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OVERCOMING INFORMATIONAL BARRIERS TO INTERNATIONAL RESOURCE ALLOCATION: PRICES AND TIES*

James E. Rauch and Alessandra Casella

Incomplete information creates matching friction that interferes with the ability of prices to allocate scarce resources across countries but can be overcome by international information-sharing networks. When the difference between country factor-endowment ratios is large relative to network ties, efficient arbitrage breaks down, the price (wage) of each country's immobile resource becomes partially insulated from changes in foreign supply, and trade liberalisation causes less resource price convergence. The model is applied to the trade and wages debate, to whether ties can reduce world welfare through trade diversion, and to the effect of ties on trade in differentiated versus homogeneous products.

Countries appear to trade too much with themselves (McCallum, 1995) and invest too much in themselves (Feldstein and Horioka, 1980). Cross-border price differentials seem too large (Engel and Rogers, 1996). Trade costs are seen as the root cause of these and other international macroeconomic puzzles (Obstfeld and Rogoff, 2001).

As tariffs and transportation costs have come down, research has increasingly focused on informal barriers to international trade as an explanation for high trade costs. One informal barrier is lack of information about international trade and investment opportunities (Portes and Rey, 1999). Empirically identifiable information-sharing networks have been found to increase the volume of international trade. Such evidence has been found for business groups¹ operating across national borders (Belderbos and Sleuwaegen, 1998), immigrants (Gould, 1994), and long-settled ethnic minorities that maintain coethnic business societies, such as the Overseas Chinese (Rauch and Trindade, 2002).² Gould (1994) and Rauch and Trindade (2002) find that these groups have less effect on trade in more homogeneous products, for which prices can effectively convey the relevant information, than on trade in more differentiated products, for which matching of multifarious characteristics of buyers and sellers is more important.

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¹ Business groups are 'sets of firms that are integrated neither completely nor barely at all' (Granovetter, 1995, p. 96–7), and where the lineages of the members can often be traced back to a founding family or small number of allied families. Typical mechanisms serving to integrate the firms include mutual stockholdings and frequent meetings of top executives. Business groups are common throughout Asia, continental Europe, and Latin America, but are rare to non-existent in Great Britain and the United States.

² For a full survey of this literature see Rauch (2001).

Closer study of how coethnic business societies and transnational business groups overcome informational barriers to trade and investment suggests formulating these barriers as a problem of matching entrepreneurs or firms: it is more difficult in the international than in the domestic market for producers to find the right distributors for their consumer goods, for assemblers to find the right suppliers for their components, for investing firms to find the right partners for their joint ventures, and so on. Weidenbaum and Hughes (1996, p. 55) write of the Overseas Chinese:

the members of the bamboo network operate in the interstices of the trading world. They make components, manufacture for others, and perform subassembly work. They are also heavily involved in wholesaling, financing, sourcing, and transporting....The leading businessmen know each other personally and do deals together, with information spreading through an informal network rather than through more conventional channels.

We can thus view 'ties' that exist across borders as helping agents solve their matching problems and find suitable trade or investment partners in other countries. These international ties need not be of a 'group' nature; the same purpose can be served by pairwise ties, probably the most important of which (at least of those that are empirically identifiable) are ties between parent firms and their subsidiaries.³

Our major concern in this paper is with the impact of incomplete information and ties on the ability of prices to allocate scarce resources internationally. With this goal in mind, we introduce a matching problem between entrepreneur-firms ('producers') into the standard one-good, two-factor, two-country model of trade in factor services.⁴ Price signals (wage differentials) guide all producers in the labour-scarce country to seek matches in the labour-abundant country, such as joint venture partners who know how to adapt the industry technology to local conditions or land developers of sites with access to the appropriate mixes of non-traded inputs. However, only tied producers know the locations of their best foreign partners, thereby extending to foreign partners the knowledge that all producers are assumed to have about domestic partners.

We find that, when the difference between the factor-endowment ratios of the two countries is small relative to the share of producers that is tied, our model is

³ It has been estimated that intrafirm trade accounts for 25% of world trade (UN Transnational Corporation and Management Division, 1992, p. 53). Rangan and Lawrence (1999, Table 1.1) compute that the total intrafirm share of US manufacturing exports, excluding petroleum and coal products, was 37.6% in 1994. A parent-subsidiary tie does not always guarantee a perfect match: a parent might introduce a new product its overseas distribution subsidiary is not suited to handle, or might make a 'greenfield' investment rather than expand an existing plant.

⁴ Since we have no reason to expect informational barriers to trade to affect the pattern of trade in commodities any differently than conventional barriers (Deardorff, 2001), we can avail ourselves of the simplicity of this model relative to the two-good (Heckscher-Ohlin-Samuelson) model. The use of the one-good model to analyse the impact of trade barriers dates back at least to Becker (1957) and MacDougall (1960). We will see in Section 2 that the one- and two-good models have the same qualitative properties relevant for our results, which are therefore not driven by use of the simpler model.

equivalent to the standard model with complete information, despite the fact that only a subset of producers know the locations of their best foreign matches. In this equilibrium relative country wages are determined solely by a conventional trade barrier or wedge and the production technology that links costs or profits to wages. When the difference between factor-endowment ratios is sufficiently large, this equilibrium breaks down and relative country wages become a function of relative country labour supplies. In the new equilibrium, the two countries are partially insulated from each other in the sense that each country's wage is more sensitive to changes in domestic than foreign labour supply and trade liberalisation causes less convergence in country wage rates. This partial insulation ultimately stems from the imperfection created by the matching friction in the process by which international trade arbitrages country wage differentials. Tied producers eliminate this matching friction and thus eliminate the imperfection in the arbitrage process, so if enough producers are tied they restore the independence of relative country wages from relative country labour supplies. The greater ability of tied producers to efficiently arbitrage international cost differentials is consistent with the evidence presented in Rangan and Lawrence (1999, ch. 4). They find that manufactured imports of US multinationals from countries in which they have subsidiaries, most of which are intrafirm, are much more elastic with respect to real exchange rates than are overall US manufactured imports from the same countries.

The next Section of this paper presents our model and the following Section derives the results just discussed plus some others. In Section 3 we discuss application of the model to the debate over the impact of international trade on domestic wages, and extend the model to address whether ties can reduce world welfare through trade diversion and to compare the effect of ties on trade in differentiated versus homogeneous products. Our conclusions are in Section 4.

1. The model

1.1. *Endowments and Technology*

The world is composed of two countries, home and foreign. In each country, there is a continuum of types of *producers* distributed over a circle of unit length. For each type, there is a continuum of producers of unit mass. The producers can therefore be said to lie on a 'unit cylinder'. Each country is also endowed with a homogeneous, inelastically supplied mass of internationally immobile labour. Since there is an equal mass, one, of producers in both countries, the ratio of labour-producer endowment ratios across countries can be summarised by the ratio L/L^* , where L is the home labour endowment and L^* is the foreign labour endowment. In all that follows, asterisks will be used to indicate foreign variables. We assume that the foreign country is the labour-abundant country, so that $L/L^* < 1$.

Output is generated through a joint venture of two producers, and the distance between their types on the circle is an index of their complementarity or the gains from trade that result from their matching. To engage in production actively,

a partnership needs to hire labour; thus output is a function of the quality of the producers' match and the labour employed:

$$y_{ij} = F(x, z_{ij}) \quad (1)$$

where z_{ij} is the shortest arc distance between the two producers of types i and j , and x is labour. Note that the maximum value of match quality z_{ij} is $1/2$. The function F is characterised by constant returns to scale.

Producers want to maximise profits. They take the wage rate w as given. With a constant returns to scale production function, total profits from the match of types i and j can be written as:

$$\Pi_{ij} = z_{ij}\pi(w) \quad (2)$$

where the function $\pi(w)$ is decreasing and convex in w . For ease of later proofs, let us also assume that $\pi(w)$ is a constant elasticity function (as would be the case, for example, if the technology were Cobb-Douglas). The labour demand generated by a partnership is then given by:

$$L_{ij}^d = -z_{ij}\pi'(w), \quad (3)$$

where the prime sign indicates the first derivative. The closeness of our model to the standard one-good, two-factor model of trade becomes more apparent once we recognise that the integral of match qualities z_{ij} over all producer partnerships plays the role of the aggregate capital stock in the standard model.⁵

1.2. Domestic and International Matching

The timing of the model is the following. First, home country producers travel to the foreign country, where foreign producers await them. Each home producer meets with one and only one potential foreign partner. Next, the type of one's partner is revealed,⁶ successful matches are confirmed and unsuccessful ones are broken. Finally, home and foreign producers who have rejected their international matches establish domestic partnerships with other home and foreign producers, respectively, whose international matches were also unsuccessful. The home and foreign labour markets clear when all demands for labour, from domestic and international ventures, are received.

Given the model timing, we must find the outcome of domestic matching before we can solve for the results of international matching. Domestic matching proceeds as follows. Each producer selects a partner. If his choice does not select him, he gets zero. If his choice does select him, the two producers form a match and

⁵ We should note that a profit function of the form $h(z_{ij})\pi(w)$, $h(z_{ij})$ strictly monotonically increasing, would leave the results of this paper qualitatively unchanged. Since this could be derived from a production function that is linear homogeneous in $h(z_{ij})$ and x (our thanks to an anonymous referee for this point), we could allow match quality to be any strictly monotonically increasing function of distance z_{ij} . We use the specification $h(z_{ij}) = z_{ij}$ because it provides the simplest and most transparent algebraic expressions.

⁶ We shall see shortly that the threat point in international bargaining is the same for all types within a country, so it is not clear that anything could be gained by misrepresenting one's type if this were possible.

bargain over the surplus. If the bargaining breaks down, both producers get zero. Hence the surplus equals the total value of the match. We use the Nash bargaining solution, so any pair of producers that forms a match will divide the total match value equally between them. We assume that every producer knows at least the domestic location of his best match type. In this case it seems natural to focus on the efficient equilibrium in which each producer selects the producer opposite him on the circle (and at the same height on the cylinder). This is an equilibrium since no producer has an incentive to change his behaviour after he has chosen and been chosen by his perfect complement. In this equilibrium $z_{ij} = 1/2$ for every partnership. Domestic partnerships are assumed to have access to domestic labour only. Since each producer receives half of the profits, a home producer forming a domestic partnership earns $(1/2)(1/2)\pi(w) = \pi(w)/4$. Similarly, a foreign producer forming a domestic partnership earns $\pi(w^*)/4$.

We now turn to international matching. At this point we must distinguish between tied and untied producers. We assume that travel of home country producers to the foreign country is costless, and hence only consider equilibria in which all home country producers attempt the foreign market. We also assume that a fraction m of every type of producer is tied, in the sense that each home producer in this subset knows the location of the foreign producer that is opposite it on the circle and at the same height on the cylinder. Untied home producers, in contrast, are completely uninformed about the locations of foreign producer types and can therefore meet with any foreign producer type at the same height on the cylinder with equal probability, given the uniform distribution of types over the circle.⁷ All tied home producers will choose to use their ties since they obtain the maximum match quality by doing so, yet lose nothing in bargaining power because the threat point (the value of a domestic match) of all foreign producers is the same.⁸

International partnerships differ from domestic partnerships in two ways. First, an international partnership has the option to locate its operation in either country and can therefore have access to the labour force of either country. Second, the producer that manages the international joint venture from abroad loses a fraction t or $t^* \in (0,1)$ of its profits. This reflects the transportation costs and trade taxes incurred when repatriating profits in terms of the numeraire good. Inclusion of trade taxes means that t or t^* can be varied by unilateral government

⁷ It is not necessary to assume that untied home country producers are completely uninformed about the locations of foreign producer types. For example, in Rauch and Trindade (2000) each home producer draws a potential foreign partner from a distribution over the circle of types that is uniform with support of length $k \in (0,1]$ and has its median at the producer's opposite type, effectively allowing the home producer to rule out the worst $100(1-k)\%$ of foreign types in advance. This alternative assumption would not change the qualitative results of this paper.

⁸ This result differs from Casella and Rauch (2002) and Rauch and Casella (1998), where some tied producers choose not to use their ties. The difference arises because in those papers types are arrayed along a line rather than around a circle and every tied producer knows the location of every other tied producer. With match quality increasing in distance, types near the endpoints of the line are inherently more attractive match partners than types near the centre of the line. Use of the ties is shown to ensure that a producer realises a match value that is perfectly correlated with his distance from the centre of the line, so that tied producers located near the centre of the line prefer to take their chances on random matching with untied producers.

action, which will allow us to use our model to analyse the impact of a government decision to liberalise (partially) or to further restrict trade.⁹

1.3. *International Bargaining*

If both domestic markets are active, the threat points in international bargaining of every home and every foreign producer are $\pi(w)/4$ and $\pi(w^*)/4$, respectively, where w and w^* are the international trade equilibrium wages.¹⁰ It is then easy to see that partners in any confirmed international match will choose to locate their operation and employ labour in the low wage country, even if the partner in the low wage country would have lost a smaller fraction of its profits upon repatriation from the high wage country (due to lower trade taxes, say). If the operation were located in the high wage country, the partner from the low wage country would have to receive more than half of the profits from the partnership to do as well as with a domestic partner, but then the partner from the high wage country must do strictly worse than with a domestic partner. From the point of view of the partner from the high wage country, then, the attraction of international matching is access to cheaper labour, whereas from the point of view of the partner from the low wage country, the attraction is greater relative bargaining power than with a domestic partner.

It is now clear that the home country cannot be the low wage country. If it were, international partnerships would demand only home labour, and demand for home labour would be relatively greater than demand for foreign labour, generating a contradiction given that supply of home labour is relatively smaller. We can also rule out $w = w^*$, since in this case because of the tax/transport cost at least one partner to an international match must do strictly worse than with a domestic partner and no international matches would be confirmed, yielding equal demand for home and foreign labour but a greater supply of the latter. It follows that in equilibrium $w > w^*$ and that all confirmed international matches will employ foreign labour. International matching thus serves to transfer labour demand from the labour-scarce to the labour-abundant country, just as does trade in the standard one-good, two-factor model. Also as in this standard model, we can think of producers and workers as using their income to purchase their own production, generating balanced international trade of producer services for numeraire output.

We can now use Figures 1 and 2 to determine the cutoff match quality for successful international partnerships. If a home country producer of type i draws a potential foreign partner of type j , denote their distance on the circle of types by z_{ij} , as represented in Figure 1. z_{ij} is uniformly distributed on the interval $[0, 1/2]$. Given the symmetry of the circle we can drop the subscripts from z_{ij} :

⁹ Just as in conventional trade models, the 'melting ice' model of transportation costs is nothing more than a convenient simplification and 'transportation costs' is an elastic concept that might include expenses of managing an operation in another country other than the cost of transporting goods. Our results are invariant to the division of the lost profits between tax revenue collected by the government and 'melting' that is lost to society.

¹⁰ Uniformly distributed, atomless producers and the symmetry of the position of every producer (tied or untied) on the circle ensure that the height of the remaining cylinder of producers in each country is the same for every type and thus domestically every producer can still match with his opposite type.

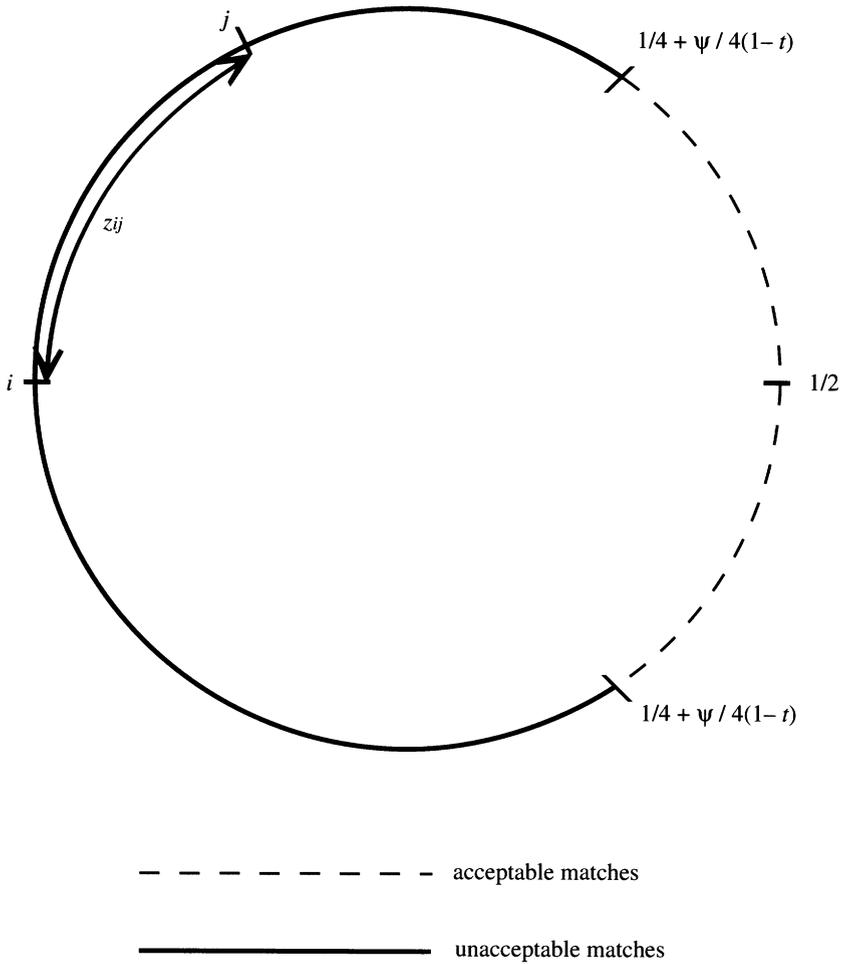


Fig. 1. *International Matching: Distances Between Home Producer i and Foreign Producer j*

every home country producer faces a uniform distribution of partner distance z , with support $[0, 1/2]$ on the circle. We represent in Figure 2 the possibilities set that results from a potential international partnership. An international match is acceptable if the threat point is not outside the Pareto frontier (the case shown in Figure 2). For symmetry with domestic partnerships we apply the Nash bargaining solution to the division of the surplus from international partnerships, yielding the (net) profits to the home and foreign producers depicted in Figure 2.¹¹

The condition that the threat point is not outside the Pareto frontier can be expressed as:

$$\begin{aligned} \pi(w^*)/4 \leq -\pi(w)/[4(1 - t)] + z\pi(w^*), \text{ or alternatively as} \\ z \geq 1/4 + \psi/[4(1 - t)], \end{aligned} \tag{4}$$

¹¹ Equal division of the surplus from international partnerships is used only in Proposition 7 and subsection 3.2.

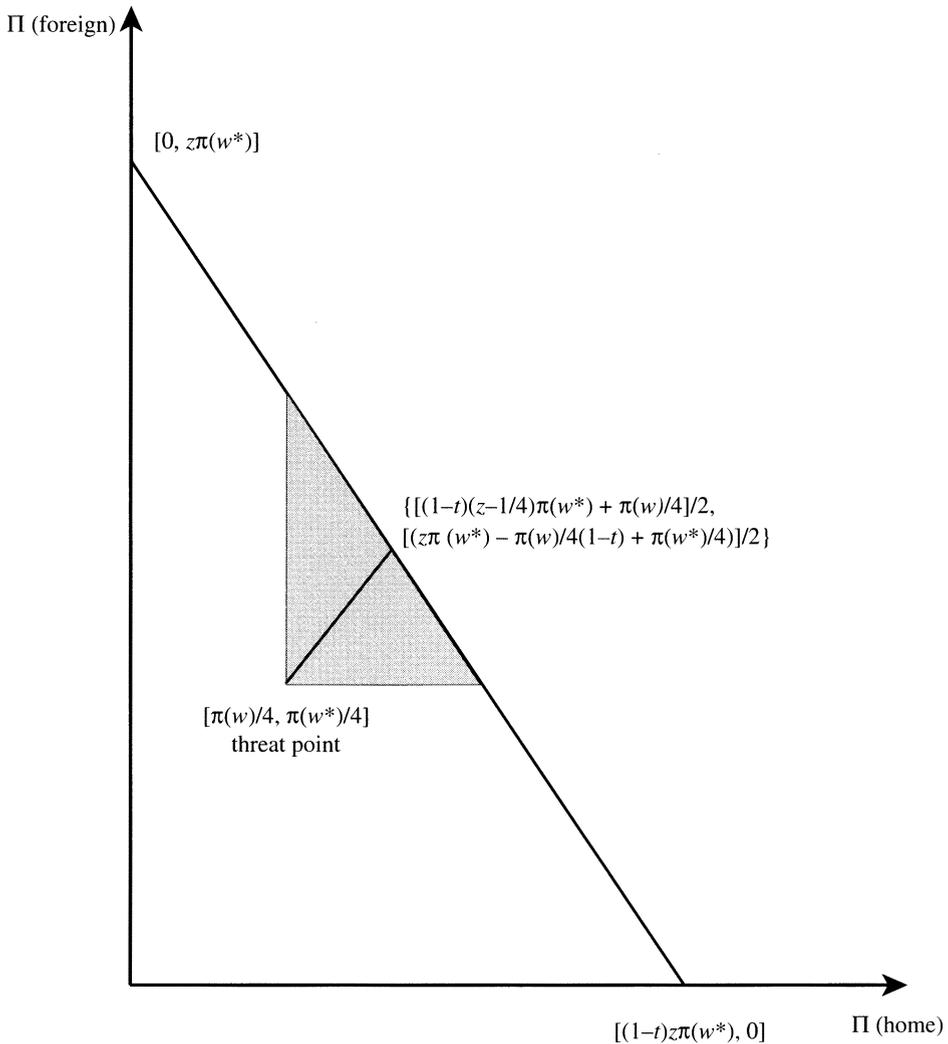


Fig. 2. *The Bargaining Problem*

where $\psi(w^*/w) \equiv \pi(w)/\pi(w^*)$ and $\psi' > 0$. This cutoff condition is represented in Figure 1. Note that we can write ψ as a function of only the ratio of wages because π is a constant elasticity function. In what follows we will loosely speak of the function ψ as the ‘wage ratio’, which should not cause any confusion because it is just a scaling of the wage ratio. Note that the smaller is the wage ratio the more likely is an international match to be of acceptable quality, reflecting the greater gains from international trade.

The key feature of our search and bargaining model is that some home producers draw foreign producers that yield match quality $z < 1/4 + \psi/[4(1 - t)]$ and then return home, with both the home and foreign parties to the failed international matches finding domestic partners instead. This is consistent with the considerable heterogeneity that exists at the firm level regarding involvement in

foreign transactions. Only a minority of firms even in high wage countries like the US have investments abroad, and in all countries studied many firms that produce tradeable goods have zero exports (Roberts and Tybout, 1997; Bernard and Jensen, 1999).¹² The result that some firms that search abroad return home empty-handed would also be obtained in a dynamic search model with an increasing marginal cost of search, but both the closeness to standard static trade models and tractability would be reduced.¹³

2. Basic Results

There are three types of equilibria in our model. If the labour-producer endowment ratios of the two countries are sufficiently close, the foreign wage will be high enough relative to the home wage that no international matches can be confirmed: if $\psi > 1 - t$ the right-hand side of (4) is greater than $1/2$, the maximum value of z . We call an equilibrium in which no international matches are confirmed a *Prohibitive Tax/Transport Cost Equilibrium* (PTE) and label as $\overline{L/L^*}$ the smallest ratio of labour-producer endowment ratios for which a PTE obtains. If the wage ratio becomes $1 - t$, international matches between tied producers become acceptable by (4) because every match between a home producer and the foreign producer to which it is tied yields match quality $z = 1/2$. As L/L^* falls below $\overline{L/L^*}$, tied producers prevent the wage ratio from falling below $1 - t$ because by (4) $\psi < 1 - t$ leads all of them to strictly prefer international matches and thus demand foreign labour. We call an equilibrium in which $\psi = 1 - t$ and a positive measure of international matches is confirmed a *Perfect Arbitrage Equilibrium* (PAE) and label as $\underline{L/L^*}$ the smallest ratio of labour-producer endowment ratios for which a PAE obtains. Finally, as L/L^* falls below $\underline{L/L^*}$, tied producers cannot transfer enough labour demand to bring about $\psi = 1 - t$, the wage ratio falls below $1 - t$ and some matches made by untied producers will be confirmed. We call such an equilibrium an *Imperfect Arbitrage Equilibrium* (IAE).

In our first Proposition we solve for the values of $\overline{L/L^*}$ and $\underline{L/L^*}$:

PROPOSITION 1. $\overline{L/L^*} = g(1 - t)$ and $\underline{L/L^*} = [(1 - m)/(1 + m)]g(1 - t)$, where $g(\psi) \equiv \pi'(w)/\pi'(w^*)$.

Proof. We begin by finding the smallest value of L/L^* consistent with existence of a PTE. To do so we solve for the labour-market clearing conditions when no international matches are confirmed. In this case there will be a mass $1/2$ of domestic partnerships in each country. Labour demand in each country can then be computed using (3), yielding the labour-market clearing conditions $-(1/4)\pi'(w) = L$

¹² Clearly some of these firms attempted the foreign market. Swedish Trade Council export consultant Kent Goldmann (quoted in Nothdurft (1992, p. 32)) stated of his clients that are marginal or failed exporters, 'Sometimes their product isn't right for the market, or the country they chose was not a good fit, or their approach or agents are not right'.

¹³ Why should the marginal cost of search be increasing? In order to judge the quality of a match with a foreign producer a manager must be intimately familiar with his own firm's operations, and thus involved in them. If he travels abroad for a week, say, someone can cover for him, but the longer he is absent the more crucial and pressing are the unmade decisions that pile up. In other words, the opportunity cost of the manager's time is increasing.

and $-(1/4)\pi'(w^*) = L^*$ for the home and foreign countries, respectively. Combining these two equations gives us $g(\psi) \equiv \pi'(w)/\pi'(w^*) = L/L^*$. Note that we can write g as a function of the wage ratio ψ because π' is a constant elasticity function. Furthermore, g is an increasing function of ψ , with $g(0) = 0$ and $g(1) = 1$. These properties tell us that, as we would expect, $L/L^* = 1$ implies $\psi = 1$ and as L/L^* falls so must ψ . A sufficient fall in L/L^* , however, drives ψ below $1 - t$, conflicting with the assumption that no international matches are confirmed. It follows that $g(1 - t)$ defines the smallest endowment ratio consistent with existence of a PTE. Next we find the smallest value of L/L^* consistent with existence of a PAE. This equals the smallest possible ratio of home to foreign labour demands consistent with $\psi = 1 - t$, which is constructed by having all tied producers demand foreign labour since with $\psi = 1 - t$ we cannot have a positive measure of confirmed international partnerships between untied producers. Using (3) we can compute that international partnerships between tied producers will generate a demand for foreign labour equal to $-(m/2)\pi'(w^*)$, where we have used the fact that m tied home producers and m tied foreign producers generate m international partnerships. The demand for home labour is then given by $-[(1 - m)/4]\pi'(w)$ and the demand for foreign labour is given by

$$-[(1 - m)/4]\pi'(w^*) - (m/2)\pi'(w^*) = -[(1 + m)/4]\pi'(w^*).$$

Dividing home by foreign labour demand and substituting in $\psi = 1 - t$ yields $[(1 - m)/(1 + m)]g(1 - t)$.

In Rauch and Casella (2001, Propositions 3 and 4) we prove that an IAE obtains if and only if $L/L^* < \underline{L/L^*}$, a PAE obtains if and only if $\underline{L/L^*} \leq L/L^* < \overline{L/L^*}$, and a PTE obtains if and only if $L/L^* \geq \overline{L/L^*}$, where $\underline{L/L^*}$ and $\overline{L/L^*}$ are given by our first Proposition above.

Any Prohibitive Tax/Transport Cost Equilibrium or Perfect Arbitrage Equilibrium is a Complete Information (Equivalent) Equilibrium (CIE),¹⁴ where a CIE is defined as an equilibrium in which all producers match with their perfect complements (i.e., $z = \frac{1}{2}$ for every confirmed match). The intuition is that with a sufficiently small difference in labour-producer endowment ratios, tied producers can transfer enough labour demand to realise all the gains from trade that are available given the conventional trade barrier, leaving untied producers to match domestically where they know the locations of their perfect complements. Note that as m approaches zero we see from Proposition 1 that $\underline{L/L^*}$ approaches $\overline{L/L^*}$ and the PAE vanishes: tied producers who eliminate the international matching friction are needed to maintain the perfect arbitrage condition $\psi = 1 - t$. On the other hand, as m approaches one we see from Proposition 1 that $\underline{L/L^*}$ approaches zero and the Imperfect Arbitrage Equilibrium vanishes. Also note that for any given endowment ratio less than $\overline{L/L^*}$, we can use Proposition 1 to solve for a value of $m < 1$ that yields a PAE by substituting the actual value of L/L^* for $\underline{L/L^*}$: only a strict subset of producers who know the locations of their perfect foreign complements is sufficient to eliminate the information problem in the world economy for any country endowments.

¹⁴ We include the qualifier 'equivalent' in the definition of a CIE because, in fact, complete information does not exist in our model of the world economy.

In a CIE, our model is isomorphic to the standard one-good, two-factor model with a world capital stock equal to $1/2$, the ownership of which is divided equally between the two countries. The number $1/2$ equals the world mass of partnerships multiplied by the maximum match quality per partnership. More specifically, in a Perfect Arbitrage Equilibrium the model is isomorphic to this standard model with the arbitrage condition $r = (1 - t)r^*$, where r is the rental rate on capital. With $\underline{L/L^*} < L/L^* < \overline{L/L^*}$, our model inherits all the static *and* comparative static properties of the standard model with $r = (1 - t)r^*$.

Here we note the properties of the model given $\underline{L/L^*} < L/L^* < \overline{L/L^*}$ whose failures to hold in an IAE are of greatest interest. These properties also obtain (qualitatively) in an incomplete specialisation equilibrium of the 2×2 Heckscher-Ohlin-Samuelson model. First, ties are irrelevant in the sense that a change in m leaves the equilibrium unchanged.¹⁵ Second, the ratio of the foreign to the home wage is fixed by the conventional trade barrier (the tax/transport cost) and the underlying production technology. As a consequence, relative country wages are independent of country labour endowments: a change in the labour endowment of either country causes wages in both countries to change by an equal percentage, and migration from the low-wage, labour-abundant country to the high-wage, labour-scarce country does not affect relative country wages.¹⁶ As another consequence, the extent to which changes in the conventional trade barrier affect relative country wages is determined entirely by the underlying production technology. We can be more specific after making the change in variable $T \equiv 1 - t$ and denoting the elasticity of producer profits with respect to the wage by ε . Note that an increase in T represents trade liberalisation and leads to convergence between foreign and home wage rates, and that ε is determined by the underlying production technology:

PROPOSITION 2. *Given $\underline{L/L^*} < L/L^* < \overline{L/L^*}$ $d[\ln(w^*/w)]/d[\ln(T)] = 1/\varepsilon$.*

Proof. $\psi(w^*/w) = T$ must hold when $\underline{L/L^*} < L/L^* < \overline{L/L^*}$. But $\psi(w^*/w) = (w^*/w)^\varepsilon$. The result then follows from logarithmic differentiation.

An IAE is not a CIE, and to develop its contrasting properties we must solve for the labour-market clearing conditions when $\psi < 1 - t$. Home producers whose international matches were broken are the sole source of demand for home labour, and with $\psi < 1 - t$ these can only be untied producers. Each partnership between such producers generates demand for home labour equal to $-(\frac{1}{2})\pi'(w)$. The mass of such partnerships, if all untied home producers formed them, would be $(1 - m)/2$. From Figure 1, however, we can see that the probability that any untied home producer will make an unacceptable international match is equal to $2(1 - t + \psi)/4(1 - t)$. Multiplying these three terms together thus gives us the demand for home labour generated by home producers whose international matches were unsuccessful, which we can equate to the home labour endowment to give us the home labour-market clearing condition:

¹⁵ Although ties are effectively invisible in a PAE they underpin the smooth functioning of the economy, performing the role claimed for them by sociologists such as Granovetter (1985).

¹⁶ Following Leamer (1995), we can call this property 'relative factor-price insensitivity'.

$$(1 - m) \left[\frac{1 - t + \psi}{8(1 - t)} \right] [-\pi'(w)] = L. \quad (5)$$

As expected, home labour demand is increasing in ψ : as the wage ratio increases, the share of international matches that are acceptable falls.

Using the same reasoning, we can show that the demand for foreign labour by foreign producers whose international matches were unsuccessful is given by the left-hand side of (5), replacing w with w^* . To this must be added the demand for foreign labour by tied producers, $-(m/2)\pi'(w^*)$, and the demand generated by successful partnerships between untied home and foreign producers. This last source of demand can be computed using (3) and (4):

$$2(1 - m) \left\{ \int_{(1-t+\psi)/[4(1-t)]}^{1/2} z[-\pi'(w^*)] dz \right\} = (1 - m) \left\{ \frac{1}{4} - \frac{[(1-t) + \psi]^2}{16(1-t)^2} \right\} [-\pi'(w^*)],$$

where we used the symmetry of the problem to integrate over only half the interval in Figure 1 and multiplied by 2. Summing the three sources of foreign labour demand and equating the result to the foreign labour endowment yields the foreign labour-market clearing condition:

$$\left\{ \frac{1 + m}{4} + \frac{(1 - m)[(1 - t)^2 - \psi^2]}{16(1 - t)^2} \right\} [-\pi'(w^*)] = L^*. \quad (5^*)$$

Foreign labour demand is decreasing in the wage ratio ψ , as expected.

Combining (5) and (5*) yields, after a little manipulation,

$$\frac{2 + 2[\psi/(1 - t)]}{4[(1 + m)/(1 - m)] + 1 - [\psi/(1 - t)]^2} g(\psi) = L/L^*. \quad (6)$$

Given the properties of g listed in the proof of Proposition 1, we know the left hand side of (6) is increasing in ψ . This allows us to prove:

PROPOSITION 3. *The home and foreign wage rates w and w^* are uniquely determined in an IAE.*

Proof. A given $L/L^* < \underline{L/L^*}$ determines a unique $\psi < 1 - t$ by (6). This solution can be substituted into (5) and (5*). Since $\psi < 1 - t$, the coefficients on π' in these equations are positive. Then, because π' is a monotonic constant elasticity function, a unique w exists that solves (5) and a unique w^* exists that solves (5*).¹⁷

We now turn to the properties of an IAE that contrast with those of a PAE. We first consider the impacts of changes in labour endowments:

¹⁷ The assumption that $\pi(w)$ is a constant elasticity function is not necessary to prove existence or uniqueness but is used to save space. Uniqueness can be proved without adding to the standard properties of a profit function by using an appropriate adaptation of Figure 1 in Rauch and Casella (1998). To demonstrate existence it is sufficient for the profit function to have been derived from an underlying production function, (1), that satisfies the Inada conditions.

PROPOSITION 4. *In an IAE, $d(w^*/w)/d(L/L^*) > 0$, $dw/dL < 0$, $dw^*/dL < 0$, $dw/dL^* < 0$, and $dw^*/dL^* < 0$.*

Proof. Equation (6) yields $d\psi/d(L/L^*) > 0$, demonstrating the first result. Now consider the results dw/dL , $dw^*/dL < 0$. From (6) we have $d\psi/dL > 0$, and from (5*) we have $dw^*/d\psi < 0$, yielding $dw^*/dL < 0$. In turn, $dw^*/dL < 0$ and $d\psi/dL > 0$ imply $dw/dL < 0$. The results dw/dL^* , $dw^*/dL^* < 0$ can be proved analogously, using (6) and (5).

Proposition 4 implies that, in an IAE, as factor endowment ratios move farther apart so do wages. It also implies that when the labour endowment of one country increases, the wage rates in both countries fall, but the wage rate in the country whose endowment increased falls more. In this sense, in an IAE a country displays excess sensitivity to changes in its own labour supply, or is partially insulated from changes in its trading partner's labour supply, unlike in a PAE. Another consequence of Proposition 4 is that migration from the low-wage, labour-abundant country to the high-wage, labour-scarce country causes wages in the latter to fall relative to wages in the former. Trade is thus a less effective substitute for factor movements in an IAE than in a PAE.

Next we consider the effect in an IAE of changes in the conventional trade barrier:

PROPOSITION 5. *In an IAE, $0 < d[\ln(w^*/w)]/d[\ln(T)] < 1/\varepsilon$.*

Proof. Make the change of variable $T \equiv 1 - t$ in (6). Since the left-hand side of (6) is decreasing in T we know that $d\psi/dT > 0$, hence $d[\ln(w^*/w)]/d[\ln(T)] > 0$. Moreover, to keep the left-hand side of (6) constant when T changes, the ratio ψ/T must fall when T rises and rise when T falls. Since $\psi(w^*/w) = (w^*/w)^\varepsilon$, it follows that $d[\ln(w^*/w)]/d[\ln(T)] < 1/\varepsilon$.

Comparing Propositions 5 and 3, we see that trade liberalisation (an increase in T) causes less convergence in country wages in an IAE than in a PAE. Again, matching friction 'delinks' the two economies in an IAE compared to a PAE.

The intuition for Propositions 4 and 5 is the same. Consider an increase in L^* or an increase in T . Each tends to generate more trade, which requires more international matches to be confirmed. If untied producers confirm more international matches, however, the quality of the marginal confirmed match must fall, requiring a fall in ψ relative to T by (4).¹⁸

Given the share of producers that are tied, we have seen that if the factor endowment ratios of the two countries are sufficiently similar, relative country wages are determined only by the conventional trade barrier and production technology, whereas if the factor endowment ratios are sufficiently different, relative country wages become a function of relative labour supplies. This is reminiscent of the shift from an incomplete to a complete specialisation equilibrium in the 2×2 Heckscher–Ohlin–Samuelson model. It is thus instructive to compare the properties

¹⁸ This intuition is sufficiently robust that we conjecture that Propositions 4 and 5 would hold for any model of search by untied producers for foreign partners in which the marginal cost of search is increasing.

of the complete specialisation equilibrium with those of the Imperfect Arbitrage Equilibrium. One key difference is that in the complete specialisation equilibrium, a change in one country's labour endowment causes *no* change in the wage of the other country measured in terms of its output. A second key difference is that in the complete specialisation equilibrium, trade liberalisation causes *no* convergence of country wages measured in terms of domestic output: indeed, country wage rates measured in terms of domestic output are not a function of the conventional trade barrier at all.

The other major property of the IAE that distinguishes it not only from a PAE but also from any equilibrium of a standard trade model is that international ties are important:

PROPOSITION 6. *In an IAE, $dw/dm < 0$ and $dw^*/dm > 0$.*

Proof. We see from (6) that $d\psi/dm > 0$, so that w^* rises relative to w . We can therefore rule out the combination of $dw/dm > 0$ and $dw^*/dm < 0$, and can also rule out the combinations $dw/dm, dw^*/dm > 0$ and $dw/dm, dw^*/dm < 0$ by proving that $(dw/dm)(dw^*/dm) < 0$. The most straightforward way to do this is simply to substitute the definition $\psi(w^*/w) \equiv \pi(w)/\pi(w^*)$ into (5) and (5*), and then to totally differentiate the resulting two equations. The results can be summarised as follows:

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} dw \\ dw^* \end{pmatrix} = \begin{pmatrix} E \\ F \end{pmatrix} dm,$$

where the matrix coefficients are functions of w, w^* , and the parameters of the model. Then a straightforward use of Cramer's rule reduces the proof to showing that $(DE - BF)(AF - CE) < 0$. The proof of this inequality, as well as the explicit expressions for the coefficients, are relegated to an appendix available on request.

A rise in the share of producers that are tied increases the transfer of labour demand from the labour-scarce to the labour-abundant country in an IAE but not in a PAE.

PROPOSITION 7. *In an IAE, in each country tied producers are strictly better off than the average untied producer.*

Proof. We see from Figure 2 that the profits received by producers in the home and foreign countries, conditional on concluding their international matches, are

$$[(1-t)(z - 1/4)\pi(w^*) + \pi(w)/4]/2$$

and

$$[z\pi(w^*) - \pi(w)/4(1-t) + \pi(w^*)/4]/2,$$

respectively. For all tied producers $z = 1/2$ and, given $\psi \equiv \pi(w)/\pi(w^*) < 1 - t$, this yields profits strictly greater than $\pi(w)/4$ and $\pi(w^*)/4$ for home and foreign tied producers, respectively. Hence all tied producers confirm their international matches and tied producers are strictly better off than untied producers in their respective countries who match domestically. Moreover, the average z obtained by untied producers who confirm international matches is strictly less than $\frac{1}{2}$, so tied producers are strictly better off than the average untied producer in their respective countries that confirms its international match.

In contrast, tied and untied producers are equally well off in a PAE.

Proposition 7 helps to explain the extremely disproportionate share of wealth, measured by stock market capitalisation, held by the Overseas Chinese in Southeast Asian countries such as Indonesia, the Philippines, and Thailand.¹⁹ Rauch and Trindade (2002) find that the Overseas Chinese network creates a large amount of trade between these countries and other countries with substantial ethnic Chinese populations that are much more labour-scarce, including Australia, Canada, Hong Kong, New Zealand, Singapore, Taiwan, and the US.

3. Discussion and Extensions

3.1. *The Impact of International Trade on Wages: Margins versus Volumes*

Should the impact of international trade on wages be measured by computing the volume of trade in factor services or by examining cost competition at the margin?

Freeman (1995, p. 21–2) elegantly summarises the debate:

If the West can import children's toys produced by low-paid Chinese workers at bargain basement prices, surely low-skilled westerners, who produce those toys at wages 10 times those of the Chinese, will face a difficult time in the job market. It isn't even necessary that the West import the toys. The threat to import them or to move plants to less-developed countries to produce the toys may suffice to force low-skilled westerners to take a cut in pay to maintain employment. In this situation, the open economy can cause lower pay for low-skilled workers even without trade: to save my job, I accept Chinese-level pay, and that prevents imports. The invisible hand would have done its job, with proper invisibility. ... These predictions [of factor-price equalisation] run counter to a wide body of evidence that domestic developments do affect wages: for instance, that the baby boom affected the pay of young workers; that the relative number of college graduates altered the premium paid for education ...²⁰

Having considered the theoretical point that cost competition from labour in low-wage countries could set the wages of comparably skilled labour in high-wage countries, the empirical method for quantifying the impact of international trade on wages that is preferred by Freeman (1995, p. 23) and many others, e.g., Sachs and Shatz (1994) remains *factor content analysis*:

¹⁹ The Economist Intelligence Unit reports the following population and market capitalisation shares, respectively, for the Overseas Chinese in Southeast Asia: Indonesia, 3–4 and 73%; the Philippines, 2 and 50–60%; and Thailand, 14 and 81% (Kluth, 2001).

²⁰ We might take the liberty of clarifying Freeman's statement to add that the baby boom affected the pay of young workers *more in the US than in China* and the relative number of college graduates *in the US* altered the premium paid for education *more in the US than in China*.

if the United States imported 10 additional children's toys, which could be produced by five American workers, the effective supply of unskilled workers would increase by five.... This five-worker shift in the supply-demand balance would put pressure on unskilled wages to fall, causing those wages to fall in accord with the relevant elasticity.

Here the impact of low wage competition depends entirely on the volume of net trade and not at all on comparison of costs at the margin.

We have seen that in the Perfect Arbitrage Equilibrium of our model the ratio of the home to the foreign wage is determined by the conventional trade barrier and production technology independent of country labour supplies. In this equilibrium margins operate perfectly, in the sense that any incipient rise in the home wage relative to the foreign wage above this ratio would be eliminated by a shift in labour demand of tied producers from the home to the foreign country, just as the first quotation above suggests. With labour-producer endowment ratios sufficiently far apart, however, tied producers cannot transfer enough labour demand to maintain the perfect arbitrage condition and the Imperfect Arbitrage Equilibrium of our model obtains: elimination of an incipient rise in the home wage requires that untied home producers shift from matching in a complete information environment domestically to an incomplete information environment abroad. Margins now operate imperfectly, and relative labour demand is no longer infinitely elastic with respect to relative country wages: the 'relevant elasticity' is finite. In other words, relative wages become a downward-sloping rather than horizontal function of relative labour supplies in the two countries, and we must therefore take into account the volume of (implicit) net trade in labour services when computing the impact of international trade on domestic wages. This is presumably the pertinent case for trade between more and less developed countries, given the very large differences in endowments of unskilled labour relative to other factors of production.

3.2. *Ties and World Welfare*

In our two-country model, international ties must complement the ability of price signals to induce transfer of labour demand from the country where labour is scarce to the country where labour is abundant. We can thus expect world welfare (equal to income in our model) to be greater in the presence of ties than in their absence because the gains from trade are more fully realised. A more interesting situation in which to investigate the impact of ties on world welfare is where ties and price signals act at cross purposes. This kind of situation can arise in a model with more than two countries if, for example, ties are *not* most dense between the countries between which the wage differentials in the absence of ties are largest. Ties then have a trade diversion as well as a trade creation effect, and their impact on world welfare depends on which effect dominates.

This is not a purely hypothetical situation. Consider the movement offshore of the Korean and Taiwanese apparel industries, which accelerated in the late 1980s and early 1990s in response to sharply rising domestic wages. Gereffi (1999, p. 59)

states, 'The preference of Korean firms for investment in Latin America (Guatemala, Honduras, the Dominican Republic, etc.) is stimulated by its proximity to the United States market and easy quota access. The pull of Asian nations such as Indonesia, Sri Lanka, and Bangladesh comes mainly from their wage rates, which are among the lowest in the world'. In contrast, Taiwanese firms invested most heavily in China, Malaysia, the Philippines, and Thailand as well as Indonesia. Ethnic Chinese ties are important in all of these countries, and in at least two (Malaysia and Thailand) wages are well above South Asian levels. Gereffi (1999) concludes (p. 63), 'social ties shape sourcing networks'.

To create a situation in our model in which price signals and ties can act at cross purposes, we add a third country with a greater labour-producer endowment ratio than either of the other two countries. We re-label the home country as country 1 and the foreign country as country 2, and label the new country as country 3. For country 3 there is a continuum of producers of every type of mass 2, so that the total mass of producers in country 3 equals the sum of the masses of producers in countries 1 and 2. We assume that producers in country 1 search abroad for partners first, followed by producers in country 2. As before, producers who form unsuccessful international partnerships must return home and match domestically,²¹ and labour markets clear after all labour demands from international and domestic partnerships are received.

We investigate the impact of ties on world welfare relative to a baseline solution of this three-country model in which there are no ties. It is easy to see that if wages in countries 2 and 3 are sufficiently close in the baseline solution, ties between countries 1 and 2 must raise world welfare. Since the source of gains from trade is the transfer of labour demand from a high-wage to a low-wage country, as the baseline wage of country 2 approaches that of country 3 the loss of gains from trade from the 'trade diversion effect' approaches zero while the gains from trade from the 'trade creation effect' get larger. The same argument implies that the increase in world welfare from ties between countries 1 and 2 declines as the country 2 wage rises relative to the country 3 wage in the baseline solution. This argument cannot establish the possibility of a decrease in world welfare from ties, however, because the trade creation effect cannot be made arbitrarily small relative to the trade diversion effect: country 1 producers choose not to use their ties when the wages in countries 2 and 1 get too close, matching with country 3 producers instead, so the effect of ties on world welfare goes to zero. We have instead established this possibility through simulation.

In the simulation we assume a Cobb–Douglas production function with labour share = $\frac{1}{2}$, yielding $\pi(w) = 1/w$. We set $m = 0.1$ between countries 1 and 2, $t = 0.1$ between all three pairs of countries,²² and the world labour endowment equal to 3. We then change the allocation of this endowment across the three countries so as to maintain $w^1/w^3 = 4$ while increasing w^2/w^3 , where w^i denotes the wage in country i in the baseline solution. World welfare with ties falls below world welfare

²¹ We could thus allow any unmatched producers in country 3 to search abroad for partners as well, but it would not matter because all partners would already have been taken.

²² We further assume that t is a pure melting transport cost, so that we do not have to keep track of tax revenues.

without ties when w^2 becomes slightly more than double w^3 , but country 1 producers do not abandon use of their ties until w^2 reaches nearly two and one quarter times w^3 .²³ It follows that, for allocations of the world labour endowment that yield baseline solutions in this range, a prohibitive tax on trade between countries 1 and 2 will increase world welfare.

The key distortion that puts us in the world of the second best is that country 1 producers choose whether to use their ties on the basis of their shares of the values of their international matches, rather than on the basis of the entire values of their matches. Their bargaining power is lower in country 3 than in country 2 because the wages of the labour to which country 3 producers are guaranteed access are lower than the wages in country 2. In effect, the producers in country 2 to which country 1 producers are tied give the latter too good a deal from the point of view of world welfare.

3.3. *Ties and Trade in Differentiated versus Homogeneous Products*

Rauch and Trindade (2002) find that ethnic Chinese networks increase bilateral trade most for differentiated products, least for products traded on organised exchanges, and an intermediate amount for products with reference prices²⁴ (hence relatively homogenous) but not traded on organised exchanges. This suggests that products could be arrayed on a continuum from most differentiated to most homogeneous, with the impact of ties on trade decreasing as one moves from the differentiated to the homogeneous end of this continuum. Our model is not set up to compare the impact of ties on trade across different goods, however, as it is a model of trade in factor services with trade in the one produced good occurring as a byproduct of the need to repatriate profits. In this subsection we will show how the model can address this issue quite naturally after some re-interpretation of the agents and variables.

We begin by re-interpreting ‘producers’ as wholesalers engaged in both domestic distribution and import-export activities. Instead of purchasing ‘labour’, wholesalers purchase goods from manufacturers, and ‘wages’ can then be interpreted as producer prices. Wholesaler ‘types’ can be interpreted as reflecting their (possibly contractual) affiliations with certain manufacturers and end users (retailers or purchasers of intermediate goods). Match quality is then increasing in the suitability of the product varieties supplied by the underlying manufacturers for the end users the wholesalers wish to serve. Equation (1) now gives the production function for wholesale services for a given product. Match quality is a more important component of wholesale services, the greater is the level of product differentiation, and this can be usefully captured by a relatively greater exponent on z_{ij} in a Cobb–Douglas specification of the production function F . It is easily shown that this implies a smaller elasticity of the profit function in (2) with respect to the producer price w . Intuitively, the more ‘commodified’ is the product, the

²³ Rauch and Casella (2001, pp. 24–6 and condition (9)) show that this is equilibrium behaviour.

²⁴ A reference price is a price that is quoted (in a trade publication, for example) without an identifying brand name.

more price sensitive are the profits of the wholesalers that handle it. The continuum of products from most differentiated to most homogeneous that we seek can thus be indexed by ε , with increasing ε corresponding to increasing homogeneity.

In this interpretation of the model, the volume of trade in any good is given by the purchases of internationally matched foreign wholesalers from their affiliated manufacturers for resale by their partner home wholesalers to their affiliated end users. We are interested in how the percentage change in this volume with respect to m , the share of wholesalers of that good that are tied, varies with ε . In order to isolate the effect of ε we assume that m , t , and the foreign cost advantage given by the ratio of producer prices w^*/w , are the same across all goods. We then consider only the case where $\psi = (w^*/w)^\varepsilon < 1 - t$ for all goods, since $\psi > 1 - t$ yields no trade in that good and $\psi = 1 - t$ can hold for at most one good. In this case, the volume of trade for any good for which there is a unit mass of wholesalers in each country²⁵ is given by

$$V = \left\{ \frac{1+m}{4} - \frac{(1-m)[(1-t)+\psi]^2}{16(1-t)^2} \right\} [-\pi'(w^*)], \quad (7)$$

where we have simply followed the derivation of the demand for foreign labour (the left-hand side of (5*)) but omitted the contribution of domestic partnerships.

Physical production is no longer in the model, so we have a partial rather than a general equilibrium framework for comparing the impact of ties on trade across many goods. In this partial equilibrium framework we assume that producer prices are determined by the costs of primary factors of production, which cannot be affected by changes in demand for any one good.²⁶ We can then prove:

PROPOSITION 8. $(dV/dm)/V$ is decreasing in ε .

Proof. With producer prices fixed, we have

$$\frac{dV}{dm} = \left\{ \frac{1}{4} + \frac{[(1-t)+\psi]^2}{16(1-t)^2} \right\} [-\pi'(w^*)].$$

Dividing by V yields

$$\frac{dV}{dm} \bigg/ V = \left\{ \frac{1}{4} + \frac{[(1-t)+\psi]^2}{16(1-t)^2} \right\} \bigg/ \left\{ \frac{1+m}{4} - \frac{(1-m)[(1-t)+\psi]^2}{16(1-t)^2} \right\}.$$

The numerator is increasing in ψ and the denominator is decreasing in ψ . Since ψ is decreasing in ε , the result follows.

²⁵ Since we are examining percentage changes in the volume of trade, scaling by the mass of wholesalers in each country for the particular good will obviously not affect the results.

²⁶ It therefore does not matter whether we consider percentage changes in the volume or value of trade. We must view Proposition 8 as referring to the impact of changing the share of wholesalers that are tied for the product in question only, starting from an equal share of tied wholesalers for all products.

Proposition 8 shows that the impact of international ties between wholesalers on bilateral trade decreases with the level of product homogeneity. The intuition for Proposition 8 is that price signals and ties are both sources of information: as price signals strengthen, the need for ties decreases. The strengthening of the price signal in Proposition 8 is reflected by the reduction in ψ as ε increases.

4. Conclusions

It is more difficult in the international than in the domestic market for producers to find the right distributors for their consumer goods, for assemblers to find the right suppliers for their components, for investing firms to find the right partners for their joint ventures, and so on. Ties through international information-sharing networks or parent-subsidiary relationships help producers to solve their matching problems and find suitable trade or investment partners in other countries. In our basic model we find that, when the difference between the factor-endowment ratios of the two countries is small relative to the share of producers that is tied, efficient arbitrage and the standard properties of neoclassical trade models prevail. When the difference between factor-endowment ratios is sufficiently large, this equilibrium breaks down and the two countries become partially insulated from each other in the sense that each country's wage (resource price) is more sensitive to changes in domestic than foreign labour supply and trade liberalisation causes less convergence in country wage rates. Efficient arbitrage fails because price signals convey incomplete information to the complete set of producers whereas ties convey complete information to an incomplete set of producers.

The imperfect operation of margins that occurs when endowment ratios are far apart suggests that, when evaluating the impact on domestic wages of trade between more and less developed countries, the volume of (implicit) trade in labour services must be taken into account. An extension of the model to three countries shows that when ties are denser between countries with small wage differences than between countries with large wage differences, they can worsen the allocation of resources and reduce the value of world output. An adaptation of the model to trade in many goods shows that ties between wholesalers increase the volume of bilateral trade more for differentiated than for homogeneous products.

The simplicity and tractability of the basic model of Sections 1 and 2 facilitate yet other modifications that allow its application to issues beyond the scope of this paper. Rauch and Trindade (2000) show how the basic model can be modified to address the effects of a reduction in informational barriers to trade through improved information technology (the Internet). Another natural direction in which to extend the basic model is to make it dynamic rather than static. In particular, trade could create new ties or retard the decay of old ones, and could increase familiarity with the foreign country so that untied home country producers are better informed about the locations of foreign producer types. This would naturally yield a positive effect of past bilateral trade on current bilateral trade, as found by Eichengreen and Irwin (1998). At the same time forces leading to loss of information, such as producer entry and exit, would have to be added to the

model to prevent informational barriers to trade from disappearing in the long run. Eichengreen and Irwin (1998) find that the more distant is past bilateral trade, the weaker is its effect on current bilateral trade. Ideally, the basic model could be sufficiently enriched that, for example, it would be possible through calibration to use the estimated effect of ties on bilateral trade to compute the share of the shortfall in world trade relative to a frictionless counterfactual that can be attributed to informational barriers.²⁷

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²⁷ Eaton and Kortum (2002) compute a very large total shortfall, but cannot allocate it between various causes.

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