International Trade in Bilateral Oligopoly*
(Work in Slow Progress)

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Abstract

In many intermediate goods markets, prices are negotiated between buyers and sellers. Being able to appropriate a share of their partner’s efficiency, all firms prefer trading with efficient foreign firms rather than inefficient domestic firms (if the efficiency differential is large in comparison to transportation costs). Thus, independent of nationality, the most efficient firms may trade with each other, the second most with each other, and so on. With two-sided market power and heterogenous firms, there is trade both in accordance with comparative advantage and comparative disadvantage. In contrast to the case of reciprocal dumping, trade is unambiguously wasteful. Still, the (overall) least efficient country may gain from trade.

Key Words: intra-industry trade; bilateral oligopoly; firm heterogeneity; link formation

JEL classification: F12, L14, C78

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1 Introduction

All the three major models of trade, perfect competition, monopolistic competition and oligopolistic competition, fail to formalize some common characteristics of intermediate goods markets – that both the buyers and the sellers are concentrated, and that the contracts are negotiated on a bilateral basis. Little is thus known about the determinants of international trade in intermediate goods. This paper provides a framework for analyzing such markets, and shows how surplus-sharing among heterogenous firms with bilateral market power may explain an important aspect of international trade, intra-industry trade in intermediate goods.

Intra-industry trade  Intra-industry trade accounts for a large share of the international trade among industrialized countries. Grubel and Lloyd (1975) estimated the share to exceed 60 percent in the OECD area. Since traditional trade theory explains trade as inter-industry specialization, based on factor intensity differentials in different industries, in conjunction with interregional differences in factor endowments, the large share of two-way trade in similar products has been perceived as a puzzle.

To reconcile the trade theory with the trade statistics, the literature has followed two broad routs. According to the first view, the puzzle is at least partly a statistical artefact, due to the high aggregation level of trade data: Also some products classified in the same category are sufficiently differentiated from a factor intensity point of view to be located in different countries, and from consumers’ point of view to motivate incurring the trade cost. The second approach has been to offer new theories of trade. It has been shown that intra-industry trade may arise as a result of comparative advantage in perfectly competitive markets with constant returns to scale.
(Davis, 1995). Under monopolistic competition, intra-industry trade may be due to specialization since consumers have tastes for variety and production has economies of scale (Krugman, 1979; Lancaster, 1980). In oligopolistic markets, intra-industry trade may arise in the form of reciprocal dumping (Smithies, 1942; Brander, 1981; Brander and Krugman, 1983).

These contributions almost exclusively concern final consumer goods; a focus which is somewhat unfortunate since over 70 percent of manufactured trade of the EC, Japan and USA consists of intermediate products and capital goods. However, Ethier (1979, 1982) shows that also intra-industry trade in intermediate goods may be due to product differentiation and (both “national” and “international”) economies of scale, assuming that the intermediate goods market is monopolistically competitive. Also some of the intra-industry trade in intermediate goods may be a statistical artifact and, in particular, due to so-called Allyn Young specialization (Kol and Rayment, 1989).

A model of intermediate goods markets  The present paper builds on two central observations. The first observation is that many intermediate goods markets are concentrated both among sellers and buyers – they are bilateral oligopolies – in which both sides exercise market power. Contracts are typically negotiated bilaterally between pairs of buyers and sellers; these negotiations are interdependent and the contract agreed in one negotiation constitutes part of an equilibrium prevailing in the market as a whole.\(^1\)

The second observation, which is already well-established in the trade literature through the work Melitz (2003) and Helpman, Melitz and Yeaple

\(^1\) *The Economist* (2000) estimates that about 80 to 90 percent of all intermediate goods are traded through extended term contracts, and that spot markets just constitute a tiny tip of a huge market of such one-to-one contract deals.
(2004), is the existence of large and persistent productivity differences among establishments in the same narrowly defined industries. Some of these studies also show that these productivity differences are strongly correlated with export status. More productive establishments are more likely to export.

Following the emerging literature on bilateral oligopoly, the present paper models an intermediate goods market as a set of interdependent bilateral bargaining games. Pairs of buyers and sellers simultaneously negotiate bilateral price/quantity contracts. An important characteristic of the equilibrium is that prices are relation specific. If a buyer is efficient in its use of the intermediate product and therefore has a high willingness to pay, it will also have to pay a high price, ceteris paribus. Likewise, if a seller has a low production cost, the price will be low, ceteris paribus. One may think of this as two-sided first-degree price discrimination. In effect, the identity of the trading partner matters even when goods are homogenous: Both the buyers and the sellers prefer efficient trading partners, since they are able to capture a share of the surplus generated by this efficiency.

As the identity of their trading partners matter to firms, they will want to chose which firms to negotiate with. As these choices are interdependent, when different firms have conflicting interests, the outcome of the "link-formation" problem is far from obvious. Previous analysis of bilateral oligopoly takes the structure of the negotiation network (what firms negotiate with what other firms) as exogenously given, however. In the present paper, the analysis of bilateral oligopoly is extended and includes a link-formation game as a first stage. In this game, the firms’ preferences over

\[\text{\textsuperscript{2}}\text{The literature has taken different routes to model negotiations. A hybrid cooperative/non-cooperative bargaining model is used by Davidson (1988), Horn and Wolinsky (1988a), and Dobson and Waterson (1997). Non-cooperative models have been studied by Horn and Wolinsky (1986b), Hart and Tirole (1990), McAfee and Schwartz (1994), Stole and Zweibel (1996) and Björnerstedt and Stennek (2001).}\]
trading partners endogenously determine the link-structure of the negotiation network and, in the end, the trade pattern. This link-formation game may be modelled in several different ways. The paper will mainly focus on a non-cooperative model of link formation, but essentially the same results may also be obtained in eg matching models.\(^3\)

**Results** The main result is that firms under certain conditions choose international rather than domestic alliances. Firms prefer to trade with efficient partners, since they can appropriate a share of the surplus generated by their partner’s efficiency. If efficiency differentials are large enough, it is better for a firm to trade with an efficient foreign firm, rather than trading with an inefficient domestic firm, despite trade costs. Being each others’ first choices, the efficient firms from two different countries will trade with each other. Absent domestic partners, the less efficient firms may have to trade with each other, even if they would have gained more from domestic trade.

While international trade arises as a result of differences between countries, in terms of efficiency in the upstream and downstream sectors, equilibrium trade is not induced by specialization. Efficient upstream firms in one country trade with efficient downstream firms in the other country, but less efficient upstream firms in the second country trade with less efficient firm in the first country. One may say that there is trade in accordance with comparative advantage, but also trade in accordance with comparative disadvantage. The model predicts two-way trade in the intermediate good even if commodities are identical (cross-hauling). Note, however, that assuming

\(^3\)In particular, the model used in the present paper is related to the work by Hart and Kurz (1983), Aumann and Myerson (1988), Myerson (1991) and Dutta, van den Nouweland and Tijs (1998). Essentially the same results can also be obtained in a model inspired by Gale and Shaply’s (1962) model of two-sided one-to-one matching without side-payments.
homogenous goods is only a trick to clearly distinguish the present mechanism from that of specialization. Efficiency differentials may induce trade also if goods are differentiated.

Trade induced by surplus-sharing and efficiency differentials differs also from reciprocal dumping: Two-sided market power is crucial for the argument presented here. The buyers receive a lower price from a more efficient seller than from a less efficient one, since the buyers have bargaining power over the sellers. Likewise, the sellers receive a higher price from a more efficient buyer than from a less efficient one, since the sellers have bargaining power. Thus, it is because both sellers and buyers have market power that both sides prefer trading with efficient partners so that the trade pattern is determined by efficiency ranks and not by trade costs only. Trade induced by efficiency differentials also has other welfare consequences than reciprocal dumping: Trade costs are not compensated by any gains from increased competition.

In this model international trade is socially inefficient. Intra-industry trade implies that transportation costs are not minimized. A less easily measured inefficiency is that international trade may reduce aggregate world production. The strategic behavior of the more efficient firms may induce the less efficient firms to leave the market, in case trade costs are prohibitively high for them to trade with each other. Since international trade lowers welfare, at least one country will be hurt. The surplus may accrue very differently to different countries, however. If countries differ in overall efficiency, the less efficient country may actually benefit from international trade, since it can appropriate a share of the other country’s efficiency (through the firms’ price negotiations) if there is international trade, but not if there is domestic trade.
2 The Model

Consider a bilateral duopoly in two countries. In each country there is one upstream firm and one downstream firm, trading a homogenous intermediate good.\textsuperscript{4} In order to present the results in the most transparent way, I will use a highly stylized model of the firms technologies, and assume that the price of the final good is constant. Each upstream firm has a constant marginal cost, denoted $c^i$, and a capacity constraint, denoted $\bar{\pi}^i$, and each downstream firm has a constant marginal valuation, denoted $v^i$, and a capacity constraint, denoted $\underline{\pi}^i$.

One country is more efficient in the upstream sector, while the other country is more efficient in the downstream sector. In particular, the upstream firm in country one has a larger marginal cost than its counterpart in country two, that is $c^1 > c^2$, and the downstream firm in country one has a higher marginal valuation of the good than its counterpart in country two, that is $v^1 > v^2$. A possible explanation for the higher valuation is that the downstream firm in country one has a lower cost of transforming a unit of intermediate good into a unit of final good. For simplicity, the two efficient firms have the same capacity constraint $\bar{\pi}^1 = \bar{\pi}^2 = H$ and the two inefficient firms have capacity constraint $\underline{\pi}^2 = \underline{\pi}^1 = L \leq H$.

If upstream firm $u$ ships goods to downstream firm $d$, the upstream firm has to pay a per unit trade cost $t_{ud}$. If the two firms belong to the same country the trade cost is zero ($t_{11} = t_{22} = 0$) while if they belong to different countries the trade cost is strictly positive ($t_{12} = t_{21} = t > 0$).

A contract between upstream firm $u$ and downstream firm $d$ specifies

\textsuperscript{4}I assume that goods are homogenous to clearly show that the argument does not in any way rely on specialization. The argument would still be valid with some amount of differentiation.
a price $p_{ud}$ and a quantity $q_{ud}$. A contract structure is one contract for every pair of upstream and downstream firms. The profit of upstream firm $i$ and downstream firm $j$ are given by $\pi_i = \sum_{d=1}^{2} (p_{id} - c^i - t_{id}) q_{id}$ and $\pi_j = \sum_{u=1}^{2} (v^j - p_{uj}) q_{uj}$ respectively. To simplify the exposition, I will study the market using partial equilibrium analysis.

The game has two stages. In the first stage firms invest in the capabilities to trade with particular partners. The outcome is called a negotiation network, describing which upstream firms that will bargain with which downstream firms. In bilateral duopoly, four possible negotiation links can be formed and there are $2^4 = 16$ different possible negotiation networks, as displayed in in the first and third columns of Figure 1. In the second stage, all pair of firms that have a negotiation link bargain over prices and quantities. Firms actually trading with each other can be said to form a trading network. Working backwards, the analysis starts with the bargaining over price/quantity contracts, and then considers choice of links.

2.1 Prices and Quantities

The analysis in the present section focuses on the bilateral price/quantity negotiations, taking the negotiation network as exogenously given. If two firms are linked, each firm will send out a representative to meet with a representative of the other firm. The representatives bargain over price/quantity contracts. Even though every negotiation is a bilateral affair, the negotiations are interdependent: The preferred agreement in one negotiation may depend on the agreement made in another negotiation. For this reason, standard Nash bargaining theory cannot be used. Instead, I adopt the natural extension, the “Nash equilibrium in Nash bargaining solutions” approach which
has been developed to study bilateral oligopoly.\textsuperscript{5} With price/quantity contracts, the Nash-Nash bargaining solution implies that the two firms in every negotiation agree on a contract prescribing the bilaterally efficient quantity (the quantity that maximizes the sum of the two firms’ profits taking all other contracts as given), and the price that splits the bilateral surpluses equally.

Bilateral efficiency\textsuperscript{6} implies that upstream firm $u$ and downstream firm $d$ will trade the maximum quantity given available capacity, ie

\begin{equation}
q_{ud} = \min \{ \kappa^u - q_{uj}, \kappa^d - q_{id} \}
\end{equation}

if trade is viable, ie

\begin{equation}
v^d \geq c^u + t_{ud}.
\end{equation}

If trade is not viable, bilateral efficiency implies that the two firms will not trade, even if there is available capacity in both firms. Throughout the paper it is assumed that trade is viable in all links, unless otherwise stated. In particular this means that $v^i > c^j$ for both countries, and that $t < v^i - c^j$ for both directions of international trade.

It can also be shown that the market is socially efficient, albeit in a constrained sense. The equilibrium outcome maximizes social welfare given the negotiation network, i.e. subject to the restriction that firms not negoti-
ating with each other also may not trade with each other.\footnote{There is also a second qualification, which is less important in the present paper, since it is assumed that the firms take final goods prices as given. The equilibrium quantities are the same as if all firms were price takers in the intermediate goods market, with downstream firms possessing whatever degree of market power they may have in the final goods market. There may thus be inefficiencies related to market power in the final goods market. For the details, see Björnerstedt and Stennek (2001).} I will use this observation here, as a convenient short-cut, to find the equilibrium contract structure, and the equilibrium trade associated with any negotiation network. Since it is assumed that the price of final goods is constant, world welfare is given by the sum of all firms’ profits, ie

\[ W = \sum_u \sum_d (v^d - e^u - t_{ud}) q_{ud}. \]  

(3)

The results are summarized in the second and fourth columns of Figure 1.

First, when the negotiation network has a complete link-structure (row 1), the Nash-Nash bargaining solution (ie full social efficiency) prescribes that firms trade as much as they can domestically, and any possible unused capacity internationally. In particular, \( q_{11} = q_{22} = L \) is traded domestically in both countries, and \( q_{21} = H - L \) is traded internationally between the two efficient firms; there is trade according to advantage. Hereby, production is maximized and trade costs minimized. Note that the link between the two inefficient firms will not be used, ie \( q_{12} = 0 \). Positive sales between the two inefficient firms would imply that these two firms have to reduce their trades with their domestic partners which, in turn, would induce these firms to trade more internationally with each other. Trade costs would thus be increased. Also in case the two inefficient firms do not negotiate with each other (row 2), there will be such first best trade.

Second, if both domestic links are present, but the two efficient firm are
Figure 1: Equilibrium trading networks for all negotiation networks
unlinked to each other, then the Nash-Nash bargaining solution (ie social efficiency, but now in a constrained sense) prescribes domestic trade (rows 3 and 6). Again, if present, the link between the two inefficient firms will not be used (row 3). In this case the equilibrium is only constrained efficient, since, in absence of a link between themselves, the two efficient firms will not operate on full capacity.

Third, if both international links are present, but at least one domestic link is absent, then the Nash-Nash bargaining solution (ie constrained social efficiency) prescribes intra-industry trade. Hereby, production is maximized but trade costs are incurred (rows 4-5 and 7). Note that domestic links will not be used (rows 4 and 5). Positive domestic sales in one country would reduce trade costs, but leave production capacity unused in the other country. Since \( t < v^i - c^i \), social welfare would be reduced.

The equilibrium trading pattern for all other negotiation networks (rows 8-16), can easily be derived in a similar way. To sum up:

**Lemma 1** For any negotiation network determined in stage 1, there exists a unique equilibrium trade-pattern in stage 2.

1. If both domestic negotiation links and the one between the two efficient firms exist, there will be first best trade, ie \( q_{11} = q_{22} = L, q_{21} = H - L \) and \( q_{12} = 0 \).

2. If both domestic negotiation links are present, but the two efficient firm are unlinked to each other, there will be domestic trade, ie \( q_{11} = q_{22} = L \) and \( q_{21} = q_{12} = 0 \).

3. If at least one domestic negotiation link is absent, but both international links exist, there is intra-industry trade, ie \( q_{11} = q_{22} = 0, q_{21} = H \) and \( q_{12} = L \).
4. Otherwise, at most one trading link will be used. If positive, \(q_{11} = q_{22} = q_{12} = L\) and \(q_{21} = H\).

The Nash-Nash bargaining solution prescribes that the price in each negotiation is set so as to split the bilateral surplus equally between the two parties, which is equivalent to setting a price such that \(p_{ud} - c^u - t_{ud} = v^d - p_{ud}\). Thus,

**Lemma 2** If \(u\) and \(d\) trade with each other, the price will be

\[
p_{ud} = \frac{v^d + c^u + t_{ud}}{2}.
\]

Note that equilibrium prices are relation-specific: a downstream firm with a high willingness to pay also has to pay a higher price in equilibrium, and an upstream firm with low production costs receives a lower price in equilibrium. Firms capture a share of their trading partner’s efficiency, and since this is a model of complete information one may think of this as two-sided first-degree price discrimination. For instance, in case the negotiation network is sufficiently complete to induce first best trade, there will be trade at three different prices in equilibrium. The equilibrium price for domestic trades in country 1 is given by \(p_{11} = (v^1 + c^1)/2\). The domestic price in country 2 is lower, and given by \(p_{22} = p_{11} - [(v^1 - v^2) + (c^1 - c^2)]/2\). The reason for why the price is higher in country 1 than in country 2 is both that the upstream firm in country 1 has a higher production cost than the upstream firm in country 2, and that the downstream firm in country 1 has a higher willingness to pay for the intermediate goods than the downstream firm in country 2. The price in the international trade link is given by

\[
p_{21} = (v^1 + c^2 + t)/2 = p_{22} + [(v^1 - v^2) + t]/2 = p_{11} + [t - (c^1 - c^2)]/2,
\]

which lies between the two domestic prices in case the trade cost is low in
relation to both efficiency differentials \((t < v^1 - v^2 \text{ and } t < c^1 - c^2)\). It should be noted that the prices in the two countries are not equalized, even when there is international trade and the allocation is fully efficient. The reason is that the prices are not determined by marginal costs and valuations but by incremental costs and valuations.

Given these equilibrium prices, the profit of upstream firm \(i\) is given by 
\[
\pi^i = \sum_{d=1}^{2} (v^d - c^i - t_{id}) q_{id} / 2,
\]
and the profit of downstream firm \(j\) is given by 
\[
\pi^j = \sum_{a=1}^{2} (v^j - c^u - t_{aj}) q_{aj} / 2.
\]
Thus:

**Lemma 3** The equilibrium profits are as follows:

1. Under domestic trade, \(\pi^1 (D) = \pi^2 (D) = L (v^i - c^i) / 2\).

2. Under intra-industry trade, \(\pi^2 (I) = \pi^1 (I) = H (v^1 - c^2 - t) / 2\) and 
   \(\pi^1 (I) = \pi^2 (I) = L (v^2 - c^1 - t) / 2\).

3. Under first best trade, \(\pi^1 (F) = \pi^1 (D), \pi^2 (F) = \pi^2 (D) + (H - L) (v^1 - c^2 - t) / 2, \pi^1 (F) = \pi^1 (D) + (H - L) (v^1 - c^2 - t) / 2 \) and \(\pi^2 (F) = \pi^2 (D)\).

The profit level of all other trading patterns may be computed in an analogous way, and often coincide with already computed profits, reducing the need for separate notation.

Depending on the different parameters \(v^i, c^i, t, L\) and \(H\) a firm will have different preferences over alternative trade-patterns. Often different firms will have conflicting interests. The purpose of the next section is to analyze how these preferences translates into a choice of partners with which to negotiate with, the equilibrium trading network.
2.2 Negotiation Network

The firms’ decisions on whether or not to form a negotiation link with other firms is represented as a strategic game. In this link formation game, each firm invests in a capacity to negotiate and trade with all the firms with which it wants to negotiate. A negotiation link is formed between \( u \) and \( d \) only if both firms want that link, and have made the necessary investments. The set of negotiation links constitute the negotiation network. Since the negotiation game in stage two uniquely determines each firm’s profit for each negotiation network, there exists a well defined payoff function also for the link formation game in stage one, and any noncooperative equilibrium concept can be used to analyze this game. Such an equilibrium corresponds to a subgame perfect equilibrium of the complete model. The critical assumption is that the firms in the link-formation stage cannot enter into binding agreements of any kind, such as those relating to the investment decision or the subsequent divisions of profits.

Although the investment cost is assumed to be small in relation to the gains of trade, and will be suppressed in the calculations, it is clear that the firms will not invest in negotiation links that are not used in equilibrium. Only if the equilibrium trading network is identical with the negotiation network, the latter is a candidate to be an equilibrium. By inspection of the second and fourth columns of figure 1, it is thus clear that there are 8 possible negotiation networks that are candidates to be Nash equilibria in the link formation game. These are marked with a box around the line number. For convenience, these networks are also displayed separately in Figure 2. The first three rows correspond to first best, domestic and intra-industry trade.

The natural starting point is to consider the Nash equilibria of the link-
Equilibrium profits

<table>
<thead>
<tr>
<th>Network</th>
<th>Equilibrium profits</th>
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<tbody>
<tr>
<td>1</td>
<td>$\pi^1(F)$</td>
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<tr>
<td>2</td>
<td>$\pi^1(D)$</td>
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<td>3</td>
<td>$\pi^1(I)$</td>
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<td>4</td>
<td>$\pi^1(D)$</td>
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<td>6</td>
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<tr>
<td>7</td>
<td>$\pi^1(I)$</td>
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<td>8</td>
<td>0</td>
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Figure 2: Equilibrium candidates.

formation game. The first conclusion is that first best trade will not occur in equilibrium, in case the trade cost is small in relation to the efficiency differences between the firms. In particular, it may be profitable for the efficient upstream firm to deviate from any negotiation network inducing first best trade (row 1 or 2 in figure 1), by eliminating the negotiation link to its domestic partner (thereby jumping to row 5 or 10 in figure 1). By such a deviation, the firm commits to trade only with the efficient downstream firm in the other country. This is profitable if

$$
\pi^2(F) < \pi^2(I) \iff \frac{v^2 - c^2}{2} + (H - L) \frac{v^1 - c^2 - t}{2} < H \frac{v^1 - c^2 - t}{2},
$$

$$
\iff t < v^1 - v^2.
$$

By committing to trade with the efficient downstream firm only, the upstream firm will be paid $p_{21} = p_{22} + [(v^1 - v^2) + t]/2$ for all units produced. In a
similar way, the efficient downstream firm has an incentive to cut its domestic link when
\[ \pi_1(F) < \pi_1(I) \iff p_{11} > p_{21} \iff t < c^1 - c^2. \] (5)

Otherwise, if none of the two inequalities is satisfied, the first best network is a Nash equilibrium. The efficient firms, thus, have an incentive to commit not to trade with their inefficient domestic partners, under certain conditions. By doing so, the efficient firms will buy and sell also their infra-marginal units at a better price.

Note also that all the other seven negotiation networks in rows 2-8 of Table 2 are Nash equilibrium outcomes. No firm has an incentive to deviate, and to unilaterally make an additional investment, since the negotiation link will not be formed anyway. No firm has an incentive to deviate and cut a link, since that would simply imply a loss of trade. There is thus a phletora of Nash equilibria, each giving rise to a distinct trade pattern - a typical feature of link-formation games.

The outcomes in which some firms do not trade at all (Table 2, rows 4-8) are not credible predictions, however, as they are the result of unrealistic coordination failures. An inactive buyer and an inactive seller could easily improve their situation by agreeing to mutually invest in a negotiation link. Even if not binding, such an agreement is self-enforcing, leaving only domestic trade and intra-industry trade as plausible equilibrium candidates, when trade costs are small, ie when inequality 4 or 5 is satisfied.

A somewhat more involved argument shows that either domestic trade or intra-industry trade is implausible in any given situation. Domestic trade may be implausible since the two efficient firms could make a non-binding agreement to both cut their domestic negotiation links, and to form a negotiation link with each other instead. If followed by both, such an agreement
would be profitable to the efficient upstream firm if

\[
\pi^2(I) > \pi^2(D) \iff H (v^1 - c^2 - t)/2 > L (v^2 - c^2)/2
\]

\[
\iff H (v^1 - v^2 - t) + (H - L) (v^1 - c^1) > 0
\]

(6)

The efficient upstream firm’s incentives hinges on two effects. The first term captures that the efficient downstream firm has a higher valuation for the good, and thus will pay a higher price than the inefficient downstream firm, also accounting for the trade cost. The second term captures that the efficient downstream firm has a larger capacity than the inefficient downstream firm, and thus will buy a larger quantity. Similarly, the agreement would be profitable to the efficient downstream firm if

\[
\pi_1(I) > \pi_1(D) \iff H (c^1 - c^2 - t) + (H - L) (v^1 - c^1) > 0.
\]

(7)

Notice that such a non-binding agreement is self-enforcing, if both inequalities are satisfied. Note also that, under the same assumptions, intra-industry trade is immune against such coordinated deviations. The two inefficient firms cannot deviate profitably, and none of the two efficient firms would have an incentive to participate in any deviation, since there does not exist any other trading pattern in which it would earn a higher profit. In fact, the inefficient firms always prefer domestic trade (and first best trade) over intra-industry trade and, thus, the two efficient firms are pivotal; if one of them prefers domestic trade to intra-industry trade, domestic trade is the plausible outcome.

The notion of efficient self-enforcing agreements for environments with unlimited, but non-binding, pre-play communication is formalized in the con-
cept of coalition-proof equilibrium (Bernheim, Peleg and Whinston, 1987). The equilibrium structure is presented in the following proposition.

**Proposition 1** There exists a unique coalition-proof equilibrium.

1. There is first best trade, if the trade cost is large in relation to both the efficiency differentials, ie $t > v^1 - v^2$ and $t > c^1 - c^2$.

2. There is intra-industry trade, if the trade cost is small in relation to at least one of the efficiency differentials, ie $t < v^1 - v^2$ or $t < c^1 - c^2$, and $t < (v^1 - v^2) + \left(\frac{H-L}{H}\right)(v^2 - c^2)$ and $t < (c^1 - c^2) + \left(\frac{H-L}{H}\right)(v^1 - c^1)$.

3. There is domestic trade, otherwise.

Proof: The last two cases are proved in the text preceding the proposition. In case the trade cost is large in relation to both the efficiency differentials, ie $t > v^1 - v^2$ and $t > c^1 - c^2$, first best is a Nash equilibrium. Moreover, this equilibrium is coalition proof. The two inefficient firms always prefer first best or domestic trade to any other trading pattern. Due to the high trade costs, also the efficient firms prefer first best to any other trading pattern. Also note that domestic trade is not coalition proof since the two efficient

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8The formal definition involves a recursion and is therefore somewhat involved. In order for a single player not to deviate, the equilibrium must have the usual best-response property (ie be a Nash equilibrium). In order for a coalition of two players not to deviate, they must be playing a Pareto undominated Nash equilibrium in the "component game" induced on the pair by keeping the other players’ actions fixed. In a three-player game, an equilibrium is coalition-proof if no pair of players have an incentive to deviate, and if there is no other such equilibrium which is Pareto-superior.

9Appendix A demonstrates that the same results are obtained in a model of two-sided matching, a la Gale and Shapley (1962).
firms both prefer first best trade to domestic trade (assuming $t < v^1 - c^2$).

QED.

The equilibrium structure is also described by figure 3. The figure includes the case when international trade between the two inefficient firms is not viable, in which case the equilibrium may prescribe international trade between the efficient firms only.

Note that two-sided market power is essential for the result. In fact, there will be intra-industry trade if the upstream firms receive any share $\alpha \in (0, 1)$ of the bilateral surplus. In contrast, if $\alpha = 0$ (or $\alpha = 1$), upstream firms (or downstream firms) are indifferent between trade patterns and the model does not generate any precise predictions. Thus, to generate a clear prediction of intra-industry trade, it is essential that both buyers and sellers have market power.
2.3 Welfare

Since it is assumed that the price of final goods is constant, world welfare may be defined as the sum of all firms’ profits. To simplify the analysis, assume that all firms have the same capacity constraints $H = L = 1$, so that first best trade is equivalent to domestic trade. Then, it is easy to see that intra-industry trade is socially inefficient, since a trade cost of $2t$ is incurred.

A country’s welfare is defined as the sum of its firms’ profits. The overall efficiency of country $i$’s industry can be measured by its value added under autarchy, i.e., $v^i - c^i$. Even if trade imposes social inefficiency, one country may prefer trade to no trade.

**Proposition 2** Assume that there is intra-industry trade. Country $i$ benefits from trade being allowed if it is substantially less efficient than country $j$, more precisely if $(v^i - c^i) < (v^j - c^j) - t$.

**Proof:** Consider first the case of intra-industry trade. The social surplus in country $i$ given by $W^i(I) = (v^1 + v^2 - c^1 - c^2 - t)/2$, in case of intra-industry trade, and $W^i(D) = (v^i - c^i)$, in case of domestic trade. Note that

$$W^i(I) > W^i(D) \iff (v^i - c^i) - (v^j - c^j) > t. \quad (8)$$

Numerical examples prove that this conditions may be satisfied in the relevant parameter region. QED.

At first sight it may be surprising to note that it is the least efficient country that may benefit from trade. The intuition for this result is that the least efficient country can appropriate some of the other country’s efficiency through the firm’s price negotiations if there is international trade, but not otherwise. Thus, selective regulation of trade in this particular market (in an environment with free trade) is not feasible, absent side payments.
2.4 Extensions

Consider a situation where the trade cost is sufficiently large so that international trade between the two inefficient firms is not viable, i.e., \( t > v^2 - c^1 \). Then, the efficient firms will induce the inefficient firms to leave the market, when they commit to trade internationally. Thus, the aggregate world production is reduced in comparison with a situation of domestic trade, implying that the social loss is \((v^2 - c^1) + t\). This result shows that to estimate the costs of free trade empirically, it is not sufficient to study the direct and “easily” observable trade costs. Also, the reduction in production that follows from free trade must be estimated.

Moreover, if downstream firms compete in the final goods market, efficient firms may have an additional incentive to trade with each other. The reason is that if an international coalition is formed, the two inefficient firms are driven out of the market, which increases the price for final goods.

It is straightforward to generalize Proposition 4 to an economy with \( n \) upstream and \( n \) downstream firms in each country where each country is more efficient than the other country in one of the two sectors. The downstream firms in country one have willingness to pay \( v_1^1 > v_2^1 > \ldots > v_n^1 \). In country two their willingness to pay is \( v_1^2 > v_2^2 > \ldots > v_n^2 \). The upstream firms in country one have production cost \( c_1^1 < c_2^1 < \ldots < c_n^1 \). In country two the production costs are \( c_1^2 < c_2^2 < \ldots < c_n^2 \). Assume that country one dominates country two in the downstream sector in the sense that the least efficient downstream firm in country one is more efficient than the most efficient downstream firm in country two, even after correcting for trade costs, that is \( v_n^1 > v_1^2 + t \). Also assume that country two dominates country one in the upstream sector, that is \( c_n^2 + t < c_1^1 \). Assume for simplicity that all firms have the same capacity constraints. The unique (coalition proof) equilibrium
trade pattern implies that the efficient upstream firms in country two trade with the efficient downstream firms in country one. The inefficient firms either trade internationally (for all $i$ such that $v_i^2 - c_i^1 > t$) or do not trade at all (for all $i$ such that $v_i^2 - c_i^1 > t$).

2.5 To be shortened and moved to the concluding remarks:

Consider a situation where trade is not allowed, or made impossible by high tariffs between the two countries. In this case there is domestic trade. Also note that there are no incentives for merger. Assume that the trade barriers are suddenly reduced. If the remaining trade cost is small enough, the two efficient firms prefer to stop trading with their domestic partners and start international trade instead. The two firms should realize, however, that such a development would reduce the efficiency of the market. A natural alternative response for the firms is to integrate. After a merger, the remaining firms can ensure that goods are not traded over the border.

**Proposition 3** If trade is opened between two formerly isolated countries, cross-border horizontal mergers and domestic vertical mergers are made profitable, since such mergers block international trade.

**Proof:** Consider a horizontal merger between the downstream or the upstream firms. The merged firm earns half of the world surplus independent of trade pattern and thus prefers domestic trade. By blocking international trade, such a merger is profitable. Consider next a vertical merger in a country that looses from international trade. The merged firm prefers domestic trade. By blocking international trade, such a merger is profitable. QED.
This proposition provides a possible explanation for the widespread belief that lowering of trade barriers may trigger international mergers, a phenomenon that has been observed in Europe after the introduction of the common market. The reason is that mergers help firms avoid (remaining) trade costs, by coordinating on domestic trade. A residual implication is that such mergers are either cross-border horizontal mergers or domestic vertical mergers.

This mechanism, thus, suggests that mergers can create efficiencies in the form of an improved trade pattern. Such efficiencies are probably not considered as an efficiency defence in any merger control system, however. In addition, there is a special political problem in Europe with the predicted mergers as they may be viewed to reduce European integration.

A similar argument to the one presented here may explain intra-firm trade, which accounts for a third of international trade. (E.g.: Use Fridolfsson’s and Stennek’s model of mergers. It is likely that the efficient firms will merge with positive probability, even though domestic mergers maximize aggregate profits. The reason is that they cannot exploit the full strength of their bargaining position if domestic mergers occur with probability one.) One may combine this story with transportation costs for final goods. Due to reciprocal dumping, there will be trade also in the final good. Trade pattern in both markets will depend on trade costs in both markets.

3 Concluding Remarks

This paper provides a rational for intra-industry trade in intermediate goods markets, based on efficiency differentials between firms.
4 References


A Two-Sided Matching

An alternative model to analyze the link-formation game is the model of two-sided one-to-one matching (without side-payments). In particular, the analysis will make use of the concept of stable matchings due to Gale and Shapley (1962).

Definition 1 A trade pattern is stable if there does not exist a buyer-seller pair that would increase both firms’ equilibrium profits, by trading with each other, instead of trading with their assigned partner.
Note that a trade pattern is unstable only if both the upstream and the downstream firms gain by the deviation.

Absent trade costs, all upstream (downstream) firms rank the downstream (upstream) firms in the same order. In particular, the most efficient upstream firm (as well as all other upstream firms) prefer to trade with the most efficient downstream firm, and vice versa. The two most efficient firms will thus agree to trade with each other. After the most efficient firms have signed their agreement, the second most efficient firms prefer to trade with each other, and so on. Since the two countries are efficient in one of the sectors, the stable trade pattern entails intra-industry trade.

The next proposition shows that international trade is the unique stable trade pattern also in the presence of trade costs, as long as the trade cost is not too high in relation to the efficiency differentials. For simplicity, assume that $H = L$ implying that first best trade is the same as domestic trade.

**Proposition 4** Assume that country 1 is more efficient in the downstream sector ($v^1 > v^2$) and that country 2 is more efficient in the upstream sector ($c^1 > c^2$). Assume that international trade is viable ($t < v^2 - c^1$). There exists a unique stable trade pattern, entailing intra-industry trade if $t < \min \{c^1 - c^2, v^1 - v^2\}$, and domestic trade otherwise.

The intuition is as follows. The efficient upstream firm 2 prefers international trade if, and only if,

$$\pi^2 (I) > \pi^2 (D) \iff \left( v^1 - c^2 - t \right) / 2 > \left( v^2 - c^2 \right) / 2 \iff t < v^1 - v^2. \quad (9)$$

The inefficient upstream firm 1 always prefers to trade with its efficient domestic colleague thereby also avoiding trade costs. The efficient downstream
firm 1 prefers international trade if, and only if,

$$\pi_1(I) > \pi_1(D) \iff (v^1 - c^2 - t)/2 > (v^1 - c^1)/2 \iff t < c^1 - c^2. \quad (10)$$

The inefficient downstream firm 2 always prefers domestic trade. Thus, the two efficient firms are pivotal. If both of them prefer international trade, there will be international trade. Otherwise there will be domestic trade.

The proof of the proposition make use of the following link formation algorithm.

**Definition 2** The link formation algorithm consists of the following steps:

1. For every upstream firm (that is not yet linked to a downstream firm), compute the most preferred partner among the downstream firms without links. For every downstream firm (that is not yet linked to an upstream firm), compute the most preferred partner among the upstream firms without links.

2. If there exists one or more pairs of firms that are mutual first choices, form a link between the two.

3. Repeat step 1-2 among the remaining set of firms, until all firms are linked to a partner (or only upstream or downstream firms remain without links).

The links that generate a positive surplus are active, firms in unprofitable links exit the market.

An economy is generic if there does not exist any pair of downstream firms such that $$v^i = v^j$$ or $$v^i = v^j + t$$, and there does not exist any pair of upstream firms such that $$c^i = c^j$$ or $$c^i = c^j + t$$. 
Lemma 4 The link formation algorithm generates the (generically) unique stable link structure. The market is cleared from above, i.e. in every step only the most efficient firms (of each country) are linked up with a partner. In a given step, an international link is formed if, and only if, the efficiency differential between the most efficient foreign firm and the most efficient domestic firm is larger than the trade cost, i.e. if and only if, both $v^f - v^d > t$ and $c^d - c^f > t$.

Proof: First note that if two firms are mutual first choices, those two firms must be linked in order for the trade pattern to be stable. Moreover, after elimination of such pairs of firms the same argument holds for two firms that are mutual first choices in the remaining set of firms.

Let $\xi_{ud}$ be equal to one if upstream firm $u$ and downstream firm $d$ belong to different countries, and zero otherwise. If $u$ trades with $d$, the profit to each firm is:

$$\pi_{ud} = \frac{v^d - c^u - t \cdot \xi_{ud}}{2}.$$  \hspace{1cm} (11)

Note that a firm prefers to trade either with the most efficient domestic firm or the most efficient foreign firm. Since we only study generic economies, every firm has a unique preferred partner. Note that the preferred partner is independent of which other links that are formed. Step one of the algorithm is, thus, well-defined.

Consider an upstream firm $u$ evaluating the most efficient domestic downstream firm $v^d$ in relation to the most efficient foreign $v^f$

$$\pi_{ud} - \pi_{uf} = \frac{(v^d - v^f) + t}{2}.$$  \hspace{1cm} (12)

\footnote{It seems that the result that markets clear from above has not received any theoretical explanation in the literature.}
The difference is independent of the upstream firm’s cost. Thus all upstream firms in a given country rank the downstream firms in the same way. Likewise, all downstream firms in a given country rank the upstream firms in the same way. These facts imply that it is sufficient to consider the most efficient firm from both sectors in both countries. Only these four firms are the relevant candidates for forming the first link(s).

Since all firms in a given sector of a given country rank potential partners in the same way, and since there are only two possible first choices, there are \(2^4 = 16\) possible rankings. It is, however, easy to verify that if the upstream firm in country \(i\) prefers the downstream firm in country \(j\), also the upstream firm in country \(j\) prefers the downstream firm in country \(j\). Thus, there remains 9 rankings. It is easy to verify that in six cases one domestic link will be formed. In two cases a cross-border link is formed. In one case two domestic links are formed. The second step is, thus, well-defined.

Thus, the algorithm generates the unique stable link structure.

Note also that the most efficient foreign firm is considered better than the most efficient domestic firm if, and only if, the efficiency differential is larger than the trade cost. QED.