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Abstract

This note explores the value of search capital in interfirm matches in the outsourcing trade, by extending Rauch and Casella's (2003) framework to a dynamic model of matching and searching. On provisional calculations, the sunken cost of this search imposes a similar order of magnitude trade barrier to most tariffs, and would be expected to affect both the intensive and extensive margins of trade.

KEYWORDS: Trade, Search, Matching, Capital. JEL Classification: F00, F12, F13

1   Introduction

The trade literature emphasises that there are substantial unspecified barriers impeding the international flow of goods and services. Trefler (1995) shows that the factor content of international trade falls far short of that predicted by the Heckscher-Ohlin-Vanek model. McCallum (1995) demonstrates the presence of large national border effects.[1] While there is no single cause for these discrepancies, two important factors have emerged: firm-level studies (Tybout, 2002) have found evidence of substantial, unspecified sunken costs of entering new markets - a finding which underlies much of the recent literature on firm heterogeneity and trade (Bernard and Jensen, 1999, Ghironi and Melitz, 2005, Bernard *et al*, 2007). In addition, gravity studies indicate significant informational barriers to trade (Rauch and Trindade, 2003). These two ideas are potentially interlinked[2]: if the search for information on trade partners is costly, and that information yields a return to those searching, then it can be viewed as a form of capital outlay. Of course, there are variants on this, depending upon the extent to which information is private, excludable and sharable within networks (free, or alternatively in return for an fee[3]).

In this note, I develop the idea in more detail, concentrating especially on the capital formation process in outsourcing relationships - such as those between Chinese garment producers and Western distribution firms. Typically, these are relationships between 'upstream' and 'downstream' trading firms, which entail contracting arrangements, even if they are relatively short-term.[4] Such ties lead to a searching/matching process: if the relationship between the firms proves successful, it will be maintained in the long term, while otherwise the firms will move on.

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[1] The difference in trade between Canadian provinces and that with neighbouring US states, when corrected for size and difference, is a matter of 22-fold, though later studies (Anderson and van Wincoop, 2003) greatly reduce this discrepancy.

[2] Rauch (1996).

[3] As in Rauch and Watson (2004)

[4] Besedes and Prusa (2006) estimate the median trading relationship is around 1 year, and argue it supports a searching/matching process.
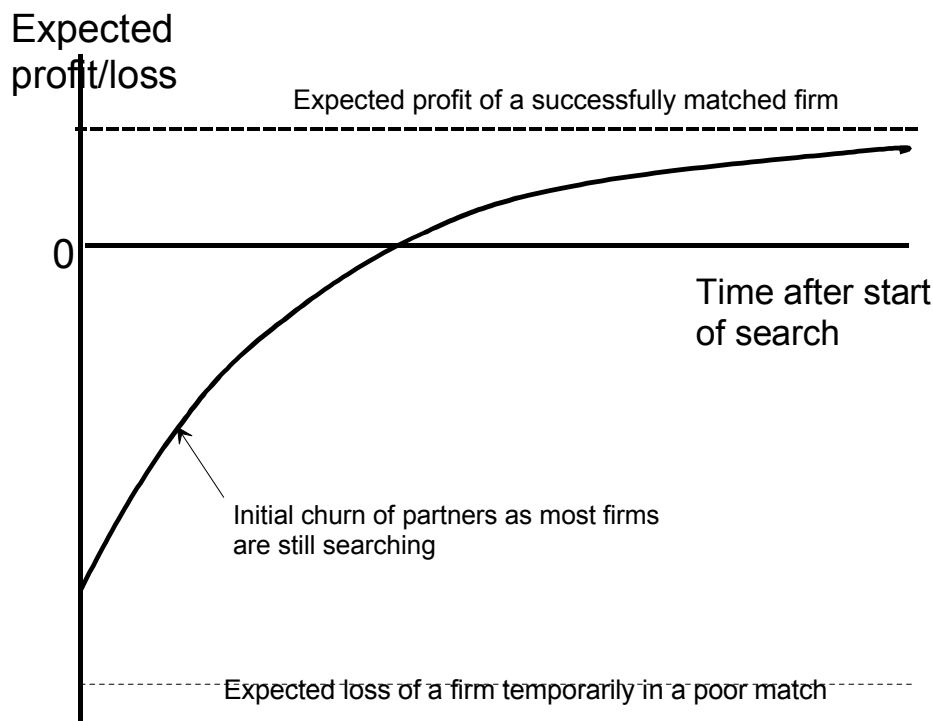
Figure 1: trend in average profit of searching firms over time, following start of search.

Following trade liberalisation[5] there will be a churn of searching firms, with many pairings making losses. Eventually, profitable pairings will emerge as dominant. This process is shown in *Figure 1.*, showing expected profit increasing over time. With free entry and exit and random match profitability, then firms entering the industry will expect, *ex ante*, to make just sufficient long-run profit to cover the interest costs of losses during the initial search. In the absence of spillovers, we would expect the average profit in long-run equilibrium to equal the interest on the costs of informational capital formation. By modelling the dynamic process of searching for matches, we can derive this long-run return, and hence estimate the implicit value of informational search capital.

2   A schematic model of match-searching in the outsourcing trade

I set up an illustrative model. Outsourcing requires the partnership of an upstream firm, u, and a downstream firm, d, which, for reasons of comparative advantage, will locate in different countries when trade is unimpeded. u sells a semi-finished good to d, who then completes the manufacture and sells it on to final consumers. The two firms are of equal size and *ex ante* expected efficiency: however, productivity varies depending on the goodness of fit of the match, μ_i. As in Rauch and Casella (2003), match quality, μ, follows a uniform, rectangular distribution

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[5]Or even, in some circumstances, in anticipation of trade liberalisation (see Edwards, 2006).

between 0 and 1, and firms do not know μ_i before entering a match i, though they know its overall distribution.

Search friction derives from the need for at least one firm to make a relationship-specific investment: in order to avoid a potential hold-up problem,[6] this generally requires a contractual relationship for at least some minimum period, which I characterise by a fixed contract period, t, during which the two firms have an exclusive relationship.

Firms employ just labour, both variable and fixed, the latter being renewable once per contract period.[7] This fixed labour cost is normalised at unity, so that profits are

$$\pi_{ui}, \pi_{di} = \beta\mu_i \text{ before the fixed cost and} \tag{1}$$

$$\Pi_{ui}, \Pi_{di} = \beta\mu_i - 1 \text{ excluding the fixed cost.} \tag{1a}$$

Since μ_i is uniformly distributed between zero and unity, expected initial match quality is $\mu_i^e = \frac{1}{2}$. *Ex ante* expected profitability from a random match is therefore

$$\pi_{ui}^e, \pi_{di}^e = \frac{\beta}{2}; \tag{2}$$

$$\Pi_{ui}^e, \Pi_{di}^e = \frac{\beta}{2} - 1. \tag{2a}$$

The annual discount rate, r, equates to a discount rate of ρ per contract period, where

$$\rho = (1+r)^t - 1. \tag{3}$$

I concentrate on a case where the industry is small in comparison to the economy as a whole, and wages are exogenous.

At the end of each contract period, a firm which had still been searching in the previous period will assess whether its latest match is worth sticking with ($\mu \geq \mu_R$, the reservation match quality,[8] which will occur with probability $1 - \mu_R$) or whether it should again renew search (probability μ_R). If the quality of successive matches is serially independent, then in period $n + 1$, a proportion $1 - \mu_R^n$ will still be searching.

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[6] See Hart (1995).

[7] This means there are no long-run sunken costs, other than that of the search.

[8] The switchpoint of a search process (Kohn and Shavell, 1974).

In period $n+1$, the expected profit before fixed costs for those firms which are still searching can be written as $\frac{\phi\beta}{2}$, where ϕ $(= \frac{(1-(1+r)^{-t})}{r})$ is an adjustment for the length of the contract period. Expected profit for firms which find a satisfactory partner equals $\frac{\phi\beta}{2}(1+\mu_R)$, while that for unsuccessful matches averages $\frac{\phi\beta\mu_R}{2}$. Expected profit over all firms will therefore be

$$\pi^e_{Sn+1} = \frac{\phi\beta}{2}(1 + \mu_R - \mu_R^{n+1}). \tag{4}$$

By contrast, if initial match quality is μ_{i0}, then if the firm chooses from the beginning to stick with its initial partner, its profit in each period will be $\phi\beta\mu_{i0}$. The net expected benefit, B^e_{Sn+1}, in period $n+1$ of having started by searching rather than not searching is

$$B^e_{Sn+1} = \frac{\phi\beta}{2}(1 + \mu_R - 2\mu_{i0} - \mu_R^{n+1}). \tag{5}$$

The expected net present value (to the beginning of the search process) of profits for a firm which chooses to start by searching, N^e_S, is a geometric progression, which can be summed to yield

$$N^e_S = \frac{\phi\beta}{2\rho}(1 + \mu_R - 2\mu_{i0}) - \frac{\phi\beta}{2}\frac{\mu_R}{(1 + \rho - \mu_R)}. \tag{6}$$

When $\mu_{i0} = \mu_R$, $N^e_S = 0$, which is satisfied by the roots of a quadratic equation, of which only the smaller is feasible:

$$\mu_R = 1 + \rho - \sqrt{\rho(1+\rho)}. \tag{7}$$

μ_R is decreasing in ρ (for $\rho > 0$), and hence in terms of r and t. For example, with $t = 1$ year and $r = 5$ per cent per annum, μ_R will equal 0.82, and average long-run match quality will be $\frac{1+\mu_R}{2} = 0.91$.

3　Search information as capital

In a long-run equilibrium, where all firms have found satisfactory partners, normalising the fixed labour cost of each firm to equal unity, the average annual profit of a matched firm after subtracting fixed costs is

$$\overline{\Pi}_f = \frac{1 - \mu_R}{2\mu_R} - 1 = \frac{1 - \mu_R}{2\mu_R}. \tag{8}$$

This equals the interest cost on the average expected level of search capital, $r\overline{SK}$.

4　Comparison to trade flows

To gauge the effect of trade search costs, I compare it to the value of trade flows. For this, it is necessary to develop the model more explicitly. Assume that a large number firm pairings sell their joint output in a Krugman-style monopolistically competitive environment. Initially we will write a simplified demand function for the joint output of firm pair i as

$$Y_u = Y_d = Y_i = \left(\frac{P_i}{A}\right)^{-\varepsilon}, \tag{9}$$

where the number of firms is large and ε approximates the Dixit-Stiglitz elasticity of substitution between varieties. A will shift if rival firm pairs enter or exit the market. The unit variable cost of each firm is $C_i(\mu_i)$, where C_i is assumed equal for the two firms and declining in terms of μ_i. Profit-maximising output is

$$Y_i^* = \left(\frac{\varepsilon}{\varepsilon - 1} \frac{2C_i}{A}\right)^{-\varepsilon}. \tag{10}$$

Assuming equal Nash bargaining weights for u and d, profit of each firm before taking account of fixed costs,

$$\pi_u = \pi_d = \frac{A}{2\varepsilon} Y_i^{* \frac{\varepsilon - 1}{\varepsilon}}. \tag{11}$$

Since we want π_u and π_d to be proportional to match quality, we set (11) equal to profit in (1) and rearrange. Where $\mu_i = \mu_R$, $\pi_u = \pi_d = 1$ and $\beta = \frac{1}{\mu_R}$, which gives $\pi_i = \frac{\mu_i}{\mu_R}$. Consequently, output,

$$Y_i^{* \frac{\varepsilon - 1}{\varepsilon}} = \frac{2\varepsilon}{A} \frac{\mu_i}{\mu_R}, \tag{12}$$

implying that the value of trade between the two firms is also proportional to match quality:

$$V_i^* = \frac{P_i^* Y_i^*}{2} = \frac{\mu_i}{\mu_R}\varepsilon. \tag{13}$$

The average match quality of successful matches is $\frac{1+\mu_R}{2}$, so the value of trade flow between an average successful pairing,

$$\overline{V} = \frac{1 + \mu_R}{2\mu_R}\varepsilon, \tag{14}$$

and hence the ratio of the interest cost on search capital to the trade flow between an average successful pairing is

$$\frac{r\overline{SK}}{\overline{V}} = \frac{1 - \mu_R}{1 + \mu_R}\frac{1}{\varepsilon}. \tag{15}$$

As an illustration, where $r = 5\%$ and $t = 1$ year - in line with Besedes and Prusa (2006) - our model indicates an annual interest cost of search capital of around 5 per cent of the total value of trade for a typical pairing facing a demand elasticity of 2. This would drop to 2 per cent for a demand elasticity of 5. Longer contract periods or higher interest rates can raise this cost quite considerably (see *Figures 2a* and *2b*).
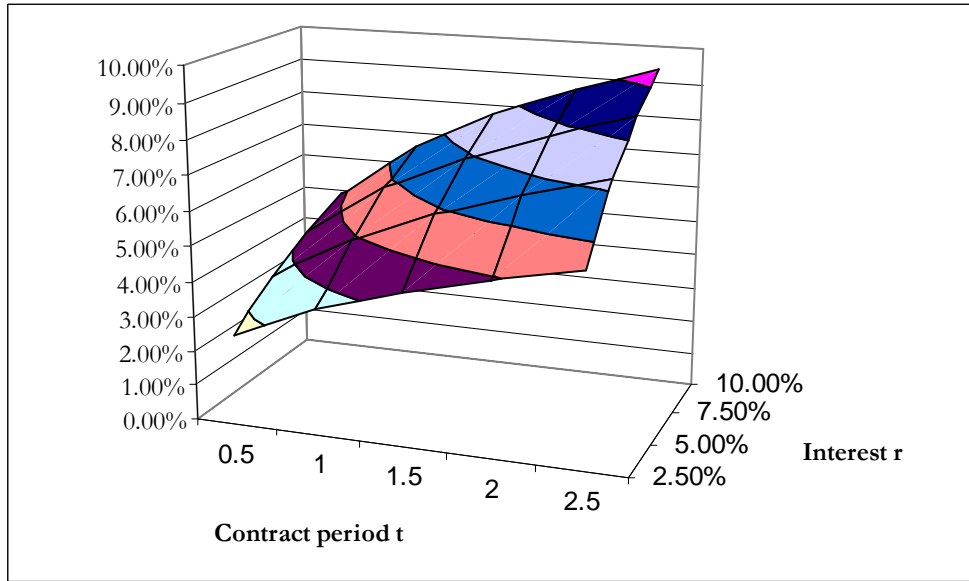

Figure 2a: interest cost of search as proportion of trade value, elasticity of demand=2.
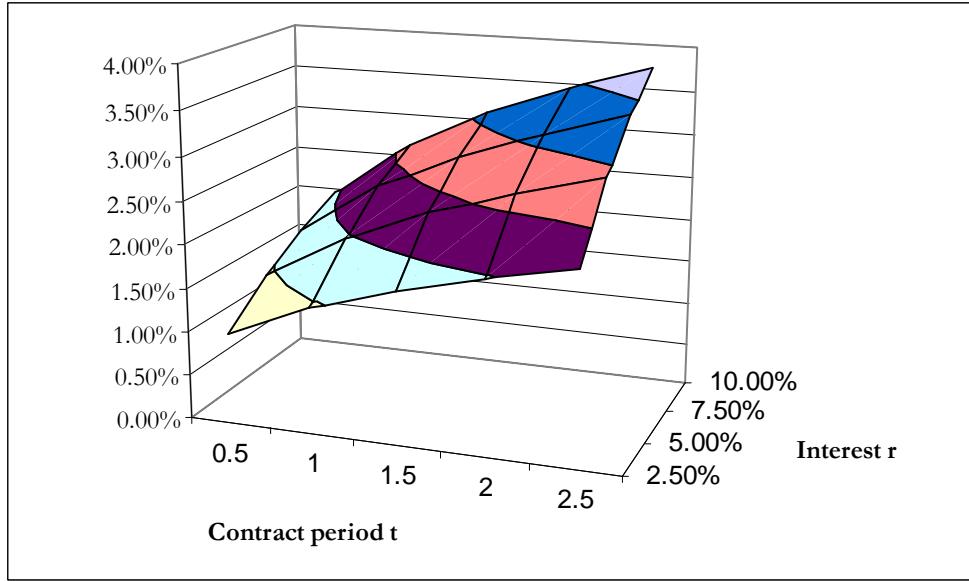
Figure 2b: interest cost of search as proportion of trade value, elasticity of demand = 5.

Over the ranges investigated $(2.5\% \leqslant r \leqslant 10\%; 0.5 \leqslant t \leqslant 2.5)$, the value of search capital stock varies from 48 to 118 per cent of trade value, when the typical elasticity of demand is 2, falling to $19 - 87$ per cent when the elasticity is 5. For a pairing of given match quality, μ_i, the cost of search would reduce sales by between 5 and 17 per cent (in both elasticity cases). This represents the effect on firms' intensive margins: however, search costs can also potentially affect extensive margins, since firms will not enter into a search for partners at all, unless there is a large enough comparative cost advantage (of proportion $\frac{1-\mu_R}{\mu_R}$) for trading pairings.

5 Conclusions

By extending the one-off matching model (Rauch and Casella, 2003) into dynamic search by repeated matching, it is possible to derive the scale of search capital costs and relate it to the value of trade . The functional form is relatively simple, and no account is taken of the role of networks in information-sharing, which requires further research. However, these rather rough calculations indicate provisionally that search costs may well be of a similar order of magnitude to typical tariff barriers.

The relationship to the recent literature on firm heterogeneity and market entry (Ghironi and Melitz, 2005) is interesting. Search costs are certainly a credible cause of the inferred sunk cost of entering new markets, and are consistent both with the selection bias towards more efficient firms and with the fact that only the most efficient exporting firms enter several markets (Bernard *et al*, 2007). In the long run, trading firms may be more profitable,

not just because the more productive firms self-select to enter trade, but also because of the return on the short-run search costs for partners, with trade search, in itself, producing further heterogeneity across firms.

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