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Efficiency Gains from the Elimination of Global Restrictions on Labour Mobility

An Analysis using a Multiregional CGE Model

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Abstract

This paper computes the worldwide efficiency gains from the elimination of global restrictions on labour mobility using a multiregional CGE model. A distinctive feature of our analysis is the introduction of a segmented labour market, as two types of labour are considered: skilled and unskilled. According to our results, the elimination of global restrictions on the mobility of skilled and unskilled labour generates worldwide efficiency gains that could be of considerable magnitude. When only skilled labour migrates, the worldwide efficiency gains are smaller, as this type of labour represents a small fraction of the labour force in developing regions.

Keywords: migration, applied CGE modelling, labour market segmentation

JEL classification: C68, F22, R13, R23

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1 Introduction

The classic economic argument in favour of labour migration is that people move in search of higher wages, hence increasing their own productivity.[1] However, as indicated by Layard *et al.* (1992), the decision to migrate also depends upon other economic, social and political considerations. Among the economic aspects, migrants may take into account comparative wage levels (actual and expected); comparative unemployment rates and unemployment benefits; the availability of housing; and the cost of migration which includes travel expenses, information costs, and the psychological cost of leaving friends and family. Weyerbrock (1995) also indicates that political instability and civil war may cause larger emigration flows than economic or demographic pressures.

Recent empirical studies on international migration have mainly focused on US-Mexico migration patterns (Hill and Méndez 1984; Robinson *et al.* 1993; Levy and van Wijnbergen 1994), and migration flows from Eastern Europe and the former Soviet Union into Western Europe (Layard *et al.* 1992; Weyerbrock 1995).

Hamilton and Whalley (1984) has been the only attempt to quantify the efficiency gains from the removal of global restrictions on labour mobility. They use a partial equilibrium framework, in which the parameters of a CES production function are estimated for a seven-region country classification. Then, the estimated parameters are used to calculate the changes in labour allocation across regions after the removal of immigration controls. They assume that the worldwide labour supply is fixed, that full employment occurs in all regions, and that differences in labour's marginal product across regions arise from barriers to inward mobility of labour in high-wage countries. Hamilton and Whalley find large efficiency gains from the removal of immigration controls; in most cases, these gains exceed world wide, GNP generated in the presence of the controls. In addition, in labour-exporting regions wage rates rise and capital owners are made worse off; on the other hand, in labour-receiving regions wage rates fall and capital owners are made better off.

In this paper we compute the worldwide efficiency gains from the elimination of restrictions on labour mobility. In contrast to Hamilton and Whalley (1984), we use a multiregional general equilibrium model instead of a partial equilibrium approach, since the former provides an ideal framework to analyse the effects of policy changes on resource allocation, the structure of distribution, and thus in economic welfare. A distinctive feature of our analysis is that we consider a segmented labour market (i.e., skilled and unskilled labour), which can be justified on the grounds that this factor is not homogeneous. The segmentation of the labour market jointly with the general equilibrium framework allows us to examine the distributional effects of migration between skilled and unskilled labour in each region, and between these two and capital.

According to our results, the elimination of global restrictions on labour mobility generates worldwide efficiency gains that could be of considerable magnitude, ranging from 15 per cent to 67 per cent of world GDP. With the introduction of a segmented labour market, welfare gains reduce since the benefits and losses of migration are not evenly distributed within each country, ranging from 13 per cent to 59 per cent of world

[1] Layard *et al.* (1992) indicate that free trade and international capital mobility can also raise productivity, without labour migration.

GDP. And when only skilled labour migrates, worldwide efficiency gains are smaller ranging from 3 per cent to 11 per cent of world GDP, since skilled labour represents a small fraction of the labour force in developing regions.

The paper proceeds as follows. Section 2 describes the basic structure of our multiregional general equilibrium model. Section 3 contains the empirical implementation, including the description of the benchmark dataset and the calibration of the model. Section 4 presents the results of the model as well as the sensitivity analysis. Section 5 presents model elaborations, including transaction costs, international capital mobility, and selective mobility. Section 6 offers some concluding remarks.

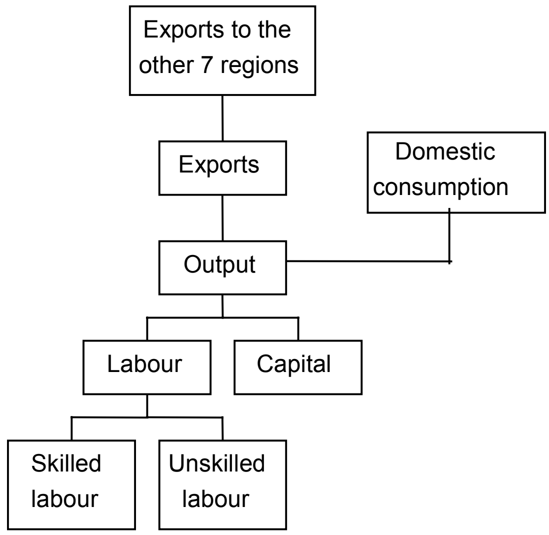
2 The model

In a world economy characterized by countries with different levels of income, individuals have incentives to migrate to countries with higher wage rates. If labour were allowed to move from one country to another without restrictions, it will do so until the marginal product of labour is the same in both low-income and high-income countries. Migration will reduce the labour force in the low-income country (source region), leading to an increase in wages,[2] and a reduction in the demand for labour. In addition, migration leads to a process of factor reallocation within the poor country: the remaining workers gain through higher wages, but capital owners lose since labour is now scarce relative to capital. Conversely, in the high-income country (destination region) the labour force increases, which leads to a reduction in the wage rate (assuming no rigidities). This lower wage will increase the demand for labour and aggregate employment. During the transition, workers will lose through lower wages and capital owners will gain since labour is now less scarce relative to capital (see e.g. Bhagwati *et al.* 1998; Layard *et al.* 1992). This analysis is based on the assumption that labour is a homogeneous factor of production, which implies that the benefits and loses of migration are evenly distributed within each country. However, as our analysis will show later on, this is not necessarily the case when there are many types of labour.[3]

[2] The magnitude of the increase will depend on the elasticity of labour demand. The more elastic the demand for labour, the smaller the increase in wages.

[3] For some trade theorists the issue of the removal of restrictions on labour mobility may not be of great relevance because of the factor price equalization theorem, according to which factor prices will be equalized by free trade without internationally mobile factors (see Samuelson 1948, 1949). However, this theorem is based on very restrictive assumptions, such as identical technologies in different countries, constant returns to scale, perfect competition, no factor intensity reversals, no specialization, and that good prices are equalized as a result of trade. Moreover, factor price equalization depends on the complete convergence of the price of the goods. In reality, the prices of the goods are not fully equalized because of both natural (e.g., transportation costs) and artificial barriers to trade (e.g., import tariffs, import quotas, voluntary export restraints). An additional reason why factor price equalization may not be achieved is that countries exhibit different technologies and resources, so that they are unlikely to remain unspecialized (see e.g. Layard and Walters 1978; Krugman and Obstfeld 1994).

Figure 1
Production structure



The structure of the model follows the standard specification of a multiregional general equilibrium model. The model is static, and consists of eight regions, each one with demand and production structures, linked through trade. Each region contains one industry that produces a single output, which is treated as heterogeneous across regions (Armington 1969). There is a representative consumer in each region and, for simplicity, intermediate production is not considered.

Production in the model involves a CES value added function with capital (*K*) and labour (*L*) as primary inputs. There are two types of labour, skilled (*Ls*) and unskilled (*Lu*), and this labour market segmentation is a distinctive feature of our modelling exercise in comparison to previous work by Hamilton and Whalley (1984). Figure 1 presents the production structure of the model.

The model uses two-stage CES production functions, which are more flexible since they allow us to have different elasticity parameters in each stage of the production process. In the first stage, *Ls* and *Lu* are combined to produce the aggregate labour input (*L*); that is,

$$L^r = \phi^r \left(\pi^r Ls^{r^{(\varsigma^r - 1)/\varsigma^r}} + (1-\pi^r) Lu^{r^{(\varsigma^r - 1)/\varsigma^r}} \right)^{(\varsigma^r/(\varsigma^r - 1)}, r = 1,...,8, \quad [1]$$

where L^r is the aggregate labour input used in region r; Ls^r and Lu^r are skilled and unskilled labour inputs in region *r*; ϕ^r is a constant defining unit of measurement; π^r is a share parameter; ς^r is the elasticity of substitution between skilled and unskilled labour in the production of the good in region *r*.

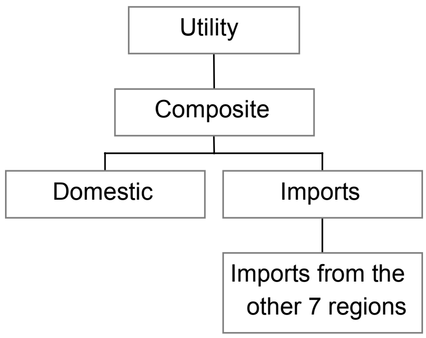
Labour demand functions for the two types of labour are obtained from cost minimization; that is, each industry selects an optimal level of *Ls* and *Lu* that minimizes the cost of producing *L* units of the aggregate input.

In the second stage the aggregate labour input and capital are combined to produce value added. In each region the industry selects an optimal level of inputs that minimizes the cost of producing value added. Further, the commodity produced in each region can be transformed either into a commodity sold on the domestic market, or into an export according to a constant elasticity of transformation (CET) function. Then, exports are allocated across regions according to a CET function.

Factors are non-produced commodities in fixed supply in each region. Factors of production are assumed to be internationally immobile, although this assumption is relaxed later on for *L*.

Turning to the demand side of the model, we assume that consumers within a region have identical homothetic preferences, which allows us to consider a representative consumer, endowed with all the labour and capital in the region. In this case, as there is only one good, the region's representative consumer demands a composite of domestically produced and imported goods subject to the region's budget constraint. Figure 2 presents the demand structure of the model.

Figure 2
Demand structure



The budget constraint in each region is given by income equal expenditure ($I^r = E^r$). The region's income is derived from ownership of factors of production, government transfers and the trade surplus (or deficit), that is:

$$I^r = P_{Lu,r}\overline{Lu^r} + P_{Ls,r}\overline{Ls^r} + P_{K,r}\overline{K^r} + TR^r + TB^r, \quad [2]$$

where $P_{Lu,r}$, $P_{Ls,r}$, and $P_{K,r}$ define the selling prices of the factors of production in region *r*; $\overline{Lu^r}$, $\overline{Ls^r}$, and $\overline{K^r}$ correspond to the region's endowment of unskilled labour, skilled labour, and capital, respectively; TR^r represents transfers from the government; and TB^r corresponds to the region's trade surplus (or deficit). On the other hand, the region's expenditure includes the amount spent on goods as well as taxes paid:

$$E^r = P_r X^r + T^r, \quad [3]$$

where P_r and T^{r} correspond to the price and taxes paid by the consumer in region r, respectively.

The model also incorporates trade and domestic tax policies. These include income, factor and consumption taxes, as well as import tariffs, all of which are modelled in *ad valorem* form. All tax revenues raised are assumed to be transferred back to consumers.

Lastly, it is worth pointing out that some of the assumptions of the model may affect the outcome of the simulations. In global models it is usually assumed that capital is internationally immobile. This assumption may not be very realistic since international capital markets are becoming more integrated. However, this assumption is fundamental to the structure of the model; if all factors of production are allowed to move freely, the concept of region is no longer clear. Hence the need for a fixed factor in the specification of the model (in one of the extensions of the model, when capital is assumed to be internationally mobile, unskilled labour is the fixed factor in the model).[4]

Regarding labour, in the model it is assumed that differences in the marginal product of labour arise from barriers to inward mobility of labour in high-wage countries. Thus, once barriers to labour mobility are eliminated, wage rates equalize across regions. The model also assumes that labour in one region is the same as labour in another region, so that differences in labour quality or human capital per worker across countries are ignored. In the real world these differences are not only present but may also be significant. For example, Lucas (1995) indicates that production per worker in the US is about fifteen times what it is in India; after correcting for differences in human capital, each American worker was estimated to be the equivalent of about five Indian workers. Another important factor that may affect labour productivity is the technology available in each region. Thus, the elimination of restrictions on labour mobility may not after all eliminate differences in productivity across regions. As can be seen, some of the assumptions used in the specification of the labour market may be highly simplified; however, incorporating differences in the quality of labour across regions is severely constrained by data availability.

Once the model has been specified, it can be solved for an equilibrium solution. Equilibrium in the model is given by a set of goods and factor prices for which all markets clear. That is, demand-supply equalities hold in each goods and factors markets; zero profit conditions hold for each industry in each region; and each region is in external-sector balance (see Appendix A). Next we calculate the parameters of the model that are consistent with the benchmark dataset; these parameters allow us to reproduce the dataset as an equilibrium solution of the model. Then we compare counterfactual equilibria with the benchmark equilibrium generated by the data.

3 Empirical implementation

The model consists of eight regions, each of which engages in domestic and foreign trade activities. These regions were chosen to reflect world trade, and we use 1990 data for the United States (USA), Japan (JAP), the European Union (12-member-EU), other

4 Instead of having a fixed factor, a nontradable good could be introduced, so that all production factors could be inter-regionally mobile.

development countries (ODC), developing America (DAM), developing Africa (DAF), developing Asia (DAS), and developing Europe (DE).[5] Appendix B presents the grouping of individual countries.

We assume that each region produces one commodity, and that each region's domestically produced and imported goods are qualitatively different (Armington 1969). We consider one commodity as our analysis focuses on the efficiency gains from the elimination of restrictions on labour mobility. The introduction of a segmented labour market is a very important feature of our model, so that we consider two types of labour: skilled and unskilled. This characteristic allows as to analyse the distributional effects that the migration of skilled labour has on unskilled labour, since the assumption of homogeneous labour implies that the benefits and losses of migration are evenly distributed within each region. Lastly, the price of the composite commodity demanded by the consumer in USA is chosen as the numeraire.

3.1 Benchmark dataset

The benchmark dataset involves domestic activity data and external sector data for each region in 1990. Domestic activity data involve data on value added by component, the segmentation of the labour market as well as domestic taxes. External sector data includes data on foreign trade and import tariffs.

The size of the eight regions is given by their respective GDP in 1990 US dollars, consistent with the World Tables (1995). The benchmark dataset satisfies the equilibrium conditions of the model in the presence of the existing policies. We use data from national accounts as compiled by the United Nations, *World Tables* produced by the World Bank, and the *Government Finance Statistics Yearbook* of the International Monetary Fund. Regarding foreign trade statistics, we use information from UNCTAD (1995) and the GATT-trade policy review for various countries.

The dataset used was based on a dataset previously assembled by the author, in which each region produced three goods, namely primary commodities, manufactured goods, and services. For the purpose of this paper, these three goods were aggregated into a single commodity. We use information from (various issues of) the *Yearbook of Labour Statistics* of the International Labour Office (ILO) to calculate the percentages of skilled and unskilled labour in each region; the following percentages were obtained:[6]

	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
Ls, %	30.2	17.4	20.6	25.5	15.7	14.3	9.1	13.5
Lu, %	69.8	82.6	79.4	74.5	84.3	85.7	90.9	86.5

5 Initially, developing Oceania (which included Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu) was included as a ninth region. At the time of solving the model we encountered numerical problems because this region was very small compared to the others (in 1990 its GDP accounted for only 0.2 per cent of world GDP). Hence, it was excluded from the analysis.

6 An appendix with the sources and the procedure followed to assemble the dataset is available from the author upon request.

As can be seen, these percentages indicate that more than 17 per cent of the labour force in developed regions is skilled, while in developing regions this percentage is less than 16 per cent. National accounts, from which the wage bill is taken, report the remuneration of employees without distinguishing between types of labour. The percentages reported above are therefore important since they are used to split the wage bill into remuneration to skilled and unskilled labour in each region. The resulting wage bills are (figures in $ billions):

	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
Ls	999.8	281.0	643.5	297.7	61.4	10.2	48.6	110.6
Lu	2,313.8	1,330.8	2,473.0	871.7	330.2	60.8	485.8	706.8

Once we have assembled the dataset, some parameter values such as share parameters and scale parameters, can be directly calculated from the equilibrium conditions of the model, following the procedure described in Mansur and Whalley (1984). Because of the functional forms used in the model, we need to specify parameter values for the elasticities of substitution and transformation that are not contained in the dataset. Once these parameters have been specified, share parameters can be obtained from demand functions. On the supply side, share and scale parameters can be obtained from cost functions.

3.2 Elasticities

The key elasticities in our model are the skilled-unskilled labour substitution elasticity, as well as the elasticity of substitution between capital and the aggregate labour input. The degree of substitutability between skilled and unskilled labour determines the change in relative wages once a policy change is introduced. On the demand side of the model, the most important are the elasticities controlling substitution between import types in forming import composites, and those controlling substitution between comparable domestic goods and aggregate imports.

The majority of studies on labour-labour substitution use a disaggregation by occupation to separate the labour force; in particular, the disaggregation most widely used is between production and non-production workers, because of data availability. There does not seem to be consensus as to an approximate value for the labour-labour substitution elasticity, and this is reflected by the fact that there is a rather large range of variation in the elasticity estimates, from 0.14 to 7.5 (Hamermesh and Grant 1979).[7] The big differences in the elasticity estimates can be the result of major methodological differences, such as the choice of estimating a cost or a production function, the choice of functional forms, the choice of data (time-series versus cross-section), and the disaggregation of the labour force according to various criteria, among others. The estimate of the elasticity of substitution between non-production-production workers was chosen as proxy for the elasticity of substitution between skilled and unskilled labour. We use a value of 0.9 in our central case, and this value is used for all regions,

7 Hamermesh (1993: 65), however, points out that the substitution relationship between production and non-production workers tells us little about the substitution between high- and low-skilled workers because ‘there is a remarkably large overlap in the earnings of these two groups’.

since estimates for each region were not available. Sensitivity analysis is performed around the value chosen in the range 0.5 to 2.5.[8]

In the case of the value added functions, the key parameters are the CES elasticities of substitution between the aggregate labour input and capital.[9] We use elasticities of factor substitution based on those used by Whalley (1985). Because of the lack of detailed regional data, our elasticities are almost identical across regions.

On the demand side of the model, two different types of elasticities are involved with the CES forms used: those controlling substitution between import types in forming import composites, and those controlling substitution between comparable domestic goods and aggregate imports. In this model, elasticities of substitution in consumption are not needed because each representative consumer demands one good only, which is a composite of comparable domestic and imported (composite) goods.

Table 1
Elasticities in the model

Elast.	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
ς	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
σ	0.830	0.800	0.820	0.840	0.850	0.860	0.840	0.840
π	0.920	0.930	0.859	0.948	1.263	1.019	1.546	2.715
ζ	0.990	0.930	0.919	1.130	0.544	0.572	1.227	1.410

Notes: ς is the labour-labour substitution elasticity.

σ is the elasticity of substitution between capital and the aggregate labour input; based on estimates presented in Whalley (1985).

π is the elasticity of substitution between domestic and imported goods. The values used are based on import price elasticities. For USA and JAP the source is Marquez (1990). For EU we use an average of the elasticities of Germany and the United Kingdom (Marquez 1990); France, Belgium-Luxembourg, Denmark, Ireland, Italy, and the Netherlands (Stern *et al.* 1976); and Portugal (Houthakker and Magee 1969). For ODC we use an average of the elasticities of Canada (Marquez 1990); Austria, Finland, Norway, Sweden, Switzerland, Australia, and New Zealand (Stern *et al.* 1976). For DAM we use an average of the elasticities of Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Uruguay (Khan 1974). For DAF we use an average of the elasticities of Ghana and Morocco (Khan 1974). For DAS we use an average of the elasticities of India, the Philippines and Sri Lanka (Khan 1974); and Pakistan and Bangladesh (Nguyen and Bhuyan 1977). For DE we use the elasticity for Turkey estimated by Khan (1974).

ζ is the elasticity of substitution between regional imports. The values used are based on export price elasticities. For USA and JAP the source is Marquez (1990). For EU we use an average of the elasticities of Germany and the United Kingdom (Marquez 1990); France, Belgium-Luxembourg, Denmark, Ireland, Italy, and the Netherlands (Stern *et al.* 1976); and Portugal (Houthakker and Magee 1969). For ODC we use an average of the elasticities of Canada (Marquez 1990); Austria, Finland, Norway, Sweden, Switzerland, Australia, and New Zealand (Stern *et al.* 1976). For DAM we use an average of the elasticities of Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, and Peru (Khan 1974). For DAF we use an average of the elasticities of Ghana and Morocco (Khan 1974). For DAS we use an average of the elasticities of Pakistan, India, Bangladesh and Sri Lanka (Nguyen and Bhuyan 1977). For DE we use the elasticity for Turkey estimated by Khan (1974).

8 It was also tried to use elasticity values greater than 2.5, but we encountered numerical problems when solving the model.

9 Whalley (1985) points out that there is no consensus as to the quantitative orders of magnitude involved, since most time-series estimates of the aggregate substitution elasticity are in the neighbourhood of unity, and cross-section estimates are often around 0.5.

Regarding trade elasticities, the most important are import-price elasticities and export-price elasticities. Substitution elasticities between import types making up any composite determine the export-price elasticities faced by regions. Substitution elasticities between import composites and comparable domestic products reflect import-price elasticity estimates in the literature, since it was not possible to find any econometric estimate of elasticities of substitution. The elasticities used in the model (central case) are presented in Table 1.

3.3 Calibration

Once the dataset has been assembled, and elasticity parameters have been specified, share and scale parameters can be calculated from the equilibrium conditions of the model, following the procedure described in Mansur and Whalley (1984).

The benchmark dataset provides information on equilibrium transactions in value terms. The first step of the calibration procedure involves the separation of these transactions into price and quantity observations. In order to do this, a units convention is widely used, in which it is assumed that a physical unit of each good and factor is the amount that sells for one dollar. That is, both goods and factors have a price of unity in the benchmark equilibrium.

However, this approach is not applicable in the case of the labour market, because we assume different marginal products of labour, resulting from barriers to inward mobility of labour in high-wage countries (that is, wages are different from one). In addition, we consider two types of labour, skilled and unskilled, each one with a different productivity and, as a result, a different price within each region.

There is no agreement as to how to calculate the average wage rate. Hence, we consider six alternative measures, which are the most widely used. First, we use the wage bill for each region (WB), as taken from national accounts, and divide it by total population (TOTP), as taken from the *UN Demographic Yearbook*. Total population, however, exceeds the workforce in each region. Therefore, we use as a second measure of the average wage rate the wage bill divided by the economically active population (EAP).[10] The third and fourth measures use GDP per capita using TOTP and EAP, respectively. The fifth and sixth measures of the average wage rate use GDP per capita using TOTP and EAP, where the GDP has been adjusted by the exchange rate deviation index, that corrects for the difference between the official and the purchasing power parity exchange rates ($AGDP_{pc}$) (Kravis *et al.* 1982). The wage measures based on GDP per capita were included for comparison purposes, since Hamilton and Whalley (1984) used this measure in their calculations. However, GDP per capita is only an approximate measure of average wages as it is a measure of economic activity, and not a measure of income. Furthermore, in the production of domestic output, labour is not the only factor of production involved; physical capital and human capital are also involved. From GDPpc it is not possible to isolate the labour component.

Since there is labour market segmentation, we need to calculate the average wage rates of skilled and unskilled labour in each region. Given that in practice such data are not

10 ILO (1996: 5) defines the economically active population as 'all persons of either sex who furnish the supply of labour for the production of goods and services during a specified time-reference period'.

available, we use average earnings per worker in finance, insurance, real state and business services as proxy for skilled labour wages, while average earnings per worker in wholesale and retail trade, restaurants and hotels as proxy for unskilled labour wages. The ratio between high and low wages is then used to infer the average wage rates for skilled and unskilled labour in each region. The resulting relative wage rates for the two types of labour are reported in Table 2. As can be seen, regardless of how the wage rates are calculated, USA, JAP, EU and ODC have higher wage rates than the developing world (i.e., DAM, DAF, DAS and DE).

The final step in the calibration procedure is to use the price-quantity data to calculate parameters for demand and production functions from the benchmark equilibrium observations, given the required values of pre-specified parameters such as elasticities and tax rates. In order to do this, we use the equilibrium conditions together with first-order conditions (from utility maximization and cost minimization), to solve for function parameter values using equilibrium prices and quantities. Calibration allows us to test the solution procedure, and ensures the consistency of agents' behaviour with the benchmark dataset. The model was solved using a routine we wrote in the General Algebraic Modelling System (GAMS) software.

Table 2
Relative wage rates (1990 US$)

	Regions							
Wage measures	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
WB/TOTP								
Unskilled labour	91.3	96.3	60.2	72.9	6.7	1.0	1.5	13.8
Skilled labour	150.0	158.1	122.2	97.6	13.1	1.8	2.2	17.3
WB/EAP								
Unskilled labour	68.5	71.3	52.9	61.6	7.1	1.0	1.6	11.3
Skilled labour	112.6	117.0	107.5	82.4	13.8	1.8	2.3	14.1
GDP_{pc}(TOTP)								
Unskilled labour	31.9	51.0	23.8	25.4	4.2	1.0	0.9	5.1
Skilled labour	52.4	83.7	48.3	33.9	8.1	1.8	1.3	6.4
GDP_{pc}(EAP)								
Unskilled labour	23.9	37.7	20.9	21.4	4.4	1.0	1.0	4.2
Skilled labour	39.3	62.0	42.5	28.6	8.6	1.8	1.4	5.2
$AGDP_{pc}$(TOTP)								
Unskilled labour	16.0	28.1	11.8	12.6	4.0	1.0	1.2	3.8
Skilled labour	26.2	46.1	23.9	16.8	7.7	1.8	1.8	4.8
$AGDP_{pc}$(EAP)								
Unskilled labour	12.0	20.8	10.4	10.6	4.2	1.0	1.3	3.1
Skilled labour	19.7	34.1	21.1	14.2	8.2	1.8	1.8	3.9

4 Model results

The model described above was used to calculate the worldwide efficiency gains from free mobility of labour (the results are presented for the six measures of wages mentioned previously). We consider two scenarios: in the first one labour is a homogeneous factor of production; this scenario is included in order to compare the results with those obtained by Hamilton and Whalley (1984). In the second scenario, labour is classified as skilled and unskilled. In the latter scenario, we consider two cases: (i) both skilled and unskilled labour migrate; and (ii) skilled labour is the only factor that migrates. We did not consider the case where unskilled labour is the only factor that migrates, since unskilled labour is usually involved in illegal migration and the model does not consider this type of migration.

The removal of restrictions on labour mobility modifies the market clearing condition that determines the equilibrium wage rate. In particular, when labour is homogeneous the equilibrium condition is given by

$$\sum_{r=1}^{8} L^r = \sum_{r=1}^{8} \overline{L^r}, \qquad [4]$$

where $\overline{L^r}$ corresponds to the region's endowment of labour. In the heterogeneous case we have

$$\sum_{r=1}^{8} Ls^r = \sum_{r=1}^{8} \overline{Ls^r} \qquad [5a]$$

and

$$\sum_{r=1}^{8} Lu^r = \sum_{r=1}^{8} \overline{Lu^r}, \qquad [5b]$$

where $\overline{Ls^r}$ and $\overline{Lu^r}$ correspond to the region's endowment of the two types of labour.

In the model international capital transfers are not considered, since it is assumed that migrant workers do not bring capital with them nor send capital back home. Capital flows and transfers may alleviate the negative effects of migration on wages. In addition, the model assumes that all migrant labour enters the labour market (some migrants such as children and elderly people will not actually work).

Once immigration controls are removed, labour migrates from low-wage regions to high-wage regions. The source regions are DAM, DAF, DAS, and DE, while the destination regions are USA, JAP, EU, and ODC. However, when the average wage rate is measured as wage bill divided by EAP, and wage bill divided by TOTP, DE becomes a destination region for the homogeneous labour case. When labour is heterogeneous, and both skilled and unskilled labour migrate, DE becomes a destination region for unskilled labour, and a source region for skilled labour. Regardless of whether labour is homogeneous or heterogeneous, the amount of the factor entering DE is not considerable.

Table 3 quantifies the effects of the removal of immigration controls on welfare, as measured by the aggregate equivalent variation.[11] In the homogeneous labour case, there is a reduction in production in all sectors in the source regions. This is accompanied by a reduction in exports and an increase in imports which compensate for the reduction in domestic output. Conversely, in the destination regions, there is an increase in production in all sectors accompanied by an increase in exports and a reduction in imports from developing regions. In this case, there are large gains from the removal of global immigration controls, ranging from 15 per cent to 67 per cent of world GDP. These gains are not as large as those obtained by Hamilton and Whalley (1984), where in some cases the gains exceeded the worldwide economy GNP. The differences may be the result of the modelling frameworks (i.e. partial equilibrium versus general equilibrium), the flows of labour leaving low-wage regions, or units of measurement as Hamilton and Whalley (1984) use population, and we use units of labour.

Table 3 also presents the welfare effects of the removal of immigration controls when labour is a heterogeneous factor. In this case, as in the previous scenario with homogeneous labour, there is an increase in domestic output in developed regions, whereas output reduces in developing countries; the reduction in domestic output is compensated by a reduction in exports and an increase in imports from developed regions. When both skilled and unskilled labour migrate, efficiency gains range from 13 per cent to 59 per cent of world GDP. The gains are smaller than in the homogeneous case as a result of the technological constraint imposed by the substitutability between skilled and unskilled labour. Thus, with a segmented labour market skilled and unskilled labour have less opportunity to reallocate. When only skilled labour migrates, worldwide welfare gains are much smaller than in the previous two cases (from 3 per cent to 11 per cent of world GDP) because skilled labour represents a small fraction of the labour force in the source regions (i.e. 14 per cent in DAM, 10 per cent in DAF, 5 per cent in DAS, and 14 per cent in DE).

The segmentation of the labour market also allows us to examine the distributional effects of immigration between skilled and unskilled labour in each region. Tables 4 and 5

Table 3
Welfare effects of the removal of immigration controls
(Equivalent variation as a percentage of world GDP)

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
WB/TOTP	67	59	11
WB/EAP	54	48	9
GDPpc TOTP)	45	41	8
GDPpc(EAP)	36	32	7
AGDPpc(TOTP)	19	17	4
AGDPpc (EAP)	15	13	3

Note: Ls and Lu denote skilled and unskilled labour, respectively.

11 The equivalent variation (EV) is a measure of welfare change. It is defined as the amount of money a particular change, that has taken place between equilibria, is equivalent to. In this case, an arithmetic sum of EVs, summed across regions is used.

present the distributional impacts of the removal of immigration controls for the six measures of wages considered. A priori one would expect that labour migration from the source regions increases the labour supply in the destination regions, reducing the average wage rate (assuming no rigidities), and benefiting capital owners. In the source regions, the removal of immigration controls is expected to reduce the labour supply, increasing the average wage rate. As a result, capital is less scarce relative to labour, so that a reduction in the return to capital is expected.

When both skilled and unskilled labour migrate (see Table 4), average wages increase in the source regions because labour is less abundant relative to capital, and the return to capital decreases. The removal of immigration controls benefits skilled labour more than unskilled labour, because the former is a small proportion of the total labour force, and after migration this factor is more scarce in developing regions. In the destination regions, average wages reduce for both skilled and unskilled labour, since labour is now less scarce relative to capital, and the return to capital increases.

When only skilled labour migrates (see Table 5), there is a substantial increase in the remuneration of this type of labour in the source regions, since this factor of production is not abundant in these regions. Unskilled workers and capital owners are worse off as a result of migration, despite the fact that there is an increase in their remuneration. As to the destination regions, the inflow of skilled labour increases the supply of this type of labour, hence reducing its average wage rate. As we would expect, the average wage of unskilled labour and the return to capital increase. Skilled labour is worse off. The flexibility of wages allows the labour market to absorb labour immigration. Lower wages induce an increase in labour demand and in aggregate employment.

The amount of labour leaving the source regions varies depending on the measure used to calculate average wages (see Table 6). For example, when these are measured as the wage bill divided by TOTP, 53 per cent of the labour endowment of developing regions migrate to developed regions; when the average wage rate is measured as adjusted GDP per capita using EAP, this percentage reduces to 37 per cent. On the other hand, when both skilled and unskilled labour migrate in the heterogeneous labour case, the percentage of labour leaving the source regions varies from 35 per cent (average wage rate measured as adjusted GDP per capita using EAP) to 50 per cent (average wage rate measured as the wage bill divided by TOTP). When only skilled labour migrates, between 59 per cent and 73 per cent of the skilled labour endowment of developing regions migrate, depending on how the average wage rate is calculated. Regarding the costs of migration, these are estimated between 5 per cent and 8 per cent of GDP (depending on the wage measure) when labour is assumed to be homogeneous and also when both skilled and unskilled labour migrate; see Table 7 These costs are clearly smaller when compared to the welfare gains reported in Table 3. On the contrary, when only skilled labour migrates, the estimated costs of migration are larger than the welfare gains, which can be explained by the fact that a much larger percentage of skilled labour leaves the developing regions. Thus, the net welfare effects of the removal of restrictions on labour mobility are negative.

In summary, migration leads to factor reallocation, and during this process there are winners and losers. In the source regions, labour becomes more scarce relative to capital (between 37 per cent and 53 per cent of the labour endowment of developing regions migrate to developed regions, depending on the wage measure used), and capital owners lose. However, not all workers are better off, since labour is a heterogeneous factor.

Table 4
Distributional impact of the removal of immigration controls
Heterogeneous labour: both skilled and unskilled labour migrate (% change)

	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
WB/TOTP								
P_{LS}	-18	-22	0	26	837	6,671	5,446	608
P_{LU}	-47	-50	-20	-34	620	4,697	3,022	249
P_K	191	236	181	164	263	1,351	900	329
WB/EAP								
P_{LS}	-12	-15	-7	21	619	5,377	4,246	604
P_{LU}	-40	-43	-23	-34	478	3,981	2,467	263
P_K	145	179	142	129	363	1,130	755	312
GDP pc (TOTP)								
P_{LS}	-7	-42	1	43	499	2,580	3,535	662
P_{LU}	-34	-59	-12	-17	406	2,005	2,161	313
P_K	113	146	116	113	308	615	655	328
GDP pc (EAP)								
P_{LS}	-3	-39	-10	33	343	1,998	2,654	631
P_{LU}	-28	-54	-17	-19	294	1,633	1,701	317
P_K	83	100	85	85	229	494	529	307
AGDP pc (TOTP)								
P_{LS}	-0	-43	9	56	238	1,342	1,374	446
P_{LU}	-17	-53	12	5	234	1,220	969	245
P_K	44	38	66	63	174	364	332	234
AGDP pc (EAP)								
P_{LS}	1	-42	-6	40	143	993	982	407
P_{LU}	-13	-50	0	-2	149	942	716	234
P_K	31	17	42	43	115	250	250	210

Note: P_{LS} corresponds to the average wage rate of skilled labour; P_{LU} is the average wage rate of unskilled labour; and P_K refers to the return to capital.

Table 5
Distributional impact of the removal of immigration controls
Heterogeneous labour: skilled labour migrates only (% change)

	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
WB/TOTP								
P_{LS}	-60	-62	-51	-38	361	2,234	2,631	249
P_{LU}	24	55	48	40	117	217	189	129
P_K	27	60	51	42	115	211	184	128
WB/EAP								
P_{LS}	-52	-54	-50	-35	289	2,862	2,250	281
P_{LU}	19	46	39	34	97	190	164	129
P_K	22	41	42	36	96	185	160	128
GDP pc (TOTP)								
P_{LS}	-46	-66	-41	-16	250	1,464	2,022	345
P_{LU}	16	35	35	34	86	116	146	139
P_K	18	39	37	35	85	113	143	138
GDP pc (EAP)								
P_{LS}	-38	-61	-43	-15	183	1,239	1,657	366
P_{LU}	13	25	26	27	67	97	121	135
P_K	14	28	28	28	66	94	118	134
AGDP pc (TOTP)								
P_{LS}	-27	-59	-20	14	147	954	978	299
P_{LU}	8	9	23	26	54	76	78	111
P_K	9	12	24	27	53	74	76	109
AGDP pc (EAP)								
P_{LS}	-21	-54	-26	10	91	761	752	299
P_{LU}	6	3	14	19	37	58	59	102
P_K	7	4	15	20	36	56	57	101

Note: See note to Table 4.

Table 6
Migration flows as % of developing regions' labour endowment

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
WB/TOTP	53	50	73
WB/EAP	51	48	72
GDPpc TOTP)	48	46	70
GDPpc(EAP)	47	44	68
AGDPpc(TOTP)	39	37	61
AGDPpc (EAP)	37	35	59

Note: Ls and Lu denote skilled and unskilled labour, respectively.

Table 7
Migration costs as % of world GDP

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
WB/TOTP	8	8	12
WB/EAP	8	8	11
GDPpc TOTP)	8	7	11
GDPpc(EAP)	7	7	11
AGDPpc(TOTP)	6	6	10
AGDPpc (EAP)	6	5	9

Note: Migration costs were calculated as the number of people migrating multiplied by the cost of moving. The number of people that migrates is calculated as the economically active population in developing regions multiplied by the percentage of labour moving from developing to developed regions. As to migration costs, we use Conley and Ligon (2002) to obtain estimates of transport costs. They report airfares between countries' capitals as the cost of transporting embodied human capital and the cost of shipping a 20 kg express package between capital cities. We used their data base, as taken from http://are.berkeley.edu/~ligon/papers/distance.tgz, to calculate an approximate average cost of moving from developing to developed regions. From the model it is possible to establish that people migrate from developing to developed regions, but not to which particular developed region.

Emigration will benefit workers whose skills are substitute to those of migrant labour, whereas it will hurt those workers whose skills are complementary to those of migrant workers. On the other hand, in the destination regions, labour becomes more abundant (less scarce) relative to capital, so that capital owners benefit. However, not all workers are worse off, because labour is a heterogeneous factor. Immigration will benefit those workers whose skills are complementary to those of the immigrant worker, whereas immigration will hurt those workers whose skills are substitute to those of immigrant workers.

We also performed a sensitivity analysis on the key elasticities of the model (these results are not reported here). In particular, in a first set of simulations the elasticity of labour-labour substitution was varied from 0.5 to 2.5. This elasticity is very important in our model since it includes a segmented labour market, a feature that has not been considered in previous works. In a second set of simulations, the elasticities of substitution in the production of value added were set at values between 0.5 and 1.5 in all regions; this elasticity corresponds to the elasticity of substitution between the aggregate labour input and capital. We conclude that the results are robust to the elasticity choice, in the sense that the elimination of immigration controls generates worldwide efficiency gains. In addition, in the destination regions capital owners benefit from labour immigration, and workers lose because of lower wages. In the source regions, capital owners are worse off and workers are better off. The sensitivity analysis also confirms that migration of skilled labour hurts unskilled labour in the source regions.

5 Model extensions

This section introduces three new features to the model: (i) transaction costs; (ii) international capital mobility; and (iii) selective labour mobility. For brevity we only report the results of two out of the six measures of average wages considered: average wage rate as measured by the wage bill divided by TOTP, and as adjusted GDP per capita using EAP. These two measures were chosen as they provided the extreme results.

5.1 Transaction costs

The first elaboration of the model is the introduction of transaction costs. This extension of the model seems appropriate, since migration is a costly process. There are costs involved in the process of moving from one region to another, such as transport costs, the costs of settling in the other region, the costs of finding a new job, and the costs of leaving friends and family behind. With the elimination of restrictions on labour mobility, labour will move until the marginal product of labour equals the cost of hiring labour; hence, a single market clearing wage no longer characterizes the equilibrium. Transaction costs thus drive a wedge between wages in developed and developing countries. These were modelled as a tax without revenue, whose rate is exogenously determined. The price received by owners of labour in each region corresponds to a percentage of the market clearing price when restrictions to labour mobility are eliminated. That is, the price of labour in each region is given by,

$$P_L^r = W(1 - TC^r), \qquad [6]$$

where W corresponds to the world price of labour, and TC^r corresponds to regional transaction costs.

Transaction costs are difficult to quantify since there are no measures available. As mentioned earlier, there are costs associated with migration from low-wage to high-wage regions. In the case of developing regions, these costs could be very high. Taking into account the substantial differences in relative wages among the regions, we assume the following values for transaction costs: 0.9 for DAF and DAS; 0.8 for DAM; and 0.7 for DE. The transaction costs for developed regions (USA, JAP, EU, and ODC) are assumed to be much smaller (i.e. 0.1), since workers in these regions have little or no incentive to move to low-wage regions.

The introduction of transaction costs reduces migration flows (see Table 8). For example, when the average wage is measure as WB/TOTP, and labour is homogeneous, migration reduces from 53 per cent of the developing regions' endowment of labour to

24 per cent. In the heterogeneous labour scenario, migration reduces from 50 per cent of the developing regions' endowment of labour to 32 per cent when the two types of labour are allowed to migrate and from 73 per cent of the developing regions' endowment of skilled labour to 53 per cent when only skilled labour migrates. Welfare gains (see Table 9) and migration costs (see Table 10) are also smaller in the presence of transaction costs, because less people are moving from developing to developed regions.

Table 8
Migration flows in the presence of transaction costs
(Migration as a percentage of developing regions' labour endowment)

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
Without transaction costs			
WB/TOTP	53	50	73
AGDP pc (EAP)	37	35	59
With transaction costs			
WB/TOTP	24	32	53
AGDP pc (EAP)	4	2	9

Note: Ls and Lu denote skilled and unskilled labour, respectively.

Table 9
Welfare effects of the removal of immigration controls in the presence of transaction costs
(Equivalent variation as a percentage of world GDP)

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
Without transaction costs			
WB/TOTP	67	59	11
AGDP pc (EAP)	15	13	3
With transaction costs			
WB/TOTP	31	26	6
AGDP pc (EAP)	1	1	1

Note: See Table 8.

Table 10
Migration costs in the presence of transaction costs as % of world GDP

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrates
Without transaction costs			
WB/TOTP	8	8	12
AGDP pc (EAP)	6	5	9
With transaction costs			
WB/TOTP	4	5	8
AGDP pc (EAP)	1	0	1

Note: See Table 8.

Regarding the distributional effects, results not reported here indicate that when the labour market is segmented, skilled labour benefits relative to unskilled labour in the source regions; in the destination regions the two types of labour lose, but unskilled workers are hurt even more when both skilled and unskilled labour migrate.

Finally, migration, welfare gains and migration costs increase as the transaction costs for the developing regions are reduced (these results are not reported here though). This is the case since transaction costs distort the labour market, specially in developing regions, and as the distortion is reduced, efficiency increases and the wage gap reduces.

5.2 Capital mobility

In the second elaboration of the model we introduce international capital mobility. Although this feature is usually ignored in global models (see e.g., Whalley 1985; Shoven and Whalley 1992), it seems interesting to include it in the model since capital markets are becoming more integrated internationally. In this case, the return to capital equalizes across regions. Therefore, a single market clearing rental rate characterizes the equilibrium; that is, the market clearing condition for the market of the capital factor is given by,

$$\sum_{r=1}^{8} K^r = \sum_{r=1}^{8} \overline{K^r} \qquad [7]$$

that is the sum of the demand for capital in each region must equal the global endowment of the factor.

Simulations were carried out for the scenario in which only skilled labour migrates, since we need a fixed factor (in this case unskilled labour). If all factors of production are allowed to move freely, the concept of region is no longer clear.

When we remove the restrictions to skilled labour mobility, we observe that labour moves from regions with low wages (DAM, DAF, DAS, and DE) to regions with high wages (USA, JAP, EU, and ODC). Capital moves from regions where it is abundant relative to labour (USA, JAP, EU, and ODC) to regions where it is scarce relative to

Table 11
Distributional impact of the removal of immigration controls in the presence of capital mobility
(% change)

	USA	JAP	EU	ODC	DAM	DAF	DAS	DE
WB/TOTP								
P_{LS}	-62	-64	-54	-42	332	3,018	2,454	226
P_{LU}	14	29	28	24	69	136	131	76
P_K	48	48	48	48	48	48	48	48
AGDPpc(EAP)								
P_{LS}	-24	-56	-29	5	82	720	712	280
P_{LU}	3	1	7	11	20	37	40	57
P_K	15	15	15	15	15	15	15	15

Table 12
Welfare effects of the removal of immigration controls in the presence of capital mobility
(Equivalent variation as a percentage of world GDP)

Wage measures	Only Ls migrates
Without capital mobility	
WB/TOTP	11
AGDP pc (EAP)	3
With capital mobility	
WB/TOTP	13
AGDP pc (EAP)	4

labour (DAM, DAF, DAS, and DE). The effects over the remuneration of the factors of production are similar to those obtained when capital is not internationally mobile. We observe a substantial increase in the remuneration of skilled labour in the source regions since this factor is not abundant in these regions, whereas unskilled labour and capital owners are worse off; in the destination regions, the remuneration of skilled labour falls and unskilled labour and capital owners are better off (see Table 11). The effects of capital mobility on the return to capital are smaller than the effects of skilled labour mobility on wages. This is explained by the fact that capital flows from developed to developing regions are smaller than labour flows from developing to developed regions. In particular, when wages are measured as the wage bill divided by TOTP, migration flows account for 56 per cent of the world endowment of labour whereas capital flows account for only 7 per cent of the world endowment of capital.

In addition, aggregate welfare improves compared with the scenario without capital mobility (see Table 12). The improved welfare is the result of a better resource allocation with smaller distributional effects.

The previous results should be taken with caution since they are ruled by the specification of the capital market. That is, since we assume a competitive market, capital will respond to variations in its rate of return. However, as indicated by Layard *et al.* (1992), developing regions have low productivity, and it is possible that migration from DAM, DAF, DAS, and DE to USA, JAP, EU, and ODC would divert capital to developed regions that could be instead invested in developing regions.[12]

5.3 Selective labour mobility

The third elaboration of the model is the introduction of selective labour mobility. This extension seems interesting since some countries have signed bilateral agreements with other countries that cover project-link work, seasonal work, work in border areas, and guest workers.[13] We focus on the case where individuals in some particular regions in the developing world are allowed to migrate to developed regions. We consider the following seven possibilities:

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12 Lucas (1995) provides an alternative explanation.

13 For example, Germany has signed labour agreements with Hungary, Poland, and the Czech Republic. Also Belgium, France and Switzerland have signed labour agreements with East European countries (Weyerbrock 1995).

- Workers in DAM migrate to USA, JAP, EU, and ODC;
- Workers in DAF migrate to USA, JAP, EU, and ODC;
- Workers in DAS migrate to USA, JAP, EU, and ODC;
- Workers in DE migrate to USA, JAP, EU, and ODC;
- Workers in DAM migrate to USA;
- Workers in DAS migrate to JAP; and
- Workers in DAF and DE migrate to EU.

Each of these seven possibilities are analysed when labour is homogeneous, when labour is heterogeneous and both skilled and unskilled workers migrate, and when labour is heterogeneous and only skilled workers migrate.

Table 13
Welfare effects of the removal of immigration controls in the presence of selective mobility
(Equivalent variation as a percentage of world GDP)

	Homogeneous labour	Heterogeneous labour	
		Both Ls and Lu migrate	Only Ls migrate
DAM → USA, JAP, EU, ODC			
WB/TOTP	5	5	2
AGDPpc(EAP)	1	1	1
DAF → USA, JAP, EU, ODC			
WB/TOTP	11	11	3
AGDPpc(EAP)	2	2	1
DAS → USA, JAP, EU, ODC			
WB/TOTP	47	52	9
AGDPpc(EAP)	11	11	2
DE → USA, JAP, EU, ODC			
WB/TOTP	3	3	1
AGDPpc(EAP)	2	2	1
DAM → USA			
WB/TOTP	4	4	1
AGDPpc(EAP)	0	0	0
DAS → JAP			
WB/TOTP	15	24	4
AGDPpc(EAP)	7	9	2
DAF, DE → EU			
WB/TOTP	10	11	3
AGDPpc(EAP)	3	3	1

Note: → indicates the direction of the migration flow.

Under this elaboration, the average wage equalizes across the regions involved, whereas each of the excluded regions will have a market clearing condition for the labour market.

We observe an aggregate welfare improvement in all seven cases (see Table 13). The magnitude of the welfare gains depends on the size of the source region in terms of the labour market endowment. In particular, the highest welfare gains are obtained when workers in DAS are allowed to migrate to USA, JAP, EU, and ODC, since DAS is the most densely populated region, and has one of the lowest average wages. Conversely, the lowest welfare gains are obtained when DE is allowed to migrate to USA, JAP, EU, and ODC; this result is not surprising since DE is the third region in terms of population in the developing world, and the region's average wages are, in some cases, the highest in the developing world.

In terms of the amount of labour that moves between regions, the largest movement occurs when workers in DAS are allowed to migrate to USA, JAP, EU, and ODC. In the homogeneous case, the proportion of labour that moves out of DAS varies between 13 per cent and 30 per cent of the world endowment of labour; in the heterogeneous labour case, the proportion of labour that moves out of DAS varies between 12 per cent and 36 per cent of the world endowment of labour. Conversely, the smallest amount of migration occurs when the workforce in DE is allowed to migrate to USA, JAP, EU, and ODC. These results suggest a positive relationship between the amount of migration and welfare gains.

As to the distributional impact of the removal of immigration controls, results not reported here indicate that the introduction of selective labour mobility does not affect our main conclusions (i.e. workers in the source region and capital owners in the destination regions benefit from migration). When both skilled and unskilled labour migrate, and workers in DAM migrate to USA, JAP, EU, and ODC, skilled labour in ODC also migrates to the other developed regions because the remuneration of this factor is the lowest of the developed world. Skilled and unskilled labour are better off relative to capital in the source regions, and in DAM unskilled labour is better off relative to skilled labour. This result contrasts with the findings in the central case, and can be explained by the fact that more unskilled labour is migrating out of the region. In the other selective labour mobility cases, skilled labour is better off relative to unskilled labour and capital in the source regions, whereas in the destination regions unskilled labour is worse off relative to skilled labour, and capitalists benefit.

Lastly, when we have a segmented labour market and skilled labour migration, skilled workers gain in the source regions relative to unskilled workers; in the destination regions, both unskilled and skilled labour lose relative to capital, although unskilled labour loses less than skilled labour.

6 Concluding remarks

In this paper we have computed the worldwide efficiency gains from the elimination of restrictions on labour mobility. One of the key features of our model is the introduction of a segmented labour market, as we consider two types of labour, skilled and unskilled. When labour is heterogeneous, we consider the cases where both skilled and unskilled labour migrate, and when only skilled labour migrates. In our analysis, wages differ across regions because of the existence of barriers to labour mobility, and wage rates are equalized as a result of the elimination of restrictions to labour mobility rather than free trade.

Our findings indicate that the elimination of global restrictions to labour mobility generates worldwide efficiency gains, that could be of considerable magnitude, ranging from 15 per cent to 67 per cent of world GDP. When only skilled labour is allowed to migrate, welfare gains are smaller since skilled labour is a small proportion of the labour force in developing regions; in this case, efficiency gains range from 3 per cent to 11 per cent of world GDP. The estimated costs of migration are smaller than the welfare gains when labour is homogeneous and also when both skilled and unskilled labour migrate. When only skilled labour from developing regions migrate, migration costs exceed welfare gains because of the large amount of qualified workers leaving these regions.

Migration also leads to a process of factor reallocation in which there are winners and losers. In the source regions, labour becomes more scarce relative to capital, and capital owners lose. However, not all workers are better off, since labour is a heterogeneous factor. Emigration will benefit workers whose skills are substitute to those of migrant labour, whereas it will hurt those workers whose skills are complementary to those of migrant workers. On the other hand, in the destination regions, labour becomes more abundant (less scarce) relative to capital, and capital owners benefit. Again, not all workers in the destination regions are worse off, because labour is a heterogeneous factor. Immigration will benefit those workers whose skills are complementary to those of the immigrant worker, whereas immigration will hurt those workers whose skills are substitute to those of immigrant workers.

The model was then extended by including: (i) transportation costs, since migration is a costly process; (ii) capital mobility, since capital markets have become more international in scope; and (iii) selective labour mobility, since some countries have introduced immigration control policies that allow migration flows from some regions and not from others. With the introduction of transaction costs, wages fail to equalize across regions, migration flows reduce and in consequence efficiency gains reduce as well. With capital mobility, global welfare improves compared with the scenario without capital mobility, as a result of a better resource allocation. With selective labour mobility, aggregate welfare improves and the magnitude of the gain depends on the size of the region in terms of the labour endowment.

Finally, our results have shown that the elimination of global restrictions on labour mobility generates considerable worldwide efficiency gains. Despite these gains, the liberalization of worldwide migration is far from realistic because of social and political tensions. High-income countries are very reluctant to open their borders to free migration because they do not want to become the destination of immigration of unskilled labour from low-income countries. In the short-run, countries regulate the flows of international migration by means of border controls, and work permits, among others. In the long-run, countries should concentrate their efforts in the elimination of the incentives to migrate, which could be accomplished by reducing income disparities among regions.

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Appendix A: Equilibrium conditions of the model

Equilibrium is given by a set of goods and factor prices for which all markets clear. That is, demand-supply equalities hold in each goods and factors markets; zero profit conditions hold for each industry in each region; and each region is in external-sector balance.

In the goods market, gross output equals final demand because intermediate production is netted out; specifically, the model has the following blocks of market clearing conditions:

- The supply of goods for domestic consumption must equal the demand for domestically produced goods.

- Exports from region *r* to region *s* must equal imports of region *s* from region *r*, because there are assumed to be no transfer (e.g. transport) costs in shipping goods from one region to another.

- Total supply of composite commodities, which consists of the composite of similar domestic products and aggregate imports, must equal consumer's demand in each region.

- In a segmented labour market, the supply of the aggregate labour input generated by the combination of *Lu* and *Ls*, must equal the demand for the aggregate labour input used in the production of value added.

In the factor markets we initially assume that all factors are internationally immobile. This assumption implies that factor prices are different in each region; this is an important assumption for the results of our model, since market clearing conditions in factor markets determine factor prices. Under this assumption, we have separate labour and capital equilibrium conditions in each region. That is, the region's endowment of capital and labour must equal factor use (i.e. full employment occurs in all regions). In the second variant of the model capital is assumed to be internationally mobile. This assumption implies that there is only one price for capital in the model, and this is determined by the market clearing condition that factor use across all industries and regions must equal the world endowment of capital.

The zero profit conditions state that the total value of sales must equal the industry's costs, they must hold in each region. In particular,

- In each region the value of domestic output must be equal to the capital and labour costs of producing the good. At the same time, the value of domestic output equals the value of commodities sold in the domestic market plus the value of commodities sold as exports.

- The value of commodities sold as exports must equal the value of the sum of exports to the other seven regions.

- The value of total imports must equal the value of the sum of imports from the other seven regions.

– The value of the composite commodity demanded by consumers must equal the value of aggregate imports plus the value of domestically produced goods.

– The value of goods sold for domestic consumption must be equal to the value of the demand for domestically produced goods.

– The value of exports from region *r* to region *s* must be equal to the value of imports of region *s* from region *r*.

– In a segmented labour market, the value of the aggregate labour input must be equal to the skilled and unskilled labour costs of producing the aggregate input.

Finally, the external sector balance condition indicates that each region is always on its budget constraint. In this case, we assume that in each region the value of exports minus the value of imports, that is the trade surplus (or deficit), remains fixed in real terms (the trade balance is not zero since this involves adjusting the data). Formally, the external sector balance condition is:

$$P_M^r IMP^r + TB^r = P_X^r EXP^r$$

where $TB^r = TB_0^r \left(\frac{P_r X^r}{P_r^0 X^r} \right)$, P_r^0 is the benchmark consumer price (this price is equal to 1), TB_0^r is the benchmark trade surplus (or deficit), and the term in parentheses is a Paasche price index. We use this price index to take into account changes in prices in the new equilibrium.

Appendix B: Regional classification

Region 1: USA	United States			
Region 2: JAP	Japan			
Region 3: EU	Belgium	Denmark	France	Germany
	Greece	Ireland	Italy	Luxembourg
	Netherlands	Portugal	Spain	United Kingdom
Region 4: ODC	Australia	Austria	Canada	Finland
	Iceland	Israel	New Zealand	Norway
	South Africa	Sweden	Switzerland	
Region 5: DAM	Antigua & Barbuda	Argentina	Barbados	Belize
	Bolivia	Brazil	Chile	Colombia
	Costa Rica	Dominica	Dominican Rep.	Ecuador
	El Salvador	Grenada	Guatemala	Guyana
	Haiti	Honduras	Jamaica	Mexico
	Nicaragua	Panama	Paraguay	Peru
	St. Lucia	St.Kits & Nevis	Suriname	Uruguay
	Trinidad & Tobago	Venezuela	St. Vincent & the Grenadines	
Region 6: DAF	Algeria	Angola	Benin	Botswana
	Burkina Faso	Burundi	Cameroon	Cape Verde
	Central African Rep.	Chad	Comoros	Congo
	Côte d'Ivoire	Djibouti	Egypt	Equatorial Guinea
	Ethiopia	Gabon	Gambia	Ghana
	Guinea	Guinea-Bissau	Kenya	Lesotho
	Madagascar	Malawi	Mali	Mauritania
	Mauritius	Morocco	Mozambique	Namibia
	Niger	Nigeria	Reunion	Rwanda
	Sao Tome & Principe	Senegal	Seychelles	Sierra Leone
	Sudan	Swaziland	Togo	Tunisia
	Uganda	Tanzania	Zambia	Zimbabwe
Region 7: DAS	Bahrain	Bhutan	Bangladesh	China
	Hong Kong	India	Indonesia	Iran (Islamic Rep)
	Jordan	Kuwait	Laos	Lebanon
	Malaysia	Mongolia	Myanmar	Nepal
	Oman	Pakistan	Philippines	Qatar
	Rep. of Korea	Saudi Arabia	Singapore	Sri Lanka
	Syrian Arab Rep.	Taiwan	Thailand	Yemen
	United Arab Emirates			
Region 8: DE	Bulgaria	Croatia	Cyprus	Czech Rep.
	Estonia	Hungary	Malta	Poland
	Romania	Slovenia	Turkey	USSR (former)
	Yugoslavia (former)			