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DOES IT MATTER WHERE IMMIGRANTS WORK? TRADED GOODS, NON-TRADED GOODS, AND SECTOR SPECIFIC EMPLOYMENT

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ABSTRACT

Immigrant employment often concentrates in non-traded goods sectors and many immigrants have low inter-sectoral mobility. We consider these observed characteristics of immigrant employment for the question of how immigration affects a nation's pattern of production and trade. We model an economy producing three goods; one is non-traded. Domestic labor and capital are domestically mobile but internationally immobile. Some immigrant labor is specific to the non-traded sector. Our model indicates that the output and trade effects of immigration depend importantly on the sector and nature of immigrant employment. Empirical investigation of the model's predictions indicates that trade and immigration are complements.

JEL classification: C23, D5, F16, F22, J61, O15

Keywords: trade, immigration, non-traded goods, specific factors, panel.

NON-TECHNICAL SUMMARY

DOES IT MATTER WHERE IMMIGRANTS WORK? TRADED GOODS, NON-TRADED GOODS, AND SECTOR SPECIFIC EMPLOYMENT

The effects of immigration on a nation is an ongoing area of investigation in economics. A traditional emphasis has been the effect of immigration on the wages of native workers. Since immigration increases a nation's labor supply, the theoretical prediction in a labor supply – labor demand framework is that immigration will lower the wages of native workers. Many studies have refined this basic prediction to consider the skill levels of immigrants compared to native workers. Regardless, most empirical studies find little evidence that immigration materially affects domestic wages. Recent work notes correctly that, if a nation is open to trade, an increased supply of labor can be absorbed by a reallocation of productive factors (including labor) across industries with no change in wages. This reallocation effect is known in the theoretical literature on international trade as a "Rybczynski effect." Empirical evidence of such an effect has recently been found with respect to migration among US states.

If immigration does not materially change wages, but instead leads to a reallocation of resources across industries, then attention shifts from the effect of immigration on wages to the effect of immigration on a nation's sectoral pattern of production and, by extension, trade. The effects of immigration on output and trade has been fundamentally overlooked in the literature concerned with the effects of immigration. In response, this paper first examines, theoretically, the effect immigration would be expected to have on a nation's pattern of production and trade. Importantly, the theoretical model takes into account two observed aspects of immigrant employment: 1) immigrant employment concentrates in non-traded goods sectors (i.e., services) and 2) some immigrants, due to language problems, low skill levels, illegal status, etc., have low mobility between sectors. The model's theoretical predictions are then assessed empirically in a sample of OECD countries over the period from 1980 to 2001.

The theoretical model specifics an economy that produces three goods: a non-traded good (services), an exported good, and a good that competes with imports (the import-competing good). Domestic labor and capital work in, and are mobile between, all three sectors. The low inter-sectoral mobility of some immigrant labor is captured by specifying that some immigrant workers are employable only in the non-traded goods sector, and are

therefore immobile between sectors. An inflow of foreign workers is then allowed to contain a mixture of two types of workers: those employable only in the non-traded services sector and those, like native workers, employable in any sector. Several key insights emerge from the theoretical analysis.

First, immigration raises production of non-traded services as long as some new immigrants are the type employable only in the non-traded services sector. Second, whether export and import-competing production rises of falls with immigration depends on a relationship between the existing share of immobile foreign workers in total service sector employment and the fraction of new immigrants that are the type employable only in the non-traded services sector. At one extreme, if all new immigrants are the type employable only in the non-traded services sector, export production rises and import-competing production falls with immigration. These output changes imply a complementary relationship between trade and immigration, so that immigration increases trade. At the other extreme, if all new immigrants are the type employable in any sector, then export production falls and import-competing production rises. These output changes imply trade and immigration are substitutes, so that immigration reduces trade.

When a new inflow of foreign workers contains a mix of both types of workers, the pattern of sectoral output changes depends on the existing employment share of immobile foreign workers in the non-traded services sector compared to the fraction of new immigrants that are the type employable only in the non-traded services sector. In general, the lower the existing share of immobile foreign workers in total non-traded services sector employment, or the larger the share of such workers in any new wave of immigration, the more likely is export production to rise, and import-competing production to fall, and hence for trade and immigration to be complements. This suggests that advanced industrial nations, who have significant native employment in non-traded services sectors, and who are also more likely to experience inflows of the type of workers (e.g., low skilled, illegal) employable only in such sectors, are more likely to experience an increase in export sector output, and therefore trade, with immigration.

We also examine how trade liberalization would affect incentives to migrate in our model. A unilateral reduction in trade barriers is found to raise the incentive to immigrate for those foreign workers who are employable only in the non-traded services sector and to reduce the incentive to immigrate for those foreign workers employable in any sector. These conclusions apply to trade liberalization by a nation whose export sectors intensively use capital relative to labor in production (e.g. industrialized nations). For countries whose export

sectors are instead intensive in labor rather than capital (e.g., developing countries), the incentives to immigrate are the reverse of those stated above.

Having developed the theoretical predictions of the model, we then empirically examine the model's implications with respect to the effect of immigration on the output of non-traded goods (services) and traded goods (exports). This analysis is conducted using a panel of OECD countries over the period from 1980 to 2001. The empirical findings indicate that, consistent with the theoretical model, immigration raises production of non-traded services. The results also indicate that trade and immigration are complements, contrary to the widely held view that immigration and trade are substitutes.

Overall, the theoretical relationships and empirical findings indicate that the effects of immigration depends importantly on the nature and sector of immigrant employment. The findings of our analysis have important implications for the design of immigration policies, particularly polices that target particular types of workers (e.g. skilled workers) and that discourage immigration of the type of workers likely to be employable only in non-traded services sectors. The findings further suggest that the trade enhancing effects associated with trade liberalization may be enhanced by a complementary relationship trade and immigration.

DOES IT MATTER WHERE IMMIGRANTS WORK?

TRADED GOODS, NON-TRADED GOODS, AND SECTOR SPECIFIC EMPLOYMENT

The effect of immigration on an economy is a topic of continuing importance. Always a central issue in the US context, immigration has recently also become central in the European Union (EU) context: the expectation of potentially large flows of workers from East European accession countries raised sufficient fears about adverse labor market and government budget impacts to cause the EU-15 to block acceding countries' workers from their markets for up to seven years. Such fears underscore that the effects of immigration on an economy are not yet fully understood.[i] As Table 1 indicates, the share of migrants in the total population of most OECD countries, except France and Belgium, has been rising. These trends, and the ongoing political debate, suggest that understanding the effects of immigration on an economy has both increasing importance and increasing relevance.

Instert Table 1 About Here

In terms of the effects of immigration, a central focus of the economics literature has been the impact of immigration on domestic factor prices.[ii] Early studies adopted a partial equilibrium perspective to consider the implications of an immigration induced increase in domestic labor supply for the wages of domestic workers. Such studies often found little evidence of significant wage effects. Recent studies have instead adopted a general equilibrium, open economy, framework to suggest that a lack of significant wage effects may reflect the operation of a Rybczynski effect; the increased labor supply is absorbed not by a change in domestic factor prices but instead by a reallocation of factors (including labor) across sectors, and hence by a change in the sectoral pattern of production. Recent research by Hansen and Slaughter (1999) indeed finds evidence to suggest a Rybczynski effect in the context of migration flows between US states. How immigration affects the sectoral pattern of production is thus an important issue that has been fundamentally overlooked in the literature dealing with the effects of immigration.

The effect of immigration on a nation's sectoral pattern of output is simultaneously linked to the long-standing question, in the international trade literature, of whether goods

trade and international factor movements are complements or substitutes.[iii] Both the theoretical and empirical trade literature have mostly focused on international capital mobility and have concluded that trade and capital flows can be either complements or substitutes. However, in most trade models, whether a substitute or complement relationship arises between trade and an internationally mobile factor derives from which factor is assumed to be used intensively in a country's export sector. In addition to presuming a complement or substitute relationship, most analyses of international factor flows assume that the domestic and internationally mobile factor are homogenous. Hence, as in the case of capital flows, studies of international labor flows do not differentiate characteristics of immigrant labor from those of domestic labor, even if a distinction is made between workers with different levels of skill. Ignoring potentially important characteristics that differentiate immigrants from native workers precludes a more general understanding of the effects that immigration may have on an economy. In particular, differences between immigrants and native workers may have important implications for the sectoral output effects arising from immigration.

One important observed characteristic of immigrants is that many work in relatively low-skilled service sector occupations (e.g., hotels, restaurants, domestic helpers, etc.) and are therefore, to a large extent, employed in sectors whose output is not internationally traded. The OECD (2004, pp. 55) notes the sector concentration of immigrant employment within OECD countries: "Foreigners are generally over-represented in construction, hospitality and catering, as well as in household services; that is, the proportion of foreigners working in these sectors is higher than their share of total employment." Figure 1 provides graphic evidence of the employment concentration of non-native workers in services for several OECD countries; as can be seen, the fraction of non-native workers employed in service sectors exceeds 50% in all countries except Germany.[iv]

Insert Figure 1 About Here

Another important characteristic of immigrant employment is that factors such as language barriers, low skill levels, and possible illegal status suggest that some immigrants have low inter-sectoral mobility and are therefore likely to remain employed in non-traded goods sectors. In this context, the OECD (2004, p. 64) reports that: "...foreigners are ...over-represented in groups at risk of poor labour market integration ...." Moreover, "The extent of

language ability ..., the presence of protected jobs and the social capital deficiency contribute to additional barriers to foreign workers. Thus, certain groups of foreign workers face serious, lasting challenges for sustainable labour market integration."

The implications of the skewed and sector specific nature of immigrant employment for the effect that immigration has on an economy's sectoral pattern of output and trade, and hence also how these aspects of immigrant employment may impinge on the question of whether trade and immigration are complements or substitutes, has been principally neglected in the literature. In response, we develop, in this paper, a simple model of a small open economy that produces two internationally traded goods and one non-traded good. Domestic labor and capital are mobile across all three sectors. The inclusion of a non-traded good in the model recognizes the observed concentration of immigrant employment in non-traded goods.[v] To capture the low inter-sectoral mobility of some immigrant workers, we assume that a fraction of new immigrants will become specific to the non-traded goods sector; the remaining fraction of new immigrants instead become "domestic-status" workers who are then mobile across all three sectors. Unlike previous work, our model does not assume that immigrant labor is intensive in a country's export (import-competing) sector and therefore it does not impose, a priori, a complement or substitute relationship between trade and international labor flows. In addition, by allowing a given inflow of new immigrants to contain a heterogeneous mixture of workers (i.e., sector specific versus domestically mobile) we significantly extend prior analyses that assume immigrants and native workers are homogenous.

While our analysis focuses on the effects of immigration on a country's pattern of output and trade, our model also offers predictions about the effect of output price changes on factor prices. In this regard, we use our model to consider the question of how immigration responds to trade liberalization by examining the effect that tariff removal would have on wages, and hence on the incentives for labor to migrate.

Having developed the theoretical predictions of our model, we then empirically examine the model's implications with respect to the effect of immigration on the output of non-traded goods (services) and traded goods (exports). This analysis is conducted using a panel of OECD countries over the period from 1980 to 2001. The results indicate that trade and immigration are complements, and they further underscore the importance of accounting for special characteristics of immigrants in order to more fully understand the economic effects of immigration.

I PERTINENT LITERATURE

The theoretical trade literature has long considered the question of whether goods trade and international factor movements are complements or substitutes, and hence how the pattern of sectoral outputs may respond to international factor flows. General investigations of this question in the context of the H-O model include Mundell (1957), Markusen's (1983), Ethier and Svensson (1986), Svensson (1984), Markusen and Svensson (1985), and Wong (1986). The overall conclusion of these theoretical works is that trade and factor movements can be complements or substitutes, so resolution of the issue appears to be an empirical matter.

Analyses of the relationship between goods trade and international factor flows in a specific factors framework has focused on international capital mobility. Most analysts adopt the framework of Jones (1971), in which each sector employs a specific factor (capital) and a domestically mobile factor (labor), and assume that sector specific capital is internationally mobile. A recent example is Neary (1995), who notes that trade and capital flows are substitutes in his model as a consequence of his assuming that (internationally mobile) capital is used intensively in (and is specific to) the import-competing sector. Similarly, although not employing a specific factors framework, trade and international factor flows were complements in Markusen's (1983) analysis as a consequence of his assuming that the internationally mobile factor was used intensively in the receiving country's export sector. Hence, in such models, substitutability or complementarity between trade and factor flows derives from the assumption about which traded goods sector (export or import-competing) exclusively employs, or intensively employs, the internationally mobile factor.

The implications of introducing a non-traded sector in a model with internationally mobile, but sector specific, capital was explored by Jones, Neary, and Ruane (1983). The impetus for their model was to explain the possibility of two-way capital flows between countries. Given the focus of their analysis, they did not address, not did they intend to address, the question of whether trade and capital flows were complements or substitutes. Moreover, by having a single "tradables" sector, their model could not (by definition) address, as we do in this paper, questions about the pattern of sectoral output changes among traded goods sectors (i.e., export versus import-competing).

Given that the prior literature on capital mobility has considered the effect of capital mobility on trade when capital is sector specific, it would seem that by re-labeling capital as labor, the results obtained from the existing literature would provide a sufficient set of

theoretical results to make a separate analysis of whether trade and labor flows (immigration) are substitutes or complements redundant. However, such a simple re-labeling would ignore important characteristics of immigrant employment and thereby also ignore the potential implications of these special characteristics.

In particular, as we will demonstrate, a complement (substitute) relationship can arise not only by assuming, a priori, that an internationally mobile factor is specific to a country's export (import-competing) sector, but also from the assumption that a given factor inflow consists entirely of homogeneous units of that factor. When a given factor inflow is instead allowed to consist of heterogeneous units of an internationally mobile factor, the presumed complement (substitute) relationship is no longer assured. To our knowledge, no model of international factor mobility has considered the implication of allowing a given factor inflow to consist of heterogeneous units. Moreover, we will show that in contrast to previous models, trade and immigration can be complements (substitutes) in our model even when immigrant labor is not the factor used intensively in a country's export (import-competing) sector. In this respect, our analysis both complements and significantly extends prior analyses of both labor and capital mobility.

Most of the relevant prior literature has dealt with international capital mobility. Among the studies dealing with labor mobility, those by Djajic (1997) and Grether, de Melo, and Muller (2001) have relevance to our present study. Djajic's (1997) model of illegal immigration shares some similarity with our model in that he assumes that illegal migrants are specific to an intermediate goods sector whose output is used to produce two traded final goods. However, since Djajic's focus was the effect of illegal immigration on wages, he did not address the question of whether illegal immigration and trade are complements or substitutes in his model.

Grether, de Melo, and Muller (2001) explore the political economy of immigration in a direct-democracy framework by combining a median voter model with the traditional Jones (1971) specification in which each of two sectors employs sector specific capital and labor is domestically mobile between sectors. Whereas they do not specifically address the relationship between trade and immigration, they do find that, in a variant of the model that assumes one of the two goods is non-traded, increased immigration leaves households better off compared to the model when both goods are traded, thereby implying that a clear majority of voters would favor additional illegal immigration. This result suggests the possible importance of including a non-traded good when studying the effects of immigration.

Empirical investigations of whether trade and international factor movements are complements or substitutes have primarily focused on whether increased trade is associated with a reduction in any disparity of factor prices (usually wages) between countries, or whether increases in trade are accompanied by reductions in international labor movements. In a recent survey, Leibfritz, O'Brien, and Dumont (2003) find a variety of conclusions. They note that while some earlier empirical work offered evidence to suggest factor price equalization, and hence a substitute relationship between trade and international factor flows, more recent work has not.

Evidence for a substitute relationship between trade and international labor flows comes from authors such as Straubhaar (1988) and Molle (2001, 2002) who examine data on intra-EU trade and intra-EU labor flows. Evidence for a complementary relationship comes from authors such as Cogneau and Tapinos (1995), who examined the relationship between trade and emigration for the specific case of Morocco, and from Richards (1994), who concluded that trade and immigration appeared to be complements in the context of Latin America.

Whereas most empirical analyses have examined the complements-substitutes question by looking only at simple correlations between trade and labor movements, Wong (1988), using data for the period 1948-1983, estimated export and import functions for the US to obtain estimated Rybczynski effects with respect to changes in capital and labor. His results suggested a complementary relationship between US trade and international movements of either capital or labor.

The above review of the literature indicates that the evidence regarding the relationship between trade and international factor movements is far from conclusive. Theoretically, trade and international factor flows can be complements or substitutes. Which of these relationships evidences itself in theoretical models depends largely on which traded good sector is assumed to use the internationally mobile, homogeneous, factor intensively in production. In the case of labor migration, some models that consider special cases such as illegal immigration have also modeled such migrants as sector specific. However, such models do not embrace the broader nature and characteristics of immigrant employment indicated by the data. Empirically, evidence for the nature of the relationship between trade and immigration is mixed. Many empirical investigations have considered only the case of a particular country or of a particular region. In some cases, the nature of the relationship between trade and immigration has been investigated using simple correlation analysis or has

been based on casual empiricism. A broader and more rigorous analysis of the trade and output responses that arise from immigration is therefore warranted.

II THE MODEL

We assume a small open economy that produces three goods: an exported good (x), an import-competing good (m), and a non-traded good (n). Below, we will often refer to the non-traded good as "services." There are three factors of production: capital (k), domestic labor (d), and immigrant labor (i). Capital and domestic labor are freely mobile across all three sectors whereas immigrant labor only works in, and is therefore specific to, the non-traded services sector.[vi]

The full employment conditions for the model can be written:

(1) $V_d = a_{dx}Q_x + a_{dm}Q_m + a_{dn}Q_n$
(2) $V_k = a_{kx}Q_x + a_{km}Q_m + a_{kn}Q_n$
(3) $V_i = a_{in}Q_n$

where V_z is the fixed domestic supply of factor "z," Q_j is the output in sector "j" and a_{zj} denotes the input requirement of factor "z" per unit of output in sector "j". Writing these three equations in matrix form gives:

(4) $$\begin{pmatrix} a_{dx} & a_{dm} & a_{dn} \\ a_{kx} & a_{km} & a_{kn} \\ 0 & 0 & a_{in} \end{pmatrix} * \begin{pmatrix} Q_x \\ Q_m \\ Q_n \end{pmatrix} = \begin{pmatrix} V_d \\ V_k \\ V_i \end{pmatrix}$$

or more compactly

(5) $$\mathbf{AQ} = \mathbf{V}.$$

The matrix **A** is commonly called the factor input requirements matrix.

We assume that production of the export good is capital-intensive, that production of the import-competing good is domestic labor-intensive, and that production of the non-traded good is the most labor intensive in terms of total labor employed per unit of capital. The ordering of capital-labor ratios across sectors is therefore assumed to be:

(6) $$\frac{a_{kx}}{a_{dx}} > \frac{a_{km}}{a_{dm}} > \frac{a_{kn}}{\left(a_{dn} + a_{in}\right)}$$

As written, the capital-labor ratio in the non-traded good sector appropriately measures capital relative to the total labor (domestic plus immigrant) employed in that sector. However, for later results we will also need to make an assumption about the use of capital per unit of each type of worker in the non-traded services sector. In this regard, we assume that the non-traded sector is also the most domestic labor-intensive sector, so that the entire ordering of capital-labor ratios is then assumed to be:

(7) $$\frac{a_{kx}}{a_{dx}} > \frac{a_{km}}{a_{dm}} > \frac{a_{kn}}{a_{dn}} > \frac{a_{kn}}{a_{in}} > \frac{a_{kn}}{\left(a_{dn} + a_{in}\right)}.$$ [vii]

II.A The Effect of Immigration on Production and Trade

To determine the change in outputs, and by extension trade, that will arise from immigration we totally differentiate equations (1)-(3) and solve the resulting system for the changes in outputs in terms of the changes in factor supplies. Doing this gives the following set of comparative static equations in matrix form:

(8) $$\begin{pmatrix} dQ_x \\ dQ_m \\ dQ_n \end{pmatrix} = \begin{pmatrix} \frac{a_{km}a_{in}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} & \frac{-a_{dm}a_{in}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} & \frac{a_{dm}a_{kn} - a_{km}a_{dn}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} \\ \frac{-a_{in}a_{kx}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} & \frac{a_{in}a_{dx}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} & \frac{a_{dn}a_{kx} - a_{kn}a_{dx}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} \\ 0 & 0 & \frac{a_{km}a_{dx} - a_{dm}a_{kx}}{a_{in}a_{km}a_{dx} - a_{in}a_{kx}a_{dm}} \end{pmatrix} * \begin{pmatrix} dV_d \\ dV_k \\ dV_i \end{pmatrix}$$

To examine the effect of immigration on the pattern of outputs, we assume that a given inflow of new migrants contains a heterogeneous mix of workers. Specifically, we assume that a fraction λ of incoming foreign workers will have domestic worker status, and thus be freely mobile across all sectors, while the remaining $(1-\lambda)$ of new migrants will instead become specific to the non-traded services sector.[viii] An inflow of "I" new foreign workers therefore increases the stock of mobile domestic workers by the amount $dV_d = \lambda I$, and increases the stock of sector specific immigrant workers (i.e., immigrant labor) by the amount $dV_i = (1 - \lambda)I$. Inserting these factor supply changes into (8), and assuming without

loss of generality that I = 1, we obtain the following expressions for the output change in each sector:

$$(9)\quad \frac{dQ_x}{dV_i} = \frac{(a_{dm}a_{kn} - a_{km}a_{dn}) + \lambda(a_{km}a_{in} + a_{km}a_{dn} - a_{dm}a_{kn})}{a_{in}\left(a_{km}a_{dx} - a_{kx}a_{dm}\right)},$$

$$(10)\quad \frac{dQ_m}{dV_i} = \frac{(a_{dn}a_{kx} - a_{kn}a_{dx}) + \lambda(-a_{in}a_{kx} - a_{dn}a_{kx} + a_{kn}a_{dx})}{a_{in}\left(a_{km}a_{dx} - a_{kx}a_{dm}\right)},$$

$$(11)\quad \frac{dQ_n}{dV_i} = \frac{(1-\lambda)(a_{km}a_{dx} - a_{kx}a_{dm})}{a_{in}\left(a_{km}a_{dx} - a_{kx}a_{dm}\right)} = \frac{(1-\lambda)}{a_{in}}$$

The denominator in expressions (9) and (10) is the determinant of the factor input requirements matrix A i.e., $|\mathbf{A}| = a_{in}\left(a_{km}a_{dx} - a_{kx}a_{dm}\right)$ which must be non-zero. This condition is satisfied if the capital-labor ratios in the export and import-competing sectors differ (i.e., $a_{kx}/a_{dx} \neq a_{km}/a_{dm}$). The value of this determinant is negative if, as we assume, the export sector is more capital-intensive than the import competing sector (i.e., $a_{kx}/a_{dx} > a_{km}/a_{dm}$). One could instead assume the import-competing sector is more capital-intensive than the export sector. However, our empirical analysis will use data on OECD countries and, for most of these countries, it is reasonable to assume that the export sector is more capital-intensive than the import-competing sector. Thus, determining the output response in each sector reduces to determining the sign of the numerator in each of the above expressions.

II.A. 1 The Export Sector

The effect of immigration on the output of the export good is determined by (the negative of) the sign of the numerator in (9). After re-arrangement this numerator can be written

$$(12)\ (a_{in} + a_{dn})a_{dm}(1-\lambda)k_m\left[\left(\frac{s}{(1-\lambda)}\right) - \left(1 - \frac{k_n}{k_m}\right)\right],$$

where $k_n = a_{kn}/(a_{in} + a_{dn})$ and $k_m = a_{km}/a_{dm}$ are respectively the capital-labor ratios in the non-traded and import-competing sectors and $s = a_{in}/(a_{in} + a_{dn})$ is the initial share of

sector specific immigrant workers in total non-traded sector employment. The sign of (12) depends only on the relationship among the terms in square brackets.

Consider first the case where $\lambda = 0$, so that all new immigrants become specific to the non-traded sector.[ix] In this case, the sign of (12) is determined by the sign of the following expression:

$$\frac{k_n}{(1-s)} - k_m \tag{13}$$

By definition, $k_n/(1-s) = a_{kn}/a_{dn}$ is the ratio of capital to domestic labor employed in the non-traded sector. Expression (13) is therefore negative given our assumption (see (7)) that the import-competing sector is more capital- domestic labor intensive than the non-traded sector. Since (9) is then positive, an inflow of foreign workers that consists entirely of workers who become specific to the non-traded sector raises the output of the export good.

For the more general case where $0 < \lambda < 1$, so that a new inflow of foreign workers contains both sector specific and domestic-status workers, the effect on export sector output depends, in a complicated way, on the terms in square brackets in (12). However, insights are possible. First, we note that the ratio k_n/k_m is less than one given our assumption that the import-competing sector is more capital-intensive than the non-traded sector. This implies that the expression $(1-(k_n/k_m))$ in (12) is positive and less than one. Given this, one can deduce that (12) is unambiguously positive, and hence that production of the export good unambiguously falls with immigration, if the employment share of sector specific immigrants in the non-traded sector exceeds the fraction of new immigrants that become sector specific, that is, if $s/(1 - \lambda) \geq 1$. This condition is more likely to be satisfied the larger is λ, that is, the larger is the fraction of new immigrants with (mobile) domestic worker status. If λ is sufficiently large, a decline in export sector production arises because the immigration induced increase in the stock of domestic workers requires that these workers be absorbed mainly by the domestic labor intensive import-competing sector. As the import-competing sector expands, it draws capital from the export sector, reducing production of the export good.

If instead $s/(1 - \lambda) < 1$ then (12) can be negative or positive, and hence export sector output could either rise or fall with immigration. To gain further insight, we ask what conditions would make it more likely that production of the export good rises with

immigration (as was the case when $\lambda = 0$). By inspecting (12) under the assumption that $s/(1 - \lambda) < 1$, one can deduce that the smaller is the ratio $s/(1 - \lambda)$, the more likely is export production to rise with immigration (since this makes (12) more likely to be negative). This in turn requires that the new inflow of foreign workers contains either a high fraction of workers who will become sector specific (large $(1 - \lambda)$) or that sector specific workers are a relatively small fraction of total employment in the non-traded sector (small s). This suggests that countries such as the United States, who have significant total employment in non-traded goods sectors, and which also experience inflows of workers likely to be sector specific, are more likely to experience an increase in export sector output with immigration.

Another condition that would make an increase in export production more likely relates to the relative sizes of the capital-labor ratios in the non-traded and import-competing sectors. Specifically, the smaller is the ratio kn/km, the more likely, other things equal, that (12) is negative, and hence the more likely that export sector output rises with immigration. This follows since the smaller is kn/km the closer to unity is the term $\left(1-\left(k_n/k_m\right)\right)$. In turn, the closer is this term to unity, the more likely is $\left(1-\left(k_n/k_m\right)\right)$ to exceed s/(1 – □), where we recall that the latter is now assumed to be less than one. Thus, when $s/(1 - \lambda) < 1$, the larger is the divergence in capital-labor usage between the non-traded and import-competing sectors (i.e., the smaller is k_n/k_m), the more likely that export sector output rises with immigration. An alternative interpretation of this relationship is that, the smaller is k_n/k_m , the smaller can be the share $(1 - \lambda)$ of sector specific workers in any given inflow of new foreign workers and still have an increase in export sector output.

The preceding analysis of the effect of immigration on the output of the export good can be summarized as follows. When $0 < \lambda < 1$ then

$$\text{(14)} \qquad \begin{cases} \dfrac{dQ_x}{dV_i} < 0 \text{ if } \dfrac{s}{(1-\lambda)} \geq 1 \\[2ex] \dfrac{dQ_x}{dV_i} < 0 \text{ if } \dfrac{s}{(1-\lambda)} > \left(1-\dfrac{k_n}{k_m}\right) \\[2ex] \dfrac{dQ_x}{dV_i} > 0 \text{ if } \dfrac{s}{(1-\lambda)} < \left(1-\dfrac{k_n}{k_m}\right). \end{cases}$$

When $\lambda = 0$, then

(15) $$\frac{dQ_x}{dV_i} > 0\,(<0) \text{ if } \left(\frac{k_n}{(1-s)} - k_m\right) < 0 \;\; (>0)$$

II.A.2 The Import-competing Sector

How production of the import-competing good responds to immigration is indicated by expression (10). A re-arrangement of the numerator in (10) yields the following expression:

(16) $$(a_{in} + a_{ln})a_{lx}k_x(1-\lambda)\left[\left(1-\frac{k_n}{k_x}\right) - \frac{s}{(1-\lambda)}\right]$$

Comparison of (16) and (12) indicates an expected symmetry between these expressions. Like the case of export production, the sign of (16) depends in a complicated way on the relationship between the existing employment share of sector specific immigrants (s) and the share of sector specific immigrants in the new wave of immigrants (1 - λ), as well as the relationship between the capital-labor ratios in the non-traded and export sectors.

We again consider first the case for which the inflow of new foreign workers consists entirely of sector specific workers (i.e., λ = 0). In this case, determining the sign of (16) reduces to determining the sign of the following expression:

(17) $$\left[k_x - \frac{k_n}{(1-s)}\right]$$

Since $k_n/(1-s) = a_{kn}/a_{dn}$ is the ratio of capital to domestic labor employed in the non-traded sector, (17) is positive given our assumption (see (7)) that the export sector is more intensive than the non-traded services sector in capital relative to domestic labor. Since (10) is then negative, production of the import-competing good falls if all new immigrants become specific to the non-traded sector. This result, together with the previous result that production of the export good rises when λ = 0, implies that trade will increase when all new immigrants become specific to the non-traded services sector. This trade effect follows since, assuming demand unchanged, a fall in the output of the domestic import-competing sector implies an increase in imports and, assuming balanced trade, also an increase in exports (which was anyway predicted when λ = 0). Hence, when all new immigrants become specific

to the non-traded sector, *trade and immigration are complements*. Important to note is that this complementary relationship arises in our model without assuming, as does most prior literature (e.g., Markusen (1983)), that the internationally mobile factor is used intensively in the export sector.

Now consider the more general case for which $0 < \lambda < 1$, so that some of the new immigrants will have (mobile) domestic worker status. Similar to the export sector analysis, the term $\left(1-\left(k_n/k_x\right)\right)$ in (17) is less than one since $k_n/k_x < 1$, given our assumption that the export sector is more capital-intensive than the non-traded sector. Given the latter, (17) will be unambiguously negative, and hence production of the import-competing good will unambiguously rise with immigration, if $s/(1 - \lambda) \geq 1$. From the export sector analysis, we found that production of the export good unambiguously falls when $s/(1 - \lambda) \geq 1$. Hence, in our model, *trade and immigration are substitutes* when the existing employment share of sector specific immigrants exceeds the share of new immigrants that become sector specific, that is, when $s/(1 - \lambda) \geq 1$.[x]

The possibility of a substitute relationship arises in our model because we have allowed a given inflow of migrants to contain a mixture of both sector specific and domestic-status workers.[xi] As found above, trade and immigration are unambiguously complements in our model if new immigrants consist entirely of sector specific workers. This underscores the importance of accounting not only for the characteristics of immigrants (e.g., skilled versus unskilled, legal versus illegal, etc.) but also for the sector and the nature (e.g. sector specificity) of employment of each type of migrant when considering the effects of immigration on an economy.

If instead $s/(1 - \lambda) < 1$ then, as was the case for export production, production of the import-competing good may rise or fall with immigration. When $s/(1 - \lambda) < 1$ one can deduce, by a reasoning similar to that done for the export good, the conditions under which production of the import-competing good is likely to fall. In this regard, expression (16) is more likely to be positive, and hence production of the import-competing good more likely to fall, the smaller is the ratio $s/(1 - \lambda)$. Therefore, the smaller is the share of sector specific workers in total non-traded sector employment (s), or the larger is the fraction $(1 - \lambda)$ of new immigrants who will become sector specific, the more likely that production of the import competing good will fall with immigration. Intuitively, the larger is the fraction of new foreign workers that become sector specific the less the inflow of new foreign workers represents an increase in the stock of mobile domestic workers, and hence the less likely is

the inflow of new foreign workers to contribute to an increase in production of the import-competing good. From the export analysis we found that the smaller is $s/(1 - \lambda)$ the more likely is export production to rise with immigration. This, and the above analysis for the import-competing sector, suggests that the smaller is $s/(1 - \lambda)$ the more likely are trade and immigration to be complements.

Finally, expression (16) is also more likely to be positive, and hence production of the import-competing good more likely to fall, the smaller is the ratio k_n/k_x. Thus, the larger is the capital-labor ratio in the export sector compared to that in the non-traded sector, the more likely is production of the import-competing good to fall with immigration. The preceding discussion of output changes for the import-competing sector can be summarized as follows.

When $0 < \lambda < 1$ then

$$(18) \qquad \begin{cases} \dfrac{dQ_m}{dV_i} > 0 \text{ if } \dfrac{s}{(1-\lambda)} \geq 1 \\[2ex] \dfrac{dQ_m}{dV_i} > 0 \text{ if } \dfrac{s}{(1-\lambda)} > \left(1 - \dfrac{k_n}{k_x}\right) \\[2ex] \dfrac{dQ_m}{dV_i} < 0 \text{ if } \dfrac{s}{(1-\lambda)} < \left(1 - \dfrac{k_n}{k_x}\right). \end{cases}$$

When $\lambda = 0$, then

$$(19) \qquad \frac{dQ_m}{dV_i} > 0 \ (< 0) \text{ if } \left(k_x - \frac{k_n}{(1-s)}\right) < 0 \ (> 0)$$

II.A.3 The Non-Traded Goods Sector

The effect of immigration on production of the non-traded good is clear from (11), namely, production of the non-traded good must rise so long as the new inflow of foreign workers contains at least some workers who will become specific to the non-traded sector, that is, as long as $(1 - \lambda) > 0$. Conversely, production of the non-traded good is unchanged if the new inflow of foreign workers consists entirely of workers with domestic worker status (i.e., $\lambda = 1$).[xii] The output response in the non-traded sector can therefore be summarized as:

(20) $$\frac{dQ_n}{dV_i} > 0 \text{ if } (1 - \lambda) > 0 \text{ and zero otherwise.}$$

That production of the non-traded good rises with immigration was expected since any increase in the stock of immigrant workers must, since these workers are specific to the non-traded sector, raise the output of this sector in order to absorb the increased supply of these workers. However, whether expansion of the non-traded sector comes at the expense of the export or import-competing sector, in terms of reduced output, depends on the fraction of new immigrants who become sector specific compared to the existing share of sector specific immigrants in non-traded sector total employment. As we have found, the higher is the fraction of sector specific workers in the new wave of immigrants, and the lower is the employment share of existing sector specific immigrants in the non-traded sector, the more likely is immigration to raise output in the export sector and to lower output in the import competing sector, and hence to increase trade.[xiii]

Lastly, we have found that production in the export and import-competing sectors can either rise or fall when $s/(1 - \lambda) < 1$. Although it is possible for production of both the export and import-competing good to fall, it is not possible that both sectors experience an increase in production since this would require an increase in the use of capital in all three sectors, which is not possible given that the stock of capital is fixed in our model.[xiv] Therefore, since production of the non-traded good must rise with any new inflow of sector specific immigrant workers, one (or both) of the traded goods sectors must contract.

II.B PARTIAL AMNESTY FOR IMMIGRANT WORKERS

In our model one could also think to examine the case of "partial amnesty" in which some fraction of existing sector specific immigrant workers gain domestic worker status and thus become mobile across all sectors (e.g., by issuing official work permits to illegal immigrants or by providing training that allows immigrants to assimilate into the general pool of workers). In the context of our model, it is clear that converting some sector specific immigrant workers into mobile domestic workers would have the same qualitative effect as an increase in the stock of domestic workers alone. In order to absorb the increase in domestic workers the import sector would need to expand, the export sector would need to contract, and by implication, trade would be reduced. Moreover, since a partial amnesty of the existing stock of immigrants entails a reduction in the number of sector specific immigrant workers, the output of the non-traded good must fall.

III TRADE LIBERALIZATION AND IMMIGRATION

This section briefly considers the implications of our model for the question of whether a move by a country toward freer trade would enhance or reduce incentives to migrate to/from that country. An assumption of this analysis is that migration flows respond to international wage differentials. Given this assumption, we consider the effect that a fall in the domestic price of the import-competing good, due to the removal of a tariff imposed on imports of this good, has on factor prices.[xv] The direction of these factor price changes, and in particular the change in the wage of sector specific immigrants, then indicates whether trade liberalization will increase or reduce incentives for migration.

Denote the prices of goods by P_j (j = x, m, or n), denote "r" as the rental return to one unit of capital, "w" as the wage of immigrant labor, and "u" the wage of domestic labor. The zero profit conditions for each sector can then be written:

$$\text{(21)} \qquad \begin{cases} P_x = a_{dx}u + a_{kx}r \\ P_m = a_{dm}u + a_{km}r \\ P_n = a_{dn}u + a_{kn}r + a_{in}w \end{cases}$$

To examine how an exogenous change in an output price would affect input prices we can solve each of these equations for r in terms of P_j, u, and w.

$$\text{(22)} \qquad \begin{cases} r = \dfrac{P_x}{a_{kx}} - \dfrac{a_{dx}}{a_{kx}}u \\ r = \dfrac{P_m}{a_{km}} - \dfrac{a_{dm}}{a_{km}}u \\ r = \left(\dfrac{P_n}{a_{kn}} - \dfrac{a_{in}}{a_{kn}}w\right) - \dfrac{a_{dn}}{a_{kn}}u \end{cases}$$

Treating the output prices and the immigrant wage (w) as parametric, each of these equations (i.e., factor price frontiers) can be graphed as shown in Figure 2. Each curve indicates, for given values of the output prices and immigrant wage, the values of r and u compatible with zero profits in each sector. As shown in Figure 2, the point where these three curves intersect is the economy-wide zero profit equilibrium. We note that in Figure 2 the

mm curve is drawn steeper than the xx curve to reflect our assumption that the export sector is capital-intensive relative to the import-competing sector. The implication of this assumption for the effect of an output price change on inputs prices will be further discussed below.

Insert Figure 2 About Here

Now consider the effect of imposing an import tariff that raises the domestic price of the import-competing good. Graphically, this price change shifts the mm curve up and to the right as shown by the curve labeled m′m′ in. Since the price of exports is fixed on world markets (small country assumption), the xx curve is also fixed.

Insert Figure 3 About Here

Therefore, to restore the economy-wide zero profit equilibrium, the nn curve must shift until it intersects the xx curve at the same point where the m′m′ curve now intersects the xx curve. Since, by assumption, the price of the non-traded good is also fixed, the shift in curve nn is accomplished by a fall in the wage of immigrant workers (w). This fall in the immigrant wage leads to the new nn curve labeled n′n′. Therefore, in the context of our model, an import tariff raises the wage of domestic workers but lowers the return to capital and the wage of sector specific immigrant workers.

By reversing the above analysis, we conclude that tariff removal would raise the return to capital and the wage of sector specific immigrant workers but lower the wage of domestic (and domestic-status immigrant) workers. Hence, if immigration responds to a wage differential, a move toward freer trade would increase the incentives for sector specific workers to immigrate but lower the incentive for domestic-status workers to immigrate. Phased in terms of “legal” versus “illegal” immigrants, trade liberalization would create incentives for illegal immigration and create disincentives for legal immigration in our model.

As can be seen in Figure 3, the effect of the tariff on the wage of sector specific immigrants depends on whether the mm curve is flatter or steeper than the xx curve. We have drawn the mm curve steeper than the xx curve since we assume the export sector is more

capital-intensive than the import-competing sector. However, if the reverse were true, then the effect of the tariff on the wage of sector specific immigrant workers would be opposite that found above. Hence, if the import-competing sector is more capital-intensive than the export sector, then a move toward freer trade would raise the wage of domestic-status workers and lower the wage of sector specific immigrant workers, and hence increase the incentive for sector specific workers to *emigrate*.

The preceding results suggest that, if comparative advantage follows the Heckscher-Ohlin prediction, the relationship between immigration and trade liberalization would be different for capital abundant and labor abundant countries. A capital abundant country that alone pursues freer trade in goods would be expected to experience an inflow of sector specific type workers and an outflow of domestic-status workers. Conversely, a labor abundant country that alone pursues freer trade in goods would experience an outflow of sector specific workers and an inflow of domestic-status workers. The case in which both capital and labor abundant countries liberalize is problematic in the present model since one country's domestic-status workers may become another country's sector specific workers. Clearly, a proper analysis of this case requires, at a minimum, a two-country model.

Linking (informally) these results to the previous analysis of immigration and trade, we conjecture that, for capital abundant countries, unilateral trade liberalization could enhance trade not only by reducing barriers to trade in goods, but also because these countries are more likely to experience an inflow of foreign workers who become employed in, and are specific to, the non-traded sector. As we have found, the higher is the fraction of immigrants that become sector specific, the more probable is immigration to increase exports and to reduce import-competing production, and to therefore enhance the pro-trade effects of trade liberalization.

IV EMPIRICAL ANALYSIS

In this section, we explore empirically the relationships between immigration, the output of non-traded goods (services), and trade (exports). Our theoretical model suggests that, to the extent some immigrants are (become) specific to the non-traded sector, immigration will be associated with an increase in the output of non-traded goods. For exports, the effect of immigration depends on the mix of new foreign workers and the share of sector specific immigrants already working in the non-traded sectors of an economy. Our

empirical analysis of exports in relation to immigration is therefore intended to identify whether the actual relationship between exports and immigration is positive or negative, and consequently whether the data reveal immigration and exports to be complements or substitutes.

IV.A Model Specification

We estimate two sets of relationships: one between exports and immigration, and one between the output of services and immigration. In each case, we use GDP per capita as a control for differences in country wealth and size and, in the case of services output, also for the known relationship between services output and GDP per capita.[xvi] We further include the square of GDP per capita to allow for the possibility of a nonlinear relationship between each dependent variable and GDP per capita.

Our data sample includes three countries (Austria, Germany, and Switzerland) that have "guest worker" programs. By definition, such programs skew the mix of incoming foreign workers toward those who will be, in the terminology of our theoretical model, "domestic-status" workers, and they may also channel employment of such immigrants into traded goods sectors. To control for this, we interact our immigration variable with a dummy for these guest-worker countries. Given the above, the relationships to be estimated take the form :

$$(23)\ Y_{it} = \beta_0 + \beta_1 \cdot GW + \beta_2 \cdot (\text{Immigration}_{it-1}) + \beta_3 \cdot (GW \cdot \text{Immigration}_{it-1}) + \beta_4 \cdot (\text{GDP per capita}_{it}) + \beta_5 \cdot (\text{GDP per capita}_{it})^2 + \varepsilon_{it.}$$

The variable Y_{it} is either exports or services output in country i at time t. We use lagged immigration since we expect there to be a lagged effect between the time a migrant arrives and the subsequent impact on trade and services output. The variable GW is the dummy variable for guest-worker countries. The variable "$GW \cdot \text{Immigration}_{it-1}$" is the interaction variable between the guest-worker country dummy and lagged immigration.

Our empirical analysis can be thought to be uncovering the sign of a Rybczynski effect associated with a change in a country's *stock* of workers. This suggests that the appropriate specification to estimate would involve the level of output in relation to the *stock* of immigrant workers. However, lacking reliable data on immigrant stocks, and for statistical reasons, we instead estimate (23) using the change (first difference) in each dependent variable and the GDP per capita controls.[xvii]

We estimate specification (23) using two different measures of the immigration variable, total immigration and net immigration (i.e., immigration minus emigration). We prefer the total immigration variable for two reasons. First, many countries in our sample do not report emigration, so limiting ourselves to net immigration would involve reduced degrees of freedom. Second, we suspect that, as with data on imports and exports of goods, the data on inflows (immigration) are likely to be more accurate than the data on outflows (emigration). The net immigration variable may therefore be subject to measurement error.

In summary, our regression model specifies the annual change in either exports or services output in relation to immigration lagged one year, an interaction variable between lagged immigration and a dummy for guest-worker program countries, the annual change in GDP per capita, and the square of the annual change in GDP per capita.

With respect to services output, the theoretical model predicts that immigration will unambiguously raise output of non-traded goods. We therefore expect a positive relationship between services output and immigration. Since we are only interested in that part of services likely to be non-traded, we limit our focus to data on non-financial services, which is further broken down into two categories: "wholesale/retail non-financial services" and "other non-financial services."

With respect to exports, we examine total exports of goods and services as well as each component separately: exports of goods and exports of services. The theoretical model indicates that the relationship between exports and immigration depends on the share of sector specific immigrants already working in the non-traded services sector relative to the fraction of new immigrants that become sector specific, as well as the relative use of capital and labor in the export and import-competing sectors.[xviii] The higher is the share of new immigrants who become specific to the non-traded sector, the more likely is there to be a positive relationship between exports and immigration. However, since either a complement or substitute relationship is theoretically possible, we have no a priori expectation for the sign of the coefficient between exports and lagged immigration.

IV.B Data

Annual data on total inflows and outflows of migrants for the period 1980-2001 were taken from the OECD's Trends in International Migration Database (OECD (2002)).[xix] The migration data refer to permanent flows and therefore exclude tourists, etc. For the time period studied, data were available in various years for twenty OECD countries: Australia,

Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the UK, and the US. Australia, Canada, France, Ireland, Italy, Portugal, the UK, and the US do not report outflows.

Data on gross domestic product, population, exports of goods and services, and the output (value added) of "wholesale/retail non-financial services" and "other non-financial services" were taken from the OECD National Accounts database. The sector "other non-financial services" includes non-business services such as public administration and health care.[xx] The "wholesale/retail non-financial services" sector encompasses wholesale and retail trade as well as hotel, restaurant, and transportation activities. Total services is calculated as the sum of the outputs of these two service categories. The data on GDP, exports, and services output are measured in 1995 US dollars.[xxi]

Since we have panel data, we performed standard tests for cross-sectional correlation, serial correlation in the panel, and group-wise heteroscedasticity. These tests indicated first order autocorrelation in the levels of both services output and exports. We correct for these AR1 processes by using first differences in the respective data.[xxii] Tests for group-wise heteroscedasticity in the residuals using the modified Wald statistic indicated its presence. In addition, the Breusch-Pagan Lagrange Multiplier (LM) test for independence of the errors across panels indicated that the errors are not independent but are correlated across countries. Because we have an unbalanced panel, we were limited in our choice of corrective estimation techniques. We therefore used the Prais-Winsten transformation to obtain panel-corrected standard errors to account for group-wise heteroscedasticity. We further specified that the covariance matrix be calculated using all available information.[xxiii]

IV.C Results

Tables 2a, 2b and 2c presents summary statistics for the data samples used to estimate specification (23) for services output, goods and services exports, and goods exports and services exports separately when total immigration is used as the immigration variable. Tables 3a, 3b and 3c present the corresponding information for each sample when net immigration is used as the immigration variable. The simple correlation between the annual change in services output and lagged immigration is 0.56; the correlation between the annual change in goods and services exports and lagged immigration is 0.47. The corresponding correlations for net immigration are 0.11 for total services output and 0.16 for exports of goods and services.

IV.C.1 Results for Services Output

The results of estimating specification (23) for the each of the three categories of services output are reported in Table 4. For the regressions using total immigration (columns 1-3 in Table 4) the coefficient on lagged immigration is positive and highly significant in all cases, consistent with the prediction of the theoretical model. For the regressions that use net immigration (columns 4-6 in Table 4), the coefficient on lagged immigration is positive and highly significant for Total Services and Other Services, and is positive and significant at the 10% level for Wholesale Services. These results are also consistent with our model's prediction that non-traded goods output rises with immigration.

Insert Table 4 About Here

The coefficient on the interaction between the dummy for guest-worker countries and total immigration (columns 1-3 in Table 4) is negative and highly significant for each of the three categories of services output. When net immigration is used (columns 4-6 in Table 4) the coefficient on the interaction variable are similarly negative and highly significant except for "Wholesale Services." These results suggest that a guest worker program, which skews the mix of immigrants toward domestic-status workers, serves to offset the expansionary effects of immigration on services output – a result consistent with our theoretical model. To determine if this offset is complete, we tested the hypothesis that the sum of the immigration coefficient and the guest worker interaction coefficient is negative. When total immigration is used as the immigration variable, the hypothesis was rejected at the 5% level for all three categories of services, indicating that the negative effect of guest worker programs is not strong enough to completely offset the generally positive effect of immigration. This finding also holds, except for "Wholesale Services," when net immigration is used as the immigration variable; the hypothesis was rejected at the 5% level for "Total Services" and "Other Services" but can be rejected only at the 14% level for "Wholesale Services."

The coefficient on per capita GDP is positive, as expected, and significant in all cases except for "Other Services" when net immigration is used as the immigration variable. In addition, except again for "Other Services," when net immigration is used as the immigration variable, the coefficient on squared GDP per capita is negative and significant. These results indicate a non-linear relationship with respect to changes in services output: changes in GDP

per capita have an increasing but diminishing marginal effect on the growth of services output.

IV.C.2 Results for Exports

Table 5 reports the results of estimating (23) for each of the three categories of exports. The coefficient on immigration is positive and highly significant in all cases except for "Goods and Services Exports" when net immigration is used as the immigration variable.[xxiv] Overall, these results indicate that exports and immigration are complements; a finding that is consistent with the predictions of our theoretical model. [xxv]

Insert Table 5 About Here

As with the services output regressions, the coefficient on the guest-worker interaction variable is negative and significant when total immigration is used as the immigration variable (columns 1-3 in Table 5), and is negative and significant only in the separate "Goods Exports" and "Services Exports" regressions when net immigration is used as the immigration variable (columns 4-6 in Table 5).

Given the negative coefficient for the guest worker interaction variable, we again tested for each model the hypothesis that the sum of the immigration coefficient and the guest worker interaction coefficient is negative. When net immigration is the dependent variable we failed to reject the hypothesis in all cases, meaning that the negative effects of targeting domestic-status type immigrants creates a substitute relationship between exports and immigration in guest worker program countries. However, this conclusion is reversed when total immigration is used as the immigration variable; the hypothesis that the sum of the coefficients is negative was rejected for both "Goods Exports" and for "Goods and Services Exports." For "Services Exports" the hypothesis could be rejected only at the 12% level. The difference in results for the two measures of immigration creates uncertainty about the true effect. The only conclusion that seems possible at this stage is that, for countries with guest worker programs, the likelihood that exports and immigration are substitutes is increased; a result that is consistent with the predictions of our theoretical model.

Finally, the coefficient on per capita GDP is positive and significant in all cases. In addition, in all cases, the coefficient on squared GDP per capita is negative and significant.

As was the case for services output, this result indicates a non-linear relationship between changes in exports and changes in GDP per capita.

V CONCLUSION

This paper has presented a model of an economy with three factors of production; two traded goods and one non-traded good. The purpose of the model was to discern the output and trade effects associated with immigration when the employment of some immigrant labor is restricted to the non-traded goods sector. Two empirical facts regarding immigrant labor motivated the structure of our model. First, a significant fraction of immigrant employment is concentrated in sectors whose output is, to a large extent, not internationally traded. Second, some immigrants face significant and persistent barriers to mobility across sectors within their host country. In constructing a model that takes account of these aspects of immigrant employment, we have demonstrated that where immigrants work, and the characteristics of their employment, have important implications for the effect of immigration on a nation's pattern of production and trade. Moreover, by allowing that a given inflow of new immigrants contains a heterogeneous mixture of foreign workers, either a complementary or a substitute relationship between trade and immigration can emerge in our model. Thus, in contrast to prior literature that has modeled an internationally mobile but domestically sector-specific factor, a complementary (substitute) relationship can arise in our model without assuming that the internationally mobile factor is used intensively in the export (import-competing) sector.

Empirical examination of the predictions of our model in a panel of OECD countries indicated that, consistent with our model, the output of services rises with the level of immigration. In addition, we found that trade (exports) and immigration are complements. We also found that, consistent with our model, this complementary relationship between trade and immigration is reduced, and could be reversed, by immigration policies, such as guest-worker programs, that target domestic-status type immigrants and which may direct the employment of such immigrants into traded goods sectors.

Our theoretical model indicates that the higher is the fraction of sector specific immigrants among new immigrants, and the lower the existing employment share of sector specific immigrants in the non-traded sector, the more likely that immigration will increase output in the export sector and decrease output in the import competing sector, and hence

increase trade. Therefore, the higher is the fraction of new immigrants that become employed in the non-traded sector, the more probable that trade and immigration are complements. One policy implication of this relationship is that countries for which immigrant workers are presently a small share of non-traded sector employment are more likely to experience an increase in export sector output consequent to immigration, under the caveat that immigration policy does not discourage the type of (sector specific) immigrants likely to become employed in non-traded goods sectors.

Not only do we have empirical confirmation of our model, our empirical results go one step further to suggest that it not only matters where immigrants become employed, but it also matters from what country migrants arrive. Workers arriving from a country where they are more likely to integrate into the domestic labor pool, or to have attained the skills to work in traded goods sectors, will reduce the positive effects on non-traded goods output and may result in trade and immigration being substitutes. In this regard, our model has implications for targeted immigration policies, such as those that encourage high-skilled labor immigration. To the extent that our results hold, targeting only high-skilled workers may remove the potential for the complementary pro-trade benefit that would arise from the employment of sector specific immigrants in non-traded goods sectors.

Our model suggests that integrating immigrants into the general pool of domestic workers would shift production from export to import-competing sectors and would therefore reduce trade. However, this does not mean that a country should limit rather than encourage the integration of immigrant workers into its economy since these sectoral output changes say nothing about national welfare, which may be significantly enhanced by such integration, particularly when social dimensions are considered.

In the context of our theoretical model we also examined the effect of trade liberalization on the incentives for workers to migrate. We found that the incentives for migration following trade liberalization differed between capital abundant and labor abundant countries. In particular, for a capital abundant country, a movement toward freer trade in goods creates an incentive to immigrate only for those foreign workers likely to become specific to the country's non-traded goods sector. This implies that for capital abundant countries, the pro-trade effect of trade liberalization may be enhanced by the complementary relationship between trade and immigration found when most new migrants become specific to the non-traded good sector. While we did not empirically examine this predicted relationship between trade liberalization and migration flows, the general empirical support for our theoretical model suggests that such effects may also be empirically valid.

We conclude with some suggested interpretations, and possible extensions, of our model. First, it is a simple matter to reinterpret the sector specific immigrants as unskilled workers and domestic-workers as skilled workers. Doing so allows one to then easily interpret our findings in this context. In line with this theme, one could also re-label capital in our model as high-skilled labor, domestic workers as low-skilled labor, and sector specific workers as unskilled labor. This extension would admit a richer analysis of the impact of immigration since any given inflow of migrants could then contain a mix of high-skilled, low-skilled, and unskilled workers. Moreover, since the export sector is then intensive in high-skilled labor, the possibility of a complementary relationship between trade and immigration may be enhanced, although, as in the present model, this would likely depend on the relative mix of each type of worker in a given inflow of new migrants as well as the relative use of factors, in production, across sectors.

Lastly, if labor were differentiated by skill level, one might also treat capital as internationally mobile. This would allow one to explore possible complementarity between capital and labor flows. As suggested by the above, the model developed here suggests a rich set of extensions that can offer more precise insights into the economic effects of immigration.

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TABLE 1

Stock of immigrants as a percent of total population, 1986 and 2000

	1986	2000	Average Annual Percent Change
France	6.2	5.4	-1.0%
Belgium	8.7	8.4	-0.2%
Netherlands	3.9	4.2	0.5%
Sweden	4.7	5.4	1.0%
Canada	15.4	17.4	1.3%
Switzerland	14.5	19.3	2.0%
UK	3.2	4.3	2.2%
Luxembourg	26.4	37.6	2.5%
Germany	5.8	8.9	3.1%
Norway	2.6	4.1	3.3%
Japan	0.7	1.3	4.6%
Denmark	2.5	4.8	4.8%
US	6.2	9.3	5.0%
Austria	4.3	9.1	11.2%
Italy	1.0	2.2	12.0%

Note: for the US and Canada the figures are foreign born population as a percentage of total population. For Austria, Canada, Italy, and the US the year 2000 figures are from 1997.

Source: Author's calculations based on data from OECD (2002) - SOPEMI .

TABLE 2A

Summary statistics, sample for services output using total immigration

Variable	Mean	Std. Dev.	Correlations			
			Total Services	Other Services	Wholesale Services	Lagged Immigration
Total Services	13596.6	28309.9	1			
Other Services	4883.9	9217.6	0.80	1		
Wholesale Services	8712.7	21632.3	0.97	0.62	1	
Lagged Immigration	166.1	262.6	0.56	0.52	0.51	1
GDP per Capita	21297.8	4359.0	0.25	0.14	0.26	0.20

Notes: observations = 297, 1980-2000. Switzerland does not report services and is therefore excluded.

TABLE 2B

Summary statistics, sample for goods and services exports using total immigration

Variable	Mean	Std. Dev.	Correlations	
			Goods and Services Exports	Lagged Immigration
Goods and Services Exports	8892.9	15994.4	1	
Lagged Immigration	157.4	252.8	0.47	1
GDP per Capita	21603.7	4343.1	0.18	0.17

Notes: observations = 325, 1980-2000. All twenty countries included.

TABLE 2C

Summary statistics, sample for goods exports and services exports using total immigration

Variable	Mean	Std. Dev.	Correlations		
			Goods Exports	Services Exports	Lagged Immigration
Goods Exports	8195.3	14399.4	1		
Services Exports	2123.6	3754.4	0.76	1	
Lagged Immigration	192.3	289.7	0.45	0.50	1
GDP per Capita	22190.4	4512.1	0.15	0.22	0.13

Notes: observations = 227, 1980-2000. Belgium, Japan, and Norway do not report separate data on goods exports and services exports and are therefore excluded.

TABLE 3A

Summary statistics, sample for services output using net immigration

Variable	Mean	Std. Dev.	Correlations			
			Total Services	Other Services	Wholesale Services	Lagged Net Immigration
Total Services	8719.3	18948.5	1			
Other Services	3908.7	8300.0	0.81	1		
Wholesale Services	4810.6	13153.1	0.93	0.54	1	
Lagged Net Immigration	36.8	80.0	0.11	0.13	0.08	1
GDP per Capita	21873.3	4438.5	-0.14	-0.18	-0.09	-0.05

Notes: observations = 183, 1980-2000. Australia, Canada, France, Ireland, Italy, Portugal, New Zealand, UK, USA do not report outflows of migrants. Switzerland does not report services and is therefore excluded.

TABLE 3B

Summary statistics, sample for goods and services exports using net immigration

Variable	Mean	Std. Dev.	Correlations	
			Goods and Services Exports	Lagged Net Immigration
Goods and Services Exports	6395.3	11423.1	1	
Lagged Net Immigration	35.0	76.0	0.16	1
GDP per Capita	22242.0	4364.9	-0.06	-0.06

Notes: observations = 204, 1980-2000. Australia, Canada, France, Ireland, Italy, Portugal, New Zealand, UK, USA do not report outflows of migrants. All 20 countries reported data for Exports of Goods and Services.

TABLE 3C

Summary statistics, sample for goods exports and services exports using net immigration

Variable	Mean	Std. Dev.	Correlations		
			Goods Exports	Services Exports	Lagged Net Immigration
Goods Exports	5438.9	9773.1	1		
Services Exports	1202.7	1954.1	0.51	1	
Lagged Net Immigration	46.6	97.7	0.16	0.22	1
GDP per Capita	23310.5	4863.2	-0.15	0.02	-0.17

Notes: observations = 115, 1980-2000. Belgium, Japan, and Norway do not report separate data on goods exports and services exports. Several other countries have missing sub-category (i.e., goods versus services) data for the 1980s. Australia, Canada, France, Ireland, Italy, New Zealand, UK, USA do not report outflows of migrants.

TABLE 4

Regressions of services output on lagged total immigration and lagged net immigration

Variable	**Total Immigration**			**Net Immigration**		
	(1)	(2)	(3)	(4)	(5)	(6)
	Total Services	**Other Services**	**Wholesale Services**	**Total Services**	**Other Services**	**Wholesale Services**
Lagged immigration	90.45 (14.33)***	26.48 (4.33)***	63.98 (11.82)***	275.57 (106.95)***	129.36 (45.64)***	146.20 (79.89)*
Guest-worker x lagged immigration	-75.07 (13.63)***	-20.83 (4.24)***	-54.25 (11.35)***	-262.07 (108.36)**	-122.71 (45.60)***	-139.36 (81.33)*
GDP per capita	21.69 (4.31)***	3.11 (1.59)**	18.578 (3.49)***	12.36238 (4.55604)**	2.14651 (1.96949)	10.21587 (3.11907)**
GDP per capita squared	-0.73 (0.18)***	-0.13 (0.06)**	-0.59 (0.15)***	-0.47 (0.17)***	-0.01 (0.07)	-0.39(0.12)***
GW dummy	-1023.61 (2037.62)	-763.57 (728.20	-260.03 (1849.09)	5,574.62 (2,708.96)**	2,119.25 (1,049.09)**	3,455.38 (2,074.40)*
Constant	-4759.07 (2441.53)*	637.62 (652.08)	-5,396.69 (2,050.41)***	-1,416.29 (2,580.26)	391.19 (1,104.56)	-1,807.47 (1,790.70)
R-Squared	0.52	0.40	0.47	0.11	0.11	0.09
Wald statistic	71.56	59.39	59.96	27.95	33.00	22.72
Observations	297	297	297	183	183	183
Countries	18	18	18	12	12	12

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors in parentheses; Immigration is lagged one period (year); Services is calculated as the total of wholesale and retail trade, and other non-financial services; The dependent and GDP per capita variables are first differenced and measured in 1995 US dollars; the coefficient of squared GDP per capita is multiplied by 100.

TABLE 5

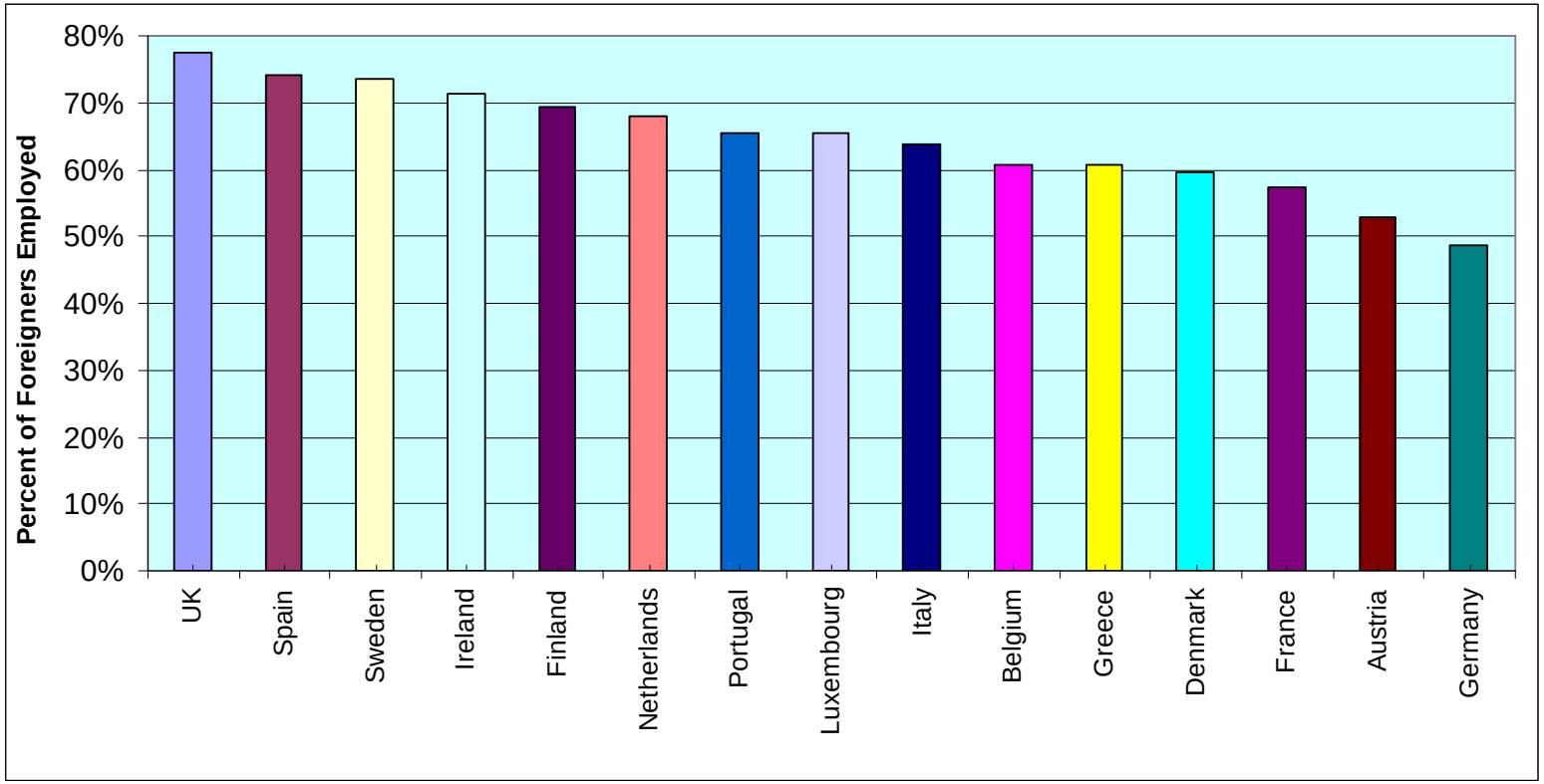
Regressions for exports on lagged total immigration and lagged net immigration

Variable	Total Immigration			Net Immigration		
	(1)	(2)	(3)	(4)	(5)	(6)
	Goods and Services Exports	**Goods Exports**	**Services Exports**	**Goods and Services Exports**	**Goods Exports**	**Services Exports**
Lagged immigration	37.71 (9.41)***	27.63 (7.67)***	9.28 (1.89)***	82.96 (64.56)	78.06 (33.70)***	14.65 (4.37)***
Guest-worker x lagged immigration	-20.40 (9.16)**	-13.94 (7.84)*	-7.43 (2.31)***	-69.68268 (63.16321)	-75.28620 (31.97346)**	-11.60950 (5.89610)**
GDP per capita	16.29 (3.13)***	12.93 (3.31)***	3.02 (0.72)***	12.05 (2.53)***	7.25 (2.25)***	1.56 (0.46)***
GDP per capita squared	-0.63 (0.136)***	-0.52 (0.139)****	-0.10 (0.03)***	-0.48 (0.10)***	-0.27 (0.10)***	-0.04 (0.02)**
GW dummy	2,184.83 (1,243.10)*	2,233.94 (2,050.16)	740.05 (509.42)	7,096.13 (2,010.02)***	10,006.16 (2,813.47)***	1,452.96 (543.07)***
Constant	-4,447.59 (2,869.70)	-4,746.77 (3,419.75)	-760.62 (687.46)	-1,951.70 (2,317.36)	-4,954.71 (3,150.48)	-1,229.39 (650.45)*
R-Squared	0.36	0.32	0.41	0.16	0.22	0.21
Wald Statistic	57.4	41.02	57.16	59.92	189.05	42.28
Observations	325	227	227	204	115	115
Countries	20	16	16	13	10	10

* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: Standard errors in parentheses; Immigration is lagged one period (year); The dependent and GDP per capita variables are first differenced and measured in 1995 US dollars; the coefficient of squared GDP per capita multiplied by 100.

FIGURE 1

Share of non-native workers aged 25 to 54 employed in services, 1995



Source: OECD (2002) Employment by Industry Division

FIGURE 2

Zero profit equilibrium with three goods

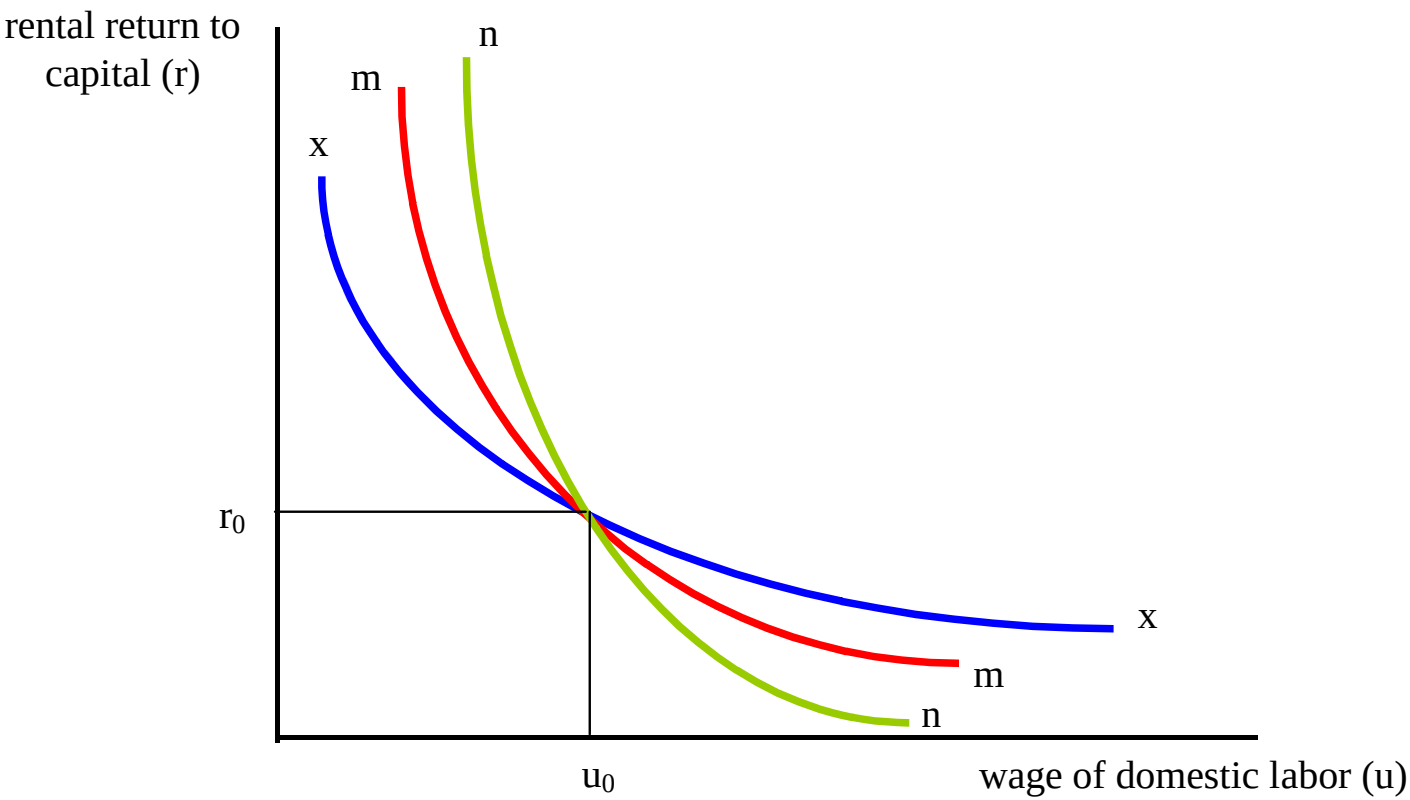
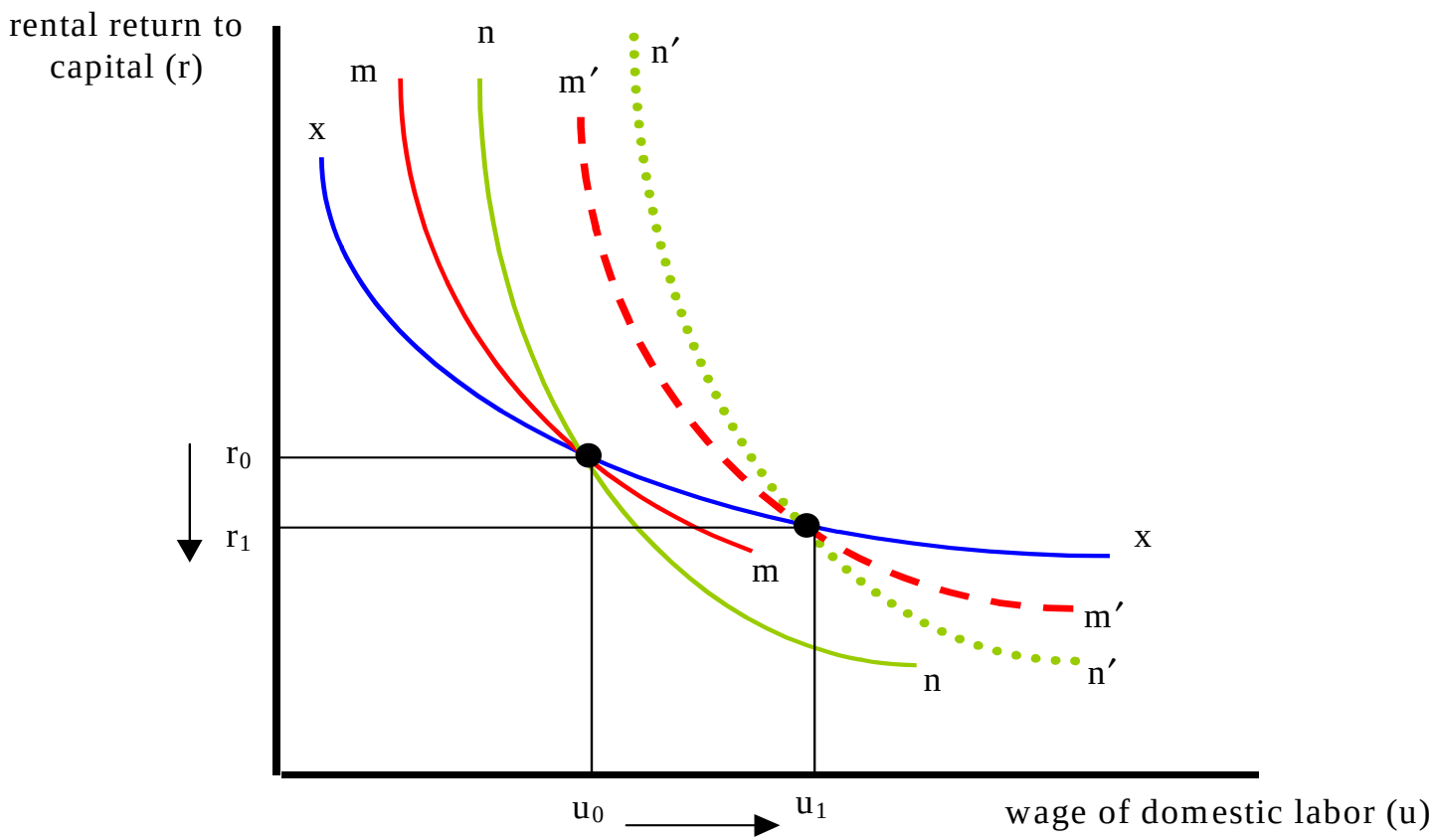


FIGURE 3

Effect of import tariff on factor prices when export production is capital-intensive relative to import-competing production



Endnotes

[i] Borjas (1994, 1995) reviews the economic benefits of immigration.

[ii] Friedberg and Hunt (1995) review studies dealing with wage effects of immigration.

[iii] In this paper, whether trade and international factor movements are substitutes or complements is analyzed in the sense of Markusen (1983): if an inflow of an internationally mobile factor raises (reduces) trade then trade and that factor are complements (substitutes). An alternative definition, first associated with Mundell (1957), concerns the relationship between goods trade, output prices, and factor prices between countries. For a discussion of these alternative definitions see Wong (1986).

[iv] The concentration of foreign workers in services often mirrors the pattern of native worker employment in services, reflecting the increased importance of services in most OECD countries. Regardless, the concentration of foreign workers in services is, by itself, what is relevant here. Moreover, within some service sectors (e.g., domestic household services) the employment of foreign workers is much more concentrated than that of native workers.

[v] Moreover, for many industrial countries, a high fraction of national value added derives from non-traded services sectors. It therefore seems increasingly important that any trade model take account of such activity.

[vi] It is important to note that "immigrant labor" refers here only to those immigrants that are specific to the non-traded goods sector and not to all immigrant (non-native) workers (some of which will be assumed to be identical to native workers).

[vii] This ordering implicitly assumes that immigrant workers are less productive than domestic workers in the non-traded sector, that is, $a_{in} > a_{dn}$. This assumption does not affect the qualitative conclusions derived from the model.

[viii] One could label new immigrants with domestic worker status as "legal" immigrants and those without domestic worker status as "illegal" immigrants. However, one can also think of immigrants with domestic worker status as those who can easily be absorbed into the economy because, for example, they are highly skilled or have a good command of the host nation's language.

[ix] This is like the case of examining only an increase in illegal immigrants, as in Djajic (1997).

[x] This implies that trade and immigration will be substitutes if no domestic workers are employed in the non-traded sector. This follows since the fraction of sector specific workers

in the non-traded sector (s) would then equal unity and hence the condition for substitutability between trade and immigration, $s/(1 - \lambda) \geq 1$, would be satisfied.

[xi] Again, this contrasts with prior work where a substitute relationship is due to the assumption that the internationally mobile factor is intensive in, or specific to, the import-competing sector.

[xii] That production does not change in sectors that employ a specific factor when there is a rise only in the supply of a mobile factor is a feature of all specific factor models. This arises because any attempt to employ additional units of the mobile factor in such sectors is constrained by the unaltered supply of the specific factor. Instead, all output adjustment must takes place in those sectors that employ only mobile factors of production.

[xiii] This suggests that illegal immigration is more likely to increase trade, and legal immigration more likely to reduce trade, since illegal immigrants as less likely to be domestically mobile across sectors.

[xiv] This suggests the possibility that, with internationally mobile capital, this "capital shortage" might be relieved by an inflow of foreign capital. This suggests one channel by which immigration and capital movements could be complementary. If so, it also suggests that trade could be found to be complementary with both immigration and international capital movements, as suggested in Wong (1988).

[xv] Our analysis therefore considers only the Stolper-Samuelson effects implied by our model.

[xvi] Across countries, GDP per capita is also highly correlated with the stock of capital per worker. Hence, GDP per capita can also be seen as a proxy of national capital-labor ratios.

[xvii] As described in the data section to follow, tests detected the presence of first order autocorrelation for both services and exports. Therefore, we correctly need to first difference before estimation.

[xviii] To illustrate, data on recent (legal) immigrants to England indicates that about 10% (= $(1 - \lambda)$) take employment in non-traded service sectors. The data also indicate that the share of immigrants in total service sector employment (s) is 7.8%. These data imply that $s/(1 - \lambda) = 0.078/.1 = 0.78$. Since $s/(1 - \lambda) < 1$, export and import-competing production may rise or fall with immigration. Since England experiences significant illegal immigration the actual fraction of new immigrants who become sector-specific may be much higher – this strengthens the case for a decline in import-competing production and an increase in export production. To say more we would need to know the capital-labor ratio in services and import-competing production, since export production rises when $s_i /(1 - \lambda) < (1- k_n/k_m)$.

Since $s/(1 - \lambda) = 0.78$ we require that $k_n < 0.22k_m$ (i.e., that the services capital-labor ratio needs to be no more than about 1/5 of the import-competing sector's capital-labor ratio) if export production is to rise with immigration.

[xix] Due to some discrepancies, data on the inflows of migrants for the UK for 1990-2000 were double checked with the UK statistical office.

[xx] Given the high social spending in these areas by some countries in the panel, a measure of non-public services would be ideal. Unfortunately, we were limited by data availability.

[xxi] Most countries needed to be rebased from their domestic currency to 1995 US dollars. The exchange rates used were taken from the International Monetary Fund's "International Financial Statistics."

[xxii] In addition, we have already discussed the appropriateness of this transformation with respect to our theoretical model.

[xxiii] All estimations were performed using STATA's "xtpcse" routine with the "pairwise" option enabled.

[xxiv] These same results also held when a time trend was included. For each equation, the time trend was statistically significant. Specific results are available from the authors.

[xxv] Some commentators on earlier versions of our paper questioned how internal migration among EU countries would affect our results. In particular, a high fraction of immigrants to EU countries are EU nationals. Since many intra-EU migrants are, in the terminology of our model, "domestic-status" immigrants, a high fraction of such immigrants would make a substitute relationship between trade and immigration more likely. Therefore, our finding, in the full sample of countries, of a positive relationship between exports and immigration when the data for EU countries includes intra-EU migrants suggests a strong complementary relationship between trade and immigration. Our theoretical model would suggest that a high faction of "domestic-status" immigrants is, other things equal, being offset by a small employment share of sector specific immigrants in non-traded goods sectors.