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Three essays on vertical relations and vertical integration

by

Ioannis N. Pinopoulos

Thesis submitted to the Department of Economics, University of Macedonia, in partial fulfillment of the requirements for the degree of Doctor of Philosophy

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Introduction

The present thesis consists of three independent essays that study vertical relations and vertical integration. Vertical relations are ubiquitous in real-world markets, as the vast majority of goods are produced in several stages of the so-called vertical production chain, from raw materials, to intermediate goods, to final products. The purpose of this thesis is to examine the classic anti-trust issues of price discrimination (Chapter 1) and horizontal mergers (Chapter 2) within the context of vertically related markets, and investigate the behavior of vertically integrated firms with respect to their contractual interaction with other vertically separated firms (Chapter 3).

The first essay (Chapter 1) deals with price discrimination in input markets. Input price discrimination is an important anti-trust issue arising in the context of the Robinson-Patman Act under US law and Article 102 of the Treaty on the Functioning of the European Union (TFEU) under EU law. We study the welfare effects of input price discrimination when a vertically separated upstream supplier that secretly contracts with two cost-asymmetric downstream firms undertakes R&D investments. Focusing on two-part tariffs (consisting of a per-unit input price and a fixed fee) and downstream Cournot competition, we show that a ban on input price discrimination increases or decreases the equilibrium level of upstream R&D investments depending on the degree of downstream cost-asymmetry. Yet, we find that welfare always decreases after the ban. Therefore, in our setting, input price discrimination should be welcomed rather than prohibited even when it decreases the upstream supplier's incentives to engage in cost-reduction activities.

A ban on input price discrimination has two effects on the upstream supplier's incentives to invest in R&D. The first effect, labelled "*elimination of commitment problem effect*", tends to increase R&D investments. Under discriminatory pricing, and due to contract unobservability, it is well-known that once a downstream firm has signed a contract, the upstream supplier has an incentive to offer better terms to the other competitor. A ban on input price discrimination eliminates contract unobservability and the supplier's associated opportunism problem (since it requires both downstream firms receiving the same offer) thus increasing the value of inducing a given cost-reduction.

The second effect, labelled "*nonappropriability of industry profits effect*", tends to decrease R&D investments. Under discriminatory pricing the supplier can appropriate all downstream profits, however, under non-discriminatory pricing it cannot do so due to the common fixed fee – it must leave a positive rent to the more cost-efficient downstream firm. Hence, a ban on input price discrimination decreases the value of inducing a given cost-reduction.

The lower is the cost-asymmetry between downstream firms, the lower is the rent left to the more cost-efficient downstream firm and thus the more likely is that the “elimination of commitment problem effect” will dominate the “nonappropriability of industry profits effect” implying that a ban on input price discrimination will increase the level of upstream R&D investments. As is well-known, a ban on input price discrimination increases both input prices – since it offers the supplier the opportunity to make commitments thereby solving its opportunism problem – and thus decreases welfare in the short-run. As it turns out, at least for the case of linear demand, this effect on input prices is strong enough so that banning input price discrimination also decreases welfare in the long-run *even though* it may increase the upstream supplier’s incentives to invest in R&D.

It is a common presumption that whenever a ban on input price discrimination increases R&D investments it also increases welfare, and vice versa. We show that, contrary to that presumption, banning price discrimination may move R&D and welfare in opposite directions: the negative welfare-effect from eliminating the upstream supplier’s commitment problem is so important that cannot be compensated by the benefits from increased R&D.

In the second essay (Chapter 2), we study upstream horizontal mergers, that is horizontal mergers that take place in the upstream sector of vertically related markets. The welfare effects of horizontal mergers is a classic topic of anti-trust economics. Nowadays, a large number of nations worldwide have laws or regulations which call for merger control (see, for example, the US Horizontal Merger Guidelines (2010, section 10) and the EC Horizontal Merger Guidelines (2004/03, art. 77)).

The existing literature that considers upstream horizontal mergers focuses on vertically separated markets. A key aspect of our analysis is that one of the merging parties is a vertically integrated firm. We consider a two-tier market consisting of two competing vertical chains, with one upstream and one downstream firm in each chain. We assume that one vertical chain is vertically integrated whereas the other chain is vertically separated. There is downstream Cournot competition and firms in the vertically separated chain trade through a two-part tariff contract. The contract stipulated in the vertically separated chain can be either observable or unobservable by the integrated chain.

In the baseline model, we assume that there is upstream cost symmetry and observable contracting. We show that such type of horizontal mergers harm consumers through a vertical foreclosure effect: the input price paid by the independent downstream firm increases thereby yielding greater market share to the downstream affiliate of the horizontally merged entity. This translates the higher input price into higher final-good prices and lower total output, making consumers worse off. This finding holds for any given relationship between downstream costs.

We consider two modifications of the baseline model under which consumer surplus may increase due to the merger. First, we maintain the assumption of observable contracting, however, we introduce upstream cost asymmetry. We assume that, in the post-merger situation, the more efficient firm transfers its technology to the less efficient firm so that the merger generates efficiency gains. In such setting, we show that *overall consumer surplus may increase due to the merger even though the input price always increases and some consumers are worse off*. When the independent upstream firm is *more* efficient than the upstream division of the vertically integrated firm, on the one hand, the merger does not lower the cost of the upstream production directed to the independent downstream firm, leaving at play only the vertical foreclosure effect. On the other hand, the merger creates efficiency gains in the upstream production directed to the downstream division of the merged firm, thus tending to decrease both final-good prices. As it turns out, the final-good price of the independent downstream firm always increase due to the merger irrespective of the magnitude of the efficiency gains. However, when the efficiency gains are sufficiently large, the final-good price of the vertically integrated firm may decrease and consumer surplus may increase as a result of the merger.

Second, we maintain the assumption of upstream cost symmetry, however, we assume unobservable contracting. In that case, we find that *the input price may decrease and consumer surplus may increase as a result of the merger even in the absence of exogenous cost-synergies between the merging firms*. In the pre-merger situation, the two-part tariff contract stipulated in the separated chain loses its pre-commitment value thereby eliminating any strategic effect on the integrated firm's behavior and resulting in upstream marginal-cost pricing. The upstream merger restores the commitment value of the contract and has two opposing effects on the input price. The first effect is the aforementioned foreclosure effect which causes the input price to increase. The second effect tends to decrease the input price: any decrease in the input price will decrease merged firm's downstream sales which will in turn increase the unintegrated downstream firm's final-good price and thus the profits that can be appropriated by the merged firm through the fixed fee. When the downstream division of the integrated firm is sufficiently less cost-efficient than the independent downstream firm, it is optimal for the merged firm to set an input price below upstream marginal cost thereby shifting final-good sales to the more profitable downstream rival. The reduction in input price ultimately leads to a reduction in final-good prices.

Two key insights from the existing literature on upstream horizontal mergers that take place in vertically separated industries are that (*i*) upstream mergers are profitable and beneficial to consumers only when they entail efficiency gains, and (*ii*) once efficiency gains are taken into account, a reduction in input price is always a necessary condition for an increase in consumer surplus. Our analysis suggests that, when one of the merging parties is a vertically integrated firm, upstream mergers can be profitable and beneficial to consumers even in the absence of any efficiency gains and once efficiency gains are taken into account, a reduction in input price is *not* always a necessary condition for an increase in consumer surplus.

In the third essay (Chapter 3), we investigate the behavior of vertically integrated firms with respect to their contractual interaction with other vertically separated firms. It has been suggested that when unintegrated downstream firms buy inputs from upstream suppliers that are also downstream competitors, the vertically integrated producers may have an incentive to compete less aggressively in the downstream market in order to support upstream sales. This downstream accommodating behavior has been formally established in models assuming downstream Bertrand competition but *not* in models considering downstream Cournot competition.

We show that downstream accommodating behavior by vertically integrated firms can also be observed under downstream Cournot competition, analyze the conditions for its presence, and draw its consequences. We consider a two-tier industry where a vertically integrated firm sells input to, and competes against a downstream rival. We show that, when the upstream division of the integrated firm chooses its input quantity and the input price is determined as a market-clearing price after all decisions are made, the downstream division accommodates rival sales: even taking rival quantity as given, the downstream division knows that, by limiting its own final-good quantity, it can increase rival revenue, and therefore willingness-to-pay for the input. The presence of this accommodating behavior has important consequences regarding the integrated firm's profitability. In particular, the integrated firm can earn Stackelberg-leader profits, despite simultaneous decisions in the downstream market. Moreover, upstream price-setting leaves no room for downstream strategic behavior implying that for an integrated input monopolist the profit maximization instrument is of great importance.

We also investigate the case the case of upstream competition: besides the integrated firm, an unintegrated upstream firm can also supply the input. We assume that the unintegrated downstream firm is a strategic buyer in the upstream market in the sense that it can select its supplier. It is shown that when the unintegrated downstream firm buys the input from both upstream suppliers, the downstream accommodation effect still exists, however, the incentive of the vertically integrated firm to accommodate downstream rival sales is now mitigated by the fact that the latter procures a portion of the input quantity from the unintegrated upstream supplier. It is also shown that, in equilibrium, the unintegrated downstream firm will never choose to buy only from the integrated firm. The downstream accommodation effect pushes the unintegrated downstream rival’s derived demand upwards causing the equilibrium input price to increase. The presence of such effect is sufficient to guarantee that the downstream rival will always be unwilling to establish the integrated firm as an upstream monopoly: it will either choose to deal only with the unintegrated upstream firm or with both firms.

Chapter 1

Input price discrimination and upstream R&D investments

1.1 Introduction

Price discrimination by big manufacturers is an important issue in competition policy. In the pharmaceutical industry, for instance, several retail pharmacies in the US alleged that big drug manufacturers, such as *Johnson & Johnson* and *American Home Products*, offer lower prices to certain purchasers thereby engaging in unlawful price discrimination under the Robinson-Patman Act (*Drug Mart Pharmacy Corp., et al. v. American Home Products Corp., et al.*; *case number 12-4689-cv*).[1]

There is by now a large theoretical literature on the welfare effects of price discrimination in input markets. This literature, which we will review in more detail in the next section, abstracts from the possibility that upstream suppliers engage in cost-reduction activities. However, investing in R&D is a common business practice by many big manufacturers; for instance, *Johnson & Johnson*, which was involved in the aforementioned antitrust case, is reported to be one of the top spenders in the pharmaceutical industry.[2] Therefore, this study aims to add to the existing literature on input price discrimination by considering the case of upstream R&D investments.

We consider a standard model with one upstream supplier and two cost-asymmetric downstream firms. Downstream firms transform one unit of the input into one unit of a differentiated final good. Under discrimination, the upstream supplier first chooses the level of its R&D investments and next, simultaneously and secretly, makes each downstream firm a take-it-or-leave-it offer. We assume two-part tariff contracts consisting of a per-unit of input price and a fixed fee. Downstream firms compete in quantities, i.e., they engage in Cournot competition. When input price discrimination is banned, the two downstream firms must receive the same contract offer and thus the game unfolds as described above, with the

[1] Regarding legal treatment, input price discrimination issues arise in the context of the Robinson-Patman Act under US law and Article 102 of the Treaty on the Functioning of the European Union (TFEU) under EU law.
[2] Michael Casey, Robert Hackett (2014, November 17). Retrieved from http://fortune.com/2014/11/17/top-10-research-development.

exception that now contract offers are observable. Following much of the extant literature on input price discrimination we consider a linear demand specification.

In such setting, we show that a ban on input price discrimination may increase or decrease the equilibrium level of upstream R&D investments depending on the degree of downstream cost-asymmetry. Yet, we find that welfare always decreases after the ban. Therefore, input price discrimination should be welcomed rather than prohibited even when it decreases the upstream supplier's incentives to engage in cost-reduction activities.

A ban on input price discrimination has two effects on the upstream supplier's incentives to invest in R&D. The first effect, which we label as the "*elimination of commitment problem effect*", is positive. Under discriminatory pricing, and due to contract unobservability, once a downstream firm has signed a contract, the upstream supplier has an incentive to offer better terms to the other competitor (Hart & Tirole, 1990; Rey & Tirole, 2007). A ban on input price discrimination eliminates contract unobservability and the supplier's associated opportunism problem (since it requires both downstream firms receiving the same offer) thus increasing the value of inducing a given cost-reduction.

The second effect, which we label as the "*nonappropriability of industry profits effect*", is negative. Under discriminatory pricing the supplier can appropriate all downstream profits, however, under non-discriminatory pricing it cannot do so due to the common fixed fee – it must leave a positive rent to the more cost-efficient downstream firm. Hence, a ban on input price discrimination decreases the value of inducing a given cost-reduction.

The lower is the cost-asymmetry between downstream firms, the lower is the rent left to the more cost-efficient downstream firm and thus the more likely is that the "elimination of commitment problem effect" will dominate the "nonappropriability of industry profits effect" implying that a ban on input price discrimination will increase the level of upstream R&D investments.

As is well-known, a ban on input price discrimination increases both input prices – since it offers the supplier the opportunity to make commitments thereby solving its opportunism problem – and thus decreases welfare in the short-run (O'Brien & Shaffer, 1994; Rey & Tirole, 2007). As it turns out, at least for the case of linear demand, this effect on input prices is strong enough so that banning input price discrimination also decreases welfare in the long-run *even though* it may increase the upstream supplier's incentives to invest in R&D.

It is a common presumption that whenever a ban on input price discrimination increases R&D investments it also increases welfare, and vice versa. Our analysis shows that, contrary to that presumption, banning price discrimination may move R&D and welfare in opposite directions: the negative welfare-effect from eliminating the supplier's commitment problem is so important that cannot be compensated by the benefits from increased R&D.

We also discuss two extensions of our baseline model. First, we assume that the upstream supplier charges a common input price but a discriminatory fixed fee after the ban.[3] In that case, the upstream supplier can appropriate all downstream profits under either pricing regime implying that the only effect at play is the "elimination of commitment problem effect" which increases the value of inducing a given cost-reduction. A ban on input price discrimination always increases the equilibrium level of upstream R&D investments yet it always decreases welfare. Second, the upstream supplier charges a common input price and a common fixed fee but discriminatory contracts are observable by downstream firms. In such case, the upstream supplier does not suffer from a commitment problem, and since it must offer the same two-part tariff to both downstream firms, the only effect at play is the "nonappropriability of industry profits effect" which decreases the value of inducing a given cost-reduction. A ban on input price discrimination always decreases the equilibrium level of upstream R&D investments and welfare.

The rest of the chapter is organized as follows. Section 1.2 provides a brief overview of the existing literature on input price discrimination. Section 1.3 presents the key elements of the baseline model. Sections 1.4 and 1.5 deal with the cases of discriminatory and non-discriminatory pricing respectively. Under discriminatory pricing, two-part tariff contracts are unobservable by downstream firms; under non-discriminatory pricing, the supplier offers the same two-part tariff contract to both downstream firms. Section 1.6 considers the case where the supplier charges a common input price but a discriminatory fixed fee after a ban on input price discrimination. Section 1.7 considers the case where discriminatory contracts are observable by downstream firms. Section 1.8 contains the concluding remarks.

1.2 Related literature and contribution

The welfare effects of price discrimination in intermediate-good (input) markets have long been discussed among economic theorists.[4] Most of the earlier contributions on input price discrimination has focused on linear input pricing. A key insight from these contributions is that an unconstrained upstream supplier optimally discriminates among downstream firms

[3] As point out by O'Brien & Shaffer (1994), this case could arise when courts are unable to verify discriminatory fixed fees.

[4] This section follows quite closely the brief but very informative reviews in Herweg & Müller (2012, 2016).

based on differences in their derived (input) demands. With linear final-good demand, the more cost-efficient downstream firm has a less elastic derived demand and thus pays a higher input price than its less efficient rival (DeGraba, 1990; Yoshida, 2000).[5,6] Under a ban on input price discrimination, the resulting common input price lies strictly between the otherwise prevailing discriminatory prices. Total output remains unchanged (a result due to demand linearity), however, a larger share of this total output is now shifted to the more efficient downstream firm.[7] Therefore, banning input price discrimination leaves consumer surplus unchanged and increases total welfare.[8]

While in some vertically related industries trading between up- and downstream firms is conducted through simple linear contracts, in others, firms trade using non-linear contracts such as two-part tariffs. Two-part tariff contracts – consisting of a per-unit input price and a fixed fee – are considered legal *per se* by antitrust agencies, since they reduce the double marginalization problem and thus enhance efficiency within a vertical chain. However, when used in a discriminatory way they may become subject of investigation and be scrutinized under the *rule of reason.* Necessary condition in order to be considered illegal is that they impede competition. Motivated by this legal conduct, a string of important contributions has investigated the welfare effects of discriminatory two-part tariff contracts. These contributions can be decomposed into two strands with respect to whether contracts are observable or unobservable when input price discrimination is practiced.

Under contract observability, each downstream firm can observe the contract offered to its rival before deciding whether to accept its own. Due to the presence of fixed fees, the upstream

[5]This finding is clearly analogous to the result in the literature on third-degree price discrimination in final-good markets - initiated by the pioneering work of Robinson (1933) - where a buyer whose demand is less price sensitive (elastic) is charged a higher price. See, e.g., Schmalensee (1981), Varian (1985), Schwartz (1990), Malueg (1993), Armstrong (2007), Stole (2007) and Aguirre *et al*. (2010).
[6]This result no longer holds when the upstream supplier is constrained in its optimal price setting. Indeed, the more efficient downstream firm will receive a discount when it has more attractive alternative supply options than its less efficient rival (e.g., it can integrate backward into the supply of the input whereas its rival cannot (Katz, 1987; O'Brien, 2014) and/or it can substitute another input that achieves greater profits than its rival could achieve with its next best alternative (Inderst & Valletti, 2009; O'Brien, 2014)). Moreover, even in the case where the upstream supplier is unconstrained in its optimal price setting, the more efficient downstream firm may still receive a discount depending on the shape of the final-good demand curve (Li, 2014).
[7]In general, banning input price discrimination has two effects on welfare, one stemming from a change in total output and the other stemming from reallocation of total output between downstream firms. As pointed out by DeGraba (1990), definite statements about welfare when these two effects collide are hard to make. See Valletti (2003) for a general analysis on this issue.
[8]Nevertheless, input price discrimination can be welfare improving (*i*) when it prevents inefficient backward integration into the supply of the input (Katz, 1987), (*ii*) when it fosters entry in the downstream market (Herweg & Müller, 2012; Dertwinkel-Kalt *et al*., 2016), (*iii*) when downstream firms have an alternative source of supply (Inderst & Valletti, 2009) and/or (*iv*) the upstream supplier contracts sequentially, instead of simultaneously, with downstream firms (Kim & Sim, 2015).

supplier can disentangle the objective of extracting surplus from that of providing downstream firms with the right incentives to choose a given final-good quantity or price. In other words, input prices are chosen so as to ensure that overall industry profits are maximized: the upstream supplier adjusts input prices so as to offset competitive pressure on downstream margins and uses the fixed fees to recover downstream profits. Given the negative externality imposed by downstream firms upon each other, the equilibrium input prices will be higher than the supplier's marginal cost. At least for the case of linear demand, the more cost-efficient downstream firm obtains a lower (marginal) input price than its less efficient rival. This is the so-called "waterbed effect", i.e., as one downstream firm becomes relatively more cost-efficient, it pays the upstream supplier to increase the other downstream firm's input price (Inderst & Shaffer, 2009).

When input price discrimination is banned, the upstream supplier can no longer maximize industry profits since the same contract terms must be offered to both downstream firms. Since it is the participation constraint of the less efficient downstream firm that determines the common fixed fee, the upstream supplier uses the common input price as a "metering device" in order to extract more surplus from the downstream firm with the higher derived demand, i.e., the more efficient firm. As a result, the common input price will be higher than both discriminatory input prices, implying that banning discrimination reduces consumer surplus and total welfare.[9] Total welfare is reduced for two reasons: total output is reduced and a larger share of the now smaller total output is shifted to the less efficient downstream firm.

Under contract unobservability, downstream firms never observe each other's contracts. In such case, the upstream supplier suffers from a *commitment problem*: each downstream firm knows that, once it has signed a contract, the supplier has an incentive to offer better terms to the other competing downstream firms.[10] Since any single downstream firm's contract terms do not affect the downstream rival firms' prices or quantities, contract terms are chosen as to maximize joint profits of the specific bilateral relation, instead of overall industry profits. As a result, all downstream firms, regardless of their efficiency, receive the same input price which is equal to the upstream supplier's marginal cost. By making contracts observable, a ban on input price discrimination eliminates the supplier's opportunism problem thereby leading to a

[9]However, banning input price discrimination can be socially desirable when downstream firms possess private information about their costs and the demand they face (Herweg & Müller, 2014) and/or the more efficient downstream firm has significantly higher fixed cost than its less efficient rival (Herweg & Müller, 2016).

[10]The assumption of unobservable contracts and the associated opportunism problem of the upstream supplier dates back to the seminal work of Hart & Tirole (1990). See also O'Brien & Shaffer (1992) and McAfee & Schwartz (1994). Rey & Tirole (2007) provide a very thorough review of this literature.

higher input price for all downstream firms and thus lower quantities of the final good being produced. This in turn implies that banning input pricing discrimination lowers consumer surplus and welfare (O'Brien & Shaffer, 1994; Rey & Tirole, 2007).[11]

All the aforementioned studies take the upstream supplier's marginal cost as exogenously given. This work, in contrast, endogenizes the supplier's marginal cost by allowing for cost-reducing R&D investments and derives implications of banning input price discrimination for optimal R&D investment levels and long-run welfare. It is widely acknowledged nowadays that non-linear contracts, such as two-part tariffs, are extensively used in practice.[12] Moreover, whereas observable contracts are more plausible when upstream agents are unions, the assumption of contract unobservability is much closer to reality when upstream agents are firms. Therefore, our main focus is on unobservable two-part tariff contracts.[13]

DeGraba (1990), Inderst & Valletti (2009), Herweg & Müller (2014) and Dertwinkel-Kalt *et al*. (2016) also study the long-run effects of input price discrimination. However, unlike the present work, they consider the case where downstream firms engage in cost-reducing R&D. Furthermore, the upstream supplier's opportunism problem due to contract unobservability, which plays a key role in our research, is completely absent in their analysis.

Finally, the work by Ikeda & Toshimitsu (2010) is also related to ours in the sense that it considers a monopolist's quality-improving R&D decision under price discrimination in the final-good market. Contrary to their one-tier setting – where the monopolist sells directly to consumers – we focus on a vertical framework and examine an upstream monopolist's cost-reducing R&D decision under price discrimination in the input market.

1.3 The baseline model

We consider a vertically related industry consisting of one upstream and two downstream firms denoted, respectively, by U and D_i with $i = 1,2$. Each downstream firm purchases an intermediate good (input) from U, transforms it into a differentiated final-good in a one-to-one proportion and sells it to consumers.

Consumers have the following utility function (Singh & Vives, 1984),

[11]However, a ban on input price discrimination can be welfare improving when the supplier is constrained by the presence of a competitive fringe (Caprice, 2006).
[12]For empirical evidence see, e.g., Berto Villa-Boas (2007) and Bonnet & Dubois (2010).
[13]Nevertheless, we briefly discuss the case of observable two-part tariff contracts in Section 1.7.

$$U = aq_1 + aq_2 - \frac{1}{2}(q_1^2 + q_2^2 + 2\theta q_1 q_2),$$

which gives the inverse demand functions,

$$p_i = a - q_i - \theta q_j, \quad i, j = 1, 2, \quad i \neq j. \tag{1.1}$$

The parameter $\theta \in (0,1)$ indexes the degree of product substitutability. As θ approaches zero final goods become independent in demand whereas as θ approaches unity final goods become perfect substitutes (homogeneous).

The upstream firm owns a research lab where it invests in order to reduce the cost of producing the input. Specifically, the unit production cost of the input is $c_U - x$, $a > c_U > 0$, where c_U is an initial exogenous cost and *x* are *U*'s R&D investments. Following d'Aspremont & Jacquemin (1988), we assume that R&D investments are subject to diminishing returns as captured by the quadratic form of R&D cost: mx^2. The cost parameter $m > 1/2$ reflects the efficiency of R&D expenditures.[14] Downstream firms face constant marginal cost of producing and selling their goods c_{Di} with $i = 1, 2$. Without loss of generality, we set $c_{D2} = c_D > c_{D1} = 0$, i.e., we assume that D_1 is more cost-efficient than D_2 and its marginal cost is zero, so that c_D denotes the production cost advantage of D_1.

Under discriminatory input pricing, the timing of the game is as follows. At the first stage, the upstream supplier chooses the level of R&D investments, *x*. The choice of *x*, and thus the supplier's resulting marginal cost, is observable by downstream firms.[15] At the second stage, the upstream supplier, simultaneously and secretly, makes each downstream firm a take-it-or-leave-it offer. We focus on two-part tariffs, consisting of a per-unit input price w_i and a fixed fee F_i. At the third stage, downstream firms compete in quantities (Cournot competition).

Due to contract unobservability, when dealing with one of the downstream firms, the upstream supplier has an incentive to cheat on the other competitor (Hart & Tirole, 1990). Multiple equilibria can arise in this setting due to the multiplicity of beliefs that downstream

[14]The latter guarantees that second-order conditions are satisfied in all cases under consideration.

[15]For instance, pharmaceutical companies have long been under great pressure by the U.S. government to disclose information about their costs at the wholesale level (thus aiming to make them justify their prices). According to the Philadelphia Inquirer, in a speech to pharmaceutical executives, former U.S. President Bill Clinton, said: "*Explain, explain, explain and disclose, disclose, disclose*" (Andrew Pollack (2015, July 23). *The New York Times*. Retrieved from http://www.nytimes.com). Nonetheless, our results carry over to the case where R&D investments are unobservable by downstream firms.

firms can form when they receive out-of-equilibrium offers. Following Hart & Tirole (1990), McAffe & Schwartz (1994) and Rey & Tirole (2007), we assume "*passive*" beliefs – also called "*market-by-market*" conjectures – which imply that when a downstream firm receives an out-of-equilibrium offer from *U*, it does not revise its beliefs about the offer received by its rival.[16]

When input price discrimination is banned, the two downstream firms must receive the same contract offer, consisting of a common input price and a common fixed fee. As noted by Inderst & Shaffer (2009), the fact that the upstream supplier offers a single two-part tariff to both downstream firms implies that the latter will pay the same marginal input price and thus compete on the same "level playing field" as required by the Robinson-Patman Act under US law and the Article 102 of the Treaty on the Functioning of the European Union (TFEU) under EU law. In such case, the game unfolds as described above, with the exception that now contracts are always observable by downstream firms.[17]

We make the following two assumptions throughout this chapter:

Assumption 1.1. $c_D < \overline{c}_D = \dfrac{2(a-c_U)m(2-\theta)}{m(6+\theta)-1}$,

Assumption 1.2. $\dfrac{c_U}{a} > \dfrac{1}{2m(1+\theta)}$.

Assumption 1.1 requires that the production cost advantage of D_1 over D_2 is not too high and guarantees that both downstream firms will produce a positive quantity of the final-good in all cases under consideration. Assumption 1.2 requires that the initial upstream marginal cost c_U is not too low relative to the market size *a*, guaranteeing that the upstream firm's marginal cost is always nonnegative. For notational reasons, we use superscripts *D* and *U* to denote, respectively, the equilibrium values under discriminatory and uniform (non-discriminatory) pricing.

[16]From the perspective of the upstream supplier, when contracts are unobservable and downstream competition is in quantities, the two downstream firms form two separate markets. Therefore, a passive-beliefs equilibrium survives both unilateral and multilateral deviations (for more details see Rey & Vergé (2004) and Rey & Tirole (2007)).

[17]When contracts are unobservable by downstream firms under discrimination, we could have assumed that after the ban contracts are still unobservable but downstream firms now hold "symmetric" beliefs: following any out-of-equilibrium contract offer, a downstream firm believes that its rival receives the same deviation contract. As is well-known, with symmetric beliefs, the upstream supplier can achieve the same equilibrium outcomes as if contracts were observable.

1.4 Input price discrimination

We start our analysis by considering the case where input price discrimination is practiced. Firm D_i observes the R&D investments, x, undertaken by the supplier and thereafter forms beliefs not only about the contract offered to downstream firm D_j, but also about the quantity produced by its rival. With passive beliefs, and for any given level of R&D chosen by U, D_i anticipates that its rival receives the equilibrium offer and puts the equilibrium quantity on the market. What matters is D_i's belief about the quantity produced by D_j, *not* the quantity actually produced: the actual quantity produced by D_j depends on the input price w_j, however, D_i's belief about that quantity is independent of w_j. Therefore, each downstream firm chooses its quantity in order to maximize its gross profits:

$$\max_{q_1} \pi_{D_1} = (a - q_1 - \theta q_2^D(x) - w_1)q_1, \quad \max_{q_2} \pi_{D_2} = (a - q_2 - \theta q_1^D(x) - w_2 - c_D)q_2 . \tag{1.2}$$

Quantities at the last-stage subgame respond only to changes in the own input price according to the downstream best-response functions:

$$q_1^D(w_1) = \frac{a - w_1 - \theta q_2^D(x)}{2}, \quad q_2^D(w_2) = \frac{a - (w_2 + c_D) - \theta q_1^D(x)}{2} . \tag{1.3}$$

Prices at the last-stage subgame also respond only to changes in the own input price:

$$p_1^D(q_1^D(w_1), q_2^D(x)), \quad p_2^D(q_1^D(x), q_2^D(w_2)) . \tag{1.4}$$

Since each downstream firm accepts the contract offer as long as the corresponding profit is nonnegative, the upstream supplier uses the fixed fee to extract all downstream profits, i.e.,

$$F_1 = [p_1^D(q_1^D(w_1), q_2^D(x)) - w_1]q_1^D(w_1), \quad F_2 = [p_2^D(q_1^D(x), q_2^D(w_2)) - w_2 - c_D]q_2^D(w_2) , \tag{1.5}$$

and sets input prices in order to maximize industry profits:

$$\max_{w_1,w_2} \pi_U = [p_1^D(q_1^D(w_1), q_2^D(x)) - (c_U - x)]q_1^D(w_1) + \\ + [p_2^D(q_1^D(x), q_2^D(w_2)) - c_D - (c_U - x)]q_2^D(w_2) - mx^2. \tag{1.6}$$

From the first order conditions of (1.6), and using (1.3), we obtain the input prices and final-good outputs for given levels of R&D investments:

$$w_1^D(x) = w_2^D(x) = w^D(x) = c_U - x, \tag{1.7}$$

$$q_1^D(x) = \frac{(a - c_U + x)(2-\theta) + \theta c_D}{4-\theta^2}, \quad q_2^D(x) = \frac{(a - c_U + x)(2-\theta) - 2c_D}{4-\theta^2}. \tag{1.8}$$

It can be easily seen from (1.7) that both downstream firms buy the input at a price *equal* to upstream marginal cost. When contracts are unobservable, the upstream supplier's contract offer to any downstream firm does not affect the downstream rival firm's quantity and thus the contract terms are chosen as to maximize joint profits of each specific bilateral relation.[18] Downstream firms form separate markets from the upstream supplier's point of view despite the fact that in reality firms themselves perceive an interdependency. This finding, originally due to Hart & Tirole (1990), highlights the supplier's commitment problem. As a result, both downstream firms pay the same input price equal to upstream marginal cost, regardless of their relative efficiency. (O'Brien & Shaffer, 1994; Rey & Tirole, 2007).[19]

The upstream supplier chooses the level of R&D investments in order to maximize:

$$\max_{x} \pi_U = [p_1^D(q_1^D(x), q_2^D(x)) - (c_U - x)]q_1^D(x) + \\ + [p_2^D(q_1^D(x), q_2^D(x)) - c_D - (c_U - x)]q_2^D(x) - mx^2. \tag{1.9}$$

From the first order condition of (1.9), we obtain the optimal level of R&D investments when input price discrimination is practiced:

[18]As can be seen from (1.6), the two contracts affect the upstream supplier's profits in a separable way.
[19]As noted by O'Brien & Shaffer (1994), even though marginal input prices are the same for both downstream firms, average prices paid for the upstream supplier's product are *not* the same since they depend on both the fixed fees and the quantity purchased by each downstream firm in equilibrium.

$$x^{D*} = \frac{2(a - c_U) - c_D}{m(2+\theta)^2 - 2}. \tag{1.10}$$

1.5 Banning input price discrimination

We now investigate the effects of a ban on input price discrimination on consumer surplus and welfare. The two downstream firms receive the same two-part tariff contract, consisting of a common input price and a common fixed fee. Contract offers are now observable by downstream firms; banning input price discrimination offers the supplier the opportunity to make commitments thereby solving its opportunism problem. All proofs in this section are relegated to Appendix 1.A.

Each downstream firm chooses its quantity in order to maximize its gross profits:

$$\max_{q_1} \pi_{D_1} = (a - q_1 - \theta q_2 - w)q_1, \quad \max_{q_2} \pi_{D_2} = (a - q_2 - \theta q_1 - w - c_D)q_2. \tag{1.11}$$

From the first order conditions of (1.11), we obtain quantities at the last-stage subgame for any given level of the input price:

$$q_1^U(w) = \frac{(a-w)(2-\theta) + \theta c_D}{4-\theta^2}, \quad q_2^U(w) = \frac{(a-w)(2-\theta) - 2c_D}{4-\theta^2}. \tag{1.12}$$

Due to downstream cost-asymmetry, the upstream supplier cannot extract all downstream profits through the common fixed fee. Since it is the less cost-efficient downstream firm's participation constraint that is binding, the upstream supplier sets the common fixed fee equal to that firm's profits - thereby leaving the more cost-efficient firm with a rent - and thus chooses the common input price w so as to maximize its upstream profits plus twice the profits of the less cost-efficient downstream firm:

$$\begin{aligned} \max_{w} \pi_U &= [w - (c_U - x)][q_1^U(w) + q_2^U(w)] + \\ &\quad + 2[p_2(q_1^U(w), q_2^U(w)) - c_D - w]q_2^U(w) - mx^2. \end{aligned} \tag{1.13}$$

From the first order condition of (1.13), and using (1.12), we obtain the common input price and final-good quantities as functions for given levels of R&D investments:

$$w^U(x) = \frac{2(2-\theta)[a\theta + (c_U - x)(2-\theta)] + c_D(4+\theta^2)}{4(2-\theta)(1+\theta)}, \tag{1.14}$$

$$q_1^U(x) = \frac{2(a - c_U + x)(2-\theta) - c_D(2-3\theta)}{4(2-\theta)(1+\theta)}, \quad q_2^U(x) = \frac{2(a - c_U + x)(2-\theta) - c_D(6+\theta)}{4(2-\theta)(1+\theta)}. \tag{1.15}$$

From (1.7) and (1.14), we have

$$w^U(x) - w^D(x) = \frac{2\theta(a - c_U + x)(2-\theta) + c_D(4+\theta^2)}{4(2-\theta)(1+\theta)} > 0 .$$

Contrary to the case of discriminatory pricing, the input price is no longer equal but *higher* than upstream marginal cost under uniform pricing. As mentioned earlier, non-discriminatory contract offers are observable by downstream firms implying that the supplier does not suffer from an opportunism problem. By recognizing the negative externality that downstream firms impose upon each other, the supplier will set the input price above its marginal cost in order to internalize downstream competition. Therefore, a ban on input price discrimination leads to a higher input price for both downstream firms and thus lower quantities of the final-good being produced. This in turn implies that banning discrimination lowers consumer surplus and welfare in the short-run (O'Brien & Shaffer, 1994; Rey & Tirole, 2007).

The upstream supplier chooses the level of R&D investments in order to maximize:

$$\begin{aligned} \max_x \pi_U &= [w^U(x) - (c_U - x)][q_1^U(x) + q_2^U(x)] + \\ &\quad + 2[p_2(q_1^U(x), q_2^U(x)) - c_D - w^U(x))]q_2^U(x) - mx^2. \end{aligned} \tag{1.16}$$

From the first order condition of (1.16), we obtain the optimal level of R&D investments when input price discrimination is banned:

$$x^{U*} = \frac{2(a-c_U)(2-\theta)-c_D(4-\theta)}{2(2-\theta)[2m(1+\theta)-1]}. \quad (1.17)$$

By comparing the equilibrium levels of upstream R&D investments in (1.10) and (1.17), we obtain the following result.

Proposition 1.1. *With unobservable two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, a ban on input price discrimination increases (decreases) the equilibrium level of upstream R&D investments when*

$$c_D < (>)\tilde{c}_D = \frac{2(a-c_U)m(2-\theta)\theta^2}{m[8(1+\theta)+\theta^2(4-\theta)]-4}.$$

A ban on input price discrimination has two effects on the supplier's incentives to invest in R&D. The first effect, which is labelled the "*elimination of commitment problem effect*", is positive. Banning input price discrimination solves the supplier's commitment problem and helps him/her to exercise its monopoly power: the marginal input price is set above upstream marginal cost in order for the negative externality between downstream firms to be corrected thereby increasing the supplier's profits and the value of inducing a given cost-reduction.

The second effect, which is labelled the "*nonappropriability of industry profits effect*", is negative. Contrary to the discriminatory-pricing case, the upstream supplier cannot extract all downstream profits under uniform pricing due to the common fixed fee and therefore a ban on discrimination decreases the value of inducing a given cost-reduction. The former effect outweighs (is dominated by) the latter when downstream cost-asymmetry is low (high). The lower (higher) is downstream cost-asymmetry, the lower (higher) is the rent left to the more cost-efficient firm and thus the more (less) likely is that a ban on discrimination will increase the equilibrium level of upstream R&D investments.

With the possibility that the R&D investment levels being higher under uniform pricing than under discriminatory pricing, it seems likely that a ban on input price discrimination will decrease input prices and increase consumer surplus in the long-run. However, the following Proposition shows that this is *not* the case.

Proposition 1.2. *With unobservable two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, the common input price lies above the otherwise prevailing* *discriminatory input prices and a ban on input price discrimination always decreases consumer surplus and welfare.*

A ban on input price discrimination has two effects on input prices and thus on consumer surplus. First, for any given upstream marginal cost (exogenous upstream R&D investments), it eliminates the upstream supplier's opportunism problem thus pushing input prices upwards (O'Brien & Shaffer, 1994; Rey & Tirole, 2007). Second, as indicated in Proposition 1.1, it may increase the level of upstream R&D investments when downstream cost-asymmetry is relatively low thus pushing input prices downwards. As it turns out, at least for the case of linear demand, the former effect is strong enough so that input prices increase and consumer surplus decrease as a result of the ban despite the increase in upstream R&D levels.

A welfare comparison is more complicated than the previous analysis regarding consumer surplus since a higher (lower) level of R&D investments also implies a higher (lower) level of R&D expenditures. The latter affects total welfare but not consumer surplus. Nevertheless, Proposition 1.2 indicates that the effect of a higher or lower level of R&D expenditures on total welfare is weak enough so that the effects of banning input price discrimination on consumer surplus and total welfare coincide.

From Propositions 1.1 and 1.2, we obtain the following important observation.

Corollary 1.1. *With unobservable two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, a ban on input price discrimination decreases consumer surplus and welfare* even when *it increases the supplier's incentives to invest in R&D.*

It is a common presumption that whenever a ban on input price discrimination increases R&D investments it also increases welfare, and vice versa. Corollary 1.1 shows that, contrary to that presumption, banning price discrimination may move R&D and welfare in opposite directions: the negative welfare-effect from eliminating the supplier's commitment problem is so important that cannot be compensated by the benefits from increased R&D.

While a regulatory banning on price discrimination reduces welfare and must be avoided, in some cases, the supplier may be able to self-impose such banning. The most commonly suggested way for doing so is by enforcing most-favored-customer clauses (MFC or "non-discrimination" clauses) which are agreements stating that whenever it offers a discount to one downstream firm, all other firms are also entitled to it. The next proposition determines when the supplier has an incentive to self-impose a ban on discrimination.

Proposition 1.3. *With unobservable two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, a ban on input price discrimination increases (decreases) the supplier's profits when the degree of downstream cost-asymmetry is low (high).*

When downstream firms are very close to being cost-symmetric, the "*nonappropriability of industry profits effect*" as a result of a ban on discrimination is negligible implying that the upstream supplier, by eliminating opportunism, will increase its R&D level and profits. When downstream cost-asymmetry is high enough, the nonappropriability effect becomes important so that the supplier does not wish a ban on input price discrimination, therefore MFC clauses will not appear. Our analysis provides an argument against allowing MFC clauses: when they are introduced, they reduce welfare. Yet, it should be noted here that the main issue with such clauses is their credibility: how can they be implemented when downstream firms can never observe price discounts eventually offered to rivals?[20]

Irrespectively of whether a ban on discrimination can be self-imposed by the supplier or it is imposed by antitrust agencies, the main message of our analysis is that it is detrimental for welfare and must be avoided even when it increases R&D levels.

1.6 Banning discrimination: common input price, discriminatory fixed fee

> "*One possibility is that the courts can verify wholesale prices but cannot verify discriminatory fixed fees, which may take the form of under-the-table payments, rebates, or other allowances that are difficult to uncover. In this case, a disadvantage retailer simply cannot prove a discriminatory fixed fee violation of Robinson-Patman.*"
>
> – O'Brien & Shaffer (1994)

In this section, we modify the baseline model by considering the case where, when input price discrimination is banned, the upstream supplier offers to both downstream firms a common input price, however, it can offer different fixed fees. This pricing regime may be a

[20]Since the commitment problem arises in situations where contracts are unobservable, it seems reasonable that the same circumstances will also make it difficult to apply MFC clauses. Competition-policy authorities, by introducing a "transparent pricing" rule (sellers cannot offer secret discounts to buyers) and by requiring a heavy penalty for its violation, can help the upstream supplier to restore its power to commit. See Motta (2004, pg 342-343) for a discussion on this issue.

result of informational constraints as pointed out in the above quote by O’Brien & Shaffer (1994). All proofs in this section are relegated in Appendix 1.B.

Similarly to the common-input-price/common-fixed-fee case considered in the previous section, banning input price discrimination eliminates the upstream supplier’s opportunism problem. Therefore, the quantities at the last-stage subgame are still given by (1.12). The important difference here is that since the supplier can still use discriminatory fixed fees it can appropriate all downstream profits. Thus, it will choose the common input price to maximize total industry profits:

$$\max_{w} \pi_U = [p_1^U(q_1^U(w), q_2^U(w)) - (c_U - x)]q_1^U(w) + \\ + [p_2^U(q_1^U(w), q_2^U(w)) - c_D - (c_U - x)]q_2^U(w) - mx^2. \tag{1.18}$$

From the first order condition of (1.18), and using (1.12), we obtain the common input price and final-good quantities as functions for given levels of R&D investments:

$$w^{UF}(x) = \frac{2[a\theta + (c_U - x)(2+\theta)] - c_D\theta}{4(1+\theta)}, \tag{1.19}$$

$$q_1^{UF}(x) = \frac{2(a - c_U + x)(2-\theta) + 3\theta c_D}{4(2-\theta)(1+\theta)}, \quad q_2^{UF}(x) = \frac{2(a - c_U + x)(2-\theta) - c_D(4+\theta)}{4(2-\theta)(1+\theta)}, \tag{1.20}$$

where the additional superscript F is used to denote the common-input-price/discriminatory-fixed-fee case. From (1.7) and (1.19), we have

$$w^{UF}(x) - w^D(x) = \frac{\theta[2(a - c_U + x) - c_D]}{4(1+\theta)} > 0.$$

As in the common-input-price/common-fixed-fee case, a ban on input price discrimination eliminates the upstream supplier’s opportunism problem leading to an increase in input prices and thus to a reduction in welfare (O’Brien & Shaffer, 1994).

The upstream supplier chooses the level of R&D investments in order to maximize:

$$\max_x \pi_U = [p_1^{UF}(q_1^{UF}(x), q_2^{UF}(x)) - (c_U - x)]q_1^{UF}(x) +$$
$$+[p_2^{UF}(q_1^{UF}(x), q_2^{UF}(x)) - c_D - (c_U - x)]q_2^{UF}(x) - mx^2. \tag{1.21}$$

From the first order condition of (1.21), we obtain the optimal level of R&D investments:

$$x^{UF*} = \frac{2(a - c_U) - c_D}{2[2m(1+\theta) - 1]}. \tag{1.22}$$

By comparing the equilibrium levels of upstream R&D investments in (1.10) and (1.22), we obtain the following result.

Proposition 1.4. *When input price discrimination is banned, suppose that the supplier offers a common input price but a discriminatory fixed fee to downstream firms. With unobservable discriminatory two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, a ban on input price discrimination always increases the level of upstream R&D investments.*

Since the upstream supplier can still use discriminatory fixed fees after the ban, it can appropriate all downstream profits under either pricing regime implying that the only effect at play is the "elimination of commitment problem effect" which increases the value of inducing a given cost-reduction. The welfare effects of banning input price discrimination are summarized in the following Proposition.

Proposition 1.5. *When input price discrimination is banned, suppose that the supplier offers a common input price but a discriminatory fixed fee to downstream firms. With unobservable discriminatory two-part tariffs, linear demand and downstream Cournot competition with passive beliefs, the common input price after the ban always lies above the otherwise prevailing discriminatory input prices and a ban on input price discrimination always decreases consumer surplus and welfare.*

Propositions 1.2 and 1.5 together imply that not only the qualitative nature of our main finding in the previous section, described in Corollary 1.1, remains robust but in fact it is stronger: a ban on input price discrimination decreases consumer surplus and welfare even though it *always* increases the upstream supplier's incentives to invest in R&D.

1.7 Observable discriminatory contracts

In this section, we modify the baseline model by considering the case where, when input price discrimination is practiced, two-part tariff contracts are observable by downstream firms. All proofs in this section are relegated to Appendix 1.C.

Each downstream firm chooses its quantity in order to maximize its gross profits:

$$\max_{q_1} \pi_{D_1} = (a - q_1 - \theta q_2 - w_1) q_1, \quad \max_{q_2} \pi_{D_2} = (a - q_2 - \theta q_1 - w_2 - c_D) q_2 . \tag{1.23}$$

The first order conditions give rise to the following best-response functions:

$$q_1(q_2, w_1) = \frac{a - w_1 - \theta q_2}{2}, \quad q_2(q_1, w_2) = \frac{a - (w_2 + c_D) - \theta q_1}{2} . \tag{1.24}$$

Solving together the best-response functions in (1.24), we obtain the equilibrium final-good quantities for given levels of input prices:

$$q_1^{DO}(w_1, w_2) = \frac{a(2-\theta) - 2w_1 + \theta(c_D + w_2)}{4 - \theta^2}, \quad q_2^{DO}(w_1, w_2) = \frac{a(2-\theta) - 2(w_2 + c_D) + \theta w_1}{4 - \theta^2} . \tag{1.25}$$

where the additional superscript *O* is used to denote the case where contracts are observable.

The upstream supplier uses the fixed fee to extract all downstream profits and sets input prices in order to maximize industry profits:

$$\begin{aligned} \max_{w_1, w_2} \pi_U = & [p_1^{DO}(q_1^{DO}(w_1, w_2), q_2^{DO}(w_1, w_2)) - (c_U - x)] q_1^{DO}(w_1, w_2) + \\ & + [p_2^{DO}(q_1^{DO}(w_1, w_2), q_2^{DO}(w_1, w_2)) - c_D - (c_U - x)] q_2^{DO}(w_1, w_2) - mx^2 . \end{aligned} \tag{1.26}$$

Solving together the first order conditions of (1.26), and using (1.25), we obtain the equilibrium input prices, final-good quantities and final-good prices for given levels of R&D investments:

$$w_1^{DO}(x) = \frac{a\theta(1-\theta)+(2+\theta)(1-\theta)(c_U - x)-\theta c_D}{2(1-\theta^2)},$$
$$w_2^{DO}(x) = \frac{a\theta(1-\theta)+(2+\theta)(1-\theta)(c_U - x)+\theta^2 c_D}{2(1-\theta^2)}, \tag{1.27}$$

$$q_1^{DO}(x) = \frac{(1-\theta)(a-c_U+x)+\theta c_D}{2(1-\theta^2)}, \quad q_2^{DO}(x) = \frac{(1-\theta)(a-c_U+x)-c_D}{2(1-\theta^2)}. \tag{1.28}$$

It can be easily verified from (1.27) that the upstream supplier imposes a markup on both input prices, that markup being lower for the more efficient firm, $c_U - x < w_1^{DO}(x) < w_2^{DO}(x)$. Due to the presence of fixed fees, through which downstream profits can be appropriated, the upstream supplier adjusts input prices so as to offset competitive pressure on downstream margins. Therefore, the equilibrium input prices will be higher than upstream marginal cost and the more efficient downstream firm obtains a lower input price than its less efficient rival (Inderst & Shaffer, 2009).

The upstream supplier chooses the level of R&D investments in order to maximize:

$$\max_x \pi_U = [p_1^{DO}(q_1^{DO}(x), q_2^{DO}(x)) - (c_U - x)]q_1^{DO}(x) +$$
$$+[p_2^{DO}(q_1^{DO}(x), q_2^{DO}(x)) - c_D - (c_U - x)]q_2^{DO}(x) - mx^2. \tag{1.29}$$

From the first order condition of (1.29), we obtain the optimal level of R&D investments:

$$x^{DO*} = \frac{2(a-c_U)-c_D}{2[2m(1+\theta)-1]}. \tag{1.30}$$

We now investigate the effects of a ban on input price discrimination on the level of R&D investments and welfare. As it turns out, irrespectively of whether the upstream supplier uses a common fixed fee and/or a discriminatory fixed fee after the ban, Corollary 1.1 is no longer valid when two-part tariff contracts are observable.

By comparing the equilibrium levels of upstream R&D investments in (1.17) and (1.30), we obtain the following result.

Proposition 1.6. *With observable two-part tariffs, linear demand and downstream Cournot competition, a ban on input price discrimination always decreases the level of upstream R&D investments.*

As mentioned earlier, the upstream supplier does not suffer from an opportunism problem when input price discrimination is practiced due to contract observability. In that case, a ban on input price discrimination has only one effect on the supplier's incentives to invest in R&D: the "*nonappropriability of industry profits effect*" which, as explained in the previous section, decreases the value of inducing a given cost-reduction. Therefore, contrary to the case of unobservable two-part tariffs, a ban on input price discrimination always decreases the level of upstream R&D investments when two-part tariffs are observable.

As already mentioned in Section 1.2, a ban on input price discrimination increases both input prices and decreases consumer surplus and welfare in the short-run (Inderst & Shaffer, 2009). Given that the level of R&D investments decreases after the ban, it is straightforward that consumer surplus also decreases in the long-run. As shown formally in the proof of Proposition 1.5, the same holds true for total welfare. Thus, unlike the case of unobservable two-part tariffs, a ban on discrimination causes both R&D levels and welfare to move in the same direction.

1.8 Conclusions

In this chapter, we study the welfare effects of price discrimination in input markets where an upstream supplier first undertakes R&D investments, and then sells input to two cost-asymmetric downstream firms using two-part tariff contracts. We show that a ban on input price discrimination increases (resp., decreases) upstream R&D levels when the degree of downstream cost-asymmetry is relatively low (resp., high). Nevertheless, we also find that consumer surplus and welfare always decrease after the ban.

Contrary to what might someone expect, we show that a ban on input price discrimination may induce upstream R&D levels and welfare to move in opposite directions. While this can never happen when contracts are observable, banning discrimination when contracts are unobservable may in some cases induce an increase in R&D, while still being detrimental for welfare. This is due to the secrecy of contracts and the supplier's associated opportunism problem.

Since our analysis is based on Cournot competition, its most immediate extension is to examine the same issues under Bertrand competition. While assuming that downstream firms hold passive beliefs when receiving out-of-equilibrium offers from the supplier is compatible with Cournot conjectures, such beliefs are inadequate for the analysis of price competition in the downstream market, posing serious equilibrium-existence problems. While according to Rey & Vergé (2004), the use of *wary* beliefs is a consistent alternative, it lacks tractability. This lack of tractability is aggravated in our setting, since we deal with endogenous R&D decisions and cost-asymmetric downstream firms. Studying the welfare effects of input price discrimination under downstream Bertrand with wary beliefs constitutes a challenging avenue for future research.

Appendix 1.A

Proof of Proposition 1.1. From (1.10) and (1.17), we calculate,

$$x^{U*} - x^{D*} = \frac{2(a-c_U)m(2-\theta)\theta^2 - c_D[m(8(1+\theta)+\theta^2(4-\theta))-4]}{[m(2+\theta)^2-2][2(2-\theta)(2m(1+\theta)-1)]},$$

where the denominator is positive due to the fact that $m > 1/2$. Thus, the above expression is positive (negative) whenever its numerator is positive (negative), i.e.,

$$c_D < (>) \tilde{c}_D = \frac{2(a-c_U)m(2-\theta)\theta^2}{m[8(1+\theta)+\theta^2(4-\theta)]-4}.$$

It can be easily checked that, for $m > 1/2$, it holds that $\tilde{c}_D < \overline{c}_D$. Therefore, a ban on input price discrimination increases (decreases) the level of upstream R&D investments when the degree of downstream cost-asymmetry is low (high). ■

Proof of Proposition 1.2. First, we calculate the final equilibrium outcomes for the two pricing regimes.

Under discriminatory input pricing, substituting (1.10) into (1.7) and (1.8), we have:

$$w_1^{D*} = w_2^{D*} = w^{D*} = c_U - \frac{2(a-c_U)-c_D}{m(2+\theta)^2-2}, \tag{1.A1}$$

$$\begin{aligned} q_1^{D*} &= \frac{m(a-c_U)(4-\theta^2)+c_D[m\theta(2+\theta)-1]}{(2-\theta)[m(2+\theta)^2-2]}, \\ q_2^{D*} &= \frac{m(a-c_U)(4-\theta^2)-c_D[2m(2+\theta)-1]}{(2-\theta)[m(2+\theta)^2-2]}. \end{aligned} \tag{1.A2}$$

Under non-discriminatory input pricing, substituting (1.17) into (1.14) and (1.15), we have:

$$w^{U*} = \frac{2a(2-\theta)(m\theta-1)+2mc_U(4-\theta^2)+c_D[m(4+\theta^2)+(2-\theta)]}{2(2-\theta)[2m(1+\theta)-1]}, \tag{1.A3}$$

$$\begin{aligned} q_1^{U*} &= \frac{2m(a-c_U)(2-\theta)-c_D[m(2-3\theta)+1]}{2(2-\theta)[2m(1+\theta)-1]}, \\ q_2^{U*} &= \frac{2m(a-c_U)(2-\theta)-c_D[m(6+\theta)-1]}{2(2-\theta)[2m(1+\theta)-1]}. \end{aligned} \tag{1.A4}$$

Input prices and consumer surplus. Using (1.A1) and (1.A3), we show that the common input price lies above the otherwise prevailing discriminatory input prices, i.e.,

$$w^{U*} - w^{D*} = \frac{(a-c_U)m(2-\theta)\theta[m(2+\theta)-1]+c_D[m(2+\theta)(4+\theta^2)-(4-2\theta+\theta^2)]}{[m(2+\theta)^2-2][2(2-\theta)(2m(1+\theta)-1)]} > 0.$$

where the positive sign stems from the fact that $m > 1/2$.

Since final-good prices increase with the input price and the utility of the representative consumer is lower for higher final-good prices, it is straightforward that consumer surplus decreases as a result of the ban.

Total welfare. Total welfare is defined as the sum of consumer surplus and industry profits, i.e.,

$$TW^{k*} = \frac{(q_1^{k*})^2 + (q_2^{k*})^2 + 2\theta q_1^{k*} q_2^{k*}}{2} + (a - q_1^{k*} - \theta q_2^{k*}) q_1^{k*} + (a - q_2^{k*} - \theta q_1^{k*} - c_D) q_2^{k*}$$

$$- (c_U - x)(q_1^{k*} + q_2^{k*}) - mx^2,$$

with $k = D,U$. Define $\Delta TW^* = TW^{D*} - TW^{U*}$. Solving $\Delta TW^* = 0$ for c_D we obtain two roots:

$$c_{D(1,2)} = \frac{2(a - c_U)(2-\theta)[\pm 2(2m(1+\theta)-1)(m(2+\theta)-2)\sqrt{A} + m(m^2 B - mC + D)]}{16 + m(m^2 E + m\theta G - H)}.$$

with

$$A = m[m(2+\theta)^2 + \theta(4 + 3\theta + \theta^2)] > 0, \quad B = m^2(1+\theta)(2+\theta)^2(8 + 4\theta^2 + \theta^3)] > 0,$$

$$C = 8(1+\theta)(4+\theta^2) + 3\theta^4(2+\theta) > 0, \quad D = 8 - \theta^2(2+\theta)(1-\theta) > 0,$$

$$E = (1+\theta)(2+\theta)^2(4+\theta^2)(4 - 4\theta - \theta^2) > 0, \quad G = 128 + 176\theta + 64\theta^2 + 8\theta^3 + 3\theta^5 > 0,$$

$$H = 48 + 80\theta + 28\theta^2 - 4\theta^3 - \theta^4 + \theta^5 > 0.$$

After some straightforward but tedious calculations, it can be verified that, for all $\theta \in (0,1)$ and $m > 1/2$, both these roots lie outside the interval $(0, \overline{c}_D)$ implying that ΔTW^* has the same sign in that interval. It then suffices to show that

$$\Delta TW^* \Big|_{c_D \to 0, \theta \to 1} = \frac{(a - c_U)^2 m^2 (90m - 55m + 8)}{(9m-2)^2 (4m-1)^2} > 0.$$

where the positive sign stems from $m > 1/2$. Therefore, banning discrimination decreases total welfare. ■

Proof of Proposition 1.3. After substituting the respective equilibrium values in (1.9), we obtain the upstream supplier's equilibrium profits under discriminatory pricing, π_U^{D*} . Similarly, after substituting the respective equilibrium values in (1.16), we obtain the upstream supplier's equilibrium profits under uniform pricing, π_U^{U*}. Define $\Delta\pi_U^* = \pi_U^{D*} - \pi_U^{U*}$. The sign of $\Delta\pi_U^*$ can be positive or negative depending on the value of c_D. It is easy to check that

$$\Delta\pi_U^*\Big|_{c_D=0} = \lim_{c_D\to 0}\pi_U^* = \frac{(a-c_U)^2 m^2\theta^2}{[2m(1+\theta)-1][m(2+\theta)^2-2]} > 0\,,$$

where the positive sign stems from $m > 1/2$. Thus, banning price discrimination increases the supplier's profits when the degree of downstream cost-asymmetry is low. Moreover, we have that

$$\lim_{c_D\to \bar{c}_D}\pi_U^* = -\frac{(a-c_U)^2 m^2[2m(3-\theta)(2+\theta)^2-(8-\theta^2)]}{[m(6+\theta)-1]^2[m(2+\theta)^2-2]} < 0\,,$$

which implies that a ban on discrimination decreases the supplier's profits when the degree of downstream cost-asymmetry is high. ■

Appendix 1.B

Proof of Proposition 1.4. From (1.10) and (1.22), we calculate,

$$x^{UF*} - x^{D*} = \frac{[2(a-c_U)-c_D]m\theta^2}{2[m(2+\theta)^2-2][(2m(1+\theta)-1)]} > 0\,,$$

where the positive sign stems from the fact that $m > 1/2$. Therefore, a ban on input price discrimination always increases the level of upstream R&D investments. ■

Proof of Proposition 1.5. The final equilibrium outcomes for the case of discriminatory input pricing are given in (1.A1) – (1.A2) (see proof of Proposition 1.2 in Appendix 1.A). Substituting (1.22) into (1.19) and (1.20), we obtain the final equilibrium outcomes for the common-input-price/discriminatory-fixed-fee case:

$$w^{UF*} = \frac{2a(m\theta-1)+2mc_U(2+\theta)-c_D(m\theta-1)}{2[2m(1+\theta)-1]}, \tag{1.B1}$$

$$q_1^{UF*} = \frac{2m(a-c_U)(2-\theta)-c_D(3m\theta-1)}{2(2-\theta)[2m(1+\theta)-1]},$$

$$q_2^{UF*} = \frac{2m(a-c_U)(2-\theta)-c_D[m(4-\theta)-1]}{2(2-\theta)[2m(1+\theta)-1]}. \tag{1.B2}$$

Input prices and consumer surplus. Using (1.A1) and (1.B1), we first show that the common input price lies above the otherwise prevailing discriminatory input prices, i.e.,

$$w^{UF*} - w^{D*} = \frac{[2(a-c_U)-c_D]m\theta(2+\theta)[m(2+\theta)-1]}{2[m(2+\theta)^2-2][(2m(1+\theta)-1)]} > 0.$$

where the positive sign stems from the fact that $m > 1/2$.

Since final-good prices increase with the input price and the utility of the representative consumer is lower for higher final-good prices, it is straightforward that consumer surplus decreases as a result of the ban.

Total welfare. Define $\Delta TW^{F*} = TW^{D*} - TW^{UF*}$. Using (1.A2) and (1.B2), we have

$$\Delta TW^{F*} = \frac{[2(a-c_U)-c_D]^2 m^2\theta A}{4[2m(1+\theta)-1]^2[m(2+\theta)^2-2]^2}.$$

with $A = (4+3\theta+\theta^2)+m[m(1+\theta)(2+\theta)^2(4+\theta)-(16+24\theta+12\theta^2+3\theta^3)]$.

After some straightforward but tedious calculations, it can be verified that, for all $\theta \in (0,1)$ and $m > 1/2$, it holds that $A > 0$. Therefore, it holds that $\Delta TW^{F*} > 0$. ■

Appendix 1.C

Proof of Proposition 1.6. From (1.17) and (1.30), we calculate,

$$x^{U*} - x^{DO*} = -\frac{c_D}{(2-\theta)[(2m(1+\theta)-1)]} < 0,$$

where the positive sign stems from the fact that $m > 1/2$. Therefore, a ban on input price discrimination always decreases the level of upstream R&D investments.

The effect of the ban on total welfare. The final equilibrium quantities for the case of non-discriminatory input pricing are given in (1.A4) (see proof of Proposition 1.2 in Appendix 1.A). Substituting (1.30) into (1.28), we obtain the final equilibrium quantities for the case of observable discriminatory contracts:

$$q_1^{DO*} = \frac{4m(a-c_U)(1-\theta)+2c_D[m(3\theta+1)-1)]}{4(1-\theta)[2m(1+\theta)-1]},$$

$$q_2^{DO*} = \frac{4m(a-c_U)(1-\theta)-c_D(4m-1)}{4(1-\theta)[2m(1+\theta)-1]}. \tag{1.C1}$$

Total welfare is defined as the sum of consumer surplus and industry profits. Define $\Delta TW^{O*} = TW^{DO*} - TW^{U*}$. Using (1.A2) and (1.C1), we have

$$\Delta TW^{O*} = \frac{c_D[32(a-c_U)m^2(2-\theta)(1-\theta^2)-c_D K]}{16(2-\theta)^2(1-\theta)[2m(1+\theta)-1]^2},$$

with $K = -\theta(4-\theta)+4m[m(1+\theta)(4-12\theta+\theta^2+\theta^3)+(4+3\theta^2-\theta^3)]$. This expression can be either positive or negative depending on the values of θ and m. Clearly, whenever $K < 0$, it holds that $\Delta TW^{O*} > 0$. Whenever $K > 0$, $\Delta TW^{O*} > 0$ holds whenever

$$\hat{c}_D < \frac{32(a-c_U)m^2(2-\theta)(1-\theta^2)}{K}.$$

After some straightforward but tedious calculations, it can be verified that for $K > 0$ it holds that $\bar{c}_D < \hat{c}_D$. Therefore, a ban on input price discrimination always decreases welfare. ■

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Chapter 2

Upstream mergers involving a vertically integrated firm

2.1 Introduction

A classic topic of antitrust economics is the welfare effects of horizontal mergers – that is mergers between competitors. Nowadays, a large number of nations worldwide have laws or regulations which call for merger control (e.g., US Horizontal Merger Guidelines (2010), EC Horizontal Merger Guidelines (2004/03)). Since vertical relations are ubiquitous in real-world markets, it is widely acknowledged, by both economic theorists and antitrust agencies, that the vast majority of horizontal mergers take place in either the upstream or the downstream sector of vertically related industries.

In this chapter, we study upstream horizontal mergers. A key aspect of our analysis is that one of the merging parties is vertically integrated. In other words, one insider party to the upstream merger is also present in the downstream market. This assumption is motivated by a number of merger cases, such as, for example, *BP /ARCO*, *Arvin Meritor/Volvo*,[21] *DFDS/Norfolk*,[22] *Arla Foods/Milk Link*,[23] and *Holcim/Lafarge*.[24]

The *BP/ARCO* merger can be seen as a prominent antitrust case concerning the important role of integrated firms in merger analysis. In 1999, British Petroleum Amoco (BP) announced its intention to acquire the Atlantic Richfield Company (ARCO). Whereas both BP and ARCO were present in the Alaskan North Slope (ANS) – the upstream market for crude oil –, only ARCO was present downstream in West Coast refining and marketing. Moreover, BP was a

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[21]Case COMP/M.3351 - *Arvin Meritor/Volvo (Assets)*, Commission decision of 1 October 2004. In the market for driven axles (upstream) for trucks of 6 tonnes or more (downstream), Volvo was one of the vertically integrated firms (present in both markets) whereas Alvin Meritor was one of the vertically separated firms (present only in the upstream market).

[22]Case COMP/M.5756 - *DFDS/Norfolk*, Commission decision of 17 June 2010. In the upstream market for unitized services by sea both DFDS and Norfolk were present, but only the latter was also present in the downstream market for contract logistics.

[23]Case COMP/M.6611 - *Arla Foods/Milk Link*, Commission decision of 27 September 2012. In the upstream market for whey both firms were present, but only Arla Foods was also present in the downstream market for permeate powder and other whey protein concentrate ("WPC") products.

[24]Case COMP/M.7252 - *Holcim/Lafarge*, Commission decision of 15 December 2014. In Croatia, Czech Republic, Hungary and Slovakia, both firms were present in the upstream market for grey cement, but only Holcim was also present in the downstream market for ready-mix concrete ("RMX").

major supplier of crude oil to ARCO's competitors, such as Chevron and Tosco. As Bulow & Shapiro (2002) comment, the basic downstream antitrust concern in the *BP /ARCO* merger "*was whether the acquisition of ARCO would allow BP to elevate the price of ANS crude oil to West Coast refineries. Ultimately, higher ANS crude oil prices might lead to higher prices of refined products, especially gasoline, on the West Coast.*" In other words, the main antitrust concern was whether *BP* would engage post-merger in input (vertical) foreclosure – a raising-rival's-costs strategy – limiting the success of its downstream competitors and ultimately hurting consumers. Input foreclosure, as a result of upstream horizontal mergers involving a vertically integrated firm, has been the subject of investigation in a number of cases in EU (see, for example, the *Arla Foods/Milk Link* and *Holcim/Lafarge* cases mentioned above)

To the best of our knowledge, a formal economic model of upstream horizontal mergers involving a vertically integrated firm has not been developed yet. Filling this gap is the main objective of this chapter. In doing so, we bring some existing effects from the vertical-mergers literature into horizontal merger analysis and, more importantly, we highlight the fact that the welfare analysis of such type of upstream mergers can significantly differ from the respective analysis of upstream mergers that involve only vertically separated firms.

Following the extant literature on upstream mergers that take place in vertically separated markets (e.g., Horn & Wolinsky, 1988; Ziss, 1995; Fumagalli & Motta, 2001; Inderst & Wey, 2003; O'Brien & Shaffer, 2005; Milliou & Petrakis, 2007; Milliou & Pavlou, 2013),[25] we consider a model with two competing vertical chains. In each chain, there is a single upstream firm that produces an input which a single downstream firm uses in one-to-one proportion in the production of a differentiated final good. We abstract from the existing literature by assuming that one vertical chain is vertically integrated whereas the other chain is vertically separated. At some point, the vertically integrated chain (or vertically integrated firm) considers merging with the upstream independent input supplier. Such a merger is classified as horizontal, since both merging entities are present in the upstream market, it has nevertheless important vertical implications since the independent downstream firm must now purchase its input from the upstream counterpart of its rival in the downstream market.

The timing of the game is as follows. At the first stage, the vertically integrated firm and the independent upstream supplier decide whether or not to merge horizontally. At the second

[25]For an analysis of horizontal mergers in one-tier industries see the seminal works of Salant *et al*. (1983), Perry & Porter (1985), Deneckere & Davidson (1985), Farrell & Shapiro (1990), McAfee & Williams (1992) and Werden & Froeb (1994). For an analysis of downstream horizontal mergers in vertically related industries see, among others, von Ungern Sternberg (1996), Dobson & Waterson (1997), Inderst & Wey (2003), Lommerud *et al*. (2005), Fauli-Oller & Bru (2008) and Symeonidis (2008, 2010).

stage, the independent upstream supplier (if the merger does not occur) or the newly merged firm (if the merger occurs) makes the independent downstream firm a take-it-or-leave-it, two-part tariff contract offer; the contract consists of an input price and a fixed fee. At the last stage, downstream competition is in quantities (Cournot).

In the baseline model, we assume upstream cost symmetry which implies that the merger does not generate any efficiency gains thus allowing to focus on the implications of the vertical relationship. We also assume that, pre-merger, the contract stipulated in the vertically separated chain is observable by the vertically integrated firm. Under a general demand function, we show that the upstream horizontal merger raises the independent downstream firm's cost: the input price paid by the latter increases, yielding greater market share to the downstream affiliate of the horizontally merged entity. This translates the higher input price into higher final-good prices and lower total output thereby making consumers worse off. This finding holds for any given relationship between downstream costs. Raising rivals' costs – also known as input foreclosure – is one of the most well-known anti-competitive effects of vertical mergers; our contribution is that we formally incorporate this effect into horizontal merger analysis.[26] Our focus is on situations where the independent downstream rival pays a higher input price and produces less of the final good in the post-merger case, however, it is not driven out of the market.[27]

We consider two modifications of the baseline model under which consumer surplus may increase due to the merger. First, we maintain the assumption of observable contracting in the pre-merger case, however, we introduce upstream cost asymmetry. We assume that, in the post-merger situation, the more efficient firm transfers its technology to the less efficient firm so that the merger generates efficiency gains.[28] In such setting, by employing a linear demand function for tractability reasons, we show that *overall consumer surplus may increase due to the merger even though the input price always increases and some consumers are worse off.* Second, we maintain the assumption of upstream cost symmetry, however, we assume

[26]As pointed out by Church (2008, pg 1472), "the hypothesis associated with raising rivals' costs typically involves input foreclosure. Input foreclosure occurs when, postmerger, the price of the upstream input rises, raising the costs of competing downstream firms." The issue of input foreclosure has been developed in depth by a number of theoretical papers (see e.g., Salinger, 1988; Hart & Tirole, 1990; Ordover *et al*., 1990; Rey & Tirole, 2007). For excellent overviews on the foreclosure effects of vertical mergers see Riordan (2005) and Church (2008).

[27]This is indeed the case when goods are differentiated and/or the independent downstream firm is a sufficiently efficient competitor (Rey & Tirole, 2007; Arya *et al*., 2008; Reisinger & Tarantino, 2015).

[28]See Williamson (1968) for a classic analysis of the tradeoff between market power and efficiency gains, as well as Röller *et al*. (2001) for a review of the literature on the efficiency gains of horizontal mergers in one-tier industries.

unobservable contracting in the pre-merger case. In that setting, under a general demand function, we find that the input price may decrease and *consumer surplus may increase as a result of the merger even in the absence of exogenous cost-synergies between the merging firms*. A necessary condition for this finding is that the unintegrated downstream rival is more cost-efficient than the downstream division of the integrated firm.

Under observable contracting in the pre-merger case but with *upstream cost asymmetry*, the effect of the merger on input price, as well as on final-good prices, crucially depends on which firm – the independent upstream firm or the upstream division of the vertically integrated firm – is more cost-efficient in the pre-merger situation. When the independent upstream firm is *less* efficient than the upstream division of the vertically integrated firm, the merger creates efficiency gains in the upstream production that is directed to the independent downstream rival causing the input price to fall. This effect works against the aforementioned raising-rivals'-costs effect and when it is sufficiently large it may outweigh the latter, resulting in lower input and final-good prices, thus benefiting all consumers.

When the independent upstream firm is *more* efficient than the upstream division of the vertically integrated firm, on the one hand, the merger does not lower the cost of the upstream production directed to the independent downstream firm, leaving at play only the raising-rivals'-costs effect. Hence, as in the case of upstream cost symmetry, the input price always increases pulling with it the final-goods prices. On the other hand, the merger creates efficiency gains in the upstream production directed to the downstream division of the merged firm, thus tending to decrease both final-good prices. As it turns out, the final-good price of the independent downstream firm always increase due to the merger irrespective of the magnitude of the efficiency gains. However, when the efficiency gains are sufficiently large, the final-good price of the vertically integrated firm may decrease and consumer surplus may increase as a result of the merger. In other words, overall consumer surplus may increase due to the efficiency gains entailed by the merger even though some consumers – those buying from the independent downstream firm – are worse off.

Under upstream cost symmetry but with *unobservable contracting* in the pre-merger case, the upstream merger increases consumer surplus even though it does not increase efficiency in the merging firms. In the pre-merger case, the two-part tariff contract stipulated in the separated chain loses its pre-commitment value thereby eliminating any strategic effect on the integrated firm's behavior and resulting in upstream marginal-cost pricing.[29] The upstream merger restores the commitment value of the contract and has an additional effect on the input price besides the raising-rivals'-costs effect: any decrease in the input price will decrease the merged firm's downstream sales which will in turn increase the independent downstream firm's final-good price and thus the profits that can be appropriated by the merged firm through the fixed fee. This effect, labelled the output-shifting effect, is identified by Reisinger & Tarantino (2015) in the context of vertical mergers. When the downstream division of the integrated firm is sufficiently less cost-efficient than the independent downstream firm, it is optimal for the merged firm to set an input price below upstream marginal cost thereby shifting final-good sales to the more profitable downstream rival. The reduction in input price ultimately leads to a reduction in final-good prices.

In all cases under consideration, the merger is always profitable. In the pre-merger case, the input price is chosen so as to maximize the vertically separated chain's profits rather than total industry profits. In the post-merger case, however, the input price is chosen so as to maximize overall industry profits. Therefore, it must hold that overall industry profits increase as a result of the merger. Since overall industry profits increase, and the independent downstream firm's net profits remain unaffected (in both cases are equal to zero), it must hold that the combined net profits of the vertically integrated firm and the independent upstream supplier increase, implying that the merger is beneficial for the merging parties.

As already mentioned above, the existing literature on upstream horizontal mergers focuses on vertically separated markets. Two key insights from this literature are that (*i*) upstream mergers are profitable and beneficial to consumers only when they entail efficiency gains, and (*ii*) once efficiency gains are taken into account, a reduction in input price is always a necessary condition for an increase in consumer surplus. Our analysis reveals that when one of the merging parties is vertically integrated, (*i*) upstream mergers can be profitable and beneficial to consumers even in the absence of any efficiency gains, and (*ii*) once efficiency gains are taken into account, a reduction in input price is *not* always a necessary condition for an increase in consumer surplus.

The rest of the chapter is organized as follows. In Section 2.2, we describe the baseline model under upstream cost symmetry and observable contracting. In Section 2.3, we perform

[29] Irmen (1998), Fumagalli & Motta (2001) and Symeonidis (2010), by considering a setting with two competing vertically separated chains, show that contract unobservability eliminates any strategic effect associated with the choice of input prices: for any given input price charged by one upstream firm, the best reply of the other upstream firm is to set an input price equal to upstream marginal cost and use the fixed fee to get profit. It is straightforward that this insight extends to the case where one vertical chain is already vertically integrated.

the equilibrium analysis and derive our main results. In Section 2.4, we modify the baseline model by introducing upstream cost asymmetry, whereas in Section 2.5, we modify the baseline model by considering the case of unobservable contracting. Section 2.6 concludes the chapter.

2.2 The baseline model with upstream cost symmetry and observable contracting

We consider a vertically related market initially consisting of two competing vertical chains. In each chain, $i = 1, 2$, there is a single upstream firm, U_i, that produces an input which a single downstream firm, D_i, uses in one-to-one proportion in the production of a differentiated final good. We assume that chain 1 is vertically integrated, whereas chain 2 is vertically separated, i.e., there is the vertically integrated firm U_1-D_1, one independent upstream supplier U_2 and one independent downstream firm D_2 (see Figure 2.1).

Marginal production costs in the upstream market are denoted by c_{Ui}. We assume that $c_{U1} = c_{U2} = c_U$, so the upstream division of the integrated firm and the independent upstream supplier are equally efficient as input providers. Marginal transformation costs in the downstream market are denoted by c_{Di}. No further assumptions are made regarding the relationship between c_{D1} and c_{D2}.

We then consider the case where the independent upstream supplier U_2 and the vertically integrated firm U_1-D_1 contemplate merging to form a new entity, denoted as firm I (see Figure 2.2). Such merger is qualified as horizontal since both firms are present in the upstream market, it has, nevertheless, an important *vertical* aspect in that U_2 is the input supplier of U_1-D_1's rival in the downstream market. The assumption of upstream cost symmetry implies that the merger does not generate efficiency gains, thus allowing to focus on the implications of the vertical relationship.

Suppose that $U(q_1, q_2)$ is a differentially strictly concave utility function and let $q = (q_1, q_2)$. The representative consumer maximizes $U(q) - pq$ giving rise to an inverse demand system $p_i = p(q_i, q_j)$, $i, j = 1, 2,\ i \neq j$, which is twice continuously differentiable. Inverse demands will be downward sloping, $\partial p_i / \partial q_i < 0$, and symmetric cross effects will be negative, $\partial p_i / \partial q_j = \partial p_j / \partial q_i < 0$, implying that final-goods are substitutes. We also assume that the own effect is larger than the cross effect, that is $\left|\partial p_i / \partial q_i\right| > \left|\partial p_i / \partial q_j\right|$.

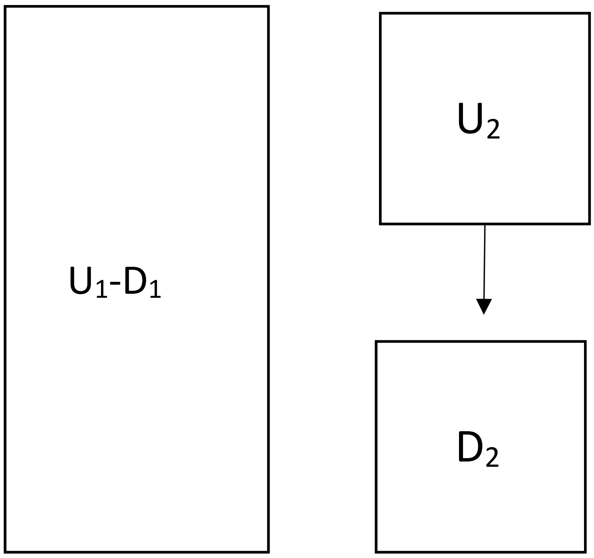

Figure 2.1. The pre-merger case.

We model market interactions as a three-stage game with timing as follows. At the first stage, firms U_1-D_1 and U_2 decide whether to merge or not. At the second stage, the independent supplier U_2 (if the merger does not occur) or firm I (if the merger occurs) makes D_2 a take-it-or-leave-it, two-part tariff contract offer; the contract consists of an input price w and a fixed fee F. If there is no merger, we assume that the contract stipulated in the vertically separated chain is observable by the integrated firm.[30] At the last stage, downstream competition takes place *a la* Cournot. For notational reasons, we use superscripts S or M to denote, respectively, the pre- and the post-merger case.

2.3 Equilibrium outcomes in the baseline model

2.3.1. The pre-merger case

Working backwards, we start by solving the last stage of the game. Firms U_1-D_1 and D_2 choose simultaneously and independently their final-good outputs to maximize profits:

$$\max_{q_1} \pi_{U_1-D_1} = p_1(q_1,q_2)q_1 - (c_{D1}+c_U)q_1\,, \quad \max_{q_2} \pi_{D_2} = p_2(q_1,q_2)q_2 - (w+c_{D2})q_2 - F\ .$$

[30]In Section 2.5, we consider the case where, in the pre-merger situation, the contract stipulated in the vertically separated chain is unobservable by the vertically integrated firm.

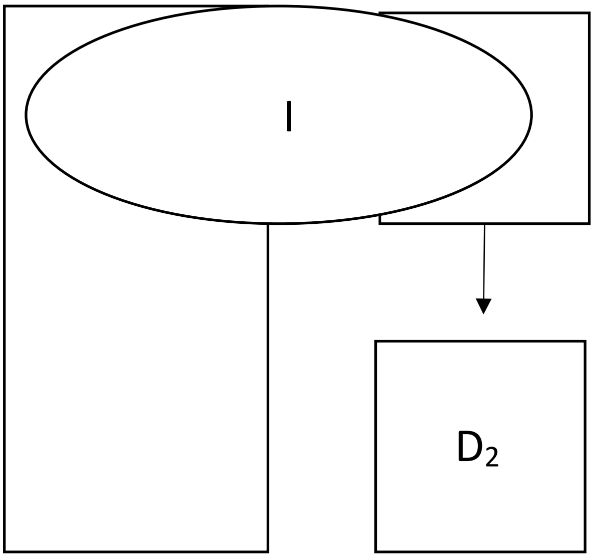

Figure 2.2. The post-merger case. U_2 and U_1-D_1 merge to form firm I.

The first order conditions of the above maximization problems are given by,

$$p_1 + q_1 \frac{\partial p_1}{\partial q_1} = c_{D1} + c_U \,, \tag{2.1}$$

and

$$p_2 + q_2 \frac{\partial p_2}{\partial q_2} = c_{D2} + w \,, \tag{2.2}$$

respectively. We make the following three assumptions:

Assumption 2.1. $\dfrac{\partial^2 \pi_{U1-D1}}{\partial q_1^2} < 0$ and $\dfrac{\partial^2 \pi_{D2}}{\partial q_2^2} < 0$.

Assumption 2.2. $\dfrac{\partial^2 \pi_{U1-D1}}{\partial q_1 \partial q_2} < 0$ and $\dfrac{\partial^2 \pi_{D2}}{\partial q_2 \partial q_1} < 0$.

Assumption 2.3. $\dfrac{\partial^2 \pi_{U1-D1}}{\partial q_1^2} + \left| \dfrac{\partial^2 \pi_{U1-D1}}{\partial q_1 \partial q_2} \right| < 0$ and $\dfrac{\partial^2 \pi_{D2}}{\partial q_2^2} + \left| \dfrac{\partial^2 \pi_{D2}}{\partial q_2 \partial q_1} \right| < 0$.

Assumption 2.1 guarantees that the second order conditions of the above maximization problems are satisfied. Assumption 2.2 implies strategic substitutability: firms' best-response functions in the downstream market are downward sloping, i.e., $dq_i/dq_j < 0$. Assumption 2.3 implies that the best-response functions are well-behaved and have slope less than one, $\left|dq_i/dq_j\right| < 1$, and therefore there exist unique and stable Cournot equilibria.

Solving together (2.1) and (2.2), we obtain the last-stage subgame equilibrium final-good outputs and prices as functions of the input price: $\hat{q}_1(w)$, $\hat{q}_2(w)$, $\hat{p}_1(w) = p_1[\hat{q}_1(w), \hat{q}_2(w)]$ and $\hat{p}_2(w) = p_2[\hat{q}_1(w),\ \hat{q}_2(w)]$. As shown in Appendix 2.A, these last-stage subgame equilibrium outcomes have the following properties:

$$\frac{d\hat{q}_1(w)}{dw} > 0, \quad \frac{d\hat{q}_2(w)}{dw} < 0, \quad \frac{d\hat{Q}(w)}{dw} < 0, \quad \frac{d\hat{p}_1(w)}{dw} > 0, \quad \frac{d\hat{p}_2(w)}{dw} > 0. \tag{2.3}$$

Next, we solve the second stage of the game in order to determine the equilibrium contract terms. The independent upstream firm U_2 uses the fixed fee to fully extract D_2's profits,

$$F = (\hat{p}_2(w) - w - c_{D2})\hat{q}_2(w), \tag{2.4}$$

and thus sets the input price so as to maximize,

$$\max_w \pi_{U_2} = (w - c_U)\hat{q}_2(w) + F = (\hat{p}_2(w) - c_U - c_{D2})\hat{q}_2(w). \tag{2.5}$$

It can be seen from (2.5) that the input price is chosen so as to maximize the unintegrated vertical chain's profits. The first order condition of the above maximization problem, after using (2.2), is given by:

$$(w - c_U)\frac{d\hat{q}_2}{dw} + \hat{q}_2 \frac{\partial p_2}{\partial q_1}\frac{d\hat{q}_1}{dw} = 0. \tag{2.6}$$

We know from (2.3) that $d\hat{q}_2/dw < 0$ and $d\hat{q}_1/dw > 0$. Therefore, given that $\partial p_2/\partial q_1 < 0$, it is straightforward that $(w^{S*} - c_U)$ must be negative in order for (2.6) to be satisfied.

Lemma 2.1. *Under upstream cost symmetry and observable contracting in the pre-merger case, the optimal upstream margin is given by*

$$w^{S*} - c_U = -\hat{q}_2 \frac{\partial p_2}{\partial q_1} \frac{dq_1}{dq_2} < 0 .$$

The optimal input price is always lower than upstream marginal cost.

According to Lemma 2.1, the input price is set below upstream marginal cost. This finding, as well as its intuition, is in line with Milliou & Petrakis (2007), who consider the case where both vertical chains are separated. In our framework, the separated vertical chain, via a lower input price, can commit to a more aggressive behavior in the final-good market. The best-response curve of its downstream firm shifts out, resulting - since best-response curves are downward sloping - in lower final-good quantity for the rival integrated chain, and higher quantity and gross profits for the own downstream firm. The portion of these gross profits that is transferred upstream via the fixed fee, more than compensates the upstream firm for the subsidy it offers.

Before proceeding to the post-merger case, we should stress here that the finding in Lemma 2.1 remains robust under upstream cost asymmetry: the equilibrium input price will always be lower than c_{U2} regardless of how the latter compares to c_{U1}.

2.3.2. The post-merger case

When the merger occurs, firms *I* and D_2 choose simultaneously and independently their final-good outputs to maximize profits:

$$\max_{q_1} \pi_I = (p_1(q_1, q_2) - c_{D1} - c_U)q_1 + (w - c_U)q_2 + F ,$$

$$\max_{q_2} \pi_{D_2} = p_2(q_1, q_2)q_2 - (w + c_{D2})q_2 - F .$$

It is straightforward that the profit maximization problem of D_2 is unaffected by the merger. The newly merged firm *I* has now profits from two sources: the term $(p_1(q_1, q_2) - c_{D1} - c_U)q_1$ captures, as in the pre-merger case, profits from sales of the final good, whereas the term $(w - c_U)q_2 + F$ reflects profits from selling the input to the independent downstream rival D_2.

Since downstream competition is over quantities, however, firm *I cannot* affect its sales of the input upstream by increasing sales of its downstream rival and thus its profit maximization problem in the downstream market also remains unaffected by the merger.[31] Therefore, the last-stage subgame equilibrium final-good outputs and prices are the same as in the pre-merger case.

Next, we solve the second stage of the game, i.e., we determine the equilibrium contract terms. The newly merged firm *I* uses the fixed fee to fully extract D_2's profits and thus set the input price so as to maximize,

$$\max_{w} \pi_I = (\hat{p}_1(w) - c_{D1} - c_U)\hat{q}_1(w) + (\hat{p}_2(w) - c_{D2} - c_U)\hat{q}_2(w) \tag{2.7}$$

Hence, the input price is actually chosen so as to maximize overall industry profits. The first order condition, after using (2.1) and (2.2), is given by:

$$\hat{q}_1 \frac{\partial p_1}{\partial q_2}\frac{d\hat{q}_2}{dw} + (w - c_U)\frac{d\hat{q}_2}{dw} + \hat{q}_2 \frac{\partial p_2}{\partial q_1}\frac{d\hat{q}_1}{dw} = 0 \tag{2.8}$$

From (2.8), we have the following Lemma.

Lemma 2.2. *Under upstream cost symmetry, the optimal upstream margin in the post-merger case is given by*

$$w^{M*} - c_U = -\frac{\partial p_2}{\partial q_1}\left(\hat{q}_1 + \hat{q}_2 \frac{dq_1}{dq_2}\right).$$

The optimal input price is lower than upstream marginal cost whenever the following holds:

$$\frac{\hat{q}_1}{\hat{q}_2} < \left|\frac{dq_1}{dq_2}\right|.$$

A necessary but not sufficient condition for the above to hold is that $c_{D1} > c_{D2}$.

Recall that, in the post-merger case, the equilibrium input price is chosen so as to maximize total industry profits. Suppose that there is downstream cost symmetry, i.e., $c_{D1} = c_{D2}$. Since downstream firms impose a negative externality upon each other, the merged firm will set an

[31]For more details on this see the following chapter.

input price above marginal cost in order to correct for this externality. When there is downstream cost asymmetry, the input price will be further adjusted in order for sales of final-good to be shifted to the more cost-efficient, and thus more profitable, downstream firm. When $c_{D1} < c_{D2}$, the merged firm has an incentive to further increase the input price to shift final-good sales to its more cost-efficient downstream division. When $c_{D1} > c_{D2}$, the merged firm has an incentive to decrease the input price to shift final-good sales to the more cost-efficient downstream rival. If the degree of downstream cost asymmetry is high enough, it then becomes optimal for the merged firm to set an input price below marginal cost.

We now show that the merger always increases the optimal input price and thus decreases consumer surplus. Compared to (2.6), expression (2.8) contains the additional term,

$$\hat{q}_1 \frac{\partial p_1}{\partial q_2} \frac{d\hat{q}_2}{dw} > 0,$$

which captures the *raising-rivals'-costs* effect of the upstream horizontal merger: any increase in the input price will decrease sales of *D2* which will in turn increase the final-good price and the merged firm's profits from downstream operations. Our contribution is that we formally incorporate this effect, which is well-established in the literature on vertical mergers, into horizontal merger analysis. Clearly, the independent upstream firm *U2* cannot internalize the raising-rivals'-costs effect and thus the input price will increase as a result of the merger. The effect of the merger on consumer surplus is then clear-cut. Since the equilibrium input price increases, we know from (2.3) that both final-good prices will increase and total output will be reduced, causing a consumer surplus reduction.

Proposition 2.1 *Under upstream cost symmetry and observable contracting in the pre-merger case, a horizontal merger between the vertically integrated firm and the independent upstream supplier always (i) increases the input price and (ii) decreases consumer surplus.*

Proposition 2.1 provides support of the basic downstream antitrust concern about such mergers: a merger between the vertically integrated firm and the independent upstream supplier increases the input price and forces the independent downstream firm to adopt a less aggressive behavior, with obvious consequences for prices and consumer surplus. Our contribution is that we formally incorporate the raising-rivals'-costs effect, which is well-established in the literature on vertical mergers, into horizontal merger analysis. Note at this point that, since in the pre-merger situation the integrated firm directs all its production to its subsidiary, the merchant input-market is a monopoly in the pre-merger situation and remains so after the merger. Hence the merger has no impact on the input-market concentration and all its consequences on prices and consumer surplus derive solely from its raising-rivals'-costs effect. It is straightforward that the latter effect is more pronounced the less differentiated final goods are.

Finally, we solve the first stage of the game by showing that the merger is always beneficial for the merging parties and the industry as a whole. Recall that in the pre-merger case the input price is chosen so as to maximize the unintegrated vertical chain's profits (see (2.5)), rather than total industry profits. In the post-merger case, however, the input price is chosen so as to maximize overall industry profits (see (2.7)). Therefore, it must hold that $\pi_{ind}^{M*}(w^{M*}) > \pi_{ind}^{S*}(w^{S*})$. Since overall industry profits increase as a result of the merger, and D_2's net profits remain unaffected (in both cases are equal to zero), it must hold that the combined net profits of U_1-D_1 and U_2 increase, implying that the merger is beneficial for the merging parties.[32]

Before closing this section, it should be noted that Proposition 1 remains qualitatively robust under the alternative assumption of downstream Bertrand competition, since the raising-rivals'-cost effect in the post-merger case does not depend on the mode of downstream competition. The only difference is that the input price is never set below upstream marginal cost under downstream price competition: the independent upstream firm (pre-merger) and/or the merged firm (post-merger) no longer wants to induce an aggressive behavior in the downstream market since prices, unlike quantities, are strategic complements.

2.4 Upstream cost asymmetry

A central objective of antitrust authorities, which are entrusted with the role of scrutinizing mergers, is to consider whether or not efficiency gains associated with horizontal mergers are likely to offset the enhanced market power of the merging firms. For instance, US Horizontal Merger Guidelines (2010, section 10) state that

[32]In light of the analysis in Section 2.5, note that the same reasoning applies to the case of unobservable contracting, i.e., when the vertically integrated firm does not observe the contract stipulated in the vertically separated chain.

> "[…] *the Agencies consider whether cognizable efficiencies likely would be sufficient to reverse the merger's potential to harm customers in the relevant market, e.g., by preventing price increases in that market*".

Moreover, in the EC Horizontal Merger Guidelines (2004/03, art. 77) it is stated that a merger would be allowed provided that

> "[…] *the efficiencies generated by the merger are likely to enhance the ability and incentive of the merged entity to act pro-competitively for the benefit of consumers, thereby counteracting the adverse effects on competition which the merger might otherwise have*".

In this section, we explore the role of efficiency gains associated with the upstream merger. In particular, we address the following question: If the upstream merger increases efficiency in the merging firms, and given that one of the merging parties is a vertically integrated firm that, in the pre-merger case, uses all its own upstream production for its downstream division, is it possible that overall consumer surplus increases even though input prices increase and some consumers are worse off?

We modify our baseline model by introducing upstream cost asymmetry. We consider two cases: the independent upstream firm is less efficient than the upstream division of the vertically integrated firm and vice versa. We assume that, in the post-merger case, the more efficient firm transfers its technology to the less efficient firm: the newly merged firm operates with marginal costs $\hat{c}_U = \min\left[c_{U1}, c_{U2}\right]$. When $\hat{c}_U = c_{U1} < c_{U2}$, the merger creates efficiency gains in the upstream production that is directed to the independent downstream rival, whereas $c_{U1} > c_{U2} = \hat{c}_U$ implies efficiency gains in the upstream production directed to the downstream division of the merged firm.

For tractability reasons, we restrict attention to the following set of linear inverse demand functions (Singh & Vives, 1984),

$$p_i = 1 - q_i - \theta q_j, \quad i, j = 1, 2, \quad i \neq j, \tag{2.9}$$

where the inverse demand intercept, without loss of generality, is normalized to one and the parameter $\theta \in (0,1)$ measures the degree of product substitutability. The higher is θ, the closer substitutes final goods are. In this section only, we assume that $c_{D1} = c_{D2} = 0$, which, besides simplifying calculations, allows to focus on the effects of the merger on input prices and consumer surplus stemming solely from upstream cost differences. All proofs in this section are relegated to Appendix 2.B.

2.4.1. The pre-merger case.

Firms U_1-D_1 and D_2 choose simultaneously and independently their final-good outputs to maximize profits:

$$\max_{q_1} \pi_{U_1-D_1} = (1-q_1-\theta q_2-c_{U1})q_1, \quad \max_{q_2} \pi_{D_2} = (1-q_2-\theta q_1-w)q_2-F \,. \tag{2.10}$$

The first order conditions give rise to the following best-response functions:

$$q_1(q_2,c_{U1}) = \frac{1-c_{U1}-\theta q_2}{2}, \quad q_2(q_1,w) = \frac{1-w-\theta q_1}{2}, \tag{2.11}$$

Solving the system of best-response functions in (2.11), we obtain the last-stage subgame equilibrium outcomes as functions of *w* and c_{U1}:

$$q_1(w,c_{U1}) = \frac{(2-\theta)+\theta w-2c_{U1}}{4-\theta^2}, \quad q_2(w,c_{U1}) = \frac{(2-\theta)+\theta c_{U1}-2w}{4-\theta^2},$$

$$Q(w,c_{U1}) = q_1(w,c_{U1})+q_2(w,c_{U1}) = \frac{2-w-c_{U1}}{2+\theta}, \tag{2.12}$$

$$p_1(w,c_{U1}) = \frac{(2-\theta)+\theta w+(2-\theta^2)c_{U1}}{4-\theta^2}, \quad p_2(w,c_{U1}) = \frac{(2-\theta)+\theta c_{U1}+(2-\theta^2)w}{4-\theta^2}.$$

It can be easily checked that the above last-stage subgame equilibrium outcomes satisfy the properties described in (2.3).

The independent upstream firm U_2 uses the fixed fee to fully extract D_2's profits,

$$F = [p_2(w,c_{U1})-w]q_2(w,c_{U1}), \tag{2.13}$$

and thus sets the input price to maximize:

$$\max_{w} \pi_{U_2} = (w - c_{U2})q_2(w, c_{U1}) + F = [p_2(w, c_{U1}) - c_{U2}]q_2(w, c_{U1}). \tag{2.14}$$

From the first order condition of (2.14), we obtain the equilibrium input price:

$$w^{S*}(c_{U1}, c_{U2}) = \frac{-(2-\theta)\theta^2 - c_{U1}\theta^3 + 2(4-\theta^2)c_{U2}}{4(2-\theta^2)} < c_{U2}, \tag{2.15}$$

which implies below cost-pricing in the spirit of Lemma 2.1.

2.4.2. The post-merger case

Firms I and D_2 choose simultaneously and independently their final-good outputs to maximize profits:

$$\max_{q_1} \pi_I = (1 - q_1 - \theta q_2 - \hat{c}_U)q_1 + (w - \hat{c}_U)q_2 + F,$$

$$\max_{q_2} \pi_{D_2} = (1 - q_2 - \theta q_1 - w)q_2 - F.$$

The first order conditions of the above maximization problems give rise to the following best-response functions:

$$q_1(q_2, \hat{c}_U) = \frac{1 - \hat{c}_U - \theta q_2}{2}, \quad q_2(q_1, w) = \frac{1 - w - \theta q_1}{2}. \tag{2.16}$$

Solving the system of best-response functions in (2.16), we obtain the last-stage subgame equilibrium outcomes as functions of w and $\hat{c}_U$:

$$q_1(w,\hat{c}_U) = \frac{(2-\theta)+\theta w - 2\hat{c}_U}{4-\theta^2}, \quad q_2(w,\hat{c}_U) = \frac{(2-\theta)+\theta\hat{c}_U - 2w}{4-\theta^2},$$

$$Q(w,\hat{c}_U) = q_1(w,\hat{c}_U) + q_2(w,\hat{c}_U) = \frac{2-w-\hat{c}_U}{2+\theta}, \tag{2.17}$$

$$p_1(w,\hat{c}_U) = \frac{(2-\theta)+\theta w + (2-\theta^2)\hat{c}_U}{4-\theta^2}, \quad p_2(w,\hat{c}_U) = \frac{(2-\theta)+\theta\hat{c}_U + (2-\theta^2)w}{4-\theta^2}.$$

In light of our subsequent analysis, we make the following two observations regarding the last-stage subgame equilibrium outcomes in the pre- and post-merger case(s). For any given level of the input price, the merger (*i*) does not affect downstream equilibrium outcomes when $\hat{c}_U = c_{U1}$ and (*ii*) increases total output and decreases both final-good prices when $\hat{c}_U = c_{U2}$.

The merged firm *I* uses the fixed fee to fully extract D_2's profits,

$$F = [p_2(w,\hat{c}_U) - w]q_2(w,\hat{c}_U), \tag{2.18}$$

and thus sets the input price to maximize:

$$\max_w \pi_I = [p_1(w,\hat{c}_U) - \hat{c}_U]q_1(w,\hat{c}_U) + [p_2(w,\hat{c}_U) - \hat{c}_U]q_2(w,\hat{c}_U) \tag{2.19}$$

From the first order condition of (2.19), we obtain the equilibrium input price:

$$w^{M*}(\hat{c}_U) = \frac{(2-\theta^2)\theta + \hat{c}_U(8-4\theta-2\theta^2-\theta^3)}{2(4-3\theta^2)} > \hat{c}_U\,. \tag{2.20}$$

The expression in (2.20) implies that the post-merger case the equilibrium input price is always above the upstream marginal cost.

We consider first the case where the independent upstream firm is less efficient than the upstream division of the vertically integrated firm. The effects of the merger on input price, final-good prices and consumer surplus are summarized in the next Proposition.

Proposition 2.2 *Under upstream cost asymmetry and observable contracting, when* $c_{U1} < c_{U2}$, *a horizontal merger between the vertically integrated firm and the independent upstream* *supplier decreases the input and final-goods prices and increases consumer surplus if and only if*

$$\frac{1-c_{U2}}{1-c_{U1}} < \gamma_1(\theta) = \frac{8-4\theta-4\theta^2+\theta^3}{2(4-3\theta^2)}.$$

When U_2 is less efficient than U_1, the merger creates efficiency gains that, while they lower the cost of the upstream production directed to the independent downstream rival, they do not affect the cost of the upstream production directed to the downstream division of the merged firm. This implies that the merger affects downstream equilibrium only through one channel, the input price. Concerning the merger's impact on the latter, two effects are in work. Due to the raising-rivals'-cost effect, the merger tends to raise, *ceteris paribus*, the input price, which induces D_2 to behave less aggressively and thus pushes both final-good prices upwardly. At the same time, however, the merger creates efficiency gains in the supply of the input to the independent downstream firm causing the input price to fall. When these efficiency gains are sufficiently large to outweigh the former effect, the merger results to an input-price reduction, which causes both final-good prices to decrease thereby making all consumers better off.

Consider now the case where the independent upstream firm is more efficient than the upstream division of the vertically integrated firm. The effects of the merger on input price, final-good prices and consumer surplus are summarized in the next Proposition.

Proposition 2.3 *Under upstream cost asymmetry and observable contracting, when* $c_{U1} > c_{U2}$, *a horizontal merger between the vertically integrated firm and the independent upstream supplier:*

(i) always increases the input price and the final-good price of the independent downstream firm,

(ii) decreases the final-good price of the vertically integrated firm if and only if

$$\frac{1-c_{U1}}{1-c_{U2}} < \gamma_2(\theta) = \frac{2[8-14\theta^2+\theta^3+5\theta^4]}{(4-3\theta^2)^2},$$

(iii) increases consumer surplus if and only if

$$\frac{1-c_{U1}}{1-c_{U2}} < \gamma_3(\theta) = \frac{2[(2-\theta^2)\sqrt{A}-\theta^3]}{16-20\theta^2+5\theta^4},$$

with $A = (64-64\theta-96\theta^2+80\theta^3+52\theta^4-20\theta^5-15\theta^6)/(4-3\theta^2) > 0$ *and* $\gamma_3(\theta) < \gamma_2(\theta)$.

When the independent upstream firm is more efficient than the upstream division of the vertically integrated firm, on the one hand, the merger does not lower the cost of the upstream production directed to the independent downstream firm, leaving at play only the raising-rivals'-cost effect. Hence, as in the case of upstream cost symmetry, the input price always increases pulling with it the final-goods prices. On the other hand, the merger also creates efficiency gains in the upstream production directed to the downstream division of the merged firm, thus tending to decrease both final-good prices.

As it turns out, the final-good price of the independent downstream firm always increase due to the merger irrespective of the magnitude of the efficiency gains. However, when the efficiency gains are sufficiently large, the final-good price of the vertically integrated firm decreases and consumer surplus increases as a result of the merger; as indicated in Proposition 2.3, the potential decrease in the final-good price of the vertically integrated firm is a necessary but not sufficient condition for consumer surplus to increase.

Milliou & Pavlou (2013), in examining, among other things, the role of efficiency gains in upstream merger analysis, show that an upstream merger between vertically *separated* firms can increase consumer surplus as long as it reduces input prices, in which case all consumers are better off. Our analysis reveals that when one of the merging parties is a vertically integrated firm *overall consumer surplus may increase due to the merger even though the input price always increases and some consumers are worse off.*

We make two final remarks regarding both cases of upstream cost asymmetry considered above. First, the merger's positive effect on consumer surplus is more likely the more differentiated final goods are. This is so because the higher is the degree of product differentiation the weaker the vertical partial foreclosure effect is. In the extreme case where final goods are independent in demand, the vertical foreclosure effect vanishes and thus the merger always increases consumer surplus.[33]

Second, the merger is always beneficial for the merging parties. Since even a merger between symmetric upstream firms is beneficial for the merging parties (see Section 2.3), a merger between asymmetric firms increases their profits even more, due to efficiency gains it creates, and this, irrespectively of whether these gains lower the input cost of the downstream division of the merged firm or the independent downstream rival.

[33]Note that when products are totally differentiated, i.e., $\theta = 0$, from Propositions 2.2 and 2.3, we have that $\gamma_1(0) = 1$ and $\gamma_3(0) = 1$. The former implies that the merger increases consumer surplus when $(1 - c_{U2})/(1 - c_{U1}) < 1$ which is always true given that $c_{U1} < c_{U2}$, whereas the latter implies that the merger increases consumer surplus when $(1 - c_{U1})/(1 - c_{U2}) < 1$ which is also always true given that $c_{U1} > c_{U2}$.

2.5 Unobservable contracting

The analysis thus far suggests that the upstream merger is detrimental to consumers unless it generates efficiency gains. A key assumption made in all previous sections is that, pre-merger, the vertically integrated firm observes the contract stipulated in the vertically separated chain. Whereas in some industries the assumption of observable contracts seems quite reasonable, in others it is not very plausible since contracts are kept highly confidential. In this section, we return to the baseline model with upstream cost symmetry (Sections 2.2 & 2.3), however, we now assume that pre-merger, the contract stipulated in the vertically separated chain is unobservable by the vertically integrated firm. Observable contracts have a commitment value in the sense that they can strategically affect the rivals' behavior. This strategic commitment is no longer possible under secret contracts. In such framework, we seek to address the following question: are there any conditions under which the upstream merger increases consumer surplus even in the absence of any efficiency gains?

2.5.1 The pre-merger case

The pre-merger equilibrium is determined as follows.[34] From (2.1), we obtain the best-response function of the downstream division of the integrated firm, $q_1(q_2)$. Given contract unobservability, the integrated firm's best-response function in the downstream market does not depend on the input price established by the independent upstream firm. Accordingly, from (2.2), we obtain the independent downstream firm's best-response $q_2(q_1, w)$. The associated final-good prices for the integrated firm and D_2 are given, respectively, by $p_1(q_1(q_2), q_2)$ and $p_2(q_2(q_1, w), q_1)$.

The independent upstream firm U_2 uses the fixed fee to fully extract D_2's profits,

$$F = [p_2(q_2(q_1, w), q_1) - w - c_{D2}]q_2(q_1, w), \tag{2.21}$$

[34]An important strand in the literature on secret vertical contracting considers one upstream manufacturer selling its product to many downstream firms (see, e.g., Hart & Tirole, 1990; O'Brien & Shaffer, 1992; Rey & Vergé, 2004). In such setting, the equilibrium contracts depend on the nature of the downstream firms' out-of-equilibrium beliefs. Since in our model one upstream firm contracts with only one downstream firm, out-of-equilibrium beliefs play no role.

and thus sets the input price so as to maximize,

$$\max_{w} \pi_{U_2} = (w - c_U) q_2(q_1, w) + F = [p_2(q_2(q_1, w), q_1) - c_U - c_{D2}] q_2(q_1, w) . \tag{2.22}$$

The first order condition of the above maximization problem, after using (2.2), is given by:

$$(w - c_U) \frac{dq_2}{dw} = 0 . \tag{2.23}$$

From (2.23) we obtain the following Lemma.

Lemma 2.3. *Under upstream cost symmetry and unobservable contracting in the pre-merger case, the equilibrium input price is always equal to the upstream marginal cost.*

According to Lemma 2.3, the optimal input price is always equal to the upstream marginal cost.[35] Irmen (1998), Fumagalli & Motta (2001) and Symeonidis (2010) consider a setting with two competing vertically separated chains and analyze, among other things, the case of unobservable two-part tariff contracts. Contract unobservability eliminates any strategic effect associated with the choice of input prices: for any given input price charged by one upstream firm, the best reply of the other upstream firm is to set an input price equal to upstream marginal cost and use the fixed fee to get profit. In other words, the two-part tariff contract has no pre-commitment effect and thus each upstream firm is indifferent between stipulating an exclusive contract with a downstream firm and vertically integrating. Clearly, this insight also applies to the case where one vertical chain is already vertically integrated.

2.5.2 The post-merger case

It is straightforward by construction of the model that there is no issue regarding contract observability in the post-merger case. Therefore, the equilibrium analysis in subsection 2.3.2 is still valid and the post-merger equilibrium input price must satisfy (2.8). From Lemmata 2.2 & 2.3 we obtain immediately the following result.

[35]It is straightforward that the finding in Lemma 2.3 remains robust under upstream cost asymmetry: the optimal input price will always be equal to c_{U2} regardless of how the latter compares to c_{U1}.

Proposition 2.4. *Under upstream cost symmetry and unobservable contracting in the pre-merger case, a horizontal merger between the vertically integrated firm and the independent upstream supplier decreases the input price whenever the following holds:*

$$\frac{\hat{q}_1}{\hat{q}_2} < \left|\frac{dq_1}{dq_2}\right|.$$

A necessary but not sufficient condition for the above to hold is that $c_{D1} > c_{D2}$.

It is straightforward from (2.8) that whether the optimal input price in the post-merger case will be above or below upstream marginal cost depends on the sign of the following expression:

$$\hat{q}_1 \frac{\partial p_1}{\partial q_2}\frac{d\hat{q}_2}{dw} + \hat{q}_2 \frac{\partial p_2}{\partial q_1}\frac{d\hat{q}_1}{dw}, \tag{2.24}$$

The first, *positive*, term in (2.24) describes the already identified raising-rivals'-costs effect. The second term in (2.24) is *negative*: any decrease in the input price will decrease merged firm's downstream sales which in turn will increase the independent downstream firm's final-good price and profits that can be appropriated by the merged firm through the fixed fee. This effect, labelled the output-shifting effect, is identified by Reisinger & Tarantino (2015) in the context of vertical mergers. The output-shifting effect is absent pre-merger because, when choosing its optimal input price, the independent upstream firm does not take into account the impact of its choice on the downstream division of the integrated firm – due to contract unobservability, the integrated firm's best-response function in the downstream market does not depend on the input price established by the independent upstream firm. When the downstream division of the integrated firm is sufficiently less cost-efficient than the independent downstream firm, it is optimal for the merged firm to set an input price below upstream marginal cost thereby shifting final-good sales to the more profitable downstream rival. In that case, the upstream merger decreases the input price and consequently *increases consumer surplus even in the absence of exogenous cost-synergies between the merging firms*.

By considering the case of two-part tariff contracts and downstream Cournot competition, Milliou & Petrakis (2007) show, among other things, that an upstream merger between two vertically *separated* firms always decreases the input price and increases consumer surplus, however, it is *never* profitable for the merging parties. In our context, where one of the merging parties is a vertically integrated firm, the merger is always profitable (see the discussion in Section 2.3) thus allowing us to provide a theoretical explanation of observed upstream mergers that might be beneficial for consumers even when they do not generate efficiency gains in upstream production.

Finally, it should be noted that the above conclusion does *not* remain robust under the alternative assumption of downstream Bertrand competition. In the pre-merger case, as in the case of downstream Cournot competition, there is upstream marginal cost pricing in the vertically separated chain due to the presence of fixed fees (Lemma 2.2 remains valid). In the post-merger case, unlike the case of downstream Cournot competition, the input price will never be lower than upstream marginal cost (Proposition 2.4 is no longer valid): under downstream price competition, it is less urgent for the merged firm to induce an aggressive behavior in the downstream market since prices, unlike quantities, are strategic complements. Therefore, under unobservable contracting, the effects of the merger on consumer surplus crucially depend on the mode of downstream competition.

2.6. Conclusions

In this chapter, we have studied upstream horizontal mergers when one of the merging parties is a vertically integrated firm. We have considered a two-tier market consisting of two competing vertical chains, with one upstream and one downstream firm in each chain, assuming that one vertical chain is vertically integrated whereas the other chain is vertically separated. We have also assumed downstream Cournot competition and that firms in the vertically separated chain trade through a two-part tariff contract.

Under upstream cost symmetry and observable contracting in the pre-merger case, we have shown that a horizontal merger between the vertically integrated firm and the independent upstream supplier harm consumers through a raising-rivals'-costs effect. Our contribution is to formally incorporate this effect, which is well-established in the literature on vertical mergers, into horizontal merger analysis. We have also identified two cases under which consumer surplus may increase due to the merger. In the *first* case, there is observable contracting in the pre-merger case but upstream costs are asymmetric. We have assumed that, in the post-merger situation, the more efficient firm transfers its technology to the less efficient firm so that the merger generates efficiency gains. We have shown that overall consumer surplus may increase due to the merger even though the input price always increases and some consumers are worse off. In the *second* case, upstream costs are symmetric but there is unobservable contracting in the pre-merger case. We have demonstrated that the input price may decrease and consumer surplus may increase as a result of the merger even in the absence of exogenous cost-synergies between the merging firms. A necessary condition for this finding is that the unintegrated downstream firm is more cost-efficient than the downstream division of the integrated firm.

In all cases under consideration, the upstream merger is always profitable for the merging parties. In contrast to the literature on upstream mergers in vertically *separated* industries, two key insights from our analysis are that (*i*) upstream mergers can be profitable and beneficial to consumers even in the absence of any efficiency gains and (*ii*) once efficiency gains are taken into account, a reduction in input price is not always a necessary condition for an increase in consumer surplus.

Whereas our formal analysis is based on take-it-or-leave-it offers, all our results extend straightforwardly to the situation where the independent upstream firm (in the pre-merger case) or the merged firm (in the post-merger case) engage in Nash bargaining with the independent downstream firm. As is well known, under two-part tariff contracts, the Nash bargaining solution can be found in two steps. First, the bargaining pair chooses the input price in order to maximize its joint surplus, which implies that the equilibrium input prices obtained in the previous sections are still valid. Second, firms negotiate the fixed fees in order to divide their maximized joint surplus. While bargaining implies different equilibrium fixed fees with the independent downstream firm no longer making zero net profits, fixed fees are simply a device used to transfer surplus and have no impact on marginal costs or quantities produced. Hence, the merger's effect on final-good prices, quantities and consumer surplus – for all cases under consideration – remains under bargaining the same as under a take-it-or-leave-it offer.

Future research may consider alternative industry settings with a larger number of competing vertical chains (both integrated and separated) and/or non-exclusive relations between upstream and downstream firms (the latter will allow for the integrated firm's participation in merchant input market, either as a seller, or even as a strategic buyer), in order to examine the impact of such type of upstream mergers under different market structures.

Appendix 2.A: Upstream cost symmetry and observable contracting

Derivation of the properties described in (2.3). As noted in subsection 2.3.1, the last-stage subgame equilibrium final-good outputs and prices as functions of the input price are given by: $\hat{q}_1(w)$, $\hat{q}_2(w)$, $\hat{p}_1(w) = p_1[\hat{q}_1(w), \hat{q}_2(w)]$ and $\hat{p}_2(w) = p_2[\hat{q}_1(w), \hat{q}_2(w)]$. As also noted in subsection

2.3.2, these equilibrium outcomes are the same regardless of whether the merger occurs or not. We derive here their properties described in (2.3).

Note first that $\hat{q}_1$ depends on w only indirectly through $\hat{q}_2$ so that $\hat{q}_1(w) = q_1[\hat{q}_2(w)]$ and $d\hat{q}_1(w)/dw = (dq_1/dq_2)(d\hat{q}_2(w)/dw)$. Given strategic substitutability (see Assumption 2) it holds that $dq_1/dq_2 < 0$. It is then straightforward that $d\hat{q}_1(w)/dw$ and $d\hat{q}_2(w)/dw$ have opposite signs. We next show that $d\hat{q}_2(w)/dw < 0$.

The last-stage subgame equilibrium final-good outputs $\hat{q}_1(w)$ and $\hat{q}_2(w)$ must satisfy the first-order conditions in the downstream market, therefore (2.2) can be written as:

$$p_2[\hat{q}_1(w),\ \hat{q}_2(w)] + \hat{q}_2(w)\frac{\partial p_2}{\partial q_2} - w - c_{D2} = 0 .$$

Using the implicit function theorem in the above expression, we obtain:

$$\frac{d\hat{q}_2(w)}{dw} = \frac{1}{2\frac{\partial p_2}{\partial q_2} + \frac{\partial p_2}{\partial q_1}\frac{dq_1}{dq_2}} = \frac{1}{\frac{\partial^2 \pi_{D2}}{\partial q_2^2}} < 0 ,$$

where the denominator $\partial^2 \pi_{D2} / \partial q_2^2$ is negative due to Assumption 2.1. Therefore, it holds that $d\hat{q}_2(w)/dw < 0$ and $d\hat{q}_1(w)/dw > 0$. Moreover, given that $|dq_1/dq_2| < 1$, it also holds that $d\hat{q}_1(w)/dw < |d\hat{q}_2(w)/dw|$. The last inequality implies that an increase in the input price decreases the total quantity supplied in the downstream market, i.e., $d\hat{Q}(w)/dw < 0$.

Regarding the effect of w on $\hat{p}_2$, we have that,

$$\frac{d\hat{p}_2(w)}{dw} = \frac{\partial p_2}{\partial q_2}\frac{d\hat{q}_2(w)}{dw} + \frac{\partial p_2}{\partial q_1}\frac{d\hat{q}_1(w)}{dw} = \frac{\partial p_2}{\partial q_2}\frac{d\hat{q}_2(w)}{dw} + \frac{\partial p_2}{\partial q_1}\frac{dq_1}{dq_2}\frac{d\hat{q}_2(w)}{dw} =$$
$$= \frac{d\hat{q}_2(w)}{dw}\left[\frac{\partial p_2}{\partial q_2} + \frac{\partial p_2}{\partial q_1}\frac{dq_1}{dq_2}\right] > 0,$$

where the bracketed term in the last inequality is negative since $|\partial p_2/\partial q_2| > |\partial p_2/\partial q_1|$ and $|dq_1/dq_2| < 1$.

Finally, regarding the effect of w on $\hat{p}_1$, we have that,

$$\frac{d\hat{p}_1(w)}{dw} = \frac{d\hat{q}_2(w)}{dw}\left[\frac{\partial p_1}{\partial q_2} + \frac{\partial p_1}{\partial q_1}\frac{dq_1}{dq_2}\right] > 0\,.$$

An increase in *w* affects indirectly $\hat{p}_1$ through $\hat{q}_2$ in two ways: On the one hand, a decrease in $\hat{q}_2$ increases $\hat{p}_1$ - a second order effect. On the other hand, a decrease in $\hat{q}_2$ leads to an increase in $\hat{q}_1$ which in turn decreases $\hat{p}_1$ - a third order effect. It is natural to assume that the second order effect is of greater importance than the third order effect implying that $\hat{p}_1$ increases with *w*.

Proof of Lemma 2.1. By making use of $d\hat{q}_1/dw = (dq_1/dq_2)(d\hat{q}_2/dw)$, the expression in (2.6) can be rewritten as:

$$\frac{d\hat{q}_2}{dw}\left[(w - c_U) + \hat{q}_2\frac{\partial p_2}{\partial q_1}\frac{dq_1}{dq_2}\right] = 0\,.$$

Given that $d\hat{q}_2/dw \neq 0$, the bracketed term in the above expression must be equal to zero, which gives the expression in Lemma 2.1. It is then straightforward that the input price is always lower than upstream marginal cost. ■

Proof of Lemma 2. By making use of $d\hat{q}_1/dw = (dq_1/dq_2)(d\hat{q}_2/dw)$ and $\partial p_i/\partial q_j = \partial p_j/\partial q_i$, the expression in (2.8) can be rewritten as:

$$\frac{d\hat{q}_2}{dw}\left[(w - c_U) + \frac{\partial p_i}{\partial q_j}\left(\hat{q}_1 + \hat{q}_2\frac{dq_1}{dq_2}\right)\right] = 0\,.$$

Given that $d\hat{q}_2/dw \neq 0$, the bracketed term in the above expression must be equal to zero, which gives the first expression in Lemma 2.2. It is then straightforward that in order for the input price to be lower than upstream marginal cost, it must hold that

$$\hat{q}_1 + \hat{q}_2\frac{dq_1}{dq_2} < 0 \quad \Rightarrow \quad \frac{\hat{q}_1}{\hat{q}_2} < \left|\frac{dq_1}{dq_2}\right|.$$

Given that $dq_1/dq_2 < 1$, in order for the above condition to be satisfied it must hold that $\hat{q}_1 < \hat{q}_2$. For any given input price, and given that the downstream division of the merged firm obtains the input at marginal cost, the latter can be true only if $c_{D1} > c_{D2}$. ■

Appendix 2.B: Upstream cost asymmetry

We first characterize the final equilibrium outcomes. In the pre-merger case, equilibrium outcomes are as follows:

$$q_1^{S*}(c_{U1},c_{U2}) = [p_1^{S*}(c_{U1},c_{U2}) - c_{U1}] = \frac{(4-2\theta-\theta^2)+2\theta c_{U2}-(4-\theta^2)c_{U1}}{4(2-\theta^2)},$$

$$q_2^{S*}(c_{U1},c_{U2}) = [p_2^{S*}(c_{U1},c_{U2}) - w^{S*}(c_{U1},c_{U2})] = \frac{(2-\theta)+\theta c_{U1}-2c_{U2}}{2(2-\theta^2)}, \tag{2.B1}$$

$$CS^{S*}(c_{U1},c_{U2}) = \frac{(16-20\theta^2+5\theta^4)(1-c_{U1})^2+4(4-3\theta^2)(1-c_{U2})^2+4\theta^3(1-c_{U1})(1-c_{U2})}{32(2-\theta^2)^2}.$$

In the post-merger case, equilibrium outcomes are as follows:

$$q_1^{M*}(\hat{c}_U) = [p_1^{M*}(\hat{c}_U) - \hat{c}_U] = \frac{(4-2\theta-\theta^2)(1-\hat{c}_U)}{2(4-3\theta^2)},$$

$$q_2^{M*}(\hat{c}_U) = [p_2^{M*}(\hat{c}_U) - w^{M*}(\hat{c}_U)] = \frac{2(1-\theta)(1-\hat{c}_U)}{4-3\theta^2}, \tag{2.B2}$$

$$CS^{M*}(\hat{c}_U) = \frac{(8-4\theta-3\theta^2)(1-\hat{c}_U)^2}{8(4-3\theta^2)}.$$

2.B.1. The case of $\hat{c}_U = c_{U1} < c_{U2}$.

First, we derive the condition under which final-good quantities are positive under both the pre- and post-merger case(s), and then show that $w^{S*}(c_{U1},c_{U2}) < c_{U2}$ and $w^{M*}(c_{U1}) > c_{U1}$.

It is straightforward that both $q_1^{M*}(c_{U1})$ and $q_2^{M*}(c_{U1})$ are positive whenever $c_{U1} < 1$. The requirement that $q_2^{S*}(c_{U1}, c_{U2}) > 0$ reduces to:

$$c_{U1}(c_{U2}, \theta) \equiv \frac{2c_{U2} - (2-\theta)}{\theta} < c_{U1}. \tag{2.B3}$$

Given the assumption that $c_{U1} < c_{U2}$, it must hold that $c_{U1}(c_{U2}, \theta) < c_{U2}$. It is straightforward that the latter condition is always true whenever $c_{U2} < 1$. Therefore, condition (2.B3) can be written as,

$$\frac{2c_{U2} - (2-\theta)}{\theta} < c_{U1} < c_{U2} < 1, \tag{2.B4}$$

or, rearranging the terms in the first inequality, as

$$\frac{1 - c_{U2}}{1 - c_{U1}} > \overline{\gamma}_1(\theta) = \frac{\theta}{2}. \tag{2.B5}$$

The requirement that $q_1^{S*}(c_{U1}, c_{U2}) > 0$ reduces to $c_{U1} < [(4 - 2\theta - \theta^2) + 2\theta c_{U2}]/4 - \theta^2$, which is always true since for $c_{U2} < 1$ it holds that $c_{U2} < [(4 - 2\theta - \theta^2) + 2\theta c_{U2}]/4 - \theta^2$. Therefore, condition (2.B4) or (2.B5) guarantees that final-good quantities are positive under both the pre- and post-merger case(s).

Using (2.15), the requirement that $w^{S*}(c_{U1}, c_{U2}) < c_{U2}$ reduces to $[2c_{U2} - (2-\theta)]/\theta < c_{U1}$, which is always true given (2.B4). Similarly, using (2.20), the requirement that $w^{M*}(c_{U1}) > c_{U1}$ reduces to $c_{U1} < 1$, which is always true given (2.B4).

Proof of Proposition 2.2. We define $\Delta w = w^{S*}(c_{U1}, c_{U2}) - w^{M*}(c_{U1})$. Using (2.15) and (2.20), we obtain:

$$\Delta w = \frac{(4-\theta^2)[(1-c_{U1})(8 - 4\theta - 4\theta^2 + \theta^3) - 2(4 - 3\theta^2)(1 - c_{U2})]}{4(4 - 3\theta^2)(2 - \theta^2)}.$$

It is straightforward that $\Delta w > 0$ whenever the bracketed term in the numerator of the above expression is positive, which yields,

$$\frac{1-c_{U2}}{1-c_{U1}} < \gamma_1(\theta) = \frac{8-4\theta-4\theta^2+\theta^3}{2(4-3\theta^2)}. \tag{2.B6}$$

It can be easily checked that $\gamma_1(\theta) > \overline{\gamma}_1(\theta)$ which implies that the results in Proposition 2.2 hold when both firms are active in the downstream market.

Given that for any given level of input prices the downstream equilibrium outcomes are the same in both the pre- and post-merger cases, it is straightforward that the merger's overall effect on final-good prices, total output and consumer surplus is solely determined by its effect on the input price. Therefore, whenever condition (2.B6) holds, both final-good prices decrease and total output increases, implying an increase in consumer surplus.

2.B.2. The case of $c_{U1} > c_{U2} = \hat{c}_U$.

First, we derive the condition under which final-good quantities are positive under both the pre- and post-merger case(s), and then show that $w^{S*}(c_{U1}, c_{U2}) < c_{U2}$ and $w^{M*}(c_{U2}) > c_{U2}$.

It is straightforward that both $q_1^{M*}(c_{U2})$ and $q_2^{M*}(c_{U2})$ are positive whenever $c_{U2} < 1$. The requirement that $q_1^{S*}(c_{U1}, c_{U2}) > 0$ reduces to:

$$c_{U2}(c_{U1}, \theta) \equiv \frac{(4-\theta^2)c_{U1} - (4-2\theta-\theta^2)}{2\theta} < c_{U2}. \tag{2.B7}$$

Given the assumption that $c_{U1} > c_{U2}$, it must hold that $c_{U2}(c_{U1}, \theta) < c_{U1}$. It is straightforward that the latter condition is always true whenever $c_{U1} < 1$. Therefore, condition (2.B7) can be written as,

$$\frac{(4-\theta^2)c_{U1} - (4-2\theta-\theta^2)}{2\theta} < c_{U2} < c_{U1} < 1, \tag{2.B8}$$

or, rearranging the terms in the first inequality, as

$$\frac{1-c_{U1}}{1-c_{U2}} > \overline{\gamma}_2(\theta) = \frac{2\theta}{4-\theta^2} \tag{2.B9}$$

The requirement that $q_2^{S*}(c_{U1}, c_{U2}) > 0$ reduces to $c_{U2} < [(2-\theta)+\theta c_{U1}]/2$, which is always true since for $c_{U1} < 1$ it holds that $c_{U1} < [(2-\theta)+\theta c_{U1}]/2$. Therefore, condition (2.B8) or (2.B9) guarantees that final-good quantities are positive under both the pre- and post-merger case(s).

Using (2.15), the requirement that $w^{S*}(c_{U1}, c_{U2}) < c_{U2}$ reduces to $[(4-\theta^2)c_{U1} - (4-2\theta-\theta^2)]/2\theta < c_{U2}$, which is always true given (2.B8). Similarly, using (2.20), the requirement that $w^{M*}(c_{U2}) > c_{U2}$ reduces to $c_{U2} < 1$, which is always true given (2.B8).

Proof of Proposition 2.3. *(i)* Given that $w^{S*}(c_{U1}, c_{U2}) < c_{U2}$ and $w^{M*}(c_{U2}) > c_{U2}$, it is straightforward that $w^{S*}(c_{U1}, c_{U2}) < w^{M*}(c_{U2})$. Using (2.15), (2.20), (2.B1) and (2.B2), we have that:

$$p_2^{M*}(c_{U2}) - p_2^{S*}(c_{U1}, c_{U2}) = \frac{\theta[(4-3\theta^2)(1-c_{U1}) - 2\theta(1-\theta)(1-c_{U2})]}{4(4-3\theta^2)}. \tag{2.B10}$$

The expression in (2.B10) is positive whenever the bracketed term in its numerator is positive, which is always true given (2.B9).

(ii) Using (2.15), (2.20), (2.B1) and (2.B2), we have that:

$$p_1^{M*}(c_{U2}) - p_1^{S*}(c_{U1}, c_{U2}) = \frac{(4-3\theta^2)^2(1-c_{U1}) - 2(1-c_{U2})(8-14\theta^2+\theta^3+5\theta^4)}{4(4-3\theta^2)(2-\theta^2)}, \tag{2.B11}$$

The expression in (2.B11) is negative whenever its numerator is negative, which yields,

$$\frac{1-c_{U1}}{1-c_{U2}} < \gamma_2(\theta) = \frac{2[8-14\theta^2+\theta^3+5\theta^4]}{(4-3\theta^2)^2}.$$

It can be easily checked that $\gamma_2(\theta) > \overline{\gamma}_2(\theta)$.

(iii) Regarding consumer surplus, we define $\Delta CS = CS^{M*}(c_{U2}) - CS^{S*}(c_{U1}, c_{U2})$. Using (2.B1) and (2.B2), and solving $\Delta CS = 0$ for $(1-c_{U1})$ we obtain two roots:

$$(1-c_{U1})_1 = \frac{2(1-c_{U2})[(2-\theta^2)\sqrt{A}-\theta^3]}{16-20\theta^2+5\theta^4} \quad \text{and} \quad (1-c_{U1})_2 = -\frac{2(1-c_{U2})[(2-\theta^2)\sqrt{A}+\theta^3]}{16-20\theta^2+5\theta^4},$$

with $A=(64-64\theta-96\theta^2+80\theta^3+52\theta^4-20\theta^5-15\theta^6)/(4-3\theta^2)>0$. Since we require that $c_{U1}<1$, we disregard the second root since it is always negative. From the first root, we obtain that $\Delta CS>0$ whenever

$$\frac{1-c_{U1}}{1-c_{U2}} < \gamma_2(\theta) = \frac{2[(2-\theta^2)\sqrt{A}-\theta^3]}{16-20\theta^2+5\theta^4}.$$

After some tedious but straightforward calculations, it can be shown that $\overline{\gamma}_2(\theta)<\gamma_3(\theta)<\gamma_2(\theta)$, which implies that (*i*) a necessary (but not sufficient) condition for consumer surplus to increase is that p_1 falls and (*ii*) the results in Proposition 2.3 hold when both firms are active in the downstream market.

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Chapter 3

Accommodation effects with downstream Cournot competition

3.1 Introduction

> *"But if an integrated firm should realize that its strategic actions in the downstream market could affect its profit in the upstream market, then the Cournot model would seem inappropriate."*
>
> \- Yongmin Chen (2001)

> *"The accommodation effect depends on downstream competition being Bertrand (over prices). Only if it is over prices can the integrated firm affect the sales of its input upstream by increasing sales of its downstream rival by raising its downstream price."*
>
> \- Jeffrey Church (2008)

Situations where vertically integrated firms, i.e., firms that are present in both upstream and downstream stage(s) of the production chain, supply their products to downstream rivals are common in many industries. For instance, in the petroleum industry, vertically integrated oil refiners have long supplied petroleum products such as petrol/gasoline both to company-owned and independent, competing retail stations. Moreover, the existence of dual channels of distribution is nowadays a widespread phenomenon: manufacturers sell their products both directly to final consumers through their websites ("internet" channel) and indirectly through independent retail stores ("traditional" channel).

It has been suggested that when unintegrated downstream firms procure inputs from upstream suppliers that are also downstream rivals, the vertically integrated producers may have an incentive to compete less aggressively in the downstream market in order to support their input sales. This downstream accommodation effect has been formally established in models assuming downstream Bertrand competition (e.g., Chen, 2001; Ordover & Shaffer, 2007; Hoffler & Schmidt, 2008; Arya *et al*., 2008; Bourreau *et al*., 2011), but *not* in models considering downstream Cournot competition, as pointed out in the above quotes by Chen (2001) and Church (2008).[36]

In this chapter, we show that such accommodating behavior can also be observed under downstream Cournot competition, analyze the conditions for its presence, and draw its consequences. We consider a vertically related market with an integrated firm that also sells the input to an unintegrated downstream rival. The timing of moves is as follows. First, the integrated firm chooses the aggregate input quantity that will be directed to both its downstream affiliate and the unintegrated downstream rival.[37] Second, the integrated firm and its rival simultaneously and independently choose their final-good outputs. The input price is determined as a market-clearing price after all decisions are made.

Within this framework, we show that, by restraining its own final-good quantity, the integrated firm allows each rival unit to be sold at a *ceteris paribus* higher final-good price, thus increasing its marginal profitability. This, in turn, increases the rival's willingness-to-pay for the input and shifts the corresponding derived (input) demand upwards. Hence, while decisions simultaneity of Cournot competition precludes affecting rival quantity, by restraining its own final-good quantity, the downstream division of the integrated firm allows its upstream partner to sell the input at a higher price.[38]

The presence of such accommodating behavior has important consequences regarding the vertically integrated firm's profitability. In particular, we show that the integrated firm can earn Stackelberg-leader profits even though downstream quantities are set simultaneously. Accommodating rival sales allows the integrated firm to better coordinate two choices (overall input quantity, own final-good quantity) that must be made at two different stages of the game, reaching decisions as if they were both decided simultaneously at the same stage.

When the integrated firm sets its input price instead of its input quantity, its downstream partner has no way to influence the profitability of input sales, since it can affect neither the

[36]One exception is Gans (2007). In particular, Gans (2007) is able to identify the accommodation effect under downstream Cournot competition by reversing the standard order between upstream and downstream decisions, i.e., by assuming that downstream decisions precede upstream ones. In this work, like in all the aforementioned papers, we adopt the standard decision-timing, i.e., upstream decisions precede downstream ones.
[37]It is widely acknowledged that oligopoly competition can be better described as Cournot when output is difficult to adjust, whereas it is better described as Bertrand when output can be easily changed. This reasoning clearly extents to the monopoly case: a monopolist is a quantity-setter or a price-setter depending on how easily it can adjust its output.
[38]Bourreau *et al*. (2011) show that if the integrated firm is a Stackelberg leader in the downstream market, then the accommodation effect is at play: by restraining its own quantity, the integrated firm affects the rival's *quantity*. In our model, due to the assumption of simultaneous decisions in the downstream market, the accommodation effect works in a thoroughly different way: by restraining its own quantity, the integrated firm affects the rival's *willingness-to-pay* for a particular quantity.

quantity of input sold (due to the standard Cournot assumption), nor the price at which that quantity is sold (which has been already determined at the first stage). Therefore, whereas for an unintegrated input supplier setting price or quantity makes no difference, when the input supplier is vertically integrated the profit maximization instrument is of great importance. For the linear demand case, it is shown that input prices, final-good prices and both the integrated firm's and its downstream rival's profits are higher when the integrated firm chooses the input quantity than when he chooses the input price.

We also investigate the case where the integrated firm is not the only supplier of the input: there also exists an equally cost-efficient unintegrated upstream supplier. Following Chen (2001), we assume that the unintegrated downstream firm can strategically choose its input supplier: it can buy the input only from the integrated firm, only from the unintegrated upstream firm or from both firms.[39] In the latter case, it is shown that the downstream accommodation effect is still present, however, the incentive of the vertically integrated firm to accommodate downstream rival sales is now mitigated by the fact that the latter procures a portion of the input quantity it needs from the unintegrated upstream supplier.

In the presence of an unintegrated upstream supplier, the unintegrated downstream firm will never choose to buy only from the integrated firm. As mentioned above, the downstream accommodation effect pushes the unintegrated downstream rival's derived demand upwards causing the equilibrium input price to increase. The presence of such effect is sufficient to guarantee that the downstream rival will always be unwilling to establish the integrated firm as an upstream monopoly: it will either choose to deal only with the unintegrated upstream firm or with both firms. When products are close substitutes, the downstream accommodation effect is relatively strong so that the input price paid by the downstream rival when deals with both firms is higher than the input price paid when deals solely with the unintegrated upstream firm. When final-goods are too differentiated, the downstream accommodation effect is relatively weak so that the downstream rival prefers to deal with both firms.

The rest of the chapter is organized as follows. In Section 3.2, we discuss the conditions for the presence of the downstream accommodation effect as established in the existing literature. In Section 3.3, we present our model and derive the main results in terms of a general demand function. In Section 3.4, we apply a linear demand function for illustrative purposes. In section 3.5, we discuss the case of upstream competition. Section 3.6 contains the conclusions.

[39] Chen (2001), unlike this work, considers a model with price setting in both up- and downstream market(s).

3.2 The downstream accommodation effect in the existing literature

To formally analyze the conditions for the presence of the downstream accommodation effect, as established in the existing literature, consider the following simple market structure. There exists a vertically related industry consisting of two firms, an integrated firm $U\text{-}D_1$ and an independent downstream firm D_2. The upstream division of the integrated entity is the sole producer of an essential input for the production of the final good. The downstream division of the integrated firm obtains the input internally from its upstream partner at marginal cost, whereas the unintegrated downstream firm, D_2, procures the input from $U\text{-}D_1$ at an input price w. Both downstream firms transform one unit of the input into one unit of the final good. For simplicity, and without loss of generality, both upstream and downstream constant marginal costs are normalized to zero.

Allowing for brand-name differentiation of the final good, the (direct) demand for each variant is $q_i(p_i, p_j)$, $i, j = 1,2$, $i \neq j$, whereas the corresponding inverse demand is $p_i(q_i, q_j)$. Both demand functions are twice continuously differentiable, downward sloping, and the cross effects are such that final-goods are imperfect substitutes.

The timing of the two-stage game is as follows. At the first stage, $U\text{-}D_1$ sets the input price it will charge to D_2. At the second stage, taking the input price as given, firms $U\text{-}D_1$ and D_2 compete in the final-good market.[40] Consider both cases of Bertrand and Cournot downstream competition: in the first case, $U\text{-}D_1$ and D_2 set simultaneously and independently their final-good prices, whereas in the second case, $U\text{-}D_1$ and D_2 simultaneously and independently choose their final-good outputs.

Under downstream Bertrand competition, the profit maximization problem of the integrated firm in the downstream market is given by:

$$\max_{p_1} \pi_{U-D_1} = p_1 q_1(p_1, p_2) + w q_2(p_1, p_2). \tag{3.1}$$

[40]The independent downstream firm D_2 has no oligopsony power over the input market. This framework suites well not only industries where the number of downstream firms is sufficiently large relative to the number of upstream firms, but also industries where the effect of an eventual downstream concentration is cancelled by the opportunity of the upstream industry to serve a fairly large number of other downstream industries. See Gulati *et al*. (2016) for a thorough list of market characteristics (and real-world examples to support them) that determine when downstream buyers have no (or at least very limited) power over the upstream market.

The first term to the right of the equality in (3.1) captures the integrated firm's profits from sales of the final-good, whereas the second term reflects *U-D₁*'s profits from selling the input to D_2. The first order condition can be written as:

$$[q_1 + p_1 \frac{\partial q_1}{\partial p_1}] + w \frac{\partial q_2}{\partial p_1} = 0 . \tag{3.2}$$

The first, bracketed, term on the left hand side of (3.2) represents marginal revenue in the downstream market, whereas the second term, which is clearly positive, entails the downstream accommodation effect: *the integrated firm realizes that any customer lost in the downstream market can be recovered via the upstream market providing it with a credible commitment to relax downstream competition* (see, e.g., Chen, 2001; Ordover & Shaffer, 2007; Hoffler & Schmidt, 2008;Arya *et al*., 2008; Bourreau *et al*., 2011).

Under downstream Cournot competition, the profit maximization problem of the integrated firm in the downstream market becomes,

$$\max_{q_1} \pi_{U-D_1} = p_1(q_1, q_2)q_1 + wq_2 .$$

It is straightforward that under upstream price-setting and downstream Cournot competition the accommodation effect no longer exists. Since the integrated firm can affect neither rival quantity (due to the standard Cournot assumption) nor the input price (which has already been determined in the first stage), it must make its downstream decision considering upstream sales as given (Arya *et al*., 2008). Therefore, the accommodation effect depends on downstream competition being of Bertrand type, since it is only then that the integrated firm can affect its upstream sales by accommodating its downstream rival through an increase in its final-good price.

Our contribution lies on the fact that downstream accommodating behavior can be observed under downstream Cournot competition when the integrated firm chooses the input quantity that will be directed to both its downstream affiliate and the unintegrated rival and the input price is determined as a market-clearing price after downstream decisions are made. In such case, even if, in accordance with the Cournot assumption, no firm can affect the quantity sold by its rival, by restraining its own final-good quantity, the integrated firm increases the unintegrated rival's marginal profitability for any given final-good quantity and consequently its *willingness-to-pay* for any given input quantity.

3.3 The downstream accommodation effect under upstream quantity-setting

In this section, we depart from the model described in the previous section in one important respect: now the vertically integrated firm chooses the input quantity instead of input price at the first stage of the game. In particular, the timing of the game is as follows:

Stage 1. The upstream division of the vertically integrated firm chooses the aggregate input quantity *X* that will be directed to both its downstream affiliate and the unintegrated downstream rival.

Stage 2. The downstream division of the vertically integrated firm and its unintegrated rival choose simultaneously and independently their final-good outputs, q_1 and q_2. Since there is a one-to-one relation between input and final-good output, firms essentially compete for their shares of the input quantity produced at the first stage.

After all decisions are made, the input price is determined as a market-clearing price. At the second stage, the downstream division of the integrated firm and its rival choose their final-good outputs. Given that the input price has not been determined yet, the unintegrated rival cannot choose a specific amount of final-good output since it does not know its actual marginal cost: it can actually only form a final-good output schedule and therefore a derived demand: the amount of input quantity it is willing to buy for any given input price and final-good quantity of its integrated rival. It is straightforward that the downstream division of the integrated firm also cannot choose a specific amount of final-good output but only an output schedule. The input price will adjust in equilibrium in order to equate demand and supply of the input.

We start by solving the last stage of the game. The maximization problem of D_2 is:

$$\max_{q_2} \pi_{D_2} = p_2(q_1, q_2)q_2 - wq_2 \tag{3.3}$$

which yields the best-response function,

$$q_2^R = q_2(q_1, w) \tag{3.4}$$

with both partial derivatives negative. Let $R_2(q_1,q_2) = p_2(q_1,q_2)q_2$ denote *D2*'s revenue. Since one unit of input produces one unit of output, the inverse derived demand for the input of *D2* is found by equating marginal revenue to marginal cost, i.e.,

$$w(q_1,q_2) = \frac{\partial R_2(q_1,q_2)}{\partial q_2}. \tag{3.5}$$

Given strategic substitutability, it holds that

$$\frac{\partial w(q_1,q_2)}{\partial q_1} = \frac{\partial^2 R_2(q_1,q_2)}{\partial q_2 \partial q_1} < 0. \tag{3.6}$$

The maximization problem of the integrated firm is:

$$\max_{q_1} \pi_{U-D_1} = p_1(q_1,q_2)q_1 + w(q_1,q_2)q_2. \tag{3.7}$$

In conformity with the Cournot conjecture, *U-D1* takes rival's final-good output as given. However, it recognizes that its own final-good quantity choice affects the profitability of any given final-good quantity that *D2* decides to sell, *thus affecting D2's willingness-to-pay for the respective input quantity*. From the first order condition of (3.7) we get:

$$\frac{\partial \pi_{U-D_1}}{\partial q_1} = p_1(q_1,q_2) + q_1 \frac{\partial p_1(q_1,q_2)}{\partial q_1} + \frac{\partial w(q_1,q_2)}{\partial q_1} q_2 = 0. \tag{3.8}$$

We know from (3.6) that the sign of the derivative $\partial w(q_1,q_2)/\partial q_1$, which captures the downstream accommodation effect, is negative: by lowering its final-good output, *U-D1* increases the profitability of any given output that *D2* decides to sell, thus increasing *D2*'s willingness-to-pay for the input quantity.

Proposition 3.1. *In a vertically related market with upstream quantity-setting and downstream Cournot competition, the downstream division of a vertically integrated firm accommodates rival sales despite the Cournot conjecture of taking rival quantity as given.*

The integrated firm's best-response function is given by

$$q_1^R = q_1(q_2)\,. \tag{3.9}$$

Simultaneously solving (3.4) and (3.9) yields the downstream equilibrium levels of output as functions of *w*, i.e.,

$$q_1(w)\,, \quad q_2(w)\,. \tag{3.10}$$

At the first stage, the integrated firm will choose its overall input quantity under the constraint,

$$q_2(w) = X - q_1(w)\,, \tag{3.11}$$

where the LHS of the above expression is the unintegrated rival's direct derived demand for the input and the RHS is the integrated firm's supply of the input to the unintegrated rival. Note that rearranging (3.11) we have that $q_1(w) + q_2(w) = X$, which implies that the aggregate final-good quantity must equal the aggregate input quantity. From (3.10) and (3.11), we obtain the input price *w* as a function of *X*, i.e., $w(X)$, based on which the integrated firm maximizes

$$\max_X = [\,p_1(q_1(X), q_2(X))]q_1(X) + w(X)q_2(X)\,. \tag{3.12}$$

From the first order condition of (3.12), we obtain the equilibrium value of *X*, which substituted into $w(X)$ yields the equilibrium input price, which in turn allows the determination of all second-stage values and prices.

The presence of the downstream accommodation effect has important consequences regarding the vertically integrated firm's profitability.

Proposition 3.2. *In a vertically related market with upstream quantity-setting and downstream Cournot competition, the vertically integrated firm is able to earn the same profits as if it were a Stackelberg leader in the market.*

Proof. Consider an alternative timing structure which establishes the integrated firm as a Stackelberg leader in the market. More specifically, at the first stage, $U\text{-}D_1$ chooses both X and q_1 to maximize its total profits whereas at the second stage, D_2 chooses q_2 to maximize its own profit. Obviously, the best-response function of the unintegrated rival and its derived demand for the input are still given by (3.4) and (3.5) respectively. We need to show that the best-response function of the integrated firm in the downstream market is still determined by (3.8). Since aggregate input quantity must equal aggregate final-good quantity, the integrated firm chooses X and q_1 to maximize the following profit function:

$$\max_{q_1, X} \pi_{U-D_1} = p_1(q_1,(X-q_1))q_1 + w(q_1,(X-q_1))(X-q_1)\,.$$

The first order conditions are given by:

$$\frac{\partial \pi_{U-D_1}}{\partial q_1} = p(\bullet) + q_1\frac{\partial p(\bullet)}{\partial q_1} + \frac{w(\bullet)}{\partial q_1}(X-q_1) - q_1\frac{\partial p(\bullet)}{\partial (X-q_1)} - (X-q_1)\frac{w(\bullet)}{\partial (X-q_1)} - w(\bullet) = 0\,. \quad (3.13)$$

$$\frac{\partial \pi_{U-D_1}}{\partial X} = q_1\frac{\partial p(\bullet)}{\partial (X-q_1)} + (X-q_1)\frac{w(\bullet)}{\partial (X-q_1)} + w(\bullet) = 0\,. \quad (3.14)$$

Combining (3.13) and (3.14), the former reduces to

$$\frac{\partial \pi_{U-D_1}}{\partial q_1} = p(\bullet) + q_1\frac{\partial p(\bullet)}{\partial q_1} + \frac{w(\bullet)}{\partial q_1}(X-q_1) = 0\,. \quad (3.15)$$

It is then straightforward that since $q_2 = X - q_1$ must always hold, the expressions in (3.8) and (3.15) are equivalent. ■

Proposition 3.2 states that the integrated firm can earn Stackelberg-leader profits even though downstream quantities are set simultaneously. Accommodating rival sales allows the integrated firm to better coordinate two choices (overall input quantity, own final-good quantity) that must be made at two different stages of the game, reaching decisions as if they were both decided simultaneously at the same stage.

As already mentioned in Section 3.2, under upstream price-setting and downstream Cournot competition, the downstream accommodation effect no longer exists: since the integrated firm can affect neither rival quantity (due to the standard Cournot assumption) nor the input price (which has already been determined at the first stage), it must make its downstream decision considering upstream sales as given. In one-tier monopolies, or upstream monopolies that do not participate in the final-good market, it is irrelevant whether profits are maximized with respect to input price or input quantity. In contrast, our analysis suggests that for a vertically integrated input monopolist facing Cournot competition downstream, the upstream profit-maximizing instrument is of paramount importance: setting the input price instead of the input quantity deprives the integrated firm from a strategic downstream accommodating behavior.

Corollary 3.1. *In a vertically related market with downstream Cournot competition, the final equilibrium market outcome depends on whether a vertically integrated firm chooses the price or the quantity of the input.*

Indeed, in the following section where the linear demand case is considered, we show that input prices, final goods prices and both the integrated firm's and its downstream rival's profits are higher when the integrated supplier chooses the input quantity than when he chooses the input price.

3.4 The linear demand case

In order to further investigate the equilibrium features of our model, in this section we consider the following linear demand function (Singh & Vives, 1984)

$$p_i = 1 - q_i - \theta q_j\,, \quad i, j = 1, 2, \quad i \neq j\,, \tag{3.16}$$

where the inverse demand intercept, without loss of generality, is normalized to one and the parameter $\theta \in (0,1)$ measures the degree of product substitutability. The higher is θ, the closer substitutes final goods are.

Firm D_2's revenue becomes $R_2(q_1, q_2) = q_2(1 - q_2 - \theta q_1)$ yielding the inverse input-demand function: $w(q_1, q_2) = 1 - 2q_2 - \theta q_1$. From the latter expression, it is straightforward that

$$\frac{\partial w(q_1, q_2)}{\partial q_1} = -\theta < 0,$$

which implies that the downstream accommodation effect is stronger (weaker) the more (less) substitutable final-goods are. In the extreme case where final-goods are totally differentiated the downstream accommodation effect vanishes. The best-response functions of U-D_1 and D_2, are respectively:

$$q_1^R = q_1(q_2) = \frac{1}{2}(1 - 2\theta q_2), \quad q_2^R = q_2(q_1, w) = \frac{1}{2}(1 - \theta q_1 - w).$$

Simultaneously solving the above yields the downstream equilibrium levels of output as functions of w,

$$q_1^A(w) = \frac{(1-\theta) + \theta w}{2 - \theta^2}, \quad q_2^A(w) = \frac{(2-\theta) - 2w}{2(2-\theta^2)}, \tag{3.17}$$

where the superscript A denotes hereafter equilibrium values of the upstream quantity-setting case. Substituting the expressions in (3.17) into (3.11), and solving for w, we obtain

$$w^A(X) = \frac{(4-3\theta) - 2(2-\theta^2)X}{2(1-\theta)}. \tag{3.18}$$

Using the above, as well as the downstream equilibrium outcomes in (3.17), we can write the integrated firm’s profits as:

$$\pi_{U-D_1} = p_1^A(X)q_1^A(X) + w^A(X)q_2^A(X) =$$

$$= \frac{(1-2\theta X)}{4(1-\theta)} + \left[\frac{(4-3\theta)-2(2-\theta^2)X}{2(1-\theta)}\right]\frac{(2X-1)}{2(1-\theta)}.$$

Straightforward maximization of the above obtains the equilibrium value of *X*, which substituted into (3.18) yields the equilibrium input price, which in turn allows the determination of all second-stage values and prices. The entire set of equilibrium values (model *A*) is summarized in the first column of Table 3.1.

Input-quantity setting (model *A*)	Input-price setting (model *B*)
$w^{A*} = \frac{1}{2}$	$w^{B*} = \frac{8-4\theta^2+\theta^3}{2(8-3\theta^2)}$
$X^{A*} = q_1^{A*} + q_2^{A*} = \frac{3-2\theta}{2(2-\theta^2)}$	$X^{B*} = q_1^{B*} + q_2^{B*} = \frac{2(1-\theta)}{8-3\theta^2}$
$q_1^{A*} = \frac{2-\theta}{2(2-\theta^2)}$	$q_1^{B*} = \frac{8-2\theta-\theta^2}{2(8-3\theta^2)}$
$q_2^{A*} = \frac{1-\theta}{2(2-\theta^2)}$	$q_2^{B*} = \frac{2(1-\theta)}{8-3\theta^2}$
$p_2^{A*} = \frac{3-\theta-\theta^2}{2(2-\theta^2)}$	$p_2^{B*} = \frac{12-4\theta-4\theta^2+\theta^3}{2(8-3\theta^2)}$
$p_1^{A*} = \frac{1}{2}$	$p_1^{B*} = \frac{8-2\theta-\theta^2}{2(8-3\theta^2)}$
$\pi_{U-D_1}^{A*} = \frac{3-2\theta}{4(2-\theta^2)}$	$\pi_{U-D_1}^{B*} = \frac{12-8\theta+\theta^2}{4(8-3\theta^2)}$
$\pi_{D_2}^{A*} = \frac{(1-\theta)^2}{4(2-\theta^2)^2}$	$\pi_{D_2}^{B*} = \frac{4(1-\theta)^2}{(8-3\theta^2)^2}$

Table 3.1. Input-quantity vs. input-price setting

Several points are worth noting. First, $q_2^{A*} = 0$ only when $\theta = 1$: given that downstream firms are equally efficient, full foreclosure of the unintegrated downstream rival is optimal only when products are completely homogeneous (Hart & Tirole, 1990; Rey & Tirole, 2007). Second, the equilibrium final-good price of the integrated firm is independent of *θ*, and equal to the equilibrium input price. Third, $q_1^{A*}/q_2^{A*} = (2-\theta)/(1-\theta) > 1$, hence, $q_1^{A*} > q_2^{A*}$: despite the accommodation effect, *U-D1* obtains a larger market share in the downstream market due to its lower marginal cost. Finally, $p_1^{A*} - p_2^{A*} = -(1-\theta)/2(2-\theta^2) < 0$, again due to the cost advantage of the integrated firm.

The equilibrium outcomes when the vertically integrated firm sets the input price at the first stage, are obtained straightforwardly. The best-response function of *U-D₁* is given by $q_1(q_2) = 1/2(1-\theta q_2)$, whereas the best-response function of D_2 is given by $q_2(q_1, w) = 1/2(1 - w - \theta q_1)$. The downstream equilibrium levels of output as functions of *w* are given by,

$$q_1^B(w) = \frac{(2-\theta)+\theta w}{4-\theta^2}, \quad q_2^B(w) = \frac{(2-\theta)-2w}{4-\theta^2}. \tag{3.19}$$

where the superscript *B* denotes hereafter equilibrium values of the upstream price-setting case. The last expression in (3.19) is also the unintegrated downstream rival's derived demand for the input. We can write the integrated firm's profits as:

$$\pi_{U-D_1} = p_1^B(w)q_1^B(w) + wq_2^B(w) = \left(\frac{(2-\theta)+\theta w}{4-\theta^2}\right)^2 + \left(\frac{(2-\theta)-2w}{4-\theta^2}\right)w.$$

Straightforward maximization of the above obtains the equilibrium value of *w*. The entire set of equilibrium values (model *B*) is summarized in the second column of Table 3.1.[41] The comparison between the two columns of Table 3.1 reveals several interesting points summarized in the following Proposition.

Proposition 3.3. *In a vertically related market with downstream Cournot competition, input prices, final-good prices and both the integrated firm's and its downstream rival's profits are higher when the integrated firm chooses its input quantity instead of the input price.*

Proof. From Table 3.1, it is easy to verify that $w^{A*} > w^{B*}$, $p_1^{A*} > p_1^{B*}$, $p_2^{A*} > p_2^{B*}$, $\pi_{U-D_1}^{A*} > \pi_{U-D_1}^{B*}$ and $\pi_{D_2}^{A*} > \pi_{D_2}^{B*}$. ■

[41]The equilibrium outcomes can also be obtained from Arya *et al*. (2008) by imposing $c_1 = c_2 = 0$ and $a_1 = a_2 = 1$ in their model.

First, it is easy to show that $q_1^{A*} < q_1^{B*}$ and $q_2^{A*} > q_2^{B*}$ which confirms the presence of the accommodation effect under upstream quantity-setting. Second, the total amount of input, and thus the total amount of final-good output, is larger when the integrated firm chooses the input quantity compared to the case where it chooses the input price, i.e., $X^{A*} > X^{B*}$. Third, the input price is higher and both final-good prices are higher in model *A*, implying that consumers are better off when the integrated firm chooses its input price than its input quantity. Finally, both firms' profits are higher in model *A*: despite the higher input price that firm *D2* must pay to the integrated firm, it benefits from the fact that the latter plays softly in a market where competition is in strategic substitutes.

3.5 Upstream competition

The analysis thus far has abstracted from upstream competition. To assess the effects of competition between upstream suppliers, we consider the following simple modification of the baseline model. Suppose that U-D_1 is not the only supplier of the input: there also exists an equally cost-efficient unintegrated upstream supplier denoted by U_2. Following Chen (2001), we incorporate the idea that the identity of the input supplier matters to the unintegrated downstream firm by assuming that it can strategically choose its input supplier. The timing of the game is as follows.

Stage 1. The unintegrated downstream firm announces its intention to purchase the input from (*i*) U-D_1 only, (*ii*) U_2 only or (*iii*) both firms.

Stage 2. Depending on the D_2's decision in the previous stage, production of the input takes place as follows.

(*i*) When D_2 intends to buy from U-D_1, then the latter chooses the aggregate input quantity X that will be directed to both its downstream affiliate and the unintegrated downstream rival.

(*ii*) When D_2 intends to buy from U_2, then the latter chooses the input quantity X_2 that will be directed to the unintegrated downstream rival.

(*iii*) When D_2 intends to buy from both firms, then U-D_1 and U_2 choose simultaneously and independently their input quantities x_1 and x_2. The integrated firm's input quantity x_1 refers to the aggregate input quantity that will be directed to both its downstream affiliate and the unintegrated downstream rival.

Stage 3. The downstream division of the vertically integrated firm and its unintegrated rival choose simultaneously and independently their final-good outputs, q_1 and q_2.

In all cases, the input price is determined as a market-clearing price after downstream decisions are made. The case where D_2 chooses to buy from only from the integrated firm has been analyzed in the previous two sections. Therefore, there two cases to consider here, i.e., D_2 buys the input only from U_2 and D_2 buys the input from both U-D_1 and U_2.

3.5.1 D_2 buys the input only from U_2

In this case, we have a model similar to that in Salinger (1988) in the sense that the vertically integrated firm does not participate in the merchant market, i.e., it does not supply the input to the unintegrated downstream rival. However, there is one important difference between Salinger's model and ours. In Salinger (1988), the unintegrated downstream firm is a *passive* buyer in the input market: the integrated firm decides not to supply the input. In our model, the unintegrated downstream firm is a *strategic* buyer in the input market: the latter decides not to procure the input from the integrated firm.

The profit maximization problem of D_2, and consequently its best-response function (given in (3.4)) remain unaffected by the introduction of firm U_2. The profit maximization problem of U-D_1 is now becomes

$$\max_{q_1} \pi_{U-D_1} = p_1(q_1, q_2)q_1, \tag{3.20}$$

Focusing on the linear demand function given in (3.13), the downstream equilibrium levels of output as functions of w are given by:

$$q_1^C(w) = \frac{(2-\theta)+\theta w}{4-\theta^2}, \quad q_2^C(w) = \frac{(2-\theta)-2w}{4-\theta^2}. \tag{3.21}$$

where the superscript C denotes hereafter equilibrium values of the case where D_2 buys the input only from U_2. The unintegrated downstream rival's derived demand must equal supply of the input, i.e.,

$$q_2^C(w) = X_2 . \tag{3.22}$$

From (3.22) and the last expression in (3.21), we obtain the inverse derived demand as a function of X_2, i.e.,

$$w^C(X_2) = \frac{(2-\theta)(1-(2+\theta)X_2)}{2} . \tag{3.23}$$

Using (3.23), the unintegrated upstream supplier chooses X_2 to maximize

$$\max_{X_2} \pi_{U_2} = w^C(X_2)X_2 = \frac{(2-\theta)(1-(2+\theta)X_2)}{2} X_2 .$$

The final equilibrium outcomes are summarized below.

$$\begin{gathered} X_2^{C*} = q_2^{C*} = \frac{1}{2(2+\theta)}, \quad w^{C*} = \frac{2-\theta}{4}, \quad q_1^{C*} = p_1^{C*} = \frac{4+\theta}{4(2+\theta)}, \quad p_2^{C*} = \frac{6-\theta^2}{4(2+\theta)}, \\ \pi_{U-D_1}^{C*} = \frac{(4+\theta)^2}{16(2+\theta)^2}, \quad \pi_{D_2}^{C*} = \frac{1}{4(2+\theta)^2}, \quad \pi_{U_2}^{C*} = \frac{2-\theta}{8(2+\theta)}. \end{gathered} \tag{3.24}$$

3.5.2 D_2 buys the input from both U-D_1 and U_2

In this case, we have a successive Cournot model where the integrated firm participates in the merchant market. The existing literature that considers successive Cournot models is unable to identify the presence of the downstream accommodation effect (e.g., Gaudet & van Long, 1996; Schrader & Martin, 1998; Higgins 1999; Inderst & Valletti 2007, 2009), presumably because they implicitly assume that the upstream market clears before downstream decisions are made. By assuming that the upstream market clears after downstream decisions are made, we show that the downstream accommodation effect is present in these models.[42]

[42]Similar to the case analyzed in the previous subsection, our successive Cournot model also differs from that in the existing literature in that the unintegrated downstream firm is a strategic rather than a passive buyer in the input market.

The profit maximization problem of D_2, and consequently its best-response function (given in (3.4)) and its derived demand for the input (given in (3.5)) remain unaffected by the introduction of firm U_2. The profit maximization problem of $U\text{-}D_1$ now becomes

$$\max_{q_1} \pi_{U-D_1} = p_1(q_1,q_2)q_1 + w(q_1,q_2)(q_2 - x_2), \tag{3.25}$$

and the first order condition is given by

$$\frac{\partial \pi_{U-D_1}}{\partial q_1} = p_1(q_1,q_2) + q_1 \frac{\partial p_1(q_1,q_2)}{\partial q_1} + \frac{\partial w(q_1,q_2)}{\partial q_1}(q_2 - x_2) = 0. \tag{3.26}$$

The downstream accommodation effect, as captured by the term $\partial w(q_1,q_2)/\partial q_1 < 0$, is still present under upstream competition: by lowering its final-good output, $U\text{-}D_1$ increases the profitability of any given output that D_2 decides to sell, thus increasing D_2's willingness-to-pay for the input quantity. However, compared to the case of upstream monopoly, the incentive of the vertically integrated firm to accommodate rival sales is now mitigated by the fact that D_2 procures a portion of the input quantity it needs from the unintegrated upstream supplier U_2.

From now on we focus on the linear demand function given in (3.13). The downstream equilibrium levels of output as functions of w and x_2 are given by:

$$q_1^D(w,x_2) = \frac{(1-\theta)+\theta w+\theta x_2}{2-\theta^2}, \quad q_2^D(w,x_2) = \frac{(2-\theta)-2w-\theta^2 x_2}{2(2-\theta^2)}, \tag{3.27}$$

where the superscript D denotes hereafter equilibrium values of the case where D_2 buys the input from both firms. Note that,

$$\frac{\partial q_1^D(w,x_2)}{\partial x_2} = \frac{\theta}{2-\theta^2} > 0, \quad \frac{\partial q_2^D(w,x_2)}{\partial x_2} = -\frac{\theta^2}{2(2-\theta^2)} < 0.$$

As indicated above, the higher is the amount of input quantity that D_2 purchases from U_2, the less eager is $U\text{-}D_1$ to induce an accommodating behavior in the downstream market.

In the upstream market, the unintegrated downstream rival's derived demand must equal supply of the input, i.e.,

$$q_2^D(w,x_2)=(x_1-q_1^D(w,x_2))+x_2\,. \tag{3.28}$$

Note that rearranging (3.28) we have that $q_1^D(w,x_2)+q_2^D(w,x_2)=x_1+x_2$, which implies that the aggregate final-good quantity must equal the aggregate input quantity. From (3.27) and (3.28), we obtain the inverse derived demand as a function of x_1 and x_2, i.e.,

$$w^D(x_1,x_2)=\frac{(4-3\theta)-2(2-\theta^2)x_1-(4-2\theta-\theta^2)x_2}{2(1-\theta)}\,. \tag{3.29}$$

The impact of x_1 and x_2 on *w* is not symmetric unless final-goods are totally differentiated, i.e., $\theta=0$. In the latter case, the downstream accommodation effect is absent and thus any given change in x_1 or x_2 has the same effect on input price. When final-goods are imperfect substitutes, i.e., $0<\theta<1$, the impact of x_1 and x_2 on *w* is not the same due to the integrated firm's accommodating behavior in the downstream market.

Using (3.29), as well as the downstream equilibrium outcomes in (3.27), the integrated firm choose x_1 to maximize

$$\max_{x_1}\pi_{U-D_1}=p_1^D(x_1,x_2)q_1^D(x_1,x_2)+w^D(x_1,x_2)[q_2^D(x_1,x_2)-x_2]=$$

$$=\frac{(1-\theta x_2)(1-\theta(2x_1+x_2))}{4(1-\theta)}+\frac{[(4-3\theta)-2(2-\theta^2)x_1-(4-2\theta-\theta^2)x_2][1-2x_1-\theta x_2]}{2(1-\theta)},$$

whereas the unintegrated upstream supplier chooses x_2 to maximize

$$\max_{x_2}\pi_{U_2}=w^D(x_1,x_2)x_2\,\frac{(4-3\theta)-2(2-\theta^2)x_1-(4-2\theta-\theta^2)x_2}{2(1-\theta)}x_2\,.$$

The final equilibrium outcomes are summarized below.

$$x_1^{D*} = \frac{16 - 22\theta + 6\theta^2 + \theta^3}{2(2-\theta^2)(6-4\theta-\theta^2)}, \quad x_2^{D*} = \frac{1-\theta}{6-4\theta-\theta^2}, \quad w^{D*} = \frac{4-2\theta-\theta^2}{2(6-4\theta-\theta^2)},$$

$$q_1^{D*} = \frac{2-\theta}{2(2-\theta^2)}, \quad p_1^{D*} = \frac{6-5\theta}{2(6-4\theta-\theta^2)}, \quad q_2^{D*} = (p_2^{D*} - w^{D*}) = \frac{4-6\theta+\theta^2+\theta^3}{(2-\theta^2)(6-4\theta-\theta^2)},$$

$$\pi_{U-D_1}^{C*} = \frac{88 - 184\theta + 110\theta^2 - 4\theta^3 - 9\theta^4}{4(2-\theta^2)^2(6-4\theta-\theta^2)^2}, \tag{3.30}$$

$$\pi_{D_2}^{C*} = \frac{(4-6\theta+\theta^2+\theta^3)^2}{(2-\theta^2)^2(6-4\theta-\theta^2)^2}, \quad \pi_{U_2}^{C*} = \frac{4-6\theta+\theta^2+\theta^3}{2(6-4\theta-\theta^2)^2}.$$

3.5.3 Which input supplier?

We now obtain our main result.

Proposition 3.4. *In a vertically related market with upstream quantity-setting and downstream Cournot competition, the unintegrated downstream firm will choose to buy the input* from *both U-D1 and U2 when* $\theta < \overline{\theta}$ *, whereas it will choose to buy the input only from U2 when* $\theta > \overline{\theta}$ *, with* $\overline{\theta} \approx 0.554413$.

Proof. From Table 3.1., (3.24) and (3.30), it can be verified, after some straightforward calculations, that $\pi_{D_2}^{C*} > \pi_{D_2}^{A*}$ and $\pi_{D_2}^{D*} > \pi_{D_2}^{A*}$ for any $\theta \in (0,1)$. It can then be easily checked that $\pi_{D_2}^{C*} > (<) \pi_{D_2}^{D*}$ when $\theta > (<) \overline{\theta} \approx 0.554413$. ■

The unintegrated downstream firm will never choose to buy only from the integrated firm: as already mentioned, the downstream accommodation effect pushes the downstream rival's derived demand upwards causing the equilibrium input price to increase. The presence of such effect is sufficient to guarantee that the downstream rival will always be unwilling to establish the integrated firm as an upstream monopoly. This implies that it will always choose the unintegrated upstream firm as its input supplier: whether it will also procure the input from the integrated firm or not depends on the degree of product substitutability. When products are close substitutes, the downstream accommodation effect is relatively strong so that the input price paid by D_2 when deals with both U-D_1 and U_2 is higher than the input price paid when deals solely with U_2. In other words, D_2 suffers so much from U-D_1's downstream behavior so that it prefers to establish U_2 as an upstream monopolist. When final-goods are sufficiently differentiated, the downstream accommodation effect is relatively weak so that D_2 prefers to deal with both firms instead with only U_2.

3.6 Conclusions

Considering a two-tier market where an integrated firm sells input to an independent rival, we have shown that the downstream division of the integrated firm will accommodate rival sales even if downstream competition is *à la* Cournot. Two conditions are necessary for this to happen: (*i*) at the upstream stage the integrated firm sets the quantity of the input and (*ii*) the input price is determined as a market-clearing price after downstream decisions are made. We have also shown that, with the help of the accommodation effect, the integrated firm can earn Stackelberg-leader profits even though downstream quantities are set simultaneously. Moreover, when the integrated firm sets its input price instead of its input quantity, its downstream partner has no way to influence the profitability of input sales, hence, while for an unintegrated monopolist setting input price or input quantity makes no difference, when it is vertically integrated the upstream profit-maximization instrument is of great importance.

We have also considered the case of upstream competition: an unintegrated upstream firm can also supply the input besides the vertically integrated firm. We allowed the unintegrated downstream firm to be a strategic buyer in the upstream market in the sense that it can select its supplier. We have shown that when the unintegrated downstream firm buys the input from both upstream suppliers, the downstream accommodation effect still exists. We have also shown that, in equilibrium, the unintegrated downstream firm will never choose to buy only from the integrated firm: it will either choose to deal only with the unintegrated upstream firm or with both firms.

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