International Trade and Search

Pertti Haaparanta*

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Abstract

The standard two-country monopolistic competition model of international trade by Helpman and Krugman based on S-D-S preferences is extended to allow for costly search between producers of varieties and retailers. This extension endogenously divides firms to closed (domestic producers matched with domestic retailers) and open sectors. Trade policies have an effect on this division. Trade policies have also an effect on the long term gross firm and job creation and destruction. In a symmetric equilibrium an increase in tariff (by both countries) increases the gross flow of firms in all sectors while gross job flows increase in the closed sector and decrease in the open sector. The welfare of effects of tariffs are surprising. Tariffs can improve welfare if they switch enough resources from the producers searching a partner from producers already matched. This is a novel result not to be found in the literature before. Another novel result is that in the model the non-equivalence of tariffs and quotas is highlighted. The consequences of differences in factor endowments are also studied. In the necessarily asymmetric equilibrium the small country has a lower wage rate than the large country. Its production of each of its exported variety is larger than the production of exported varieties in the large country.

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Contact: Pertti Haaparanta, Department of Economics, Helsinki School of Economics, PO Box 1210, FIN-00101 Helsinki, Finland

email: Pertti.Haaparanta@hkkk.fi

1. Introduction

This paper builds a model of international trade and monopolistic competition with costly search between producers and retailers of varieties of goods. The aim of the paper is to show that accounting for

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trading frictions may e.g. matter very much for the evaluation of ther impacts of trade policies. Perhaps more significantly, the approach helps to produce implications for how job flows are determined.

Most theories of international trade assume that trading is frictionless unless trade policies impose costs on traders. Recently models in new economic geography (Fujita-Krugman-Venables 1999) have taken seriously the fact that there may be costs associated with international trade. The costs in these models are international transport costs but aside from them trading is frictionless. In particular, intranational trading is frictionless (except in models which study the formation of cities). Another strand of literature studies the role of labour market frictions arising from costly search in international trade (Davidson-Lawrence-Matusz 1999) with the focus on the relationship between unemployment and international trade.

Recently Rauch (1999) has argued that organized markets do not exist for differentiated products. He claims that "Instead connections between sellers and buyers are made through a search process that because of its costliness does not proceed until the best match is achieved. This search is strongly conditioned by proximity and preexisting 'ties' and results in trading networks rather than 'markets'." (Rauch 1999 pp. 7-8). In his empirical work he shows that proximity and common language or colonial ties are more important in matching international sellers and buyers for differentiated products than for homogenous products. Search barriers are also more important for differentiated products. My point here is to study formally the implications of costly search for international trade in differentiated goods.

In this paper I shall focus on trading frictions in commodity trade using standard matching models (Pissarides 1990, Mortensen-Pissarides 1999 Saint-Paul 1997). The set-up has some similarities to the extension of the Kiyotaki-Wright-model by Matsuyama-Kiyotaki-Matsui (1993). In my model producers (suppliers) of differentiated goods and sellers of those goods are searching for each other. The matches between these agents are determined by a matching function giving the successful matches. The supplier-seller relationship is assumed to be permanent unless it is broken by some exogenous event ("death"). To the best of my knowledge this type of approach has been used before only by Liski and Virrankoski (1999) who consider the trade in rights to emit greenhouse gases and assume that traders have to search for the partner. In their model other markets work frictionlessly.

The underlying model is that of the simplest monopolistic competition with consumers having Spence-Dixit-Stiglitz (SDS) preferences originally presented by Krugman (1981). The new twist is the separation between production and sales activities and the modeling of the relationship between sellers and producers using the matching models. The change is made for the following reasons: a) Modern consumer goods are in many cases very specialised and customised. Thus, it is hard to image the markets for these goods to be like standard competitive markets but instead involve costly search between sellers and producers. b) Due to the post 2nd world war period trade liberalization trade barriers as such are quite low among the most developed countries. In Europe it is claimed that the impacts of EU integration are in reducing trading frictions other than explicit trade policies. Matching models are one way to analyse these frictions. c) Gains from trade may be affected by trading frictions. With frictions some producers are left without sellers. This implies that all varieties are not actually sold. Trade policies may affect both the number of varieties supplied and the number of varieties entering shops. For consumer welfare it is obviously the number of varieties in the shops that count. For a given degree of slack (suppliers without sellers) an increase in the number of suppliers benefits consumers but there is an additional potential gain (or loss for that matter) from how the number of slack firms changes. d) Trade policies may interact with the trading frictions. Thus, the welfare impacts of trade policies may be much stronger than those predicted by the frictionless trading model. Finally, some trade policies can be interpreted as being trading frictions in matching models. E.g. assume a quota on imports is imposed. Assume further that import license must be renewed each period and that all firms (old and new) are treated similarly by the authorities. If all firms are similar then not all firms (including some old firms) can get the license implying a termination of old supply relationships.

Since the model production and sales activities are differentiated from each other it can be understood to formalise the formation and functioning of vertical supply chains, i.e. chains of supply from the producer to the final consumer. Recently, the role of supply chains has been emphasised in the strategic management research (Helfat 1999) but they have not been analysed in international trade models. Venables (1996) and Krugman-Venables (1995) have studied how input linkages between firms affect the location of economic activities but in their models there are no supply chains (or all firms belong to the same supply chain). In my model there exist several supply chains within the same industry and the number of chains is determined endogenously. In the model sellers and producers will be grouped in four groups which could be seen as strategic groups (see Peteraf 1999 for the notion) that are competing in the same markets. The division of firms in groups also divides endogenously the economy in a "closed" (producers and seller coming from the same economy) and in an "open" (sellers and producers from different countries) sector.

The model can also help in understanding job/worker flows which arise from entry and exit of firms. As has been known since the research by Haltwanger-Davis-Schuh (1996) the gross job/worker flows are much bigger than net flows. Quite often theoretical work to explain this and other related phenomena has utilised matching models for labour markets. Here I am concerned with long run implications of changes in structural policies like trade policies. In this context it is quite natural also to focus on flows due to exit and entry of firms (like in Caballero and Hammour (1997, 1998) when different types of firms must be matched with each other.

2. The Model

The world is divided in two countries, H (Home) and Foreign (F). Labour is the only factor used in the production of commodities and in the sales activities. Country i is endowed with L^i units of labour, i = H,F. There is only one industry but all the goods produced and supplied to the consumers are differentiated (horisontally) from each other. The (temporal) consumer welfare in country i is given by SDS-preferences:

$$u^i = \left[\sum_{k=1}^{n^i} \left(c_k^i \right)^\sigma \right]^{\frac{1}{\sigma}}, 0 < \sigma < 1, \tag{1}$$

where n^i = the number of varieties (k) sold in country i and c_k^i = the amount of variety j consumed in i.

The consumer has to buy the good from a retail shop, and consumers in country i can only visit shops located in country i. This is not a restrictive assumption since I assume that shops can get their goods from producers of either country. I assume that each shop can provide only one variety and thus must choose which producer to contact. Producers can (and do) enter both markets, H or F. They enter both of the markets with the same (and one) variety. There are thus four groups of retailers and producers: H retailers buying from H producers, H retailers buying from F producers and the same for F retailers.

The traders, retailers and producers, have to find each other. Once they have found a partner they maintain their relationship unless it is broken by some exogenous event (to be interpreted below). At each moment of time the retailer searching for a producer has a non-zero probability of finding one producer and a producer searching for a retailer has likewise a non-zero probability of finding this. At the market level the process of retailer-producer pair formation is governed by a matching function (see e.g. Pissarides 1990, ch. 1, for an introduction to matching models):

$$x_j^i = x_j^i \left(\upsilon_j^i N^j, \nu_j^i M_j^i \right), \tag{2}$$

where x_j^i = number of country i shops being matched with producers from country j, N^j = total number of country j producers either in an existing relationship or searching for a retailer with υ_j^i = proportion of them searching. The total number of retailers searching for a partner is a proportion ν_j^i of retailers M_j^i serving market i getting good from country j supplier. Number of matches is increasing in both the number of retailers and producers looking for a partner. I assume (2) to be linearly homogenous (see again Pissarides 1990 for an explanation).

At the individual level the process of matching of a retailer to a producer is a Poisson process with meeting intensity (the flow probability of a retailer finding a producer)

$$\frac{x_j^i \left(\upsilon_j^i N^j, \nu_j^i M_j^i \right)}{\nu_j^i M_j^i} = x_j^i \left(\frac{\upsilon_j^i}{\nu_j^i} \frac{1}{s_j^i}, 1 \right) \equiv q_j^i \left(\theta_j^i \right), \tag{3}$$

where $\theta_j^i \equiv \frac{\nu_j^i}{\upsilon_j^i} s_j^i$, $s_j^i \equiv \frac{M_j^i}{N^j}$, and consequently $\left(q_j^i \right)' < 0$. The value of a new shop, V_j^i , is now, in the steady state, governed by the following arbitrage equation (which can be derived by dynamic programming, see Mortensen-Pissarides 1999):

$$rV_j^i = -\omega^i \mu + q_j^i \left(\theta_j^i \right) \left(J_j^i - V_j^i \right), \tag{4}$$

with the value of the existing relationship, J_j^i , being governed by a similar equation

$$rJ_j^i = \left(p_j^i - \tau_j^i w_j^i \right) g_j^i + b_j^i \left(V_j^i - J_j^i \right). \tag{5}$$

Here r = rate of interest (= consumers' subjective rate of time preference in both H and F), ω^i = wage rate in i, μ = labour retailers have to use while searching (making search costly), p_j^i = retail price of the good (all varieties sold in a country by producers from a given country will be similarly priced in equilibrium), w_j^i = price paid to the producer, and g_j^i = volume of goods sold and produced[1]. The relationship between the retailer and the producer can come to an end due to some exogenous disturbance. This can occur at any point of time and its intensity is given by b_j^i ,i.e.I allow for the possibility that the intensity differs across relationships. One example of an exogenous event is quantitative restrictions on imports. If import license has to be renewed at each point of time and old traders are competing with new traders on equal terms for import permits then (assuming the quota is binding) it is always possible that old relationships are broken. In this case the intensity of breakdown differs across traders: Retailers trading with producers from the same country do not face quantitative restrictions while retailers in business with foreign producers face it. τ_j^i measures here trading costs across countríes. For each unit of goods imported a payment has to be paid. The gross cost of a unit of good bought for the retailer is then $\tau_j^i w_j^i$, with $\tau_i^i = 1$, and $\tau_j^i \geq 1$ for $i \neq j$.

Before describing how markets are equilibrated I first present the equivalents of (4,5) for the producers. Like entrant retailers the entrant producers (as also the producers whose relationship has been broken) must search for a trading partner. The intensity of finding a partner is given by

$$\frac{x_j^i \left(\upsilon_j^i N_j^i, \nu_j^i M_j^i\right)}{\upsilon_j^i N_j^i} = \theta_j^i q_j^i \left(\theta_j^i\right), \tag{6}$$

where the equality follows from (3). It is straightforward to see that $\left(\theta_j^i q_j^i \left(\theta_j^i\right)\right)' > 0$.

I assume that producer of any variety can search for a retailer in both of the countries. To make the modelling effort as simple as

[1]For simplicity only, I assume that sales activities do not require any use of labour as an input.

possible I assume that producers divide their firms in two independent divisions each serving one of the markets H or F. The role of the headquarter is to keep up the production facility and organize search. These activities create a cost $2\omega^j \rho$ which is equally divided between the divisions. Alternatively, both of the divisions organize search by themselves leaving the (costless) coordination activities (choice of variety) to company headquarters. The total value of an entering producer from country j is

$$U_j = U_j^H + U_j^F, \tag{7}$$

where the value of a new production unit from country j looking for a retailer from country i, U_j^i, is given by

$$rU_j^i = -\omega^j \rho + \theta_j^i q_j^i \left(\theta_j^i\right) \left(W_j^i - U_j^i\right), \tag{8}$$

where ρ is the amount of labour producers use while (e.g. for keeping production facilities in proper condition) and for searching, and W_j^i = value of an ongoing business relationship to the producer. W_j^i is determined by

$$rW_j^i = \left[w_j^i g_j^i - \left(\alpha + \gamma g_j^i\right) \omega^j\right] + b_j^i \left(U_j^i - W_j^i\right), \tag{9}$$

where $\left(\alpha + \gamma g_j^i\right) \omega^j$ = cost of production with $\alpha + \gamma g_j^i$ giving the labour requirement for any given level of poduction, α = fixed cost incurred in the production of any variety (at each point of time like e.g. control of the production process) and γg_j^i = variable labour requirement. Unlike in the static monopolistic competition model I can allow $\alpha = 0$. As will become clear below the fixed flow costs of search alone are sufficient to nail down the size of a (producing) firm. The search context thus adds to the possibilities to interpret the fixed costs. Finally, I assume that all the producers are capable in principle of producing any variety. The variety is chose together with the retailer after the relationship is formed. It is clear that a variety which nobody else produces is chosen because it gives a monopoly to the supply chain. From now on I set

$\alpha = 0$. The value of a producer in country j matched in both markets is

$$W_j = W_j^H + W_j^F.$$

and $W_j = W_j^H + U_j^F$ or $W_j = W_j^F + U_j^H$ if it has found match in only one of the markets.

I assume that there is free entry to retailer and producer activities, in the spirit of the monopolistic competition model. I assume also that retailers and producers can freely choose the location of the partner with whom they want to trade. With free entry new firms should not be able to earn any extra profits, i.e. the following should hold:

$$V_j^i = 0 = U_j. \tag{10}$$

I will concentrate myself on the case where $U_j^i = 0$, which certainly guarantees that (10) holds. In fact, as will be clear from calculations below, it is the only possibility. The freedom of entry with respect to the location of the partner implies that $V_j^i = V_{j'}^i$, $i \neq i'$, $j \neq j'$. It is easy to show that in the steady state these equations are redundant given (10). Similarly, in equilibrium entrepreneurs are indifferent between entering retailing and production. Now (4), (5) and (10) imply that

$$J_j^i = \frac{\omega^i \mu}{q_j^i\left(\theta_j^i\right)} = \frac{\left(p_j^i - \tau_j^i w_j^i\right) g_j^i}{r + b_j^i}, \tag{11}$$

which gives the free entry condition for retailers:

$$\left(p_j^i - \tau_j^i w_j^i\right) g_j^i = \frac{\left(r + b_j^i\right) \omega^i \mu}{q_j^i\left(\theta_j^i\right)}. \tag{12}$$

This is like the free entry condition in the standard monopolistic competition model except that temporal profits must positive to cover the interest costs on costs of searching partner (search costs adjusted for the expected breakdown of the current relationship and the length of search). A similar expression is obtained for producers from (8), (9), and (10) using $U_j^i = 0$:

$$w_j^i g_j^i - \left(\alpha + \gamma g_j^i\right) \omega^j = \frac{\left(r + b_j^i\right) \omega^j \rho}{\theta_j^i q_j^i \left(\theta_j^i\right)}. \tag{13}$$

Prices charged from the consumers, price obtained by the producers and quantities produced are determined in bargaining between the retailer and producer once they have been matched. This bargaining is assumed to follow the usual procedures of Nash bargaining, i.e. the parties choose price, the transfer price and variety to maximize

$$\left(J_j^i - V_j^i\right)^{\beta_j^i} \left(W_j^i - U_j^i\right)^{1-\beta_j^i}, \tag{14}$$

which (given (10), (11), and the equivalent expressions for producers) can be written as

$$\left[\frac{\left(p_j^i - \tau_j^i w_j^i\right) g_j^i}{r + b_j^i}\right]^{\beta_j^i} \left[\frac{w_j^i g_j^i - \left(\alpha + \gamma g_j^i\right) \omega^j}{r + b_j^i}\right]^{1-\beta_j^i}. \tag{15}$$

Here β_j^i = bargaining power of the seller (given exogenously)[2]. Analogously to the standard monopolistic competition model I assume that each producer-retailer pair regards itself as "small" in the sense of not taking into account the effect of its actions on real income (i.e. on aggregate price level). This implies, from (1), that each pair (producing and selling variety k) takes $A\left(p_{jk}^i\right)^{-\frac{1}{1-\sigma}}$ as the demand curve it faces (A = real expenditure on the good). Maximising (15) subject to this perceived demand curve gives the standard pricing rule

$$p_j^i = \frac{\tau_j^i \gamma \omega^j}{\sigma}, \tag{16}$$

[2]Kultti (1999) has argued that the only value for β_j^i consistent with striking deals immediately even though they have an option to wait on other possible partners is 1/2.

implying that the partners maximise the joint surplus from the relationship, and the rule for dividing the total surplus between the parties

$$\tau_j^i w_j^i g_j^i = \left(1 - \beta_j^i\right) p_j^i g_j^i + \beta_j^i \tau_j^i \left(\alpha + \gamma g_j^i\right) \omega^j. \tag{17}$$

Note that, ceteris paribus, the income of the producer declines if the tariff on her product is increased.

The remaining building blocks of the model are the key steady state requirement (exit of firms must equal the entry of firms), equilibrium condition for the labour market and goods market equilibrium conditions. In the steady state the number of exiting firms must equal the number of entering firms (number of matches): $b_j^i n_j^i = x_j^i \left(\upsilon_j^i N^j, \nu_j^i M_j^i\right)$, where n_j^i = total number of matched firms. Since, by definition, $\upsilon_j^i = \frac{\left(N^j - n_j^i\right)}{N_j^i}$, the steady state condition can be written as

$$b_j^i \left(1 - \upsilon_j^i\right) = \upsilon_j^i \theta_j^i q_j^i \left(\theta_j^i\right). \tag{18}$$

(18) is nothing but the Beveridge curve relating open vacancies (entering retailers) to unemployment (new producers)[3].

The equilibrium condition for country i labour market is:

$$N^i \upsilon_i^i \rho + n_i^i \gamma g_i^i + M_i^i \nu_i^i \mu + N^i \upsilon_i^j \rho + n_i^j \gamma g_i^j + M_j^i \nu_j^i \mu = L^i, i \neq j. \tag{19}$$

The first term gives the demand for labour by i producers searching for i retailers, the second by i producers producing for i retailers, the third by i retailers searching for i producers, the fourth and fifth by i producers searching and producing for j retailers and the the sixth by i retailers searching for j producers.

[3]Equation (18) implies that the steady state flow conditions hold also in the labour market (i.e. new employment equals the loss of jobs due to termination of relationships between retailers and producers).

Finally, the equilibrium conditions for the goods markets have to be specified. Assuming that tariff revenues are handed back to consumers in a lump sum fashion the consumer steady state expenditure in country i is

$$\begin{aligned} Y^i &= \omega^i L^i + r\left[n_i^i W_i^i + n_i^j W_i^j + m_i^i J_i^i + m_j^i J_j^i\right] + \\ &\quad + m_j^i\left(\tau_j^i - 1\right) w_j^i g_j^i, \end{aligned} \tag{20}$$

where $i \neq j$ and $m_j^i \equiv \left(1 - \nu_j^i\right) M_j^i$, the first term gives the labour income, the next the income from wealth and the third the tariff revenue (assumed to be transferred by the government in a lump sum fashion)[4]. From (1) it is straightforward to derive the equilibrium condition in goods markets. Given the pricing equations (16) it is natural to concentrate on symmetric equilibrium (which has already been implicitly assumed above when dropping the variety index k) where all varieties supplied in i and produced in j are produced (and consumed) in identical quantities. With this the equilibrium condition is in i for products produced in i

$$g_i^i = \frac{\left(\frac{\gamma\omega^i}{\sigma}\right)^{\frac{1}{\sigma-1}}}{n_i^i\left(\frac{\gamma\omega^i}{\sigma}\right)^{\frac{\sigma}{\sigma-1}} + n_j^i\left(\frac{\tau_j^i\gamma\omega^j}{\sigma}\right)^{\frac{\sigma}{\sigma-1}}} Y^i \tag{21}$$

and for products produced in j, $i \neq j$,

$$g_j^i = \frac{\left(\frac{\tau_j^i\gamma\omega^j}{\sigma}\right)^{\frac{1}{\sigma-1}}}{n_i^i\left(\frac{\gamma\omega^i}{\sigma}\right)^{\frac{\sigma}{\sigma-1}} + n_j^i\left(\frac{\tau_j^i\gamma\omega^j}{\sigma}\right)^{\frac{\sigma}{\sigma-1}}} Y^i \tag{22}$$

The model is now completed after the numeraire is chosen. Let it be country H labour, i.e. set $\omega^H = 1$.

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[4]The consumer faces an intertemporal optimization problem. Since we the rate of interest is equal to the rate of time preference and the flow income of the consumer is constant (at the steady state level) the consumer flow expenditure is equal to the consumer income at any point of time. The income consists of dividends from the firms (which quarantee that the rate of return from firms is equal to r).

3. Trade policies and search

In this paper the main focus is on the symmetric equilibrium, the next section outlines the general case. In the symmetric equilibrium $\tau_j^i = \tau_i^j \equiv \tau$, $N_i = N_j \equiv N$, for $i \neq j$ etc. Also $\omega^F = \omega^H = 1$. The first result is the flows of new retailers relative to flows of new producers can be explicitly solved from the model:

Proposition 1 $\theta \equiv \frac{\nu}{v}s = \frac{\rho\beta}{\mu(1-\beta)}$, $\overline{\theta} \equiv \frac{\overline{\nu}}{\overline{v}}\overline{s} = \frac{\rho\overline{\beta}}{\frac{\mu}{\tau}\left(1-\overline{\beta}\right)}$.

Proof Given $\omega^F = \omega^H = 1$, using (16) g can be solved from (12) and substituted in (17) and (13). Notice that when (16) is substituted in (17) the equation does not depend on τ.This gives two equations to solve for wg ($\overline{wg}$) and θ ($\overline{\theta}$). Solving out wg leads to an equation the solution of which is given in the proposition.■

The flows of new retailers relative to flows of new producers depends naturally on costs incurred while searching: lower relative search costs induce higher rate of search. The more powerful retailers are relative to producers in bargaining the smaller the relative rate of entry by retailers. The remarkable result is that trade policies affect the relative rates of entry when agents are located in different countries: an increase in tariffs increases the entry of new (domestic) retailers relative to the entry of new (foreign) producers. An increase in tariff also has an effect on the producer gross income since (from the proof of Proposition 1):

$$\overline{wg} = \frac{1}{1-\sigma}\left[\frac{\left(1-\overline{\beta}\left(1-\sigma\right)\right)}{\overline{\beta}}\frac{\left(r+\overline{b}\right)\frac{\mu}{\tau}}{\overline{q}\left(\overline{\theta}\right)}\right] \tag{23}$$

Now $\left(\overline{q}\left(\overline{\theta}\right)\right)' < 0$ and $\overline{\theta}$ increases with τ. The elasticity of $\overline{\theta}$ with respect to $\frac{\mu}{\tau}$ is -1 (from Proposition 1) and the elasticity of $\overline{q}\left(\overline{\theta}\right)$ with respect to $\overline{\theta}$ is larger than -1[5]. This means that the income of producers supplying markets abroad is the lower the higher the tariff. Since, from the proof of Proposition 1, using (23),

$$\overline{g} = \frac{\sigma}{(1-\sigma)\gamma}\left[\frac{\left(r+\overline{b}\right)\frac{\mu}{\tau}}{\overline{\beta}\overline{q}\left(\overline{\theta}\right)}\right], \tag{24}$$

the volume of goods produced and sold for markets abroad also declines when tariff is increased. Since θ and $\overline{\theta}$ do not depend on b $\left(\overline{b}\right)$ the impact of changes in the separation probabilities can be directly read from (23) and (24). I have now established

Proposition 2 *Higher tariffs reduce the gross income from supplying markets beyond national borders. Also the scale of foreign operations (volume sold which equals the production volume) is the smaller the higher the tariff. The incomes of producers and retailers working within their national economies are not affected by tariffs. An increase in the probability of separation increases the volume of production.*

It is noteworthy that tariffs have an effect on the scale of operations by (some) firms. This is in contrast to the standard monopolistic competition trade model (e.g. Krugman-Venables 1995). Since the sales by retailers selling varieties produced outside their national borders are smaller when tariffs are higher their gross incomes are also smaller. Their profits of both producers and retailers engaged in international transactions are also the smaller the higher the tariffs. This can be directly seen from (12) and (13). If the changes in the probability of separation are interpreted as changes in non-tariff barriers it is interesting that an increase in this probability due to more

[5] $\overline{q}\left(\overline{\theta}\right) \equiv x\left(\frac{1}{\overline{\theta}}, 1\right)$ giving $\left(\overline{q}\left(\overline{\theta}\right)\right)' = -\frac{x_1}{\overline{\theta}^2}$. But also $\overline{q}\left(\overline{\theta}\right) = \frac{x_1}{\overline{\theta}} + x_2$ by Euler-equation. Thus, $-1 < \frac{\left(\overline{q}\left(\overline{\theta}\right)\right)'\overline{\theta}}{\overline{q}\left(\overline{\theta}\right)} < 0$.

restrictive policies increases the firm size contrary to the effects of a tariff increase. The interpretation is natural: If the probability of separation increases one has to make enough of the relationship while it exists. Tariffs reduce the profitability of the ongoing relationship but does not have any effect on its expected durability.

Equation (24) also establishes the claim made above: now $\alpha = 0$ is a permissible choice. The fixed flow costs of search are enough to give a determinate size to the volume of production by each firm (or producer-retailer pair).

The rate of entry of new producers, υ, can be solved from the Beveridge-curve, i.e. from (18):

$$\frac{1-\upsilon}{\upsilon} = \frac{\theta q(\theta)}{b}, \frac{1-\overline{\upsilon}}{\overline{\upsilon}} = \frac{\overline{\theta}\overline{q}\left(\overline{\theta}\right)}{\overline{b}}. \tag{25}$$

This gives directly

Proposition 3 *The share of entering producers to supply markets abroad (producers looking for a match) of total number of producers, $\overline{\upsilon}$, is the lower the higher the tariff. It is the higher the higher the larger is the intensity of separations. The impact of tariffs on $\overline{\upsilon}$ is the smaller the higher b.*

Proof Obviously, since $\left(\overline{\theta}\overline{q}\left(\overline{\theta}\right)\right)' > 0$, and $\frac{\partial\overline{\theta}}{\partial\tau} > 0$, $\overline{\upsilon}$ must be lower with higher τ. ■

The varieties produced will in the end be solved just like in the standard monopolistic competition model from the labour market equilibrium: the size of the market is crucial for the number of varieties. To get there requires some work, however. Using Propositions 1 and 3 gives $\nu s = \upsilon\frac{\rho\beta}{\mu(1-\beta)}$ and $\overline{\nu s} = \overline{\upsilon}\frac{\tau\rho\overline{\beta}}{\mu\left(1-\overline{\beta}\right)}$. Now, by definition

$M = N(1-\upsilon) + \nu M$, since the number of retailers already selling, $M(1-\nu)$, equals the number of producers already producing, $N(1-\upsilon)$. This gives

$$s = (1-\upsilon) + \nu s = (1-\upsilon) + \upsilon \frac{\rho\beta}{\mu(1-\beta)}. \tag{26}$$

Similarly

$$\overline{s} = (1-\overline{\upsilon}) + \overline{\nu s} = (1-\overline{\upsilon}) + \overline{\upsilon} \frac{\tau\rho\overline{\beta}}{\mu\left(1-\overline{\beta}\right)}. \tag{27}$$

It is straightforward to see on the basis of Proposition 3 that $\frac{\partial \overline{\nu s}}{\partial \tau} > 0$. From (27) it can be shown that $\frac{\partial \overline{s}}{\partial \tau} > 0$, i.e. that an increase in tariff rate increases the total number of retailers in the market relative to the number of producers. This assertion follows, because the elasticity of $\overline{\upsilon}$ with respect to $\frac{\overline{\theta}\overline{q}(\overline{\theta})}{\overline{b}}$ and the elasticity of $\frac{\overline{\theta}\overline{q}(\overline{\theta})}{\overline{b}}$ with respect to τ are both below unity.

The symmetric steady state labour market equilibrium condition is from (19), (26), (27)

$$N\left[(\upsilon+\overline{\upsilon})\rho + (\nu s + \overline{\nu s})\mu + (1-\upsilon)\gamma g + (1-\overline{\upsilon})\gamma\overline{g}\right] = L. \tag{28}$$

This can be solved for N. The model is now completely solved (it is easy to show the existence of the steady state equilibrium). From Proposition 1, (24) and (25) (28) can be written as

$$N\left(1+\frac{\sigma}{1-\sigma}\right)\rho\left[\upsilon+\overline{\upsilon}\right] = L. \tag{29}$$

The following result is immediate (from Proposition 3):

Proposition 4 *Total number of producers increases with tariff, and decreases when the producer cost of searching for a partner,* ρ*, increases and when the elasticity of substitution between varieties,* σ*, increases. The number of producers decreases when the separation intensity,* b*, increases.*

The mechanism underlying Proposition 4 is novel. Tariffs reduce the scale of production for foreign markets reducing the overall demand for labour. At the same time it reduces the number of vacant producers and increases the number of vacant retailers. Both of these effects tend to increase the demand for labour. The net effect is a reduction in the demand for labour. Consequently, the number of producers increases when tariffs are increased. An important implication of the proposition is that tariffs induce a shift of resources from the open sector to the closed sector. While this is not surprising again the mechanism is worthwhile to spell out. Since tariffs do not affect the scale of operations in the closed sector nor the number of retailers and vacancy rates but increase the total number of producers labour must shifted to the home market operations. But this means that less labour is employed in international operations.

Let us next take up the welfare effects of trade policies. Recall that the supply of varieties in the closed sector is $n \equiv (1-\upsilon) N$ and in the open sector $\overline{n} \equiv (1-\overline{\upsilon}) N$. The welfare from (1) can be written as

$$u = n^{\frac{1}{\sigma}} g + \overline{n}^{\frac{1}{\sigma}} \overline{g}$$

Since higher tariffs increase N, the number of varieties supplied through home retailers, n, increases since their vacancy rate is not affected by tariffs. Similarly the number foreign varieties supplied through domestic retailers increases since the vacancy rate of foreign producers at domestic markets declines (and number of matched producers increases). The only negative effect on welfare comes from the amount of each imported variety consumed. To get a concrete example of welfare improving tariffs is is easy to see from Proposition 1 and (24) that $\overline{g} = \frac{\sigma}{(1-\sigma)\gamma} \frac{\left(r+\overline{b}\right)\rho}{\left(1-\overline{\beta}\right)\overline{\theta}\overline{q}\left(\overline{\theta}\right)}$. Also, $\overline{\upsilon} = \frac{\overline{\theta}\overline{q}\left(\overline{\theta}\right)}{\overline{b}+\overline{\theta}\overline{q}\left(\overline{\theta}\right)}$, $1-\overline{\upsilon} = \frac{\overline{\theta}\overline{q}\left(\overline{\theta}\right)}{\overline{b}+\overline{\theta}\overline{q}\left(\overline{\theta}\right)}$ and $N = \frac{(1-\sigma)}{\rho(\upsilon+\overline{\upsilon})}$. By plugging these in the previous expression of welfare it is easy to see that a sufficient condition for a small tariff to improve welfare is $\frac{(1-\sigma)\overline{b}}{\sigma} > \theta q(\theta)$. Thus, the smaller the elasticity of substitution between varieties and the larger the trading frictions the more likely it is that a small tariff increases welfare. The following claim has now been established:

Proposition 5 *The welfare impacts of tariffs are ambiguous. Tariffs can increase welfare. The higher the trading frictions the more likely it is that a small tariff at least improves welfare.*

The last point of the proposition shows that the trading frictions may be crucial for policy conclusions. Since the tariff analyzed is a tariff imposed by both of the trading countries the welfare impact does not at all depend on the standard argument for tariffs in the monopolistic competition framework.

The final issue to be studied are the firm/job flows. In the steady state there are naturally no net flows. Gross flows are positive, however. Since the rate of firm destruction (which is equal to gross creation) in the closed sector production is $bN(1-\upsilon)$ and in the closed sector retailing $bM\ (1-\nu)$ the gross destruction (gross creation) will be increased in both activities by tariff increases. The same holds in the open sector. The interesting point is that the gross firm flows in the open sector are higher than in the closed sector as long as the tariff rate is positive. This is since the tariff reduces the open sector vacancy rate but does not have any effect on the closed sector vacancy rates. In the open sector it is also interesting to notice that gross flows are increased more in retailing than in production. This is the case since

$\overline{M} = \overline{s}\overline{N}$,

and $\overline{s}$ increases with the tariff.

The firm flows can be directly translated into job flows. In the closed sector gross job flows move together with gross firm flows if tariffs are increased since the flows depend on tariffs only through tghe number of firms. In the open sector things are more surprising. In fact in the open sector production the gross job flows decrease when tariffs are raised. It is easy to show that the gross job destruction (and job creation) rate in the open sector production, $\overline{b}N\left(1-\overline{\upsilon}\right)\gamma\overline{g}$ can be written as $\frac{\sigma\overline{b}L}{\left(1-\overline{\beta}\right)\left[\frac{\left(\overline{b}+\overline{\theta}\overline{q}\left(\overline{\theta}\right)\right)b}{b+\theta q(\theta)}+\overline{b}\right]}$ which is decreasing in the tariff rate. To sum up

Proposition 6 *A tariff increase increases gross firm flows (gross firm creation and destruction) in all sectors. In the tariff protected sector the gross firm flows in retailing increase more than in production.*

Higher tariff increases also gross job flows (job creation and destruction) in the closed sector. Higher tariff reduces gross job flows in the open sector.

The impacts of changes in trading frictions b and $\overline{b}$ differ in many ways from the impacts of tariffs. This clear since e.g. θ and $\overline{\theta}$ do not depend on them. One very interesting implication is (from (24)) that production of any variety will increase if trading frictions in the market for that variety increase. Given the possibility to interpret trading frictions as arising from quotas there is a fundamental non-equivalence between the policies: With tariffs the open sector firm production levels are smaller while with quotas they are higher. Larger trading frictions also imply, from (25), that the producer vacancy rate is also higher. It is now clear, using (29), that the number of varieties unambiguously declines when trading frictions increase. These can be collected in

Proposition 7 *The volume of production of a variety increases when the trading friction in the market for that variety increases. Trading frictions reduce the number of varieties produced and their welfare implications are exactly opposite to the welfare effects of tariffs.*

The basic asymmetry between tariffs and trading frictions extends also to the gross firm flows: The reasoning just made shows that

$bN(1-\upsilon)$ and $\overline{b}N(1-\overline{\upsilon})$ get smaller whenever any trading frictions increase. Since now $1-\upsilon = \frac{\theta q(\theta)}{b+\theta q(\theta)}$ and the corresponding expression holds for the open sector (24) implies that the gross job flow in the closed sector, $bN(1-\upsilon)\gamma g$, definitely declines when trading frictions increase, while the job flow in the open sector $\frac{\sigma}{(1-\sigma)}\frac{\left(r+\overline{b}\right)\frac{\rho}{\tau}}{\overline{\beta}\left(\overline{b}+\overline{\theta}q\left(\overline{\theta}\right)\right)}$ can increase or decline when $\overline{b}$ increases. It is straightforward to calculate that job flow increases or decreases according to $\overline{\theta}q\left(\overline{\theta}\right) \lesseqgtr r$. If the producer's probability of finding a retailer is high enough then gross job flows in the open sector increase while if the probability is low enough the reverse holds. To sum up

Proposition 8 *Higher trading frictions in any sector reduce the gross firm flows in all sectors. An increase in b ($\overline{b}$ resp.) reduces the gross job flow in the closed (open) sector but may increase it in the closed (open) sector.*

4. Asymmetric equilibria: Size differences

The previous section studied only the case of perfectly identical trading partners. To understand how the model can treat asymmetric countries consider the case of countries differing in labour endowments but otherwise perfectly identical. Assume also that separation probabilities are the same in domestic and international transactions. Denote the F country wage rate by ω (recall that H country wage rate is the numeraire). Using (12), (13), (16), and (17) one can solve for relative vacancy rates in all of the markets:

$$\theta_H^H = \theta_F^F = \frac{\beta\rho}{(1-\beta)\mu}, \theta_F^H = \frac{\beta\rho\omega}{(1-\beta)\mu}, \theta_H^F = \frac{\beta\rho}{(1-\beta)\mu\omega}. \tag{30}$$

It is interesting that the asymmetry does not have any effect on the home market vacancy rates. In F home market the change in wage rate has equiproportional effect on the producer price of the commodity leaving all the real variables unchanged. The wage rate has an effect on vacancy rates in international transactions. An increase in F wage rate increases the search costs for foreign producers. This leads to an increase in the vacancy rate of H retailers in business with F producers. The opposite happens in the matching process between H producers and F retailers: higher F wage rate increases the cost of search of F retailers increasing the relative producer vacancy rate.

Given (30) the scale of operations (sales) by the matched firms in different markets can be solved:

$$g_i^j = \frac{\sigma (r+b) \rho}{\gamma (1-\sigma)(1-\beta) \theta_i^j q\left(\theta_i^j\right)}, i, j = H, F. \tag{31}$$

Since $\theta q(\theta)$ is increasing in θ (30) implies that if the wage cost in production increases then the sales abroad (of a single variety) decline while if the wage costs of a retailer increase then the retailer imports more of the variety, i.e. the scale of imports of any foreign variety increases. This is like the international competitiveness effect in conventional models but again the mechanism behind the result is novel. When the wage costs for F producers increase they have to cover higher anticipated costs of search (though, from (13), the search costs do not increase in proportion to ω, since the probability of finding a retailer also increases). Thus they have to get higher profits from the ongoing match. From (12), (13), (16), and (17) one gets

$$w_F^H g_F^H = \frac{r+b}{1-\sigma}\left(1+\frac{\sigma\beta}{1-\beta}\right)\frac{\rho\omega}{\theta_F^H q\left(\theta_F^H\right)} \tag{32}$$

which implies that the producers cannot pass completely the higher costs on retailers. But (31) and (32) together imply that w_F^H increases in fixed proportion to ω. Since producers do not have all the power in negotiations with retailers they have to bear some of the cost increase they face. In this model the whole adjustment is in the quantity traded. Similarly when F retailers are matched with H producers the negotiated producer income is

$$w_H^F g_H^F = \frac{r+b}{1-\sigma}\left(1+\frac{\sigma\beta}{1-\beta}\right)\frac{\rho}{\theta_H^F q\left(\theta_H^F\right)}. \tag{33}$$

This increases with ω (since θ_H^F decreases with ω). Since the consumer price level does not in this case depend on the wage rate and the retailer has to increase her income (to cover the anticipated losses from search in case the relationship is broken) she must increase the sales: (31) and (33) imply that w_H^F is not influenced by the wage rate.

The labour market equilibrium conditions for H and F respectively can now be written using (19),(18), (30), and (31) as follows:

$$\left\{\left[1+\frac{(r+b)\,\sigma}{b\,(1-\sigma)}\right]\frac{\upsilon_H^H}{1-\beta}+\left[1+\frac{(r+b)\,\sigma}{b\,(1-\sigma)\,(1-\beta)}\right]\upsilon_H^F\right\}\rho N^H + \tag{34}$$
$$+\frac{\beta\omega}{1-\beta}\upsilon_F^H\rho N^F = L^H$$

and

$$\left\{\left[1+\frac{(r+b)\,\sigma}{b\,(1-\sigma)}\right]\frac{\upsilon_F^F}{1-\beta}+\left[1+\frac{(r+b)\,\sigma}{b\,(1-\sigma)\,(1-\beta)}\right]\upsilon_F^H\right\}\rho N^F + \tag{35}$$
$$+\frac{\beta}{(1-\beta)\,\omega}\upsilon_H^F\rho N^H = L^F.$$

Final equation needed is the equilibrium for goods markets. Take the equilibrium in F for varieties produced in F. Using (12), (13), (16), (18), (20), (21), (30), and (31) it is

$$\left\{\left[\frac{(r+b)}{1-\sigma}-r\right]\frac{\upsilon_F^F}{1-\beta}-r\upsilon_F^H\right\}\frac{\omega}{b}\rho N^F + \tag{36}$$
$$+\left[\frac{(r+b)\,\theta_H^F q\left(\theta_H^F\right)\omega^{\frac{1}{1-\sigma}}}{\theta_F^F q\left(\theta_F^F\right)(1-\sigma)}-r\beta\right]\frac{\upsilon_H^F}{b\,(1-\beta)}\rho N^H = \omega L^F$$

The previous three equations can now be solved for the total number of producers in both countries and for the F wage rate. Consider first the perfectly symmetric equilibrium where both countries have identical labour endowments. In that equilibrium the wage rates are equal, $\omega = 1$, as also are the number of producers and retailers and the vacancy rates in different types of matches, $\theta_j^i = \theta \; \forall \; i,j$. Consider now what happens if the F labour endowment becomes smaller and H labour endowment grows to keep the world total labour endowment unchanged. (34) and (35) imply that at unchanged F wage rate the number of H producers (varieties produced in H), N^H, must increase and the number of F producers (product varieties originating from F), N^F, must decline keeping the total number of producers, $N^H + N^F$ unchanged. Look next at (36). It is easy to see, that the coefficient of N^F is smaller than the coefficient of N^H when evaluated at the symmetric equilibrium. The proposed change in the labour endowments increases the left hand side of the equation while the right hand side remains constant, there is "excess supply" in the goods market. How can it be eliminated? From (30) and (18) it is seen that υ_F^H is a decreasing function of ω while υ_H^F is an increasing function of ω. Divide both sides of the equation by ω. Then the right hand side does not depend on the wage rate at all. Since the elasticity of $(\theta q(\theta))$ with respect to θ is less than unity the left hand side is an increasing function of the F wage rate unless σ is very small. In fact $\sigma \geq \frac{1}{2}$ is sufficient, but definitely not necessary, for it. The new equilibrium can then be reached only if the F wage rate declines. Hence, the small country (F in this case) will have a lower wage rate than the large country. Recalling the above analysis on the determination of production levels the small country will produce (and export) larger quantities of each of the variety it produces than the large country. In addition, the small country produces a smaller number of varieties. This discussion can be summed up in

Proposition 9 *In a world with two countries with different factor endowments but otherwise identical countries the small country has* *a lower wage rate, produces fewer number of varieties than the large country. The level of production of each of the variety it produces is larger than in the large country.*

Consider next the implications of size differences to firm and job (and given full employment to worker) flows. Since now θ_F^H is smaller than $\theta_F^F = \theta_H^H$, which again are smaller than θ_H^F (since θ_F^F and θ_H^H are at the same levels as they are in the perfectly symmetric equilibrium) (18) implies that $\upsilon_F^H > \upsilon_F^F = \upsilon_H^H > \upsilon_H^F$. These imply that the gross firm flow rates $(b(1-\upsilon)N)$ in all sectors of the small country (since $N_F < N_H$) are below those in the large country, as is natural. It is more interesting to compare the sectoral firm flows relative to the total firm flows in each of the countries. For the small country the flows in the export manufacturing relative to total manufacturing[6] are $\frac{bN^F\left(1-\upsilon_F^H\right)}{bN^F\left(1-\upsilon_F^H\right)+bN^F\left(1-\upsilon_F^F\right)}$. The previous argumentation gives directly

Proposition 10 *The gross flow of firms in the export sector relative to total fmanufacturing irm flows in the small country is smaller than the corresponding gross flow in the export sector of the large country.*

The significance of this result is in that it shows how asymmetries between countries may give rise to natural international differences in firm flows. These differences cannot then be automatically regarded as evidence of better functioning of markets etc.. The same applies to job and worker flows. Consider again the gross job flows in export manufacturing relative to total manufacturing $\frac{bN^F\left(1-\upsilon_F^H\right)\gamma g_F^H}{bN^F\left(1-\upsilon_F^H\right)\gamma g_F^H+bN^F\left(1-\upsilon_F^F\right)\gamma g_F^F}$. Use first (18) to solve out υ_F^H and υ_F^F. Then after inserting the

[6]I consider only manufacturing flows because most of the empirical research on the flows focuses (due to data availability and quality) on manufacturing.

production levels from (31) the relative job flow expression becomes $\frac{\frac{1}{b+\theta_F^H q\left(\theta_F^H\right)}}{\frac{1}{b+\theta_F^H q\left(\theta_F^H\right)}+\frac{1}{b+\theta_F^F q\left(\theta_F^F\right)}}$. The following proposition is now immediate:

Proposition 11 *The gross job flows in the export manufacturing relative to total manufacturing are larger in the small country than in the large country.*

The gross job flows in the export manufacturing are larger even though the firm vacancy rate is also larger. The scale of production in the small country export production is sufficiently large to overcome the effect from the vacancy rate.

Finally, it is interesting to notice that differences in endowments also imply differences in production structure. The share of export production in total manufacturing production is in the small country $\frac{N^F\left(1-\upsilon_F^H\right)g_F^H}{N^F\left(1-\upsilon_F^H\right)g_F^H+N^F\left(1-\upsilon_F^F\right)g_F^F}$. Thus, the argument preceeding the previous Proposition implies that

Proposition 12 *The share of export production in manufacturing production is larger in the small country than in the large country.*

The proposition just tells that small countries are more open than large countries even without any policy differences.

5. Concluding comments

This paper has shown that allowing producers and retailers search for each other matters for the structure of international trade. It was shown that the economy is naturally divided in open and closed sectors through entry of firms to search processes with partners from different countries. Trade policies among other things affect this division. Trade policies can also potentially have effects not considered in the traditional literature. Here trade policies have an affect on the scale of production unlike in the ordinary model of monopolistic competition. An increase in tariff reduces the production of any internationally traded variety. The overall number of varieties produced increases with the tariff. Trade policies also have an effect on the proportion of firms matched relative to firms in the search process. Increased tariffs increase the relative number of retailers in search while the relative number of producers in search decreases. The model has also implications for the firm and job flows. Higher tariffs increase the long run gross firm creation and destruction. Job flows (job creation and destruction) will increase in the closed sector but decrease in the open sector when tariffs are raised. The asymmetry is due to the fact that tariffs reduce the firm size.

The welfare effects of tariffs are non-standard and surprising. It is possible that tariffs can improve welfare if tariffs release resources enough from producers in the search process relatively more than from producers actually matched and producing in the sector not protected by the tariff. This channel for welfare effects of tariffs has not been found in the earlier literature. In particular, it was shown that if trading frictions are large enough then a small tariff definitely improves welfare. I considered only the case of perfectly symmetric countries which eliminated the usual role for trade policies found in the monopolistic competition model so this is a new channel for tariffs to be welfare improving.

I argued that trading friction (the flow probability of a break-down of the match between a producer and a retailer) can be interpreted as arising from a quota (auctioned at each point of time) imposed on imports. With this interpretation the equivalence between tariffs and quotas does not hold. More strict quotas imply that the level of production of any internationally traded variety increases. Also, the overall number of varieties produced declines when quota becomes stricter. All this implies that the welfare effects of quotas are almost the opposite to those of tariffs.

The implications of differences in labour endowments was also considered. In the two country world the small country wage rate is smaller than in the large country. It produces a smaller number of varieties but the output of varieties it sells to the large country is larger than the large country output of varieties imported by the small country. The asymmetries show up also in gross firm and job flows. The export sector job gross job flow relative to the total manufacturing sector gross job flow is larger in the small country than in the large country while the opposite holds for the gross firm flows.

6. References

Caballero R. and M. Hammour (1997) The cleansing effect of recessions, Quarterly Journal of Economics.

Caballero R. and M. Hammour (1998) Improper churn: Social costs and macroeconomic consequences, NBER Working Paper 6717.

Davidson C., M. Lawrence, and S. Matusz (1999) Trade and search generated unemployment, Journal of International Economy, vol. 48, 2.

Fujita M., P.Krugman, and A. Venables (1999) The spatial economy, MIT Press.

Haltiwanger J., S. Davis, and S. Schuh (1996) Job creation and destruction, MIT Press.

Helfat C. (1999) Vertical supply chains and competitive advantage, mimeo, Darthmouth College.

Krugman P. (1981) Intraindustry specialization and gains from trade, Journal of Political Economy 89, 5.

Krugman P. and A. Venables (1995) Globalization and inequality of nations, Quarterly Journal of Economics, November.

Kultti K. (1999) About bargaining power, Helsinki School of Economics Working Paper W-233.

Liski M. (1999) Emission trading and trading costs, mimeo, Department of Economics, Helsinki School of Economics.

Liski M. and J. Virrankoski (1999) Bilateral CO2 Trading, Department of Economics, Helsinki School of Economics.

Matsuyama K., N. Kiyotaki, and A. Matsui (1993) Toward a theory of international currency, Review of Economic Studies.

Mortensen D. and C. Pissarides (1999) New developments in models of search in the labour market, CEPR Discussion Paper 2053.

Peteraf M. (1999) Strategic groups and competitive advantage, mimeo, University of Minnesota.

Pissarides C. (1990) Equilibrium Unemployment Theory, Basil Blackwell.

Rauch J. (1999) Networks versus markets in international trade, Journal of International Economics, vol. 48, No. 1, 7-36.

Saint-Paul G. (1997) Dual labor markets, MIT Press.