UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

**WORKING PAPERS IN ECONOMICS**

**No 464**

# Wage Effects of Labor Migration with International Capital Mobility

**Joakim Ruist**
**Arne Bigsten**

**August 2010**

**ISSN 1403-2473 (print)**
**ISSN 1403-2465 (online)**

Department of Economics
School of Business, Economics and Law at University of Gothenburg
Vasagatan 1, PO Box 640, SE 405 30 Göteborg, Sweden
+46 31 786 0000, +46 31 786 1326 (fax)
www.handels.gu.se  info@handels.gu.se

# Wage Effects of Labor Migration with International Capital Mobility*

by

Joakim Ruist and Arne Bigsten
Department of Economics
University of Gothenburg

*Corresponding author*: Arne Bigsten, Department of Economics, University of Gothenburg, Box 640, SE 405 30 Gothenburg, Sweden; email:
arne.bigsten@economics.gu.se;
Tfn: +46-31-7861358;
Fax:+46-31-7861326

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## Abstract

Wage effects of immigration are investigated in a setting with international capital mobility, which eliminates two-thirds of the native wage-effects of immigration. Without international capital mobility, overall gains from migration in the immigration region are only a small fraction of total losses to native workers, but with perfect international capital adjustment, overall gains are larger than total losses to native workers. Two alternative tax policies to eliminate the negative wage-effects of immigration on low skilled native workers are evaluated.

**Keywords**: International labor migration, wage effects

**JEL-code**: F21, J61

***We are grateful for comments from Giovanni Peri, Per Lundborg, Lennart Hjalmarsson, Lennart Flood, Ola Olsson, Sven Tengstam and Rick Wicks. All remaining errors are our own responsibility.

# 1. Introduction

One of the most contentious issues in the public debate in industrialized countries is the impact of immigration from less-developed countries, in particular, potential negative effects on native wages. Consequently - though they officially support measures to improve the living standards of people in the poorer parts of the world[1] - all industrialized countries have restrictions on immigration. How valid is the concern about the impact on native wages? We estimate the effects of immigration from low-income countries on native wages in North America and Europe.

Basic theory predicts that immigration of labor, by increasing the supply of labor, causes native wages to fall, at least in the short term. Models by Borjas (1995, 2003) do not allow any international capital mobility, while Ottaviano and Peri (2008) allow sluggish adjustment of capital stocks. We extend the analysis by considering how results are affected by the introduction of perfect international capital adjustment to migration.

We calibrate a model with CES production functions for six world regions, allowing labor to migrate (at an exogenously given rate) and regional capital stocks to respond in order to equalize capital returns across regions. Allowing for international capital adjustment is found to diminish the estimated negative impact on native wages substantially and to increase the efficiency gains from immigration. Regions not directly involved in the migration are found to lose out, since they lose capital. Finally, two policy proposals to redistribute income in order to leave native low skilled workers' wages unaffected by immigration are evaluated.

[1] For example, Clemens (2010) argues that rich countries should consider its immigration policy to be part of its international development policy.

We address three questions: What are the wage effects of migration in the immigration country with international capital adjustment? What are the effects in the rest of the world? Could one design policies to leave native low-skilled workers' wages unaffected by immigration? Section 2 reviews literature on migration and wages and provides the rationale for the analysis with perfect capital adjustment. Section 3 then describes the model and the data used. Section 4 presents the results in the immigration region, while Section 5 presents the results in the emigration region and the rest of the world. Section 6 evaluates the feasibility of policies to eliminate the effect on native low-skilled workers' wages. Section 7 summarizes and draws conclusions.

## 2. Theoretical background

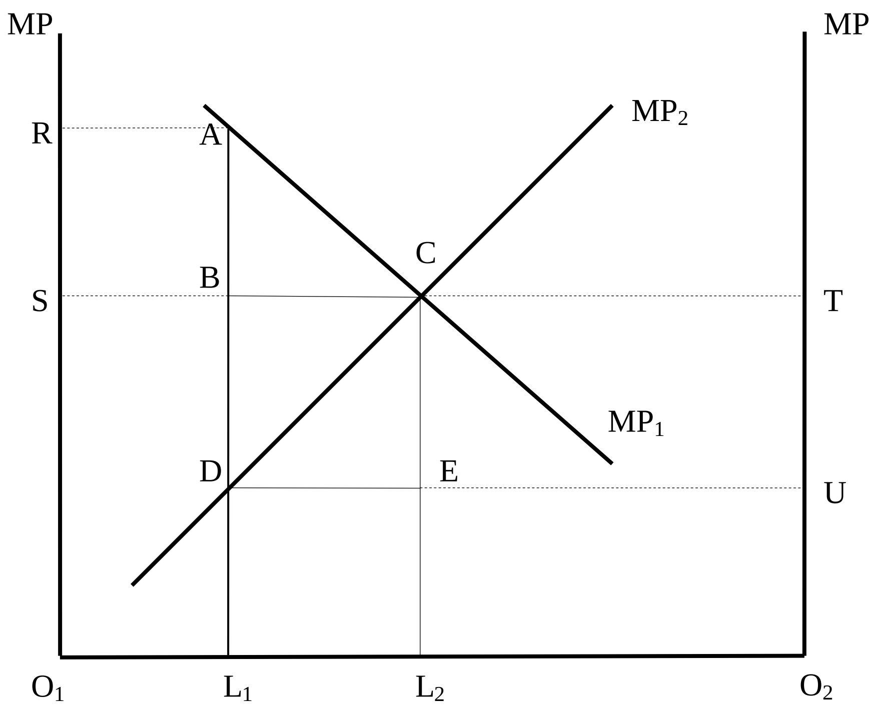
We first present a basic model of output- and wage-effects of labor migration, and the "immigrant surplus" (Borjas, 1995). We then make the case for analyzing these effects under the assumption of perfect international capital adjustment to migration.

### 2.1 A Simple Model

Figure 1 provides a standard textbook treatment of international migration (Bhagwati et al. 1998) between countries 1 and 2. The total labor-endowment is $O_1O_2$ with initial distribution marked by $L_1$; so the labor endowment in country 1 is $O_1L_1$ and the endowment in country 2 is $O_2L_1$. Labor is paid its marginal product, and factors of production other than labor are immobile. The curve $MP_1$ is drawn from the left and gives the marginal product of labor in country 1 as a function of the labor endowment in country 1. The curve $MP_2$ is drawn from the right and gives the same information for country 2. The areas beneath the relevant parts of the curves represent total output in each country. As labor is unequally distributed, its marginal product is higher in country

1. If restrictions on migration were removed, $L_1L_2$ workers would migrate until labor distribution $L_2$ was achieved and wages were equalized at point C. The global gain from this would be the area ACD. The gain to the migrants would be the area BCED. The gain to the immigration country (net of wages paid to the immigrants) would be ABC.

**Figure 1. A model of international migration**




Gains and losses to countries do not refer to their workers. For example, in the country that "gains", the wage falls by AB, so that the native workers together lose RABS. The wage in the country that "loses" increases by BD and the workers that stay behind in the emigration country together gain CEUT. So native workers in the immigration country lose, and workers in the emigration country gain. Obviously, the gains to other factors of production in country 1 are RACS, and losses in country 2 are CDUT.

So if the immigration country gains from migration, why do high-income countries restrict immigration? One important reason can be seen from comparing the areas ABC (gains to the immigration country) and RABS (losses to native workers). Since the distance $O_1L_1$ (native workers) is large relative to $L_1L_2$ (migrants), RABS must be a lot bigger than ABC. Losses to native workers are thus larger than the total gains to the country. Those gains accrue to other factors, notably capital owners. Total gains to the immigration country thus mask a redistribution of income from labor to capital.

Borjas (1995) refers to the area ABC as “immigrant surplus”, estimating its size in the US to be merely one nineteenth of the area RABS. This makes it reasonable to focus discussion of the economic effects of immigration on the redistribution it causes, rather than on total gains. Borjas’ estimate is based on an elasticity of wages with regard to labor supply of -0.3 taken from Hamermesh (1993), combined with an assumption of inelastic capital supply.

**2.2 Introducing International Capital Mobility**

In the theoretical model just outlined capital is fixed, but clearly there is international capital mobility. In most of the world formal controls on capital movements have gradually been relaxed. The integration of global capital markets has meant that there has been convergence of capital returns across countries. Obstfeld (1995, p. 255) notes that the approximation of free capital mobility “has become better and better in recent years, but scope for greater financial integration clearly remains”. We further note that Wood (1994) argues that capital can no longer be the basis for comparative advantage, since global capital markets are completely integrated.

Boyer, Hatton and O'Rourke (1993) analyze the wage effects of emigration from Ireland and Hatton and Williamson (1998) wage convergence due to migration from Britain to the US 1850-1910, assuming perfect international capital adjustment to migration. Allowing for capital adjustment reduces the wage effect of emigration in Ireland by 62-68%, in Britain by 46%, and in the US by 73-74%. There are wage effects also when capital is mobile, when land is included as an important factor of production.[2]

In a study of US immigration 1990-2006, Ottaviano and Peri (2008) treat immigration as a shock and assume that following immigration, capital gradually returns towards its balanced growth path, by a combination of changes in international capital movements and domestic capital accumulation. Ottaviano and Peri use a convergence speed estimate of 10% per year, but note that this may be a conservative estimate for the US and that for more open economies convergence should be faster. Between 1990 and 2006, immigration increased total hours worked in the US by 11%. With no capital adjustment, their estimated effect on native wages over the period is -3.2%; with capital adjustment the effect is -1.1%. To the extent that immigration is expected, capital adjustment should be faster and wage effects even smaller.

We would argue that the process of migration is largely predictable and that capital therefore can adjust relatively quickly to the labor reallocation. We do not see this as short-term or long-term responses to a shock, but as a rather smooth and largely predictable process of adjustment to the labor re-allocation. We therefore argue that it is worthwhile to investigate how the effect of migration on wages changes in a setting with perfect international capital adjustment. By

[2] Output effects of migration with perfect international capital mobility are analyzed by Klein and Ventura (2007).

assuming perfect adjustment we at the least get a lower bound of the effect of migration on wages in the recipient economy.

## 3. Empirical Model

The main aim of this paper is to investigate to what extent the pressure of immigration on native wages is mitigated by capital reallocation. We aim to compare our results with those of Borjas (2003), and therefore we use a similar approach. We also make the same simplifying assumption as Borjas in ignoring the effect of changes in prices or terms of trade. This may affect the absolute level of the effects, but it should not matter substantially for our estimates of how the effect on wages is affected by the introduction of capital adjustment.

We will first analyze the effect of labor migration with fixed capital and then see how results change when we allow capital to reallocate between countries. We are of course aware that both global labor and capital stocks grow, but to simplify our analysis we choose to ignore this, which should not have any major effect on the validity of our comparison of the effects of migration with versus without international capital adjustment.

We estimate international capital adjustment in a model with production functions for six world regions. The model is calibrated so that capital returns are initially equal in all regions. Following migration, capital is reallocated across regions so that returns are again equalized. This section describes how the model was constructed, the data that was used, and how the model was calibrated (including limitations of the model).

### 3.1 World Regions

The model divides the world into six regions, which are presented in Table 1.

**Table 1. World regions in the model**

| *Region* | *Short form* | *Comment* |
|---|---|---|
| European Union | EU | including Norway, Iceland and Switzerland |
| North America | NA | the US and Canada |
| Japan, Australia and New Zeeland | JAN | |
| Eurasia/Pacific | EUP | excluding those in EU and JAN |
| Africa | AF | |
| Latin America | LA | |

*Note*: Appendix A lists the countries in each region.

Our primary interest is the impact of migration from low-income to high-income regions.[3] Therefore we have divided up the world according to income levels with three high-income and three low-income regions. The precision of the analysis is improved if the countries within each region share other characteristics. Allowing immigration is a political decision, and policies are more uniform within our regions than between them. The JAN region is somewhat mixed, since it includes Australia and New Zeeland as well as Japan, but we did not feel it would be useful to analyze these countries separately.

### 3.2 The Production Function

A CES production function is used, with *capital* (K), *low-skilled labor* (L), *high-skilled labor* (H), and *land and natural resources* (R) as factors of production:

[3] What is modeled is always *net* migration but, between low- and high-income regions, the difference between gross and net migration is usually small.

$$Y = A\left(\theta\left(K^{\alpha}R^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} + (1-\theta)\left(\beta H^{\frac{\mu-1}{\mu}} + (1-\beta)L^{\frac{\mu-1}{\mu}}\right)^{\frac{\sigma\mu-\mu}{\sigma\mu-\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

where Y is income, A is a measurement constant, σ and μ are elasticities of substitution, and α and θ are constants derived from income shares. Land and natural resources is included in order to have an immobile factor of production, and because it represents important shares of income in the three low-income regions.[4]

The two-level CES function, with one K-R aggregate ($K_{tot}$) and one H-L aggregate ($L_{tot}$), is used to allow for different elasticities between different pairs of factors. A disadvantage of such a model is that one has to define the aggregates. Our choices mean that we can enter distinct values for the elasticities between three pairs of factors: K-R, H-L and $K_{tot}$-$L_{tot}$, which means that we cannot distinguish between for example the pairs of K-H and K-L.[5] The elasticity of K-R is set to 1, which is supported by the survey of estimates in World Bank (2005). Therefore, the K-R aggregate is constructed in Cobb-Douglas form.

Forming an aggregate of H and L is almost necessary for the reliability of the existing estimates of σ, as they have generally been made without distinction between kinds of labor (Hamermesh 1993). The other aggregate is more problematic, as R has not been part of any K-aggregate when σ has been estimated. However, since R is small in relation to K in high income countries (where most capital adjustment will happen), and considering the estimated elasticities in World Bank (2005), this should not significantly distort the results. Following Pessoa et al (2005), the central

[4] Using World Bank (1995) figures we have calculated the income shares of land and natural resources in Africa, Latin America and Eurasia/Pacific to be 32%, 13% and 18% respectively.
[5] Importantly, this distinction is not allowed for by any empirical study that we refer to in this paper, so it does not affect comparisons.

value of σ used in the model is 0.7 (allowed to vary between 0.5 and 1), Following Katz and Murphy (1992), the value of μ is 1.4.

All simulations reported in this paper leave the ratio of high-skilled to low-skilled workers in the immigration regions unchanged. Still the disaggregation of labor is important as it influences parameter values of the calibrated production functions and thus the international response of capital to migration. The disaggregation also helps the analysis of policy measures directed at low-skilled native workers in Section 6.

**3.3 Data**

Parameters in the model - except elasticities (which are uniform) - were set by region, while the available data is typically aggregated by country. Regional values were thus calculated by summing up the available data for countries in the region, weighted by each country's share of the region's population. The only exception is land and natural resources, where the weights were each country's share of regional surface areas. Data was available for the majority of countries in each region.

Data sources for regional factor endowments and output are presented in Table 2. Although PPP-adjusted output data was derived from Penn World Tables (Heston et al. 2006), these figures were reconverted into dollars at the going exchange rates. While purchasing power matters in migration decisions, it would be inappropriate to use PPP figures in the model, as PPP is not relevant to internationally mobile capital, which relocates based on rates of return at going exchange rates.

**Table 2. Data sources on regional factor endowments and output**

| | |
|---|---|
| Capital (K) | Calculated for the year 2000 using a perpetual inventory method in World Bank (2005). |
| Land and natural resources (R) | Calculated for the year 2000 as the present value of their income over the next 25 years, at a 4% discount rate (World Bank 2005), |
| High-skilled labor (H) | The percentage of population having completed tertiary education in 1995 (from Barro and Lee 2000). Percentages are then multiplied with population data for 2000. |
| Low-skilled labor (L) | Calculated as 60% of country population for the year 2000 (from the Penn World Tables) minus high-skilled labor. |
| Output (Y) | GDP for the year 2000 from the Penn World Tables. |

*Note*: This measure of L is consistent with data for the year 2000 from the US Census Bureau. In "less developed countries" those aged 15-64 are considered to be in the labor force, while in "more developed countries" it is those aged 20-64. The continent with the least good fit for this figure is Africa, with an estimated 54% aged 15-64.

The model assumes perfect competition and full employment of all factors of production and free competition, so factors are paid their marginal products. The figure used to calculate returns to capital net of depreciation is 4%.[6] We set the capital depreciation rate to 5% in all regions, meaning that initial marginal product of capital (MPK) is 4+5=9% everywhere.

With values of R, K, MPR MPK and Y available, the income shares of R and K, as well as the parameter α - the internal income share of capital within the K-R aggregate - can be calculated. Subtracting the income shares of R and K from 1 then gives the income share of the H-L aggregate; the income share of labor, when labor is not differentiated.

These figures can be compared to other estimates. According to the United Nations *National Accounts Statistics*, labor income shares typically average about 55% in OECD countries, 50% in Asia, 40% in Latin America and the Middle East and 30% in Africa. A well-known problem with

[6] So net returns to capital equal the discount rate.

these estimates is that they treat income from small enterprises and the self-employed entirely as capital income. Gollin (2002) therefore calculated adjusted income shares. Table 3 shows a comparison of the labor income shares we have calculated as residuals (by subtracting R and K shares) with averages derived from Gollin's second adjustment (dividing income from small enterprises and self-employed between capital and labor in the same ratio as in the rest of the economy).

**Table 3. Comparison of labor-income shares to Gollin's (2002) estimates**

| *Region* | *Residual calculation* | *Derived from Gollin* |
|---|---|---|
| European Union | 71% | 73% |
| North America | 76% | 74% |
| Japan, Australia and New Zeeland | 64% | 69% |
| Eurasia/Pacific | 57% | 81% |
| Africa | 41% | 67% |
| Latin America | 63% | 59% |

The fit is very good for EU and NA (the regions focused upon in this analysis), though only reasonable for JAN and LA, and poor for EUP and AF. To handle the bad fits for the poorest regions, one has to decide which part of the data is the most plausible. Gollin's total sample is only 31 countries, and there are quite wide disparities between the estimates within the poorer regions. This suggests that his data quality is not generally better than that used in the World Bank calculations of K and R (the PWT estimates of Y are certainly quite good). The residual labor-income shares for all regions are also substantially higher than in the UN *National Accounts Statistics*, which they should be. Therefore, we used the residual shares in the model.

The next step was to divide the income shares of the labor aggregate between L and H, and then to determine MPL and MPH, which are assumed to be equal to the wages of low-skilled and high-skilled labor. The ILO October inquiries present data on wages in many occupations, but it is not useful for comparison between countries and regions, as some countries report minimum wages, others average or median wages; therefore this data is not used directly to measure high-skilled and low-skilled wages. But across occupations within countries, measures should be more consistent, and therefore we used the data to calculate the ratios between high-skilled and low-skilled wages. The occupations chosen for the calculations are shown in Table 4. There is no internal ordering of wage levels within the two groups that fits most countries. For example, in several countries, physicians have the highest wages in the high-skilled sample, but in several other countries, they have the lowest.

**Table 4. Sample of occupations used to estimate initial relative wages**

| *Low-skilled* | *High-skilled* |
|---|---|
| Thread and yarn spinners in the textiles industry (#25) | Chemical engineers in the manufacture of industrial chemicals (#52) |
| Sewing machine operators in the manufacture of wearing apparel excluding footwear (#30) | Power distribution and transmission engineers (#76) |
| Laborers in printing, publishing and allied industries (#51) | Bank accountants (#129) |
| Laborers in the manufacture of industrial chemicals (#56) | Computer programmers in the insurance industry (#133) |
| Laborers in the manufacture of other chemical products (#59) | Government executive officials in public administration (#139) |
| Laborers in the manufacture of machinery except electrical (#70) | Mathematics teachers at the tertiary level (#145) |
| Laborers in electric light and power (#80) | General physicians (#152) |
| Laborers in construction (#90) | |

*Note*: Numbers are ILO occupational codes.

When possible, data from the year 2000 was used to calculate relative wages. As the year 2000 data was a bit thin, data from the years 1998-2002 was used when necessary. No data was available for Japan, so the ratio calculated for Australia and New Zeeland was used to represent the much more important Japanese economy. Still, the calculated ratio seems plausible for Japan, being a bit below the EU and NA averages. With estimates of the ratios between MPH and MPL, we estimated the actual wages, which are shown in Appendix B

We need production functions for all six world regions, since they are used to analyze the behavior of internationally mobile capital. Initially, the model is calibrated so that capital returns are equal in all regions. Migration changes that by raising capital returns in the immigration region and lowering them in the emigration region. The global capital stock then adjusts to again equalize global returns, which also affects wages in all six regions. The model solves a system of six equations in six unknowns, which are the capital stocks in each region:

$$\left(\frac{\partial Y}{\partial K}\right)_1 = \left(\frac{\partial Y}{\partial K}\right)_2 = \ldots = \left(\frac{\partial Y}{\partial K}\right)_6 \qquad (2)$$

$$\sum_{i=1}^{6} K_i = \overline{K} \qquad (3)$$

With six unknowns and six equations, the model has one unique solution. Output and wages are then calculated from the adjusted regional capital stocks.

### 3.4 Limitations of the Model

The model draws on the models in Hamilton and Whalley (1984), Moses and Letnes (2004), and Iregui (2005), which also used regional CES production functions and estimated what global production gains and wage effects would be if all barriers to migration were lifted, and people migrated until all wage differences were eliminated across the world. They estimated huge (and widely differing) worldwide gains. However, we do not find it reasonable to allow labor migration to be extensive enough to eliminate inter-regional wage differences. And when building a model using CES production functions, one must keep changes in factor distributions reasonable. If we did not enter migration restrictions in our model, all three poor regions would be completely depleted of people without any equilibrium being reached. This is because the other studies have more important immobile factors of production, and fewer mobile ones. They treated capital as immobile, and had two or three mobile factors (labor or high-skilled and low-skilled labor). That made the immobile factor influences the earnings of the mobile one/ones enough so that equilibrium was reached. So an important restriction is that migration levels are reasonably small in relation to total regional populations.[7]

## 4. Wage Effects in Immigration Regions With and Without Capital Mobility

### 4.1 Immigration to North America

Borjas (2003) estimated that the immigration-induced an 11% increase in the US labor force between 1980 and 2000 reduced the wage of the average native worker by 3.2%. For comparison we simulated a 10% increase in the North American labor force – caused by immigration from Latin America – such that high-skilled and low-skilled proportions remained unchanged, with

[7] None of the three studies mentioned here presents their resulting numbers of migrants, but Moses and Letnes do so in another publication (Moses and Letnes 2005): Roughly half of the world's population would migrate in their model, meaning that, with no change in capital stocks the population of the high-income regions would increase by around 300%, a very extreme case. They have another concern with this kind of exercise, comparing their results with Borjas (1995) and concluding that, since the gains they identify even at reasonably small numbers of migrants are nine times as large as Borjas', their method is probably not reliable. If this were so, it would apply also to our model. But they compare their own figures for *total gains* with Borjas' figures for *immigration surplus*. Correcting for that, and for another important difference, their figures actually correspond quite well to Borjas'. (North America consists of the US *and Canada,* but since the Canadian economy accounts for only 7% of regional output, the comparison is not much affected.)

*immobile* capital and also found that wages fell 3.2% (with σ = 0.7). With σ between 0.5 and 1.0, wages fell 2.3-4.6%.[8]

Assuming a 10% immigrant share of population, Borjas (1995) used Hamermesh's elasticity value of -0.3 to estimate the immigrant surplus – total gains net of what was taken by the immigrants themselves – at 0.1% of GDP (about 1.5% of the output gain caused by immigration) and 5.3% of what was redistributed from native workers to capital owners (Table 5). Our results, also simulated without international capital adjustment, are quite similar.

**Table 5. Comparison to Borjas (1995) of resulting wages and immigrant surplus in North America with internationally immobile capital**

| *Measure* | *Borjas 1995* | *Our central results* | Interval |
|---|---|---|---|
| Immigrant surplus / Total output | 0.1% | 0.11% | 0.08% – 0.16% (-) |
| Immigrant surplus / Output gain | 1.5% | 1.6% | 1.1% – 2.3% (-) |
| Immigrant surplus / Redistributed from native workers | 5.3% | 4.9% | 4.9% |
| Wage change | -3% | -3.2% | -2.3% – -4.6% (+) |

Note: A (+) sign means that the value rises with rising σ, a minus (-) sign that it falls with rising σ.

With international capital adjustment (Table 6), the average wage decrease shrinks to a third, while the immigrant surplus relative to total output or total output gain becomes more than ten times as important. We obtained a major change in the immigrant surplus: Instead of being a mere 1:19 of what is redistributed from native workers, it became 240% of that. Thus, with

[8] Borjas uses an income share of labor of 0.7 and unit elasticity of substitution between capital and labor. We get the same result because the effects of our higher income share and lower elasticity of substitution cancel each other. We will note further on how our consequent analysis would have changed if we had used the same values as Borjas on these two variables.

international capital adjustment, one needs to take total gains into account, not just the distributional effects of immigration, because there is a vast increase in possible redistribution to compensate native labor for their lower wages. [9]

**Table 6. Results for wages and immigrant surplus in North America with internationally mobile capital**

| *Measure* | *Our central results* | *Interval* |
|---|---|---|
| Immigrant surplus / Total output | 1.6% | 1.5% – 1.7% (-) |
| Immigrant surplus / Output gain | 19% | 18% – 20% (-) |
| Immigrant surplus / Redistributed from native workers | 240% | 200% – 280% (+) |
| Δ wage | -1.0% | (-0.8 – -1.2)% (+) |

*Note*: A plus (+) sign means that the value rises with rising σ, a minus (-) sign that it falls with rising σ.

With internationally immobile capital, immigration means that more labor has to work with a given capital stock. The combination of an increase in the labor force and the fall in wages creates the immigrant surplus. With international capital adjustment, the fall in wages is smaller, but an immigrant surplus many times larger is created by the inflow of capital that follows. Since what is redistributed (by the fall in wages) shrinks, the ratio of immigrant surplus to it changes spectacularly.

[9] Borjas (1995) estimated the immigrant surplus relative to other measures using a labor income share of 0.7 and unit elasticity of substitution between capital and labor. The results we would have got for NA with mobile capital if we had used the same values are close to what we get for the EU in Table 7 with σ=1, since our estimated labor income share for the EU is 0.71. The wage change that we get then is -1.0% and the immigrant surplus divided by the losses to native workers is 2.7. Although the two regions are not perfectly equal in how they attract capital from the rest of the world, this comparison still indicates that had we used Borjas' figures for the US economy, the resulting effects would have been even slightly more positive for the immigration region.

We get relative effects of introducing capital mobility that are about similar in size to those in Boyer, Hatton and O'Rourke (1993), and Hatton and Williamson (1998), but for quite different reasons. One hundred years ago, land was an important factor of production also in the more industrialized US economy, and for this reason those studies get substantial wage effects of migration also when capital responds perfectly. In our model the importance of land and natural resources in the immigration regions is much smaller. The reasons for the wage effects with mobile capital are instead the substantial differences between the capital/labor ratios of the six world regions, and the fact that four out of five regions that send capital to the immigration region have not lost any workers. These factors imply that capital adjustment in the immigration region in response to immigration is not automatically one for one, and as long as migration happens from a capital-scarce to a capital-rich region it is necessarily *less* than one for one

### 4.2 Immigration to the European Union

Simulations for the EU with and without international capital adjustment – with Africa as the emigration region - also give similar results (Table 7). The wage decreases are about 30% larger, but so are the immigrant surpluses. The proportional effect of introducing capital mobility is the same: The wage decrease shrinks to a third.

**Table 7. Results for wages and immigrant surplus in the European Union**

| *Measure* | *Our central results immobile capital* | *Interval* | *Our central results mobile capital* | *Interval* |
|---|---|---|---|---|
| Immigrant surplus / Total output | 0.13% | 0.09% – 0.18% (-) | 1.8% | 1.7% – 1.9% (-) |
| Immigrant surplus / Output gain | 2.0% | 1.4% – 2.8% (-) | 22% | 21% – 23% (-) |
| Immigrant surplus / Redistributed from native workers | 4.9% | 4.9% | 220% | 170% – 270% (+) |
| Δ wage | -3.9% | -2.7% – -5.5% (+) | -1.3% | -1.0% – -1.7% (+) |

Note: A plus (+) sign means that the value rises with rising σ, a minus (-) sign that it falls with rising σ.

## 5. Global Output and Wage Effects

As noted, the model allows capital to relocate across the globe in response to labor migration. With migration from Latin America increasing the labor force in North America by 10%, world output increases by 2.0% (Table 8), due to improved international allocation of factors of production. Output and wages in all other regions fall, since capital leaves those regions. Regional wage-decreases due to export of capital in regions not involved are about the same as the decrease in the immigration region.

Part of the output gain for the immigration region (North America) is losses for other regions, but not all; the difference is the increase in world output. The ratio of the (absolute) worldwide output gain to the output gain in North America is 0.66, meaning that 34% of North America’s output gain is at the expense of other regions

**Table 8. Worldwide output and wage effects of migration from Latin America to North America**

| *Region* | *Output* | *Wages* |
|---|---|---|
| North America | +9.3% | -1.0% |
| Latin America | -10.1% | H:+19.0% |
| | | L:-3.5% |
| Europe | -0.5% | -0.7% |
| Africa | -0.7% | -0.9% |
| Japan/Australia/New Zealand | -0.8% | -1.1% |
| Eurasia/Pacific | -0.5% | -0.8% |
| World | +2.0% | MPK:+2.0% |

The cell at the bottom right of Table 8 displays the worldwide increase in returns to capital before depreciation.

In the region of emigration, the proportion of high-skilled to low-skilled workers was quite strongly altered; in fact, almost a third of high-skilled workers left. That is arguably beyond the reasonable limits of the CES production function, so the results for Latin American wages are not completely plausible.

For comparison, we simulated a similar emigration from Eurasia/Pacific to the EU (Table 9). Here, wage effects in the emigration region are more plausible, as Eurasia/Pacific had more high-skilled workers initially. The results in Tables 8 and 9 are similar. Effects on the emigration region (Eurasia/Pacific) are much smaller in Table 9, as the region is much bigger. The largest wage decreases again appear in Japan/Australia/New Zealand, which loses quite a lot of capital. Worldwide output-gains are slightly smaller than with emigration from Latin America to North America, although the number of migrants is twice as large. This happens because initial wages and the capital/labor ratio are substantially higher in North America than in the EU, implying larger economic gains from migration. The ratio of worldwide output-gain to the output-gain in the EU is 0.73, meaning that 27% of the EU's output-gain is at the expense of other regions.

**Table 9. Worldwide output and wage effects of migration from Eurasia/Pacific to the European Union.**

| *Region* | *Output* | *Wages* |
|---|---|---|
| North America | -0.5% | -0.7% |
| Latin America | -0.7% | -0.9% |
| Europe | +9.0% | -1.2% |
| Africa | -0.9% | -1.2% |
| Japan/Australia/New Zealand | -1.0% | -1.4% |
| Eurasia/Pacific | -1.9% | H:+1.3% |
| | | L:-0.8% |
| World | +1.8% | MPK:+2.6% |

## 6. Policy for Low Skilled Labor in Immigration Regions

The academic discussion on the economic effects of immigration has focused predominantly on the wage effects for low-skilled native workers (Borjas 1994, 2003, 2009; Card 2005; Ottaviano and Peri 2008). What happens to low-skilled native workers is obviously politically important, affecting how immigration is perceived. Our simulations with international capital adjustment have shown that the output-gains from immigration might be twice as large as the losses to native workers, making redistribution of some of the gains to the losing group possible, while still benefiting from much of the overall gain.

Are there policies that would completely neutralize the negative income effects on low-skilled natives? Consider tax cuts for low-skilled native workers, financed by a tax on either capital or immigrants, the factors that experience the most important gains from migration. As noted, returns to capital increase with migration, and migrants themselves receive much higher incomes. However, if the immigration region imposes a tax on returns to capital, it will not move to that region as much as it would otherwise, and returns will not increase as much.

It is assumed throughout this section that immigration does not alter the ratio of high-skilled to low-skilled workers in the immigration region.[10]

### 6.1 A Tax-Cut for Low-Skilled labor Financed by a Tax on Returns to Capital

Assume first that we can direct the tax cut to low-skilled workers (natives and immigrants), while high-skilled natives and immigrants do not benefit. We simulate separate 10% increases in the high- and low-skilled labor forces of North America (from Latin America) and of the EU (from Africa), with the restriction that after-tax wages of low-skilled native workers must be unchanged.

At the equilibrium tax on returns to capital, there is still a net inflow of capital to the immigration region in both simulations (Table 10), though output gains in the immigration region are lower. The EU needs to impose a higher tax on capital returns than North America, because of capital's higher share of income in the EU, making demand for capital more elastic with respect to price in the EU. The tax is thus more "effective" (an unwanted effect) at keeping capital out, requiring a yet higher tax to raise the necessary revenue.

[10] In the US, the way we define high-skilled and low-skilled, this has largely been the case for forty years (Borjas 2003).

**Table 10. Effects of a tax cut for low skilled natives financed by a capital tax**

| *Region* | *Tax %* | *%ΔMPK global* | *%ΔMPK global net of depr.* | *%ΔY immigration region* | *%ΔY global* | *%ΔK immigration region* |
|---|---|---|---|---|---|---|
| North America | 2.3% | +1.4% | +3.0% | +8.9% | +2.0% | +6.4% |
| NA Interval (-) | 1.9% – 2.9% | +0.9% – +1.9% | +2.1% – +4.2% | +8.8% – +9.0% | +2.0% | +5.8% – +6.9% |
| EU | 5.7% | +1.0% | +2.2% | +7.8% | +1.9% | +2.8% |
| EU Interval (-) | 4.3% – 7.6% | +0.7% – +1.4% | +1.5% – +3.1% | +7.7% – +7.8% | +1.9% | +2.5% – +3.1% |

*Note*: A plus (+) sign means that the value rises with rising σ. A minus (-) sign means that the rate falls with rising σ. The minus signs in the table do not apply to %ΔY global column, which is unaffected by varying σ; %ΔMPK is after-tax in the region of immigration

### 6.2 A Tax Cut for Low-Skilled Labor Financed by an Immigrant Tax

In this case the tax cut is only for low-skilled *natives*, financed by a tax on both high-skilled and low-skilled immigrants, who might pay a "fee to immigrate" through a future tax on earnings. The necessary level of the immigrant tax (t) in percent is:

$$t = \frac{\Delta w_{LN} \times LN}{I \times w_{mean}} \qquad (4)$$

where $\Delta w_{LN}$ is the wage decrease for low-skilled natives, LN is the number of low-skilled natives, I is the number of immigrants, and $w_{mean}$ is the weighted mean wage (of both high- and low-skilled workers) after immigration.

The results for (separate) proportional labor force increases in North America (from Latin America) and the EU (from Africa) are presented in Table 11. Again, the necessary tax rate is lower in North America than in the EU, this time because North America experiences a smaller wage decrease (once again reflecting a higher labor-share of income) and has a higher mean wage (both before and after immigration). But both the calculated tax rates are obviously low enough for immigrants to make a decent living after paying it. Still, it might be hard to get political acceptance for this type of tax.

**Table 11. Immigrant tax rates needed to finance tax cuts for low skilled natives**

| *Region* | *Tax rate* | Interval (-) |
|---|---|---|
| North America | 4.3% | 3.5% – 5.4% |
| EU | 9.8% | 7.5% – 12.8% |

Note: A minus (-) sign that it falls with rising σ.

## 7. Summary and Conclusions

We set out to answer three questions: What are the wage effects of migration in the immigration country with international capital adjustment? What are the effects in the rest of the world? Could one design policies to leave native low-skilled workers' wages unaffected by immigration?

For the region of immigration, allowing for international capital adjustment to migration in the analysis changed the predicted negative wage-effect from 3 – 4% to only 1 – 1.3%. Output gains from immigration are much larger with capital adjustment, as one would expect. Borjas (1995) argued that output gains in the immigration region are dwarfed by the income redistributed from native workers to capital, but this is not the case with international capital adjustment, where output gains are estimated to be twice as large as the redistribution. Thus redistribution of gains from the winners (capital owners and/or immigrants) to native workers should be possible.

When capital adjusts by relocating between regions, output and wages in regions not directly involved in migration falls, as they lose some of their capital. Surprisingly, the wage decreases in those regions are about equal in size to these in the immigration region. A substantial part of the gains to the immigration region are thus at the expense of other regions.

To redistribute the gains from immigration and leave native low-skilled (after tax) wages unaffected, two policy proposals were evaluated: a tax cut financed by a tax on returns to capital and a tax cut financed by a tax on immigrants. Both policies seem feasible, although measures that tax immigrants, in particular, might be hard to implement politically.

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## Appendix A. World regions: Countries

**European Union**
Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom

**North America**
Canada, United States

**Japan, Australia, New Zeeland**
Australia, Japan, New Zeeland

**Eurasia/Pacific**
Afghanistan, Albania, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Bhutan, Bosnia and Herzegovina, Brunei, Cambodia, China, Croatia, Fiji, Georgia, Hong Kong, India, Indonesia, Iran, Iraq, Israrel, Jordan, Kazakhstan, Kiribati, Democratic Republic of Korea, Republic of Korea, Kuwait, Kyrgyzstan, Laos, Lebanon, Macao, Macedonia, Malaysia, Maldives, Micronesia, Moldova, Mongolia, Nepal, Oman, Pakistan, Palau, Papua New Guinea, Philippines, Qatar, Russia, Samoa, Saudi Arabia, Serbia and Montenegro, Singapore, Solomon Islands, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Tonga, Turkey, Turkmenistan, Ukraine, United Arab Emirates, Uzbekistan, Vanatu, Vietnam, Yemen

**Africa**
Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe

**Latin America**
Antigua, Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St Kitts & Nevis, St Lucia, St Vincent & Grenadines, Suriname, Trinidad & Tobago, Uruguay, Venezuela

Myanmar is excluded altogether due to not being present in PWT 6.2

## Appendix B. World Regions: Parameters

| | *EU* | *NA* | *JAN* | *EUP* | *AF* | *LA* |
|---|---|---|---|---|---|---|
| Population (millions) | 495 | 315 | 150 | 3,768 | 803 | 522 |
| R (billion $) | 3,019 | 5,233 | 822 | 13,803 | 2,958 | 4,047 |
| K (billion $) | 26,120 | 24,204 | 20,319 | 13,434 | 1,790 | 5,576 |
| H (millions) | 35 | 57 | 16 | 85 | 12 | 20 |
| L (millions) | 262 | 132 | 74 | 2,175 | 470 | 293 |
| Y (billion $) | 8,814 | 10,479 | 5,198 | 4,863 | 592 | 2,079 |
| R share of income | 0.02 | 0.03 | 0.01 | 0.18 | 0.32 | 0.13 |
| K share of income | 0.27 | 0.21 | 0.35 | 0.25 | 0.27 | 0.24 |
| H share of income | 0.18 | 0.42 | 0.18 | 0.07 | 0.02 | 0.16 |
| L share of income | 0.53 | 0.34 | 0.46 | 0.50 | 0.39 | 0.48 |
| H wage ($/year) | 44,886 | 77,132 | 58,975 | 3,873 | 1,074 | 16,694 |
| L wage ($/year) | 17,927 | 27,050 | 32,037 | 1,121 | 488 | 3,365 |