This paper investigates the competitive effects of outsourcing between vertically integrated competitors. Outsourcing diminishes the residual capacity of the subcontractor to offer products independently downstream. As such, it is a means to reduce competition. Upstream production capacity serves a bargaining purpose. It threatens to compete on a stand-alone basis when firms would disagree about outsourcing. In equilibrium, outsourcing occurs and can inactivate the subcontractor as downstream competitor. Uninformed observers face an identification problem in distinguishing the horizontal agreement from a vertical one. This distinction, however, is crucial because vertical agreements are generally presumed to be less harmful for competition.

Keywords: vertical integration, outsourcing, industry structure, horizontal subcontracting.

JEL-codes: D23, D43, L13, L14, L22, L41
1. Introduction

A vertically integrated firm has access to assets located upstream as well as assets located downstream in the value chain. Vertical integration can occur by means of a vertical merger, e.g. a merger between an upstream producer and a downstream retailer, or by internal growth (Riordan, 2005).

Vertical mergers have received a lot of attention in the context of vertical agreements. In an environment with linear wholesale tariffs, vertical integration can substitute for a vertical agreement and can overcome the double marginalization problem. Vertical integration has also been related to market foreclosure. In Hart and Tirole (1990), it is a way to alleviate contractual externalities. A firm with upstream market power, e.g. due to a cost advantage, may vertically integrate to commit not to secretly oversupply outside retailers. In Ordover et al. (1990), a vertically integrated firm has fewer incentives to compete for serving an outside downstream competitor. The outside downstream competitor’s marginal cost rises in equilibrium, which increases the downstream price.

Vertical integration by internal growth can be modelled with a continuous capacity variable. Several studies have related endogenous capacity choices with horizontal competition issues. In Riordan (1998), a dominant firm vertically integrates by acquiring capacity. While a larger investment expands total capacity in equilibrium, a larger investment also reduces the size of the competitive fringe, so that vertical integration inherits features of a horizontal merger. In standard models of horizontal competition, production capacity also takes a strategic role. Kreps and Scheinkman (1983) show that firms have unilateral incentives to commit to a maximal production capacity before they engage in price competition. The intuition is that, by limiting one’s own capacity to serve all consumers, the rival firm is guaranteed to profit from residual consumers. In this way, being capacity-constrained induces the rival to become less aggressive. In other words, installing too much capacity can backfire, as it leads to a more aggressive competitor. Firms therefore revert to a puppy dog strategy (Fudenberg and Tirole (1984) terminology). The main result from Kreps and Scheinkman (1983) is that, under endogenous capacity choices, the competitive outcome moves away from fierce Bertrand competition, and can for example equal the Cournot outcome, depending on the rationing rule.
This paper introduces the possibility for competing firms to sign outsourcing agreements with each other, henceforth *horizontal outsourcing*, into the Kreps and Scheinkman (1983) framework. The outsourcing decision occurs after the unilateral decision to invest in upstream production capacity, and before firms engage in downstream price competition. The horizontal outsourcing stage can reflect the possibility for competing firms to trade on forward markets. Such horizontal forward trade is important, not just for commodity markets such as natural gas and electricity, but also for financial securities markets. Other industries such as manufacturing industries or markets for transportation services may not be characterized by liquid forward markets, but also commonly feature outsourcing agreements between (potentially) competing firms.

The analysis yields a striking result: horizontal outsourcing turns the downstream market into a monopoly. As such, the analysis reveals an anti-competitive motive for horizontal outsourcing agreements that has remained unreported so far, both in the vertical integration literature and the Bertrand-Edgeworth competition literature. The analysis also uncovers new interactions between the possible gains from signing anti-competitive horizontal outsourcing agreements and firms’ decisions to invest in production capacity.

Outsourcing agreements between competing vertically integrated firms can weaken competition as follows. Outsourcing agreements are signed before the downstream competition stage. They specify a quantity to be subcontracted in return for a lump-sum transfer. As such, outsourcing reduces the residual capacity of the subcontractor to offer products independently downstream. When the subcontractor deploys its entire capacity to supply the rival, it is no longer able to compete for consumers downstream. Gains from outsourcing arise from reduced downstream competition. The subcontractor is willing to sign the agreement when its profits from subcontracting exceed its outside option profits from competing without subcontracts. The contractor sourcing from the rival is willing to sign an expensive outsourcing agreement when it anticipates reduced downstream competition.

The choices to become active upstream and downstream are endogenous. The subcontractor can become inactive downstream because of its upstream capacity constraint.

\[^2\text{For example, treasury auctions are often preceded by when-issued markets, where competing dealers can trade with each other (see Coutinho, 2013).}\]
The contractor, even when vertically integrated, can become inactive upstream because of reduced marginal revenues on the downstream market.

The analysis shows that outsourcing affects the observed industry structure. In my framework, firms optimally sign an outsourcing agreement that requires the subcontractor to produce at full capacity. This agreement inactivates the subcontractor as downstream competitor. While the agreement is horizontal, it may not be assessed as horizontal by indicators that are exclusively based on production figures, market shares, or bidding data. If so, uninformed observers face an identification problem in distinguishing the horizontal agreement from a vertical one. Since vertical agreements are usually regarded as less harmful for competition, this finding suggests that potentially harmful outsourcing agreements may remain unnoticed in practice.

The outsourcing agreement considered in this paper is a forward contract (also sometimes labelled quantity-forcing contract): it pre-determines the amount of products supplied, together with the lump-sum transfer to be paid in return. Strikingly, forward contracts can, from an effects-based point of view, be similar more sophisticated types of cooperation such as e.g. option contracts, exclusive dealing contracts, leasing or purchasing contracts for production assets, joint bidding agreements, mergers, or collusive agreements. Compared to other, more sophisticated horizontal outsourcing agreements, forward contracts are less likely to receive attention from competition authorities. As we will see, in my framework, there is no incentive for firms to turn to more sophisticated contracts.³

For antitrust purposes, it is important to emphasize that the anticompetitive effect described in this paper does not follow from a unilateral strategy by the contractor to foreclose a cost-efficient rival (see Rey and Tirole, 2007). Both parties, including the subcontractor who is inactive downstream, benefit from the outsourcing agreement. In the Treaty on the Functioning of the European Union, the relevant article is therefore Article 101 on agreements between firms rather than Article 102 on the abuse of dominant position. The anticompetitive effect should also be distinguished from Aghion and Bolton (1987), where the agreement extracts rents from an outside potential entrant. Here, there is reduced

³ As such, my analysis differs from Chen (2001), Sappington (2005), and Arya et al. (2008). A vertically integrated firm could sell its input using a contract that provides a rival retailer the option to buy the input after it has competed for consumers. These contracts have an anticompetitive effect because they create an opportunity cost of serving consumers downstream. Indeed, by serving final consumers, the vertically integrated firm foregoes subcontracting revenues received from the rival. My analysis of vertical integration and outsourcing does not rely on this opportunity cost.
competition from the subcontractor taking part in the agreement, and surplus is extracted from the final consumer.

The analysis incorporates two pro-competitive effects that can offset the possible anti-competitive effects of horizontal outsourcing. First, the analysis allows for cost-efficiencies in the sense that outsourcing agreements allow firms to shift their production activity towards the lowest-marginal cost production technology. While cost-efficiencies can add to the gains from outsourcing, however, they are not required for the outsourcing agreement to be profitable in reducing competition.\(^4\) Second, the analysis suggests an incentive to excessively invest in production capacity for strategic reasons. In particular, when firms bargain over an outsourcing agreement, production capacity credibly threatens to act as a stand-alone competitor when firms would disagree. Both effects can benefit consumers. However, the latter effect suggests that firms may considerably waste resources to invest in idle production capacity.

The anticompetitive motive for horizontal outsourcing has not been incorporated in the vertical integration literature. It does not arise in the limiting case where competing vertically integrated firms have constant marginal costs and no capacity constraints (Hart and Tirole, 1990, Ordover et al., 1990, and more recently Chen, 2001, and Nocke and Rey, 2014). Indeed, the anticompetitive effect described here requires that supplying the rival reduces the ability of the subcontractor to serve consumers independently. The *scarce supplies* model in Hart and Tirole (1990) analyzes the other extreme where total capacity in the industry is smaller than the monopoly quantity. This assumption, too, removes the role for horizontal outsourcing to reduce competition. Indeed, there are no incentives for the industry to reduce industry output further below the monopoly quantity. Finally, the anticompetitive effect described in this paper requires sequentiality: the outsourcing agreement should be signed before the competition stage. That sequential order in which supplies are determined is not present in de Fontenay and Gans (2005), leading them not

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\(^4\) This result differs from Spiegel (1993)’s analysis of ex ante horizontal subcontracting. In Spiegel (1993), an outsourcing agreement that inactivates the subcontractor always benefits consumers. The driving assumption in that analysis is that gains from outsourcing are concave with respect to the subcontracted quantity (proposition 7, p. 581). My analysis shows that such concavity is naturally violated in the context of anticompetitive outsourcing. The reason is that firms gain from reducing competition both when one firm subcontracts at full capacity to its rival (positive subcontracted quantity), as well as vice versa (negative subcontracted quantity). Therefore, by assuming concave gains from outsourcing, Spiegel (1993)’s results understate the anticompetitive motive for horizontal outsourcing.
to find the anticompetitive effect described in this paper, despite the presence of increasing marginal costs.\(^5\)

Importantly, I argue that intermediate levels of upstream capacity constraints, which lead to the anticompetitive effect, arise endogenously from the analysis of internal growth. When a firm decides how much to invest in capacity, it not only accounts for the outside option profits it would earn if it would refuse to sign an outsourcing agreement, but also accounts for the gains from outsourcing it can capture. That decomposition into outside option profits and gains from outsourcing reveals that each firm is likely to invest in some capacity, though not too much. On the one hand, firms do not have incentives to build large capacities. Indeed, capacity constraints are needed for outsourcing to be anti-competitive, so installing a large amount of production capacity can reduce the gains from outsourcing. On the other hand, Hart and Tirole (1990)’s *scarce supplies* scenario is unlikely to be an equilibrium phenomenon either. The reason is that upstream capacity takes a strategic role in preserving a firm’ s outside option profits. It follows that firms have incentives to commit to act as horizontal competitor absent outsourcing, while signing an outsourcing agreement that reduces competition in equilibrium.\(^6\) As the gains from outsourcing include the profits from reducing competition, cost-efficiency gains from outsourcing are not needed for vertical integration to complement outsourcing.\(^7\)

\(^5\) My findings also contribute methodologically by suggesting caution with the assumption of concave profits that is intended to guarantee a unique equilibrium. The assumption of concave profits biases the analysis towards symmetric outcomes. In my framework, however, ex ante similar (symmetric) firms have incentives to sign outsourcing agreements so that they undertake complementary (asymmetric) activities in the vertical supply chain. A setting that assumes concave profit functions would have overlooked this equilibrium phenomenon.

\(^6\) The role upstream capacity investment resembles the role of vertical integration in Chen and Riordan (2007). They analyze a vertically merged firm that offers an exclusive dealing contract to an outside downstream retailer. Vertical integration affects firms’ outside option profits, as well as the marginal profits from signing an exclusive dealing contract. More precisely, the vertical merger commits to a price war absent exclusive dealing, and exclusive dealing serves to reduce competition downstream. My analysis does not require the possibility to sign exclusive dealing contracts.

\(^7\) This result does not arise from other settings where the horizontal outsourcing agreement is only a means to reduce production costs (see e.g. Hart and Tirole (1990) and Bouckaert and Van Moer (2017), among others). More generally, these insights highlight that vertical integration needs not substitute for outsourcing. That result differs from Shy and Stenbacka (2003) and Bühler and Haucap (2006), where outsourcing is a substitute for vertical integration. In their frameworks, a strategic interdependency arises because the input price from outsourcing exceeds the marginal cost after an in-house investment. Outsourcing from the input market then subjects a firm to a high input price that softens its incentive to compete fiercely downstream. For discussions and analyses of vertical integration and outsourcing in other contexts, I refer to the seminal works of Williamson (1979, 1985) on transaction cost economics and Klein et al. (1978) on the hold-up problem for relationship-specific investments.
The anticompetitive effects of horizontal outsourcing described in this paper have also remained unreported in the Bertrand-Edgeworth literature. Van Cayseele and Furth (1996, 2001) differ from my framework by analyzing a buyout possibility at the downstream price. My framework analyzes outsourcing at the wholesale level and has applications to a range of commonly observed outsourcing agreements between businesses. Bouckaert and Van Moer (2017) and Hunold and Muthers (2017) also analyze capacity constraints but differ from my analysis by investigating outsourcing agreements that are signed after the competition stage (ex post), yielding competitive effects that are distinct in nature.\(^8\)

The extension of Kreps and Scheinkman (1983) with a horizontal outsourcing stage, besides altering the competitive outcome, has the potential to considerably simplify the duopoly analysis. The reason is that, in equilibrium, the subcontractor will turn inactive as a downstream competitor, possibly avoiding the need to analyze mixed strategies.

The topic of wholesale market foreclosure in the natural gas industry provides an example with an application to competition policy. To fix ideas, let the upstream segment represent the production and transportation of natural gas, which are capacity-constrained.\(^9\) The downstream segment represents the wholesale market.

In many countries, upstream producers offer long-term contracts to supply incumbents. For example, in Denmark, there is a supply contract between three upstream producers (DUC consortium) and a vertically integrated incumbent (DONG). The vertically integrated incumbent is active as an upstream producer and is dominant on the wholesale market. This paper contributes by showing that the supply contract in itself can harm competition; supply contracts decrease the capacity available by the suppliers to offer independently on the wholesale market.\(^10\)

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8 For example, for price-inelastic demand, when two duopolists each have a production capacity equal to market demand, there is no anti-competitive role for ex post outsourcing, while outsourcing before the competition stage implements collusion, as we will see.

9 The maximal capacity offered by natural gas producers is limited, both by their production equipment and by their acquired transportation rights.

10 Producers (upstream) are potential Danish wholesale competitors (downstream). The following statement in the European Commission’s DG competition report on the energy sector inquiry (2007) supports this claim: “[i]t cannot be excluded that certain producers [—subcontractors—] will develop into credible competitors that reduce concentration on European gas wholesale markets. The effects on competition of the entry of such companies must, however, be examined in detail in the light of the cooperation which exists between some of these producers and a number of incumbents players. In any case, the effects of long-term reservations by large gas producers remain the same for other potential new entrants.”
The theory of harm presented in this paper differs from the ones raised by competition authorities. Indeed, competition authorities have been concerned with this case for three reasons. First, they have investigated joint price setting in the consortium, which raises horizontal concerns. Second, clauses in the supply contract intended to reduce competition.\textsuperscript{11} Finally, the duration of the supply contracts is considered an important barrier to enter for new potential entrants, raising exclusion concerns.\textsuperscript{12} While the concerns raised by competition authorities are likely to have valid grounds, several interventions have not resulted in much entry. Indeed, the Danish Energy Regulatory Authority (DERA) reported in 2008 that DONG still had access to 85\% of the gas available in the wholesale market. Only one of the DUC partners, Shell, was active on the Danish wholesale market, with a market share below 5\% (DERA, 2008).

The analysis also contributes to understanding the competitive effects of commodity forward markets. Allaz and Vila (1993) show that the possibility for firms to sell forward contracts to \textit{financial firms} increases competition on a Cournot spot market.\textsuperscript{13} However, installing a forward market also allows \textit{competitors} to reallocate financial commitments.\textsuperscript{14} In a setting where forward trade takes place between competing producers, I show that installing a forward market can reduce spot market competition. As such, my setting relates more closely to Coutinho (2013), who analyzes when-issued markets where inter-dealer trade occurs before competing on a treasury auction. In a similar fashion, the when-issued (forward) positions affect auction (spot) outcomes. In Coutinho (2013), however, the when-issued positions do not affect the auction price. My findings indicate that this is an artefact of the marginal utility (cost) functions imposed (linear and common slope).

My analysis suggests that some firms may opt for an intermediary rather than to bid directly on the treasury auction. As such, introducing a when-issued market, next to serving a

\textsuperscript{11} In particular, the supply contract included a ‘necessary adjustment mechanism’. The mechanism is “[...] interpreted as providing that the DUC partners and DONG have to agree on adjustments to the gas supply agreements, e.g. the take-or-pay obligations of DONG, if the DUC partners start selling gas into Denmark” (Schnichels and Vallie, 2003). The mechanism discouraged the DUC partners to start selling gas independently.

\textsuperscript{12} Aghion and Bolton (1987) show that below-marginal cost pricing can act as a barrier to entry. Polo and Scarpa (2013) analyze the anticompetitive effects of Take-Or-Pay contracts where marginal costs are very low up to a pre-agreed quantity.

\textsuperscript{13} Mahenc and Salanié (2004) show the opposite result when the spot market is best characterized by price competition.

\textsuperscript{14} Electricity markets are an important example. When an electricity producer experiences an unavailability of one of its production plants, it can either provide back-up production in-house, or buy production on the market. The counterparty is often a downstream competitor with access to cheaper production, e.g. a wind farm producer with favorable weather forecasts.
possible efficiency purpose, can reduce competition and participation in the main treasury auction, a finding that can help explain high concentration on the main auction.

2. The setup

There are two firms.\textsuperscript{15} A vertically integrated firm has the ability to produce products upstream, as well as the ability to market products downstream.

The upstream cost function exhibits decreasing returns to scale. In particular, given capacity investments, each firm $i = 1, 2$ is characterized by marginal costs $c_i$ up to its capacity constraint $k_i$.\textsuperscript{16} Denote the lowest marginal cost by $c_L = \min(c_1, c_2)$ and the highest marginal cost by $c_H = \max(c_1, c_2)$. I will refer to the lowest-cost firm as the efficient (or cost-efficient) firm, and the highest-cost firm as the inefficient (or cost-inefficient) firm. When both firms have the same marginal cost, the distinction can simply be read as firm $i$ and firm $j$.

Capacity provides a firm with the ability to produce. Capacity is industry-specific, i.e., a firm can only use its capacity to supply its downstream unit or to supply the rival’s downstream unit. The capacity variable is continuous and investing in additional capacity is costly. Formally, when $r_i(k_i, c_i)$ represents firm $i$’s cost of installing the capacity to produce at most $k_i$ at marginal cost $c_i$, we have that $r_i(x, c_i) > r_i(y, c_i)$ when $x > y$.\textsuperscript{17}

\textsuperscript{15} An important advantage of the duopoly setup is that it presents the results without relying on contractual externalities. As we will see, the main intuition extends to an N-firms oligopoly. The extension raises the issue of contractual externalities that is common in the literature, and requires a more detailed description of how firms establish horizontal outsourcing agreements.

\textsuperscript{16} Manufacturing firms are often constrained by the production capacities of their plants. Also, the number of qualified workers is usually limited in the short run.

\textsuperscript{17} The capacity cost function does not depend on the capacity choice of the rival, to make sure that the raising rival’s costs channel analyzed in Riordan (1998) is inactive.
Downstream marketing costs are zero for simplicity. Since retail assets are often not industry-specific, I do not introduce retail capacity constraints. The underlying idea is that retail assets could be flexibly acquired if needed.\textsuperscript{18}

There are three stages. In the investment stage, firms simultaneously choose to vertically integrate by building upstream production capacity. In the outsourcing stage, firms bargain with each other over an outsourcing agreement. The agreement specifies and settles a quantity to be produced in return for a transfer. To capture that supplier relationships are often flexible, the outsourcing stage takes as given the upstream capacities.\textsuperscript{19} Finally, in the downstream competition stage, firms compete to offer homogenous products to final consumers.

**Investment stage**

In the investment stage, firms unilaterally and simultaneously invest in upstream production capacity $k_i$. The investment stage incorporates the possibility of zero capacity, in which case the firm only holds downstream assets. Every unit invested keeps constant the rival’s upstream capacity, so the investment should be interpreted as the installation of new capacity, i.e., internal growth, rather than the takeover of existing capacity.

**Outsourcing stage**

Firms can sign a horizontal outsourcing agreement. In particular, firm 1 subcontracts quantity $\tilde{q}$ to firm 2 in return for a transfer. The standard analysis without outsourcing agreements corresponds to $\tilde{q} = 0$. The sign of $\tilde{q}$ determines the direction of the outsourcing agreement; firm 2 acts as a subcontractor for negative values. Subcontracting for the rival firm implies a transaction cost $t \geq 0$ incurred by the subcontractor.\textsuperscript{20}

*Cost-efficient direction:* The efficient firm acts as subcontractor.

\textsuperscript{18} Remark that it is possible to construct an analogous framework for markets with upstream buyer power for inputs, and downstream capacity constraints.

\textsuperscript{19} Arrunada and Vázquez (2006) report that “many strategic alliances end up devolving into temporary market-agreement relationships”. They present the example of DaimlerChrysler, which asked Magna Steyr to assemble the Mercedes-Benz M-Class SUV eight months after the deal. They argue that, as a result of standardization and flexible manufacturing, contract manufactures can be replaced rather easily.

\textsuperscript{20} It is possible to interpret the transaction cost as a relation-specific investment required for the outsourcing agreement. In my framework, this interpretation does not imply a hold-up problem because the transfer is agreed upon simultaneously with the decision to sign an outsourcing agreement.
Cost-inefficient direction: The inefficient firm acts as subcontractor.

The subcontracted quantity $\bar{q}$ affects industry profits through the equilibrium quantities, prices and production levels. In contrast, the transfer does not affect the industry profits; it is sunk in the competition stage and cancels out. If firms can increase joint industry profits from horizontally outsourcing $\bar{q}$, there always exists a transfer such that both firms want to sign the horizontal outsourcing agreement. I assume that firms share the gains from outsourcing using the symmetric Nash-Bargaining solution. This solution has the desirable property that, when firms invest symmetrically, they earn the same profits in equilibrium.\textsuperscript{21}

We can summarize that firm $i$ ‘s profits are

\begin{equation}
\pi_i^o = \pi_i^{no} + 0.5 \left( \pi_{1i}^o + \pi_{2i}^o - \pi_{1i}^{no} - \pi_{2i}^{no} \right)
\end{equation}

, where $\pi_i^o$ equals $i$ ‘s profits under outsourcing and $\pi_i^{no}$ equals $i$ ‘s profits under no outsourcing. Profits consist of the firm’s outside option profits, $\pi_i^{no}$, and its share of the gains from outsourcing according to the symmetric Nash-bargaining solution.

The profit functions include the costs of investing $r_i(k_i,c_i)$ and $r_j(k_j,c_j)$. However, that cost does not affect the gains from outsourcing since it cancels out. The gains from outsourcing, when positive, are adjusted for the transaction cost $t$. The transfer paid from the contractor to the subcontractor cancels out.

\textbf{Competition stage}

As a prerequisite, the following concepts specify what happens when firms do not offer their acquired production downstream.

\textit{Prohibitive disposal:} The contractor offers at least its contracted quantity. Prohibitive disposal requires that, if a firm contracts from its competitor, it must offer at least its contracted quantity downstream. In other words, the firm cannot pile up acquired production.\textsuperscript{22}

\textsuperscript{21} Whether firms share the surplus symmetrically does not affect the results but may affect the magnitude of the investment incentives.

\textsuperscript{22} An example product is electricity, which cannot easily be stored.
**Free disposal:** The contractor can choose not to offer its contracted quantity downstream at no charge.\(^{23}\) In case the contractor’s in-house marginal cost is zero, the tie-breaking rule specifies that the contracted production is offered first.

The basic model investigates three modes of competition: price competition with price-inelastic demand, quantity competition, and price competition with price-elastic demand. The basic framework investigates homogeneous goods. The extension section discusses product differentiation.

**Price competition with price-inelastic demand**

Firms compete in prices to supply \(D\) divisible units. In particular, a non-strategic procurer or consumer wants to buy at most \(D\) units at per unit valuation \(V\).\(^{24}\) Quantity \(D\) is trivially equal to the monopoly quantity. The tie-breaking rule favors the efficient firm, if any, and randomly selects the winner otherwise.

Note that a price competition framework cannot accommodate the assumption of prohibitive disposal. The reason is that the price-competitive contractor’s ability to offer downstream is subject to the rival’s price. In particular, if the rival charges a lower price, the contractor sells zero and piles up its contracted quantity. The price competition framework therefore proceeds while allowing for free disposal.\(^{25}\)

**Cournot competition**

Firms compete in quantities. Inverse demand equals \(P(q_i + q_2)\). Label the monopoly quantity when a firm’s marginal cost is \(c_i\) absent capacity constraint as \(q^{m,c_i} = \arg\max_q \left[ P(q) - c_i \right] \). The monopoly quantity increases when marginal costs decrease, or \(q^{m,c_i} \leq q^{m,c_i} \leq q^{m,0}\). As usual, suppose that quantities are strategic substitutes, meaning that a firm’s optimal offered quantity is a decreasing function of the rival’s offered quantity. Also, the best response functions are not too steep so that an exogenous increase in a firm’s offered quantity leads to an increase in industry output \(q_i + q_2\).

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\(^{23}\) Free disposal is in line with Chen et al. (2011).

\(^{24}\) Valuation \(V\) could represent the consumer’s cost of acquiring a substitute product.

\(^{25}\) The main insights also hold for any bounded disposal cost.
Note that the quantity competition framework can accommodate both the free disposal and the prohibitive disposal assumption because a quantity-competing contractor is always able to offer at least its contracted quantity downstream.

*Price competition with price-elastic demand*

This mode of competition mimics Kreps and Scheinkman (1983) and extends it by allowing for horizontal outsourcing. Denote the demand function by \( Q(p) \), the inverse of the function \( P(Q) \) we use in the Cournot model. Assume that the downstream marginal costs are constant and symmetric at \( 0 = c_L = c_H \), and that the capacity cost functions are symmetric and written as \( r(k_i, 0) \) and \( r(k_j, 0) \). The demand function is well-behaved and there exists a monopoly price \( p^M = \arg \max_p pQ(p) \). The monopoly quantity is the demand associated with the monopoly price, or \( q^M = Q(p^M) \). When the rival sells \( k_j \), the optimal response is to offer \( \rho_j(k_j) = \arg \max_{q_k} \left( q_k P(q_k + k_j) \right) \) by charging \( P(\rho_j(k_j) + k_j) \).

As the price competition framework with price-inelastic demand, this framework also proceeds by allowing for free disposal.

### 3. Analysis

The basic model investigates a homogenous product duopoly setting and provides a monopoly result. In particular, the duopoly model finds that the cost-efficient firm acts as subcontractor and deploys its entire capacity to supply the cost-inefficient firm. The contractor sourcing from the rival then becomes monopolist downstream.

The result arises from backward induction in two steps.
**Outsourcing and competition stages**

The first step investigates only the outsourcing and competition stage. It starts by giving an intuitive outline of the possible effects of outsourcing. It proceeds with a formal analysis and finds a sufficient condition for the downstream market to be a monopoly.

If we do not account for the investment stage, horizontal outsourcing can have ambiguous effects on costs as well as on competition (see Spiegel, 1993).

- Horizontal outsourcing agreements have the potential to reduce or increase production costs. In particular, production can shift between inefficient and efficient firms, total output can change, and an outsourcing agreement can involve a transaction cost. The cost effect crucially depends on the direction of the subcontract. Total costs tend to decrease when the cost-efficient firm acts as subcontractor for the cost-inefficient firm and tend to increase otherwise.

- Without considering endogenous investments, horizontal outsourcing agreements also have the potential to benefit or harm consumers. There are two opposing competitive effects. On the one hand, an outsourcing agreement *softens* the subcontractor on the downstream market. By acting as subcontractor, a firm reduces its capacity available to offer additional production downstream. On the other hand, an outsourcing agreement makes the contractor *aggressive* on the downstream market. The reason is that the contractor’s cost of offering contracted production downstream is zero because the transfer paid to purchase this production is sunk. As such, the contractor does not account for the production costs incurred by the subcontractor. The net effect of horizontal outsourcing on consumer surplus could therefore be ambiguous.

Remark that the profitability of horizontal outsourcing depends on how the production cost effects balance against the competitive effects. Provided that the outsourcing agreement signed must have been profitable, the outsourcing agreement must have been cost-reducing, anticompetitive, or both.

Proposition 1 provides a sufficient condition for the downstream market to be a monopoly.

**Proposition 1**: if each firm installs a production capacity that equals at most the monopoly quantity, and if the transaction cost is sufficiently low, the downstream market is a monopoly.
The appendix provides the proof.

The intuition is that, when each firm installs at most the monopoly quantity, firms can always agree on the following outsourcing agreement:

- in the outsourcing stage, the efficient firm, who has the lowest marginal cost, acts as the subcontractor and sells an amount of products equal to its capacity constraint to its rival.
- in the competition stage, the contractor is monopolist.

This agreement always maximizes joint profits: revenues are optimal from a joint profit perspective, and production is efficient from a joint profit perspective.\(^{26}\)

Since the contractor is monopolist, firms do not impose a competitive externality on each other downstream. In other words, in terms of revenue generation, the incentives of the contractor are aligned with the incentives of the industry. As a result, the contractor charges the monopoly price or, for the quantity competition model, offers the monopoly quantity.

In terms of production costs, the outsourcing agreement is efficient because the production technology with the lowest marginal cost receives priority and is deployed first. Indeed, the contractor incurs zero additional costs to offer its contracted production to the final consumer. The contractor will only activate in-house production after the efficient technology is maximally utilized.

Remark that, in the special case where both firms’ production technology is characterized by the same marginal production cost, there are two optimal outsourcing agreements, one in each direction. The analysis remains unchanged; both outsourcing agreements are equivalent in terms of profits and consumer welfare.

**Investment stage**

The second step investigates the investment stage. Again, it starts with an intuitive overview of the possible effects, and proceeds with a formal result.

Firm \(i\)'s profit function can be rewritten as

\[
\pi_i^o = 0.5\pi_i^{no} - 0.5\pi_j^{no} + 0.5\left(\pi_1^o + \pi_2^o\right)
\]

\(^{26}\) Joint profit maximization refers to the outsourcing and competition stage and thus treats the investment choices and costs as given and sunk.
Installing upstream capacity affects a firm’s profits via several channels. I next discuss the first two terms, which highlight firms’ unilateral—and possibly conflicting—interests to build capacity, as opposed to the final term, which highlights their joint interests.

- First, the effect of investing on a firm’s own outside option profits \(\pi_i^{no}\) are as follows. Clearly, without investment, a firm fully eliminates its outside option profits. Indeed, without capacity, it is unable to offer any product downstream. An intermediate level of investment implies strictly positive gross profits under no outsourcing (excluding the investment cost). Indeed, strictly positive profits are predicted both by models of price competition with capacity constraints as well as Cournot competition models. Finally investing in a lot of capacity commits to compete aggressively. This commitment can be profitable in a quantity competition context with strategic substitutes, because the rival will respond by offering less. In contrast, the commitment to compete fiercely typically reduces profits in a price competition context with strategic complements, because the rival will respond by reducing its price. This creates a downward effect on \(\pi_i^{no}\).²⁷

- Second, additional production capacity reduces the rival’s outside option profits \(\pi_j^{no}\), and thereby the gains from outsourcing. In particular, both for quantity and price competition, installing a positive capacity implies that the rival faces an extra competitor. The larger the capacity installed, the larger the commitment to compete fiercely absent outsourcing. Hence, capacity investments always reduce the rival’s outside option profits \(\pi_j^{no}\).

The formal result requires to rule out dominated investment strategies: installing a capacity larger than the monopoly quantity always reduces a firm’s outside option profits, and can decrease the gains from outsourcing.

**Proposition 2:** monopoly result: *in the investment equilibrium, each firm installs at most the monopoly quantity. It follows that, for a sufficiently low transaction cost, two vertically integrated competitors sign a horizontal outsourcing agreement such that*

²⁷ This insight is illustrated by the standard Bertrand price competition model. Given that the rival invests in an infinite amount of capacity, following suit and investing an infinite amount of capacity in the same technology would lead to fierce competition and an equilibrium price down to marginal cost.
- the cost-efficient firm subcontracts at full capacity;
- the cost-inefficient firm is monopolist downstream;
- consumer surplus decreases (for given capacities).

The appendix provides the proof.

The intuition uses that a firm’ profits consist of outside option profits and the gains from outsourcing it can capture, as displayed in equation (1). Installing capacity beyond the monopoly quantity reduces a firm’s outside option profits, as doing so is costly on the margin and does not contribute to the standard duopoly profits. At the same time, firms benefit from having a capacity constraint that is at most equal to the monopoly quantity, as that allows for anticompetitive outsourcing agreements.

The investment stage rules out that the effect of horizontal outsourcing on consumers is ambiguous. The reason is that, in the investment equilibrium, the possible pro-competitive effect is zero on the margin. On the investment equilibrium path, firms invest in sufficiently small capacities because it is a dominated strategy to invest in capacity that will never be offered. For small capacities, it is always in the interest of the industry to fully deploy the capacity of the cost-efficient firm. Marginal sales by the contractor are covered with its in-house production assets. Consequently, the contractor responds to the actual marginal production cost in equilibrium.28

A more informal, perhaps too informal, way of understanding the monopoly result is as follows. First, since the gains from signing an outsourcing agreement are shared between the firms, profitable investment decisions are likely to be the ones that lead to profitable outsourcing agreements. Profitable outsourcing agreements, in turn, are the ones that reduce costs, reduce downstream competition, or both. Therefore, the outsourcing agreements we see in equilibrium are likely to be the ones that reduce costs, reduce downstream competition, or both.

It is useful to note that the monopoly result does not rely on the presence of multiple downstream markets. Then, a monopoly outcome can also result because serving one market of consumers is cost-increasing for the remaining markets.29 Finally, the monopoly

28 As described, off the investment equilibrium path, the subcontractor’s capacity could be larger than the monopoly quantity. The contractor would then act too tough on the downstream market: marginal sales are covered with contracted production, of which the perceived marginal cost is zero.
29 Dudey (1992) analyzes capacity-constrained firms competing in multiple markets throughout time. Granting the rival a monopoly position on some markets exhausts its available capacity on
outcome also does not rely on a Stackelberg-leadership effect by the contractor. The contractor could take a Stackelberg-leader role because the cost of acquiring production is sunk at the moment of competing. Chen (2011) shows that, in the presence of entry costs, this effect can prevent entry.\(^{30}\)

Proposition 3 confirms that the result is robust to the introduction of more sophisticated contracts during the outsourcing stage.

**Proposition 3.** *Suppose that firms can sign more sophisticated contracts during the outsourcing stage. Then, firms can do no better than signing the forward contract analyzed in this paper, and the analysis remains unchanged.*

The intuition is that firms can already achieve the collusive outcome (given capacity choices), so they cannot improve their profits by signing a more sophisticated contract.

This section proceeds by comparing the consumer welfare level predicted by my framework with the consumer welfare level predicted by Kreps and Scheinkman (1983).

In Kreps and Scheinkman (1983), the equilibrium price equals the market-clearing price that follows from Cournot competition. The cost function upon which the Cournot benchmark is based equals the sum of the capacity cost functions, \( r(q, 0) \), and the production cost functions, which are zero. Formally, a firm’s duopoly quantity is implicitly defined as \( q^d \equiv \arg \max_q \left[ qP(q + q^d) - r(q, 0) \right] \), and leads to a market-clearing price equal to \( P(2q^d) \).

In my framework, the equilibrium price equals the monopoly price, or weakly exceeds it when firms install little capacity. The monopoly price in my framework, however, is only based on the production cost functions. In other words, it does not account for the marginal costs of investing in capacity. The reason is that investment costs are sunk at the moment of signing an outsourcing agreement. Therefore, the gains from outsourcing are

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\(^{30}\) Interestingly, entry deterrence can then motivate a cost-inefficient sourcing agreement. Chen et al. (2011) show that cost-inefficient sourcing agreements can also arise without entry costs. The reason is that the subcontractor needs to be compensated not only for its production cost, but also for incurring the Stackelberg-follower disadvantage.
independent of the incurred investment costs. Formally, we can write that, in my framework, the equilibrium quantity offered to consumers is weakly lower than 

\[ Q^M \equiv \arg \max_q \left[ qP(q) \right], \]

and leads to a price weakly higher than \( p^M = P(Q^M) \).

Proposition 4 finds that the direction of the consumer welfare effect depends on how the duopoly quantities compare to the monopoly quantity.

**Proposition 4.** Suppose that the transaction cost is sufficiently low. Then, introducing the outsourcing stage into Kreps and Scheinkman (1983) results in reduced consumer welfare if and only if the marginal cost of installing capacity is sufficiently small (\( 2q^d > Q^M \)).

The proof is in the appendix.

When the marginal cost of installing capacity is small, \( 2q^d > Q^M \) holds and outsourcing reduces industry output from \( 2q^d \) to a level of at most \( Q^M \).

When the marginal cost of installing capacity is large, \( 2q^d \leq Q^M \), the introduction of the outsourcing stage does not harm consumers. That result follows from firms’ incentives to invest in sufficient production capacity.

As an example, suppose that the inverse demand function equals \( P(Q) = 1 - Q \) and that the marginal capacity cost is \( r'(k, 0) = b \). It follows that the monopoly quantity is \( Q^M = 0.5 \), and that the duopoly capacities are \( q^d = \frac{1-b}{3} \). The condition that \( 2q^d > Q^M \) can be rewritten as \( b < \frac{1}{4} \).

Remark that the Kreps and Scheinkman (1983) benchmark does not incorporate asymmetric marginal costs, and therefore does not allow for any cost-efficiencies from horizontal outsourcing.

This section concludes with a discrete investment game example. The purpose is to show that outsourcing can lead to an inefficiently large investment.

**Discrete investment game example**
Suppose that demand $D=1$, production is indivisible, and that the transaction cost is sufficiently low so that the gains from outsourcing are always positive. By investing in one unit of inefficient capacity with marginal cost $c_H$, a firm incurs a fixed cost $f$. Acquiring one unit of efficient capacity with marginal cost $c_L$ requires a more costly investment of $F$, where $f < F$.

When only one firm invests in capacity, the other firm earns zero profits and there are no gains from outsourcing. Investment costs are assumed sufficiently low such both firms invest in positive capacity. As we will see, there is a strategic incentive to vertically integrate; even if a firm holds idle capacity, it can still earn positive profits because it captures a portion of the gains from outsourcing.

For the outsourcing agreement to be profitable, the subcontracted quantity should equal the subcontractor’s capacity, or $q^* \in \{k_1, -k_2\}$. The proof is by contradiction. When the subcontractor does not subcontract the quantity equal to its capacity, its marginal cost of offering an additional product is unchanged. The contractor acquires production at a sunk cost, and is therefore willing to compete more fiercely for the consumer. As such, a subcontracted quantity smaller the subcontractor’s capacity cannot increase the equilibrium price. It also does not reduce production costs, because the efficient firm already wins the consumer without the outsourcing agreement. Any strictly positive transaction cost $t$ would make the outsourcing agreement strictly unprofitable. Therefore, any profitable outsourcing agreement involves a subcontracted quantity equal to the subcontractor’s capacity.

Given that the subcontracted quantity equals the subcontractor’s capacity, the outsourcing agreement always makes the contractor a monopolist downstream. As a result, the contractor charges $V$ in equilibrium. The optimal direction of the outsourcing agreement is the one that is cheapest to implement. In particular, firms choose the outsourcing agreement costing $\min\{c_1k_1, c_2k_2\}$. Importantly, an outsourcing agreement in the cost-inefficient direction could be profitable when the capacity of the efficient firm is higher than the capacity of the inefficient firm.
The gains from outsourcing are \(\max\left\{ V - \min\{c_i k_1, c_2 k_2\} - t - (c_H - c_L), 0 \right\} \). The expression shows that investing more than \(k_i = 1\) never increases the gains from outsourcing. Investing in extra capacity can only be unprofitable by increasing the subcontracted quantity needed to reduce downstream competition. In any investment equilibrium, therefore, installing \(k_i = 1\) dominates installing more. We get that \(\min\{c_i k_1, c_2 k_2\} = \min\{c_i, c_2\} \). Firms always subcontract in the cost-efficient direction: the efficient firm subcontracts to the inefficient firm. Nonetheless, outsourcing can be cost-increasing because of the transaction cost.

When firms invest symmetrically, the no outsourcing profits \(\pi^\text{no}_i\) are negative because of the investment cost. Firms can then profit only from the gains from outsourcing. In the asymmetric setting where one firm invests in one unit of efficient capacity and the other firm invests in inefficient capacity, the outside option of the efficient firm equals \(c_H - c_L - F\). Figure 1 displays the possible profits in the investment game.

\[
\begin{array}{|c|c|c|}
\hline
 & \text{efficient} & \text{inefficient} \\
\hline
\text{efficient} & -F + 0.5(V - c_L - t), & c_H - c_L - F + 0.5(V - c_H - t), \\
 & -F + 0.5(V - c_L - t) & -F + 0.5(V - c_H - t) \\
\hline
\text{inefficient} & -F + 0.5(V - c_H - t), & -F + 0.5(V - c_H - t), \\
 & c_H - c_L - F + 0.5(V - c_H - t) & -F + 0.5(V - c_H - t) \\
\hline
\end{array}
\]

Figure 1: the investment game.

All scenarios presented are possible equilibria, depending on the investment costs. When firms invest asymmetrically, the efficient firm cannot profitably deviate when \(F - f \leq c_H - c_L\). The inefficient firm cannot profitably deviate when \(0.5(c_H - c_L) \leq F - f\). So, when \(0.5(c_H - c_L) \leq F - f \leq c_H - c_L\), there is an asymmetric equilibrium. When both firms invest in the efficient capacity, no firm can
profitably deviate when \( F - f \leq 0.5 (c_H - c_L) \). When both firms invest in the inefficient capacity, no firm can profitably deviate when \( c_H - c_L \leq F - f \).

### 4. Extensions and robustness

The outline of this section, including main intuitions, is as follows.

The first extension investigates the incentives to build downstream assets (forward integration), as opposed to the basic model that analyzes the incentives to build upstream production assets (backward integration).

The second extension section investigates a vertical merger that takes as given the existing upstream assets (see e.g. de Fontenay and Gans, 2005, among others), as opposed to the basic model that analyzes investment in new capacity. By doing so, this paper captures two extremes. The basic model uses as a benchmark that there is no substitution between a firm’s investment decision and the rivals’ upstream capacities. A vertical merger occurring after firms’ investment decisions captures the other benchmark: full substitution between the acquired capacity and the rivals’ upstream capacities.\(^{31}\)

The third extension investigates differentiated products and shows that, then, the downstream market can be a duopoly. Consumers value the presence of two independent suppliers downstream, so that the optimal outsourcing agreement may spare some of the subcontractor’s production capacity. The insight that outsourcing agreements can reduce competition is remains valid.

The fourth extension is the oligopoly extension. It requires to specify how firms sign outsourcing agreements. A natural concept is bilateral efficiency: two firms should not be able to improve profits by trading with each other, taking as given the other trades in the industry (Crémer and Riordan, 1987). There is an important distinction between public and private (secret) contracting. Under private contracting, outsourcing agreements are not observed by outsiders to the agreement. Consequently, outsourcing agreements only affect

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\(^{31}\) As mentioned, in Riordan (1998), vertical integration by a dominant firm reduces capacity investments by the competitive fringe, while increasing total capacity investments.
the behavior of the firms engaging in the agreement, and are used to soften competition on the downstream market. Under public contracting, outsiders can react to the agreement signed. This generates a strategic Stackelberg effect, similar to the one studied in Jeon and Lefouili (2015), that depends on the mode of competition. Price-competing firms have a strategic incentive to commit to reduce competition as outsiders will respond by raising their prices. In contrast, quantity-competing firms have a strategic incentive to commit to compete aggressively in order to reduce the production offered by outsiders. Outsourcing agreements between quantity-competing firms can therefore improve competition, provided that the strategic Stackelberg effect is sufficiently large.

The fifth extension analysis learning by subcontracting. In some industries, by outsourcing, the contractor shares know-how and ability with the subcontractor. The sharing of knowledge can then lead to a stronger competitor. One could think that learning could discourage the contractor from signing such an agreement. The subsection on learning by subcontracting investigates provides a counterargument to this claim: an efficiency improvement of the competitor can translate into increased gains from outsourcing.

The final extension deals with strictly increasing marginal cost functions. The analysis suggests that the anticompetitive effect of horizontal outsourcing does not rely on capacity constraints, but suggests a weaker requirement that the outsourcing agreement sufficiently raises the marginal cost of the subcontractor.

**The strategic value of downstream assets**

The insights on the strategic value of installing upstream assets extend to downstream assets. In particular, the ability to serve consumers downstream also serves a bargaining purpose. When a firm does not have access to downstream assets, the alternative to the outsourcing agreement implies the firm earns zero profits (excluding investment costs), and that the rival acts as a vertically integrated monopolist. There is no threat of fierce competition absent outsourcing. Downstream assets and upstream production capacity thus serve a similar strategic role in acting as a bargaining chip.

Downstream assets, however, may have different characteristics as compared to upstream assets. In particular, there is no need for forward integration when downstream assets are not industry-specific and can be flexibly acquired or hired ex post. Absent outsourcing, a firm could then sell production through an outside retailer. The basic model therefore focused on investment in upstream capacity. Upstream production capacities are often
more rigid and require investments ex ante. However, in industries where downstream assets are equally industry-specific or inflexible, the strategic motive to build upstream assets extends to downstream assets.

**Vertical merger**

This subsection investigates the incentives to acquire existing capacity, as opposed to the basic model’s investment in new capacity. A full-fletched merger game is beyond the scope of this paper. Nonetheless, it is useful to investigate whether the setting with two vertically integrated firms is an equilibrium. In particular, taking as given upstream capacities and the vertical integration decision by the rival, do firms prefer to merge or to be vertically separated?

Consider the discrete example price competition model where both upstream production plants can produce one indivisible unit \((k = 1)\). There is demand for one indivisible unit \((D = 1)\). The willingness to pay equals \(V\) and marginal costs are constant at \(c\). Suppose that transaction costs are zero \((t = 0)\).

When the upstream and downstream firms vertically merge, they earn \(0.5(V - c)\), excluding the investment cost. There is an incentive to vertically merge when the upstream and downstream firm jointly earn less under vertical separation.

The analysis follows Crémer and Riordan (1987) by adopting bilateral efficiency. The definition of bilateral efficiency is similar to Jeon and Lefouili (2015), and relates to the Nash-in-Nash concept. In particular, bilateral efficiency requires that, in the contract equilibrium, two firms sign a bilateral outsourcing agreement, if any, so as to maximize their joint profits, taking as given the other outsourcing agreements and the anticipated equilibrium outcome of the competition stage. I assume that contracts are public; rivals are aware of a deviation and respond to it in the competition stage. I will also impose that the terms of the outsourcing agreement satisfy individual rationality; no firm has an incentive

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32 A positive transaction cost from outsourcing would bias the analysis in favor of vertical integration.
33 See e.g. Rey and Vergé (2016) for recent work on Nash-in-Nash.
to reject a contract, taking as given the other outsourcing agreements and the anticipated equilibrium outcome of the competition stage.

Suppose first that the upstream firm does not act as a subcontractor. Then, the vertically integrated rival can guarantee monopoly profits by declining any agreement. It follows from individual rationality that the vertically separated firms earn zero profits.

Suppose second that the upstream firm acts as a subcontractor. There are two possibilities: the upstream firm supplies the independent downstream firm or supplies the vertically integrated rival. I show that joint profits under vertical separation are lower, or no higher, than those under the vertical merger. Hence, given investments, the setting with two vertically integrated firms is an equilibrium.

1. First, consider the subcontract where the upstream firm subcontracts to the vertically integrated rival in return for a transfer denoted by $\tilde{t}$. The upstream firm’s profits are $\tilde{t} - c$ and the integrated firm’s profits are $V - \tilde{t}$. I argue that the contract equilibrium requires that $\tilde{t} = c$ using individual rationality. Indeed, when $\tilde{t} > c$, the integrated firm would be better off not signing the contract and earning $V - c$. Contracting would be too expensive for the integrated firm, so it would prefer to decline the outsourcing agreement and serve consumers on a stand-alone basis. When $\tilde{t} < c$, the upstream firm sells below marginal cost and would be better off not signing the contract. Finally, the contract equilibrium is an equilibrium. Indeed, the vertically separated firms cannot profitably deviate from $\tilde{t} = c$ as there is no product left available to trade. Their joint profits equal zero excluding their investment costs.

2. Second, consider the outsourcing agreement between the vertically separated firms. If this is the only outsourcing agreement, industry profits are zero because the downstream firm competes fiercely with the vertically integrated rival. The downstream price equals $c$. However, there is an incentive for the downstream firm to act as intermediary by selling its acquired production to the vertically integrated firm. By doing so, the vertically integrated firm becomes monopolist. Under symmetric Nash-bargaining, the vertically separated firms can replicate the profits they could have achieved by merging. Suppose instead that the independent downstream firm cannot act as a seller on the input market. This generates an incentive for the vertically integrated firm to supply the independent downstream
firm when $V - 2c > 0$. Indeed, by incurring an extra cost $c$, the downstream firm would be monopolist downstream and charge $V$ rather than $c$. Importantly, this equilibrium is not cost-efficient because there is excessive production. The vertically separated firms earn joint profits $0.5 \max (V - 2c, 0)$. They benefit from merging because it avoids excessive production, and therefore the gains from outsourcing.

The above analysis shows that a vertical merger is an equilibrium phenomenon. It does not rule out that a non-linear contract could substitute for a vertical merger, provided that such a non-linear contract could be signed before the outsourcing stage.

**Differentiated products**

This section translates the previous insights in a setting with differentiated products. The extension to differentiated products makes two claims and proceeds by reporting the possible industry structures.

(i) outsourcing can reduce competition for sufficiently low product differentiation.

Consider a well-behaved symmetric Hotelling model with symmetric investments in capacity $k = D$, equal marginal costs, and zero transaction costs. Without outsourcing, each firm charges $p_1$ and $p_2$ for its end-product, respectively. Suppose that an equilibrium set of prices exists, and denote these prices by $p_1^*$ and $p_2^*$. The resulting profits are denoted by $\pi_1^* \left( p_1^*(p_2^*), p_2^*(p_1^*) \right)$ and $\pi_2^* \left( p_1^*(p_2^*), p_2^*(p_1^*) \right)$. In a symmetric equilibrium each firm serves $0.5D$ consumers.

Now consider the outsourcing agreement where the contractor contracts $\tilde{q} = D$ intermediary products from the subcontractor. The subcontractor is then unable to offer products independently. Let price $p_2 = \infty$ represent that firm 2 does not offer products downstream. Firm 1 is a monopolist and earns $\pi_1^* \left( p_1^*(\infty), \infty \right)$. The outsourcing agreement is profitable whenever

$$\pi_1^* \left( p_1^*(\infty), \infty \right) > \pi_1^* \left( p_1^*(p_2^*), p_2^*(p_1^*) \right) + \pi_2^* \left( p_1^*(p_2^*), p_2^*(p_1^*) \right).$$
The profitability of the outsourcing agreement depends on the amount of product differentiation. When product differentiation is low, competition without outsourcing agreements is fierce (low right-hand side).

Horizontal outsourcing can be profitable. Indeed, in the limit as we let firms’ locations almost coincide, the condition reduces to \( \pi_1^* (p_1^* (\infty), \infty) > 0 \), which is always satisfied.

In the example, any profitable outsourcing agreement is signed with the purpose of reducing competition at the expense of consumers. Indeed, there are no other reasons to sign the outsourcing agreement. Absent outsourcing, production was already efficient because of symmetric marginal costs. Moreover, the product variety offered was already welfare-optimal because each firm served half of the consumers.

(ii) the downstream market can be observed as duopoly

The downstream monopoly result depends on the assumption of homogenous products. I present the argument intuitively and rely on a limiting case. Consumer taste for variety may make it profitable for firms to continue market two products. In particular, the optimal outsourcing agreement may leave some capacity available to the subcontractor. The subcontractor can then continue offering its independent brand to the consumers that value it the most. In the limit where the two firms serve two separated downstream markets, there is no anticompetitive motive for outsourcing and both firms are active downstream.

The upstream market structure can be observed as monopoly (full sourcing) or duopoly (partial or dual sourcing). As the contractor acquires and markets more production from the subcontractor, there are less incentives to produce and market additional goods. For example, in a symmetric quantity competition setting where \( 0.5q^{m,c} < k \leq q^{m,c} \) and \( k_i = k_j = k \), the contractor has an incentive to produce an additional \( q^{m,c} - k \geq 0 \) in-house.

Figure 2 shows the possible industry structures. The left figures display the entire setup, whereas the right figure only displays the observables in equilibrium. The monopoly-full sourcing combination represents the vertical chain.
Oligopoly

The same insights can extend to an oligopoly situation where more than two firms compete. The extension, however, requires to specify how firms horizontally outsource before competing.

*Multilateral efficiency:* firms take advantage of all gains from outsourcing.

Multilateral efficiency can for example arise from a cooperative setting, where firms share the gains from trade using the Shapley value. The Shapley value approach is multilaterally efficient by assumption. Hence, it will lead to outsourcing if and only if it is multilaterally efficient.

*Bilateral efficiency:* firms bilaterally bargain, and that each bilateral contract maximizes the gains from outsourcing, taking as given the other bilateral contracts and the anticipated outcome of competition stage.

There is an important distinction between private (secret) contracts and public contracts. Under secret contracting, firms always wish to sign contracts that reduce competition. Indeed, the bilaterally optimal contract will try to reduce the competitive externality between the two contracting parties. Firms intend to reduce their joint outputs or to increase their equilibrium prices. However, when firms outside the agreement can publicly observe the contracts signed, the outsiders will respond in equilibrium. A Stackelberg effect arises (see Jeon and Lefouili, 2015). Quantity-competing firms may use the contract to commit
to a large output, in order to reduce the rivals’ outputs. As such, outsourcing could serve to increase competition rather than reduce it. The intuition connects to Allaz and Vila (1993), but differs from it because the contract signed here is a bilateral one between competing producers. Importantly, analogous to Mahenc and Salanié (2004), the intuition reverses for price-competing firms. When prices are strategic complements, there is an incentive to commit to high prices, since outsiders will respond by increasing their prices as well.

Consider a price competition model with three symmetric firms characterized by marginal cost \( c \) and \( k = 1 \) each. Without outsourcing, each firm earns zero (excluding the investment cost). Suppose that the bilateral contracts are publicly observable.

Figure 3 summarizes the setting.

Figure 3: oligopoly

This extension makes two claims. The first one compares multilateral efficiency with bilateral efficiency (secret contracts).

(i) In the example, bilateral efficiency (secret contracts) can sustain no outsourcing when outsourcing is multilaterally efficient, and vice versa, it can sustain outsourcing when it is not multilaterally efficient.

No outsourcing refers to the situation without outsourcing. It leads to zero industry profits (excluding the investment cost). I argue that no outsourcing can always be a bilaterally efficient equilibrium. Given that the two rival firms do not sign outsourcing agreements, it is best not to sign an outsourcing agreement as well. Indeed, when only one firm acts as subcontractor, there is fierce competition between the contractor and the outside firm. The contractor wins in equilibrium by charging \( c \) and industry profits are \(-t\). One bilateral contract is insufficient to raise the equilibrium price above \( c \). So, no outsourcing can always be a bilaterally efficient equilibrium. Remark that no outsourcing is only
multilaterally efficient when \( V - 2c - 2t < 0 \). Indeed, as we will see, there are two possible ways to signing outsourcing agreements to eliminate downstream competition. Both of them can raise the price by \( V - c \) at the extra incurred cost of \( c + 2t \).

Direct outsourcing: firm A \( \rightarrow \) firm C & firm B \( \rightarrow \) firm C; firm C acquires one unit from each of the other firms directly. Profits excluding investment costs are \( V - 2c - 2t \): the equilibrium price is \( V \) and two firms are producing. Given that firm C contracts one unit from one firm already, the gains from contracting one unit from the other firm equal \( \max(V - 2c - t, 0) \). Indeed, the outsourcing agreement raises the equilibrium price by \( V - c \) but involves extra costs equaling \( c + t \). So, whenever \( V - 2c - t \geq 0 \), outsourcing can be a bilaterally efficient equilibrium. Remark that this solution is only multilaterally efficient whenever \( V - 2c - 2t \geq 0 \). Negative profits are a possibility, in which case the bilaterally efficient outsourcing agreements are not individually rational. In particular, firm C may benefit from a double-sided deviation by declining the two outsourcing agreements simultaneously. Remark also that the two subcontractors do not have an incentive to sign an outsourcing agreement, because they are capacity-constrained.

Indirect outsourcing: firm B \( \rightarrow \) firm A \( \rightarrow \) firm C; firm C acquires two units from firm A, and firm A acquires one unit from firm B. Given that firm C buys two units from firm A, the gains from having firm A contract one unit from firm B are infinity. The reason is that it needs the contract deliver upon its commitment because of its capacity constraint. Given the outsourcing agreement between firm A and B, the gains from trading for firm A with firm C equal \( \max(V - 2c - t, 0) \). Indeed, without this contract, competition would be fierce and lead to a price equal to \( c \). The outsourcing agreement raises the price by \( V - c \) but involves extra costs equaling \( c + t \). When \( V - 2c - t \geq 0 \), indirect outsourcing can be a bilaterally efficient equilibrium. Again, this solution is only multilaterally efficient whenever \( V - 2c - 2t \geq 0 \). Firm A may earn negative profits, in which case it benefits from a double-sided deviation by declining the two outsourcing agreements simultaneously. Remark also that firm C does not have an incentive to sign a contract with firm A. Firm A cannot subcontract another unit because of the capacity constraint, and there is no incentive to subcontract to firm B because that would lead to fierce competition.

To summarize, the outsourcing agreement that eliminates downstream competition can be implemented when \( V - 2c - t \geq 0 \). It is only multilaterally efficient, however, whenever
\( V - 2c - 2t \geq 0 \). So, bilaterally efficiency can explain outsourcing when it is not multilaterally efficient.

(ii) In a quantity competition setting with bilaterally efficient public contracts, firms may have incentives to sign outsourcing agreements that increase competition.

The purpose of this subsection is to illustrate that there can be incentives to sign outsourcing agreements that commit to aggressive competition downstream. Importantly, I do not analyze a full game here. When multiple firms are active downstream, there is a myriad of competitive externalities. Depending on the setting, a bilaterally efficient equilibrium may not exists.

Consider the standard quantity-competition setting with \( N \) firms, symmetric marginal costs, and inverse demand function \( P = 1 - Q \). Without outsourcing agreements, when capacity constraints do not bind, each firm produces \((1-c)/(N+1)\) in equilibrium. Two firms jointly produce \(2(1-c)/(N+1)\).

Suppose that two firms could commit to producing the Stackelberg quantity \( q^S \) instead. Then the \( N-2 \) outsiders would respond by producing \((1-c-q^S)/(N-1)\) each. The bilateral profits of the firms committing to \( q^S \) equal \((1-c-q^S-(N-2)(1-c-q^S)/(N-1))q^S\). The optimal Stackelberg quantity \( q^S \) to commit to thus equals \( q^{S*} = (1-c)/2 \). For \( N \geq 4 \), we have that the optimal Stackelberg quantity exceeds the joint quantities offered in the standard downstream equilibrium, or \( q^{S*} > 2(1-c)/(N+1) \). This illustrates that the Stackelberg effect can be sufficiently large so that two firms wish to sign bilateral outsourcing agreements that commit to aggressive behavior downstream.

**Learning by subcontracting**

This subsection shows that contracting can be profitable even when it leads to a more efficient competitor. The reason is that a more efficient competitor increases the gains from outsourcing.
When the cost-reduction is subcontract-specific, learning by the subcontractor is profitable because of the production cost decrease. Indeed, suppose that under the outsourcing agreement, the subcontractor incurs a cost of only $\gamma c$ where $0 \leq \gamma \leq 1$. The parameter $\gamma$ represents that the subcontractor incurs lower costs by subcontracting rather than if it were to produce on a stand-alone basis. Learning does not affect any of the firms’ outside option profits under no outsourcing, but increases the gains from outsourcing. Therefore, learning makes both firms better off. Such learning could be interpreted as a cost-efficiency gain from outsourcing.

When the subcontractor’s cost-reduction is not subcontract-specific, it has an ambiguous effect on the contractor’s profits. While a cost reduction worsens the contractor’s outside option, it increases the gains from outsourcing. Figure 4 summarizes the insights.

<table>
<thead>
<tr>
<th>contractor’s profits</th>
<th>= outside option $\pi^{\text{no}}_1$</th>
<th>+ $\alpha^*$(gains from outsourcing) $0.5 \left( \pi^{\text{no}}_1 + \pi^{\text{no}}_2 - \pi^{\text{no}}_1^{\text{no}} - \pi^{\text{no}}_2^{\text{no}} \right)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>subcontract-specific cost reduction</td>
<td>does not affect outside option</td>
<td>improves the gains from outsourcing</td>
</tr>
<tr>
<td>not subcontract-specific cost reduction</td>
<td>worsens outside option</td>
<td>improves the gains from outsourcing</td>
</tr>
</tbody>
</table>

Figure 4. Learning by subcontracting

**Strictly increasing marginal costs**

The appendix works out a partial characterization of a symmetric quantity-competition setting with differentiable and strictly increasing marginal costs. The setting does not include an investment stage and closely reflects Spiegel (1993).

As in Spiegel (1993), under these assumptions, the effect of horizontal outsourcing agreements on cost-efficiency is unambiguously harmful. The reason is that a horizontal outsourcing agreement results in the subcontractor producing more than the contractor, while it would be cost-efficient to have each firm produce the same amount. The competitive effects of horizontal outsourcing are ambiguous.

The appendix shows that a critical condition for industry output to drop is convexity in the marginal cost function. In particular, the change in industry output follows from two effects. The subcontractor, by producing for the rival, moves up its marginal cost curve.
This effect reduces its downstream equilibrium quantity. The magnitude of the effect depends on the slope of the marginal cost curve beyond the standard Cournot quantity. In contrast, the contractor acquires access to production ex ante, so that it moves down its marginal cost curve. The contractor therefore increases its downstream quantity. The magnitude of this effect follows from the slope of the marginal cost curve below the standard Cournot quantity. Whether the net effect of horizontal outsourcing on industry output is negative or positive, depends on whether the marginal cost curve is steeper for the subcontractor than the contractor (convex / increasing slope) or vice versa (concave / decreasing slope). The marginal cost increase that causes the subcontractor to offer less, should be larger than the marginal cost decrease that causes the contractor to offer more. The analogy with the baseline model is that the production inefficiency, for example from a transaction cost, should be balanced against the profits from reducing competition.

This partial characterization is useful because it suggests that the anticompetitive effect of horizontal outsourcing does not require capacity constraints. Instead, it points towards a weaker requirement that the slope of the subcontractor’s marginal cost function in the relevant region is steeper than the slope of the contractor’s marginal cost function in the relevant region. This weaker requirement would also be reflected in an investment stage that precedes the outsourcing stage. In particular, committing to be capacity-constrained is not needed to generate gains from outsourcing; it can suffice for firms to install production facilities that are characterized by a marginal cost function with a sufficiently steep slope.

5. Conclusion

This paper presents a theory of vertical integration and the competitive effects of horizontal outsourcing. A subcontractor producing at full capacity to supply a rival firm is unable to offer products independently downstream. The contractor may be inactive upstream because of decreasing marginal revenues on the downstream market. A horizontal outsourcing agreement can thus be perceived as vertical. As such, uninformed observers could overlook subcontractors as potential competitors. This poses a concern because vertical agreements are generally regarded as less harmful for competition than horizontal agreements. Possibly harmful outsourcing agreements may therefore remain under the radar screen of competition authorities.
From an effects-based point of view, outsourcing agreements can be similar to mergers. In a similar way, outsourcing agreements can reduce costs, for example when the subcontractor is more cost-efficient. At the same time, they can be used to reduce competition. The difference is that, when two firms merge, the ownership of the production assets changes. Under the outsourcing agreement, firms only trade products.

Vertical integration by internal growth serves a bargaining purpose. Building upstream capacity (backward integration) reduces the rival’s outside option profits by credibly threatening to a price war absent outsourcing. As such, it leads to more favorable terms of trade, i.e., lower contracting costs or higher subcontracting revenues. In equilibrium, firms build upstream capacity while preserving the gains from outsourcing. The strategic motive for backward integration extends to forward integration because a credible commitment to a price war absent outsourcing requires upstream capacity as well as the ability to serve consumers downstream. Of course, a vertical relation could substitute for vertical integration when firms can call upon a competitive market for retail services ex post.

While the vertical integration literature has investigated vertical and horizontal outsourcing agreements, it has not yet reported an anticompetitive motive for horizontal outsourcing. The reason is that most of this literature focusses on vertical mergers. The decision of internal growth, which I model with an endogenous capacity choice, is complementary and uncovers that the anticompetitive motive for horizontal outsourcing is an equilibrium phenomenon.

The introduction of the horizontal outsourcing stage in Kreps and Scheinkman (1983) provides an elegant result: the downstream market is always a monopoly. Since the monopoly result can avoid the need to analyze mixed strategies, the analysis can considerably simplify when it is extended with a horizontal outsourcing possibility.

Two extensions provide a richer set of predictions. First, a differentiated product market can lead to a downstream duopoly rather than a monopoly. The reason is that firms can profit from signing an outsourcing agreement such that multiple firms stay active downstream. The main insight from this paper, the possible anticompetitive motive for horizontal outsourcing, remains valid for a differentiated product markets. Second, with more than two firms, public contracts take a strategic role by affecting the outsiders’ behavior. The competitive effects of horizontal outsourcing then depend on the mode of competition and the number of firms.
The airline industry provides a concluding example. Code-sharing is common practice where firms market tickets from flights operated by competing airlines. The operation of a particular flight fits within the framework as the upstream segment. The marketing of the flight can be viewed as the downstream segment. As such, the analysis applies to markets for inter-hub flights, where the flights offered by competing firms are substitutes. This paper provides new insights on the effects of code-sharing. The extent to which inter-hub routes are overlap routes, where several airlines offer competing flights, is endogenous to the possibility to sign code-share agreements. It is insufficient to argue in favor of a code-share agreement by assessing that its efficiency gains are large given the observed industry structure.

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34 The analysis could also incorporate bundled flights by adding additional layers in the supply chain. Different flights can then be interpreted as complementary inputs needed to reach a particular destination.
35 A recent merger remedy has used the possibility to sign a code-share agreement as a policy instrument. The Department of Justice (DoJ) received a merger request by Alaska Airlines and Virgin America. Pre-merger, Alaska Airlines had an extensive code-sharing agreement with third party American Airlines. Virgin America was a fierce competitor of American Airlines because it owns gates as well as takeoff and landing rights (slots) at constrained airports in some of American Airlines’ strongholds (DoJ, 2016a). There was a concern that the code-share agreement could give incentives for the merged entity to discontinue using its slots to compete with American Airlines. The merger remedy required Alaska Airlines to scale back its code-share agreement with American Airlines (DoJ, 2016b).
References


Appendix

Proof of proposition 1.

Price competition with price-inelastic demand

When firms invest in $k_i \leq D$ capacity, firms can implement the collusive outcome (treating the investment choices and costs as given and sunk) and the downstream market is a monopoly. Consider the following outsourcing agreement. In the outsourcing stage, the cost-efficient firm subcontracts at full capacity to the cost-inefficient firm. Indeed, consider then the outsourcing agreement in the cost-efficient direction where the efficient firm subcontracts a quantity corresponding to its capacity to the inefficient firm. The contractor is then a monopolist downstream. It starts by offering contracted production, which is optimal since the subcontractor’s quantity is no larger than its monopoly quantity. The contractor proceeds by activating more expensive in-house production to the extent that industry marginal revenues exceed the marginal production cost. When the transaction cost is sufficiently low to merit an outsourcing agreement, this outsourcing agreement maximizes the gains from outsourcing: revenues are maximal and production takes place efficiently, taking as given the investment choices.

Quantity competition

When firms invest in $k_i \leq q^{m,c}$ capacity, firms can implement the collusive outcome (treating investment choices and costs as given and sunk). Indeed, consider then the outsourcing agreement in the cost-efficient direction where the efficient firm subcontracts a quantity corresponding to its capacity to the inefficient firm. The contractor is then a monopolist downstream. It starts by offering contracted production, which is optimal since the subcontractor’s quantity is no larger than its monopoly quantity. The contractor proceeds by activating more expensive in-house production to the extent that industry marginal revenues exceed the marginal production cost. When the transaction cost is sufficiently low to merit an outsourcing agreement, this outsourcing agreement maximizes the gains from outsourcing: revenues are maximal and production takes place efficiently, taking as given the investment choices.

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1 This subcontract assumes vertical integration by both firms. When only one firm would invest in capacity, that firm can trivially implement the collusive outcome that treats capacity investments as sunk.
2 Again, when only one firm builds capacity, it trivially implements the collusive outcome treating the investment choices and costs as given and sunk.
the gains from outsourcing. For given capacities, the outsourcing agreement decreases consumer surplus because it eliminates the competitive externalities among the two firms.

*Price competition with price-elastic demand*

When firms invest in \( k_i \leq q^M \) capacity, firms can implement the collusive outcome (treating the investment choices and costs as given and sunk) and the downstream market is a monopoly. Consider the following outsourcing agreement. In the outsourcing stage, one firm subcontracts at full capacity to the other firm.\(^3\) In the competition stage, the subcontractor is then unable to offer further production. The contractor is monopolist, so that the price it charges exceeds \( p^M \) when \( k_i + k_j < q^M \) and equals \( p^M \) when \( k_i + k_j \geq q^M \). Its perceived cost of offering the contracted quantity is zero and its marginal cost of offering additional in-house production is also zero. From the tie-breaking rule, the firm will offer the contracted production first. In-house production is only used to serve residual demand. When the transaction cost is sufficiently low to merit an outsourcing agreement, this outsourcing agreement maximizes the gains from outsourcing: profits are maximal taking as given the investment choices.

**Proof of proposition 2.**

*Price competition with price-inelastic demand*

I prove that the investment equilibrium is such that \( k^*_i \leq D \). Proposition 2 then follows from proposition 1.

In particular, when the rival invests in \( k_j \leq D \), it is a dominated strategy to invest \( k_j > D \). The proof looks at both components of a firm’s profit function: (i) its outside option profits under no outsourcing, and (ii) its share in the gains from outsourcing.

(i) Investing more than \( D \) reduces the no outsourcing profits \( \pi^{no}_i \). Indeed, absent outsourcing, the competition game (players, possible strategies, payoffs) would be the same if the firm invests \( k_i = D \). However, the no outsourcing

\(^3\) This subcontract assumes vertical integration by both firms. When only one firm would invest in capacity, that firm can trivially implement the collusive outcome that treats capacity investments as sunk.
profits would suffer from the additional cost of investing \( r_i(k_i, c_i) - r_i(D, c_i) \).

(ii) Any further investment beyond \( k_i = D \) keeps constant the gains from outsourcing, at best. To validate this statement, it suffices to look at profits excluding the investment cost (gross profits) because the cost of investing cancels out in the gains from outsourcing. As argued, the competition game under no outsourcing would lead to the same gross profits. Under outsourcing, by investing \( k_i = D \), firms implement the collusive outcome (treating the investment choices and costs as given and sunk). Gross profits under outsourcing cannot increase by investing in capacity beyond \( k_i = D \).

Therefore, investment beyond \( k_i = D \) never contributes to the gains from outsourcing.

**Quantity competition**

The investment equilibrium features that \( k_i^* \leq q^{m,c_i} \). Proposition 2 then follows from proposition 1.

In particular, given that the rival invests in \( k_j \leq q^{m,c_j} \) capacity, it is optimal for a firm to invest less than \( k_j \leq q^{m,c_j} \) as well. Analogously to the price competition model, the proof looks at both components of the firm’s profit function: its outside option profits and its share in the gains from outsourcing. First, investing more than \( q^{m,c_i} \) reduces the no outsourcing profits \( \pi_i^{no} \): the cost of investing reduces the outside option profits, while the competition game would be the same if the firm invests \( q^{m,c_i} \). Indeed, offering more than the monopoly quantity is a dominated strategy by the definition of monopoly quantity combined with strategic substitution. Second, the gains from outsourcing are already maximal when the firm invests \( k_i = q^{m,c_i} \). Any further investments never contribute to the gains from outsourcing.

**Price competition with price-elastic demand**

I prove that the investment equilibrium is such that \( k_i^* \leq q^M \). Proposition 2 then follows from proposition 1.
In particular, when the rival invests in \( k_j \leq q^M \), it is a dominated strategy to invest \( k_i > q^M \). The proof looks at both components of a firm’s profit function: (i) its outside option profits under no outsourcing, and (ii) its share in the gains from outsourcing.

(i) Investing more than \( q^M \) reduces the no outsourcing profits \( \pi_n^o \). The intuition is as follows. Installing a lot of capacity reduces the residual demand for the rival when the rival charges the highest price. The rival will respond to this threat by pricing more aggressively. This effect discourages firm \( i \) from installing capacity beyond \( q^M \). The proof uses Kreps and Scheinkman (1983, p.335, proposition 1, part b). Since \( k_i \geq k_j \) and \( k_i > \rho(k_j) \), we know that firm \( i \) earns \( \left( \rho_i(k_j)P(\rho_i(k_j)+k_j) \right) - r_i(k_i) \). For \( k_i > q^M \), from strategic substitution, the first term is independent of \( k_i \). The second term is decreasing in \( k_i \). This shows that a firm’s outside option profits are decreasing in \( k_i \) when \( k_i > q^M \) and \( k_j \leq q^M \).

(ii) Any further investment beyond \( k_i = q^M \) keeps constant the gains from outsourcing, at best. To validate this statement, it suffices to look at profits excluding the investment cost (gross profits) because the cost of investing cancels out in the gains from outsourcing. As argued in (i), further investment reduces gross profits under no outsourcing. Under outsourcing, by investing \( k_i = q^M \), firms implement the collusive outcome (treating the investment choices and costs as given and sunk). Gross profits under outsourcing cannot increase by investing in capacity beyond \( k_i = q^M \). Therefore, investment beyond \( k_i = q^M \) never contributes to the gains from outsourcing.

**Proof of proposition 3.**

*Price competition with price-inelastic demand*

I argue that the possibility to sign more sophisticated outsourcing agreements does not change the analysis. If firms invest in \( k_i \leq D \) capacity, the analysis would be equivalent. Indeed, the outsourcing agreement under consideration can already implement the
collusive outcome (treating the investment choices and costs as given and sunk). The outsourcing agreement under consideration is the unique maximizer when signing a more sophisticated contract would involve an extra transaction cost. It needs to be checked whether firms have incentives to install $k_i > D$ capacity. In that event, a more sophisticated contract can outperform the one studied. However, given that the rival invests $k_j \leq D$, investing $k_i = D$ dominates investing $k_i > D$. By (i) in the proof of proposition 2, investing more would reduce the no outsourcing profits. By (ii) in the proof of proposition 2, any further investment beyond $k_i = D$ keeps constant the gains from outsourcing, at best.

*Quantity competition*

Analogously to the price competition model with price-inelastic demand, the analysis does not change when firms can sign more sophisticated outsourcing contracts.

*Price competition with price-elastic demand*

I argue that the possibility to sign more sophisticated outsourcing agreements does not change the analysis. If firms invest in $k_i \leq q^M$ capacity, the analysis would be equivalent. Indeed, the outsourcing agreement under consideration can already implement the collusive outcome (treating the investment choices and costs as given and sunk). It is the unique maximizer when signing a more sophisticated contract involves an extra transaction cost. It needs to be checked whether firms have incentives to install $k_i > q^M$ capacity. In that event, a more sophisticated contract can outperform the one studied. However, given that the rival invests $k_j \leq q^M$, investing $k_i = q^M$ dominates investing $k_i > q^M$. By (i) in the proof of proposition 2, investing more would reduce the no outsourcing profits. By (ii) in the proof of proposition 2, any further investment beyond $k_i = q^M$ keeps constant the gains from outsourcing, at best.
Proof of proposition 4.

When the marginal cost of installing capacity is sufficiently small, for example when it approaches zero, it must be true that \( 2q^d > Q^M \).\(^4\) That condition represents a sufficient condition for outsourcing to harm consumer welfare.

When the opposite relationship holds, \( 2q^d \leq Q^M \), the analysis is as follows. There are two possibilities.

First, suppose that, in equilibrium, firms invest such that they do not sign an outsourcing agreement in equilibrium \((k^*_i + k^*_j \leq Q^M)\). Then, firms’ equilibrium profits only consist of their outside option profits. For the capacity equilibrium to be an equilibrium, firms should not have incentives to deviate. The deviation profit functions equal at least firms’ outside option profits, and may include positive gains from outsourcing. Therefore, while a necessary condition for the equilibrium to be valid is that is also an equilibrium in Kreps and Scheinkman (1983), it is not a sufficient condition as the exclusion of gains from outsourcing may understate firms’ incentives to deviate. The only candidate equilibrium is the one where firms invest the Cournot duopoly capacities \((k^*_i = k^*_j = q^d)\). If the equilibrium is valid, the introduction of the horizontal outsourcing stage does not affect consumer welfare. If the equilibrium is invalid, it must be true that \( Q^M < k^*_i + k^*_j \).

Second, suppose that in equilibrium, firms invest such that \( Q^M < k^*_i + k^*_j \). Then, firms sign an outsourcing agreement to offer the monopoly quantity \( Q^M \). In this second scenario, firms sign an anticompetitive outsourcing agreement in equilibrium, but the pro-competitive effect from extra capacity more than offsets the anti-competitive effect from outsourcing.

Strictly increasing marginal costs

Let firm \( i \) offer \( Q^i \) so that the total quantity offered equals \( Q = Q^1 + Q^2 \). Each firm incurs cost \( C(x) \) to produce \( x \) units.\(^5\)

\(^4\) This statement uses two standard properties that are commonly assumed for Cournot competition: quantities are strategic substitutes and the best-response functions are not too steep.

\(^5\) The superscript is omitted because firms have the same cost function.
Assumption 1: the inverse demand function \( P = a + PQ \) is linear and decreasing. It follows that reaction functions are downward sloping.

Assumption 2: marginal costs \( C'(x) \) are continuous, non-negative and increasing. There are decreasing returns to scale.

Assumption 3: \( P(0) > C'(0) \). Production is profitable. It follows that, without subcontracts, both firms produce a strictly positive quantity in equilibrium.

No horizontal outsourcing.

Under the standard analysis without horizontal outsourcing, the equilibrium is standard. Denote the standard Cournot market-clearing price by \( P^c \). The first-order condition is

\[
P q^c + P^c - C'(q^c) = 0
\]

Horizontal outsourcing.

Firms choose how much to offer in equilibrium. Firm 1’s problem is to maximize its profit function

\[
PQ^1 - C(Q^1 + \tilde{q}) + \tilde{\tau}
\]

with respect to \( Q^1 \geq 0 \). The second term represents the cost of producing \( Q^1 \) for consumers and \( \tilde{q} \) for the rival. Firm 2’s problem is to maximize its profit function

\[
PQ^2 - C(Q^2 - \tilde{q}) - \tilde{\tau}
\]

with respect to \( Q^2 \geq 0 \).

The second term represents the cost of producing \( Q^2 - \tilde{q} \), the additional production beyond the quantity already contracted from the rival. The stage-two equilibrium quantities are denoted by \( Q^1^* (\tilde{q}) \) and \( Q^2^* (\tilde{q}) \). Importantly, recall that the equilibrium quantities do not take account of the transfer \( \tilde{\tau} \) because it is sunk at the moment of competing.

The first-order conditions depend on the industry structure in equilibrium. Table A1 lists the first-order conditions.
Table A1. first-order conditions.

**Lemma A1.** The subcontractor produces more than the Cournot quantity and the contractor produces less.

Formally, Lemma A1 states that $Q^{*}(\bar{q}) + \bar{q} > q^C$ and $Q^{**}(\bar{q}) - \bar{q} < q^C$. It follows that the subcontractor's marginal cost increases and that the contractor's marginal cost decreases. Figure 1 visualizes Lemma 1.

![Figure 1](image.png)

Figure 1. A visualization of Lemma A1.

**Proof of Lemma A1.**

Lemma 1 is in line with Spiegel's proposition 6 (p. 580). A proof is possible by contradiction. Suppose otherwise, then one of the following three scenarios must hold.

A situation where the subcontractor produces $Q^{*}(\bar{q}) + \bar{q} \leq q^C$ and the contractor produces $Q^{**}(\bar{q}) - \bar{q} < q^C$ would not be optimal for the subcontractor. As compared to standard Cournot with first-order condition (1), firm 1 now offers less and industry output
is lower. Hence, firm 1's marginal revenues from increasing production, \( P'Q'^*(\tilde{q}) + P \), are larger than \( C'\left(q^C\right) \). However, marginal costs \( C'\left(Q'^*(\tilde{q}) + \tilde{q}\right) \) are (weakly) lower than \( C'\left(q^C\right) \). It follows that \( P'Q'^*(\tilde{q}) + P > C'\left(Q'^*(\tilde{q}) + \tilde{q}\right) \), which contradicts firm 1's first-order condition, both for monopoly and duopoly.

A situation where the subcontractor offers \( Q'^*(\tilde{q}) + \tilde{q} > q^C \) and the contractor offers \( Q''(\tilde{q}) - \tilde{q} \geq q^C \) would not be optimal for the contractor. As compared to standard Cournot with first-order condition (1), firm 2 now offers more and industry output is higher. Hence, firm 2's marginal revenues from increasing production, \( P'Q''(\tilde{q}) + P \), are lower than \( C'\left(q^C\right) \). However, marginal costs \( C'\left(Q''(\tilde{q}) - \tilde{q}\right) \) are (weakly) higher than \( C'\left(q^C\right) \). It follows that \( P'Q''(\tilde{q}) + P < C'\left(Q''(\tilde{q}) - \tilde{q}\right) \), which contradicts firm 2's first-order condition for partial sourcing. But full sourcing requires \( Q''(\tilde{q}) = \tilde{q} \), which violates \( Q''(\tilde{q}) - \tilde{q} \geq q^C \).

Finally, a situation where the subcontractor offers \( Q''(\tilde{q}) + \tilde{q} \leq q^C \) and the contractor offers \( Q''(\tilde{q}) - \tilde{q} \geq q^C \) also leads to a contradiction by comparing both firms' first-order conditions. Start from the contractor's first-order condition \( P'Q''(\tilde{q}) + P = C'\left(Q''(\tilde{q}) - \tilde{q}\right) \) which must hold with equality because \( Q''(\tilde{q}) - \tilde{q} \geq q^C \). Since the contractor offers more than the subcontractor, marginal revenues are larger for the subcontractor than for the contractor, so that \( P'Q'^*(\tilde{q}) + P > P'Q''(\tilde{q}) + P \). At the same time, however, the subcontractor produces at a (weakly) lower marginal cost than contractor, so that \( C'\left(Q''(\tilde{q}) - \tilde{q}\right) > C'\left(Q'^*(\tilde{q}) + \tilde{q}\right) \), which contradicts the subcontractor's first-order condition, both for monopoly and duopoly.

Lemma A2. Suppose firms have invested in marginal costs functions that are twice differentiable, weakly concave, and that disposal is prohibitive. Then, horizontal outsourcing benefits consumers.
Proof of Lemma A2.

When marginal costs are twice differentiable and weakly concave, we can write

\[ C''(x) \leq 0. \]

From Lemma A1, we know that the marginal cost of the subcontractor has increased, and that the marginal cost of the contractor has decreased.

From concavity, we know that the average rate at which the marginal cost of the contractor has decreased in absolute values (left hand side) is larger than the average rate at which the marginal cost of the subcontractor has increased (right hand side), or

\[ \frac{C'(q^c) - C'(Q^{2*}(\bar{q}) - \bar{q})}{q^c - Q^{2*}(\bar{q}) + \bar{q}} \geq \frac{C'(Q^{1*}(\bar{q}) + \bar{q}) - C'(q^c)}{Q^{1*}(\bar{q}) + \bar{q} - q^c}. \]

Both sides of the inequality are positive from Lemma A1. We use prohibitive disposal \((Q^* \geq \bar{q})\) to guarantee that \(C'(Q^{2*}(\bar{q}) - \bar{q})\) exists.

Suppose by contradiction that it were true that consumers suffered from a decrease in equilibrium output. Then \(Q^{1*}(\bar{q}) + Q^{2*}(\bar{q}) - 2q^c \leq 0\), which can be written as \(q^c - Q^{2*}(\bar{q}) + \bar{q} \geq Q^{1*}(\bar{q}) + \bar{q} - q^c\). By plugging in this inequality on the left hand side, we obtain that the concavity condition implies

\[ \frac{C'(q^c) - C'(Q^{2*}(\bar{q}) - \bar{q})}{Q^{1*}(\bar{q}) + \bar{q} - q^c} \geq \frac{C'(Q^{1*}(\bar{q}) + \bar{q}) - C'(q^c)}{Q^{1*}(\bar{q}) + \bar{q} - q^c}, \]

and hence

\[ (2) \quad C'(q^c) - C'(Q^{2*}(\bar{q}) - \bar{q}) \geq C'(Q^{1*}(\bar{q}) + \bar{q}) - C'(q^c). \]

To see that this is a contradiction, use the first-order conditions and (1) to write

\[ C'(Q^{1*}(\bar{q}) + \bar{q}) - C'(q^c) \geq P - P^c + P'(Q^{1*}(\bar{q}) - q^c) \]
\[ C'(Q^{2*}(\bar{q}) - \bar{q}) - C'(q^c) \geq P - P^c + P'(Q^{2*}(\bar{q}) - q^c). \]

By summing both expressions, we obtain

\[ C'(Q^{1*}(\bar{q}) + \bar{q}) + C'(Q^{2*}(\bar{q}) - \bar{q}) - 2C'(q^c) \geq 2P - 2P^c + P'(Q^{1*}(\bar{q}) + Q^{2*}(\bar{q}) - 2q^c). \]
Since \( P \left( Q^x (\tilde{q}) + Q^z (\tilde{q}) - 2q^C \right) \) equals the price change \( P - P^C \), we get
\[
C \left( Q^x (\tilde{q}) + \tilde{q} \right) + C^z \left( Q^z (\tilde{q}) - \tilde{q} \right) - 2C^z \left( q^C \right) \geq 3 \left( P - P^C \right).
\] Since a decrease in industry output requires an increase in the equilibrium price (right hand side), the left hand side must be positive. But (2) implies the left hand side is negative, a contradiction. ■