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Wang-Sheng Lee

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Wang-Sheng Lee*
Melbourne Institute of Applied Economic and Social Research
The University of Melbourne

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Melbourne Institute of Applied Economic and Social Research
The University of Melbourne
Victoria 3010 Australia
Telephone **(03) 8344 2100**
Fax **(03) 8344 2111**
Email **melb-inst@unimelb.edu.au**
WWW Address **http://www.melbourneinstitute.com**

Abstract:

This paper shows how some simple modifications to the classical Heckscher-Ohlin model in international trade can be made so that it can be used to analyse the impact of immigration on wages. In particular, this is accomplished by constructing a model in which countries have very different endowments of factors, reside in different diversification cones and specialise in production. In such a model, it is not necessary that factor prices are equalised across countries. Based on simulation results of this modified Heckscher-Ohlin model, it is found that the actual immigrant flow in the U.S. from 1979 to 1995 is unlikely to be a major contributor to the observed high-skill/low-skill wage gap increase over the period.

Key Words: Immigration, Heckscher-Ohlin, multi-cone, general equilibrium.

1. Introduction

The aim of this paper is to suggest a framework for examining the effect of immigration on wages in an open economy setting that considers both demand- and supply-side effects. Specifically, the question that is addressed is whether immigration has helped to widen the wage gap between native high-skilled and native low-skilled workers. Almost all research to date has used one of two methodologies: the 'labour' approach or the 'trade' approach. As highlighted by Slaughter (1999) and Gaston and Nelson (2000), a key difference between the basic labour model and the basic trade model is dimensionability. The labour approach assumes a single output sector whereas the trade approach assumes multiple output sectors.

Building on Gaston and Nelson (2000), who contend that the trade approach is more useful as a presumption for an evaluation of immigration policy, and Ottaviano and Peri (2006), who argue that the effects of immigration on wages are most appropriately measured in a general equilibrium framework, this paper uses an open economy general equilibrium trade model framework to examine the effect of immigration on wages. A key feature of the trade framework utilised in this paper is that it does not make the potentially restrictive assumption of factor price equalisation (FPE). For analysing the effects of immigration, a need to relax the FPE assumption had been stressed by Friedberg and Hunt (1995) in a survey article over ten years ago:

> "A model of trade and factor flows that captures many realistic features is one in which countries have very different endowments of factors, and factor price equalization might not occur even with free trade; rather, countries will specialize in production, instead of each producing all goods. Thus, countries with a large labor endowment will produce a more labor-intensive mix of goods than countries with a large capital endowment. The resulting cross-country differences in wages could then generate migration" (p. 29)

To date, however, no studies of the effects of immigration on wages have been based on an open economy model with features such as those described above.

Much of the accumulated knowledge economists have on the effects of immigration on wages are based on empirical labour studies. Despite more than two decades of empirical investigations, an unambiguous consensus view of the effects of immigration in the U.S. has not emerged. An ongoing debate is about whether the U.S. should be considered as a single national labour market or as many segmented local labour markets. Based on analyses of employment changes at the national-level which is often referred to as the "aggregate factor proportions" approach, researchers have found a negative impact of immigration on native wages, in particular, the wages of workers with less education (e.g., Borjas, Freeman and Katz 1997; Borjas 2003; Borjas and Katz 2005). This viewpoint emphasizes that immigration greatly increases the labour supply of low-skilled workers and significantly decreases their

relative wages. On the other hand, based on analysing local labour markets which are characterised by large variations in the share of immigrants (the "spatial correlations" approach), other researchers have found no evidence of any negative effect of immigration on the wages of less-educated native-born workers (e.g., Card and Dinardo 2000; Card 2001).

This paper makes no attempt to resolve this debate about the appropriate level of analysis in a labour theoretic framework. Instead, the focus is on contrasting the single output model used by labour economists with the multiple sector output model used by trade economists. The next section compares and contrasts the theoretical effects of immigration on wages in a single output model and a multiple output Heckscher-Ohlin (H-O) framework. Section 3 describes in detail how the textbook H-O model can be modified to accommodate the analysis of the effects of immigration. More specifically, in a 2 country, 3 goods and 2 factors (low-skilled and high-skilled labour) setting, it is assumed that countries reside in different diversification cones, specialise in production and that FPE does not hold. Section 4 describes simulation results of an experiment based on the modified H-O model where there is a lump sum shift in labour endowments from one country to the other. The results suggest that the actual immigrant flow in the U.S. from 1979 to 1995 is unlikely to be a major contributor to the observed high-skill/low-skill wage gap increase over the period. The final section concludes.

2. Theory

According to economic theory, the impact of immigration depends primarily on the type of model used (Friedberg and Hunt 1995; Dustmann et al. 2005). In this section, we discuss three alternative frameworks for analysing the effects of immigration – the basic labour framework, the basic trade framework based on the standard H-O model, and a multi-cone H-O model – and their corresponding implications. By assuming a single output sector and a closed economy, the basic labour framework assumes no flexibility in the output mix and no mechanism for international trade of the goods and services produced. By contrast, trade models that allow changes in the mix of output produced and openness to trade will have smaller wage effects if there are adjustments in the output mix as a response to increases in labour supply.[1]

The basic labour framework used to analyse the effects of immigration on wages is illustrated in Figure 1, where L denotes low-skilled labour, H high-skilled labour, and (H, L) the initial endowment. Given perfect competition in all markets, full employment and cost

[1] The Rybczynski effect occurs when an increase in the supply of a factor leads to an increase in the output of the commodity using that factor intensively and a decrease in the output of the other commodity.

minimisation by firms, the equilibrium relative wage $\omega = \frac{w_H}{w_L}$ is given by the slope of the line tangent to the unit-value isoquant. When immigration of low-skilled labour occurs, shifting endowments from (*H*, *L*) to (*H*, *L*'), this results in a fall in w_L and a fall in ω. Assuming that the price of the final good is fixed, this translates to a real increase in the wage w_H and a real decrease in the wage w_L. In such a partial equilibrium framework, changes in the skill mix of labour due to immigration are reflected entirely through a change in relative factor prices.

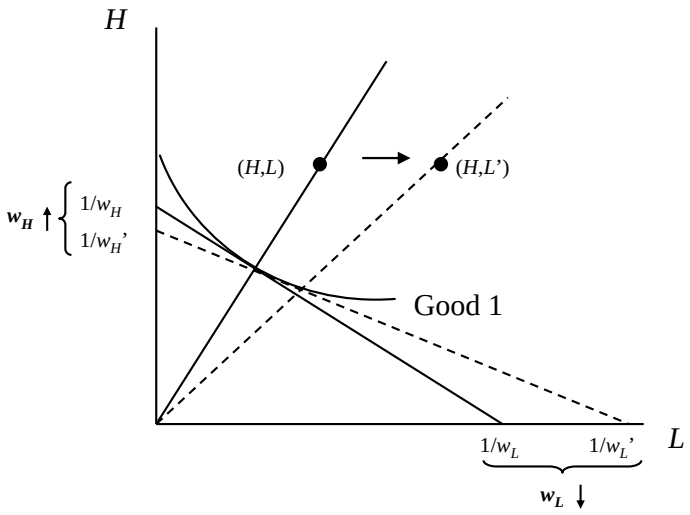
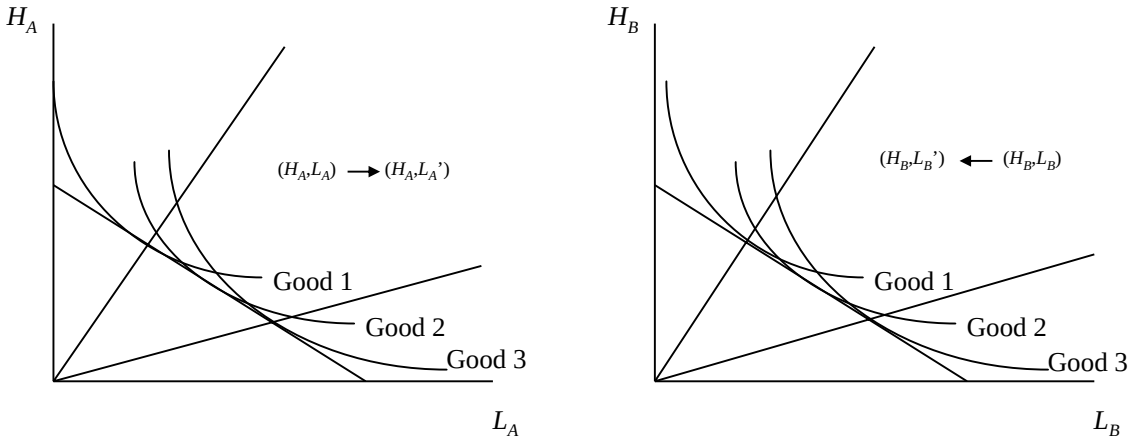


Figure 1: The Effects of Migration of Low-Skilled Labour in a One Sector Model

A basic trade framework for analysing the effects of immigration on wages is the H-O model, one of the major models used in trade analysis. Trefler (1998) discusses alternative trade frameworks for analysing the effects of immigration based on the Ricardian model and trade models with increasing returns to scale, while more recently, Dasgupta and Osang (2007) employ a multisector specific factors model to analyse the effects of changes in relative labour endowments on the skill premium. In the H-O model, assuming that FPE occurs, immigration is predicted to *not* have any effects on factor prices. This is depicted in Figure 2 with the aid of two Lerner-Pearce diagrams side by side that illustrate a 2 country, 3 goods and 2 factors framework (where (H_A, L_A) and (H_B, L_B) denote the initial endowments in the two regions A and B). Relative wages in each region are given by the line tangent to the three unit-value isoquants. Under the assumptions that both regions produce all three goods and that the production functions in both regions are identical, when low-skilled migration occurs, if trade equalises commodity prices so that both regions have identical unit-value isoquants, and if endowments of both regions are not too dissimilar from each other (i.e. within the same cone of diversification), nothing happens to factor prices in both regions in

the long run.[2] The adjustment in an open economy model with FPE may be thought of as occurring through the labour embodied in traded goods. Immigration will cause the host country to compensate by exporting more (or importing less) labour as embodied in goods.



Region A Region B

Figure 2: The Effects of Migration of Low-Skilled Labour from Region B To Region A in a Single-Cone Model

By modifying the traditional one-cone H-O model and constructing a model in which countries have very different endowments of factors, specialise in production and in which FPE does not hold, it is shown in this paper that the H-O open economy model can be made more realistic and capable of estimating the effects of immigration on wages.[3] In particular, by assuming a two country world with two factors of production – low-skilled and high-skilled labour – and a lateral transfer of endowments from one country to the other, the resulting change in relative wages between low-skilled and high-skilled labour can be used to provide an estimate of the effects of immigration.

The multi-cone Lerner-Pearce diagram in Figure 3, in which the diagrams for Regions A and B from Figure 2 have been combined and collapsed into one figure, illustrates the modification to the conventional single-cone H-O model. The question of interest is what happens to relative wages when there is migration of labour from the less developed region to the more developed region. In this case, FPE fails to hold as a change in factor endowments

[2] The corollary to factor price equalization, the factor price insensitivity theorem (Leamer and Levinsohn 1995), is another way to state matters. The theorem states that within a country, factor prices are altogether insensitive to changes in factor supplies holding product prices fixed as long as factor endowments remain in the original cone of diversification.

[3] Pervasive skill-biased technological change (i.e., occurring simultaneously in many countries) is another way the H-O model can be modified to induce a change in relative factor prices. See Berman, Bound and Machin (1998).

changes world outputs, which changes product prices, which causes factor prices to change (in terms of Figure 3, product price changes cause the unit-value isoquants to shift, causing the tangent lines, which are relative wages, to shift).

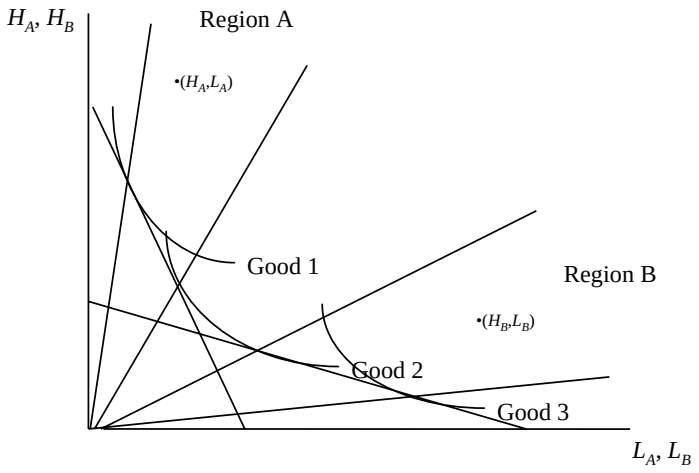


Figure 3: The Effects of Migration of Labour from Region B
To Region A in a Multi-Cone Model

Multi-cone models have sporadically been mentioned in the international trade literature as an extension to the single-cone H-O model. Recently, there has been a growing recognition among trade economists that the assumption that all countries lie within a single cone of diversification can be very restrictive. In the context of analysing the effects of trade on wages, Slaughter (1998) highlights the possibility of modifying the one-cone H-O model to allow some role for factor supplies. Leamer (1987) was the first to provide solid evidence that one reason for the failure of FPE was the fact that there are multiple cones of diversification. Schott (2003) and Debaere and Demiroglu (2003) confirm that country endowments in the world are so different that it is unlikely that all countries of the world can produce a similar set of goods and lie within the same cone of diversification. Within the framework of the H-O model, this observation has important implications. Because of the very different factor endowments between developed and developing countries, it implies that trade cannot equalise factor prices worldwide.

3. A Two Region Multi-Cone Open Economy Model

Suppose that the world economy consists of two regions, developed and less developed, and produces three goods. Region A, the developed region, is relatively more abundant in high-skilled workers, and produces goods 1 and 2. Region B, the less developed

region, is relatively more abundant in low-skilled workers, and produces goods 2 and 3.[4] Since the focus of this analysis is on labour market developments, a strategic simplification is made by assuming that the only productive inputs are high-skilled and low-skilled labour.[5] The main reason for doing this is that the distribution of income between capital and labour has neither changed a lot nor been a major source of controversy in the last few decades.[6] The share of labour compensation in U.S. national income, for example, has barely changed, rising from 73 to 74 percent between 1973 and 1993.

We begin the specification of the multi-cone H-O model by considering the commodity markets. Let P_{ij} be the domestic price of good *i* in region *j* (for *j* = A, B; *i* = 1, 2 for Region A and *i* = 2, 3 for Region B), C_{ij} be the consumption of good *i* in region *j*, and Y_j be income in region *j*. Since the focus of the general equilibrium model in this paper is on the production side, consumption is neutralised by assuming that both regions have identical tastes and the same Cobb-Douglas utility functions:

$$U_j = U = \prod_{i=1}^{3} C_i^{\alpha_i} \tag{1}$$

Assuming utility maximisation and that $\alpha_i = \frac{1}{3}$, the demand function for each good is given by:

$$C_{ij} = \frac{Y_j}{3P_{ij}} \tag{2}$$

Production is also assumed to be based on a Cobb-Douglas functional form. Such a functional form has been widely used in the growth literature in macroeconomics.[7] In order to represent the different high-skill/low-skill factor mix employed in production, the parameters of the production function for each good

$$X_{ij} = L_{ij}^{\delta_{ij}} H_{ij}^{(1-\delta_{ij})} \tag{3}$$

are allowed to vary by sector and region, where *i* = 1, 2 for Region A and *i* = 2, 3 for Region B. Assuming constant returns to scale, it is not possible to derive supply functions. Instead,

[4] Goods here refer to an aggregate bundle of goods. This assumption certainly seems more realistic than assuming that all countries produce goods in every industry. Although different countries have many basic industries in common, there are many specialised industries that are unique to developed and undeveloped countries.

[5] We follow Davis (1998) and Krugman (1995, 2000) in making this simplification. Ideally we would work with three or more factors, but to do so would obscure the important issues discussed later in the paper.

[6] The long-term stability of factor shares for many poor and rich countries is often considered one of the "stylised facts" of growth (Kaldor 1961).

[7] Jones (2005) provides microfoundations for using this standard production function as a building block in macro-type economic models.

unit price equations $P_{ij} = r_j h_{ij} + w_j l_{ij}$ are derived for each firm, where *r* is the price of high-skilled labour *H* and *w* is the price of low-skilled labour *L* . The unit factor requirements h_{ij} for H are therefore given by

$$h_{ij} = \left[\left(\frac{\delta_{ij}}{1-\delta_{ij}} \right) \left(\frac{w_j}{r_j} \right) \right]^{1-\delta_{ij}} \tag{4}$$

and the unit factor requirements l_{ij} for *L* are given by

$$l_{ij} = \left[\left(\frac{1-\delta_{ij}}{\delta_{ij}} \right) \left(\frac{r_j}{w_j} \right) \right]^{\delta_{ij}} \tag{5}$$

In order for market clearing of goods to occur, consumption of each good in each region must equal the sum of its domestic production and net imports. Region A does not produce good 3 and must import it in order to consume it. Similarly, Region B does not produce good 1 and needs trade to make its consumption feasible. It is assumed that factor market clearing occurs, where the supply of each type of labour must equal each region's endowment of it.

We assume a one-consumer economy (one for each region), where the consumer is not only the supplier of the factor services, but also receives the profits of the firms (which are zero). The consumer's income in each region is:

$$Y_j = r_j \sum_i H_{ij} + w_j \sum_i L_{ij} \tag{6}$$

In the open economy, there are two sets of prices, world prices (P_{wi}) and domestic prices (P_{ij}), which are linked by an exchange rate (F_j) for each region. The relationship, assuming no barriers to trade or taxes, is $P_{ij} = F_j P_{wi}$. Since total expenditure on imports must equal total earnings from exports in equilibrium, the balance of payments constraints for each region is given by

$$\sum_{i=1}^{3} P_{wi} NX_{ij} = 0 \tag{7}$$

where NX_{ij} are net exports. Similarly, since the imports of Region A must equal the exports of Region B, and vice versa, the following equations

$$\sum_{j=A}^{B} NX_{1j} = 0 \,, \; \sum_{j=A}^{B} NX_{2j} = 0 \text{ and } \sum_{j=A}^{B} NX_{3j} = 0 \tag{8}$$

close the model.[8]

[8] When completely specified, the general equilibrium system consists of 23 endogenous variables for each region and 3 endogenous variables for the world, giving a total of 49 endogenous variables.

3.1 Model Implications

Recall that the Rybcyznski theorem relates changes in endowments to changes in the pattern of production. Specifically, for a 2 country, 2 goods and 2 factors world, if relative commodity prices are constant and if both commodities continue to be produced, an increase in the supply of a factor will lead to an increase in the output of the commodity using that factor intensively and a decrease in the output of the other commodity. In the context of Figure 3, if the immigration flow of low-skilled labour into Region A from Region B is small, the Rybcyznski effect should hold within cones. In this case, the implications of a two-cone model would be the same as for a one-cone equilibrium since any single country can lie only in a single cone at any one time. With an increase in low-skilled labour in Region A, there will be an increase in the output of its low-skilled intensive good (good 2) and a contraction in output in its high-skilled intensive good (good 1).

However, if Region A accumulates enough low-skilled labour, it will pass out of its diversification cone, specialise for a time in producing only good 2, then enter then diversification cone of Region B where it begins to produce good 3 as well. With a further increase in low-skilled labour, output of good 2 will fall because it is now the more skill-intensive of the two that it produces. In other words, the two-cone model predicts that as a region absorbs more low-skilled immigration, its mix of outputs will change, with production of some goods first increasing and then decreasing over time as it passes through different cones of diversification.

While it would be informative to be able to sign the direction of relative wage effects in response to immigration in the two-cone model, such a general result appears difficult to obtain. In the classical H-O model, when the Rybcyznski theorem is proved, product prices are assumed to be exogenous. However, in a general equilibrium model like the one specified in this section, all prices are endogenously determined. In the context of a H-O model, Cheng, Sachs and Yang (2000) conjecture that when all prices are allowed to be endogenously determined, the relationship between factor endowments, outputs and commodity prices can be quite arbitrary. They show that the general applicability of the Stolper-Samuelson theorem does not always hold and confirm the Sonnenschein-Mantel-Debreu theorem that "anything goes." Their findings cast doubt on a general applicability of Stolper-Samuelson and Rybcyznski type effects derived from the classical H-O model for analysing the effects of trade and immigration on wages.[9]

[9] Sonnenshein (1973), Mantel (1974) and Debreu (1974) had shown that without explicit model specifications, no unambiguous comparative-statics results can be derived from a general equilibrium model except that Walras's law holds.

4. An Empirical Application

This section uses the multi-cone model developed in the previous section to perform a comparative-statics exercise on the effects of immigration on relative wages. So far, the model has been defined in terms of dividing the world into a developed region and a less developed region. The majority of the literature on immigration has, however, focused on the effect of immigration on the U.S. economy. In order to make our results comparable with other estimates in the literature, let us suppose that the world consist only of two economies: Region A is the U.S. and Region B is the less developed Latin America/Caribbean countries from which many low-skilled workers migrants to the U.S. originate from.[10] Formulated in such a way, if plausible parameter and endowment values are available, the model can be calibrated to assess the role that immigration has played on the growing high-skill/low-skill wage disparity in the U.S. by performing numerical simulations.[11]

In order to get an estimate of the impact of low-skilled migration on wages, the following experiment was conducted. Assume that migrants and natives are perfect substitutes within skill groups but not between groups. Further assuming that the working population of the world is held constant and that the size of the populations in both regions are the same, we simulated the effects of reducing labour supply in Region B by x percentage points and increasing labour supply in Region A by the same x percentage points.[12] This attempts to mimic real world immigration flows.[13] Since absolute price levels cannot be determined in a general equilibrium model, in order to solve our system of equations, Walras' Law was applied and the exchange rate in Region A, F_A, was chosen as the numeraire.

4.1 Skill Classification

Before proceeding with simulations of the computational general equilibrium model, it is necessary to define what constitutes "high-skilled" and "low-skilled" labour, employ some plausible parameters for the initial share of high-skilled and low-skilled labour in the labour force, as well as parameters for high-skilled and low-skilled labour's share of labour income.

[10] According to the 1990 U.S. Census, almost half of post-1980 immigrants to the U.S. hail from Central or South America (including Mexico and the Caribbean).

[11] Davis (1998) considers the effect of immigration on unemployment in a similar 2 country world. His main analysis involves a model of world trade between a flexible wage U.S. and a minimum wage Europe and assumes that FPE holds. However, he also indicates that amendments to the H-O framework, such as the multi-cone approach employed in this paper, can be valuable extensions.

[12] Barro and Lee (2001) estimate that the total population age 15 and over in Latin America and the Caribbean in 1990 was 270 million, while the U.S. Census Bureau estimates that the total population age 15 and over in the U.S. in 1990 was 195 million. The populations of the two regions are therefore approximately nearly of equal size. For analytic convenience, they are assumed to be equal.

[13] As the model specified in section 2 assumes that Region A always produces goods 1 and 2, while Region B always produces goods 2 and 3, it will not be valid for simulating a *large* migration of low-skilled labour from one region to the next as each region would transition to a different diversification cone. This would lead to a different mix of goods being produced by each region.

As there is considerable variation in the literature in how economists define high-skilled and low-skilled workers, two alternative definitions of skill levels are employed in this paper based on different cutoffs for years of education.[14]

First, high-skilled workers are defined as those having at least a high school education and low-skilled workers as high school dropouts.[15] Using this definition of identifying skill level, the initial share of high-skilled labour in the labour force for Region A was chosen to be 88 percent, a percentage based on the 1990 U.S. Census and given in Appendix 1 in Autor, Katz and Krueger (1998). For Region B, educational attainment data on developing countries in 1990 from Table 3 in Barro and Lee (2001) was utilised and it was assumed the initial share of high-skilled labour in the labour force was 16 percent. The top panel of Table 1 shows the corresponding parameters chosen for the production function in Region A, the developed region, which are based on wage-bill shares given in Appendix 1 in Autor, Katz and Krueger (1998). They estimate that low-skilled workers (high school dropouts) accounted for only 8 percent of the total wage bill in 1990. Since the model requires that the wage-bill share be broken down by sector, we extrapolate from this figure and assume that high-skilled labour's share of income in producing good 1 is 95 percent and 80 percent in the less skill intensive product good 2. Further assuming that the technology used in producing good 2 is the same across regions (i.e. they share the same isoquant, as depicted in Figure 3), it follows that the production function used in producing good 2 for both regions has to share the same parameters.[16] Finally, high-skilled labour's share in income in sector 3 for Region B, the less developed region, has to be less than 80 percent based on our use of the Cobb-Douglas functional form, and it has been chosen it to be 20 percent arbitrarily.[17]

Second, an alternative definition based on classifying all persons who have completed primary schooling as high-skilled and those who have no education or only some primary education as low-skilled was employed.[18] Based on using this definition of skill, the share of high-skilled labour in Region A is chosen to be 95 percent while the share of high-skilled labour in Region B is chosen to be 41 percent.[19] The corresponding wage-bill shares for each of the goods are given in the bottom panel of Table 1. They have been chosen to be consistent

[14] Lawrence and Slaughter (1993) and Sachs and Shatz (1994) identify non-production workers as high-skilled and production workers as low-skilled but we prefer not to use such an occupational-based approach as education is arguably the most important determinant of one's skill level.
[15] This definition was employed, for example, in Borjas, Freeman and Katz (1997) and Ciccone and Peri (2005).
[16] Although both regions produce good 2 using the same production function, they use a different mix of inputs. Region A uses a more skill-intensive technique than Region B due to its different factor prices.
[17] In Region B, sector 2 uses relatively more skilled labor than sector 3 in production. This implies that when the wage ratio is at an equilibrium in Region B, skilled labor's share of income in sector 2 has to be greater than skilled labor's share of income in sector 3.
[18] This definition was the preference of Caselli and Coleman (2006).
[19] These figures are based on Barro and Lee's (2001) educational attainment estimates for the U.S. (Table 7) and for Latin America/Caribbean Countries (Table 3) respectively.

with the parameters in the top panel (i.e., a larger endowment implies a larger wage-bill share).

Table 1: Parameters of the Production Function

	Sector 1		Sector 2		Sector 3	
	High-Skilled Labour (δ_{1A})	Low-Skilled Labour	High-Skilled Labour (δ_{2A}, δ_{2B})	Low-Skilled Labour	High-Skilled Labour (δ_{3B})	Low-Skilled Labour
High-Skilled = at least high school						
Region A	0.95	0.05	0.80	0.20		
Region B			0.80	0.20	0.20	0.80
High-Skilled = at least completed primary school						
Region A	0.97	0.03	0.85	0.15		
Region B			0.85	0.15	0.50	0.50

Notes: In the top panel, high-skilled labour is defined as having at least a high school education while low-skilled labour consists of high school dropouts. In the bottom panel, high-skilled labour is defined as having at least completed primary school while low-skilled labour consists of no education or some primary.

4.2 A Simulated Immigrant Supply Shock

In order to carry out our simulations, an estimate of the immigrant supply shock to the U.S. is needed. The 1995 U.S. Current Population Survey implies that immigrants account for about a 5.5 percent increase in full-time equivalent labour supply in the U.S. from 1979-1995 and that the fraction of high-skilled immigrants is 0.68.[20] In other words, the increase in labour supply due to high-skilled immigrants over that time period is 3.7 percent and the increase due to low-skilled immigrants is 1.8 percent.

Table 2 illustrates the impact on Region A's real wages (i.e., nominal wages deflated by the Laspeyres price index).[21] Using the first definition of skill level, immigration of 5.5 percent (of which the fraction of high-skilled immigrants is 0.68) from Region B to Region A leads to an increase in high-skilled worker's wages by 0.7 percent and a decrease of 4.8 percent in low-skilled worker's wages in Region A (Table 2, column 1).[22] Using the second definition of skill level, immigration of 5.5 percent from Region B to Region A leads to an increase in high-skilled worker's wages by 2.1 percent and a decrease of 17.4 percent in low-skilled worker's wages in Region A (Table 2, column 2). However, as we use an alternative definition of high-skilled labour in column 2, to be consistent, we should also use a higher

[20] Both these statistics are reported in Borjas, Freeman and Katz (1997), who use the "at least high school education" definition for skilled labour.

[21] Numerical approaches for non-linear problems can be used to provide numerical solutions for the system of equations in section 3. The generalised reduced gradient algorithm is employed for the computations in this paper.

[22] Although impacts on Region B's wages are also available, we do not report them since the literature generally focuses on the effect of immigration on the developed country's wages. Note that due to the huge disparity in initial endowments, each region remains in its original cone and the patterns of specialisation before and after migration remain the same.

fraction of "high-skilled" immigrants when simulating the labour supply shock. This is done in column 3, where it is assumed that the fraction of high-skilled immigrants is 0.75. In this case, comparing columns 2 and 3, the increase in skill worker's wages is not as large (1.5% vs. 2.1%) and the decrease in low-skilled worker's wages is also of a smaller magnitude (12.3% vs. 17.4%). Under either definition of skilled labour, the 5.5 percent increase in immigrants also causes a slight increase in income, which suggests that the overall effects of immigration have been beneficial, despite some redistributive effects.

Table 2: Effects of Immigration from Region B to Region A on Region A

	High-Skilled = at least high school	High-Skilled = at least completed primary school	High-Skilled = at least completed primary school
	(1)	(2)	(3)
Percent Change in			
Real High-Skilled Wage	0.7	2.1	1.5
Real Low-Skilled Wage	-4.8	- 17.4	-12.3
Relative Real Wages	5.7	23.6	15.8
Real Income	5.4	6.5	6.4

Notes: In columns 1 and 2, the simulated immigration shock is 5.5 percent of which 3.7 percent comprises of high-skilled migrants and 1.8 percent comprises of low-skilled migrants (i.e. the fraction of high-skilled migrants is 0.68). In column 3, the simulated immigration shock is 5.5 percent of which 4.1 percent comprises of high-skilled migrants and 1.4 percent comprises of low-skilled migrants (i.e. the fraction of high-skilled migrants is 0.75).

4.3 Discussion

The 1980s and early 1990s can be characterised as a period of rising inequality of earnings. The rise in the skill premium since the late 1970s has been well documented by labour economists. Either way the data is sliced, it appears that the least educated or least skilled workers were the ones that experienced the largest declines in real wages. For example, in 1979, male college educated workers earned on average 30 percent more than male high school educated workers. By 1995, this premium had risen to 70 percent. The overall wage distribution reveals a similar picture of rising inequality. Between 1979 and 1994, the ratio of earnings of a male worker at the 90th percentile of the wage distribution compared with one at the 50th percentile rose from 1.73 to 2.04. At the same time, the earnings of that median male worker rose from 1.84 to 2.13 times the earnings of a worker at the 10th percentile of the wage distribution.[23] Various explanations have been offered and elaborated in detail elsewhere, among them trade and immigration (Borjas, Freeman and Katz 1997), the decrease in the relative supply of college workers (Katz and Murphy 1992) and skill-biased technological change (e.g., Bound and Johnson 1992; Autor, Katz and Krueger 1998).

[23] These statistics are from the 1997 *Economic Report of the President.*

When the “no education or some primary” group of low-skilled workers is used as a basis for comparison, our simulations suggests that real wages of low-skilled workers decrease by 12 percent. This provides support to the viewpoint that immigration adversely affects the least educated natives. On the other hand, when the “at least high school education” definition of high-skilled labour is used, the definition more commonly adopted in the immigration literature, our estimate of -4.8 percent for the real wage effect on low-skilled workers is similar to the findings in Borjas, Freeman and Katz (1997, Table 19), who estimate that the adverse effect of immigration on U.S. native workers with less than a high school education is -4.6 percent. Our simulations suggests that immigration causes a larger decrease in low-skilled wages when the “completed primary education” definition of high-skilled labour is used than when the “at least high school education” definition of high-skilled labour is used. Thus, the size of the simulated high-skill/low-skill wage gap as a result of immigration partly depends on how the comparison is made.

Our simulated results based on a two-tier level definition of skill are consistent with U.S. data on relative wage trends broken down by four educational levels (dropouts, high school, some college and college) in the 1980s. For example, Bound and Johnson (1992) document that real wages for dropouts fell the most and rose the fastest for the college educated during the 1980s. As a result, any relative wage comparisons over time that involves dropouts in the denominator would appear larger relative to a comparison that, say, involves dropouts and high school graduates combined in the denominator.

5. Conclusion

This paper takes a “global” approach to analysing the impacts of immigration on wages, in which the cross-country structure of labour demand, production and prices of goods are endogenous. It is based on the premise that a meaningful exploration of immigration and wages requires a clear understanding and treatment of the general equilibrium mechanisms at play. By making some simple modifications to the H-O model, still a workhorse in international trade analysis, it was shown how the impact of immigration on wages can be analysed. In particular, instead of making the standard assumptions that countries do not specialise in production and that they all lie within a single cone of diversification, it was assumed that country specialisation in production occurs and that countries with very different endowments lie in different diversification cones so that factor price equalization does not obtain. Although highly stylised, the multi-cone H-O model takes us well beyond what traditional trade theory tells us about the effects of immigration.

In an attempt to simulate the effects of immigration on wages in the U.S., based on using a high-skilled/low-skilled dichotomy commonly adopted in this literature, it was found

that a 5.5 percent increase in the labour force due to immigration, an approximation based on the actual immigrant flow in the U.S. from 1979 to 1995, caused the high-skill/low-skill wage differential to increase by about 6 percent. As this is a fraction of the actual observed wage gap increase over the period, it suggests that increased immigration is unlikely to be a major contributor to the observed high-skill/low-skill wage gap increase over the period. However, an alternative high-skilled/low-skilled dichotomy that isolates the least educated in the workforce finds that there can be relatively larger adverse effects. This provides support to the view that immigration could have negative impacts on the least-skilled workers. Although the explanatory power of economic models are model-structure specific, functional-form specific and parameter-value specific, by making realistic assumptions and choosing reasonable functional forms and parameter values for our exercise in comparative-statics, it is arguable that these results provide an informative depiction of the effects of immigration on relative wages in a general equilibrium setting.

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