

# Downstream merger with upstream market power

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## Abstract

We examine how a downstream merger affects input prices and, in turn, the profitability of a such a merger under Cournot competition with differentiated products. Input suppliers can be interpreted as ordinary upstream firms, or trade unions organising workers. If the input suppliers are plant-specific, we find that a merger is more profitable than in a corresponding model with exogenous input prices. In contrast to the received literature, we find that it can be more profitable to take part in a merger than being an outsider. For firm-specific input suppliers, on the other hand, results are reversed. We apply our model to endogenous merger formation in an international oligopoly, and show that the equilibrium market structure is likely to be characterised by cross-border merger.

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## 1. Introduction

Downstream mergers may affect not only output prices, but also input prices. Empirical work suggests that mergers can affect wages, the price of one of the most important inputs to production (see e.g. Peoples et al., 1993; McGuckin et al., 1995). Despite this, the theoretical literature on mergers typically does not investigate possible links between mergers on the one hand and wages and other input prices on the other,

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but rather concerns itself with how a merger affects the rivalry among firms in the downstream market.<sup>1</sup> The purpose of this paper is precisely to study how a downstream merger may trigger lower or higher input prices, and how this in turn influences the profitability of the merger.

Can a merger that is wholly anti-competitive be profitable? This question was raised in a well-known paper by [Salant et al. \(1983\)](#). They showed that in a model with homogeneous goods, Cournot competition, linear demand and exogenously given and equal marginal costs, only mergers that almost lead to a full-blown monopoly would be profitable. This is quite a counter-intuitive result, and many authors have highlighted the weaknesses of this model. Another prediction in the Salant et al. model is that free-riding incentives are always present: even if a merger is profitable it would be even more profitable for firms not to take part in the merger.<sup>2</sup> One aspect of the Salant et al. model is that a merger is seen simply as the elimination of one firm in an oligopoly. The merged entity is no larger or different than any other firm that did not participate in the merger. [Deneckere and Davidson \(1985\)](#) used a model where a merged unit is larger than any of the original firms, in the sense that the participants keep all their brands after the merger.<sup>3</sup> Assuming product differentiation and Bertrand competition, they found that merger without marginal cost savings tend to be profitable. Even in this setting, though, it is better to free-ride on the merger than to participate.

[Perry and Porter \(1985\)](#), along with [Farrell and Shapiro \(1990a,b\)](#) and [McAfee and Williams \(1992\)](#), also challenged the view that a merged firm is no ‘larger’ than any of the constituent firms. These studies introduce the existence of some ‘crucial assets’ that are in limited supply in order to capture the notion that some firms are larger than others in a homogenous product industry. This assumption implies rising marginal cost of output production and, consequently, there are internal cost savings from mergers which could make a merger profitable.<sup>4</sup>

Our contribution is to point out that even without the possibility of internal cost savings from a merger, lower marginal costs can also result from the fact that other

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<sup>1</sup> There are a few notable exceptions. [González-Maestre and López-Cuñat \(2001\)](#) and [Ziss \(2001\)](#) analyse merger in a homogeneous Cournot model where each owner delegates output decisions to a manager. The manager’s incentive scheme, which is endogenous in the model and thereby affected by a merger, can be regarded as an input price. Since the incentive scheme is set by the owner, these models are distinctly different from ours, where we have independent input suppliers that set input prices. In [Bárcena-Ruiz and Garzón \(2000\)](#), a merger affects wage setting. However, they analyse a merger from duopoly to monopoly. [Horn and Wolinsky \(1988a\)](#) apply a bargaining model to analyse a merger from duopoly to monopoly, either upstream (unions) or downstream (firms). Our approach is different in several ways, though. Horn and Wolinsky consider downstream merger only in the case of a single upstream input supplier. For our purposes, this turns out to be the least interesting case. Furthermore, since we are concerned about the well-known free-rider problem in the merger literature, we apply a model which includes a non-merging firm.

<sup>2</sup> This free rider problem was first pointed out in [Stigler \(1950\)](#). [Fridolfsson and Stennek \(2002a\)](#) show that this mechanism may delay a merger rather than prevent it completely.

<sup>3</sup> See also [Lommerud and Sjørgard \(1997\)](#).

<sup>4</sup> [Fridolfsson and Stennek \(2002b\)](#) also work with the assumption that a merger in oligopoly can lower marginal cost.

parties – external to the firm – lower the prices they charge from the merged unit. The core substance of the paper is an attempt to delineate under which circumstances a downstream merger can have this beneficial effect on input prices – and thereby marginal costs – that in turn would suggest profitable anti-competitive mergers and an elimination of the free-rider paradox.<sup>5,6</sup>

In the present paper, the downstream market is described by a three-firm Cournot oligopoly model with differentiated products.<sup>7</sup> Each producer is locked in a bilateral monopoly situation with its own independent input supplier.<sup>8</sup> A trade union may be a prime example, but the model is meant to have a broader applicability. The input supplier is assumed unilaterally to set the input price that the downstream firm faces.<sup>9</sup> As is common in the vertical relations literature, this is assumed to happen prior to the Cournot subgame in the final product market. In the case where the input supplier is a trade union, we study how outcomes are affected by how much weight the unions put on achieving a high wage relative to obtaining a high level of employment. In the case where the input supplier is a firm, we think profit maximisation is the more natural assumption. However, it could be that the firm rather is sales oriented, which corresponds to a union that puts a high emphasis on employment.

If a merger takes place, the merged entity will continue to produce both of its brands. Each of the plants will keep its own input supplier, but we discuss the possibility that these suppliers do or do not coordinate their behaviour. The two input suppliers of the merged firm can become indirect competitors, though, because the downstream firm now in principle can choose if it wants to serve the market by the one or the other of its two brands. Product differentiation of course limits the severity of this indirect competition. Focussing on the central questions of whether or not mergers are profitable, and whether or not firms prefer to be among the merger participants, the degree of product differentiation – as well as the degree to which input suppliers are sales (employment) oriented – turn out to be of crucial importance.

We distinguish between three different ways to organise the supply of input: the input suppliers can be plant-, firm- or industry-specific. These distinctions also turn

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<sup>5</sup> If the supply curve of the input supplying industry is upward sloping, it is straightforward that a contraction of the downstream industry, following a merger, can lead to lower input prices. Here the focus is on how input suppliers can choose to lower their prices as a strategic response to the merger.

<sup>6</sup> A referee has drawn our attention to [Creane and Davidson \(2001\)](#). In this paper, a merged firm retains the original firms as divisions with some autonomy. The headquarter can stage a Stackelberg quantity-setting game among the divisions, and this can lead to profitable mergers with insiders benefitting more than outsiders. A quite parallel research effort is [Huck et al. \(2003\)](#).

<sup>7</sup> As we show in [Lommerud et al. \(2000\)](#), results are quite parallel in a model with Bertrand competition in the output market.

<sup>8</sup> The existence of bilateral monopolies is a natural assumption if input suppliers are trade unions. Generally, the plausibility of the assumption requires a certain degree of asset specificity, which create a ‘lock-in’ effect. Sunk investments which increase the value of trade between a buyer (downstream firm) and seller (upstream firm) also create a switching cost, which decreases the value, in relative terms, of any outside option. A typical example of such investments is irreversible R&D expenditures.

<sup>9</sup> By letting the input supplier set prices, we have de facto applied a monopoly union model in the cases where the input suppliers are trade unions. It can be shown that our results are valid also in a setting with an efficient bargaining model rather than a monopoly union, see [Lommerud et al. \(2000\)](#).

out to be very important for questions about merger profitability.<sup>10</sup> *Plant-specific* input supply means that each plant has its own independent supplier both before and after a possible merger. This is arguably the more natural assumption where the input suppliers are firms. It also seems natural in the trade union context when bargaining structures are very decentralised, or when the merger in question is an international one.

*Firm-specific* input supply means that the two involved input suppliers act in an uncoordinated manner prior to the merger, but that they too merge in response to a downstream merger. We think this perhaps is most relevant in the trade union example for countries where bargaining takes place at a company rather than at the plant level.<sup>11</sup> We do not rule out that it in some cases also can be relevant for firms as input suppliers. *Industry-specific* input suppliers mean that all input suppliers in the industry coordinate their actions both before and after a possible merger. This type of bargaining structure can be found in some European countries. It is also relevant for highly concentrated upstream industries.

Our main focus is directed towards the case of plant-specific input suppliers, which dramatically changes the results from a model with exogenous input prices. As is well known from the trade union theory, a monopoly input supplier will choose a price–quantity combination on the input demand schedule, and the optimal behaviour of the input supplier is determined by the elasticity of input demand. So, how does a downstream merger influence the elasticity of input demand for the two suppliers involved in the merger? First, a merger leads to a *negative shift* in the demand for inputs. This is derived from the dampening-of-competition effect in the product market. A demand reduction in the product market in turn leads to a reduction in demand for inputs. Second, a merger also affects the slope of the input demand curve by making demand *more responsive* to input price changes. The reason is that the merger enables the merged firm to shift production between its two plants. It can partly replace a share of one of its product’s sale by increasing the sale of the other product.<sup>12</sup>

Both effects contribute to more elastic input demand, and the suppliers of the merged firm will, consequently, respond to the merger by lowering the prices they charge, which obviously contributes positively to the profitability of a merger. For a large set of parameter values this is enough to turn an unprofitable merger into a profitable one. The only case where a merger is not profitable in a setting with plant-specific input suppliers is when the input supplier has very strong preferences for sales. For instance, a highly employment-oriented trade union would imply that wages are close

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<sup>10</sup> There is a comparatively large literature on international unionised oligopoly, see, e.g., Naylor (1998) and Lommerud et al. (2003). In much of this literature the degree of bargaining centralisation is not very important. This changes, however, once the possibility of mergers is introduced.

<sup>11</sup> The causal link between corporate and trade union mergers is identified in several empirical studies (e.g., Buchanan, 1974, 1981; Chitayat, 1979). See also Geroski and Knight (1984).

<sup>12</sup> The potential for replacement depends on the substitutability between the products. In the limit with perfect substitutes there is a one-to-one relationship, while at the other extreme – when products are independent in demand – there is no replacement potential at all.

to the competitive level initially, so that a merger has only a limited effect on wages.

A downstream merger will also influence the elasticity of input demand for the input supplier linked to the non-participating firm, implying that also the outsider's input price will change. However, we show that the merging firm's input prices are always lower than the non-merging firm's input price. This explains why the free-rider paradox can be solved by introducing endogenous input prices. The exception is, again, the case of highly sales-oriented input suppliers. In this case, the merger has only limited effects on input prices, and the traditional result about merger in Cournot oligopoly applies.

If the input suppliers are firm- rather than plant-specific, our results are reversed. In this case, a merger implies a higher concentration also in the upstream market, which reduces the rivalry between the input suppliers. A merger consequently results in higher input prices, and more so for the merging firms than for the non-merging firm. Not surprisingly, a merger is now less profitable than in the case with exogenous input prices. In this case, a merger is unprofitable under Cournot competition unless the products are highly differentiated and the input suppliers are highly sales oriented. Since input prices increase more for the merging firms, an outsider earns more from a merger than a participant. Thus, the traditional result in the literature is restored in this respect.

We also apply our model to endogenous merger formation. A firm can merge either with another domestic firm or with a foreign firm. Given that the input suppliers are trade unions, we argue that a domestic downstream merger may lead to union merger as well, whereas a merger between a domestic and a foreign firm would not lead to such a union merger. By applying the approach introduced in [Horn and Persson \(2001a\)](#) we show that for a large set of parameter values the equilibrium market structure is cross-border merger. The reason is that such a merger would reduce rents among the input suppliers, while a domestic merger would have the opposite effect.

The paper is organised as follows. In the next section, we present the model with a benchmark for comparison. In Section 3, we investigate downstream merger with plant-specific input suppliers, while we in Section 4 analyse how our results change if we have either firm- or industry-specific input suppliers. In Section 5, we apply the model to endogenous merger formation, and in Section 6 we discuss some extensions of our model. We offer some concluding remarks in Section 7.

## 2. Some preliminaries

Consider an oligopoly industry that consists of three firms, each producing one brand of a differentiated product. Firm  $i$  produces brand  $i$  in quantity  $q_i$ . There is no entry or threat of entry, and firms compete in Cournot fashion. For the moment we assume that firms 1 and 2 are the merger candidates. Later on, we allow for endogenous merger formation. We assume that the merged firm continues to produce two brands (1 and 2), making it 'larger' than either of the pre-merger firms. The outsider (firm 3) continues

to produce one brand (3). As a benchmark for comparison, we start out by considering the case of exogenous input prices.

### 2.1. A benchmark

Demand for the differentiated product is characterised by a symmetric demand system, where the inverse demand function for brand 1 is given by

$$p_1 = 1 - q_1 - b(q_2 + q_3) \quad (1)$$

with a corresponding demand structure for the other brands. The parameter  $b \in (0, 1)$  is a measure of substitutability in demand. If  $b \rightarrow 0$  the brands are regarded as (almost) unrelated, whereas  $b \rightarrow 1$  corresponds to the case of (almost) homogeneous goods.

There is only one factor of production, and one unit of input is supplied to the downstream firm at a price  $w$ . We assume homogeneous inputs and identical technologies, so the only factors that tie a certain brand to a firm are patent rights or sunk marketing investments.

We adopt a very simple linear production function, given by

$$q_i = l_i, \quad (2)$$

where  $q_i$  is total quantity produced (of brand  $i$ ) by firm  $i$ , and  $l_i$  is the total amount of input employed by firm  $i$ . In this case, output and input are equivalent.

As a benchmark for later comparison, consider the following result.

**Lemma 1.** *If input prices are exogenous and equal across firms, a downstream merger is profitable if  $b < 0.55$ , and more profitable for the outsider than for a participant.*

**Proof.** Results follow directly from Lommerud and Sørgaard (1997).  $\square$

An outsider's best response to a reduction in sales by the merging firm is to *increase* its sales, thereby reducing the profitability of a merger. The effect of the outsiders' response may dominate so that a merger is unprofitable. However, each outsider's response is dampened if products are differentiated. This explains why a merger can be profitable under Cournot competition if products are sufficiently differentiated.<sup>13</sup>

Irrespective of the nature of competition, the outsider will be a free-rider on the merger. It will experience higher prices *and* higher sales, and will therefore gain more from the merger, compared with the insiders.

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<sup>13</sup>Note that the benchmark for our analysis is *not* a Salant et al. (1983) type of model, where merger only leads to one firm disappearing, but a Lommerud and Sørgaard (1997) type of model where a merged firm is 'larger' than other firms because it now controls two brands. There is a close parallel to Baye et al. (1996), where keeping a divisionalised structure, for example after a merger, plays much the same role as keeping 'brands' in our previous model. Another related model is found in Deneckere and Davidson (1985), where the merged firm has two subsidiaries each selling its own brand. In contrast to our basic model, though, firms compete in prices (Bertrand).

## 2.2. The upstream market

We model the upstream market in such a way that input suppliers can be interpreted as either traditional profit maximising firms, or as trade unions which maximise union welfare. The most convenient way is to model the input supplier as a trade union, and then treat the profit maximising firm as a special version of the utility maximising trade union. For the moment then, let us consider the trade union. We assume that wages are unilaterally set by monopoly unions.<sup>14</sup> They are characterised by identical Stone–Geary utility functions, given by

$$U_i = (w_i - \bar{w})^\theta (l_i)^{1-\theta}, \quad (3)$$

where the parameter  $\theta \in \langle 0, 1 \rangle$  captures the relative importance of wages and employment to the unions.<sup>15</sup> The reservation wage,  $\bar{w}$ , is equal to the wage that could be earned in the competitive sector of the economy. For simplicity,  $\bar{w}$  will be set equal to zero.

Now it is easily seen that, with  $\bar{w} = 0$ , a profit maximising input supplier would be analogous to a union that maximises rents. Further, setting  $\theta = \frac{1}{2}$ , we have a maximisation problem that is equivalent to the one facing profit maximising upstream firms that are allowed to set the prices of the input they deliver to downstream firms. When  $\theta \rightarrow 0$ , this means that the upstream input suppliers only care about sales/employment. This approximates the situation one would get if the input supplier is a price taker at a competitively given price.

The structure of the upstream market is assumed to be exogenously given.<sup>16</sup> Our main focus is directed towards the case which we find most interesting, namely that of plant-specific input supply, in which input suppliers are unable to coordinate their prices across different plants. This structure might be the natural one when the input suppliers are upstream, profit maximising firms, since there are no institutional mechanisms implying that a downstream merger should trigger a merger between input suppliers. In addition, in markets where firms are located in different countries, there are obviously both geographical and cultural obstacles to input supply cooperation. In particular, whereas international merger is a highly prevalent phenomenon among firms, we hardly ever observe a formal cooperation between trade unions across borders.<sup>17</sup> One main reason is probably that capital is highly mobile between countries, whereas labour is generally not.

With domestic mergers, though, a natural modelling approach might in some cases be to assume firm-specific input suppliers. For example, trade unions are typically

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<sup>14</sup> As pointed out by, e.g. Dowrick (1989), this can be viewed as a limiting case of the wage-bargaining union, where the union has all the bargaining strength.

<sup>15</sup>  $\theta$  can be viewed as a measure of labour market distortion caused by unions. When  $\theta \rightarrow 0$  the wage approaches the competitive level.  $\theta$  is assumed to be equal for all unions.

<sup>16</sup> The observation of great variation in the organisation of upstream markets – for example trade union structure – across different countries and industries indicates the importance of various institutional determinants of the organisation of input suppliers.

<sup>17</sup> In 1999, the share of all mergers and acquisitions, in terms of value, that was cross-border reached nearly 31% (UNCTAD, 2000).

organised within a firm.<sup>18</sup> A downstream merger would then naturally lead to union merger as well. Moreover, it turns out that the merged firms' input suppliers are worse off following a downstream merger. It is then natural also to investigate the case where a downstream merger automatically is followed by an upstream merger which is captured in the model with firm-specific input suppliers.

Since a merger is a long-term commitment, it is natural for the merger candidates to anticipate the input suppliers' response to a downstream merger. Accordingly, we let the merger decision be taken at the first stage of the game. Moreover, we would expect the input suppliers to anticipate how their price setting affects the price setting in the downstream market. These assumptions imply the following sequence of moves:

*Stage 1:* Firms 1 and 2 decide whether or not to merge.

*Stage 2:* The input suppliers set input prices.

*Stage 3:* The downstream firms set quantities.

### 3. Plant-specific input suppliers

With plant-specific input suppliers, input prices are determined at plant level. The decision of whether or not to merge, is assumed to be based on a payoff comparison with the no-merger benchmark equilibrium. In the no-merger game, firm  $i$  chooses  $l_i$  to maximise

$$\pi_i = (p_i - w_i)l_i, \quad (4)$$

where  $w_i$  is the input price set by firm  $i$ 's input supplier, which maximises

$$U_i = (w_i)^\theta (l_i)^{1-\theta}. \quad (5)$$

In the *post-merger* game, the merged firm chooses  $l_1$  and  $l_2$  to maximise

$$\pi_m = (p_1 - w_1)l_1 + (p_2 - w_2)l_2, \quad (6)$$

where  $w_1$  and  $w_2$  are the input prices set by the input suppliers at plants 1 and 2, respectively. These input suppliers set their prices simultaneously, and non-cooperatively, by maximising

$$U_1 = (w_1)^\theta (l_1)^{1-\theta} \quad (7)$$

and

$$U_2 = (w_2)^\theta (l_2)^{1-\theta}. \quad (8)$$

Regarding the input price response to a merger, we have the following result:<sup>19</sup>

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<sup>18</sup> Unions are not firm-specific in all countries. In countries with very decentralised bargaining structures, as the US and the UK (to the extent that these still are unionised countries), this might perhaps best be represented as plant-specific unionism, especially when there is a substantial product differentiation among the divisions in a merged entity. The recent strike at Boeing, following the merger with McDonnell Douglas, can perhaps best be interpreted as a plant-specific union struggling, after a merger, to avoid cut-backs in employment at precisely their own plant.

<sup>19</sup> All remaining proofs are presented in Appendix B. Regarding notation, subscript  $i$  refers to the symmetric no-merger outcome, whereas all other subscripts refer to the post-merger outcome.



**Lemma 2.**

- (i)  $w_3 > w_i$  if  $\theta < \frac{1}{2}$  or  $b$  is sufficiently low.
- (ii)  $w_i > w_1 = w_2$ .
- (iii)  $w_3 > w_1 = w_2$ .

The merging firms' input prices fall, while the input price set by the outsider's input supplier will increase *or* decrease, depending on the degree of product differentiation, and union preferences in the case of trade unions. Importantly, though, the merged firm always faces lower input prices than the outsider.

The intuition behind these results can be traced by considering the input suppliers' maximisation problem in more detail. The first-order condition for input supplier  $i$  can be expressed as

$$\eta_i = \frac{\theta}{1 - \theta}, \quad (9)$$

where  $\eta_i$  is the price elasticity of input demand for firm  $i$ , given by

$$\eta_i = - \frac{\partial l_i(w_i, \mathbf{w}_{-i})}{\partial w_i} \frac{w_i}{l_i(w_i, \mathbf{w}_{-i})}. \quad (10)$$

Given the input prices set by other input suppliers,  $\mathbf{w}_{-i}$ , supplier  $i$  will set a price  $w_i$  that equates the perceived input demand elasticity with its relative preferences for prices over total sales. By setting an input price, the input supplier in effect chooses a price–quantity combination on the relevant input demand schedule. Given the preferences, input demand elasticity governs optimal behaviour.

A merger in the downstream market will lead to a change in input prices only if the elasticity  $\eta_i$  is changed as a result of the merger. From (10) we see that the price elasticity of input demand depends on the demand schedule  $l_i(w_i, \mathbf{w}_{-i})$  in two different ways.

First, there is an effect through changes in the slope of the demand curve. If the demand for input  $i$  becomes more (less) responsive to price changes, i.e. if  $|\partial l_i / \partial w_i|$  increases (decreases), this will, *ceteris paribus*, make input demand more (less) elastic which leads to a reduction (increase) in the price set by supplier  $i$ .

Second, there is a demand shifting effect. For a given set of input prices, an increase (decrease) in demand for input  $i$  will make the demand facing supplier  $i$  less (more) elastic. *Ceteris paribus*, this leads supplier  $i$  to set a higher (lower) input price.

Let us start out by investigating the first effect. From the input demand functions of the *pre-merger* game (see Appendix A) we have that

$$- \frac{\partial l_i(\mathbf{w}, b)}{\partial w_i} = \frac{2 + b}{2(2 - b)(1 + b)}. \quad (11)$$

A downstream merger gives rise to asymmetric input demand in the industry, and from the *post-merger* input demand functions we can derive

$$- \frac{\partial l_1(\mathbf{w}, b)}{\partial w_1} = - \frac{\partial l_2(\mathbf{w}, b)}{\partial w_2} = \frac{(4 - b^2)}{4(2 + 2b - b^2)(1 - b)}, \quad (12)$$

$$-\frac{\partial l_3(\mathbf{w}, b)}{\partial w_3} = \frac{(1+b)}{(2+2b-b^2)}. \quad (13)$$

Comparing (11) and (12) we find that

$$-\frac{\partial l_1(\mathbf{w}, b)}{\partial w_1} - \left( -\frac{\partial l_i(\mathbf{w}, b)}{\partial w_i} \right) = \frac{b^2(2+b)(3-b)}{4(2+2b-b^2)(1-b)(2-b)(1+b)} > 0.$$

As a result of the downstream merger, the input demand facing a supplier of one of the merging firms becomes more price responsive. *Ceteris paribus*, this leads to an increase in the elasticities  $\eta_1$  and  $\eta_2$  which lowers the optimal input prices set by the suppliers of the merger participants. This effect is due to the fact that the merged firm is able to shift production between its two plants, making the input demand more responsive to input price differentials between the two suppliers of the merged firm. The strength of this effect depends on the substitutability in demand of the final goods. A lower degree of product differentiation implies that the merger-induced competition between the input suppliers intensifies. In the extreme case where products are homogeneous, there is no scope for input price differentials, since the merged firm in that case will produce only at the low-cost plant. In this case, both input suppliers are forced to set prices at the reservation level.

The demand shifting effect is also present. For a given wage vector  $\mathbf{w}$ , a downstream merger implies a reduction of output, and thus a reduction of input demand, from the merged firm. This is due to the familiar effect of a merger, where the merger participants coordinates their production volumes in order to internalise a negative externality. *Ceteris paribus*, this also leads to an increase in  $\eta_1$  and  $\eta_2$ , as seen from (10), implying lower input prices for the merged firm. Since both effects pull in the same direction, we will always observe lower input prices after a merger in an industry with plant-specific input suppliers.

At least for relatively high values of  $b$ , though, the first effect (more price-responsive input demand) is clearly the important one. This is seen most clearly by considering the limit case of homogeneous products. From (12) we see that  $b \rightarrow 1$  implies  $-\partial l_1/\partial w_1 = -\partial l_2/\partial w_2 \rightarrow \infty$ . Thus, the suppliers of the merged firm face perfectly elastic demand for their inputs when the final products are homogeneous.

We now turn to study the effect of a downstream merger on the input price of the *outside* firm. This can be analysed in a similar way. Comparing (11) and (13) we find that

$$-\frac{\partial l_3(\mathbf{w}, b)}{\partial w_3} - \left( -\frac{\partial l_i(\mathbf{w}, b)}{\partial w_i} \right) = \frac{-b^3}{2(2+2b-b^2)(2-b)(1+b)} < 0.$$

The input demand facing the supplier of the outside firm becomes *less* price responsive as a result of the merger. *Ceteris paribus*, this leads to a decrease in  $\eta_3$ , which raises the optimal input price set by supplier 3. This follows from *reduced product market competition* due to the merger. A more concentrated downstream industry means that the market share of a non-participating firm is less responsive to a change in the

firm's production costs, which implies that input demand is less responsive to changes in input prices.<sup>20</sup>

The initial demand shifting effect goes in the same direction. For a given set of input prices, the optimal response to the merger is for the outside firm to expand output which implies a decrease in  $\eta_3$ . However, this is not the whole story. The competition between input suppliers causes additional strategic responses that could overturn the initial demand shifting effect for the outside firm. Since input prices are strategic complements, the incentive to set a higher price by the supplier to the outside firm is moderated by the input price reduction for the merged firm, and vice versa. However, because of the post-merger asymmetry – with incentives for input price responses being larger for the suppliers to the merged firm – this effect is clearly more pronounced for the outside firm. Consequently, if the input price reduction for the merged firm is sufficiently large, the strategic complementarity in input price setting could cause a reduction of input prices also for the outside firm, compared with the no-merger equilibrium. From Lemma 2, we see that this will be the case if  $\theta$  and  $b$  are sufficiently high. This confirms the intuition: the degree of strategic complementarity in input prices is increasing in  $\theta$ , whereas a large value of  $b$  implies that the incentives for input price reductions are strong for the suppliers to the merged firm.<sup>21</sup>

Having established the effect of a downstream merger on input prices set by plant-specific upstream suppliers, we are now ready to state the following result about the profitability of such a merger.

**Proposition 1.** *With plant-specific input suppliers, a merger is (i) always profitable for the participants unless  $b > 0.55$  and  $\theta$  is close to zero, and (ii) more profitable for a participant than for the outsider unless  $\theta$  is very low.*

We see from Proposition 1 that the results in the received literature – referred to in Lemma 1 – are reproduced when  $\theta$  approaches zero.<sup>22</sup> As already noted, in this case an input supplier (trade union) only cares about sales (employment). Consequently, a price (wage) close to the reservation price (wage) results both before and after the merger. We are in fact close to what the situation would have been with an input supplier (trade union) without market power. In this case, a merger (in the limit) has no effect on input prices, and it is profitable only if the products are sufficiently differentiated ( $b < 0.55$ ).

If input suppliers are profit maximising firms – the case of  $\theta = \frac{1}{2}$  – we see from the proposition that a merger is always profitable for the merging firms, and it is always more beneficial to participate in the merger, rather than being an outsider. Obviously, the driving force is the input price changes reported in Lemma 1. The merged firm

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<sup>20</sup> This effect is in line with findings in related union-oligopoly models, where input prices are wages (see e.g. Dowrick, 1989).

<sup>21</sup> From the first-order conditions for optimal input prices it is easily confirmed that  $\partial^2 w_i(\mathbf{w}_j, b, \theta) / \partial w_j \partial \theta > 0$ ,  $i \neq j$ .

<sup>22</sup> This is illustrated in Fig. 1, where  $\theta = 0$  can be interpreted as the case with exogenous input prices. We see that there is a cutoff point at  $b = 0.55$ . For  $b < 0.55$ , a merger is profitable.

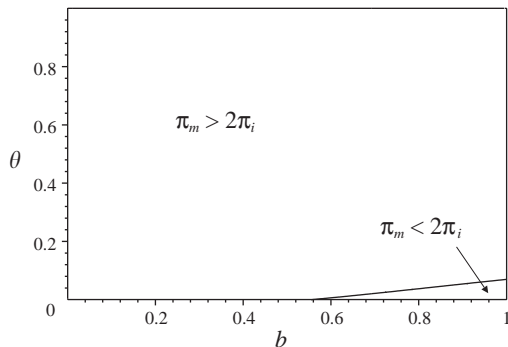


Fig. 1. Merger profitability with plant-specific input suppliers.

will face lower input prices, and these prices are lower than the corresponding input price for the outside firm.

If the input suppliers are trade unions, we see from the proposition that it matters whether or not they are employment oriented. If an input-supplying firm is not a profit maximiser, it matters correspondingly how it weighs a higher price against lower sales. Here, we concentrate on the trade union example. We find the existence of a hump-shaped relationship between  $\theta$  and post-merger wage responses.<sup>23</sup> This, in turn, determines a similar relationship between  $\theta$  and merger profitability. For low levels of  $\theta$ , pre-merger input prices are close to the competitive level, and there is not much room for wage reductions. As  $\theta$  increases, the larger is the merger-induced wage reduction, increasing the profitability of the merger. However, for very high values of  $\theta$ , the unions have a strong preference for high wages, and even though there are considerable room for wage reductions, a merger will only trigger small wage adjustments. Nevertheless, for values of  $\theta$  close to 1, even a marginal reduction in post-merger wages will make a merger profitable for the participants.

Product differentiation triggers two opposing forces in our model, and the strength of these forces are determined by the degree of differentiation. On the one hand, a lower degree of product differentiation makes the outsider's aggressive response stronger, which tends to make a merger less profitable (cf. Lemma 1). On the other hand, if products are close substitutes, the degree of competition between input suppliers is fierce, making a merger highly effective as a disciplinary device towards the input suppliers. From Proposition 1 it is apparent that these two effects tend towards cancelling each other out, making a merger profitable for every degree of product differentiation, the exception being highly sales (employment) oriented input suppliers (unions). As shown in Fig. 1, a merger is profitable even if products are (almost) identical as long as  $\theta$  is above a certain threshold level.

<sup>23</sup> This is quite natural. A change in wages takes place if a merger changes the trade-off between wages and employment. This trade-off is of importance when both wages and employment matter for the trade unions, which is especially the case for medium values of  $\theta$ . Equilibrium input prices and profits are provided in Appendix A.

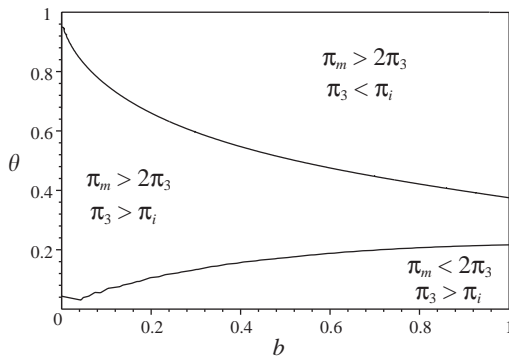


Fig. 2. Insider versus outsider profitability of a merger when input suppliers are plant-specific.

From Lemma 2 we know that the input price reduction following a merger is always larger for the merged firm, compared with the outsider. This helps explain the result illustrated in Fig. 2. A participant gains more from a merger, compared with the non-participant. This is always true for the profit maximising input supplier, and true for the case of trade unions as long as the unions are sufficiently wage oriented. Furthermore, from Fig. 2 we also see that if  $\theta$  and  $b$  are sufficiently high, a downstream merger will actually harm the outside firm, in terms of profits.

#### 4. Other types of input supply structures

As demonstrated in the previous section, a downstream merger may lead to a reduction in upstream rents when input suppliers are plant-specific. This suggests that a downstream merger could provide the input suppliers with extra incentives for input price coordination. One way to do so is for the merging downstream firms' input suppliers to merge.<sup>24</sup> In this case, the input suppliers are firm- rather than plant-specific. In this section, we contrast the outcome derived in the previous section for plant-specific input suppliers with the case of firm-specific input suppliers.<sup>25</sup> In addition, we briefly describe the case of a single input supplier for the entire industry.

##### 4.1. Firm-specific input suppliers

If input suppliers are firm-specific, a merger between two or more firms will implicitly lead to a higher degree of centralisation in input price setting, since the merged firm only confronts one input supplier in the post-merger game. In the second stage of the post-merger game, the merged firm chooses  $l_1$  and  $l_2$

<sup>24</sup> Collusion is another way this can be achieved, but this is not further pursued in the present paper. For such an analysis within the context of a unionised international duopoly, see Straume (2002).

<sup>25</sup> See once again the references in footnote 11 about how company mergers in many settings also imply a trade union merger.

to maximise

$$\pi_m = (p_1 - w_m)l_1 + (p_2 - w_m)l_2, \quad (14)$$

where  $w_m$  is the input price set by the merged firm's input supplier, which maximises

$$U_m = (w_m)^\theta (l_1 + l_2)^{1-\theta}. \quad (15)$$

**Lemma 3.**  $w_m > w_3 > w_i$ .

After the merger, equilibrium input prices increase for both the insiders and the outsider, but the merged firm faces a higher input price than the outsider. Comparing with Lemma 2, the results are reversed when we go from plant- to firm-specific input suppliers.

The intuition for the results in Lemma 3 can be developed along the same lines as our discussion of input price responses with plant-specific input suppliers. From the input demand functions in the post-merger game with firm-specific input suppliers (see Appendix A) we can derive

$$-\frac{\partial l_1(\mathbf{w}, b)}{\partial w_m} = -\frac{\partial l_2(\mathbf{w}, b)}{\partial w_m} = \frac{1}{2 + 2b - b^2}, \quad (16)$$

$$-\frac{\partial l_3(\mathbf{w}, b)}{\partial w_3} = \frac{1 + b}{2 + 2b - b^2}. \quad (17)$$

A comparison of (16), (17) and (11) reveals that

$$-\frac{\partial l_1(\mathbf{w}, b)}{\partial w_m} - \left( -\frac{\partial l_i(\mathbf{w}, b)}{\partial w_i} \right) = \frac{-(4 + 2b - b^2)b}{2(2 - b)(1 + b)(2 + 2b - b^2)} < 0,$$

$$-\frac{\partial l_3(\mathbf{w}, b)}{\partial w_3} - \left( -\frac{\partial l_i(\mathbf{w}, b)}{\partial w_i} \right) = \frac{-b^3}{2(2 - b)(1 + b)(2 + 2b - b^2)} < 0.$$

A downstream merger means that input demand becomes less price responsive for all firms. This implies, *ceteris paribus*, a decrease in the input demand elasticity, which provides the input suppliers with an incentive to increase prices. The mechanisms are analogous to the case of the outside firm for plant-specific input suppliers.

The incentives for input price increases are partly mitigated by the demand shifting effects of the merger. The incentives for output reductions by the merged firm should, *ceteris paribus*, lead to lower input prices. We find that this effect is not strong enough to overturn the former effect. In our model, we thus find that a downstream merger leads to increased input prices for all firms if input suppliers are firm-specific.

After the merger, there is an asymmetry between the firms. The merged firm offers two brands while the outsider offers one brand. For a uniform input price in the industry, this would imply that the input price/sales ratio is lower for the merged firm's input supplier. It will then be optimal for the merged firm's input supplier to set a price in

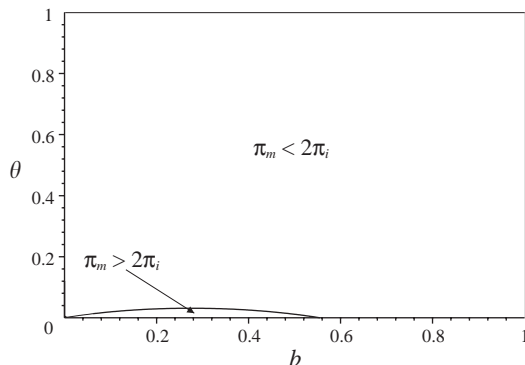


Fig. 3. Merger profitability with firm-specific input suppliers.

excess of the input price facing the outside firm. Consequently, the input price increase due to the merger is larger for the merged firm than for the non-merged firm.

Implications for merger profitability are stated in the following proposition.

**Proposition 2.** *With firm-specific input suppliers, a merger is (i) profitable for the participants only if  $b < 0.55$  and  $\theta$  is close to zero, and (ii) more profitable for the outsider than for a participant.*

In Fig. 3 we have shown the set of parameter values for which the merger is profitable for the participants. We see that except for a few combinations of low  $\theta$  and low  $b$ , a merger is unprofitable. It suggests that if the input suppliers are profit maximising firms, a merger is never profitable in the presence of firm-specific input suppliers. If the input suppliers are trade unions, we have to impose extremely strong assumptions regarding union preferences for a merger to be profitable. This is no surprise, given that a merger triggers an input price increase for the merged firm that is larger than the corresponding input price increase for the outside firm.

Comparing with Fig. 1, we see the importance of the input supply structure. While it is very likely that a merger is profitable with plant-specific input suppliers, it is highly *unlikely* that a corresponding merger in an industry with firm-specific input suppliers is profitable.

Note also from part (ii) of Proposition 2 that, in contrast to our results with plant-specific input suppliers, it is better being the outsider than being a participant in the merger. This is, however, in line with the results in the received literature. Since we know that a merger with exogenous input prices is more profitable for an outsider than for an insider, it is obvious that this conclusion still holds when a merger results in a higher input price increase for the merged firm than for the non-merged firm.

#### 4.2. An industry-specific input supplier

If there are no obstacles to cooperation between the input suppliers, it is obvious that the input suppliers could gain by coordinated behaviour. If input suppliers are

profit maximising firms, anti-trust policy would normally prevent the input suppliers from establishing a cartel or to merge to a monopoly. If the input suppliers are trade unions, on the other hand, there are in many countries no constraints on the cooperation between different trade unions. If all the firms in the industry recruit workers from an integrated labour market with a high degree of worker mobility, we would reasonably expect the workers to be organised in a single encompassing union (cf. [Horn and Wolinsky, 1988b](#)).

It is easily shown that, in this model, an industry-specific input supplier will set the input price

$$w = \theta, \tag{18}$$

regardless of the number of firms in the industry. Thus, a merger would not affect input prices at all.

A downstream merger causes a reduction of total output, which implies a negative shift in the demand for inputs. *Ceteris paribus*, this makes input demand more elastic and should lead to a reduction of the input price. However, it can easily be shown that the slope of the demand curve also changes, causing input demand to become less price responsive. These two effects cancel out, leaving the input price unchanged. It is important to note that this is in fact a fairly general result, and is not dependent on the specific demand system assumed in this model. In a recent paper, [Dhillon and Petrakis \(2002\)](#) show that this result holds for a broad class of industry and demand specifications.

## 5. An application: Domestic versus international merger

A corollary of our model is that international mergers can be more profitable than domestic mergers. This prediction can be explored in greater detail by looking at a more specific set-up. Assume that, pre-merger, firms 1 and 2 are located in a ‘domestic’ country, whereas firm 3 is located in a ‘foreign’ country. To make things simple, we abstract from trade costs and assume that the firms compete in a single market.<sup>26</sup>

In our setting, the difference between a domestic and an international merger can be found in the organisational responses in the upstream market. Let us now interpret input suppliers as trade unions. In line with our previous discussion we assume that a cross-border downstream merger does not lead to a merger between the trade unions of the merging firms, whereas, in the case of a domestic downstream merger, this will indeed be the case.<sup>27</sup>

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<sup>26</sup> This corresponds to the ‘third-market’ model of [Brander and Spencer \(1985\)](#).

<sup>27</sup> There are a few other recent contributions to the analysis of the pattern of cross-border mergers. [Norbäck and Persson \(2002\)](#) study the effects of different liberalisation programs, with an emphasis on a comparison between greenfield investments and cross-border merger. [Horn and Persson \(2001b\)](#) focus on domestic versus cross-border merger, but this is done under the assumption of exogenous production costs. In another related paper, [Straume \(2003\)](#) endogenises production costs by introducing unionised labour, but the focus is here on international merger only, in an industry with both unionised and non-unionised firms. Finally, [Huck and Konrad \(2002\)](#) consider the choice between national and cross-country merger when strategic trade policy possibly could be influenced.



In order to make predictions about merger formation in this particular variant of our model, we will make use of an approach developed by [Horn and Persson \(2001a\)](#), which treats the merger process as a cooperative game of coalition formation, where the players are free to communicate and write binding contracts. Using the terminology of Horn and Persson, we let an ownership structure  $M_i$  be a partition of the set  $N = \{1, 2, 3\}$  of owners (firms) into coalitions. Excluding the possibility of complete monopolisation, there are three possible categories of market structures, with a combined total of four different ownership structures:

1. *The decentralised structure (no merger)*:  $M_n = \{1, 2, 3\}$ .
2. *A domestic merger*:  $M_d = \{(1 + 2), 3\}$ .
3. *A cross-border merger*:  $M_c = \{(1 + 3), 2\}$  and  $M'_c = \{1, (2 + 3)\}$ .

Without going into details about the theoretical foundations, the approach involves a comparison of any two possible ownership structures  $M_i$  and  $M_j$ , where  $M_i$  is said to dominate  $M_j$  ( $M_i \text{ dom } M_j$ ) if the combined profits of the *decisive group* of owners are larger in  $M_i$  than in  $M_j$ . The *decisive group* of owners are the owners that are expected to be able to influence whether  $M_i$  will be formed instead of  $M_j$ , and vice versa.

Which are the *decisive* owners? We do not allow payments between coalition, so owners belonging to *identical coalitions* in the two structures cannot affect whether  $M_j$  will be formed instead of  $M_i$ , but all remaining owners can influence this choice and are thus *decisive*. If they participate in a non-singleton coalition in  $M_j$  that does not exist in  $M_i$ , this coalition requires the consent of all members of the coalition to be formed. Alternatively, if they stand alone in  $M_j$  and thus lose partners by moving from  $M_i$  to  $M_j$ , they can forgo surplus in  $M_i$  in order to prevent  $M_j$  from being formed.<sup>28</sup>

Finally, the solution concept is the *core*. Those structures that are in the core (i.e. the structures that are *undominated*) are defined as *equilibrium ownership structures*. Using this criterion, we are able to state the following.

**Proposition 3.** *The equilibrium market structure implies cross-border merger, unless  $b > 0.55$  and  $\theta$  is close to zero, for which the equilibrium market structure implies no merger.*

Given the previous results regarding the effects of downstream mergers on input prices, this result is quite intuitive. In the model of endogenous merger formation that we use, mergers are conducive to market structures with large industry profits. In our model such market structures are characterised by cross-border merger, since this is a more efficient way to reduce rents among the input suppliers.<sup>29</sup>

<sup>28</sup> See [Horn and Persson \(2001a\)](#) for a formal definition of *decisive owners*.

<sup>29</sup> It can easily be verified that less rents to input suppliers would lead to more profits to downstream firms. This follows directly from (A.3) in Appendix A, where we have that  $\partial \pi_i / \partial \theta < 0$ .

## 6. Extensions

Our basic model is rather stylised, so it is natural to check the robustness of our results. Let us, therefore, explain how results may change when we extend our basic model in three different directions. For more details, see [Lommerud et al. \(2000\)](#).

### 6.1. *Bertrand competition*

We know from the literature that if Bertrand competition prevails in a differentiated products industry, then a merger with exogenous input prices is always profitable. With plant-specific input suppliers, we find that this result is reinforced. More interestingly, we find that – as is the case with Cournot competition and endogenous input prices – an insider can be better off than an outsider as a result of a merger. If the input suppliers are firm-specific, though, a merger can be unprofitable even in a setting with Bertrand competition. The driving force is the input price increase following a merger. Hence, our main results hold also in this extended version of our model. The reason is that the change in input prices following a merger most of all depends on the rivalry between the input suppliers, and the nature of this rivalry – input prices being strategic complements – is independent of the nature of competition in the downstream market.

### 6.2. *Efficient bargaining*

In the basic model we have assumed that the input suppliers unilaterally set the input price while the downstream firms have complete discretion over sales decisions. In the case of trade unions, this is a special case of the right-to-manage model. The union and the firm bargain over the wage while the firm sets employment. In the literature this model is often contrasted with the efficient bargaining model, where the union has the same relative bargaining strength over wage setting as well as employment decisions (and possibly other relevant decision variables). The existing literature suggests that which bargaining game will emerge as the equilibrium outcome depends on the characteristics of the industry in question.<sup>30</sup>

It is then natural to check whether our results still hold if we apply an efficient bargaining model rather than a monopoly union model. We have only investigated the case of plant-specific unions. It turns out that the qualitative results depend on the relative bargaining strength of the players. However, we find that our main results are still valid. A merger can be profitable even in a Cournot setting without any exogenous fixed costs savings, and the insider may earn more from a merger than an outsider. The intuition is that efficient bargaining introduces two additional opposing forces. On the one hand, the unions can extract a share of the potential profit increase following a merger. This tends to make a merger less profitable in a setting with efficient bargaining.

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<sup>30</sup> [Bughin \(1999\)](#) finds that efficient bargaining is the most-likely equilibrium outcome, and even more so under the threat of entry. [Petraakis and Vlassis \(2000\)](#) find that right-to-manage bargaining is the equilibrium outcome if the unions' bargaining power is sufficiently high, while [Espinosa and Rhee \(1989\)](#) find that efficient bargaining may emerge as an equilibrium outcome in infinitely repeated games.

On the other hand, the merged firm will enjoy an improved bargaining position since it can bargain with two different unions.<sup>31</sup> These two opposing forces tend towards cancelling each other out for a large set of parameter values.

### 6.3. Multi-plant mergers

We have shown that the presence of plant-specific input suppliers considerably increases the profitability of a downstream merger between two single-plant firms. We have also argued that this might be particularly relevant for cross-border mergers. The profitability of a merger in the plant-specific case is caused by the merger-induced decrease in input prices which is strongly related to the merged firm's ability to re-allocate production between different plants. A natural question is whether our results are also valid in the case of mergers involving multi-plant firms. This can be analysed by considering the following example.

Assume that four brands are produced by three different firms. One firm is a multi-plant (and multi-product) firm, whereas the two other firms are single-plant producers. The effects of different types of downstream merger on input prices and merger profitability in this case are calculated in Appendix C. In order to improve the analytical tractability, we have considered the special case of rent-maximising input suppliers, i.e.  $\theta = \frac{1}{2}$ .

Regarding the input price responses to a downstream merger, we find that our previous results are confirmed. Whether we consider a merger between a two- and a single-plant firm, or a merger between two single-plant firms, input prices will decrease for merger participants and increase for non-participants as long as  $b < 1$ . Regarding merger profitability, we find that both types of merger are always profitable for  $\theta = \frac{1}{2}$ .

However, this kind of set-up also raises the issue of which kind of merger is more likely to be undertaken. Using the endogenous merger model of Section 5, and excluding the possibility of full monopolisation, we find that a merger between a two- and a single-plant firm is the equilibrium outcome if products are sufficiently differentiated. In this case, the merger process is mainly motivated by a quest for increased market power, and the owners can maximise total industry profits by forming a highly concentrated market structure. Since the outside firm will face increased input prices post-merger, this market structure implies a near-monopoly position for the merger participants.

On the other hand, if products are sufficiently close substitutes, the merger process is mainly driven by cost-saving motivations, since production costs can be substantially reduced by eliminating all single-plant firms from the industry. Consequently, the equilibrium outcome is a merger between the two single-plant firms. In other words, the model predicts a positive correlation between the degree of product differentiation and the degree of asymmetry in the market structure. Numerical simulations confirm that this is a general tendency also for  $\theta \neq \frac{1}{2}$ .

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<sup>31</sup> See also Davidson (1988).

## 7. Conclusions

In this paper, we have shown that the organisation of the upstream market is decisive for input price responses to a downstream merger, and hence for the profitability of such a merger. While plant-specific input suppliers tend to increase the profitability of a merger, and may even make it more profitable to take part in a merger than being an outsider, the results are reversed in a setting with firm-specific input suppliers.

Our results suggest that downstream firms considering to merge in an industry with upstream market power should be concerned about how the input suppliers respond to a possible merger. The existence of plant-specific input suppliers is obviously an argument in favour of a merger, from the viewpoint of downstream firms. The reason is that a downstream merger triggers stronger competition between the input suppliers of the merging firms, thereby reducing the rent captured by the input suppliers. However, the argument in favour of downstream merger is also an argument in favour of merger between the input suppliers. By doing so they can prevent the reduction in their own rent. The plant-specific input suppliers are then not plant-specific after the merger, but instead de facto firm-specific input suppliers. The downstream firms should anticipate such an outcome. We extend our model to an endogenous merger model of international versus national mergers to take this into account. We show that the equilibrium market structure might be cross-border merger. The reason is that merger between input suppliers is less likely in cross-border mergers. If so, the downstream firms merge across borders to reduce the rent extracted by the input suppliers.

Finally, we think our results could guide future empirical research on the wage effects of mergers. The results in the received empirical literature are mixed. Some find support for a wage increase following a merger, some for a wage cut, while others find no effect at all.<sup>32</sup> If one in the same data material combines mergers with plant- and firm-specific unions, one might find that mergers have – if any – only a limited effect on wages. According to our results, the underlying truth could be that some mergers result in wage drops while others give wage rises. A proper empirical test should then start with a detailed study of the union structure which, in turn, should lead to a discrimination in the data material between industries with plant- and firm-specific unions.

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<sup>32</sup> Cremieux and Van Audenrode (1996) and Peoples et al. (1993) find support for a wage cut following a merger, while McGuckin et al. (1995) find the opposite result. Hekmat (1995) finds no evidence of any link between mergers and wages, while Gokhale et al. (1995) find no or only limited evidence of a link between takeovers and wages.

of Economics at the University of California, Santa Barbara, whose hospitality is gratefully acknowledged.

## Appendix A. Equilibrium outcomes

### A.1. No merger

The first-order conditions of the downstream firms' profit-maximising problems determine the following input demand function for firm  $i$ :

$$l_i(\mathbf{w}, b) = \frac{2 - b - (2 + b)w_i + b \left( \sum_{j=1}^3 w_j - w_i \right)}{2(2 - b)(1 + b)}. \quad (\text{A.1})$$

Using (A.1) to derive input prices and profits in the symmetric Nash equilibrium, we find that these are given by

$$w_i = \frac{\theta(2 - b)}{2 + b - 2\theta b}, \quad (\text{A.2})$$

$$\pi_i = \frac{(2 + b)^2(1 - \theta)^2}{4(1 + b)^2(2 + b - 2\theta b)^2}. \quad (\text{A.3})$$

### A.2. Plant-specific input suppliers

The input demand functions in the post-merger game are given by

$$l_1(\mathbf{w}, b) = \frac{2(1 - b)(2 - b) - (4 - b^2)w_1 + b(4 - b)w_2 + 2b(1 - b)w_3}{4(2 + 2b - b^2)(1 - b)}, \quad (\text{A.4})$$

$$l_2(\mathbf{w}, b) = \frac{2(1 - b)(2 - b) - (4 - b^2)w_2 + b(4 - b)w_1 + 2b(1 - b)w_3}{4(2 + 2b - b^2)(1 - b)}, \quad (\text{A.5})$$

$$l_3(\mathbf{w}, b) = \frac{2 - 2(1 + b)w_3 + b(w_1 + w_2)}{2(2 + 2b - b^2)}. \quad (\text{A.6})$$

Using (A.4)–(A.6), we derive the following input prices and profits in the asymmetric post-merger Nash equilibrium:

$$w_1 = w_2 = \frac{2\theta(2 - b + \theta b - 2b^2 - \theta b^2 + b^3)}{\eta}, \quad (\text{A.7})$$

$$w_3 = \frac{\theta(4 - b^2 - 5\theta b^2 + 2\theta b^3)}{\eta}, \quad (\text{A.8})$$

$$\pi_m = \frac{(1 - \theta)^2(2 - b)^2(2 + b)^2(b + 1)(2 + b + \theta b - b^2)^2}{2(2 + 2b - b^2)^2\eta^2}, \quad (\text{A.9})$$

$$\pi_3 = \frac{(1-\theta)^2(1+b)^2(4-b^2-5\theta b^2+2\theta b^3)^2}{(2+2b-b^2)^2\eta^2}, \quad (\text{A.10})$$

where

$$\eta = 4 + 4b - 4\theta b - b^2 - 3\theta b^2 - 2\theta^2 b^2 - b^3 + \theta b^3 + 2\theta^2 b^3 > 0.$$

### A.3. Firm-specific input suppliers

The input demand functions in the post-merger game are given by

$$l_1(\mathbf{w}, b) = l_2(\mathbf{w}, b) = \frac{2(1-w_m) - b(1-w_3)}{2(2+2b-b^2)}, \quad (\text{A.11})$$

$$l_3(\mathbf{w}, b) = \frac{1 - (1+b)w_3 + bw_m}{2+2b-b^2}. \quad (\text{A.12})$$

Input prices and profits in the asymmetric post-merger Nash equilibrium are given by

$$w_m = \frac{\theta(2+b+\theta b-b^2)}{2+2b-\theta^2 b^2}, \quad (\text{A.13})$$

$$w_3 = \frac{\theta(2+2\theta b-\theta b^2)}{2+2b-\theta^2 b^2}, \quad (\text{A.14})$$

$$\pi_m = \frac{2(1-\theta)^2(1+b)(2+b+\theta b-b^2)^2}{(2+2b-\theta^2 b^2)^2(2+2b-b^2)^2}, \quad (\text{A.15})$$

$$\pi_3 = \frac{(1-\theta)^2(1+b)^2(2+2\theta b-\theta b^2)^2}{(2+2b-\theta^2 b^2)^2(2+2b-b^2)^2}. \quad (\text{A.16})$$

## Appendix B. Proofs

**Proof of Lemma 2.** (i) From (A.2) and (A.8),  $w_3 > w_i$  if

$$\frac{\theta b^2(1-\theta)(4-4\theta-4\theta b+2\theta b^2-b^2)}{\eta(2+b-2\theta b)} > 0.$$

The denominator is obviously positive for  $\theta \in (0, 1)$ ,  $b \in (0, 1)$ . The numerator is positive if  $(4-4\theta-4\theta b+2\theta b^2-b^2) > 0$ . Rearranging yields  $4(1-\theta(1+b))+b^2(2\theta-1) > 0$ . We see that this condition holds if  $\theta < \frac{1}{2}$  or if  $b$  is sufficiently low.

(ii) From (A.2) and (A.7),  $w_i > w_1 = w_2$  reduces to

$$\frac{\theta b(1-\theta)(4+4b-b^2-b^3-2\theta b^2(1-b))}{(2+b-2\theta b)\eta} > 0,$$

which holds for  $\theta \in (0, 1)$ ,  $b \in (0, 1)$ .

(iii) From (A.7) and (A.8),  $w_3 > w_1 = w_2$  reduces to

$$\frac{\theta b(2b+1)(2-b)(1-\theta)}{\eta} > 0,$$

which is true for  $\theta \in \langle 0, 1 \rangle$ ,  $b \in \langle 0, 1 \rangle$ .  $\square$

**Proof of Proposition 1.** (i) A merger is profitable if  $\pi_m - 2\pi_i > 0$ . From Lemma 1 we know that this is true if  $\theta = 0$  and  $b < 0.55$ . From Lemma 2 it must be the case that this is also true for  $b < 0.55$  and  $\theta > 0$ . For  $b > 0.55$  we know (from Lemma 1) that  $\pi_m - 2\pi_i < 0$  if  $\theta = 0$ . Setting  $b = 1$ , we can from (A.3) and (A.9) find that  $\pi_m - 2\pi_i > 0$  if

$$\frac{-9 + 138\theta - 127\theta^2 + 8\theta^3(1 + \theta)}{72(2\theta - 3)^2} > 0.$$

This condition is met if  $\theta > 0.07$ . Then we know that for  $\theta \in \langle 0, 1 \rangle$  and  $b \in \langle 0.55, 1 \rangle$  there are critical values where  $\pi_m = 2\pi_i$ . In Fig. 1 (Section 3) we have plotted the curve where  $\pi_m = 2\pi_i$  in a  $(\theta, b)$ -diagram, using the expressions in (A.3) and (A.9). It follows immediately that  $\pi_m > 2\pi_i$  above the curve.

(ii) A participant earns  $\pi_m/2$  and the non-merging firm  $\pi_3$  in the post-merger equilibrium. We know from Lemma 1 that for  $\theta = 0$ , then  $\pi_m - 2\pi_3 < 0$ . Setting  $b = 1$  and using the expressions reported in (A.3) and (A.10), we have that  $\pi_m - 2\pi_3 < 0$  if  $20\theta - 7\theta^2 > 4$ . This condition is met if  $\theta < 0.21$ . Then we know that for  $\theta \in \langle 0, 1 \rangle$  and  $b \in \langle 0, 1 \rangle$  there are critical values where  $\pi_m - 2\pi_3 = 0$ . In Fig. 2 (Section 3), we have plotted the curve where  $\pi_m = 2\pi_3$  in a  $(\theta, b)$ -diagram, using the expressions in (A.3) and (A.10). Obviously,  $\pi_m > 2\pi_3$  above the curve.  $\square$

**Proof of Lemma 3.** From (A.2), (A.13) and (A.14), and after rearranging,  $w_m > w_3$  reduces to

$$\frac{\theta b(1-b)(1-\theta)}{(2+2b-\theta^2 b^2)} > 0,$$

whereas  $w_3 > w_i$  reduces to

$$\frac{\theta b^2(1-\theta)(2+2\theta-\theta b)}{(2+2b-\theta^2 b^2)(2+b-2\theta b)} > 0.$$

It can easily be seen that both inequalities hold for  $\theta \in \langle 0, 1 \rangle$ ,  $b \in \langle 0, 1 \rangle$ .  $\square$

**Proof of Proposition 2.** (i) We know from Lemma 1 that if  $\theta = 0$ , then  $\pi_m > (<)2\pi_i$  if  $b < (>)0.55$ . From Lemma 3 it must also be the case that  $\pi_m < 2\pi_i$  if  $b > 0.55$  and  $\theta > 0$ . Then we know that there are combinations of  $\theta \in \langle 0, 1 \rangle$  and  $b \in \langle 0, 0.55 \rangle$  such that  $\pi_m = 2\pi_i$ . By using the expressions in (A.3) and (A.15), we find these combinations of  $\theta$  and  $b$ . They are plotted in a  $(\theta, b)$ -diagram in Fig. 3 (Section 4.1). Obviously,  $\pi_m < 2\pi_i$  above the curve shown in Fig. 3.

(ii) We know from Lemma 1 that for exogenous input prices,  $\pi_m < 2\pi_3$ . Given the result in Lemma 3, it is trivial to see that the result in Lemma 1 applies in this case too.  $\square$

**Proof of Proposition 3.** When comparing  $M_d$  and  $M_n$ , the decisive group of owners consists of the merger participants in  $M_d$ . The comparison of equilibrium payoffs in this case coincides with the case of firm-specific input suppliers in Section 4.1. Let  $\pi_i(M_j)$  be the equilibrium profits of firm  $i$  in ownership structure  $M_j$ . From Proposition 2 we know that  $\pi_m(M_d) > 2\pi_i(M_n)$ , implying  $M_d \text{ dom } M_n$ , if  $b < 0.55$  and  $\theta$  is close to zero. For other parameter values, the dominance relation is reversed. Likewise, when comparing  $M_c$  and  $M_n$ , the decisive owners are the merger participants in  $M_c$ . This coincides with the case of plant-specific input suppliers in Section 3, and from Proposition 1 we know that  $\pi_m(M_c) > 2\pi_i(M_n)$ , implying  $M_c \text{ dom } M_n$ , unless  $b > 0.55$  and  $\theta$  is close to zero. For this (small) set of parameter values, the dominance relation is reversed. Finally, when comparing  $M_c$  and  $M_d$ , all three owners are decisive. In this case, we have to compare total industry profits in the two different market structures. This corresponds to a comparison of post-merger industry profits for the case of plant- and firm-specific input suppliers, respectively. Using (A.9), (A.10), (A.15) and (A.16) in Appendix A, we find that  $\sum_{i=1}^3 \pi_i(M_c) > \sum_{i=1}^3 \pi_i(M_d)$ , implying  $M_c \text{ dom } M_d$ , for the entire set of parameter values. Hence,  $M_c$  is undominated unless  $b > 0.55$  and  $\theta$  is close to zero, for which  $M_n$  is undominated.  $\square$

## Appendix C. Multi-plant mergers

Consider an industry with three firms and four brands. Firm A produces two brands, 1 and 2, at different plants, whereas brands 3 and 4 are produced by firms B and C, respectively. Brand  $i$  is produced with input supplied by the plant-specific input supplier  $i$ . Ruling out the possibility of merger-to-monopoly by assumption, we can cover all possible market structures by considering two types of merger: a merger involving the multi-plant firm ( $M_I$ ) and a merger between the two single-plant firms ( $M_{II}$ ).

Extending the symmetrical demand system (1) to four brands, and setting  $\theta = \frac{1}{2}$ , we find equilibrium input prices and profits to be given by the following expressions.

### 1. No merger ( $M_0$ )

$$w_1(M_0) = w_2(M_0) = \frac{(1-b)(2-b)(4+5b-2b^2)}{2(8+6b-10b^2+b^4)}, \quad (\text{C.1})$$

$$w_3(M_0) = w_4(M_0) = \frac{(2-b)(4+2b-5b^2+b^3)}{2(8+6b-10b^2+b^4)}, \quad (\text{C.2})$$

$$\pi_A(M_0) = \frac{(1+b)^3(2-b)^4(4+5b-2b^2)^2}{8(2+3b-b^2)^2(8+6b-10b^2+b^4)^2}, \quad (\text{C.3})$$

$$\pi_B(M_0) = \pi_C(M_0) = \frac{(2+2b-b^2)^2(4+2b-5b^2+b^3)^2}{4(2+3b-b^2)^2(8+6b-10b^2+b^4)^2}. \quad (\text{C.4})$$



## 2. Merger between firms A and B ( $M_I$ )

$$w_1(M_I) = w_2(M_I) = w_3(M_I) = \frac{(1-b)(8+14b-7b^2)}{16+32b-7b^2-5b^3}, \quad (\text{C.5})$$

$$w_4(M_I) = \frac{(2-b)(4-b)(1+2b)}{(16+32b-7b^2-5b^3)}, \quad (\text{C.6})$$

$$\pi_A(M_I) + \pi_B(M_I) = \frac{3(1+2b)(2+2b-b^2)^2(8+14b-7b^2)^2}{(4+8b-3b^2)^2(16+32b-7b^2-5b^3)^2}, \quad (\text{C.7})$$

$$\pi_C(M_I) = \frac{4(1+2b)^2(8+10b-11b^2+2b^3)^2}{(4+8b-3b^2)^2(16+32b-7b^2-5b^3)^2}. \quad (\text{C.8})$$

## 3. Merger between firms B and C ( $M_{II}$ )

$$w_1(M_{II}) = w_2(M_{II}) = w_3(M_{II}) = w_4(M_{II}) = \frac{2(1-b)}{(4-b^2)}, \quad (\text{C.9})$$

$$\pi_A(M_{II}) = \pi_B(M_{II}) + \pi_C(M_{II}) = \frac{(1+b)(2+2b-b^2)^2}{2(1+2b)^2(4-b^2)^2}. \quad (\text{C.10})$$

We see that the input price responses of a merger follow a general pattern. Input prices decrease for merger participants and increase for non-participants. Comparing (C.1), (C.2) and (C.5), (C.6) we find that  $w_1(M_I) - w_1(M_0) < 0$ ,  $w_3(M_I) - w_3(M_0) < 0$  and  $w_4(M_I) - w_4(M_0) > 0$  for all  $b \in (0, 1)$ . Likewise, comparing (C.1), (C.2) and (C.9) we have that  $w_1(M_{II}) - w_1(M_0) > 0$  and  $w_3(M_{II}) - w_3(M_0) < 0$  for all  $b \in (0, 1)$ .

Regarding merger profitability, a comparison of equilibrium profits in the different market structures show that  $\pi_A(M_I) + \pi_B(M_I) > \pi_A(M_0) + \pi_B(M_0)$  and  $\pi_B(M_{II}) + \pi_C(M_{II}) > \pi_B(M_0) + \pi_C(M_0)$  for all  $b \in (0, 1)$ . Thus, both types of merger are always profitable. Using the endogenous merger model presented in Section 5, the equilibrium market structure is in this case determined by a comparison of total industry profits. Comparing (C.7), (C.8) and (C.10) we find that  $\sum \pi(M_{II}) > (<) \sum \pi(M_I)$  iff  $b > (<) 0.75$ . Thus, the model predicts a merger between the two single-plant firms if products are sufficiently close substitutes, and a merger involving the multi-plant firm otherwise.

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