History Matters for Import Demand: the implications of match-searching in international trade.*

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Abstract

This paper investigates the implications of imperfect information and matching/searching for international trade theory. I develop an illustrative model where firms find such partners by a search through successive matches. The consequences include linking today's import demand patterns to past changes in costs, protection and interest rates. Today's policy decisions will likewise affect future trade. Trade diversion from a preferential trading agreement may well persist as informational diversion well after the preferential agreement has been scrapped. This is perhaps an important argument in favour of multilateral over bilateral trade liberalisation.

KEYWORDS: Trade, Protection JEL Classification: F00, F12, F13

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This paper considers the implications for trade theory of searching, matching and networking processes. I build on a relatively new literature which suggests that much of international trade is generated by agents searching for customers and suppliers in a world of imperfect information. By developing a simple model of this process, initially applied to interfirm trade, I draw a number of propositions, many of which are new to this literature, linking trade volumes and elasticities to the parameters of the search process and to the past history of trade between countries. It is shown that trade volumes depend on interest rates and contract periods, and that lower interest rates generally favour the growth of trade. The behaviour of trading firms depends to a large extent whether they are already well-matched or still searching for partners. Countries with a large number of well-matched firms will show relatively low price elasticities of demand for imports and exports, and in particular for trade with new partners. Apparent home bias in current trade patterns may well reflect past, rather than present, trade costs and protection.

1 Outline of the paper

The structure of this paper is as follows. In section 2, I review the relatively recent literature on matching models of trade. I then develop in section 3 a theoretical 'match-searching' model. This is a very basic model of the search process, which I use to derive a number of key results expounded as propositions. In section 4, I outline a numerical example showing the significance of the path-dependency of match-searching models of trade for sequential trade liberalisation agreements.

Next, I consider more realistic but complicated search models. These are seen as extensions/modifications of the basic model, incorporating consumer search or including networking

between firms. Many of the basic properties of the match-searching model carry across to these situations. While this paper is largely theoretical, in section 6 I briefly consider the existing empirical evidence.

2 Background: historicity in demand and supply-side models of trade

In standard neoclassical models of international trade[1] history is unimportant, at least in the longer run when factor mobility problems are assumed to be overcome.[2] This path-independence on both the supply and demand sides is based not just upon assumed of constant returns to scale, but also upon the idea that agents either already possess all relevant information, or else can obtain it costlessly. The combination of these assumptions leads to perfectly competitive models where trade specialisation takes place rapidly in response to price shifts and reflects factor endowments, unless blocked by protectionist policies.

The new trade theory models[3] are a response to perceived failures of the neoclassical model (eg the 'Leontief Paradox' debate and the observation of the dominance of two-way trade within an industry between advanced countries, which indicate that factor endowments do not primarily determine such trade) by developing imperfectly competitive models of costs and dynamic comparative advantage on the supply side,[4] combined with a variety goods model

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[1] See eg Stolper and Samuelson, 1948.

[2] The importance of time-frame in the behaviour of trade models when factors are immobile is emphasised in Neary (1978) and Edwards and Whalley (2002).

[3] See eg Grossman and Helpman (1993)

[4] The related debate about whether a single technology model can be consistent with cross-country productivity differences is discussed in some detail in Nelson and Pack, 1998.

of demand.[5]

By contrast, on the demand side, there is perhaps only more recent awareness of the difficulty explaining import patterns in terms of ahistoric models. Two important observations are:-

1) In general countries trade far less between each other than the theory would predict even when account is taken of transport costs.[6]

2) Trading patterns between countries frequently follow historical patterns. Hence, for example, the UK trades relatively more with India and Australia, France with Algeria or Cote D'Ivoire.

Much of the current litarature ascribes these patterns to either technical barriers to trade or to exogenous differences in demand patterns. [7] However, the idea of habit formation in preferences has gradually been introduced at least for aggregate import demand.[8]

In this paper, I apply matching and searching theory to trade. To date, this has been developed primarily for the case of inter-firm trade. This approach assumes that each firm's products have differentiated characteristics - however, unlike the variety goods model, it is not variety of choice that purchasing or selling firms are looking for, but rather the best attainable match for their individual requirements. The obstacle to finding that best match is that firms

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[5] See Dixit and Stiglitz, 1977.

[6] This was most notably shown by McCallum (1995) who demonstrated that, after correcting for size of economy and distance effects, trade between Canadian provinces exceeded that between Canadian provinces and US States by a factor of around 20. This discrepancy was referred to by Trefler as 'missing trade'.

[7] For the economic significance of this assumption see LeJour et al (2001). A wider discussion of technical barriers to trade is in Maskus and Wilson (2001).

[8] See De la Croix and Urbain, 1998.

have only imperfect information. For example in Rauch and Trindade (2003) firms are only able to tell whether a potential partner is better than a certain threshold match quality, where the threshold varies according to the company's ability to gather information on the country in which it is seeking a partner: if it already has ties to the region, or if there are common language ties or strong historic trading links the threshold will be higher. It follows that companies are more likely to set up trading ties with countries with which they have some initial familiarity, even if there are other, less familiar countries, where potential profits would be higher if perfect information were available. Another consequence of the one-off matching models currently discussed in the literature[9] is that firms will not all initially find good potential matches in one country even when there is a change in the average factor prices in that country relative to other countries: in this way the relative inelasticity and persistence of trade patterns is explained.[10]

Such ties, as well as existing patterns of networking may do much to explain observed trading patterns. They also naturally generate a degree of imperfect competition in trade, since a firm which has a good match with a foreign partner possesses a degree of monopoly power, as does a country with good historic trade ties with a second country.

Nevertheless, I argue that the above models do not go far enough in the sense that they treat the relative degree of information firms have about partners in alternative countries as an exogenous constant. In reality, it is probably more sensible to see information as a valuable

[9]Though this characteristic is not shared by the match-searching model derived in this paper. The reason import demand is not fully price-elastic in a match-searching model is that not all domestic-domestic matches are of equally high quality.

[10]See Rauch and Casella, 2003.

commodity, for which people will search if the cost of searching is low enough relative to the potential gains, and the history of search determines familiarity. Costs of searching may differ according to many factors, including transport costs and existing language and other ties, but also according to costs of borrowing (information can be seen as a form of capital) and according to the flexibility of the two trading partners.

3 Match-searching in trade

In this paper, I extend the approach of matching between firms, to include the assumption that firms acquire information by a search process over time. I start off with a simple form of such a model: this search is assumed to be carried out in the form of a series of successive matches with trading partners, each for a fixed contract period. A firm does not know the quality of a match before entering into it, but once it enters the match it does know. At the end of the contract period it will decide whether to continue the existing partnership, or to start another search. The cost of searching is the risk of having a series of poor-quality partnerships, while the benefit is the possibility of eventually finding a much better match.

This initial model is deliberately simplified in that it concentrates on modelling the matching between firms rather than other elements of trade, and excludes important elements of networking which may affect the search process. The aim is to draw out the main properties of this basic model, some of which are quite powerful. I then consider to what extent they carry over to more complex models.

Definition 1 *I define a match-searching model as one in which a firm searches for the most profitable partner by undertaking a succession of matches, each for a fixed contract period,*

until a satisfactory match is found.

The key result that comes from this approach is that a firm will choose to search for a new partner if its existing match quality falls below a reservation level. This is shown to depend essentially upon interest rates and the minimum contract period, as well as upon relative prices.

3.1 A simple model of match-searching

For the reasons outlined above, I propose here a match-searching model which builds on much of the framework of the one-off matching model (e.g. Rauch and Casella, 2003), but with certain modifications. As in one-off matching models: trade takes place between two firms, one upstream, u, and one downstream, d, and the extent and profitability of that trade is directly proportional to the quality of the match between those firms. Match quality, μ_{ud} is assumed to be randomly drawn from a uniform distribution between zero and unity. In a simple matching model the firms make a one-off random choice of match. A match-searching model differs from this framework in that matches are for a given contract period of c years, and it is assumed initially that a firm can only investigate a new partner by entering into a contract with it, and burning its bridges with its former partner. However, after the first contract period, the firms are again free to repeat the random matching process if their initial match falls short of a reservation quality μ^R.[11]

To set up a basic theoretical model, I start by assuming that firms are distributed uniformly,

[11]It is worth noting that, unless relative prices change, if a firm had accurate information about the distribution of potential match quality, then if it once decided to abandon a partner it will never return to that partner, except perhaps temporarily (see Section 5).

in terms of some key characteristics, along the perimeter of a circle,[12] circumference length 2. Each firm aims to match with the firm directly opposite on the circle: match quality, μ_{ud}, is equal to the circumference distance between the two firms, and hence is distributed uniformly between zero and unity with $\mu_{ud} = 1$ being the perfect match quality. We assume that both the volume of output of the two firms and the level of profits of each of the two firms is proportional to this match quality. Hence

$$Y_u, Y_d = \alpha\mu_{ud} \tag{1}$$

$$\pi_u, \pi_d = \beta\mu_{ud} \tag{2}$$

where Y_u, Y_d represent real output of each firm (defined here to be equal, so that one unit of the final product requires one unit of production at both upstream and downstream stages). Trade between the firms in real terms will equal Y_u. π_u, π_d are the profits of the two firms, which in the simple version of the model are equal, the proceeds from the match being split evenly.

Starting initially with a single-country model, the match-searching process is as follows. In the first period, each firm type u will seek a partner type d selected randomly from the pool

[12] This is an adaptation of Salop's model of qualitative differences between firms, and uses a similar initial set-up to Rauch and Casella's (2003) model, but differes in assuming that repeated matching is feasible.

of available firms. Firm u knows accurately the distribution of potential partners, but not the exact characteristics of any one firm d (and vice-versa). The match quality is unformly distributed between zero and unity, so that average expected initial match quality is $\mu_{ud1} = 1/2$. Average output and profitability of firms in this initial period are therefore

$$\overline{Y}_{u1}, \overline{Y}_{d1} = \alpha/2; \tag{3}$$

$$\overline{\pi}_{u1}, \overline{\pi}_{d1} = \beta/2. \tag{4}$$

The first contract period lasts for c years. At the end of that period, each firm can either renew its contract or start afresh with a new, randomly-chosen match. No firm is assumed to be inherently superior to any other: it is simply match quality which affects efficiency. A firm which fails to find an initially good match therefore has as good a chance as any other firm if it renews the search process. It is also assumed for simplicity that firms have infinite lives.

I assume the industry comprising all firms types u and d is small in comparison to the economy as a whole, and that wages and prices can be taken as exogenously given and constant, as are interest rates, r per annum. These partial equilibrium assumptions simplify the analysis considerably. In particular, they imply that the reservation match quality, μ^R, above which

firms will choose to stick with their existing partner, will be constant over time. In addition, the symmetry of the two firms u and d and the 50-50 split of profits indicates that the decision to stick together or renew search will be mutual, and that once firms have found a suitable partner they will stay together permanently.[13]

The series of consecutive search or stick decisions can be represented as a tree of nested probabilities. At the end of each period of the search process, a firm which had still been searching in the previous period will assess whether its current match is worth sticking with ($\mu_{ud} \geq \mu^R$, which will occur with probability $1 - \mu^R$) or whether it should again renew search (probability μ^R). After n periods, the probability that it has still not found a satisfactory match is $1 - (\mu^R)^n$, so the proportion of firms which will still be searching in period $n + 1$ is $1 - (\mu^R)^n$ while the proportion not still searching will be $(\mu^R)^n$.

Looking in more detail at period $n + 1$ the expected profit for those firms which are still searching can be written as $\phi\beta/2$, where ϕ is a conversion factor due to the fact that the length of the contract period may not equal 1. Expected profit for those firms who start initially by searching but which have found a satisfactory partner will equal $(\phi\beta/2)(1+ \mu^R)$. Expected profit over all firms in period $n + 1$will therefore be

$$\pi^{Se}_{n+1} = (\phi\beta/2)\{1 + \mu^R - (\mu^R)^{n+1}\} \tag{5}$$

[13]The analysis is considerably complicated by introducing circumstances where one firm which thought it had a satisfactory match might be jilted by its partner.

By contrast, if initial match quality is μ_{ud}, then if the firm chooses from the beginning to stick with its initial partner, its profit in each period will be $\phi\beta\mu_{ud}$ .The net expected benefit B^{Se}_{n+1} in period $n+1$ of having started by searching rather than not searching is

$$B^{Se}_{n+1} = (\phi\beta/2)\{(1+\mu^R - 2\mu_{ud} - (\mu^R)^{n+1}\} \tag{6}$$

Assuming a constant reservation match quality μ^R_{ud}, and constant interest rate r per annum, which, crucially, can be converted to an interest rate ρ per contract period, where

$$\rho = (1+r)^c - 1, \tag{7}$$

it is possible to derive the expected net present value V^{Se} (to the beginning of the search process) of profits for a firm which chooses to start by searching. This is a geometric progression, which can be summed to yield discounted present values

$$V^{Se} = (\phi\beta/2\rho)(1+\mu^R - 2\mu_{ud}) - (\phi\beta/2)(\mu^R/(1+\rho-\mu^R)) \tag{8}$$

When $\mu_{ud} = \mu^R$, $V^{Se} = 0$. Carrying out a little manipulation, it is possible to show that this is a quadratic equation in mu^R. Of the two solutions, only the smaller one will fall below unity. Hence, after a little more manipulation we can write

$$\mu^R = 1 + \rho - \sqrt{\rho(1+\rho)}. \tag{9}$$

This expression is decreasing in ρ (for positive values of ρ), and consequently leads to our first proposition:

Proposition 2 *The reservation match quality μ^R depends only on interest per contract period ρ, which is a function of the interest rate r and contract period c. Specifically, the shorter the contract period and the lower the interest rate, the nearer μ^R will be to unity.*

The implications of this in practice can be seen in the following table, showing the effect on reservation quality of changing either the contract period or the interest rate.

Table 1: Effects of contract period and interest rates on reservation match quality.

Contract period c	Interest rate per annum r	Reservation match quality μ^R
1	5	0.82
1	10	0.77
1	15	0.73
3	5	0.73
3	10	0.67
3	15	0.63
5	5	0.68
5	10	0.62
5	15	0.59
10	5	0.62
10	10	0.56
10	15	0.54

Our next propositions, which are quite easily derived, relate to the dynamics of this process:

Proposition 3 *Total profits and output in the first period of search for those firms who choose initially to search are the same for all values of r and c, but in the long run both are higher the lower is r and the lower is c. Subsequent average match quality increases over time. Average output per firm and profits correspondingly also increase, and in the long run both are higher the lower is r and the lower is c.*

Proposition 4 *Convergence to the long run value will be faster the shorter is the contract*

period c.

3.2 Implications of match-searching for trade

I have shown how the match-searching process in a closed economy moves towards a long-run equilibrium, in which firm match quality varies only over a limited range from μ^R to unity. Modelling of trade is more complicated, but I will concentrate in this section upon the opening up of a formerly autarkic economy to international trade for the first time. Specifically, I allow upstream and downstream firms for the first time to seek matches in a second country. I will assume that the potential maximum profit of an international pairing in the absence of transport costs or tariffs is π', which is greater than the maximum feasible for domestic-only partnerships by a factor $(1+\epsilon)$. However, transport costs and tariffs take proportion τ of this profit, so the maximum profit available to an international pair of companies is $(1-\tau)\pi'$. If a pairing with a foreign firm is made at random, the average quality match for a trading firm μ^T will again range from 0 to 1, and annual profits for an individual firm will be evenly distributed between 0 and $(1-\tau)(1+\epsilon)\beta/2$.

Crucially, I will initially assume that this extra profitability opportunity applies equally to both upstream and downstream firms in the home country (which we will denote by u_h and d_h), and that there is a ready supply of foreign partners. These assumptions maintain the symmetry of the supplier/purchaser relationship (so that with a 50-50 profit split, firms u_h and d_h are in agreement over whether to maintain their current relationship or to start searching abroad.

In the previous, one country case, the expected present value of future profits of a firm which chose to search was shown to be equal to the profits earned by a firm sticking with its

match partner with match quality μ^R, as determined by equation (9).

By analogy, a firm which searches abroad will have an expected present value of future profits equivalent to a firm which has a constant foreign match quality μ^{RF}, also satisfying equation (9).

But the expected profits of a foreign match quality μ^{RF} will equal $(1-\tau)(1+\varepsilon)$ times the expected profits of the marginal existing match at home, μ^R. It follows that, if the economy has reached equilibrium in autarky before starting to trade, there will be no firms at home with match quality less than μ^R. If this is the case, and if $\varepsilon > 1/(1-\tau) - 1$ (i.e. there is no profit advantage to trade) then no firms will seek overseas partners .

A key conceptual difference in this analysis is between firms who have already found match partners, and those who are still searching.

Definition 5 *A firm is defined as initially searching if at the start-point of our analysis it has not found a satisfactory partner, $\mu > \mu^R$. Otherwise it is defined as initially matched.*

Definition 6 *An economy is defined here as mature if all or most firms have found satisfactory partners.*

Of initally matched firms, a small potential profit advantage from a foreign partner, ϵ, will only outweigh the advantages of avoiding the costs of search for those firms whose matches were only marginally better than the initial reservation match quality, μ^R. Most other firms will not find it worthwhile starting a search unless ϵ is considerably larger than this.

Proposition 7 *As ε increases, the number of firms choosing to abandon their existing home partner to search abroad will steadily increase, until all firms abandon home pairings.*

The last firms will abandon home pairings only when $\varepsilon \geq (1/\mu^R) - 1$, ie when

$$\varepsilon \geq \{1/[1+\rho-\sqrt{\rho(1+\rho)}\} - 1. \tag{10}$$

Firms will choose to search abroad if

$$\mu_{u_h d_h} < \mu^{RF}/(1+\varepsilon). \tag{11}$$

Figure 1 (Appendix) represents diagramatically the proportion of firms seeking a foreign partner when a mature autarkic economy opens up to trade.In the initial case (shown by the bold diagonal line) the share of firms seeking foreign matches increases steadily as ε increases from 0 to ε^*, where ε^* is the value which makes equation (10) an equality.

Now if we allow the per-contract-period discount rate ρ to fall from ρ_0 to ρ_1, due either to a fall in the interest rate r or a shortening of the contract period c, then the value of ε at which all firms look abroad will fall from ε_0^* to ε_1^*, and the curve showing the response of the proportion of firms seeking foreign matches in response to changes in ϵ becomes much steeper.

The implication is that the price sensitivity of imports and of exports increases the less 'lumpy' foreign contracts are (the lower is c), and also the lower the interest rate, r. One interesting suggestion is that import demand elasticities and export supply elasticities should be lower for 'lumpy' products, and also lower during prolonged periods of high interest rates.

Proposition 8 *Imports and exports should be more price sensitive the shorter are foreign contracts and/or the lower the interest rate.*

Since the greater the price sensitivity of imports, the lower are optimal tariffs, Proposition 4) leads to an interesting conclusion regarding trade policy.

Proposition 9 *Other things equal, the lower are interest rates, the lower are optimal tariffs and the greater is the likelihood of more open trade policies.*

This leads to an interesting hypothesis: that there should be a correlation between periods of prolongued low real interest rates and opening up of international markets.

The issues of the dynamics of trade adjustment and the importance of history in determining trade flows in this model are also worthy of investigation. It is worth noting that, in this model, if there is a one-off trade liberalisation, a firm will face a decision whether to stick with its existing domestic partner or to enter into a search process, and unless relative prices subsequently change that decision will not change subsequently. Consequently, a firm which is going to enter trade will do so quickly (at the next end of contract period) after the trade liberalisation.

Proposition 10 *All firms who are going to enter into trade following removal of trade barriers will do so as soon as their current contracts expire.*

However:

Proposition 11 *after the initial increase in trade volumes from firms entering the search process, trade will continue to increase more gradually until a new equilibrium is reached.*

This latter proposition is related to the increase in output volumes as the search process procedes, as noted in proposition 2). It can be shown that, when $varepsilon < (1/mu^R) - 1$, total output in the first period of entering trade will only increase if[14]

$$\varepsilon > (2\mu^R - 1)/(-mu^R). \tag{12}$$

As r and/or c are reduced to zero, μ^R will tend towards 1 and first period output is more likely to increase for any price advantage to trade. [15]

Proposition 12 *The short run impact of trade liberalisation on output for a country which is in long-run equilibrium before engaging in trade, will be a reduction if the price advantage to trade, ε, is relatively small and if interest rates are high and the contract period long. By contrast, the long run effect on total output across countries, as match quality improves with search, will be positive.*

Next, it is worth considering what happens if the country is not in a long-run equilibrium at the time when the trade liberalisation takes place. In the above analysis, it was assumed all firms had found 'satisfactory' long-run partners, before the option of looking abroad for partners was introduced. By contrast, it is possible that some firms were still searching for a partner: in this case, the firm does not need to compare the potential profits from a foreign partner with those if its existing partner, but only with those of the expected return from the

[14]The proof is this is that, if the economy is in a long-run equilibrium pre-trade, then only firms whose (pre-trade) match quality lies between μ^R and $(1+\varepsilon)\mu^R$ will choose to search. Average pre-trade output of these firms is $\alpha(2+\varepsilon)\mu^R/2$. By contrast, average match quality for the first post-trade match is 1/2 and average output is $\alpha(1+\varepsilon)/2$.

[15]For larger values of ε, total output in the first period will only increase if $\varepsilon > mu^R$.

next domestic partner if it continues to search at home. Consequently, while price sensitivity of import demand for matched firms (those with long-term domestic partners) is relatively low, all searching firms will switch abroad if the average price advantage of foreign versus domestic partners, $\varepsilon > 0$.

Proposition 13 *Searching firms who have not yet found stable domestic partners will be very price-sensitive in choice of their next partner, but many initially matched firms will not.*

The next proposition is related:

Proposition 14 *the greater the rate of new firm startups in an economy, the greater the price-sensitivity of imports.*

Since new firm startups may well be lower when interest rates are lower, this tends to reinforce the previous hypothesis that periods of low interest rates globally are likely to favour trade growth and liberalisation.

These propositions also have important implications concerning the significance of the order of trade liberalisation with other countries. If country A liberalises trade initially only with country B, then, if trade with B has a price advantage $\varepsilon_B > 0$, some or all of the firms in A will start looking for partners in B (depending on whether their initial match in A was good enough to outweigh the cost advantages of entering into search). Now consider that A subsequently decides also to liberalise trade with country C, which has an even larger cost advantage $\varepsilon_C > \varepsilon_B > 0$. If this second liberalisation takes place very quickly after the liberalisation with B, due to the presence of contract periods, many countries in A may not even have reached the stage of starting their foreign search, and will automatically choose

the most cost-effective foreign partner: ie country C. If the second liberalisation takes place slightly later, so that many firms have already started their trial matches with firms in B, then we would expect proportion μ^R of these to reject their partners in B at the end of the first match even in the absence of the second liberalisation. These firms, again, will be very price-sensitive and will choose firms from C for their next partners. By contrast, a proportion $1 - \mu^R$ of those firms who had started an initial match with firms in B will have found their first foreign partner satisfactory, and would be less price-sensitive in deciding whether to start trading with C.

If the second liberalisation does not take place until much later, then it is worth noting that as time progresses, fewer and fewer firms in A would still be searching B for a new partner: more would have found satisfactory ones. Consequently, the later is the second liberalisation, the greater the lasting trade advantage country B has over country C.

Proposition 15 *The price sensitivity of a country's trade share with another country, and its vulnerability to being displaced by a new partner, is less the more established is trade between the two initial partners.*

Proposition 16 *The price sensitivity of imports from a third country is lower, and hence the level of optimal tariffs higher, when a customs union between two countries is established rather than recent.*

Since it is usually assumed (in the absence of production economies of scale) that trade patterns which are closest to those indicated by comparative advantage lead to the highest welfare, we can derive another proposition. If trade is liberalised by a series of sequential bi-lateral deals between countries, and if the time-lags between these deals are significant relative

to the length of the contract period c, then the order of trade liberalisation will weigh heavily relative to comparative advantage in determining eventual trade patterns. Consequently

Proposition 17 *The same eventual trade liberalisation deal is likely to be more beneficial to global welfare if reached simulataneously by all countries, rather than if arrived at by a series of sequential bilateral deals.*

4 A numerical example

A worked example shows the importance of the historical sequencing of trade liberalisation deals. Let us examine a three country example, starting with complete autarky. The model is a partial equilibrium model, in which an industry consists of partnerships between upstream firms, u and downstream firms, d. The overall price PFi of the final good (which is the product of pairs of firms $\{u, d\}$) is normalised at unity in all three markets, $i = A$, B and C. PF_i consists of the upstream price, Pu_i plus the downstream price Pd_i. However the relative upstream and downstream costs vary: I assume that, in equilibrium under autarky, $P_{uA} = 0.4$, $P_{uB} = 0.5$ and $P_{uC} = 0.6$. This implies that of the three countries, A is the most competitive in the upstream part of the industry and the least competitive in the downstream part, while C is most competitive in downstream and least competitive upstream. There is one factor only, labour. The model approach here is partial equilibrium, where the wage rate W is set at unity in all three countries, and total expenditure on the industry's final products is assumed to be a constant amount X, equal in all three countries.

The model here is slightly more complicated than that outlined above. For any firm f of

type h ($h = u$ or d) , maximum potential total output is given by

$$Y_f^* = \gamma_{ih} L_f^{\delta} \tag{13}$$

where γ_{ih} is a productivity scale parameter, depending on country and industry and δ is an elasticity of output with respect to labour input L_f, and assumed to be somewhere between zero and unity. It is assumed that each firm also consumes a fixed amount F_{ih} of its output per annum to run. Overall output of f and its chosen partner g will fall short of Y^* depending upon the match quality μ_{fg}, where potential values of μ are uniformly distributed between zero and unity (as above). We assume

$$Y_f = \mu_{fg}^{1-\delta} Y_f^* \tag{14}$$

It is not difficult to show that, in this model, if wages are set at unity,

$$L_f = \mu_{fg} (\delta \gamma_{ih} P_{ih})^{1/(1-\delta)} \tag{15}$$

$$Y_f = \mu_{fg} \gamma_{ih} (\delta \gamma_{ih} P_{ih})^{\delta/(1-\delta),} \tag{16}$$

and hence we can derive profits

$$\pi_f = \mu_{fg} \gamma_{ih}^{1/(1-\delta)} P_{ih}^{1/(1-\delta)} (\delta^{\delta/(1-\delta)} - \delta^{1/(1-\delta)}) - F_{ih} P_{ih}. \tag{17}$$

It follows that, where prices are constant, output will be proportional to match quality, as before, as will profits before deducting fixed costs.

Firms face an annual interest rate of r and have a match contract period of c, as before. Consequently, we can calculate the reservation match quality for the search process, μ^R as in equation 9) above. The number of firms of each type, upstream and downstream in country i, will equal N_i, and output of the upstream and downstream partners in any pair will be equal.

In equilibrium, profits (after deducting fixed costs) for a firm with the reservation match will equal the expected present discounted value of profits for a new entrant firm, which in turn will equal zero so that at the margin there is no incentive on firms to enter or leave the industry. From this we are able to derive a value for γ_{ih}.[16]

Starting with $r = 5$ per cent per annum and $c = 5$ years, we have a value of $\mu^R = 0.68$ (as shown in Table 1). We will assume total initial demand in each country, $X = 1000$, and prices accruing to the upstream and downstream sections of the industry are as suggested before. In a long-run autarkic equilibrium, average match quality will equal $(1 + \mu^R)/2 = 0.84$. For simplicity we assume the output elasticity with respect to variable labour, $\delta = 0.5$, and that the fixed cost $F_{ih} = 1$ for all firms, which gives us the following values for γ_{ih} and N_i:

Table 2: pre-trade equilibrium values for number of firms, output, labour and profit in three-country model.

[16]First we note that $\gamma_{iu}/\gamma_{iu} = (P_{iu}/P_{id})^{-\delta}$. We can substitute from this into equation (17) noting that where the number of firms is in equilibrium the net profits of a firm on the reservation match quality will equal zero. Hence $\gamma_{ih} = [F_{ih}/(\mu^R(\delta^{\delta/(1-\delta)} - \delta^{1/(1-\delta)}))]^{1-\delta} P_{ih}^{-\delta}$

Country & industry	Price	Gamma	N of firms	For avg firm Net Output	Labour	Profit
A & u	0.4	3.83	682	1.47	0.49	0.09
A & d	0.6	3.13	682	1.47	0.74	0.14
B & u	0.5	3.42	682	1.47	0.62	0.12
B & d	0.5	3.42	682	1.47	0.62	0.12
C & u	0.6	3.13	682	1.47	0.74	0.14
C & d	0.4	3.83	682	1.47	0.40	0.09

We now assume countries A and B initiate a free trade agreement between themselves, but excluding country C with which they still do not trade. This is a partial equilibrium model, in which the industry comprising firms u and d is small, so we assume no effect on wages. Consequently the marginal cost at which a new firm will be expect to be able to enter the market and supply profitably is the same as the pre-trade price: in other words an upstream firm in A will be able to supply at price 0.4 and a downstream firm in B will be able to supply at price 0.5, so that the price for the combined final good in the two countries falls from 1 to 0.9. However, some downstream firms in country A and some upstream firms in country B will have such good (pre-trade) matches that they will continue to produce even after their output price falls. The proportion staying open in this way is given by the formula

$$\Psi i = (1 - \mu^R(P_{iu0} + P_{id0})/(P_{iu1} + P_{id1}))/(1 - \mu^R) \tag{18}$$

and works out at 76 per cent of the initial firms in both cases. The firms in these good initial matches will reduce output since their final prices fall. Total output from surviving

existing matches is therefore reduced to around 63 per cent of its value under autarky. With total expenditure on the good assumed to be fixed (i.e. a Cobb-Douglas upper level utility function), in the new long-run equilibrium total final demand rises by 11.1 per cent. The net result is that downstream firms in country B take an eventual 43 per cent of the downstream market in country A, and upstream firms in A take a similar share of the market in B.

Now consider what happens if countries A and B decide subsequently to open up to free trade with country C as well. C has an underlying comparative advantage (before taking account of match quality) in the downstream industry compared to both A and B. Various dates of liberalisation are considered in Appendix Table 1. The price of each stage of production falls to 0.4, set by the price charged by new entrants to upstream production in A and downstream production in C. According to equation (18), in each country, just over 46% of the original pre-trade domestic-domestic matches can still be profitable. Output of domestic-domestic matches in each country is reduced to 30% of the pre-trade levels. This is irrespective of the timing of the second liberalisation deal.

The trade between A and B, when trade with C is liberalised, will depend crucially upon the timing of the second trade liberalisation: if trade with C is liberalised only one contract period (5 years) after trade between A and B, then only proportion $(1 - \mu^R) = 32$ per cent of pairings between firms in A and B will be of reservation match quality or more, before liberalisation of trade with C. The remaining 68 per cent will switch demand very easily to a new, more profitable trading partner. By contrast, after 4 contract periods, the proportion still searching will be reduced to just 21.4 per cent. 73 per cent of these $A - B$ matches will survive the opening up of trade with C. Taking account of the reduced output of each of these firms as prices fall, trade between A and B is 59 per cent of its level before liberalisation of

trade with C.

Inspecting Appendix Table 1 we can see that, if trade between A/B and C is only liberalised 20 years after trade between A and B, then output of the upstream industry in B will remain at 84 per cent of its initial level, even though it has higher underlying costs compared to the industry in C, whereas if the liberalisation with C took place just 5 years after that between A and B, output of B's upstream industry would be just 34 per cent of pre-trade levels, and if the liberalisations were simultaneous it would be just 24 per cent.

Even though long-term prices (after trade between all three countries is liberalised) and consumer welfare are the same regardless of the sequence and timing of liberalisation, there are at least two forms of welfare costs of delaying the second liberalisation. Firstly, the profits of the upstream firms in B which continue to produce because of the delayed liberalisation with C will be less than the profits of the upstream firms in C which would have taken their place given earlier liberalisation. We could call this the ongoing informational trade diversion effect. Secondly, however, in the intervening years, firms in both A and B will have spent effort (and foregone production) in a search for partners in A/B which was effectively wasted when the possibility of finding more cost effective partners in C was allowed. This could be termed the intermediate search diversion cost.

Definition 18 *'Informational trade diversion' is the trade which takes place between one country and a second, when trade with a third party is potentially more profitable, because the costs of searching for information on partners in a third party outweigh the potential profits from comparative advantage.*

Definition 19 *'Search investment diversion' is the additional cost incurred on partners who*

search for a match in one country under a preferential trading agreement when they could potentially have searched for more profitable matches elsewhere given non-discriminatory trade policies.

Proposition 20 *In a match-searching model, if two countries who have already liberalised trade between themselves delay liberalising trade with a third country, there will be welfare costs from both search investment diversion and informational trade diversion.*

5 The effects of variations on the match-search formulation

The model developed above is rather simple in a number of respects. It assumes there are no specific costs attached to forming a partnership, whether foreign or domestic, but that the quality of a potential match can only be assessed by entering into a trial contract of period c. Introducing a fixed cost for searching in addition to this would raise the overall cost of searching relative to sticking with an existing partner, and so tend to lower the reservation match quality μ^R, encouraging fewer firms to start a search for a foreign partner once trade is liberalised, and to settle on an eventual partner sooner. A lower reservation match quality would mean greater variation in the initial quality of domestic matches. The consequences of these changes are to lower the price elasticities of trade, making the model less neoclassical in its properties.

Other potential changes would be more likely to increase trade price elasticities. For example, as an alternative to picking a random foreign partner for a trial period, a searching firm could expend money (eg hiring an agent) to gain better information on the potential match quality. This would only be done if it lowered the search costs (which in turn would

raise μ^R making trade more price elastic). It would also raise the possibility that, if two domestic firms investigated foreign partners and found the combined potential profits from their respective overseas matches were less than joint profits from sticking together, they could return to each other temporarily for a contract period c, before renewing search. Again this would serve to lower search costs and make trade more price elastic. It would also mean that not all firms who eventually want to trade would necessarily start doing so during the first contract period.

Extension of this model would suggest that firms could investigate a number of potential foreign partners (with diminishing returns to search, since each new partner costs money to investigate but the probability of its being a better partner than the next best in the set investigated falls). Such models would involve a lot of bargaining between a lot of firms (including the original domestic partner) with possibilities of jilting - in consequence they are likely to be complicated.

Another possible modification would be to allow for a constant probability of firm death δ (perhaps with the constraint that this always happens at the end of a contract). On the one hand, this would be rather similar to raising the per contract period discount rate ρ to $\rho + \delta$, so discouraging search and lowering μ^R for firms with existing partners. This would make the model less neoclassical in the sense that trade between firms with existing partners would be less price elastic. On the other hand, in each period there would be a proportion of new firms (or newly bereaved firms) entering the market searching for the first time. These would be very price sensitive in terms of choice of foreign partner. In the very long run, these new firms would dominate demand, though it may take a long time for this to happen.

5.1 Consumer search

Although the match-searching process outlined here applies to inter-firm trade, similar principles could potentially apply to the sale of final consumer goods as well, though with key differences, such as the fact that many consumers purchase commodities from the same suppliers. An investigation into the implications of searching for preferred suppliers by heterogeneous consumers may well produce important insights into the behaviour of import demand over time. Again the key conclusions of the importance of history in determining current import patterns and the importance of sequencing and timing of current trade policy decisions are likely to be similar.

5.2 Networking between firms

The simple model I have set up assumes that firms can only use information they have individually acquired. In practice, there are strong reasons to believe there will be some information-sharing between certain subsets of firms. Mechanisms by which this networking will take place include ethnic or family ties between firm owners, the presence of trade associations, the movement of key staff between firms and the employment of firms to act as agents in the matching process.[17] Clearly, networking can take a wide variety of forms, partly determined by historical, institutional and sociological factors, and the precise nature of the process by which information spreads can have significant effects upon how a country engages in international trade.

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[17]See the articles by Rauch, Feenstra et al and McLaren in the (1999) JIE symposium on Business and Social Networks in International Trade, as well as the introduction by Feenstra and Rauch.

For an illustration of one way in which networking might work in a match-searching framework, consider a particular form of network: a club for firms whose broad characteristics are similar. For example, in Figure 2 (Appendix) upstream firms within the range $U_L - U_H$ are assumed to be eligible to join an industry association. It is assumed that an association member u who matches with an overseas firm d will disclose d's identity to other members of the association if 1) firm d falls within the range $D_L - D_H$, which matches most closely with the association's own range, and 2) u has decided its individual match $\mu_{u,d}$ does not meet its reservation match quality.

For association members, the search process is somewhat changed. For a member located at either extreme U_L or U_H, potential matches from within the pool of available partners offered by association members will range from $1-(D_H - D_L)$ to 1, which, if the association is not too wide-ranging in terms of members is considerably better than the expected match quality for non-members. For the most centrally located association member (located at $U^{'}$) the choice is even more attractive, ranging from $1-(D_H - D_L)/2$ to 1. The chances of finding a highly profitable match are increased, while the potential costs of searching are much less, since unattractive matches are ruled out of the pool. It follows that an association member a will have a higher reservation match quality μ_a^{RA} than that for non-members μ^R, and that this is particularly so for the centrally located association members. As a result of this, not only does match quality improve rapidly for an association member, but the eventual long-run equilibrium match quality will be higher than for non-members.

The negative aspect of networking is that, if information is freely available to association members, there is a free-rider problem regarding the initial search for downstream partners. Firm a has little incentive to search for new partners (outside the network's existing pool

of partners), since it is likely the benefit of the discovery will accrue to another association member rather than itself. Consequently, establishing a new network pool may be difficult. It follows that, in the presence of network effects, trade with new overseas partners is likely to be suboptimal, unless there is a good system for reimbursing members of the network who do the searching. This tends to imply that there may be welfare benefits to policies which actively promote trade search.

A further related aspect of networking is that, once a network has become established and has developed a good set of matched partners in two countries, say A and B, the very fact that equilibrium matches between A and B are better than in a solo match-search model means that it may be even more difficult for a third country, C, to break into the market, even after trade is formally liberalised. In this way, networking will reinforce many of the conclusions of the sections above regarding informational trade diversion. However, because the match qualities of those firms in A or B which are in a network and initially matched are distributed much closer to 1 (and hence are more uniform) than in a model with no networking, once firms from C begin to match with the networked firms in A/B, the increase in trade will be more price-elastic than in the absence of networks.

There are ways in which a network may be set up which is more condusive to initial search. For example, one could envisage a setup where upstream firm a may only be able to join an association and access its pool of suitable downstream matches $D_L - D_H$ if a first finds a suitable firm within that range itself, and offers it to the other association members in exchange. This would reduce the free-rider problem. However, if the range $D_L - D_H$ is relatively narrow, it would take a long time before many firms found good enough partners for them to be able to join the association, while if $D_L - D_H$ is wide the potential gains from

membership are small.

5.3 Bayesian search

The above analysis has assumed that, while firms do not know much about individual potential partners, they do at least know the distribution of potential profits with firms by country. However, it may be more reasonable to assume that firms estimate the profitability of trade with a foreign country only by either searching there themselves, or by observing the success or failure of other countries searching for partners there. As successful matches are observed with a foreign country, a firm will revise its Bayesian prior about the profitability of trade.

A Bayesian model of search for trade which incorporates information from observing other firms may well have similar implications to the networking model discussed in the previous section: namely, that one firm's search for foreign partners will carry external benefits in terms of information, and that therefore, if trade costs are lower than historically, there will be a general tendency for trade to be suboptimal, unless there are specific trade-promotion policies.

5.4 Clustering and signalling

There is a considerable literature on agglomeration economies and the supply-side reasons for clustering of firms (see e.g. Krugman, 1991 and 1995). However, it may well be that the concentration of firms of a particular type in a particular locality (such as high-quality steelmakers in Sheffield, UK) may serve as a signal to potential customers aiding the search process. A cluster which arises for geographical or sociological reasons may be reinforced by the fact that its presence becomes known aiding matching (see e.g. the history of the surgical steel

cluster in Sialkot, Pakistan, discussed in Schmitz, 1999). One result of this signalling process and its facilitation of search may be an intensification of competition among local suppliers, with more intense competition, as described in Schmitz, 1999.[18] Local denomination of origin labelling schemes may also aid this signalling and search process.

6 Empirical evidence

The aim of this paper is primarily to draw out some propositions and hypotheses from the application of matching and searching theory to trade. However, it is worth a cursory look at the literature to assess whether there is evidence to back the propositions. Much of the evidence comes from empirical gravity models.

6.1 Historical ties and trade directions.

Rauch (1999) estimates a cross-country gravity model, with products divided into homogeneous and differentiated products. Incorporation of dummies for colonial ties and common language is strongly supported in the case of the latter products, much less so in the former (indicating that historical trade patterns persist much more where goods are differentiated and matching/searching is an important element of trade).

6.2 Habit formation in trade.

While I am not aware of specific evidence on habit formation in trade volumes between any pair of countries, there is some evidence of habit formation with regards to aggregate imports.

[18] In a match-search model, the less costly is the search process, the less monopolistic power an upstream or downstream firm has on a matched partner.

For example, De la Croix and Urbain (1998) estimate non-durable import demand for France and the USA, finding strong support of habit formation (compared to a standard life-cycle model) at least in the latter case.

6.3 The relationship of finance to globalisation.

The match-search model suggests that entering into trade is in part an investment process, and that the availability of cheap capital may boost trade growth and trade price elasticities (favouring openness of policies). Rousseau and Sylla (2001), examining the history of 17 countries over the 1850-1997 period, found a strong link between finance and economic growth and trade, especially prior to the Great Depression. Countries with more sophisticated financial systems engaged in more trade and were better integrated. Econometric analysis and case studies suggested that 'economic growth and the increasing globalization of the Atlantic economies might indeed have been "finance-led".'

6.4 The importance of timing and sequencing of accession to trade agreements.

Freund and McLaren (1999) studied the dynamics of trade in response to enlargement of the EU and other economic blocs. Typically they found an s-shaped adjustment process, lasting about 12 years, with the adjustment being consistent with sunk costs (presumably including search costs). Tariff changes produced step jumps in trade. There is some evidence of anticipatory investment in the cases of EU enlargement and Mercosur.

Trade shares with the EU and trade intensity with the EU increased both among core members when the original EEC was set up, and among the first and second waves of accession countries, starting perhaps 4 years before accession and distributed over a 12 year period. The

initial core members seem to be more closely integrated than the first and second waves of accession, as match-searching theory might indicate, but the second wave of accession seems to have a higher trade intensity with the EU than the first wave.

7 Conclusions

This paper builds on a recent literature which seeks to explain import demand patterns in terms of imperfect information, particularly in the case of interfirm trade in differentiated products. I seek to draw out the potential implications of this class of model by setting out a basic match-search model and investigating its properties. This match-search model goes somewhat further than existing models (e.g. Rauch and Casella, 2003 or Rauch and Trindade, 2003) in the sense that the degree of information on matches is treated as endogenous, being the result of a repeated search of each firm for a good partner by matching successively with various partners for a succession of fixed-period contracts until a good quality match is eventually found. However, perfect information will never be achieved, since searching is potentially costly in terms of output and profits foregone in poor-quality short-term matches. As a result, a firm will be reluctant to give up a reasonably good existing match, especially if contract periods are long and interest rates are high.

The consequences of this type of model both for explaining observed current trade patterns and for analysing the effects of trade policy are potentially significant. It is no surprise that observed trade patterns between countries do not tally easily with comparative advantage, and that considerable 'home bias' and two-way trade in the same commodity class are common. Such features may well represent, at least in part, the vestiges of past changes in alternative production efficiency, transport costs, trade protection and exchange rate movements. Many

firms which developed a market foothold at a time when their home market was relatively sheltered may well be able to maintain it even when that protection is removed. Likewise, firms will gain export and import markets at times when comparative advantage, exchange rate fluctuations or bilateral trade deals favour them may well continue to export or import even when patterns of competitiveness change drastically.

While existing matching models of trade do acknowledge verbally the existence of historical factors in influencing trade links, there is perhaps a failure to emphasise that today's policy decisions are tomorrow's historical factors. Trade diversion from a preferential trading agreement may well persist as informational diversion well after the preferential agreement has been scrapped. This is perhaps an important argument in favour of multilateral over bilateral trade liberalisation.

Some of the static and dynamic features of the match-searching framework are perhaps shared by other potential models of import demand, such as habit-formation or informational capital models. However, I suggest there are distinctive features of match-searching models which may have significance for understanding trade policy issues. In particular, there is a key difference between import demand by firms still searching for a satisfactory partner, and demand by firms who have already found such a good partner. In the former case, their demand is very sensitive to changes in prices of relative supply sources, while in the latter demand may be much less price-sensitive. A consequence is that long-standing trade blocs may well have lower import price elasticities and higher optimal tariffs than newer trade arrangements. Countries which are attempting to break into new export markets may find themselves needing to compete keenly on price with other new entrant countries, while established producers may not have the same price-sensitivity.

I then investigate variations on the search process. While some of the assumptions of the basic match-search model here are simplified (such as infinite firm life), and may overstate the degree to which firms can benefit by entering into a match-searching process of trade, on the other hand, there may be incentives for firms to use alternative information-acquiring processes, such as employing agents[19], or copying known competitors with similar characteristics, or by firms in one country congregating in one section of the market, in order to speed the match-search process. Multinational firms, which move into a new country with a list of pre-existing preferred suppliers and purchasers may also be by-passing the match-search process by making use of existing information (though with some costs, in the sense that they will be importing parts from existing overseas suppliers rather than finding potentially cheaper local sources), and presumably gaining a rent from their ability to re-use existing information across the world. Networking between firms is an important variation on the match-searching process: on the one hand there is potential for reducing search costs and improving eventual match. On the other hand, many types of network structure will introduce a free-rider problem, so that firms are reluctant to initiate a search process, and trade will be suboptimal in the absence of positive trade promotion policies.

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Appendix Table 1: Importance of the order and timing of trade liberalisation for eventual net export patterns.

Country	Industry	Production	Consumption	Net export
Pre-trade				
A	u	1000	1000	0
	d	1000	1000	0
B	u	1000	1000	0
	d	1000	1000	0
C	u	1000	1000	0
	d	1000	1000	0
After Initial Liberalisation Between A and B				
A	u	1811	1000	811
	d	411	1000	-589
B	u	411	1000	-589
	d	1811	1000	811
C	u	1000	1000	0
	d	1000	1000	0
If A and B liberalise trade with C after 20 years				
A	u	3269	1250	2019
	d	240	1250	-1010
B	u	240	1250	-1010
	d	843	1250	-407
C	u	240	1250	-1010
	d	2666	1250	1416
If A and B liberalise trade with C after 5 years				
A	u	3269	1250	2019
	d	240	1250	-1010
B	u	240	1250	-1010
	d	342	1250	-908
C	u	240	1250	-1010
	d	3168	1250	1918
If A, B and C liberalise all trade in year 1.				
A	u	3269	1250	2019
	d	240	1250	-1010
B	u	240	1250	-1010
	d	240	1250	-1010
C	u	240	1250	-1010
	d	3269	1250	2019
If all trade was always liberalised				
A	u	3750	1250	2500
	d	0	1250	-1250
B	u	0	1250	-1250
	d	0	1250	-1250
C	u	0	1250	-1250
	d	3750	1250	2500

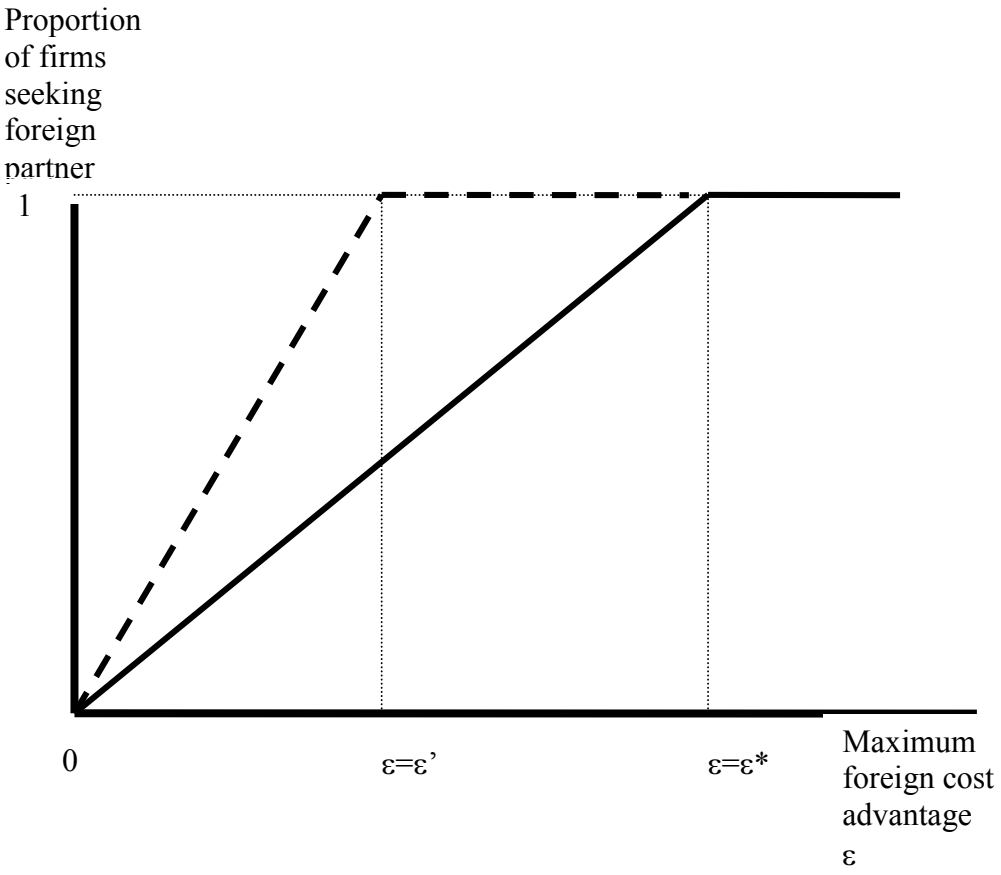

Figure 1: Proportion of firms seeking a foreign partner related to the maximum foreign cost advantage compared to domestic partnerships.

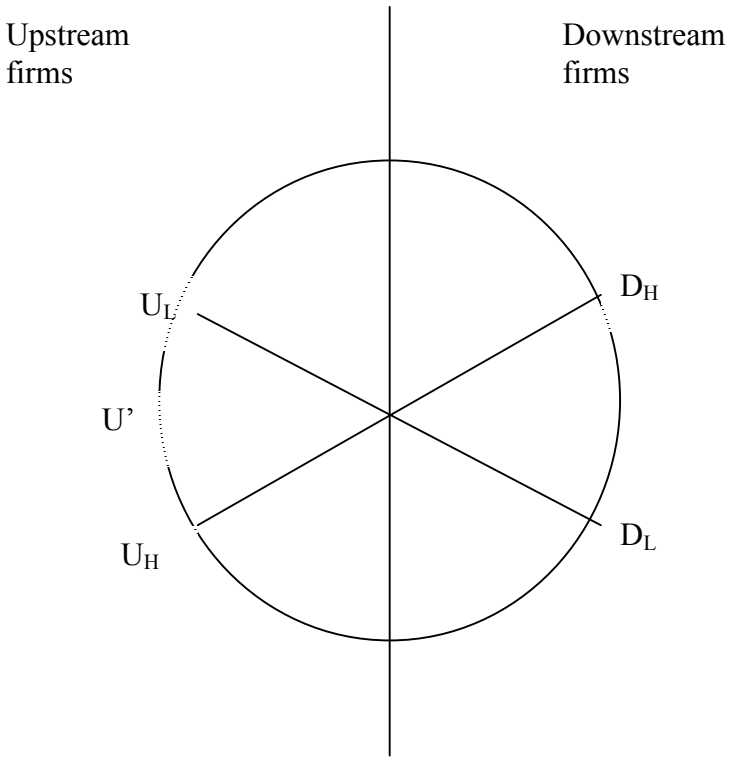

Figure 2: A possible trading network of upstream firms located between U_L and U_H exchanging information on downstream partners located between D_L and D_H.