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Does It Matter Where Immigrants Work? Traded Goods, Non-traded Goods, and Sector Specific Employment

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Traded Goods, Non-traded Goods, and Sector Specific Employment

by

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Abstract

Immigrant employment concentrates in sectors whose output is not internationally traded and many immigrants have low inter-sectoral mobility. We consider these aspects of immigrant employment for the question of how immigration affects a nation's 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 effects of immigration on output and trade depend importantly on the sector and nature of immigrant employment. Empirical investigation of the model's predictions indicates immigration and trade are complements.

JEL classification: C23, D5, F16, F22, J61, O15
Keywords: trade, immigration, non-traded goods, specific factors, panel.

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Does It Matter Where Immigrants Work?

Traded Goods, Non-Traded Goods, and Sector Specific Employment

The effects of immigration on an economy is a topic of continuing importance. While 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 as to cause the EU-15 to block the acceding countries' workers from their markets for up to 7 years. Such fears underscore that the effects of immigration on an economy are not yet fully understood. 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 suggest that understanding the effects of immigration on an economy has both increasing importance and relevance.

Two aspects of immigration have tended to dominate the economics literature: why immigration occurs and its effect on domestic factor prices.[1] The cause of immigration is usually treated as an analysis of the redistribution of labor supply in response to a wage differential.[2] For example, in the well-known Harris-Todaro (1970) model, migration occurs if the wage differential between two areas exceeds the expected costs of migration.[3]

The effect of immigration on domestic factor prices, in particular on the wage of domestic workers, is usually examined as an exogenous increase in the supply of domestic workers. How this increased supply of labor is predicted to affect wages depends on whether one takes a closed or open economy perspective. In the closed economy (partial equilibrium) setting, the common theoretical prediction is that immigration will lower (raise) the prices of factors that are close substitutes (complements) but it can have an ambiguous effect on the prices of factors that are imperfect substitutes. However, in an

open economy (general equilibrium) setting, if goods trade equalizes factor prices between countries then an exogenous increase in labor supply has no effect on factor prices. Instead, the increased supply of labor is absorbed by a change in the allocation of labor across sectors (i.e., the Rybczynksi effect).

While the migration literature has focused on the causes of immigration and its effect on native wages, less emphasis has been given to the effect of immigration on output and trade. In this context, an important question is whether trade and immigration are substitutes or complements. Starting with Mundell (1957), the classic view based on the Heckscher-Ohlin (H-O) model is that trade and international factor flows are substitutes; in the sense that goods trade replaces international factor flows as a means to bring about an equilibrium distribution of production across countries. As long as goods trade narrows any difference in factor prices between countries, trade and factor flows are substitutes. In the limiting case of full factor price equalization between countries, goods trade completely obviates factor price differences as a basis for international factor movements. In this sense, if an exogenous change results in increased trade (e.g., a reduction in trade barriers), and this increase in trade in turn reduces any disparity in factor prices between countries, then goods trade and factor movements are substitutes.

An alternative interpretation for whether trade and factor movements are substitutes or complements considers the impact on trade of an exogenous change that creates a factor inflow into a country (i.e., a reduction in capital taxation). If this factor inflow leads to reduced (increased) trade then trade and the movement of this factor are substitutes (complements). Adopting this interpretation, Markusen (1983) insightfully demonstrates, in the standard H-O framework, that complementarity between trade and international factor movements can arise in the presence of scale economies or various distortions in product or labor markets.[4] However, in all cases, the source of this

complementarity is the assumption that the internationally mobile factor is used intensively in the receiving country's export sector. If this factor were instead intensive in a country's import-competing sector, then a substitute relationship would obtain.

An important feature of the actual pattern of immigrant employment is that many immigrants work in relatively low-skilled service sector occupations (e.g., hotels, restaurants, domestic helpers, etc.) and are thus to a large extent employed in sectors whose output is not internationally traded. For example, the March 2002 Current Population Survey reported that "...19 million of the 135 million employed U.S. workers were foreign-born. Foreign-born workers were significantly less likely to be in managerial and technical occupations, and more likely to be in farming and service occupations. These occupation gaps were most pronounced for foreign-born workers who arrived since 1990."[5] Similarly, the OECD (2004, pp. 55) notes the sector concentration of immigrant employment in 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." Lastly, even sociologists contend that because low-skilled manufacturing jobs have largely evaporated, at least in the US, much of the low-wage job growth has been in areas such as domestic help.[6] 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 is greater than 50% in all countries except Germany.[7]

In addition to immigrant employment being skewed toward sectors that produce non-traded goods, factors such as language barriers, low skill levels, and the often illegal status of immigrants suggests that some immigrants are likely to remain employed in such 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 observed concentration of immigrant employment in services and the low inter-sectoral mobility of some immigrant workers within an economy suggests that one can operationally consider many immigrant workers to be a factor that is specific to an economy's non-traded goods sectors. The implications of this skewed and sector specific nature of some immigrant employment for the effect of immigration on an economy's output and trade has been largely neglected in the literature.

This paper investigates the theoretical implications of the skewed and sector specific nature of some immigrant employment for the output of both non-traded and traded goods, and hence also on trade. We first develop a simple model of a small open economy producing two internationally traded goods and one non-traded good. Domestic labor and capital are mobile across all three sectors. To capture the long-term sector specific nature of some immigrant employment, we assume that when labor migrates to the country, a fraction of new immigrants become specific to the non-traded goods sector; the remaining fraction of new immigrants instead acquire "domestic-worker" status and are therefore mobile across all three sectors. Allowing a given inflow of new immigrants to contain a heterogeneous mixture of workers (i.e., sector specific versus domestically mobile) contrasts with prior work that treats all immigrants the same (even if a distinction is made between immigrants with different skill levels), in terms of both the sectors where immigrants become employed and the nature of that employment. In this respect, our model extends, more generally, prior analyses of international factor movements and their impact on trade.

The focus of our analysis is the effect of immigration on the pattern of output and trade. However, our model also has implications for the effect of output price changes on factor prices and in this regard, we also examine the effect of tariff removal on factor prices. Assuming migration flows respond to international wage differentials, this tariff analysis provides an indication of how immigration would respond to trade liberalization in the framework of our model.

Having developed a theoretical framework that captures both the sector bias and sector specific nature of some immigrant employment, we then empirically examine the model's implications with respect to the effects of immigration on the output of non-traded goods (services) and traded goods (exports) in a panel of OECD countries over the period from 1980 to 2001. Our analysis of exports in relation to immigration is intended to discern empirically whether trade and immigration are substitutes or complements.

I. Pertinent Literature

The theoretical trade literature has long been occupied with the question of whether goods trade and international factor movements are substitutes or complements. General analyses of this question in the context of the H-O model include Ethier and Svensson (1986), Svensson (1984), Markusen and Svensson (1985), and Wong (1986). The overall conclusion from these works is that trade and factor movements can be complements or substitutes, so the issue is largely an empirical question.

In the context of a specific factors framework, the nature of the relationship between goods trade and international factor flows has focused on international capital mobility. In this respect, most analysts adopt the specific factors framework of Jones (1971) in which each sector employs a specific factor along with a domestically mobile factor. A recent example is Neary (1995), who develops a two-country, two-sector, three

factor model (land, labor, and capital) in which capital is internationally mobile but specific to one sector (manufactures). Labor and land are internationally immobile; land is specific to the agriculture sector and labor is domestically mobile across both sectors. As Neary notes, trade and capital flows are substitutes in his model as a consequence of assuming that capital is specific to the import-competing sector. Similarly, trade and factor flows were complements in Markusen's (1983) analysis as a consequence of assuming that the internationally mobile factor was specific to the export sector. Hence, in such models, complementarity or substitutability between trade and factor flows derives solely from the assumption about which traded goods sector (export or import-competing) is intensive in, or exclusively employs, the internationally mobile factor.

The implications of introducing a non-traded sector in a model with an internationally mobile, but sector specific, factor was explored by Jones, Neary, and Ruane (1983).[8] The impetus for their model was to explain the possibility of two-way capital flows between countries. Their model contained two sectors: one producing a tradable good and the other producing a non-traded good. Labor is internationally immobile but domestically mobile between sectors. Capital is internationally mobile but specific to each sector. The return to capital is fixed on world markets. As they note, this assumption implies that capital in their model can be aggregated into a single Hicksian composite factor, and hence that the two types of capital are effectively one homogenous type of capital. Since their model was designed to illustrate conditions under which two-way capital movements could arise, they in no way addressed, not did they intend to address, the question of whether trade and capital flows were substitutes or complements. In addition, 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 renaming 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 complements or substitutes 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 our model will demonstrate, a complement (substitute) relationship can arise not just from assuming 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, complementarity 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.

As will be demonstrated, trade and immigration can be complements in our model even when labor is not the factor used intensively in a country's export sector.[9] This contrasts with prior models that demonstrate complementarity by assuming that the internationally mobile is either intensive in, or specific to, the production of a country's export good (e.g., Markusen (1983)). In this regard, our analysis of immigration flows both complements and extends prior analyses of both labor and capital mobility.

In the specific context of the literature on immigration, our model shares some similarities to Djajic's (1997) intriguing model used to study the effect of illegal immigration on wages. As in our model, his model contains two final goods and one non-traded good. However, his non-traded sector produces an intermediate good whereas our

non-traded sector produces a final good. In addition, he assumes that capital, which is employed in all three sectors, is internationally mobile. The intermediate good is used, along with capital and skilled labor, to produce one of the two final goods. In Djajic's model, illegal migrants are specific to the intermediate good sector while skilled labor is specific to the one sector that uses the intermediate good. Effectively, his model can be thought to have two traded final goods, one of which employs capital, native unskilled labor, sector specific skilled labor and (indirectly) sector specific illegal labor while the other good employs capital and native unskilled labor. While Djajic's focus was the effect of illegal immigration on wages, his analysis did generate results for output changes in response to an increase in illegal migrants. However, he did not indicate which of his two traded final goods is exported, so discerning a complement or substitute effect in his model is problematic. If one assumes that the good which employs skilled labor is exported then his results appear to suggest complementarity between trade and (illegal) immigration. Of course, this conclusion would be reversed if this good were instead assumed to be imported.

In Grether, de Melo, and Muller (2001), a traditional Jones (1971) specification of two traded final goods: a factor specific to each sector, and a single domestically mobile factor, is combined with a median voter model to explore the political economy of immigration in a direct-democracy framework. They thus study alternative factor price outcomes associated with increased immigration under different variants of their basic model. The one variant of potential relevance here is when all immigrants are illegal and one good is non-traded. However, in introducing their non-traded good they retain the two good setup, so that one sector produces a composite traded good, as in Jones, Neary, and Ruane (1983). Capital therefore is assumed specific to each sector with labor mobile between sectors. While they do not address the relation between trade and immigration, it

is of note that they find that increased immigration leaves households better off in the non-traded good variant of their model compared to the model in which both goods are traded, implying that a clear majority of voters would favor additional illegal immigration. This indicates the possible importance of including non-traded goods when studying the effects of immigration.

Empirical investigations of whether trade and international factor movements are complements or substitutes have primarily focused on the Mundell interpretation of this relationship. These therefore investigate whether an increase in trade is associated with a reduction in the 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 of a substitute relationship comes from authors such as Straubhaar (1988) and Molle (2002) who examine data on intra-EU trade and intra-EU labor flows. Straubhaar found a negative correlation between trade and labor movements over the period from 1958 to 1980; a period in which trade barriers among EU countries were sharply reduced. He also observed that for a subset of EU countries fulfilling the H-O criteria (the northern countries), an expansion of goods trade was not accompanied by expanded migration. Similarly, Molle (2001) analyzed intra-EU trade and labor flows over the period 1973-2000 and concluded that migration between EU countries diminished as free trade increased. He termed this the "integration effect," and he argued that there was no evidence of a complementary relationship between trade and factor flows. In fact, he went so far as to suggest that within the EU, not only are goods trade and labor

movements substitutes, but goods trade and capital movements together are a substitute for labor movements. However, these conclusions were not based on any rigorous analysis of the data.

Evidence of a complementary relationship was offered by Cogneau and Tapinos (1995) who examined the relationship between trade and emigration for the specific case of Morocco. Richards (1994), in the context of Latin America, also concluded that trade and immigration are complements. These two studies also incorporated the further reasoning that as a country develops more of its citizens can afford to migrate.[10]

Whereas most empirical analyses have only looked at simple correlations between trade and labor movements, Wong (1988) estimated export and import functions derived from an indirect trade utility function specification for the US economy over the period from 1948-1983. His analysis yielded estimated Rybczynski effects with respect to changes in capital and labor. All estimated effects were positive, indicating that a change in either capital or labor would increase both exports and imports, and hence the volume of US trade. In this sense, his results suggest a complementary relationship between US trade and the international movement of either capital or labor.

Indirect evidence for the Mundell type substitute relationship between trade and immigration comes from work that examines the effect of labor migration on wages. A example is Hanson and Slaughter (1999) who investigate why increases in the supply of foreign-born workers have had minimal impact on the wages of native-born US workers. They examine immigration into U.S. states by adopting a H-O framework that treats individual states as H-O "countries." Arguing that an absence of wage effects may reflect wage equalization across states, they first test for relative factor price equalization by examining if the wages of productivity-equivalent workers are equalized across states. They conclude that relative factor price equalization holds and that, consistent with this

finding, states absorb changes in regional labor endowments, not through changes in wages, but rather through changes in the allocation of employment across sectors. This evidence of a Rybczynksi effect implies that trade and labor flows would be substitutes, at least among US states.

The above review of the literature suggests the following conclusions regarding the relationship between trade and immigration (or more generally, international factor movements). Theoretically, trade and international factor flows can be complements or substitutes. Which of these relationships evidences itself depends largely on which traded goods sector is assumed to use the internationally mobile factor intensively in production. In the case of labor migration, models that consider specific cases such as illegal immigration have 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 therefore seems 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.[11] Given this, 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) $$\frac{a_{kx}}{a_{dx}} > \frac{a_{km}}{a_{dm}} > \frac{a_{kn}}{(a_{dn} + a_{in})}$$

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:

$$(7) \qquad \frac{a_{kx}}{a_{dx}} > \frac{a_{km}}{a_{dm}} > \frac{a_{kn}}{a_{dn}} > \frac{a_{kn}}{a_{in}} > \frac{a_{kn}}{(a_{dn}+a_{in})}.$$ [12]

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 can total differentiate system (4) 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:

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

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 foreign 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.[13] An inflow of "I" new foreign workers will therefore increase the stock of mobile domestic workers by the amount $dV_d = \lambda I$, and increase the stock of sector specific immigrant workers by the amount $dV_i = (1 - \lambda)I$. By inserting these factor supply changes into (8) one obtains the following expressions for the output change in each sector:[14]

$$(9) \qquad \frac{dQ_x}{dV_i} = \frac{(a_{dm}a_{kn}-a_{km}a_{dn})+l(a_{km}a_{in}+a_{km}a_{dn}-a_{dm}a_{kn})}{a_{in}(a_{km}a_{dx}-a_{kx}a_{dm})},$$

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

(11) $$\frac{dQ_n}{dV_i} = \frac{(1-l)(a_{km}a_{dx} - a_{kx}a_{dm})}{a_{in}(a_{km}a_{dx} - a_{kx}a_{dm})} = \frac{(1-l)}{a_{in}}$$

The denominator in expressions (9) and (10) is the determinant of the factor input requirements matrix **A** i.e., $|\mathbf{A}| = a_{in}(a_{km}a_{dx} - a_{kx}a_{dm})$ 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 that 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. Given this, determining the output response in each sector reduces to determining the sign of the numerator in each of the above expressions.

The effect of immigration on the output of the export good is determined by (the negative of) the sign of the numerator in (9), which, after considerable re-arrangement, can be written

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

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. Given this, the sign of (12) depends on the relationship among the terms in square brackets.

First consider the case where $\lambda = 0$, so that all new immigrants become specific to the non-traded sector.[15] In this case, the sign of the numerator in (12) is determined by the sign of the following expression:

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

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 that the import-competing sector (k_m) 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 expression (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 $\left(1-\left(k_n/k_m\right)\right)$ 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 occur the higher is the fraction λ of new immigrants with (mobile) domestic worker status. If λ is sufficiently large, the decline in export sector production arises because the immigration induced increase in the stock of domestic workers requires these workers to be absorbed mainly by the domestic labor intensive import-competing sector.

As the import-competing sector expands, it then 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 can 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 workers contains either a high fraction of workers who will become sector specific (large $(1 - \lambda)$) or that sector specific workers are initially a relatively small fraction of total employment in the non-traded sector (small s). This suggests that countries with relatively small immigrant worker populations are more likely to experience an increase in export sector output due to 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 k_n/k_m, 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 k_n/k_m, 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 $s/(1 - \lambda)$, 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 to still have an increase in production of the export good.

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

$$(14)\quad \begin{cases} \dfrac{dQ_x}{dV_i} < 0 \text{ if } \dfrac{s}{(1-l)} \geq 1 \\ \dfrac{dQ_x}{dV_i} < 0 \text{ if } \dfrac{s}{(1-l)} > \left(1 - \dfrac{k_n}{k_m}\right) \\ \dfrac{dQ_x}{dV_i} > 0 \text{ if } \dfrac{s}{(1-l)} < \left(1 - \dfrac{k_n}{k_m}\right). \end{cases}$$

When $l = 0$, then

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

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

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

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 ($1 - \lambda$), as well as the relationship between the capital-labor ratios in the non-traded and export sectors.

We consider first the case for which the inflow of new foreign workers consists entirely of sector specific workers (i.e., $\lambda = 0$). 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 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 $\lambda = 0$, 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 $\lambda = 0$). Hence, when all new immigrants become specific to the non-traded sector, *immigration and trade are complements*. It is important to note that this complementary relationship arises in our model without assuming, as does prior literature, that the internationally mobile factor is used intensively in the export sector (e.g., Markusen (1983)).

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 $s/(1 - \lambda) \geq 1$.[16]

We note that 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.[17] 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 specific) of employment of each type of migrant when considering the effects of immigration on an economy.

If instead $s/(1 - \lambda) < 1$ then, like the case of 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 share 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 is 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

$$(18) \quad \begin{cases} \dfrac{dQ_m}{dV_i} > 0 \text{ if } \dfrac{s}{(1-l)} \geq 1 \\ \dfrac{dQ_m}{dV_i} > 0 \text{ if } \dfrac{s}{(1-l)} > \left(1 - \dfrac{k_n}{k_x}\right) \\ \dfrac{dQ_m}{dV_i} < 0 \text{ if } \dfrac{s}{(1-l)} < \left(1 - \dfrac{k_n}{k_x}\right). \end{cases}$$

When $\lambda = 0$, then

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

The effect of immigration on production of the non-traded good is clear from (11), namely, production of the non-traded rises so long as the new inflow of 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.[18] The output response in the non-traded sector can therefore be summarized as:

(20) $\frac{dQ_n}{dV_i} > 0$ if $(1 - l) > 0$ 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 this output expansion in the non-traded sector comes at the expense of a reduction in output in the export sector or the import-competing sector depends on the share of sector specific immigrants in the new wave of immigration versus the existing employment share of sector specific immigrants in the non-traded sector. As we have found, the higher is the share of sector specific workers in the new wave of immigrants, and the lower is the employment share of existing 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.[19]

Lastly, we have found that production in the export and import-competing sectors can either rise or fall when $s/(1 - \lambda) < 1$. While 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.[20] 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

In this section, we briefly consider 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 that country. An assumption of this analysis is that migration flows respond to international wage differentials. Given this, 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.[21] 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 immigration.

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:

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

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.

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

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.

Now consider the effect of imposing a 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 Figure 3. Since the price of exports is fixed on world markets (small country assumption), the xx curve is also fixed. 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 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 raises the return to capital and the wage of sector specific immigrant workers but lowers 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 type workers to immigrate but lower the incentive to immigrate for workers who would have domestic worker status. 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 immigrant workers 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 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 workers and lower the wage of sector specific immigrant workers, and hence increase the incentive for sector specific type of worker to *emigrate*.

The preceding results suggest that, if comparative advantages follow 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 workers. Conversely, a labor

abundant country that alone pursues freer trade in goods would experience an outflow of sector specific type workers and an inflow of domestic workers. The case in which both capital and labor abundant countries liberalize is problematic in the context of the present model since one country's domestic type workers may become the other country's sector specific type worker. Clearly, 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 the non-traded sector. As we found, the higher is the fraction of immigrants that become sector specific, the more likely is immigration to increase exports and to reduce import-competing production, and therefore, to 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 immigrants are 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 characteristics of new immigrants and the share of 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.[22] 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 two countries (Germany and Switzerland) that have "guest worker" programs. Such programs may direct a large fraction of immigrant employment into traded goods sectors and, by definition, skews the mix of immigrants toward those who will have, in the terminology of our theoretical model, "domestic-worker" status. 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 takes the form :

$$(23) \quad Y_{it} = \beta_0 + \beta_1 GW \cdot \beta_2 \cdot Immigration_{it-1} + \beta_3 \cdot (GW \cdot Immigration_{it-1}) + \beta_4 \cdot GDP\ per\ capita_{it} + \beta_5 \cdot (GDP\ per\ capita_{it})^2 + \varepsilon_{it.}$$

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·Immigration" 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 Rybcznyksi effect associated with a change in a country's *stock* of workers. This suggests that an 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. [23]

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 involves a loss in degrees of freedom. Second, we suspect that, like 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 the inflow of migrants 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 exports, we use specification (23) to examine total exports of goods and services as well as the two components of this variable - exports of goods and exports of services. Our theoretical model indicates that the relationship between exports and immigration depends on the fraction of new immigrants that become sector specific versus the share of sector specific immigrants already working in the non-traded services sector, as well as the relative use of capital and labor in the export and import-competing sectors.[24] The higher is the share of new immigrants who will work in the non-traded sector, the more likely is there to be a positive relationship between exports and immigration. We note that our expectation of a positive relationship between exports and

immigration applies primarily to exports of goods. Our theoretical results do not have clear implications for traded services, and hence the sign of the coefficient on lagged immigration for services exports could be positive or negative.

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."

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)). The migration data refer to permanent flows and therefore exclude tourists, etc. For the time period studied, data were available in various years for fourteen OECD countries: Australia, Belgium, Canada, Denmark, France, Germany, Japan, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, the UK, and the US. Australia, Canada, France, 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.[25] 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.[26]

Since we have panel data, we test for group and time interaction effects. In addition, we perform standard tests for cross-sectional correlation, serial correlation in the panel, and groupwise 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.[27] Tests for groupwise 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 are limited in our choice of corrective estimation techniques. We therefore use the Prais-Winsten transformation to obtain panel-corrected standard errors to account for groupwise heteroscedasticity. We further specify that the covariance matrix is calculated using all available information.[28]

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 0.54; the correlation between the annual change in goods and services exports and lagged immigration is 0.44. 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 significant at least at the 5% level 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 the level of immigration.

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. The coefficient on this interaction variable when net immigration is used (columns 4-6 in Table 4) 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 type 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.

As expected, the coefficient on per capita GDP is positive 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

The results of estimating (23) for each of the three categories of exports are reported in Table 5. The coefficient on immigration is positive and highly significant in all cases except for Exports of Goods and Services when net immigration is used as the immigration variable. As noted earlier, out primary interest is the results for goods exports, and in this respect the results are again consistent with the predictions of our model: exports of goods are positively and significantly associated with higher levels of immigration.

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 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 dependent variable: the hypothesis that the sum of the coefficients is negative was rejected for both goods exports and for exports of goods and services. For services exports, the hypothesis could be rejected only at the 12% level. The difference in results for the two measures of the level 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. This finding is consistent with the predictions of our theoretical model.

For the exports regressions, the coefficient on per capita GDP is positive and highly significant in all cases. In addition, in all cases the coefficient on squared GDP per capita is negative and highly significant. Like the case for services output, this indicates a non-linear relationship with respect to changes in exports: changes in GDP per capita have an increasing but diminishing marginal effect on the growth of exports.

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 (services). Second, some immigrants face significant and persistent barriers to mobility across sectors within their host country.[29] 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, does have important implications for the effects of immigration on output 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 share of sector specific immigrants among new immigrants, and the lower the employment share of existing 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 lead to increased trade. Therefore, the higher is the fraction of new immigrants that become employed in the non-traded sector, the more likely are trade and immigration to be

complements. One policy implication of this relationship is that countries for whom 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 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 capital abundant countries, a movement toward freer

trade in goods creates an incentive to immigrate only for 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 some possible extensions, of our model. First, it is a simple matter to reinterpret the immigrants who become sector specific as low-skilled workers and those who have domestic-worker status as high-skilled. Doing so allows one to then interpret our findings in this context. In line with this theme, one could also re-label capital in our model to be high-skilled labor, so that exports are skilled-labor intensive. This extension would admit a richer analysis of the impact of immigration since any given inflow of migrants could then contain both high-skilled and low-skilled workers, where the latter would also be a mixture of sector specific low-skilled workers and domestic-status low-skilled workers. Since high-skilled labor is intensive in the export sector, the possibility of a complementary relationship between trade and immigration may then 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.

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.

Endnotes

[1] Welfare effects of immigration have also been considered (e.g., Srinivasan (1983)). See Borjas (1994, 1995) for a review of the economic benefits of immigration.

[2] For an overview of theories relating to international migration, see Massey, et al. (1993). For a summary of the wage effects of immigration see Friedberg and Hunt (1995).

[3] Harris and Todaro (1970) model rural to urban migration in which a wage differential is the main incentive for migration. However, their model also takes into account characteristics of both rural and the urban sector labor markets and hence much of the literature based on their model also considers the role of unemployment in urban areas. The Harris-Todaro model has been successful empirically and is often the basis for considering wage differentials and labor market characteristics as key determinants of migration both within and between countries.

[4] The distinction between the Mundell (1957) and Markusen (1983) interpretation of when trade and factor flows are substitutes or complements seems important in an empirical context. The Markusen view asks whether an increased inflow of a factor raises or reduces trade. Empirically, this suggests models that relate trade flows to factor flows. The Mundell view asks whether increases in goods trade move factor prices toward equality. Empirically, this suggests models that relate factor price differences to trade flows.

[5] Migration News, http://migration.ucdavis.edu/mn/comments.php?id=2698_0_10_0

[6] New York Times, May 6, 2004. "4-Hour Trek Across New York for 4 Hours of Work, and $28."

[7] 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.

[8] A number of studies examine the welfare implications of tariffs, etc, in models with non-traded goods and internationally mobile factors (e.g., Michael (1992). However, none of these studies address the issue of whether trade and factor flows are substitutes or complements.

[9] In this paper, whether trade and immigration are substitutes or complements is analyzed in the sense of Markusen (1983): if immigration raises (reduces) trade then trade and immigration are complements (substitutes).

[10] A large body of literature examines the effect of a country's stage of development on migration decisions (e.g., Fiani and Venturini (1993)). In the migration literature, Hatton and Williamson (2002) identify economic and demographic fundamentals leading to migration. Schiff (1996) contends that whether trade and migration are substitutes or complements depends fundamentally on migration costs, credit constraints and the potential income in the receiving country. These income and incentive effects for migration are outside the scope of our model.

[11] The term "immigrant labor" refers to those prior immigrants that became specific to the non-traded good sector.

[12] 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 reached.

[13] 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.

[14] Without loss of generality we assume I = 1.

[15] This is like the case of examining only an increase in illegal immigrants, as in Djajic (1995).

[16] 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, $s/(1 - \lambda) \geq 1$, is satisfied.

[17] 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.

[18] 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.

[19] 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.

[20] This suggests the possibility that, with internationally mobile capital, this "capital shortage" might be relieved by an inflow of foreign capital which 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).

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

[22] 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.

[23] As described in the data section, tests detect the presence of AR1correlation for both services and exports. Therefore, we correctly need to first difference before estimation.

[24] To illustrate, data on recent (legal) immigrants to England indicates that about 10% (= (1 - λ)) take employment in non-traded service sectors. The data also indicate that the share of immigrants in total service sector employment is 7.8%. These data imply that $s/(1-\lambda) = .078/.1 = 0.78$. Since $s_i/(1-\lambda) < 1$, export and import-competing production may rise or fall with immigration. Since England experiences significant illegal immigration the actual fraction of new immigrants that take sector-specific employment could be much higher – which 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 $s/(1-l) < (1 - k_n/k_m)$. Since $s/(1-\lambda) = 0.78$ we require that $k_n < 0.22\ k_m$ (i.e., the services capital-labor ratio would need to be less than about 1/5 the capital-labor ratio in the import-competing sector) if export production is to rise with immigration.

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

[26] 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."

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

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

[29] The persistence of such immobility suggests that, unlike past analyses of models that involve a sector specific factor, a separate short-run versus long-run analysis of our model is unwarranted (e.g., Neary 1979).

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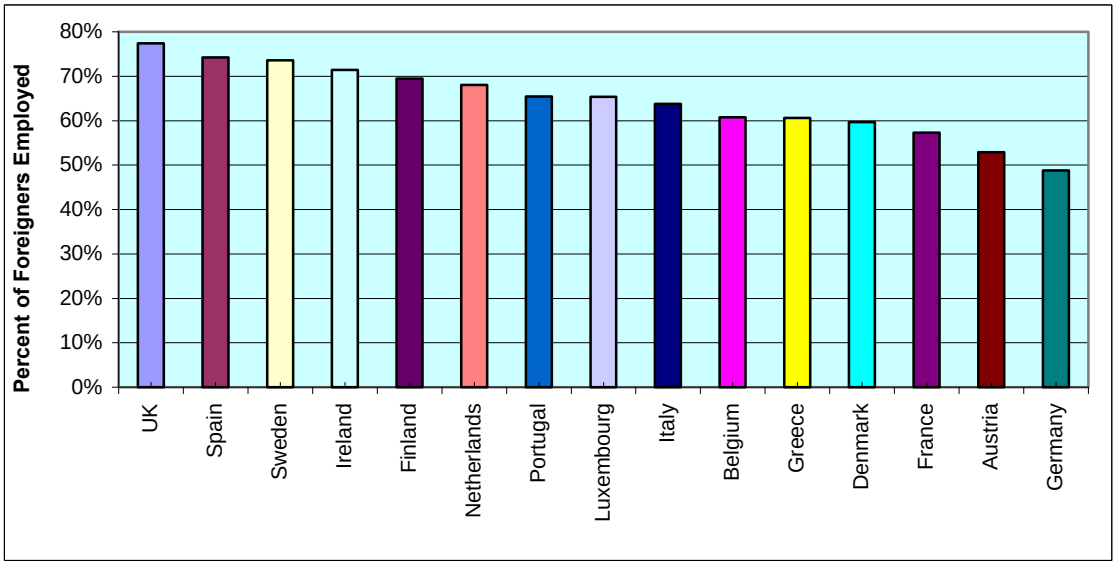
Figure 1. Share of foreigner workers aged 25 to 54 employed in services, 1995



Source: OECD (2002) Employment by Industry Division

Figure 2. Zero Profit Equilibrium With Three Goods

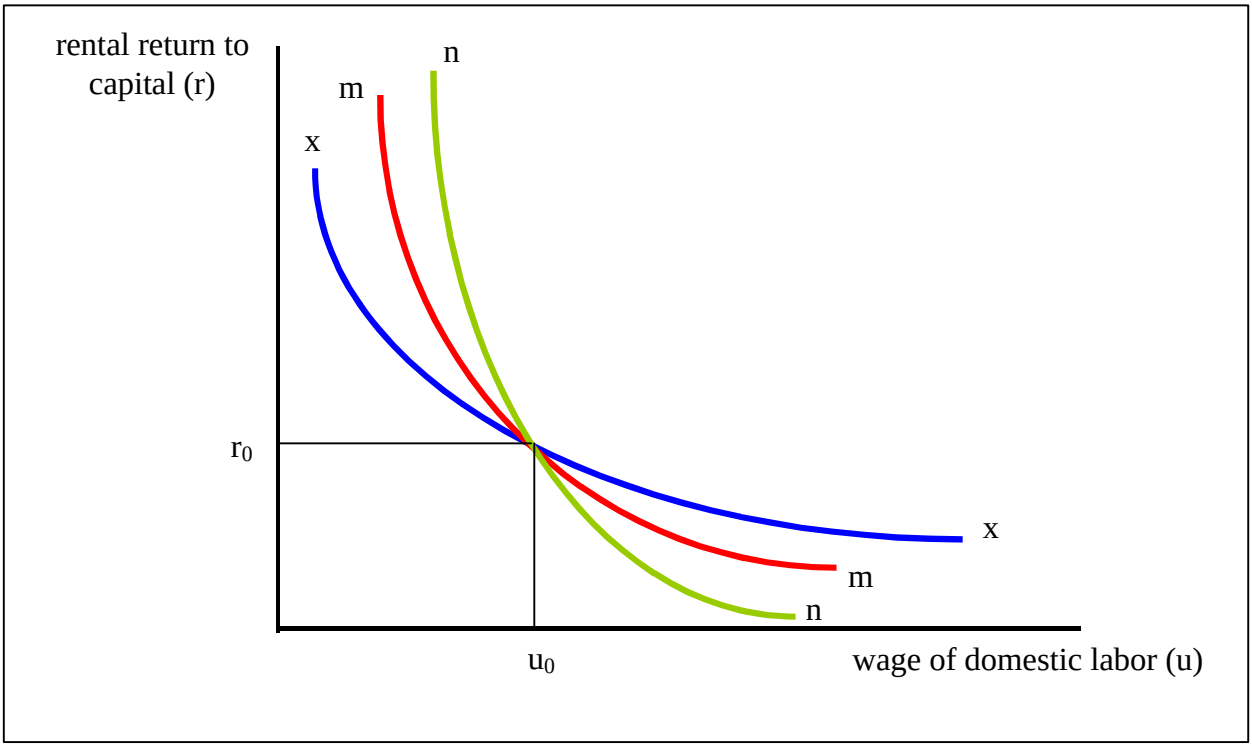


Figure 3. Effect of Import Tariff on Factor Prices When Export Production is Capital-Intensive Relative to Import-Competing Production

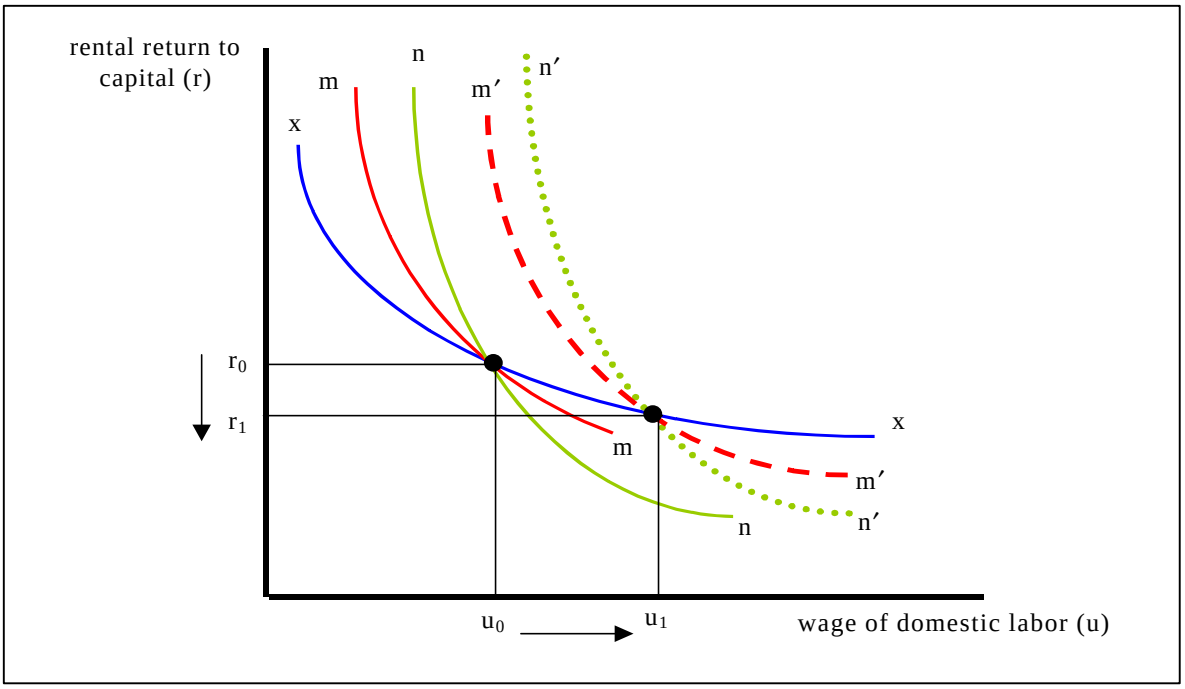


Table 1. Stock of immigrants as a percent of total population, 1986 and 2000

	1986	2000	Average Annual Percent Change
France	6.18	5.39	-1.0%
Belgium	8.65	8.41	-0.2%
Netherlands	3.90	4.19	0.5%
Sweden	4.67	5.38	1.0%
Canada	15.4	17.4	1.3%
Switzerland	14.54	19.27	2.0%
UK	3.20	4.33	2.2%
Luxembourg	26.41	37.56	2.5%
Germany	5.81	8.88	3.1%
Norway	2.62	4.10	3.3%
Japan	0.71	1.33	4.6%
Denmark	2.51	4.84	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 for 1997.

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

Table 2a. Summary statistics, sample for services output using total immigration

Variable	Mean	Std. Dev.	Total Services	Other Services	Wholesale Services	Lagged Immigration
Total Services	14927.0	29521.2	1			
Other Services	5436.6	9826.8	0.80	1		
Wholesale Services	9490.4	22442.4	0.96	0.61	1	
Lagged Immigration	185.3	274.2	0.54	0.51	0.48	1
GDP per Capita	21526.6	4286.5	0.23	0.11	0.24	0.17

observations = 249, 1980-2000, Switzerland, who does not report services, is excluded.

Table 2b. Summary statistics, sample for exports of goods and services using total immigration

Variable	Mean	Std. Dev.	Goods and Services Exports	Lagged Immigration
Goods and Services Exports	8965.5	15767.8	1	
Lagged Immigration	177.6	265.3	0.44	1
GDP per Capita	21816.6	4265.6	0.13	0.14

observations = 269, 1980-2000, All 14 countries are included.

Table 2c. Summary statistics, sample for goods exports and services exports using total immigration

Variable	Mean	Std. Dev.	Goods Exports	Services Exports	Lagged Immigration
Goods Exports	8396.7	14322.5	1		
Services Exports	2212.7	3913.3	0.74	1	
Lagged Immigration	221.9	305.5	0.40	0.48	1
GDP per Capita	22318.3	4629.7	0.11	0.19	0.11

observations = 183, 1980-2000, Belgium, Japan, and Norway do not report the sub-categories for exports of goods and services and are therefore excluded.

Table 3a. Summary statistics, sample for services output using net immigration

Variable	Mean	Std. Dev.	Total Services	Other Services	Wholesale Services	Lagged Net Immigration
Total Services	9478.3	19774.3	1			
Other Services	4198.1	8741.7	0.80	1		
Wholesale Services	5280.0	13758.7	0.93	0.52	1	
Lagged Net Immigration	41.6	86.7	0.11	0.12	0.08	1
GDP per Capita	498.5	504.5	0.06	-0.03	0.10	-0.13

observations = 159, 1980-2000, Australia, Canada, France, UK, USA do not report outflows of migrants. Switzerland does not report services.

Table 3b. Summary statistics, sample for exports of goods and services using net immigration

Variable	Mean	Std. Dev.	Goods and Services Exports	Lagged Net Immigration
Goods and Services Exports	6453.6	11492.8	1	
Lagged Net Immigration	39.2	82.0	0.16	1
GDP per Capita	465.3	507.5	0.17	-0.11

observations = 179, 1980-2000, Australia, Canada, France, UK, USA do not report outflows of migrants. All 14 countries reporting Exports of Goods and Services.

Table 3c. Summary statistics, sample for goods exports and services exports using net immigration

Variable	Mean	Std. Dev.	Goods Exports	Services Exports	Lagged Net Immigration
Goods Exports	5967.6	10788.5	1		
Services Exports	1380.0	2242.5	0.45	1	
Lagged Net Immigration	57.2	108.8	0.15	0.25	1
GDP per Capita	519.0	609.8	0.03	0.17	-0.14

observations = 93, 1980-2000. Belgium, Japan, and Norway do not report the sub-categories for goods exports and services exports. Several other countries have missing sub-category data for the 1980s. Australia, Canada, France, UK, USA do not report outflows of migrants.

Table 4. Services output regressions for 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	87.79 [14.96]***	26.73 [4.56]***	61.07 [12.23]***	158.07 [70.50]**	72.19 [24.00]***	85.88 [50.10]*
Guest-worker x lagged immigration	-75.63 [15.22]***	-22.71 [4.89]***	-52.92 [12.52]***	-147.63 [70.63]**	-66.96 [24.38]***	-80.67 [50.42]
GDP per capita	25.12 [4.95]***	4.03 [1.93]**	21.08 [3.97]***	14.78 [5.81]**	2.55 [2.76]	12.24 [3.88]***
GDP per capita squared	-0.86 [0.21]***	-0.16 [0.07]**	-0.68 [0.17]***	-0.61 [0.22]***	-0.13 [0.10]	-0.48 [0.15]***
GW dummy	1,415.95 [3,086.48]	511.80 [1,149.54]	904.15 [2,902.10]	4,757.90 [2,004.49]**	1,652.96 [837.87]**	3,104.95 [1,693.04]*
Constant	-5,342.20 [2,786.16]*	499.31 [790.56]	-5,842.15 [2,308.21]**	739.38 [2,148.20]	1,619.32 [1,001.43] **	-879.94 [1,454.47]
R-Squared	0.51	0.39	0.44	0.09	0.06	0.08
Wald statistic	58.07	59.64	54.16	29.78	30.34	28.26
Observations	249	249	249	159	159	159
Countries	13	13	13	10	10	10

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

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

Table 5. Export regressions for lagged total immigration and lagged net immigration

Variable	Total Immigration			Net Immigration		
	(1)	(2)	(3)	(4)	(5)	(6)
	Goods & Services Exports	**Goods Exports**	**Services Exports**	**Goods & Services Exports**	**Goods Exports**	**Services Exports**
Lagged immigration	33.38 [8.78]***	23.33 [7.20]***	8.85 [1.92]***	81.02 [56.23]	81.10 [40.69]**	26.46 [6.72]***
Guest-worker x lagged immigration	-17.88 [9.27]*	-14.58 [8.02]*	-7.22 [2.54]***	-69.92 [58.01]	-82.37 [43.44]*	-23.51 [7.77]***
GDP per capita	18.39 [3.46]***	15.26 [3.73]***	3.46 [0.85]***	15.05 [2.53]***	10.61 [2.94]***	2.24 [0.69]***
GDP per capita squared	-0.69 [0.14]***	-0.59 [0.15]***	-0.11 [0.03]***	-0.57 [0.10]***	-0.39 [0.10]***	-0.06 [0.03]**
GW dummy	2,190.42 [1,628.13]	4,258.06 [2,511.56]*	690.59 [719.22]	7,373.93 [2,197.74]***	11,085.20 [3,512.54]***	1,570.46 [591.43]***
Constant	-1,518.81 [1,262.37]	-496.79 [1,514.52]	-342.80 [358.33]	-1,348.82 [1,376.19]	-2,421.07 [2,601.72]	-600.07 [363.67]*
R-Squared	0.34	0.29	0.40	0.19	0.23	0.26
Wald Statistic	51.39	32.68	48.54	49.75	35	42.68
Observations	269	183	183	179	93	93
Countries	14	11	11	11	8	8

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

Notes: Standard errors in brackets.
Immigration is lagged one period (year).
Dependent and GDP per capita variables are first differenced and measured in 1995 US dollars.
Coefficient of squared GDP per capita multiplied by 100.

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