

# Import Search and the Path Dependency of 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 has important implications for the timing of trade liberalisation.

KEYWORDS: Trade, Protection, Search, Outsourcing

JEL Classification: F00, F12, F13

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This paper presents an alternative to the traditional view that trade decisions are made under perfect information. With differentiated products and suppliers of variable reliability, detailed knowledge of trading partners is important for many types of goods and services, yet although there is a relatively new literature exploring the nature of matching in trade and evidence for its existence, the implications for trade policy and the dynamics of trade flows have not, to date, been explored. In the presence of imperfect information, path dependency may conceivably be just as important on the demand as the supply side of trade. Search theory indicates that not only will the current pattern of trade reflect past costs and policy decisions, but the price elasticity of import demand will be path-dependent. Equally importantly, today's trade policy decisions will have important implications for future trading patterns and likely future policy decisions.

To investigate these implications, I build on existing matching models of trade to incorporate search. 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. If economies are seen as moving from being relatively closed initially,<sup>1</sup> then contract periods and the availability of finance will greatly affect growth of trade. The behaviour of trading firms depends to a large extent upon whether they are already well-matched or still searching for partners. Countries with a large initial number of well-matched firms will show relatively low price elasticities of

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<sup>1</sup>Trade increased from 6 per cent of global GDP in 1950 to 15 per cent by the mid 1990s (source: Maddison, unpublished).

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.

While there are many applications of this theory, I focus here particularly upon the implications for the sequencing and timing of trade liberalisation decisions. It is shown, using a fairly simple example, that match-searching theory strengthens the argument that global welfare is likely to be enhanced by liberalising trade multilaterally rather than by stepwise bilateral deals. However, individual countries may lose from this route, and I investigate the circumstances under which bilateral deals may serve as stepping stones towards global liberalisation.

## **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 investigate the significance of the path-dependency of match-searching models of trade for sequential trade liberalisation agreements.

Section 5 suggests other possible applications of the model. Finally, in section 6, I briefly 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.

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

The notion of path dependency on the supply side of international trade is a familiar one, developed from the infant industry argument and running through the more recent literature on ‘learning by doing’, scale and agglomeration economies in trade, which can broadly be labelled the ‘New Trade

Theory’.<sup>2</sup> However, there has been much less recognition of the importance of history and path-dependency on the demand side.

Two important characteristics of import demand are:-

1) In general countries trade far less between each other than the theory would predict even when account is taken of transport costs.<sup>3</sup>

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.<sup>4</sup>

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<sup>2</sup>See eg Grossman and Helpman (1993)

<sup>3</sup>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 Treffer as ‘missing trade’. Other studies (e.g. Anderson and van Wincoop, 2003) find much smaller residual border effects.

<sup>4</sup>Rauch (1999) estimates a cross-country gravity model, with products divided

Much of the current literature ascribes these patterns to either technical barriers to trade<sup>5</sup> or to exogenous differences in demand patterns, or argues that transactions costs are underestimated in the gravity literature.<sup>6</sup> However, the idea of habit formation in preferences has gradually been introduced, at least for aggregate import demand.<sup>7</sup>

I argue these observed patterns may, to a large extent reflect not exogenous differences in preferences, but the rational response of firms and consumers to a situation where their information on trading partners is incomplete, reflecting in turn low historic trade volumes. This implies that import demand might best be seen in terms of matching and searching theory. To date, such a theory 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 'love of variety' model,<sup>8</sup> 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 have only

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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).

<sup>5</sup>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).

<sup>6</sup>Obstfeld and Rogoff, 2000.

<sup>7</sup>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. 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.

<sup>8</sup>Dixit and Stiglitz (1977).

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: if a firm already has ties to the region, or if there are common language ties or strong historic trading links the threshold will be higher. 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<sup>9</sup> 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.<sup>10</sup>

Such ties, as well as existing patterns of networking may potentially explain observed trading patterns.<sup>11</sup> 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 foreign partners as exogenous. In reality, it is probably more sensible to see information

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<sup>9</sup>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.

<sup>10</sup>See Rauch and Casella, 2003.

<sup>11</sup>Evidence of similar informational effects in determining cross-border capital flows is presented by Portes and Rey (1999).

as a valuable 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. If this model is combined with a history where transport costs were much higher, and protectionist barriers much greater in the past than today, then it is quite conceivable that today's observed border effects in trade may reflect the ongoing informational effects of past barriers.

## **2.1 Match-searching in trade**

In this paper, I introduce the assumption that firms acquire information by a search process over time. I start off with a simple model: this search is 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 until it enters into it. 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 of 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.

## **2.2 A simple model of match-searching**

In one-off matching models (see Rauch and Casella, 2003), 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,  $\mu_{ud}$  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  $\mu_R$ .<sup>12</sup>

To set up a basic theoretical model, I start by assuming that firms are distributed uniformly, in terms of some key characteristics, along the perimeter of a circle,<sup>13</sup> circumference length 2. The circle is simply a diagrammatic representation of the a simple probability distribution in which firms are evenly and uniformly distributed in terms of their characteristics, and no firm is intrinsically superior to another. Each firm aims to match with the firm directly opposite on the circle<sup>14</sup>: match quality,  $\mu_{ud}$ , 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 the real output of each firm (defined here to be equal,

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<sup>12</sup>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).

<sup>13</sup>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 differs in assuming that repeated matching is feasible.

<sup>14</sup>This could be taken as a schematic representation of complementarity between firms.

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  $Y_u$ .  $\pi_u, \pi_d$  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 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 uniformly 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

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

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

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,  $\mu_R$ , 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 imply 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.<sup>15</sup> Importantly, I also assume for simplicity that a firm has accurate prior knowledge about the probability distribution of match quality with potential partners, even though it lacks information on the quality of an individual match.

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  $\mu_R$ ). After  $n$  periods, the probability that it has still not found a satisfactory match is  $(\mu_R)^n$ , so the proportion of firms which will have found satisfactory partners by period  $n + 1$  is  $1 - (\mu_R)^n$  while the proportion still searching will be  $(\mu_R)^n$ .

Looking in more detail at period  $n + 1$  the expected profit for those firms

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<sup>15</sup>The analysis is considerably complicated by introducing circumstances where one firm which thought it had a satisfactory match might be jilted by its partner.

which are still searching can be written as  $\phi\beta/2$ , where  $\phi$  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  $(\phi\beta/2)(1 + \mu_R)$ ; in other words it exceeds the expected profit of searching firms by  $(\phi\beta\mu_R/2)$ . Expected profit over all firms in period  $n + 1$  will therefore be

$$\pi_{S_{n+1}}^e = (\phi\beta/2)\{1 + \mu_R - (\mu_R)^{n+1}\} \quad (5)$$

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**Derivation of equation (5)**

$$\pi_{S_{n+1}}^e = (\phi\beta/2)\mu_R^n + (\phi\beta(1 + \mu_R)/2)(1 - (\mu_R)^n),$$

$$\pi_{S_{n+1}}^e = (\phi\beta/2)\{\mu_R^n + (1 - (\mu_R)^n) + \mu_R - (\mu_R)^{n+1}\}.$$

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By contrast, if initial match quality is  $\mu_{ud}$ , 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  $B_{S_{n+1}}^e$  in period  $n + 1$  of having started by searching rather than not searching is

$$B_{S_{n+1}}^e = (\phi\beta/2)\{1 + \mu_R - 2\mu_{ud} - (\mu_R)^{n+1}\} \quad (6)$$


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**Derivation of equation (6)**

$$B_{S_{n+1}}^e = \pi_{S_{n+1}}^e - (\phi\beta\mu_{ud}/2) = (\phi\beta/2)\{1 + \mu_R - 2\mu_{ud} - (\mu_R)^{n+1}\}.$$


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Assuming a constant reservation match quality  $\mu_R$ , and constant interest rate  $r$  per annum, which, crucially, can be converted to an interest rate  $\rho$  per contract period, where

$$\rho = (1 + r)^c - 1, \quad (7)$$

it is possible to derive the expected net present value  $N_S^e$  (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

$$N_S^e = (\phi\beta/2\rho)(1 + \mu_R - 2\mu_{ud}) - (\phi\beta/2)(\mu_R/(1 + \rho - \mu_R)). \quad (8)$$


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**Derivation of equation (8)**

$$\begin{aligned}
N_S^e &= \sum_{n=0}^{\infty} (\phi\beta/2) \{1 + \mu_R - 2\mu_{ud} - (\mu_R)^{n+1}\} / (1 + \rho)^{n+1}, \\
&= \sum_{n=0}^{\infty} (\phi\beta/2) \{1 + \mu_R - 2\mu_{ud}\} / (1 + \rho)^{n+1} - \sum_{t=1}^{\infty} (\phi\beta/2) (\mu_R / (1 + \rho))^{n+1}, \\
&= (\phi\beta/2) \{1 + \mu_R - 2\mu_{ud}\} / \rho - (\phi\beta/2) [1 / ((1 + \rho) / \mu_R) - 1].
\end{aligned}$$

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When  $\mu_{ud} = \mu_R$ ,  $N_S^e = 0$ . After carrying out some 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

$$\mu_R = 1 + \rho - \sqrt{\rho(1 + \rho)}. \quad (9)$$

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### Derivation of equation (9)

At any particular value of  $\mu_{ud}$ ,

$$N_S^e = (\phi\beta/2\rho)(1 + \mu_R - 2\mu_{ud}) - (\phi\beta/2)(\mu_R / (1 + \rho - \mu_R)). \quad (8)$$

But when  $\mu_{ud} = \mu_R$ ,  $N_S^e = 0$ ;

$$\begin{aligned}
(\phi\beta/2\rho)(1 + \mu_R - 2\mu_R) &= (\phi\beta/2)(\mu_R/(1 + \rho - \mu_R)); \\
(1 - \mu_R)/\rho &= \mu_R/(1 + \rho - \mu_R); \\
(1 - \mu_R)(1 + \rho - \mu_R) &= \rho\mu_R; \\
1 + \rho - \mu_R - \mu_R - \rho\mu_R + \mu_R^2 - \rho\mu_R &= 0; \\
\mu_R^2 - 2(1 + \rho)\mu_R + (1 + \rho) &= 0;
\end{aligned}$$

$$\begin{aligned}
\mu_R &= [2(1 + \rho) \pm \sqrt{4(1 + \rho)^2 - 4(1 + \rho)}]/2; \\
&= (1 + \rho) \pm \sqrt{(1 + \rho)(1 + \rho - 1)}.
\end{aligned}$$

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

**PROPOSITION 1:** *The reservation match quality  $\mu_R$  depends only on interest per contract period  $\rho$ , which is a function of the interest rate  $r$  and length of contract period  $c$ . Specifically, the shorter the contract period and the lower the interest rate, the nearer  $\mu_R$  will be to unity.*

The implications of this in practice can easily be calculated. For example, with  $c = 1$  year and  $r = 5$  per cent per annum, the reservation match quality  $\mu_R$  will equal 0.82, and average match quality in the long run will be  $(1 + \mu_R)/2 =$

0.91. By contrast, with  $c=10$  years and  $r=15$  per cent per annum,  $\mu_R = 0.54$  and average long-run match quality is 0.77.

While 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  $c$ ,<sup>16</sup> in the long run both will be higher the lower is  $r$  and the lower is  $c$ . This is because with lower  $r$  or  $c$  firms will have a higher reservation match  $\mu_R$ , and so will be prepared to keep searching longer, leading eventually to a better average quality of match. 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  $c$ . We would also expect, of course, that convergence to the long run value will be faster the shorter is the contract period  $c$ .

### 3 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  $\mu_R$  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

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<sup>16</sup>This follows since match quality in the first period of search is assumed to be random.



absence of transport costs or tariffs is  $\pi'$ , which is greater than the maximum feasible for domestic-only partnerships by a factor  $(1 + \epsilon)$ . However, transport costs and tariffs take proportion  $\tau$  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 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  $\mu_R$ , as determined by equation (5.9).

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  $\mu_{RF}$  also satisfying equation (5.9).

But the expected profits of a foreign match quality  $\mu_{RF}$  will equal  $(1 - \tau)(1 + \epsilon)$  times the expected profits of the marginal existing match at home,  $\mu_R$ . 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  $\mu_R$ . 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 5.2:** *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.*

An economy is defined here as mature if all firms have found satisfactory partners.<sup>17</sup>

Of initially matched firms, a small potential profit advantage from a foreign partner,  $\epsilon$ , 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,  $\mu_R$ . Most other firms will not find it worthwhile starting a search unless  $\epsilon$  is considerably larger than this.

**PROPOSITION 2:** *For  $\epsilon > 0$ , all initially searching firms will choose their next partner from abroad. By contrast, among initially matched firms, the proportion choosing to abandon their existing partner to search abroad will only gradually increase as  $\varepsilon$  increases.*

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<sup>17</sup>In practice, of course, no economy will ever reach complete maturity, but in an economy where the great majority of firms have found satisfactory partners, we would expect most of the properties to be close to those of a mature economy.

Henceforth, for simplicity, I will assume transport costs and tariffs are zero (where there is trade), so  $\tau = 0$ . In these circumstances, the last firms will abandon home pairings only when  $\varepsilon \geq (1/\mu_R) - 1$ , ie when

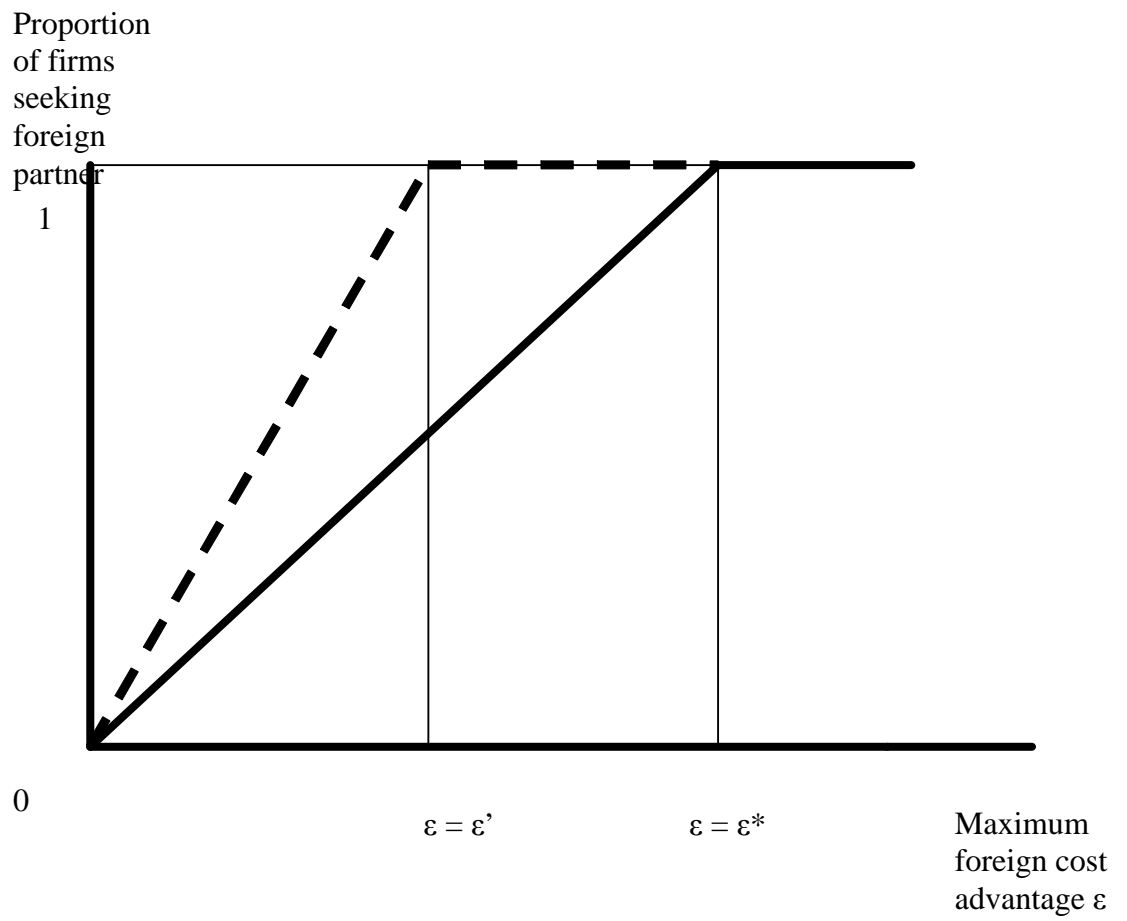
$$\varepsilon \geq \{1/[1 + \rho - \sqrt{\rho(1 + \rho)}]\} - 1. \quad (10)$$

Firms will choose to search abroad if

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

*Figure 1* represents diagrammatically 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  $\varepsilon$  increases from 0 to  $\varepsilon^*$ , where  $\varepsilon^*$  is the value which makes equation (10) an equality.

*Figure 1: effect of a fall in the per contract period discount rate on the proportion of firms seeking a foreign partner related to the foreign cost advantage.*



Now if we allow the per-contract-period discount rate  $\rho$  to fall from  $\rho_0$  to  $\rho_1$ , due either to a fall in the interest rate  $r$  or a shortening of the contract period  $c$ , then the value of  $\varepsilon$  at which all firms look abroad will fall from  $\varepsilon_0^*$  to  $\varepsilon_1^*$ , and the curve showing the response of the proportion of firms seeking foreign matches in response to changes in  $\varepsilon$  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,  $r$ .

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 of its existing partner, but only with those of the expected return from the 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,  $\varepsilon > 0$ .

Another way of putting proposition 3 is that 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. A related conclusion is that the greater the rate of new firm startups in an economy, the greater the

price-sensitivity of imports.

## 4 Path dependency and implications for the sequencing of trade liberalisation.

The difference in behaviour between initially matched and initially searching firms underlies the path dependency of import demand. Once a search process has gone on for long enough, a high proportion of established firms will have found partners and become matched. Once this has happened, they will be much less sensitive to the arrival of new potential trade partners.

This has important implications concerning the sequencing and timing 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  $\mu_R$  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  $C$ .

**LEMMA 1:** *Other things equal, the proportion of firms in a pair of countries which are searching will fall over time following a trade liberalisation between them.*

From this follows:

**PROPOSITION 3:** *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 4:** *The price sensitivity of imports from a third country is lower, and hence the level of optimal tariffs is higher,<sup>18</sup> when a customs union*

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<sup>18</sup>It is worth noting that for optimal tariffs to be non-zero the world supply



*between two countries is established rather than recent.*

#### **4.1 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  $PF_i$  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

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price also has to vary with respect to demand by country  $c$ : i.e. export supply curves have to slope upwards.

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

$$Y_f^* = \gamma_{ih} L_f^\delta \quad (12)$$

where  $\gamma_{ih}$  is a productivity scale parameter, depending on country and industry and  $\delta$  is the 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  $\mu_{fg}$ , where potential values of  $\mu$  are uniformly distributed between zero and unity (as above). We assume

$$Y_f = \mu_{fg}^{1-\delta} Y_f^* \quad (13)$$

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

$$L_f = \mu_{fg} (\delta \gamma_{ih} P_{ih})^{1/(1-\delta)}, \quad (14)$$

$$Y_f = \mu_{fg} \gamma_{ih} (\delta \gamma_{ih} P_{ih})^{\delta/(1-\delta)}, \quad (15)$$

and hence we can derive profits

$$\pi_f = \mu_{fg} \gamma_{ih}^{1/(1-\delta)} P_{ih}^{1/(1-\delta)} (\delta^{\delta/(1-\delta)} - \delta^{1/(1-\delta)}) - F_{ih} P_{ih}. \quad (16)$$

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Derivation of equations (14)-(16)

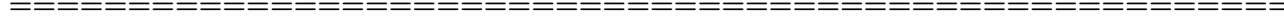
$$\begin{aligned}
Y_f &= \mu_{fg}^{1-\delta} Y_f^*, \\
&= \mu_{fg}^{1-\delta} \gamma_{ih} L_f^\delta \text{ from (5.12)}.
\end{aligned} \tag{13}$$

$$\partial Y_f / \partial L_f = \delta \mu_{fg}^{1-\delta} \gamma_{ih} L_f^{\delta-1} = 1/P_{ih};$$

$$L_f = \mu_{fg} (\delta \gamma_{ih} P_{ih})^{1/(1-\delta)}, \tag{14}$$

$$\begin{aligned}
Y_f &= \mu_{fg}^{1-\delta} \gamma_{ih} L_f^\delta = \mu_{fg}^{1-\delta} \gamma_{ih} \mu_{fg}^\delta (\delta \gamma_{ih} P_{ih})^{\delta/(1-\delta)}, \\
&= \mu_{fg} \gamma_{ih} (\delta \gamma_{ih} P_{ih})^{\delta/(1-\delta)}.
\end{aligned} \tag{15}$$

$$\begin{aligned}
\pi_f &= P_{ih}Y_f - L_f, \\
&= \mu_{fg}\gamma_{ih}^{1/(1-\delta)}\delta^{\delta/(1-\delta)}P_{ih}^{1/(1-\delta)} - \mu_{fg}(\delta\gamma_{ih}P_{ih})^{1/(1-\delta)}, \\
&= \mu_{fg}\gamma_{ih}^{1/(1-\delta)}P_{ih}^{1/(1-\delta)}[\delta^{\delta/(1-\delta)} - \delta^{1/(1-\delta)}]. \tag{16}
\end{aligned}$$



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,  $\mu_R$  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  $\gamma_{ih}$ .<sup>19</sup>

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

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<sup>19</sup>First we note that  $\gamma_{iu}/\gamma_{id} = (P_{iu}/P_{id})^{-\delta}$ . 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  $\gamma_{ih} = [F_{ih}/(\mu_R(\delta^{\delta/(1-\delta)} - \delta^{1/(1-\delta)}))]^{1-\delta}P_{ih}^{-\delta}$ .

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  $\gamma_{ih}$  and  $N_i$ :

*Table 1: pre-trade equilibrium values for number of firms, output, labour and profit in three-country model.*

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

$$\Psi_i = (1 - \mu_R(P_{iu0} + P_{id0})/(P_{iu1} + P_{id1}))/ (1 - \mu_R) \quad (17)$$

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 5.2 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 3:** *‘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 4:** *‘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 5:** *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 Other areas of application**

### **5.1 Search information as capital**

We can view information on potential matches as an important, but neglected, form of human capital. Our model suggests that there are strong parallels between the economics of accumulation of search information and that of other forms of capital. The ‘lumpiness’ of a match (i.e. the length of contract period in our model) is an important aspect of the cost of accumulation of capital. Our model indicates that import demand elasticities and export supply elasticities should be lower for ‘lumpy’ products, and also lower during prolonged periods of high interest rates. The latter property really results from the idea that information is a form of capital, involving finance to cover the investment in attaining better information by searching. In addition, 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.

In general we would expect that imports and exports should be more price sensitive the shorter are foreign contracts and/or the lower the interest rate, as well as the better-developed are financial institutions. This is to some extent borne out by historical research: 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’.

We would also expect the financial climate to affect countries’ behaviour with respect to trade: other things equal, the lower are interest rates, the lower are optimal tariffs and the greater is the likelihood of more open trade policies.

## 5.2 Dynamics of trade

The dynamics of trade are another area where match-searching has potential application. 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 6:** *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, 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 proceeds, 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<sup>20</sup>

$$\varepsilon > (2\mu_R - 1)/(1 - \mu_R). \quad (18)$$

As  $r$  and/or  $c$  are reduced to zero,  $\mu_R$  will tend towards 1 and first period output is more likely to increase for any price advantage to trade.<sup>21</sup>

As for effects on output: 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,  $\varepsilon$ , 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.

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<sup>20</sup>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  $\mu_R$  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  $\alpha(1 + \varepsilon)/2$ .

<sup>21</sup>For larger values of  $\varepsilon$ , total output in the first period will only increase if  $\varepsilon > \mu_R$ .

### 5.3 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  $\mu_R$ , 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  $\mu_R$  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 re-

newing 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  $\delta$  (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  $\rho$  to  $\rho + \delta$ , so discouraging search and lowering  $\mu_R$  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.

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.

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.<sup>22</sup> 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.

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  $f$  has little incentive to search for new partners (outside the network's existing pool of partners), since it is likely the benefit

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<sup>22</sup>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.

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.

The precise way in which a network is set up may well determine how conducive it is to search. This may be a way in which institutional culture of countries may be reflected in their responsiveness to trade liberalisation. Another related extension worth investigating is that the search process may also be aided by clustering of firms of a given type in a given locality, or by the use of signals by firms to indicate their type.<sup>23</sup>

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<sup>23</sup>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).

A final suggested extension is Bayesian search, where 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. Such models will tend to give welfare benefits to active trade-promotion policies.

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