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A Simple General Equilibrium Model with International Labour Market Linkages

INTRODUCTION

AN IMPORTANT ASPECT OF GLOBALIZATION is the growing importance of international labour mobility. Although, in overall volumes, migrations remain largely traditional (i.e. non-skilled labour from non-OECD countries to OECD countries; see Gross and Schmitt, 2002), there is growing intra-OECD country labour mobility and there is a perception that a substantially higher level of international labour mobility may be just around the corner. Current intra-OECD labour mobility exhibits a relatively high mean and variance with respect to skill level as compared to worldwide international labour mobility. In this regard, Canada and the United States are probably at the forefront of that evolution due in large part to the relatively high degree of labour mobility at the national level and to the natural pressure thus created on cross-border mobility under current migration policies. In Europe, despite legally free mobility within the European Union, migration flows, though rising, remain modest. For instance, it is rumoured that well over 250,000 French citizens have recently moved to London and that a high share of these migrants are young, highly skilled and entrepreneurial individuals fleeing the French bureaucracy in favour of British laissez-faire. The number of cross-border commuters is growing steadily in border regions (for instance between Switzerland and neighbouring countries). With rapidly aging populations, Germany, Italy, Austria and Switzerland are adopting policies aimed at attracting and facilitating the migration of skilled individuals.[1] However, even if mobility within the European Union were to increase dramatically, it is unlikely that it will ever be able to contain

the costs of a rapidly aging population. Hence, migration will have to come from outside the European Union (Fertig and Schmidt, 2002).

What are the economic costs and benefits of international labour mobility in a modern economy? Should it be encouraged? Should it be encouraged for some skills but not for others? Is international labour mobility of skilled workers an important factor for specialization? Although these questions are interesting, they require new tools. In particular, the existing literature largely treats skills as homogeneous and identical across countries. If international labour mobility with homogeneous skills is potentially important because of its scale effect, such treatment of international mobility and its impact on modern economies is obviously oversimplified. For high-value-added manufacturing and service sectors, we need to differentiate skills and, more importantly, assign a significant role to highly skilled individuals in the production of goods and services. The main purpose of this study is to suggest a modeling approach to highlight the potential economic effects of migration when differentiating labour by skills. One could imagine building an applied general equilibrium model with these features, and our study could be considered a tentative first step in this direction.

The study is organized as follows. In the section entitled *Trade Liberalization and International Labour Mobility*, we review the main channels through which international labour mobility affects the economy. In the next section, entitled *A Model of Trade, Wage Distribution and International Labour Mobility*, we focus on one particular mechanism based on trade and income inequality. We develop a model where individuals choose to migrate wherever their skills support the highest wage. In the following section, we conduct simulation exercises using fictitious data in order to highlight the basic mechanisms at work.

TRADE LIBERALIZATION AND INTERNATIONAL LABOUR MOBILITY

THE TRADITIONAL HECKSCHER-OHLIN APPROACH to international trade and factor mobility predicts that international factor mobility will not occur with free international trade of products since all efficiency gains can be realized by international trade alone. This classic result due to Mundell (1957) thus suggests that trade and international labour mobility are substitutes. Because the assumptions underlying the neoclassical approach are quite stringent, it is easy to find models where this substitution does not hold and, therefore, where the pressures to migrate increase with freer trade. Such complementarity between trade and labour mobility can be obtained in a variety of cases (for surveys and a discussion, see Faini, de Melo and Zimmermann, 1999; and Venables, 1999). In fact, many cases have now been identified and it is probably

fair to say that, today, economists place a greater emphasis on such complementarity than on the more classic substitution between trade and factor mobility. This is important because complementarity between trade and factor flows implies that the economic effects of integration can be very different with or without international factor mobility, and thus with or without integration of different labour markets. We first review some of the main predictions about the relationship between trade and factor flows coming from the workhorse models used in the field.

MAIN TRADE MODELS

TODAY, THE MOST COMMONLY USED TRADE MODELS are without doubt the Heckscher-Ohlin model, the specific factor model, the intra-industry trade monopolistic competition model, and the 'core-periphery' model of economic geography. In a world without distortion where the same factors of production are used to produce every good, the Heckscher-Ohlin model predicts substitution between trade and factor flows. Essentially, in this world, smaller international price differences for a product lead to smaller differences in factor prices. Thus, if there is no incentive to move factors across borders before trade liberalization, freer trade certainly does not create international factor mobility. And, if there is an incentive to move factors across borders before trade liberalization, this incentive necessarily decreases with freer trade. In other words, the Heckscher-Ohlin approach leads to the classical substitution between trade and factor mobility.

This result does not necessarily hold with the specific factor model. This point is important because factor specificity is probably a key element of modern economies. It is indeed fair to say that, with globalization, there is an overall increase in factor specificity (including labour specificity) through factor specialization. To see why factor specificity could lead to complementarity between trade and international labour mobility, suppose that capital or natural resources are specific and that trade liberalization decreases the price of the importable without increasing the price of the exportable. If labour is the intersectoral mobile factor in this economy, the nominal wage will fall. However, the real wage may rise (in terms of the importable) or fall (in terms of the exportable) with ambiguous effects on the incentive to migrate. Suppose now that labour is specific to an import-competing sector. By lowering its real return, trade liberalization increases the incentive to migrate to another country. The important point here is that trade liberalization does not necessarily lead to a lower incentive to migrate, as in Mundell's story, because factor specificity adds a rich set of possible interactions between factors. As a result, factor flows accompanying trade liberalization may make economies more different.[2]

Complementarity between trade and factor flows also arises in models of imperfect competition and increasing returns to scale. Suppose for example that one sector is characterized by Dixit-Stiglitz monopolistic competition, while the factors of production used in that sector conform to the Heckscher-Ohlin model (see Venables, 1999, for such a model). Consumers buy all the differentiated products from this sector, with constant elasticity of substitution (CES) between products. This approach adds several important elements. First, an absolute advantage now matters since a larger country implies a greater number of differentiated products and a more competitive environment. When the differentiated products are used as intermediate inputs in other sectors, then the more competitive environment amounts to a cost reduction in these sectors, translating into higher returns to other factors used in production. Second, firms tend to locate in the larger country because consumers spend more on the differentiated products. This means a higher demand for factors of production in the larger country, and thus higher factor prices. This combined with a lower cost of living (since there is more competition in the larger country) also contribute to raise factor prices in terms of the numeraire. Not surprisingly, factor mobility could be destabilizing in this model. Full agglomeration occurs only in the unlikely case of perfect mobility of all factors. Even if not every factor is mobile (say one of two are not mobile), trade liberalization may lead the smaller economy to become even 'smaller', resulting in a core-periphery type of structure (Krugman, 1991). Whether this occurs in a continuous or a discontinuous fashion depends on the specificity of the model. In particular, for this to occur, at least one factor of production must be perfectly mobile. Hence, there is complementarity between trade and labour mobility since 'free trade' does not eliminate the incentives to migrate. As can be easily imagined, the economic impact of relaxing international migration rules could be quite significant in such an environment,[3] with possible core-periphery type of outcomes.[4]

Other mechanisms leading to complementarity between trade and factor flows could be imagined, but they would not necessarily be relevant for developed economies like those of Canada, the United States or Western European countries. It should be clear, for instance, that mechanisms based on differences in technology among countries are probably not good candidates simply because it is unlikely that substantial technological differences exist among Western countries. Other avenues are not very promising either. They include migration as a response to adjustment lags (e.g. in investment) and complementarity due to the presence of migration networks. These networks imply a potential positive reinforcement effect between trade and migration. Although this explanation certainly has validity for countries like the United States or

Canada with respect to the rest of the world,[5] it is probably not very significant between two developed economies.

Factor specificity, imperfect competition, and geography and trade seem the most relevant building blocks to capture important elements of modern economies and the effects of labour mobility in a freer trade environment. However, two important problems must be addressed. First, the geography and trade approach is notoriously sensitive to assumptions and quite complex to apply. Integrating such a building block into an applied general equilibrium model is not an easy task. Second, although it is straightforward to consider skilled labour as the mobile factor and unskilled labour as the immobile factor, nothing in the trade and geography approach actually links these factors to labour. In other words, the main mechanisms at work are independent of the functioning of labour markets or of the role of workers. For these reasons, we turn our attention to trade models characterized by labour heterogeneity.

MODELS OF LABOUR HETEROGENEITY AND TRADE

AS SHOULD BE CLEAR FROM ABOVE, it is possible to re-interpret the monopolistic competition/geography and trade type of model as a model of international mobility of skilled labour (see Commander, Kangasniemi and Winters (2002) for more details). We want to depart from this model by introducing more structure on the firm's production side to account for labour heterogeneity. The main advantage is to have differentiation at the input level, specifically among workers, introducing the possibility of international movements of workers with well-defined characteristics. By doing so, one can address specific concerns, such as: Would a country like Canada lose firms (or industries) using very highly skilled labour if international labour mobility was made easier? What would be the impact on other sectors and on wages? Could Canada become a peripheral region for activities where market size and skills are important features?

Models of this type work as follows. The production technology requires skilled individuals (let's call them entrepreneurs) along with labour and/or capital in order to produce goods. These models have two key aspects. First, skilled labour is a complementary input to other factors of production. Hence, there are non-convexities in the model, so that a given level of talent (skill) can have a very different impact depending on the size of the market. This is a Rosen 'superstar' type of effect (Rosen, 1981). Second, the impact of talent is modeled in one of two ways, namely as an efficiency effect or as a demand effect. Consider an entrepreneur exercising his talent through a firm. When this talent translates into an efficiency effect or a production effect, the total production derived from a given set of inputs is higher the more the entrepreneur is talented. Whether it is due to organizational or marketing talent, a more able

entrepreneur is simply able to produce more than a less able entrepreneur. This productivity effect is useful because it can be incorporated into a model with homogeneous products. Hence, in such a model, the efficiency effect translates into a firm-size effect and a profit effect (given a fixed supply of entrepreneurs). The set-up is particularly simple in a model where individuals choose the role they want to play, such as the choice between acting as an entrepreneur (hiring other workers and/or capital) or as a worker. In this case, the number and the size distribution of firms become endogenous. Not surprisingly, the most talented individuals act as entrepreneurs while less talented individuals act as workers. Consequently, if (workers') wages rise for any reason, it implies that, *ceteris paribus*, the number of firms (or entrepreneurs) will decrease. The basic model is due to Lucas (1978) and it has been used by Murphy, Shleifer and Vishny (1991), Rauch (1991) and Schmitt and Soubeyran (2002). For instance, Rauch (1991) investigates the connection between the pattern of trade and the pattern of migration in a Heckscher-Ohlin framework, while Schmitt and Soubeyran (2002) use this framework to investigate theoretical aspects of the international mobility of brains in a two-country environment.[6]

An alternative way to model the impact of talents is through a demand effect. In this case, the entrepreneur's ability is not associated with her production ability but with how she (or her product or service) is viewed by consumers. Hence, there is a demand-volume effect associated with higher skilled entrepreneurs (think about entertainers). Manasse and Turrini (2001) model this case by assuming a correspondence between the entrepreneur's skill and product quality. They then assume a correspondence between the quality of a product and the volume of demand for it. This means that products are differentiated at least along the quality spectrum.[7] It also implies that imperfect competition is the more natural environment in which to set this demand effect of skilled entrepreneurs.

So, what are the economic effects of international labour mobility inferred by this approach? To illustrate why labour heterogeneity may imply significant economic effects compared to a more standard approach, consider the following case. A standard approach with homogeneous labour typically assumes that labour and capital are substitutes in production (as in the trade and geography approach; see Venables, 1999). Hence, international labour mobility essentially implies some substitution away from capital for the host country and scale effects in production. When skilled entrepreneurs and labour and/or capital are required to produce differentiated goods, the introduction of international labour mobility of skilled entrepreneurs has a direct impact on the number of products and, thus, the number of firms in an industry, as skilled entrepreneurs are required complementary inputs to other factors of production (whether the entrepreneurs' effect operates through efficiency or demand). When a country

loses skilled entrepreneurs, there are non-trivial sectoral and general equilibrium consequences for it.[8]

This may suggest that the out-migration of skilled individuals has mainly negative economic effects. But it is not always the case. Several arguments suggest that out-migration can favour growth in the country losing skilled labour. Such is the case, for instance, when human capital formation is boosted by the prospects of emigration. Here, emigration provides more opportunities for skilled labour than the confines of the domestic market, thus offering a potentially higher return on human capital investment. The average level of human capital may be higher following an out-migration of skilled labour than in the absence of mobility (Wildasin, 2002; Stark, Helmenstein and Prskawetz, 1998).[9] In the same vein, arguments can be made about increased labour market integration as a mean to enhance the flexibility and functioning of national labour markets (Wildasin, 2000). These effects are dynamic in nature and will not be considered further here.

However, another potential positive effect of out-migration can be taken into account in the proposed approach. It is the effect linked to the possibility that individuals may not be able to exercise fully their talent in their country of origin but could do so in the country of immigration. Whether this is due to differences in market size or to the absence of complementary inputs in the country of origin does not matter. The important point is that new knowledge, products or services may emerge from migration, benefiting both the country of emigration and the country of immigration. Another way to put it is to recognize that it is efficient for the world that individuals can migrate to a country where market size or complementary inputs allow them to create new products, services or knowledge that they would not have created otherwise.[10]

An important question is, of course, whether incorporating labour heterogeneity and the role of entrepreneurs into an applied general equilibrium model is relevant to the Canada-U.S. case. First, it must be clear that such an approach makes more sense for high-value-added service and manufacturing sectors (like high technology, biotechnology and the like) than for more traditional manufacturing sectors. In other words, it is relevant for knowledge-based sectors more than for any other sector. Second, the fact that highly skilled individuals are (or could be) entrepreneurs in one country or another is clearly a static long-term effect. Consequently, like most applied general equilibrium analysis, this one has essentially a long-term horizon. Third, the fact that these individuals are entrepreneurs should not necessarily be taken literally. It simply means that highly skilled entrepreneurs are essential production inputs. Whether they are literally the residual claimant is not crucial to the story.

A MODEL OF TRADE, WAGE DISTRIBUTION AND INTERNATIONAL LABOUR MOBILITY

THE COMPARISON BETWEEN CANADA AND THE UNITED STATES over the last two decades or so generally leads to three key observations (Harris and Schmitt, 2003): (i) there is increased wage inequality across skill groups in both Canada and the United States; (ii) there is a productivity gap between the two countries; and (iii) there was significant growth in trade and foreign direct investment following trade liberalization in North America. The model proposed below can take into account the first two phenomena. By 'taking into account', we do not necessarily mean an endogenous determination of all the relevant effects, but a model that can endogenize the first element and that could be calibrated to account for the second.

The model developed in this section builds on Manasse and Turrini (2001). The main purpose of their study is to link labour heterogeneity in a country and international trade (or technological change). Their aim is not to investigate the economic impact of the international movement of skilled workers, but rather to explain income inequality through trade, technological change and globalization. We consider this link as one of the main causes of the international movement of skilled workers among developed countries. Simply put, if it is true that, everything else being equal, trade (or technological change) creates income inequality within a country and across countries, then it must also create incentives for individuals to move across borders in order to take advantage of these inequalities because it likely means that the return to a given skill level is becoming increasingly different among countries. An easy way to cast the complementarity between trade and international labour flows implied by this model is to say that trade tends to create income inequalities within and across countries (in the presence of positive transport costs) and that international labour mobility tends to mitigate these inequalities.

The principle here is essentially the same as in more traditional models of international labour mobility, except that it works not only at the country level but also at the individual level. In a standard model of international labour mobility with a homogeneous labour force, the necessary ingredient for international mobility is a difference in (uniform) country real wages. With labour heterogeneity, the average wage may differ not only across countries but across individual wages. This means that, for an individual's skill level, the wage difference between two countries can be positive, negative or nil, and that if international trade creates more inequalities in the absence of international labour mobility, then trade liberalization and international mobility may induce certain categories of workers to emigrate to a particular country and other categories to immigrate. It is the economic consequences of this particular link

between trade liberalization, international mobility and the location of firms and entrepreneurs that we want to investigate.

Consider two countries indexed *i, j* with two sectors indexed *x, y*. Sector *y* (called hereafter High Tech) produces differentiated goods (that are imperfect substitutes), while sector *x* (called hereafter Low Tech) produces a homogeneous good. Each country has two factors of production: entrepreneurs and raw labour. Unskilled labour is homogeneous, in fixed overall supply and competitively priced. In contrast, an entrepreneur is a specific factor used only in the High Tech sector. The domestic supply of entrepreneurs is also in fixed overall supply, but this factor is differentiated according to skills n such that $n \in [\underline{n}, \overline{n}]$. The entrepreneur is the residual claimant in the firm where she exercises her talent. The production of each differentiated good requires one unit of entrepreneur and a variable amount of raw labour proportional to the quantity produced. The entrepreneur's skill improves the quality of the product and thus the quantity demanded. Hence, producing differentiated goods has both a horizontal component in the Dixit-Stiglitz tradition and a vertical component since quality matters. In the absence of international mobility of entrepreneurs, and unlike the typical Dixit-Stiglitz model, there is a fixed number of firms determined by the supply of entrepreneurs.[11] However, each firm earns zero profit since the entrepreneur captures the entire quasi-rent generated by her talent. The production in the Low Tech sector is very standard: firms are price takers and the production function is Ricardian for raw labour. In the current version of the model, we assume this homogeneous product to be a purely non-traded good.

International trade of goods produced in High Tech involves two specific costs (both expressed in terms of raw labour): a variable cost, which can be interpreted as a transport cost (of the iceberg type), and a fixed cost interpreted as a cost to access a foreign market (for instance, to establish a sales network). This fixed cost of trade is critically important because it partitions firms into two subsets: those who are able to export and those who are confined to the domestic market.

The demand side comes from a standard Dixit-Stiglitz sub-utility function, except for the role of quality. Higher perceived product quality increases utility and thus the demand for the product. Manasse and Turrini adopt a relatively *ad hoc* specification since they simply assume the existence of a function T mapping technology and the entrepreneur's skill into a quality component as perceived by consumers. Hence, the representative consumer's utility function, over the set of products N available to him, takes the general CES form:

$$(1) \quad U^{\sigma-1/\sigma} = \sum_{n \in N} T_n(a)^{1/\sigma} d_n^{(\sigma-1)/\sigma}, \ \sigma > 1,$$

where d_n is the quantity consumed of product n and $T_n(a)$ is the quality of the product as evaluated by the representative consumer and which depends on the entrepreneur's skill n used to produce good n and on the technology of production represented by the parameter a.

It is important to underline here two characteristics of the model. First, if raw labour is used in proportion of the quantity produced of one differentiated good, one unit of talent is used whether the market is small or large. Second, only talent (for given technology) adds quality to a product. In other words, even if horizontal differentiation needs both the primary factors and one entrepreneur, vertical differentiation requires the skill of an entrepreneur only. It is these non-convexities in production and in consumption that give a 'superstar'-Rosen-type flavour to the model.

Given (1), country i's demand for a variant takes the following form:

$$E_{i,i,n} = T_{i,n}(a_i)\left[\frac{p_i^y}{p_i}\right] c_i^y$$

$$E_{j,i,n} = T_{j,n}(a_j)\left[\frac{p_i^y}{p_j / \tau_{j,i}}\right] c_i^y .$$

Hence, the demand for one variant depends on its quality $T_{i,n}(a_i)$, $T_{j,n}(a_j)$, on income devoted to the consumption of differentiated products c_i^y, p_i^y, and on the price aggregator over available differentiated products individually priced p_i and p_j adjusted for the (iceberg-type) barrier to trade $\tau_{j,i}$. These demands depend on the entrepreneur's skill through two channels: the quality perceived by consumers and the price of the product.

Because the utility function is CES, firms with the same technology have the same mark-up. Thus, higher product quality simply translates into a higher volume of sales and not into a higher price. Since the entrepreneur is the residual claimant, her wage is equal to the operating profit. This profit is different depending on whether the firm exports or not. If it does not trade, then the wage of the non-trader-entrepreneur $w_{i,n}^{low}$ is simply equal to:

$$(2) \quad w_{i,n}^{low} = \left[p_i - v_i\right] E_{i,i,n} ,$$

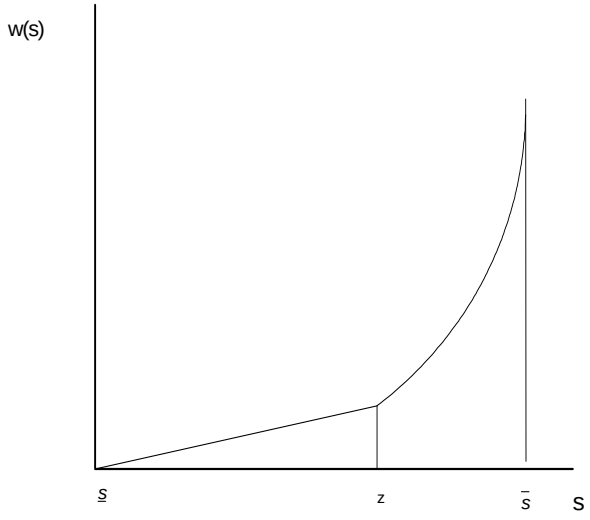
where v_i is the variable unit cost as well as the price of raw labour (Ricardian technology). Of course, the profit of the entrepreneur depends on her skill. If the entrepreneur is trading, her wage is equal to:

$$(3) \quad w_{i,n}^{high} = \left[p_i - v_i\right]\left(E_{i,i,n} + \frac{E_{i,j,n}}{\tau_{i,j}}\right) - v_i \gamma_i \phi_{i,n}^{\eta},$$

where the last term is the fixed cost of exporting.[12] This cost is assumed to decline ($\eta < 0$) with the number of type-*n* exporters (penetration of foreign markets is easier when many producers are willing to sell abroad). The main difference with the non-trader-entrepreneur is that the entrepreneur's skill allows for sales at home and abroad. In other words, talents gain from market size. In this case, the trader-entrepreneur's wage increases more than proportionately with skill. Because of the difference in market size, the general relationship between the entrepreneur's wage and skill is illustrated in Figure 1.

FIGURE 1

RELATIONSHIP BETWEEN ENTREPRENEUR'S WAGE AND SKILL



Entrepreneur n_i chooses to be a trader or a non-trader depending on whether exporting provides a higher operating profit or not. At low levels of n, the non-trader entrepreneur's wage increases with skill. As soon as the firm trades, her wage increases more than proportionately as a given level of entrepreneur's talent now reaches a much larger market. The exporting firm necessarily generates a higher gross profit than a non-exporting firm. However, because exporting involves a fixed cost, only the most talented entrepreneurs participate in the export market. Of course the skill level z_i of the entrepreneur who is just indifferent between trading and not trading is endogenous. Therefore, at z_i, we have $w_{i,z_i}^{low} = w_{i,z_i}^{high}$. Trade liberalization, whether through a lower transport cost or a lower fixed access cost, boosts the wage of the trader-entrepreneur (since the foreign market can now be more easily accessed) and thus decreases the level of the critical skill necessary to participate in the export market. Trade liberalization creates wage inequality insofar as the relative earnings of a trader-entrepreneur rises compared to the earnings of a non-trader entrepreneur.

It is important to note that, in the absence of migration, the total number (and the range of product quality) of goods produced (and thus of entrepreneurs) in each country is exogenously fixed. This is not the case for consumption since the number of goods consumed depends on the number of products that are traded.[13]

Let's now introduce international labour mobility. Suppose first that only skilled entrepreneurs can move between the two countries. A skilled entrepreneur can move across the border and be either a trader- or a non-trader entrepreneur in the other country. In other words, being of one type in one country does not pre-determine the type of entrepreneur in the other country.[14] Since we have just established that, in one country, an individual with skill n_i chooses to be a trader or a non-trader according to

$$Max\left\{\frac{w_{i,n}^{low}}{p_i^{con}}, \frac{w_{i,n}^{high}}{p_i^{con}}\right\},$$

this entrepreneur will migrate from country i to country j if and only if

$$(4) \quad Max\left\{\frac{w_{i,n}^{low}}{p_i^{con}}, \frac{w_{i,n}^{high}}{p_i^{con}}\right\} < Max\left\{\frac{w_{j,n}^{low}}{p_j^{con}}, \frac{w_{j,n}^{high}}{p_j^{con}}\right\} - \rho_{i,j},$$

where $\rho_{i,j}$ is the fixed cost of moving to country j and p_i^{con}, p_j^{con} are the consumer price indices in each country. Similarly, an entrepreneur migrates from country j to country i if and only if

$$(5) \quad Max\left\{\frac{w_{j,n}^{low}}{p_j^{con}}, \frac{w_{j,n}^{high}}{p_j^{con}}\right\} < Max\left\{\frac{w_{i,n}^{low}}{p_i^{con}}, \frac{w_{i,n}^{high}}{p_i^{con}}\right\} - \rho_{j,i}.$$

It is of course quite possible that for some range of skills, skilled individuals will want to move from one country to another, while for other ranges, they will have no incentive to migrate or will have an incentive to migrate in the other direction. In other words, it is quite possible in this model that the pattern of migration of skilled individuals would be a two-way migration. Obviously, even within a single sector, the possible migration patterns are much richer than in more traditional models of international labour mobility.

Consider now the possibility that unskilled labour migrate across the border. Since v_i is the wage of unskilled labour, workers will move from country i to country j if

$$(6) \quad \frac{v_i}{p_i^{con}} < \frac{v_j}{p_j^{con}} - \rho_{i,j},$$

where $\rho_{i,j}$ is the (static) cost of moving across the border for unskilled labour. Unskilled labour moves in the other direction if

$$(7) \quad \frac{v_i}{p_i^{con}} - \rho_{j,i} > \frac{v_j}{p_j^{con}}.$$

Not surprisingly, only a one-way migration pattern is possible with international mobility of unskilled labour.

The main difficulty with having international migrations (of skilled or unskilled labour) is that it affects the demands for the products since workers and entrepreneurs are also consumers. In the case of entrepreneurs, we need to take into account the distribution of entrepreneurs and truncate it according to who is leaving and who is staying. Similarly, these migrants affect the distribution of entrepreneurs in the host country. In addition, we need to know which role (trader or non-trader) they play in each country. In the next section, we develop a simple general equilibrium model where, using artificial data, we investigate the sensitivity of trade and labour flows to exogenous shocks.

SIMULATION EXERCISES

WE NOW USE A TWO-COUNTRY VERSION OF THE ABOVE MODEL in order to investigate the model's sensitivity to international labour mobility. The equations used in this model are presented in the Appendix. We proceed in two steps. First, we set the model in a free-migration environment (migration costs are set to zero) and in a quasi free-trade environment (the per unit transport cost is equal to zero but the fixed export cost is positive), and we simply ask: Given a specific asymmetry between the two countries, what are the effects of introducing free international mobility of entrepreneurs?

Assume that the two countries are strictly identical. There is clearly no incentive to migrate (for any skill level, the wages are the same across countries). But there is nonetheless trade between the two countries (at least as long as the iceberg transport cost is not prohibitive) since products are differentiated both horizontally and vertically. Not surprisingly, the model boils down to a standard intra-industry trade model with two factors of production (skilled labour and raw labour). In order to investigate the effects of international labour mobility, we must introduce asymmetries between the two countries. We consider four different types of asymmetries: (i) Country 1 has a larger endowment of skilled individuals than Country 2 (but the same endowment of raw labour); (ii) Country 1 has a larger endowment of unskilled labour than Country 2; (iii) Firms exporting from Country 1 faces a higher fixed export cost than firms exporting from Country 2, and (iv) The technology in the Low Tech sector is more productive in Country 1 than in Country 2.

For each of these cases, we compare the equilibrium with and without international mobility of skilled labour (entrepreneurs). We depict the results with two graphs: one representing the distribution of entrepreneur's wage per skill (similar to Figure 1), the other displaying the distribution of firms in each country per skill (and thus quality). We set the model in such a way that the initial distribution of firms without international mobility (and thus the initial distribution of skills) is the same and is uniform in both countries.

Consider the first case, where *Country 1 has 20 percent more skilled labour than Country 2* but both countries have the same endowment of raw labour. As Figure 2b illustrates, this difference is uniformly distributed over the range of entrepreneur's skills (Country 1 has a uniform density of entrepreneurs equal to 1.2, while Country 2 has a uniform density equal to 1). To understand how the model works, we start from the initial symmetric international equilibrium and implement a 20-percent increase in Country 1's endowment of entrepreneurs. We first assume no migration and an exogenous skill level z_i that separates exporting entrepreneurs from non-exporting entrepreneurs. At given prices, the resource constraint implies that the increase in $\phi_{in} \forall n$ induces a 20-percent

FIGURE 2a

SKILLED LABOUR ASYMMETRY

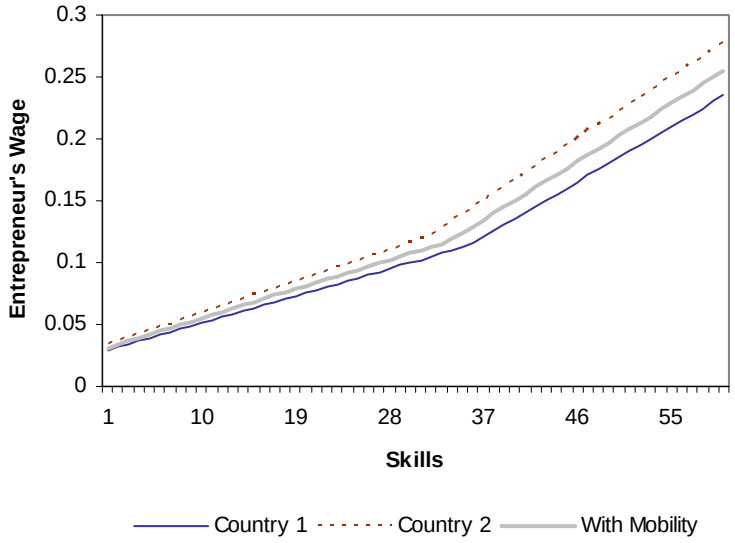
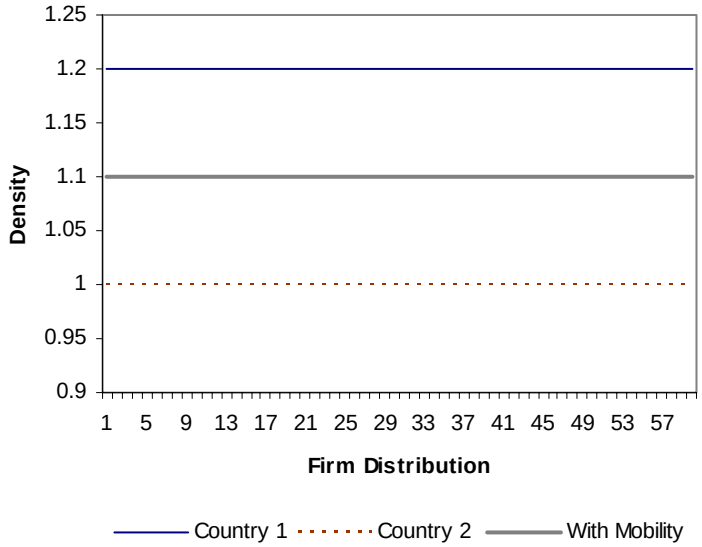


FIGURE 2b

SKILLED LABOUR ASYMMETRY



decrease in the individual firm's size for each type of good n; hence, both w_1^{low} and w_1^{high} fall. Because of the fixed export cost, the downward shift of the w_1^{high} curve is more important and the intersection between the two curves moves to the right. However, a higher ϕ_{in} implies more diversity for the Dixit-Stiglitz household, both domestic and foreign: substitution in consumption follows at the expense of the competitively produced good: $c_j^y \forall j$ rises. The individual domestic firm's sales increase both in the local ($\forall n$) and in the foreign ($\forall n > z_i$) market so that both w_1^{low} and w_1^{high} now increase. However, competition for raw resources induces v_i to rise, which hurts the exporters' profits relatively more (through the fixed cost) than other producers so that the upward shift of the w_1^{low} curve exceeds the other; the new intersection between the two curves is moved further to the right. Endogenizing z_i thus results in an increase in the minimal talent level required for exporting. Not surprisingly, given the initial increase in ϕ_{1n}, at the resulting equilibrium an individual entrepreneur's real earning is lower in Country 1 than in Country 2, for all skill levels. Allowing for migration re-establishes international symmetry. The relative abundance of entrepreneurs now increases the lowest skill level required for profitable exports in both countries. Table 1, Experiment 1 summarizes some aggregate results of the two equilibria — with and without international mobility of talents.

With the introduction of international mobility of entrepreneurs, the welfare (of the representative consumer) decreases in Country 1 and increases in Country 2 by about 1 percent (Table 1). This is due, among other things, to the change in product variety for consumers in each country. Without mobility, consumers of Country 1 benefit from a larger offering of products than consumers in Country 2 since there are more entrepreneurs in Country 1 and some of the additional products are non-traded. The mobility of entrepreneurs re-equilibrates the number of products available to consumers irrespective of their location. The welfare effect is relatively small simply because two forces act in opposite directions. With mobility, some non-traded products are no longer available to consumers of Country 1, but Country 2 exports a larger fraction of the total number of its differentiated products than it did without international mobility.

Consider now the second case, where the asymmetry is with respect to the endowment of unskilled (or raw) labour: *Country 1 is endowed with a 20 percent larger number of unskilled workers* than Country 2. Again, we trace the effects of this asymmetry by using the initially symmetric international equilibrium with no migration and z_i fixed as a starting point. Since the number of entrepreneurs is the same in both countries, so is the number of firms in the High Tech sector

TABLE 1

THE EFFECTS OF FOUR SIMPLE ASYMMETRIES

	COUNTRY 1		COUNTRY 2	
	NO MOBILITY	WITH MOBILITY	NO MOBILITY	WITH MOBILITY
EXPERIMENT 1: +20% ENTREPRENEURS IN COUNTRY 1				
Welfare	1.0180	1.009	0.998	1.008
$p_i^x = v_i$	1.026	1.000	1.000	1.000
p_i^y	0.340	0.338	0.345	0.338
c_i^x	343.100	343.300	343.400	343.300
c_i^y	1037.000	1017.000	995.700	1017.00
Pop	360.000	329.700	300.000	330.300
PopExp	153.600	151.100	149.000	151.600
EXPERIMENT 2: + 20% UNSKILLED LABOUR IN COUNTRY 1				
Welfare	1.199	1.222	1.008	0.987
$p_i^x = v_i$	0.969	1.004	1.00	1.000
p_i^y	0.335	0.334	0.336	0.351
c_i^x	413.000	412.900	342.400	342.400
c_i^y	1194.500	1242.100	1018.500	976.300
Pop	300.000	381.400	300.000	218.600
PopExp	166.000	168.300	162.000	162.700
EXPERIMENT 3: +20% EXPORT FIXED COST IN COUNTRY 1				
Welfare	0.996	0.993	0.997	1.000
$p_i^x = v_i$	0.991	0.986	1.000	1.000
p_i^y	0.342	0.341	0.346	0.346
c_i^x	342.900	342.300	343.600	344.300
c_i^y	993.200	989.00	993.300	996.600
Pop	300.000	311.400	300.000	288.600
PopExp	130.000	138.000	147.000	136.300

in the absence of international mobility of entrepreneurs. However, more abundant and, thus, cheaper raw labour implies that the scale of these firms is larger in Country 1 (compare, for instance, v_i between the two countries without

mobility; see Table 1, Experiment 2). Though profits of both domestic exporters and non-exporters are boosted, the impact on the former is larger because of the fixed export cost. The intersection between the two wage profiles moves to the left, indicating that less-talented entrepreneurs are now able to undertake profitable export activities. Not surprisingly, entrepreneurs' real wages are higher in Country 1 for all skills (Figure 3a).

Costless migration induces entrepreneurs to move to Country 1 in order to take advantage of cheaper resources and a larger market. Interestingly, there is a strong composition effect in this migration since those who are massively moving to Country 1 are the *non-trader* entrepreneurs. As Figure 3 indicates, this migration of non-trader entrepreneurs increases with skill level in Country 1. This is simply due to the fact that the incentive to migrate increases with the skill level since it is directly related to the difference in real earnings between the two countries. However, the same is not true for trading firms as there is a two-way flow of medium/high skills: some intermediate skills are attracted into the home country, while there is an outflow of high talents. This is not surprising: because $z_1 < z_2$ at the no-migration equilibrium, moving into Country 1 makes it possible for some foreign intermediate-skill entrepreneurs to become exporters and increase their profits, everything else being equal. This motivation to migrate is obviously not shared by the most talented who are exporters independently of their geographic location. More importantly, the balance-of-trade equilibrium requires that if there is a net inflow of intermediate-skill exporters, there must be — due to terms-of-trade changes — a net outflow of (a smaller number of) high-skill exporters. There is also a second effect. The large inflow of entrepreneurs in Country 1 raises the cost of producing High Tech goods domestically. Indeed, v_i increases by 3.6 percent while remaining unchanged abroad (see Table 1, Experiment 2). Since the fixed cost of exporting is expressed in terms of raw labour, exporting from Country 1 would be more costly, everything else being equal, than it was without mobility. However, there are now more exporters in Country 1 than before, which makes penetration of foreign markets less costly from the home country, thanks to the export externality.[15] Hence, the fixed cost of exporting may actually be lower in Country 1 despite the difference in v_i. Obviously, this effect is particularly crucial for the marginal traders since the export cost is most significant in the decisions of these firms. Here too, intermediate-skill entrepreneurs have a specific incentive to move into Country 1 that the most talented ones do not share: for the latter, access is ensured to all markets, domestic and foreign. And again, the balance-of-trade equilibrium requires that if there is a net inflow of intermediate-skill exporters, there must be a net outflow of high-skill exporters.

FIGURE 3a

UNSKILLED LABOUR ASYMMETRY

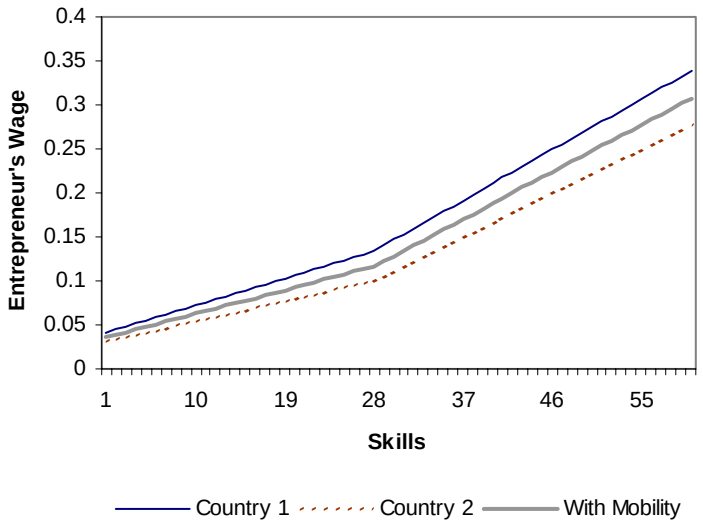
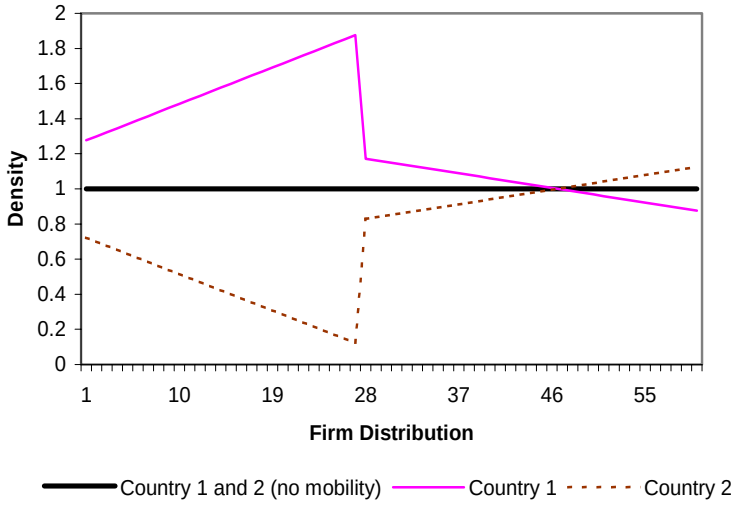


FIGURE 3b

UNSKILLED LABOUR ASYMMETRY



In this case, allowing for entrepreneur mobility increases welfare by about 2 percent in Country 1 and decreases it by 2.1 percent in Country 2 (Table 1). This significant welfare effect is not surprising given the improvement in the terms of trade of Country 1 and the substantial net increase in the number of differentiated goods available to its consumers (especially non-traded goods).

We see from the two previous experiments that the size of the relative skilled- versus unskilled-labour endowments matters a lot in this model. Depending on where the asymmetry lies, the introduction of international entrepreneur mobility has very different qualitative and quantitative effects. When the endowment of skilled entrepreneurs in Country 1 is greater than in Country 2, entrepreneurs move to the latter, whereas when the unskilled labour endowment is larger in Country 1, the dominant flow is that of entrepreneurs moving to Country 1. These asymmetries also result in different production specialization and trading patterns. In the first two experiments, more High Tech products (traded and non-traded) are produced in Country 1 without labour mobility than with mobility. This means that fewer resources are being used in the High Tech sector, and Country 1 exports relatively less High Tech products with mobility than without mobility. In the second asymmetry, the opposite occurs. With mobility, there is a relative specialization in production toward the High Tech sector at the expense of the Low Tech sector in Country 1 but, quite interestingly, it leads to relative specialization along the quality dimension within the High Tech sector. Indeed, mobility leads Country 1 to specialize mainly in low and intermediate quality variants, while Country 2 tends to specialize in high quality export products.

The quantitative effects are also quite different. In the first experiment (+20 percent skilled workers in Country 1), the flow of skilled entrepreneurs moving from Country 1 to Country 2 is roughly equal to half the difference in endowment (representing 10 percent of the initial number of entrepreneurs in Country 2). In the second case (+20 percent raw labour in Country 1), the *total number* of skilled entrepreneurs migrating between the two countries represents about 34 percent of the initial endowment of entrepreneurs in each country (for a net change equal to 27 percent of the initial endowment). This is quite a significant effect.

Consider now the third case, where *the γ set-up cost of exporting High Tech products from Country 1 is 20 percent higher*. Non-trading firms are only indirectly affected by the cost of the primary factor. As is to be expected, in the absence of international labour mobility, the entrepreneurs' wages are very similar in the two countries (Figure 4a). Given such small differences in terms of operating profits, introducing international mobility of entrepreneurs cannot change the entrepreneur's wage much. Nonetheless, the effect on the migration of entrepreneurs is significant, especially for those working in trading firms,

FIGURE 4a

EXPORT COST ASYMMETRY

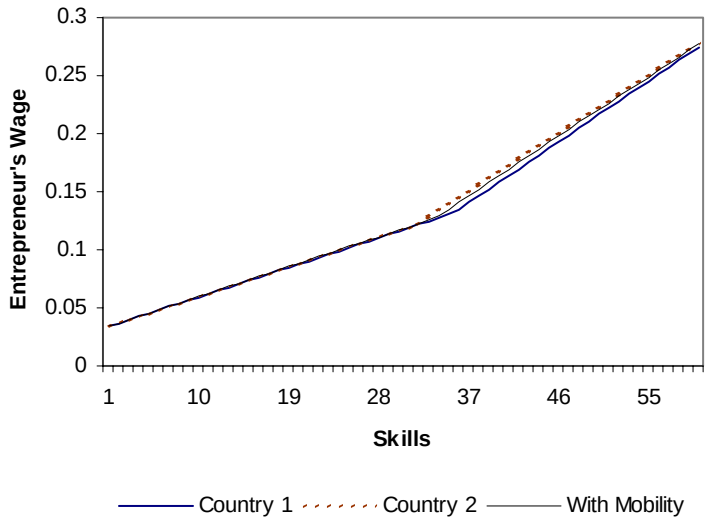
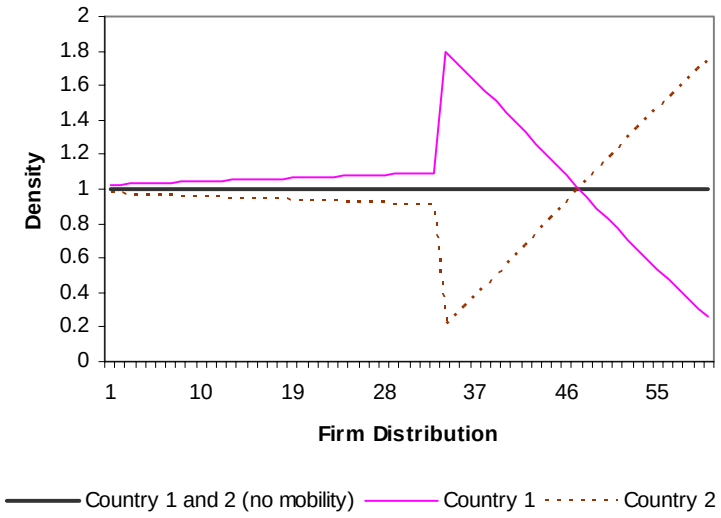


FIGURE 4b

EXPORT COST ASYMMETRY



where some entrepreneurs migrate from Country 1 to Country 2, while others migrate from Country 2 to Country 1 (Figure 4b). The higher fixed cost of exporting leads to lower raw labour cost in Country 1 with or without labour mobility. Indeed, mobility reduces the price of labour even further, which induces a decrease in the fixed cost of exporting in Country 1. At the equilibrium with mobility, Country 1 ends up with more traders than Country 2 despite the 20 percent higher fixed cost of exporting. Hence, at equilibrium, given the number of exporters and the price of labour in Country 1, the fixed cost is lower in that country than in Country 2. It is apparent that, even if the two countries are similar except for the fixed cost of exporting, many 'trading' entrepreneurs will migrate across the border. Mobility brings greater *specialization* along the quality dimension among High Tech products: Country 1 specializes relatively in low quality traded products, while Country 2 specializes relatively in high quality traded products. Indeed, at each end of the quality range of traded products, there is almost complete specialization in each country. At the very high end, nearly *all* trading firms produce in Country 2 and, at the other end (but still among the trading firms), nearly *all* trading firms produce in Country 1.

Despite the migration of a significant fraction of entrepreneurs, welfare only marginally changes in each country (with a slight decrease in Country 1 and a slight increase in Country 2; see Table 1).

In the last experiment, factors are more productive in Country 1 than in Country 2 in the Low Tech sector: +20 percent total factor productivity in Country 1's Low Tech sector. In the absence of international labour mobility, resources will be heavily used in the Low Tech sector as the price of the Low Tech product is low. Because the consumption function takes a Cobb-Douglas form over the Low Tech and High Tech products and because the Low Tech product is a non-traded good, the effect of this higher productivity shock is confined to the Low Tech sector. Movements of entrepreneurs still take place when mobility is allowed since the real value of the quasi rents in the High Tech sector is now higher in Country 1. Migration follows from Country 2 to the home country, with effects on non-trading as well as on trading firms. The number of trading firms increases in Country 1, with a similar externality effect and, through it, similar production specialization (at least for trading firms) and trade pattern effects, as in previous simulations. It should be noted that, in this case, mobility affects mainly trading firms because the difference in real quasi-rents between the two countries increases with skill level. Hence, there is a much stronger incentive to move for trading firms than for non-trading firms. Of course, the balance-of-trade condition prevents that these entrepreneurs move in one direction only.

FIGURE 5a

TECHNOLOGICAL ASYMMETRY

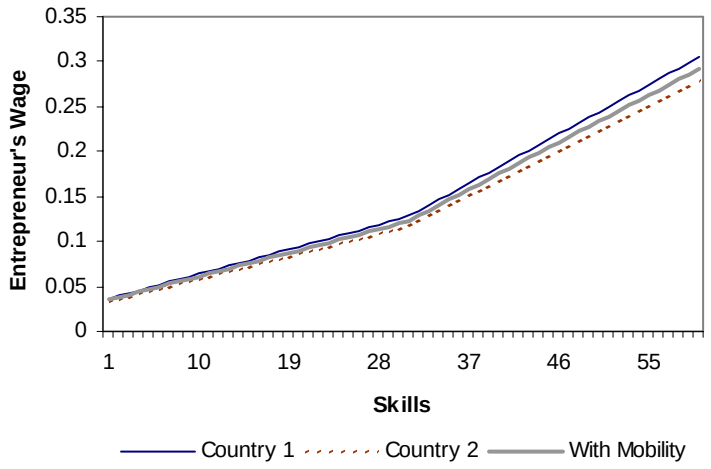
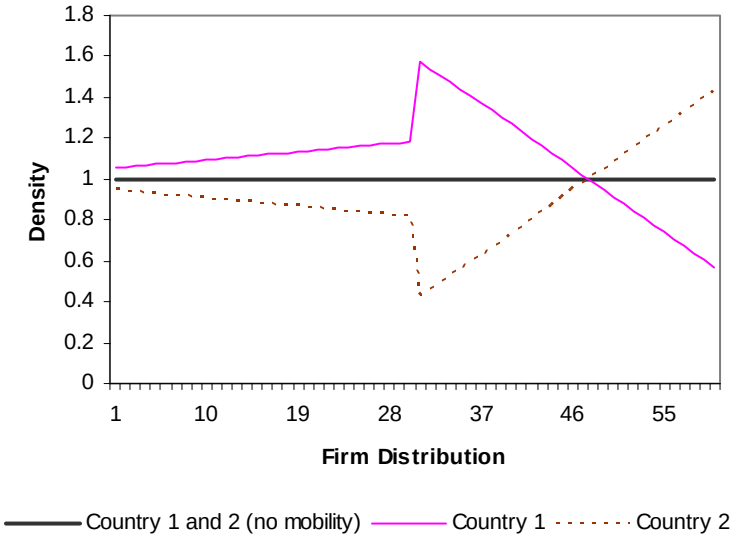


FIGURE 5b

TECHNOLOGICAL ASYMMETRY



CONCLUSIONS

WHAT TO MAKE OF THESE SIMULATIONS? Of course, we have used artificial data so that none of these simulations directly apply to the Canada-U.S. case. We have also completely disregarded how we might make the model operational with real data. However, the particular model used here raises a number of issues about the meaning of skills, the correspondence between skills and firms, not to mention the correspondence between skills and product quality. Though specific, we believe that this type of model has great potential for a number of reasons.

First, there is a link between trade, earning inequality and labour mobility. The link between trade and earning inequality comes from two sources. Since trade affects the wages of unskilled and skilled workers (entrepreneurs), and wages among entrepreneurs, trade-induced increases in inequality may mean here that the wages of skilled workers increase with respect to the wages of unskilled workers, and it can mean that the wages of highly skilled workers (in trading firms) increase with respect to the wages of less highly skilled workers (in non-trading firms). Since these inequalities occur not only within a country but across countries, they create incentives to migrate across the border in order to take advantage of earning differentials. Second, skills matter in this model and the returns to skills are positive, giving the model a Rosen "superstar" flavour.

Third, because individuals (at least skilled workers) are differentiated, migration decisions are potentially different among individuals. Introducing international labour mobility leads to changes in specialization at the production level across sectors and within sectors producing differentiated goods. In turn, this leads to changes in trade patterns. This is an interesting result because the changes in trade patterns across and within sectors are not due to trade liberalization *per se* but *are by-products of liberalizing international labour migration*.

In order to illustrate why this last point may make this model relevant for the Canada-U.S. case, consider the following. In a study commissioned by the EU Commission, Fontagné, Freudenberg and Péridy (1998) have uncovered interesting changes in trade patterns within the European Union between 1980 and 1994. They first divided trade between every pair of EU member countries into inter- and intra-industry trade, and further divided intra-industry trade into horizontal (Helpman-Krugman type) and vertical (Shaked and Sutton-quality type) trade. To this end, they simply compared the price of export with the price of import. If, at the level of the variants, the price of export is roughly similar to the price of import, then trade in this variant belongs to the horizontal intra-industry trade category. If there is a significant difference (positive or negative) between the two prices, then trade in this variant belongs to the vertical intra-industry trade category. Aggregating these trade shares, they

discovered that if, as expected, the share of overall intra-industry in total trade increased over the period, it is not due to an increase in the share of horizontal intra-industry trade but to an increase in the share of vertical intra-industry trade. In other words, based on their methodology, some kind of specialization has taken place in Europe at the country level despite the presence of similar countries (say France and Germany) and of trade liberalization. Nobody has yet offered a good explanation for this phenomenon.

Applying a similar methodology to the Canada-U.S. case over the 1989-99 period, Andresen, Harris and Schmitt (2001) find similar changes but on a much smaller scale than in Europe. Why? We do not really have a good answer either. However, our simulations suggest that this may have a very simple explanation: the difference between the results obtained for Europe and for North America might simply be associated with differences in the degree of economic integration. The 1992 Unique Market (decided well before 1992) may well have triggered location decisions among firms (for instance) focused at serving Europe as a whole rather than at serving only a specific European country, whereas NAFTA did not have the same impact on firms' location decisions (or on individuals' location decisions) because of its more limited focus.[16] This suggests that, in evaluating the effects of a deeper integration between Canada and the United States and, in particular, measures of integration dealing with international labour mobility, an important aspect would be the consequences of these measures on international trade and on the patterns of trade.

The above advantages are purely static. Needless to say, in a dynamic environment, other elements could be added to a model of this type, for example human capital formation, the impact of an aging population, or quality-ladder/endogenous growth components.

ENDNOTES

1 For instance, Germany is adopting a Canadian-point-type system to evaluate immigrants. A bilateral agreement between Switzerland and the European Union is now in force since June 1, 2002. After a five-year transition period, it is supposed to free up labour mobility between Switzerland and the European Union. The main reason for these policies seems to be linked to labour shortages in specific highly skilled activities.

2 See Markusen (1988) for a model belonging to this category and specifically addressing positive and normative aspects of human capital formation, skilled labour and the brain drain.

3 The 2002 state-by-state statistics on the U.S. high-tech industry, published by the American Electronics Association, are revealing about growth and job concentration in an economy with free mobility: California had the highest number of high-tech jobs (nearly 8 percent of its workers), followed by Texas, New York and Massachusetts. The latter had roughly one quarter of the number of high-tech jobs that California had. South Dakota had the highest job loss rate in the high-tech industry (–15 percent), and Montana the highest job growth rate (+17 percent). See
www.aeanet.org/publications/IDMK_cyberstates2002_brochures.

4 See Ludema and Wooton (1999) for a model of geography and trade with imperfect factor mobility. Their conclusion is that the de-industrialization just mentioned is not unavoidable, especially when a country can control trade liberalization, the degree of factor mobility and the sequence of implementation of these two policies. Tabuchi and Thisse (2001) also consider imperfect factor mobility through taste heterogeneity in workers' perceptions of the characteristics of regions.

5 See Gould (1994) concerning the United States and Head and Ries (1998) or Head, Ries and Wagner (1998) concerning Canada.

6 Grossman (2002) introduces imperfect labour contracts in a model with two-country trade and labour heterogeneity whose characteristics are similar to the one developed above. He shows that in the presence of two sectors (one with team production, the other with individual production), the most talented individuals have an incentive to flock to the sector with individual production in the presence of imperfect labour contracts, especially in the country with greater labour heterogeneity. Hence, imperfect labour contracts are a source of comparative advantage, and freer trade can exacerbate this polarization in the allocation of labour.

7 Manasse and Turrini (2001) also use horizontal differentiation through a standard Dixit and Stiglitz's model of monopolistic competition.

8 The fact that skilled workers are intrinsically more mobile than unskilled workers is supported by empirical evidence (see, for example, Shields and Shields, 1989). See also Finnie (2001) who shows that Canada has been losing a significant fraction of its market elite as judged by individuals' income tax data.

9 See Beine, Docquier and Rapoport (2001) for an empirical investigation concerning developing countries. There is no reason why this argument would apply only to developing countries. See Faini (2002) for a paper doubting the positive effects of a brain drain on the home country, and Wildasin (2002) for a theoretical analysis of labour market integration and investment in human capital.

10 Coe and Helpman (1996) show that international R&D spillovers are not trivial for Canada. Eaton and Kortum (2002) suggest that a country like Canada benefits from technology improvements (whether created by Canadian out-migrating brains or not) in the United States because it is both close to the United States and its economy has the flexibility to downsize manufacturing.

11 See below the discussion on this point.

12 Recall that the mark-up is the same on domestic and foreign sales. This implies that p in (3) is also the producer price in foreign sales.

13 This exogenous feature of the number of goods produced (or of entrepreneurs) in the absence of international migration can be relaxed in one of two ways: one is to endogenize the number of products, the other is to endogenize the number of entrepreneurs. In the first case, this can be achieved by introducing a fixed cost of production; here, full employment of resources dictates that a product can be traded only if some other non-traded product exits the industry (see Schmitt and Yu, 2001, for such a model). Alternatively, one can endogenize the number of entrepreneurs. For instance, individuals can work as entrepreneurs or as workers depending on the comparison or earnings in each activity. If they are workers, they belong to the 'unskilled' group (see Schmitt and Soubeyran, 2002, for such a model).

14 Hence, a non-trader entrepreneur in Canada could be a trader-entrepreneur in the United States. It is through this type of trade creation mechanism that the model captures the 'gains' from the brain drain.

15 The reason for the presence of such externality is twofold. First, realism suggests that it is more costly to pioneer than to follow. The second reason is more technical. As is easily seen, our assumptions imply that, without the externality, $w_{i,n}^{high}$ depends on n exclusively through the quality index $T_{i,n}$, so that a technological link ties together the rents earned by entrepreneurs of different skills. Introducing the externality breaks this unrealistic tie.

16 Given the low degree of intra-EU worker mobility, it is hard to believe that international labour mobility alone causes these differences between Europe and North America.

BIBLIOGRAPHY

Andresen, Martin, Richard Harris and Nicolas Schmitt. "Canada-U.S. Intra-Industry Trade Patterns." Prepared for Jim Melvin's Festschrift, 2001. Mimeo.

Beine, Michel, Frédéric Docquier and Hillel Rapoport. "Brain Drain and Economic Growth: Theory and Evidence." *Journal of Development Economics* 64, 1 (2001): 275-289.

Commander, Simon, Mari Kangasniemi and L. Alan Winters. "The Brain Drain: Curse or Boon? A Survey of the Literature." 2002. Mimeo.

Eaton, Jonathan, and Samuel Kortum. "Technology, Geography and Trade." *Econometrica* (2002). Forthcoming.

Faini, Riccardo. "Migration, Remittances and Growth." September 2002. Mimeo.

Faini, Riccardo, Jaime de Melo and Klaus Zimmermann. "Trade and Migration: An Introduction." In *Migration: The Controversies and the Evidence*. Edited by R. Faini, J. de Melo and K. Zimmermann. Cambridge: CEPR and Cambridge University Press, 1999, Chapter 1.

Fertig, Michael, and Christoph Schmidt. *Mobility Within Europe – What Do We (still not) Know?* IZA Discussion Paper No. 447. Bonn: Institute for the Study of Labour, 2002.

Finnie, Ross. *The Brain Drain: Myth and Reality: What It Is and what Should Be Done?* Working Paper No. 13. Queen's University (School of Policy Studies), 2001.

Fontagné, Lionel, M. Freudenberg and Nicolas Péridy. *Intra-Industry Trade and the Single Market: Quality Matters*. CEPR Discussion Paper No. 1959. 1998.

Gould, David. "Immigration Links to the Home Country: Empirical Implications for U.S. Bilateral Trade Flows." *Review of Economics and Statistics* 76, 2 (1994): 302-316.

Gross, Dominique, and Nicolas Schmitt. "The Role of Cultural Clustering in Attracting New Immigrants." *Journal of Regional Science* (2002). Forthcoming.

Grossman, Gene. *The Distribution of Talent and the Pattern and Consequence of International Trade*. CESIfo Working Paper No. 745. June 2002.

Harris, Richard G., and Nicolas Schmitt. "The Consequences of Increased Labour Mobility Within an Integrating North America." In *North American Linkages: Opportunities and Challenges for Canada*. Edited by R.G. Harris. Industry Canada Research Series, Volume No. 11. Calgary: University of Calgary Press, 2003.

Head, Keith, and John Ries. "Immigration and Trade Creation: Econometric Evidence from Canada." *Canadian Journal of Economics* (1998): 47-62.

Head, Keith, John Ries and Don Wagner. *Immigrants and the Trade of Province*. RIIM Working Paper No. 98-21, Vancouver (B.C.), December 1998.

Krugman, Paul. "Increasing Returns and Economic Geography." *Journal of Political Economy* 99 (1991): 483-499.

Lucas, Robert. "On the Size Distribution of Business Firms." *Bell Journal of Economics* 9 (1978): 508-523.

Ludema, Rodney, and Ian Wooton. "Regional Integration, Trade and Migration: Are Demand Linkages Relevant for Europe?" In *Migration: The Controversies and the Evidence*. Edited by R. Faini, J. de Melo and K. Zimmermann. Cambridge: CEPR and Cambridge University Press, 1999.

Manasse, Paolo, and Alessandro Turrini. "Trade, Wages and 'Superstars'." *Journal of International Economics* 54 (2001): 97-117.

Markusen, Jim. "Production, Trade and Migration with Differentiated, Skilled Workers." *Canadian Journal of Economics* 21, 3 (1988): 492-506.

Mundell, Robert. "International Trade and Factor Mobility." *American Economic Review* 47 (1957): 321-335.

Murphy, K.M., Andrew Shleifer and Robert Vishny. "The Allocation of Talent: Implications for Growth." *Quarterly Journal of Economics* (1991): 503-530.

Rauch, James. "Reconciling the Pattern of Trade with the Pattern of Migration." *American Economic Review* 81, 4 (1991): 775-796.

Rosen, Sherwin. "The Economics of Superstars." *American Economic Review* 71 (1981): 845-858.

Schmitt, Nicolas, and Antoine Soubeyran. "International Labor Mobility, Brain Gain and Distribution of Firms." 2002. Mimeo.

Schmitt, Nicolas, and Zhihao Yu. "Economies of Scale and the Volume of Intra-Industry Trade." *Economics Letters* 74 (2001): 127-132.

Shields, G.M., and M.P. Shields. "The Emergence of Migration Theory and a Suggested New Direction." *Journal of Economic Surveys* 3 (1989): 277-304.

Stark, Oded, Christian Helmenstein and Alexia Prskawetz. "Human Capital Depletion, Human Capital Formation and Migration: A Blessing or a Curse?" *Economics Letters* 60, 3 (1998): 363-367.

Tabuchi, Takatoshi, and Jacques-Francois Thisse. "Labor Mobility and Economic Geography." January 2001. Mimeo.

Venables, Anthony. "Trade Liberalization and Factor Mobility: An Overview." In *Migration: The Controversies and the Evidence*. Edited by R. Faini, J. de Melo and K. Zimmermann. Cambridge: CEPR and Cambridge University Press, 1999.

Wildasin, David. "Economic Integration and Labour Market Institutions: Worker Mobility, Earning Risk and Contract Structure." 2000. Mimeo.

——. "Labor Market Integration, Investment in Risky Human Capital, and Fiscal Competition." *American Economic Review* (2002). Forthcoming.

APPENDIX

i,j	=	country index

PARAMETERS

n_i	=	index of variety
$T_{i,n}(a_i)$*	=	quality index of variety n_i
σ	=	differentiation elasticity between goods of type n
$\tau_{i,j}$	=	(iceberg) transportation cost on flows from i to j
γ_i	=	fixed costs on exports
η	=	export-cost externality parameter

VARIABLES

z_i	=	index of lowest quality type exported
Inc_i	=	income
L_i^{sup}	=	raw labour supply
w_i	=	price of raw labour
$\phi_{i,n}$	=	number of entrepreneurs producing variety n
$w_{i,n}^{low}$	=	low-skilled type n entrepreneur's earnings
$w_{i,n}^{high}$	=	high-skilled type n entrepreneur's earnings
p_i^x	=	price of competitive good x
c_i^x	=	consumption of competitive good x
p_i^y	=	price of (aggregate) good y
c_i^y	=	consumption of (aggregate) good y
θ_i^x	=	consumption share of competitive good x
p_i	=	price of good of variety n
$E_{i,j,n}$	=	sales of goods of variety n by a firm in i to a household j.

* We use an identical linear function for the two countries: $T_{i,n}(a_i) \equiv c + an_i$, noted $T_{i,n}(a_i) \equiv T_{i,n}$ hereafter.

MODEL

Households

$$Inc_i = v_i L_i^{sup} + \sum_{n_i \le z_i} \phi_{i,n} w_{i,n}^{low} + \sum_{n_i \le z_i} \phi_{i,n} w_{i,n}^{high}$$

$$log\, p_i^{con} + \phi_i^x \, log\, c_i^x + (1-\theta_i^x)\, log\, c_i^y = Inc_i$$

$$p_i^x c_i^x = \theta_i^x Inc_i \,,$$

$$p_i^y c_i^y = (1-\theta_i^x Inc_i \,,$$

$$\left[p_i^y\right]^{1-\sigma} = \sum_{n_i} \phi_{i,n} T_{i,n} \left[p_i\right]^{1-\sigma} + \sum_{n_j \le z_j} \phi_{j,n} T_{j,n} \left[\frac{p_j}{\tau_{j,i}}\right]^{1-\sigma}$$

$$E_{i,i,n} = T_{i,n} \left[\frac{p_i^y}{p_i}\right]^{\sigma} c_i^y$$

$$E_{j,i,n} = T_{j,n} \left[\frac{p_i^y}{p_j / \tau_{j,i}}\right]^{\sigma} c_i^y$$

Firms of Sector *x*

$$p_i^x = v_i$$

$$L_i^x = c_i^x$$

Firms of Sector *y*

$$p_i = v_i \left[\frac{\sigma}{\sigma - 1}\right]$$

$$w_{i,n}^{low} = \left[p_i - v_i\right] E_{i,i,n}$$

$$w_{i,n}^{high} = \left[p_i - v_i\right] \left(E_{i,i,n} + \frac{E_{i,j,n}}{\tau_{i,j}} \right) - v_i \gamma_i \phi_{i,n}^{\eta}, \qquad \eta<0$$

$$L_i^y = \sum_{n_i \le z_i} \phi_{i,n} E_{i,i,n} + \sum_{n_i > z_i} \phi_{i,n} \left(E_{i,i,n} + \frac{E_{i,j,n}}{\tau_{i,j}} \right) + \gamma_i \phi_{i,n}^{\eta}, \quad \eta<0$$

Raw Labour Market

$$L_i^x + L_i^y + L_i^{sup}$$

Migration of Entrepreneurs

$$\underset{\phi_{i,n}}{Max}\left\{\frac{w_{i,n}^{low}}{p_i^{con}}, \frac{w_{i,n}^{high}}{p_i^{con}}\right\} = \underset{\phi_{j,n}}{Max}\left\{\frac{w_{j,n}^{low}}{p_j^{con}}, \frac{w_{j,n}^{high}}{p_j^{con}}\right\}, \qquad \phi_{i,n} + \phi_{j,n} = \overline{\phi_n}.$$