of this, the supplier prefers to trade with its customers with two-part tariffs than with wholesale price contracts. Thereby, the use of two-part tariffs in our main analysis in justified. The same holds for the use of sequential contracting: the supplier prefers to contract sequentially with its potential customers to avoid the opportunism problem that arises under simultaneous contracting. Furthermore, the emergence of outsourcing in equilibrium is independent of the

mode of competition. Firms outsource under price competition too, but outsourcing is driven then by collusion and harms welfare.

When the supplier's customers differ in terms of their input production efficiency, the supplier continues to generate a cost asymmetry in favor of the second firm even when the latter is the one that has the ex ante cost disadvantage. In fact, the supplier prefers to trade second than first with the less efficient firm. It extracts a larger share of the profits of its more preferred customer whose outside option is worse when faced with a cost disadvantage. Notably, the supplier is worse off with than without a cost advantage relative to its first customer.

Allowing for differentiated products, we observe that the external supplier's profits increase with product substitutability. The vertical contracting literature (e.g., Rey and Tirole, 2007) demonstrates that when products become closer substitutes, and thus, competition intensifies, the supplier suffers more from opportunism and makes less profits. When the supplier's customers have an outside option, as in our framework, the increase in product substitutability has an additional effect. It weakens a firm's outside option – its profits with in-house production, and allows the supplier to extract a higher share of its customer's profits.

The structure of the rest of the paper is as follows. In Section 2, we review the related literature. In Section 3, we describe our main model and present the benchmark case of in-house input production. In Section 4, we introduce outsourcing and explore its implications and incentives. In Section 5, we study the role of various aspects of contracting. In Section 6, we further extend our model, and in Section 7, we conclude.

2 Related Literature

Various fields of economics and management, including industrial organization, operational management, and marketing, study outsourcing.[7] Many explore its cost-saving motives (e.g., Lewis and Sappington, 1989, van Mieghem, 1999, Cachon and Harker, 2002, Shy and Stenbacka, 2003). Others provide strategic explanations for outsourcing by competing firms to multiple or vertically integrated suppliers (e.g., Chen et al., 2004, Chen et al., 2011, Feng and Lu, 2012 and 2013, Bakaouka and Milliou, 2018, Colombo and Scrimitore, 2018) and to a common external supplier (e.g., Buehler and Haucap, 2006, Gilbert et al., 2006, Arya et al. 2008, Feng and Lu, 2012 and 2013, Grahovac et al., 2015). According to Buehler and Haucap (2006), Gilbert et al. (2006) and Grahovac et al. (2015), there is a collusive motive behind outsourcing to a common supplier. In Buehler and Haucap (2006) outsourcing softens competition by resulting in exogenously assumed higher wholesale prices and in Gilbert et al.

[7] A large branch of the economics literature, starting with Coase (1937), focuses on firm's boundaries and points out that asset specificity and contract incompleteness contribute to the expansion of boundaries, thereby restrict outsourcing (e.g., Grossman and Hart, 1986, Grossman and Helpman, 2002).

(2006) and Grahovac et al. (2015) by curbing overinvestment in cost-reduction. Arya et al. (2008) argue, instead, that a raise in rival's cost motivates outsourcing; a firm outsources to the supplier of its rival to alter the supplier's vested interests and increase its rival's wholesale price. Feng and Lu (2012 and 2013) point out that firms outsource when they can extract a sufficient share of the larger generated surplus. A commonality of these papers is their need to assume that the external supplier has a cost advantage.[8] Without a cost advantage, outsourcing does not arise in their environments in which trade is with wholesale price contracts (Buehler and Haucap, 2006, Gilbert et al., 2006, Arya et al. 2008) or occurs simultaneously (Feng and Lu, 2012 and 2013).

Our paper complements these works in three respects. First, we demonstrate that a cost advantage is not necessary for the emergence of outsourcing and provide justification for the documented cases of outsourcing to suppliers that have access to similar production factors as their customers. Second, we incorporate a different contractual form – two-part tariffs – than the commonly used in the outsourcing literature wholesale price contracts.[9,10] Wholesale price contracts, as we discuss below, do not have support in the vertical contracting literature. Moreover, they lack wide support in empirical studies which conclude that in various industry sectors, such as in the US yogurt market and the bottled water market in France, two-part tariffs are used (e.g., Villas-Boas, 2007, Bonnet and Dubois, 2010 and 2015). The incorporation of non-linear contractual forms is crucial for the emergence of outsourcing. Third, we provide a novel strategic motive for outsourcing. We argue that outsourcing can be driven by the ability of the supplier to convert, through contracting, Cournot competition to Stackelberg competition.

The literature on supply chain coordination - vertical contracting studies the efficiency of contractual forms in various environments, including when a monopolist input supplier transacts with multiple competing firms (e.g., Cremer and Riordan, 1987, Hart and Tirole, 1990, McAfee and Schwartz, 1994, Cachon and Lariviere, 2005, Taylor, 2002, Rey and Vergé, 2004, Milliou and Petrakis, 2007). Two-part tariffs, as this literature extensively demonstrates, outperform wholesale price contracts by, among other things, not giving rise to the 'double marginalization' externality. Still, as this literature also demonstrates, two-part tariffs, due to the monopolist's inability to commit that it will not behave opportunistically, do not always suffice for the maximization of industry profits. Most papers in this literature consider

[8] Exceptions include Liu and Tyagi (2011) and Colombo and Scrimitore (2018), which consider a supplier without a lower cost, but have different focus: the role of product position and of strategic delegation respectively.

[9] In this sense, our paper is also related to contributions which explore how two-part tariffs can induce vertical separation in place of vertical integration (e.g., Bonanno and Vickers, 1988, Rey and Stiglitz, 1995, Jansen, 2003). Most of these contributions focus on settings with exclusive – specialized input suppliers rather than with a common supplier.

[10] Feng and Lu (2013) also consider two-part tariffs, but as mentioned above, they need to assume that the supplier has a cost advantage for outsourcing to arise.

simultaneous contracting. Exceptions include McAfee and Schwartz (1994), Möller (2007) and Bedre-Defolie (2012) that allow for sequential contracting but only to symmetric downstream firms without the option of in-house production, thus, under exogenously assumed outsourcing.[11] We contribute to this literature by showing how the contractual form and the timing of contracting can affect the input production pattern, by exploring the order of contracting with asymmetric firms, and by demonstrating how the existence of alternative input sourcing options can affect vertical foreclosure incentives. Importantly, since our paper helps explain why firms may not undertake all their production in-house, we provide a justification for the typically exogenously assumed in this literature vertical structure of the market.

3 The model

There are two firms in the market, firm 1 and firm 2, that produce a homogeneous good. Market demand is given by the standard linear demand function: $p(q_1, q_2) = a - q_1 - q_2$, where p is the price and q_i is the quantity supplied by firm i, with $i = 1, 2$.

To produce the good, each firm i uses an input in an one-to-one proportion. Both firms produce the input in-house at marginal cost s or outsource it to an external firm, firm S, whose marginal cost is also s, with $5s > a > s > 0$.[12] When firm i outsources, it trades with firm S via a two-part tariff contract, consisting of a wholesale price per unit of input, w_i, and a fixed fee, f_i. We consider other contractual forms in Section 5.

Firms play a three-stage game. In stage one, firm S makes a take-it-or-leave-it offer (w_1, f_1) to firm 1.[13] Firm 1 decides whether to accept or reject it. In case of rejection, it produces the input in-house.[14] In stage two, firm S offers (w_2, f_2) to firm 2, and, in turn, firm 2 accepts or rejects the offer. In the last stage, firm 1 and firm 2 choose their quantities simultaneously and separately. All past actions and decisions are observed.[15] Contracting takes place sequentially as in Arya et al. (2008) and Buehler and Haucap (2006). This can be justified, as Arya et al. (2008) argue, in environments in which firm 1 and firm 2 are

[11] Aghion and Bolton (1987) and Marx and Shaffer (2007) also study a three-players environment with sequential trade. However, in their environment, the common player is the buyer which trades with competing suppliers.

[12] The upper limit on a guarantees that the optimal wholesale prices will be non-negative.

[13] In Section 5, we allow for bargaining over the contracts terms and discuss what happens when the final product manufacturers have a more active role in the determination of the outsourcing arrangements.

[14] A firm commits to its sourcing decision; the outsourcing contract is binding. This is a standard assumption in the outsourcing literature (e.g., Shy and Stenbacka, 2003, Buehler and Haucap, 2006, Gilbert et al., 2006, Arya et al. 2008, Feng and Lu, 2012 and 2013, Colombo and Scrimitore, 2018). It is justified when firms undertake specific investments for the external supplier's input, when firms shut-down their own input production facilities, and when there are considerable lead times for the application of procurement plans. Anderson and Parker (2002) show that, due to learning effects, it is very difficult to reverse a decision to outsource.

[15] When firm 2 observes in stage two only the acceptance decision and not the contract terms of its rival, the results are exactly the same, provided that both firms observe their rival's contracts terms in the last stage of the game. See the Appendix for details. In Section 5, we further discuss the issue of observability.

incumbent and entrant in the market respectively. Importantly, it can also be justified by the fact that, as we demonstrate in Section 5, the supplier prefers to contract sequentially rather than simultaneously with its potential customers.

We solve for the pure strategy subgame perfect equilibria and reason by backward induction. In the last stage, each firm i, with $i = 1, 2$, chooses q_i to maximize its (gross from f_i) profits: $\pi_i(q_i, q_j) = p(q_i, q_i)q_i - k_i q_i$, where k_i is firm i's per unit cost, with $k_i = s$ and $k_i = w_i$ when firm i opts for insourcing and outsourcing respectively. The first order conditions give rise to: $R_i(q_j) = (a - k_i - q_j)/2$, with $i, j = 1, 2$ and $i \neq j$. The resulting quantities are:

$$q_i(k_i, k_j) = \frac{a - 2k_i + k_j}{3}. \tag{1}$$

In the benchmark case, there is no outsourcing; firms produce the input in-house – II case. Firms play the standard Cournot game with marginal costs $k_1^{II} = k_2^{II} = s$. The equilibrium net profits, π_S^{II}, π_1^{II} and π_2^{II}, are included in Table 1. Clearly, the external supplier makes no profits.

4 Outsourcing

There are two second-stage subgames depending on whether or not firm 1 outsources in stage one. We examine what happens in each of them.

When firm 1 does not outsource, in stage two, firm S offers (w_2, f_2) to firm 2 to maximize its own profits subject to the constraint that firm 2 accepts its offer. It solves the following:

$$\max_{w_2, f_2} \ \pi_S(w_2, f_2) = (w_2 - s)q_2(w_2, s) + f_2, \tag{2}$$

$$\text{s.t.} \ \ \pi_2(q_2(w_2, s), q_1(s, w_2)) - f_2 \geq \pi_2^{dIO},$$

where π_2^{dIO} is firm 2's disagreement payoff – outside option: $\pi_2^{dIO} = \pi_2^{II}$. The constraint is binding, and we rewrite (2) as:

$$\begin{aligned} \max_{w_2} \ \pi_S(w_2) &= (w_2 - s)q_2(w_2, s) + \pi_2(q_2(w_2, s), q_1(s, w_2)) - \pi_2^{II} \\ &= [p_2(q_2(w_2, s), q_1(s, w_2)) - s]q_2(w_2, s) - \pi_2^{II}. \end{aligned}$$

This yields: $w_2^{IO} = \frac{5s-a}{4} < s$. Thus, firm S subsidizes the production of its only customer. As the literature on strategic delegation (e.g., Fershtman and Judd, 1987, Sklivas, 1987) and on vertical separation (e.g., Bonanno and Vickers, 1988, Rey and Stiglitz, 1995, Jansen, 2003) has explained, the upstream supplier has incentives to enhance the output of its customer to increase its profits that it partially extracts through the fixed fee. A straightforward implication is that firm 1 has a cost disadvantage in the final market. An additional implication

is that firm S manages, through contracting, to transform firm 2 to a Stackelberg leader and firm 1 to a Stackelberg follower, that produce $q_2^{IO} = \frac{a-s}{2}$ and $q_1^{IO} = \frac{a-s}{4}$ respectively.

From the appropriate substitutions, we obtain firms' net equilibrium profits when only firm 2 outsources – IO case – and include them in Table 1. We observe that $\pi_S^{IO} > \pi_S^{II}$. Therefore, when firm 1 insources, firm S can offer $(w_2^{IO}, f_2^{IO} - \varepsilon)$ to firm 2, with $f_2^{IO} = \pi_2(w_2^{IO}, s) - \pi_2^{II}$, $\varepsilon > 0$ and $\varepsilon \to 0$, and profitably induce outsourcing by firm 2.

When, instead, firm 1 outsources, in stage two, firm S offers (w_2, f_2) to firm 2 given (w_1, f_1) from the previous stage. That is, firm S solves:

$$\max_{w_2, f_2} \ \pi_S(w_1, w_2, f_1, f_2) = (w_1 - s)q_1(w_1, w_2) + (w_2 - s)q_2(w_2, w_1) + f_1 + f_2, \qquad (3)$$

$$\text{s.t.} \quad \pi_2(q_2(w_2, w_1), q_1(w_1, w_2)) - f_2 \geq \pi_2^{dOO},$$

where the outside option of firm 2 now is the profits that it makes when it produces the input in-house whereas its rival outsources, $\pi_2^{dOO} = \pi_2(s, w_1)$; these profits do not depend on w_2. The constraint is binding, and (3) results in:

$$w_2(w_1) = \frac{3s + 2w_1 - a}{4}. \qquad (4)$$

Note that $\partial w_2 / \partial w_1 > 0$. This is because when w_1 increases, firm 2 enjoys a larger competitive advantage that allows firm S to increase w_2 without restricting too severely its input purchases (Arya et al., 2008). The opposite holds for the fixed fee: $\partial f_2 / \partial w_1 < 0$. The higher is w_1, the higher is the advantage that firm 2 enjoys relative to its competitor when it rejects firm S's offer, and thus, the lower is the share of profits that firm S extracts from firm 2.

In the previous stage, when firm 1 rejects firm S's offer, its profits are π_1^{IO} from above. In light of this, firm S solves the following:

$$\max_{w_1, f_1} \pi_S(w_1, f_1) = (w_1 - s)q_1(w_1, w_2(w_1)) + (w_2(w_1) - s)q_2(w_2(w_1), w_1) + f_2(w_1) + f_1, \quad (5)$$

$$\text{s.t.} \quad \pi_1(q_1(w_1, w_2(w_1)), q_2(w_2(w_1), w_1)) - f_1 \geq \pi_1^{IO}$$

The constraint is binding, and we rewrite (5) as:

$$\begin{aligned} \max_{w_1} \pi_S(w_1, f_1) \quad = \quad & (w_1 - s)q_1(w_1, w_2(w_1)) + (w_2(w_1) - s)q_2(w_2(w_1), w_1) + f_2(w_1) \\ & + \pi_1(q_1(w_1, w_2(w_1)), q_2(w_2(w_1), w_1)) - \pi_1^{IO}. \end{aligned}$$

The resulting wholesale price offered to firm 1 is: $w_1^{OO} = \frac{a+25s}{26} > s$. The wholesale price offered to firm 2 follows from substitution of w_1^{OO} into (4): $w_2^{OO} = \frac{16s-3a}{13} < s$. We observe that $w_1^{OO} > w_2^{OO}$. Firm S favors firm 2; hence, firm 1 faces a cost disadvantage relative to its rival even when, similarly to its rival, outsources.

Next, we evaluate the implications of outsourcing by firm 1 on the input sourcing terms.

Proposition 1 *When firm* 1 *outsources, it raises both its own and its rival's per unit cost,* $k_1^{OO} > k_1^{IO}$ *and* $k_2^{OO} > k_2^{IO}$.

Proof: Recall from above that when firm 1 opts for insourcing, in the following stage, firm S optimally induces outsourcing by firm 2, i.e., we have IO. Thus, when firm 1 opts for insourcing, its per unit cost is $k_1^{IO} = s$. When, instead, firm 1 opts for outsourcing, its per unit cost is $k_1^{OO} = w_1^{OO}$. Since $w_1^{OO} > s$, it follows immediately that $k_1^{OO} > k_1^{IO}$.

The per unit cost of firm 2 is $k_2^{IO} = w_2^{IO}$ and $k_2^{OO} = w_2^{OO}$, when firm 1 insources and outsources respectively. We find that $w_2^{IO} - w_2^{OO} < 0$. Thus, $k_2^{OO} > k_2^{IO}$. ■

Proposition 1 informs us that when firm 1 outsources, it raises its rival's cost at the expense of increasing its own cost. In fact, its own cost increases more than its rival's cost: $k_1^{OO} - k_2^{OO} > k_1^{IO} - k_2^{IO}$. This means that opting for outsourcing, firm 1 inflicts itself a higher damage, in terms of per unit cost, than the damage it inflicts to its rival. An implication is that outsourcing decreases firm 1's output, $q_1^{OO} = \frac{3(a-s)}{13} < q_1^{IO}$, while it leaves firm 2's output intact, $q_2^{OO} = q_2^{IO}$.[16] A further implication is that firm S compensates firm 1 for the damage via the fixed fee, $f_1^{OO} < 0$, while it uses the fixed fee to extract part of firm 2's profits, $f_2^{OO} > 0$.

Offering $(w_1^{OO}, f_1^{OO} - \varepsilon)$ and $(w_2^{OO}, f_2^{OO} - \varepsilon)$, firm S guarantees higher joint profits for itself and either of the two firms when it supplies both of them than in all other cases. Therefore, with these contracts, firm S induces outsourcing by both firms in equilibrium.

Proposition 2 *Outsourcing by both firms always arises in equilibrium.*

Proof: We find firms' net equilibrium profits in the OO case from the appropriate substitutions and include them in Table 1. We already know that firm S prefers to serve firm 2 when firm 1 insources; it prefers IO to II.

Does firm S also prefer to serve firm 2 when firm 1 outsources? When it does not serve firm 2, in the OI case, outcomes are as in the IO case, with the roles of firm 1 and firm 2 reversed. We know that $\pi_S^{OI} = \pi_S^{IO} > \pi^{II}$. Thus, the only thing we need to check is whether firm S prefers IO/OI or OO. Comparing firm S's profits in the two regimes, we find: $\pi_S^{OO} - \pi_S^{IO} = (a-s)^2/1872 > 0$. It follows that firm S prefers to induce outsourcing by both firms. Firm S can do so by offering $(w_1^{OO}, f_1^{OO} - \varepsilon)$ and $(w_2^{OO}, f_2^{OO} - \varepsilon)$ to firm 1 and firm 2 respectively. Its offers will be accepted since $\pi_1^{OO} + \varepsilon > \pi_1^{IO}$ and $\pi_2^{OO} + \varepsilon > \pi_2^{OI}$. ■

When firm 1 produces the input in-house, firm S's revenues come exclusively from firm 2, thereby, firm S has vested interests only in firm 2. When, alternatively, firm 1 outsources,

[16] This is because from (1), we have: $dq_1/dw_1 = \frac{\partial q_1}{\partial w_2}\frac{\partial w_2}{\partial w_1} + \frac{\partial q_1}{\partial w_1} < 0$ and $dq_2/dw_1 = \frac{\partial q_2}{\partial w_2}\frac{\partial w_2}{\partial w_1} + \frac{\partial q_2}{\partial w_1} = 0$.

firm S can have revenues from firm 1 too. However, firm S continues to have higher vested interests in firm 2. This is due to the fact that firm S can transform the firm with which it trades second into a more aggressive competitor (e.g., McAfee and Schwartz, 1994, Bedre-Defolie, 2012). When firm S serves firm 1, it improves the position of the firm in which it has higher vested interests; it increases the downstream cost asymmetry in favor of firm 2. This leads, as mentioned above, to a lower output for firm 1 and to the same monopoly output for firm 2. Firm S manages to do this and at the same time decreases its subsidy to firm 2: $w_2^{OO} > w_2^{IO}$ and $f_2^{OO} = f_2^{IO}$. Stated differently, outsourcing to firm 1 allows firm S "to kill two birds with one stone": it improves the competitive position – market share – of its preferred customer and increases its own revenues.

In fact, firm S purposely makes a net loss from its transactions with firm 1. Firm S serves firm 1 not to enjoy higher input demand. It serves firm 1 to increase the profits that it makes from its sales to firm 2. Industry profits would be maximized and monopoly profits would be achieved, if firm S fully foreclosed firm 1 from the market. To do so, it would have to offer a higher w_1 than w_1^{OO}. This, though, would reinforce the competitive position of firm 2 under in-house production, and thus, enlarge its outside option; recall that f_2 increases with w_1. In other words, firm S would not be able to extract a large share of the monopoly profits. For this reason, it prefers to not maximize industry profits – to generate a smaller pie, by keeping firm 1 in the market–, and extract a larger share of the smaller pie. Stated differently, the external supplier takes into account not only the rent generation effects of vertical contracting but also its distributional effects.[17] In contrast to the vertical contracting literature, the upstream monopolist does not maximize industry not due to its opportunistic behavior, but due the fact that its customers have the outside option of in-house production.[18] Due to the same fact and in contrast again to most of the vertical contracting literature, the supplier cannot restore the monopoly outcome through the inclusion of exclusivity clauses in its contract offers.

It is important to stress that although the supplier does not have a cost-advantage, it induces outsourcing. In fact, as we show in Section 6, the supplier can induce outsourcing even when it has a sufficiently small cost disadvantage. The reverse – the existence of a cost advantage – is a necessary condition for the emergence of outsourcing in the literature (e.g.,

[17] Caprice (2006) also shows that an upstream supplier takes into acount the distributional effects outside option of downstream firms is a less efficient upstream fringe. In his environment though, this holds only when the supplier is not allowed to price discriminate. We discuss the implications of a ban on price discrimination later on.

[18] When products are homogeneous and firm S can fully extract firm 2's profits, as is the case, for instance, when firm 2 does not have input production capability, firm S fully forecloses firm 1 from the market (e.g., Hart and Tirole, 1990, McAfee and Schwartz, 1994, Milliou and Pechlivanos, 2019). When products are differentiated, and thus, industry profits are not maximized with foreclosure, as the vertical contracting literature has shown (e.g., McAfee and Schwartz, 1994, Rey and Vergé, 2002, Milliou and Petrakis, 2007), an upstream monopolist dealing with competing downstream firms via nonlinear contracts is unable to maximize industry profits because it suffers from the 'opportunism problem': when it makes an offer to a firm, it cannot commit that it will not make a better offer to the rival firm.

Arya et al., 2008, Buehler and Haucap, 2008, Feng and Lu, 2012 and 2013). As we explain in detail in the next section, this difference hinges mainly on the contractual form.

Outsourcing, here, is not motivated by collusion, in contrast to Buehler and Haucap (2006), Gilbert et al. (2006), and Grahovac et al. (2015). The price of the final good is lower when both firms outsource than when neither firm does: $p^{OO} < p^{II}$. This is because of the lower than s variable input sourcing cost that firm 2 faces in the OO case.

Outsourcing is not motivated by a raise in rival's cost either, in contrast to Arya et al. (2008). Firm 1 deteriorates its competitive position when it outsources since then the supplier generates more cost asymmetry against firm 1. This is consistent with the empirical findings of Görzig and Stephen (2002) and Marjit and Mukherjee (2008), according to which outsourcing reduces firm's profitability. If firm 1 did not outsource, it would play the role of the Stackelberg follower without being compensated for it. Therefore, f_1 serves as a bribe: firm S pays firm 1 to abstain from producing the input itself. The weaker competition faced by firm 2 in the OO works not only in favor of firm 2, but also in favor of firm S; it allows firm S to enlarge its profits.[19]

Importantly, outsourcing arises because the use of the external supplier works as a means for the competing firms to commit, by accepting the contract terms, to input costs that transform their competition from Cournot to Stackelberg. Clearly, this mechanism has the flavor of the Bertrand-Edgeworth model. There, firms transform Bertrand to Cournot competition by committing through their sunk costs in capacity. In our environment, the supplier makes firm 1 commit to a higher unit cost, in return of a lump-sum payment, thereby allowing firm 2 to make Stackelberg profits. Firm S, thus, does not provide lower input costs to its customers, its provides them a commitment mechanism.

We have established that a technologically redundant input supplier can enter into a duopoly market and alert the equilibrium outcome non-trivially. It remains to check to which direction consumers and the economy will be affected.

Proposition 3 *When both firms outsource:*

(i) consumer surplus is higher than when neither firm outsources and lower than when only one firm outsources, $CS^{IO} > CS^{OO} > CS^{II}$,

(ii) producer surplus is lower than when neither firms outsources and higher than when only one firm outsources, $PS^{II} > PS^{OO} > PS^{IO}$, *and*

(iii) welfare is higher than when only one firm outsources, while it is higher in the latter case than when neither firm outsources, $W^{OO} > W^{IO} > W^{II}$.

Proof: (i) Consumer surplus is given by $CS = aq_1^v + aq_2^v - (1/2)(q_1^{v2} + q_2^{v2} + q_1^v q_2^v) - (a - q_1^v - q_2^v)q_1 - (a - q_2^v - q_1^v)q_2^v$, with $v = OO, IO, OO$. We find: $CS^{OO} - CS^{II} = \frac{545(a-s)^2}{12168} > 0$

[19] Firm 1 is worse off when both firms outsource than when neither outsources, while the opposite holds for its rival: $\pi_1^{OO} < \pi_1^{II}$ and $\pi_2^{OO} > \pi_2^{II}$.

and $CS^{OO} - CS^{IO} = \frac{-77(a-s)^2}{5408} < 0$.
(ii) Producer surplus is given by $PS^v = \pi_1^v + \pi_2^v + \pi_S^v$. We find: $PS^{OO} - PS^{II} = \frac{-150(a-s)^2}{6084} < 0$ and $PS^{OO} - PS^{IO} = \frac{25(a-s)^2}{2704} > 0$.
(iii) Welfare is given by $W^v = PS^v + CS^v$. We find: $W^{OO} - W^{IO} = \frac{109(a-s)^2}{416} > 0$ and $W^{IO} - W^{II} = \frac{7(a-s)^2}{288} > 0$. ■

Outsourcing enhances consumer and total welfare. In disparity with the outsourcing literature, this result is not driven by the fact that a more efficient supplier produces the input. It is exclusively induced by vertical contracting, which entails lower unit input cost for one of the firms. On this basis, we can conclude that presence of an otherwise redundant and not more efficient firm in the upstream market can be socially desirable.

Non-discrimination: Ban and clauses

Our analysis can be relevant for antitrust policy and, in particular, for the treatment of price discrimination in input markets. We saw that an external supplier offers different contract terms to its customers and induces welfare-enhancing outsourcing. Would the supplier also be able to induce outsourcing if price discrimination was prohibited? If the answer is yes, would outsourcing without price discrimination also be desirable from a welfare perspective?

Rey and Tirole (2007) show that in an environment where the upstream monopolist's customers do not have an outside option, a ban on price discrimination adversely affects consumers. The reason is that with the law in place, the external supplier overcomes its commitment problem. It fully exercises its monopoly power and generates the monopoly outcome. In contrast, Caprice (2006) shows that a price discrimination ban can be socially desirable when downstream firms have the alternative option of sourcing the input from a less efficient upstream fringe: although the ban restores the supplier's commitment, it can lead to commitment to lower wholesale prices. Next, we explore the implications of a price discrimination ban in our environment in which contracting is sequential and firms have the equally efficient alternative of in-house input production.

Assume that a price discrimination ban which requires that firm S offers the same contract terms, (w, f), to firm 1 and firm 2 is imposed. If in the first stage, firm 1 does not outsource, the outcomes are the same with and without the ban: π_S^{IO}, π_1^{IO}, π_2^{IO}. If firm 1 outsources, firm S solves:

$$\max_{w,f} \ \pi_S(w,f) = 2[(w-s)q_i(w) + f], \tag{6}$$

$$s.t. \ \ \pi_2(q_2(w), q_1(w)) - f \geq \pi_2(s,w),$$

where $q_i(w) = \frac{a-w}{3}$, with $i = 1, 2$. This yields: $w^{OOn} = \frac{(-a+7s)}{6}$. We note that $w_1^{OO} > s > w^{OOn} > w_2^{OO}$. Substituting, we find the equilibrium profits: $\pi_S^{OOn} = \frac{(a-s)^2}{54}$, $\pi_1^{OOn} = \pi_2^{OOn} = \frac{25(a-s)^2}{324}$. Firm S will profitably induce outsourcing by both firms, since $\pi_S^{OOn} > \pi_S^{IO}$ and $\pi_1^{OOn} > \pi_1^{IO}$. Similarly though to our main analysis, the supplier will not maximize industry

profits due to the distributional effects. The ban does not work against the supplier. Firm S makes higher profits with than without the ban: $\pi_S^{OOn} > \pi_S^{OO}$. The ban also results in higher consumer surplus and welfare. This is so because with the ban in place the supplier subsidizes both of its customers. On this basis, we conclude that the emergence of outsourcing to a supplier without a cost advantage does not depend on the supplier's ability to price discriminate. We also conclude that, in contrast to Rey and Tirole (2007) and in line with Caprice (2006), a ban on price discrimination can at the same time benefit consumers and welfare and reinforce the incentives of a supplier to enter into the market.

5 Contracting features

In this section, we explore the role of various features of contracting for our main findings.

5.1 Contractual form

We start with the analysis of the role of the contractual forms.

Wholesale price contracts

When wholesale price contracts are used, in stage two, if firm 1 insourced, firm S solves: $\max_{w_2} \pi_S(w_2) = (w_2 - s)q_2(w_2, s)$. This yields: $\widehat{w}_2^{IO} = (a + 3s)/4$. As expected, in the absence of a fixed fee, firm S sets a positive mark-up and generates a cost disadvantage for firm 2. In turn, firm 2 is be better off if it rejects the offer, $\pi_2^{II} > \pi_2(\widehat{w}_2^{IO}, s)$. Firm 2 would outsource only if $w_2 < s$, and thus, if firm S would make a loss; hence, IO cannot arise in equilibrium.

If firm 1 outsourced, in stage two, firm S solves: $\max_{w_2} \pi_S(w_1, w_2) = (w_1 - s)q_1(w_1, w_2) + (w_2 - s)q_2(w_2, w_1)$. This leads to: $w_2(w_1) = (a + s + 2w_1)/4$. In the previous stage, firm S optimally offers $\widehat{w}_1^{OO} = s$ and, in turn, $\widehat{w}_2^{OO} = s$. Firm 1, though, would accept firm S's offer if and only if $w_1 > s$. But a $w_1 < s$ would trigger a lower w_2, since $dw_2/dw_1 > 0$, and result in higher q_1, since $dq_1/dw_1 < 0$, and no change in q_2, since $dq_2/dw_1 = 0$. Hence, firm S would end up selling more units to firm 1 at a loss and the same amount of units to firm 2 at a lower wholesale price than before. In other words, the supplier would experience a loss from one customer and a decrease in its revenues from the other.

Proposition 4 *When wholesale price contracts are used, outsourcing does not arise in equilibrium.*

An external supplier without a cost advantage is not in the position to profitably induce outsourcing with wholesale price contracts. A similar result can be found in Arya et al. (2008). Without the fixed fees, the supplier cannot generate cost asymmetry so as to increase the size of the pie and in turn use the fees to compensate and extract. From Proposition

2, we know that the opposite holds with two-part tariffs. Therefore, the contractual form is not innocuous: it can have significant implications for the production pattern that emerges in equilibrium.

This together with Proposition 3 indicate that, as standard in the vertical contracting literature, two-part tariffs generate a more efficient outcome – higher consumer surplus and welfare – than wholesale price contracts. Given the contractual form's crucial role for market outcomes, a question that arises is which form will be used in equilibrium. A supplier will always prefer two-part tariffs to wholesale price contracts since with two-part tariffs it profitably induces outsourcing.[20]

Corollary 1 *The external supplier strictly prefers to use two part tariff contracts than wholesale price contracts.*

Corollary 1 provides a justification for the use of two-part tariffs in our main model.

Quantity-forcing contracts

We consider now what happens when firm S offers to its potential customers quantity-forcing contracts – also known as price-quantity bundle contracts. That is, it offers $T_i(.)$ to each firm i, with $T_i(0) = 0$, $T_i(\overline{q}_i) = \overline{f}_i$ if $q_i = \overline{q}_i$ and $T_i(q_i) = \infty$ if $q_i \neq \overline{q_i}$, where $\overline{q}_i$ is specified by firm S and $\overline{f}_i$ is a fixed fee that firm i pays to firm S (e.g., Rey and Tirole, 2007).

If only firm 2 outsourced, in the last stage, firm 1 observes $\overline{q}_2$ and chooses its own output: $q_1(\overline{q}_2) = \frac{a-s-\overline{q}_2}{2}$. In the previous stage, firm S solves: $\max_{\overline{q}_2,\overline{f}_2} \pi_S(q_2, \overline{f}_2) = \overline{f}_2 - s\overline{q}_2$, s.t. $(a - q_1(\overline{q}_2) - \overline{q}_2)\overline{q}_2 - \overline{f}_2 \geq \pi_2^{II}$. The constraint is binding, and we have: $\overline{q}_2^{IO} = q^{mon} = q_2^{IO}$, $\overline{q}_1^{IO} = q_1^{IO}$, $\overline{\pi}_S^{IO} = \pi_S^{IO}$, $\overline{\pi}_1^{IO} = \pi_1^{IO}$, and $\overline{\pi}_2^{IO} = \pi_2^{IO}$; hence, in the IO case, the results with quantity-forcing contracts and two-part tariffs coincide.

If both firms outsourced, in the last stage, firms simply produce their already agreed quantities. In stage two, firm S faces: $\max_{\overline{q}_2,\overline{f}_2} \pi_S(\overline{q}_1, \overline{q}_2, \overline{f}_1, \overline{f}_2) = \overline{f}_1 - s\overline{q}_1 + \overline{f}_2 - s\overline{q}_2$, s.t. $(a - \overline{q}_1 - \overline{q}_2)\overline{q}_2 - \overline{f}_2 \geq (a - \overline{q}_1 - q_2(\overline{q}_1) - s)q_2(\overline{q}_1)$. We solve firm S's problem, taking into account that $q_2(\overline{q}_1) = \frac{a-s-\overline{q}_1}{2}$, and we find again $\overline{q}_2(\overline{q}_1) = q_2(\overline{q}_1)$. In the previous stage, firm S solves:

$$\max_{\overline{q}_1,\overline{f}_1} \pi_S(\overline{q}_1, \overline{f}_1) = \overline{f}_1 - s\overline{q}_1 + (a - \overline{q}_1 - \overline{q}_2(\overline{q}_1) - s)\overline{q}_2(\overline{q}_1) - \frac{(a - \overline{q}_1 - s)^2}{4}, \tag{7}$$

$$\text{s.t.} \quad (a - \overline{q}_1 - \overline{q}_2(\overline{q}_1))q_1 - \overline{f}_1 \geq \pi_1^{IO}$$

The constraint is binding, and maximization yields: $\overline{q}_1^{OO} = q^{mon}$ and $\overline{q}_2^{OO} = \frac{a-s}{4}$. Firm S now reverses the roles of the two firms; it transforms the first firm into a Stackelberg leader

[20] Firm 2 is also better off with two-part tariffs, $\pi_2^{OO} > \pi_i^{II}$. Even though firm 1 makes higher profits with wholesale price contracts, if its rival trades with a two-part tariff, it can be convinced by firm S, through an appropriate transfer, to also trade with a two-part tariff.

and the second firm to a Stackelberg follower. The equilibrium profits are now: $\overline{\pi}_S^{OO} = \overline{\pi}_1^{OO} = \overline{\pi}_2^{OO} = \frac{(a-s)^2}{16}$, with $\overline{\pi}_S^{OO} > \pi_S^{IO} > \pi_S^{II}$; hence, the supplier induces outsourcing by both firms with quantity-forcing contracts too. Why? In both the IO and the OO case, the supplier generates Stackelberg competition and extracts profits exclusively from the Stackelberg leader. The Stackelberg leader though differs in the two cases, firm 2 and firm 1 in the IO and the OO case respectively, and has different disagreement payoffs. Firm 2's disagreement payoffs are the profits of a Cournot competitor, while firm 1's are the profits of a Stackelberg follower. As the profits of a Stackelberg follower are lower than those of a Cournot competitor, firm S extracts higher share of the Stackelberg leader's profits in the OO case, and thus, prefers OO.

Clearly, as with two-part tariffs, outsourcing is motivated by neither the supplier's cost advantage nor a raise in rival's cost, and enhances consumer surplus and welfare. The mechanism behind the emergence of outsourcing is the same under both two-part tariffs and quantity-forcing contracts: outsourcing arises because the supplier can transform Cournot to Stackelberg competition.

Yet the supplier is better off with quantity-forcing contracts than with two-part tariffs, $\overline{\pi}_S^{OO} > \pi_S^{OO}$. This is because with quantity-forcing contracts, the supplier directly imposes firms' output and reproduces the standard Stackelberg model. This result raises the question of why we use two-part tariffs and not quantity-forcing contracts in our main analysis. We do so, first, because the generation of Stackelberg competition is less surprising under quantity-forcing contracts than under two-part tariffs; under the former, the quantities of two competing firms are chosen a sequentially just like in the standard Stackelberg model. Second, because quantity-forcing contracts entail more commitment (see subsection 5.3) than two-part tariffs. And, third, because quantity-forcing contracts are not always suitable since they lack flexibility. For instance, they do not allow firms to adjust their output to changes in market conditions.

5.2 Simultaneous contracting

Next, we examine what happens when the supplier approaches its potential customers simultaneously. To do so, we modify our model and assume that in stage one, firm S makes simultaneous offers to firm 1 and firm 2 over (w_1, f_1) and (w_2, f_2) respectively and, in turn, each firm decides whether it accepts or rejects its offer without knowing the offer made to its rival. The assumption that offers are secret when they are made simultaneously reflects the reality that competing firms typically have separate meetings with the input supplier. This assumption is very common in the vertical contracting literature (e.g., Hart and Tirole, 1990, O'Brien and Shaffer, 1992, McAfee and Schwartz, 1994, Rey and Vergé, 2004, Rey and Tirole, 2007) that points out that public commitment to contract terms offered to competing

firms is extremely hard to be sustained.[21] As noted in this literature, multiple equilibria can arise when offers are simultaneous and secret, due to the multiplicity of the beliefs that firms can form when they receive out-of-equilibrium offers. We obtain a unique equilibrium by assuming that firms have passive beliefs, i.e., when firm i receives an out of equilibrium offer, it keeps on believing that firm j has received the equilibrium offer (e.g., Hart and Tirole, 1990, Rey and Vergé, 2004).

We start with the analysis of the case in which contract terms are *ex-post observable*: each firm observes all the contract terms before choosing its output.[22] The solution of the last stage is given again by (1). When, in stage two, firm S outsources to both firms, it offers (w_i, F_i) to firm i, taking as given its equilibrium offer to firm j, $(\widetilde{w}_j^{OO}, \widetilde{f}_j^{OO})$. In particular, it solves:

$$\max_{w_i, f_i} \pi_S(w_i, f_i) = (w_i - s)q_i(w_i, \widetilde{w}_j^{OO}) + (\widetilde{w}_j^{OO} - s)q_j(\widetilde{w}_j^{OO}, w_i) + f_i + \widetilde{f}_j^{OO}, \tag{8}$$

$$\text{s.t.} \quad \pi_i(q_i(w_i, \widetilde{w}_j^{OO}), q_j(\widetilde{w}_j^{OO}, w_i)) - f_i \geq \widetilde{\pi}_i^{dOO},$$

where firm i's disagreement payoff coincides with its profits in the IO of the main analysis: $\widetilde{\pi}_i^{dOO} = \pi_1^{IO}$. The constraint is binding; rewriting (8) and solving for w_i, we find: $\widetilde{w}_i^{OO} = \frac{3s-a+s}{2}$. Again, the supplier does not maximize industry profits. Now, though, not because of its customer's outside option but because of the 'opportunism problem' (e.g., Hart and Tirole, 1990, McAfee and Schwartz, 1994, Rey and Vergé, 2004, Milliou and Petrakis, 2007). A straightforward implication is that outsourcing does not generate cost asymmetry, and it is unprofitable for firm S.

When contract terms are *ex post unobservable* contracts, i.e., when firms never observe their rival's contract terms, the equilibrium outcome is for the supplier to set the wholesale prices equal to marginal cost (e.g., McAfee and Schwartz, 1994, Rey and Tirole, 2007, Pagnozzi and Picolo, 2012), $\overline{w}_1^{OO} = \overline{w}_2^{OO} = \overline{w}_1^{OI} = \overline{w}_2^{IO} = s$. Therefore, outsourcing is again unprofitable for the supplier.

This means that the supplier has no reason to enter into the market when contracting is simultaneous and secret (at least in the contracting stage). On the contrary, as we saw in our main analysis, when contracting is sequential, the supplier can create a profitable market for itself. On this basis, we reach the next conclusion.

[21] In the Appendix, we also consider the case of simultaneous public contracts. We show that outsourcing by both firms always arises, and that although contracts are public, industry profits are not maximized because the supplier takes into account distributional effects.

[22] Feng and Lu (2012 and 2013) also consider a similar setting with simultaneous and secret offers which are observable in the last stage. In many papers in the vertical contracting literature (e.g., McAfee and Schwartz, 1994, Rey and Vergé, 2004, Milliou and Petrakis, 2007) also the contracts terms are not observable in the contracting stage, while they are observable in the quantity competition stage. We will discuss shortly the case in which contract terms are *ex-post unobservable*.

Proposition 5 *The external supplier strictly prefers contracting with firm* 1 *and firm* 2 *sequentially rather that simultaneously and secretly.*

The supplier's preference of sequential contracting is due to its inability to commit under simultaneous and secret contracting. Clearly, this conclusion points out that in three-party trading, the order in which trading occurs may affect both the size and the division of the generated pie. Importantly, it reveals that the order of moves that we adopt in our main model can arise endogenously.

5.3 Observability and commitment

In our main analysis, the external supplier commits to its contract terms. One might wonder what happens when the supplier lacks commitment power because it can offer secret discounts. As we saw above, the possibility of offering secret discounts hurts the supplier and does not allow it to induce outsourcing under simultaneous contracting. When the contract offers though are sequential the supplier can profitably induce outsourcing even though the rival's contract terms are secret when offers are made, and thus, even when it does not commit to firm 2 regarding the terms already offered to firm 1. This is so when firm 2 observes only its rival's acceptance in stage two and both firms observe the contract terms ex post - in the last stage. Next, we analyze the case of sequential contracting with ex post unobservable contract terms.

In the last stage of the game, maximization of each firm i's profits leads to: $q_i^{BR}(k_i, q_j^*) = \frac{a-k_i-q_j^*}{2}$. If firm 1 did not opt for outsourcing and this is observed for firm 2, in stage two, firm S solves:

$$\max_{w_2,f_2} \pi_S(w_2, f_2) = (w_2 - s)q_2^{BR}(w_2, q_1^*) + f_2, \tag{9}$$

$$\text{s.t.} \quad \pi_2(q_2^{BR}(w_2, q_1^*), q_1^*) - f_2 \geq \pi_2^{II}.$$

We rewrite (9) taking into account that the constraint is binding, and we find: $w_2^{IOu} = s$ and $f_2^{IOu} = (a - q_1^* - q_2^{BR}(s, q_1^*) - s)q_2^{BR}(s, q_1^*) - \pi_2^{II} = 0$. Hence, firm S cannot profitably induce IO. If firm 1 outsourced, firm S solves:

$$\max_{w_2,f_2} \pi_S(w_1, f_1, w_2, f_2) = (w_1 - s)q_1^{BR}(w_1, q_2^*) + f_1 + (w_2 - s)q_2^{BR}(w_2, q_1^*) + f_2, \tag{10}$$

$$\text{s.t.} \quad \pi_2(q_2^{BR}(w_2, q_1^*), q_1^*) - f_2 \geq \pi_2(q_2(s, q_1^*), q_1^*).$$

Substituting the binding constraint, we note that the terms that depend on w_2 are exactly the same as the ones in the IO case above. Hence: $w_2^{OOu} = w_2^{IOu} = s$ and $f_2^{IOu} = 0$. Moving to stage one, firm S solves:

$$\max_{w_1,f_1} \pi_S(w_1, f_1) = (w_1 - s)q_1^{BR}(w_1, q_2^*) + f_1, \tag{11}$$

$$\text{s.t.} \quad \pi_1(q_1^{BR}(w_1, q_2^*), q_2^*) - f_1 \geq \pi_1(q_1(s, q_2^*), q_2^*).$$

Rewriting and solving (11), we find again: $w_1^{OOu} = s$ and $f_1^{OOu} = 0$. Therefore, firm S cannot profitably induce outsourcing in equilibrium when contract terms are ex post unobservable even when contracting occurs sequentially.

This points out that the importance of the observability of the rival's contract terms at least before the market competition stage for the emergence of outsourcing. Otherwise, the contract terms play no strategic role, and thus, cannot alter market competition. Since the supplier makes positive profits only when it induces outsourcing, it clearly has incentives to disclose on its own the contract terms before its customers compete in the output market.[23] Furthermore, in some industry sectors, regulations that do not permit the confidentiality of the wholesale prices are in place. This is the case, for instance, in the market for the supply of ready-to-mix concrete in Denmark. Similarly, in the US, the government has made efforts to mandate the disclosure of the wholesale costs of medical equipment and pharmaceuticals.

5.4 Negotiations

Next, we explore what happens when firm 1 and firm 2 engage in bilateral negotiations with the supplier over the contract terms. We modify our model and assume that firm S the bargaining power of firm S and firm i, with $i = 1, 2$, is β and $1 - \beta$ respectively, with $\beta \in [0, 1)$.

In stage two, if firm 1 has not reached an agreement with firm S, firm S and firm 2 solve:

$$\max_{w_2, f_2} \; [\pi_S(w_2) + f_2]^{\beta} + [\pi_2(w_2, s) - \pi_2^{dIO} - f_2]^{1-\beta}, \tag{12}$$

where the disagreement payoff of firm 2 is again $\pi_2^{dIO} = \pi_2^{II}$. Maximizing with respect to f_2, we find: $f_2 = \beta[\pi_2(w_2, s) - \pi_2^{II}] - (1 - \beta)\pi_S(w_2)$. From this it follows that (12) corresponds to an expression which is proportional to the joint profits of firm 2 and firm S minus firm 2's disagreement payoff. This expression is maximized again by w_2^{IO}, while the fixed fee now depends on the distribution of the bargaining power: $f_2^{IO} = \frac{(9+\beta)(a-s)^2}{72}$. If firm 1 has agreed to outsource, (12) becomes:

$$\max_{w_2, f_2} \; [\pi_S(w_1, w_2) + f_1 + f_2 - \pi_S^{dOO}]^{\beta} + [\pi_2(w_2, w_1) - \pi_2^{dOO} - f_2]^{1-\beta}, \tag{13}$$

where $\pi_2^{dOO} = \pi_2(s, w_2)$. Note that firm S has a disagreement payoff too now: $\pi_S^{dOO} = \pi_S^{OI}$. Maximization results in (5). Taking this into account, we move to the first stage of the game,

[23] A number of recent papers (e.g., Arya and Mittendorf, 2011, Pagnozzi and Picolo, 2012, Skartados and Petrakis, 2018) endogenize the upstream firm's decision to disclose all the contract terms before its customers compete in the product market.

in which firm S bargains with firm 1 over (w_1,f_1). They solve:

$$\max_{w_1,f_1}[\pi_S(w_1,w_2(w_1))+f_1+f_2(w_1)-\pi_S^{dOO}]^{\beta}+[\pi_1(w_1,w_2)-\pi_1^{dOO}-f_1]^{1-\beta}.$$

This yields: $w_1^{OOn}=\frac{a(3-2\beta)+s(27-2\beta)}{30-4\beta}>s$ and $w_2^{OOn}=\frac{-3a+2s(9-\beta)}{15-2\beta}<s$. So, in line with our main analysis, firm S continues to favor firm 2. However, the profits of firm S are lower now since its customers have bargaining power that allows them to extract a bigger piece of the joint profits. Still, firm S again profitably induces outsourcing by both firms.

This points out that our main results extend to situations where the bargaining power is more evenly distributed between the supplier and its potential customers. They also extend to situations where outsourcing is initiated by powerful original brand manufacturers.

6 Further extensions

We now make further changes to our main model to gain additional insights.[24]

6.1 Asymmetric firms

We relax the assumption that firm 1 and firm 2 have symmetric production capabilities, and consider the case in which they face different marginal costs of in-house input production. Specifically, we assume that firm i's, with $i=1,2$, cost is z, while its rival's and firm S's costs remain s, with $z>s$. Two scenarios arise depending on whether or not the firm with which the supplier trades second is the one with the cost disadvantage. In both scenarios, as long as the less efficient firm is active in the market ($z<(3a+s)/4$), firm S generates outsourcing by both firms in equilibrium.

When its customers are ex ante symmetric, the supplier is indifferent between contracting first or second with either firm, and manages to create ex post asymmetry through the contract terms. When, instead, its customers are ex ante asymmetric, firm S is no longer indifferent. It prefers to trade second with the firm that has the cost disadvantage.

Proposition 6 *When a firm has a cost disadvantage in input production, the external supplier prefers to trade second with this firm than with the firm without a cost disadvantage, and its profits increase with the cost disadvantage.*

Proof: See Appendix.

Recall that the supplier can generate more profits for the firm with which it trades second. This holds independently of whether or not this firm faces a cost disadvantage. What changes when the second firm faces a cost disadvantage is that it has a weaker outside option that

[24] When the detailed analysis is not included in the paper, it is available from the author upon request.

allows the supplier to extract a larger share of its profits. In fact, the higher is the cost disadvantage of its second customer, and thus, the worse is its competitive position when it rejects the supplier's offer, the higher are the profits that the supplier makes. In contrast, when the first firm faces a cost disadvantage, it works against the external supplier. Then, the supplier has to keep a less efficient firm active in the market, so that it generates more profits for the second firm. In this way, it reinforces the outside option of the second firm and extracts less profits from it. Interestingly, the supplier is worse off with than without a cost advantage relative to the first firm.

Asymmetry between firms can also arise from the complete lack of in-house input production capability. A firm, e.g., firm 2, might not have the option of in-house input production. Arya at el. (2008) explore such a situation with wholesale price contracts and a supplier with a cost advantage. In the benchmark of this case, there is outsourcing by firm 2. We find that its rival with in-house production capability also outsources to the same supplier without a cost advantage even though outsourcing raises its own cost more than its rival's cost.

6.2 Supplier with a cost disadvantage

In our main analysis, we demonstrated that outsourcing to a supplier without a cost advantage is possible. In what follows, we examine whether outsourcing to a supplier with a cost disadvantage is also possible. We modify our model and assume that firm S's marginal input production cost is z, with $z > s$, while the input production cost of its potential customers remains s. For simplification reasons, we set $s = 0$; hence, z captures the size of firm S's cost disadvantage.

As in our main analysis, firm S generates cost asymmetry between its potential customers, through the wholesale price(s), when at least one of them outsources. Furthermore, when both firms outsource, it generates a cost advantage for firm 2 – its preferred customer – relative to firm 1. The profits of firm S, although they decrease with its cost disadvantage z, they are positive when its cost disadvantage is not too large, and in particular, when $z < \frac{(26\sqrt{3}-45)a}{2}$. Therefore, when this condition is satisfied, in equilibrium, we have outsourcing by both firms to a supplier with a cost disadvantage. Surprisingly, although the input is produced with a less efficient technology, consumer surplus and welfare are still higher than when the input is produced in-house by both firms.

6.3 Product differentiation

We relax now the assumption that firms sell a homogeneous good, and analyze the case in which they sell differentiated products. Specifically, we assume that the market demand for firm i's product, with $i, j = 1, 2$ and $i \neq j$, is given by $p_i = a - q_i - \gamma q_j$, where γ, with $\gamma \in (0, 1)$, denotes the degree of product differentiation.

Firm S now, when it serves both firms, suffers from the 'opportunism problem' and does not maximize industry profits because of this. Still, outsourcing by both firms arises in equilibrium, and it is procompetitive. Outsourcing is again motivated by the fact that the external supplier transforms Cournot to Stackelberg competition.

Typically, when products become closer substitutes, and thus, competition gets fiercer, the supplier's opportunism problem gets more severe and its profits decrease (e.g. Rey and Tirole, 2007). In contrast, here the supplier's profits increase with γ. The reason is that the profits of a firm that produces the input in-house decrease with the intensity of competition. This means that the disagreement payoff of the supplier's customer decreases and the supplier extracts a larger share of profits. Another interpretation of this finding is that outsourcing is more likely to take place when competition is intense because then the switch to Stackelberg competition is more valuable. An interesting insight results: the impact of downstream competition intensity on upstream profits can crucially depend on the downstream firms' input sourcing options.

6.4 Price competition

We now examine whether outsourcing arises when firms compete in prices and their products are differentiated. We assume that the demand for firm i's product, with $i, j = 1, 2$ and $i \neq j$, is given by: $q_i = \frac{(a-p_i)-\gamma(a-p_j)}{1-\gamma^2}$.

With the prices being strategic complements, firm S does not wish its customer(s) to behave aggressively (e.g., Bonanno and Vickers, 1988, Rey and Stiglitz, 1995); hence, it does not subsidize them. Specifically, in the IO case, firm S sets a positive mark-up to its unique customer, $w_2^{IOb} > s$, it relaxes downstream competition and, in turn, increases final prices and industry profits, $p_i^{IOb} > p_i^{IIb}$ and $PS^{IOb} > PS^{IIb}$. Firm S further increases industry profits in the OO case, by setting a positive mark-up on both firms, $w_i^{OOb} > s$, and by raising its mark-up on firm 2, $w_2^{OOb} > w_2^{IOb}$. Since firm S extracts via the wholesale prices now, a piece of the larger pie, it induces again outsourcing by both firms in equilibrium.

This implies that the external supplier's ability to induce outsourcing does not depend on the mode of competition. But under price competition, outsourcing is motivated by collusion, and thus, its welfare implications differ significantly from the respective ones under quantity competition. When firms compete in prices, the entry of a not more efficient dominant contract manufacturer in the market can harm consumers and welfare.

7 Conclusion

We have shown that competing firms outsource to an external common supplier and increase consumer surplus and welfare although the supplier does not have a cost advantage in input production. The incentives and the implications of outsourcing are driven by contracting. An

external supplier can use its contract offers to create cost asymmetry that works in its favor. At the same time, the incumbents manage to commit, through contracting with the external supplier, to input costs that transform their competition from Cournot to Stackelberg.

The supplier, though, does not have incentives to enter into the market and serve its potential customers unless it uses non-linear contracts and contracts sequentially with them. With wholesale price contracts or simultaneous contracting, a supplier without a cost advantage is not in the position to induce outsourcing. Therefore, the contractual form and the order of contracting can be significant for the emergence of outsourcing.

Our analysis suggests an explanation for the practice of outsourcing even absent the usual cost advantage of external suppliers. Indeed, in our environment, opting for outsourcing might be profitable despite a rise in cost. It also suggests that the emergence of large contract manufacturers is not necessarily due to cost advantages. It can also be due to the contract terms that they offer to original brand manufacturers. In fact, their presence in the market, although it is technologically redundant, can be socially desirable.

Our conclusions persist qualitatively when products are differentiated, firms negotiate over the contract terms or differ in terms of their input production capability. In all cases, the supplier generates cost asymmetry and transforms one of the firms to a Stackelberg leader, while it abstracts from maximizing industry profits in order to secure a larger share of the generated profits.

In future work, we plan to explore outsourcing to exclusive or vertically integrated suppliers without cost advantages. We also plan to explore the possibility that outsourcing causes supplier 'encroachment' in the downstream market and the incentives of vertically integrated firms to spin-off their input production divisions.

8 Appendix

Table 1: Profits with symmetric input production costs

$\pi_S^{OO} = \frac{3(a-s)^2}{208}$	$\pi_1^{OO} = \frac{(a-s)^2}{16}$	$\pi_2^{OO} = \frac{81(a-s)^2}{676}$
$\pi_S^{II} = 0$	$\pi_1^{II} = \frac{(a-s)^2}{9}$	$\pi_2^{II} = \frac{(a-s)^2}{9}$
$\boldsymbol{\pi}_S^{OI} = \frac{(a-s)^2}{72}$	$\boldsymbol{\pi}_1^{OI} = \frac{(a-s)^2}{9}$	$\boldsymbol{\pi}_2^{OI} = \frac{(a-s)^2}{16}$
$\pi_S^{IO} = \frac{(a-s)^2}{72}$	$\pi_1^{IO} = \frac{(a-s)^2}{16}$	$\pi_2^{IO} = \frac{(a-s)^2}{9}$

Table 2: Profits with asymmetric input production costs ($k_1^{II} = s$ & $k_2^{II} = z$)

$\pi_S^{OOa} = \frac{(3a^2-102as+35s^2+32(3a+s)z-64z^2)}{208}$	$\pi_1^{OOa} = \frac{(a-s)^2}{16}$	$\pi_2^{OOa} = \frac{9(3a+s-4z)^2}{676}$
$\pi_S^{IIa} = 0$	$\pi_1^{IIa} = \frac{(a-2s+z)^2}{9}$	$\pi_2^{IIa} = \frac{(a-2z+s)^2}{9}$
$\pi_S^{IOa} = \frac{(a^2-34as+s^2+32(a+s)z-32z^2)}{72}$	$\pi_1^{IOa} = \frac{(a-s)^2}{16}$	$\pi_2^{IOa} = \frac{(a-2z+s)^2}{9}$

Table 3: Profits with asymmetric input production costs ($k_1^{II} = z$ & $k_2^{II} = s$)

$\pi_S^{OOb} = \frac{3(a^2-28as-12s^2+26(a+2s)z-39z^2)}{208}$	$\pi_1^{OOb} = \frac{(a-3z+2s)^2}{16}$	$\pi_2^{OOb} = \frac{81(a-s)^2}{676}$
$\pi_S^{IIb} = 0$	$\pi_1^{IIb} = \frac{(a-2z+s)^2}{9}$	$\pi_2^{IIb} = \frac{(a-2s+z)^2}{9}$
$\pi_S^{IOb} = \frac{(a-2s+z)^2}{72}$	$\pi_1^{IOb} = \frac{(a+2s-3z)^2}{16}$	$\pi_2^{IOb} = \frac{(a-2s+z)^2}{9}$

Sequential contracting with secret and ex post observable contract terms

Assume that in stage two firm 2 does not observe its rival's contract terms but it observes whether its rival agreed to outsource. Indeed in many instances, it is easier for a firm to learn whether its rivals made an agreement with a supplier than to learn the exact terms of the agreement.

In the last stage of the game quantities are given by (1) as in our main analysis. In stage two, if firm 1 did not outsource, firm S solves:

$$\max_{w_2,f_2} \pi_S(w_2,f_2) = (w_2-s)q_2(w_2,s) + f_2, \tag{14}$$

$$\text{s.t.} \quad \pi_2(q_2(w_2,s),q_1(s,w_2)) - f_2 \geq \pi_2^{II}.$$

This coincides with the maximization problem in the IO case of our main analysis; hence, we have π_S^{IO}, π_1^{IO}, and π_2^{IO} and firm S can profitably generate outsourcing by firm 2 in equilibrium.

If, instead, firm 1 outsourced, firm S solves:

$$\max_{w_2,f_2} \pi_S(w_1,f_1,w_2,f_2) = (w_1-s)q_1(w_1,w_2) + f_1 + (w_2-s)q_2(w_2,w_1) + f_2, \tag{15}$$

$$\text{s.t.} \quad \pi_2(q_2(w_2,w_1),q_1(w_1,w_2) - f_2 \geq \pi_2(q_2(s,w_1),q_1(w_1,s)).$$

This coincides with the OO case of our main analysis. Therefore, whether or not the contract terms offered to firm 1 are observed by firm 2 in stage two plays no role as long as firm 1's agreement decision is observed and firms observe their rival's contract terms in the last stage of the game.

Simultaneous public offers

In stage one, when firm S outsources to both firms, it solves the following:

$$\max_{w_1,f_1,w_2,f_2} \pi_S(w_1,f_1,w_2,f_2) = (w_1-s)q_1(w_1,w_2) + (w_2-s)q_2(w_2,w_1) + f_1 + f_2, \tag{16}$$

$$\begin{aligned} \text{s.t.} \quad \pi_1(q_1(w_1,w_2),q_2(w_2,w_1)) - f_1 &\geq \pi_1^d(w_2) \\ \pi_2(q_2(w_1,w_2),q_1(w_2,w_1)) - f_2 &\geq \pi_2^d(w_1), \end{aligned}$$

where π_i^d is firm i's, with $i = 1,2$, disagreement payoff - the profits that it makes when it insources whereas its rival outsources: $\pi_i^d(w_j) = \pi_i q_i(s,w_j), q_j(w_j,s) = \frac{(a-2s+w_j)^2}{9}$. Since the

constraints are binding, we rewrite the above as:

$$\begin{aligned}\max_{w_1,w_2} \pi_S(w_1,w_2) &= [p_1(q_1(w_1,w_2),q_2(w_2,w_1))-s]q_1(w_1,w_2)-\pi_1^d(w_2) \\ &\quad +[p_2(q_2(w_2,w_1),q_1(w_1,w_2))-s]q_2(w_2,w_1)-\pi_2^d(w_1).\end{aligned} \tag{17}$$

This yields: $w_i^{OOp}=\frac{7s-a}{6}$ and $f_i^{OOp}=\frac{2(a-s)^2}{27}$. The supplier's profits are: $\pi_S^{OOp}=\frac{(a-s)^2}{54}$. If, instead, the supplier offers an outsourcing contract only to firm i, it solves again (2). The resulting equilibrium values coincide and the equilibrium values of the IO case in our main analysis, π_i^{IO}, with $i=1,2,S$. It is easy to check that it is more profitable for the supplier to serve both firms than to serve just one firm. Firm 1 and firm 2 profitably accept firm S's offers, $(w_1^{OOp}, f_1^{OOp}-\varepsilon)$ and $(w_2^{OOp}, f_2^{OOp}-\varepsilon)$ respectively, and get $\pi_1^{OOp}=\pi_2^{OOp}=\frac{25(a-s)^2}{324}+\varepsilon$. Thus, just in our main analysis, outsourcing by both firms arises in equilibrium.

Interestingly, the monopoly industry profits, $\Pi_{mon}=(a-s)^2/4$, are not achieved even though contracts are public. Why? The wholesale price that induces the monopoly outcome, $w_i^{mon}=(a+3s)/4$, exceeds s, and thus, w_i^{OO}. When firm i accepts $w_i^{mon}>s$, its rival can make higher variable profits by rejecting and producing in-house. Thus, to achieve the monopoly industry profits, firm S must offer a lower fee than f_i^{OOp}. Firm S's own profits though are then lower than π_S^{OOp}; hence, it prefers to generate a smaller pie and keep a larger share for itself.

Proof of Proposition 6: When firm i's marginal cost of in-house production is z, while firm j's is s, with $i,j=1,2$ and $i\neq j$, we assume that $z<\frac{a+2s}{3}$ so that firm i is active in the market in all cases under consideration. We start with the case in which firm i is firm 2. Then, firms' profits in the II case are $\pi_1^{IIa}=\frac{(a-2s+z)^2}{9}$ and $\pi_2^{IIa}=\frac{(a-2z+s)^2}{9}$. If firm 1 does not outsource, in stage two, firm S solves again (2), with the difference that $\pi_2^{dIO}=\pi_2^{IIa}$. This results again to $w_2^{IOa}=w_2^{IO}$, and, in turn, to the profits π_S^{IOa}, π_1^{IOa}, and π_2^{IOa} included in Table 2. If, instead, firm 1 outsources, in stage two, firm 2 faces (3), with the difference that $\pi_2^{dOO}=\pi_2(z,w_1)$. This leads to (4). In stage one, firm one solves (5), with $f_2(w_1)=\pi_2(w_2(w_1),w_1)-\pi_2(z,w_1)$ and $\pi_1^{IO}=\pi_1^{IOA}$. This yields $w_1^{OOa}=\frac{(a+9s+16z)}{26}$ and $w_2^{OOa}=\frac{(-3a+4(3s+z))}{13}$. From the appropriate substitutions, we find π_S^{OOa}, π_1^{OOa}, and π_2^{OOa} included in Table 2. We note that $\pi_S^{OOA}>\pi_S^{IOA}>\pi_S^{IIA}=0$. Thus, in equilibrium firm S profitably generates outsourcing by both firms by offering them $(w_1^{OOa}, \pi_1(w_1^{OOa},w_2^{OOa})-\pi_1^{IOa}-\varepsilon)$ and $(w_2^{OOa}, \pi_2(w_2^{OOa},w_1^{OOa})-\pi_2(z,w_1)-\varepsilon)$.

We turn to the case in which firm i is firm 1. Following the same procedure as above, we find the equilibrium profits included in Table 3. We note that $\pi_S^{OOb}>\pi_S^{IOb}>\pi_S^{IIb}=0$. Thus, we conclude that in this case too, firm S profitably generates outsourcing by both firms in equilibrium.

Comparing the profits of firm S in the two cases, we find that $\pi_S^{OOa}>\pi_S^{OOb}$. Thus, firm S prefers to trade first with the more efficient firm and second with the less efficient firm

than the other way around. Furthermore, we find that $\pi_S^{OOa} > \pi_S^{OO}$ and $\frac{\partial \pi_S^{OOa}}{\partial z} > 0$. ■

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