Measuring the Impact of the Movement of Labor Using a Model of Bilateral Migration Flows

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Abstract

The economics literature increasingly recognizes the importance of migration and its ties with many other aspects of development and policy. Examples include the role of international remittances (Harrison et al, 2003) or those immigrant-links underpinning the migration-trade nexus (Gould, 1994). More recently Walmsley and Winters (2005) utilised their Global Migration Model (GMig) to demonstrate that lifting restrictions on the movement of natural persons would significantly increase global welfare with the majority of benefits accruing to developing countries. Although an important result, the lack of bilateral labor migration data forced Walmsley and Winters (2005) to make approximations in important areas and naturally precluded their tracking bilateral migration agreements.

In this paper we incorporate bilateral labor flows into the GMig Model developed by Walmsley and Winters (2005) to examine the impact of liberalizing the temporary movement of natural persons. Quotas on both skilled and unskilled temporary labor in the developed economies are increased by 3% of their labor forces. This additional labor is supplied by the developing economies. The results confirm that restrictions on the movement of natural persons impose significant costs on nearly all countries, and that those on unskilled labor are more burdensome than those on skilled labor.

Developed economies increasing their skilled and unskilled labor forces by 3% raise the real incomes of their permanent residents. Most of those gains arise from the lifting of quotas on unskilled labor. On average the permanent residents of developing countries also gain in terms of real incomes from sending unskilled and skilled labor, albeit the gains are lower for skilled labor. While results differ across developing economies, most gain as a result of the higher remittances sent home.

JEL Classification: F22, C68, O15

Keywords: Applied general equilibrium modelling, GATS Mode 4, labor mobility, skill, real income, migration

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1. Introduction

The Uruguay round heralded a new wave of optimism for developing country members as the first international discussions on the '*temporary mobility of natural persons* (Mode 4)' took place and the the General Agreement on Trade in Services (GATS) was created as a permanent forum for managing services trade liberalization. Developing countries hoped at last to capitalise on their abundant labor. But despite a backdrop of many years of capital and goods market liberalization, policy makers on both sides of the GATS Mode 4 negotiations remained cautious and defensive, resulting in little progress being made (Winters, 2005a). This contrasts strongly with the evidence that the welfare benefits from liberalizing the movement of labor across boundaries would be huge.

First, Winters (2001) argued that if individuals moving from a developing to a developed country made up just a quarter of the wage gap between the two nations, mobility equivalent to a 5% increase in industrialised countries populations would yield a global welfare gain of approximately $300bn at 1997 prices. A similar back-of-the-envelope calculation estimated that liberalization equivalent to a 3% rise in 'rich' countries' labor forces supplied by 'poor' countries on a temporary and rolling basis, with each individual residing abroad for between 3 and 5 years, would raise developing countries annual welfare by $200bn (Rodrik, 2004). More systematic approaches based on various modelling scenarios corroborated these back of the envelope computations.

Walmsley and Winters (2005) estimated that liberalization of the quotas on the flows of both skilled and unskilled labor from developing to developed nations equivalent to 3% of the latter's labor force would yield a global welfare gain of $150bn at 1997 prices. Indeed, simulations from subsequent models based on bilateral migration flows (as opposed to from a global migrant pool) suggested that a similar lifting of quotas would produce approximately double these gains (World Bank, 2006). World Bank (2006) used the GMig2 Data Base with a modified version of the World Bank's LINKAGE recursive-dynamic general equilibrium model. The paper found a global welfare gain of US$674 billion in 2025 (in 2001 $US) compared to the baseline, from a 3% increase in the labor force of high-income countries, with the developing world supplying the additional

workers. The World Bank (2006) also found that natives and new migrants in high-income countries, and the natives of the developing countries, all experienced welfare gains; while the old migrants in the developed countries experienced welfare losses. The larger gains found by the World Bank (2006) be explained by the fact that the World Bank (2006) paper uses a dynamic model to investigate the impact of migration and is based on the GMig2 Data Base (based on 2001) developed for the model used in this paper. This GMig2 Data Base differs considerably from the one used in Walmsley and Winters (2005) for a number of reasons including: this data base is based on 2001, while the previous model was based on 1997 data; migrants have higher productivities in this paper than in Walmsley and Winters (2005); remittances are much higher in the new data base; and finally improved data on skill shares has resulted in fewer skilled migrants. Furthermore the World Bank (2006) paper assumes that native workers and migrant workers do not compete directly with each other, they are related instead by a finite elasticity of substition.

Although all of these estimations should be viewed with a large degree of caution – not least because even relatively minor alterations to any of the crucial underlying assumptions can impact heavily upon the results – the orders of magnitude are astonishing, especially in comparison to the total annual foreign aid budget or the estimated gains to goods trade liberalization. Moreover, these benefits represent only static gains. They fail to account for any dynamic effects, such as those associated with simulated investment, technology transfer or 'brain circulation', whereby service providers return home with greater levels of experience and 'learning from doing' abroad. Spillover and indirect effects of increased service provision may also increase welfare benefits (Winters 2003). On the other hand, increased migration also implies challenges – of integration, of family separation and of labor market shocks in host countries – which policy analysis must take into account.

In this paper we develop a bilateral global migration model, based on the GTAP Model (Hertel, 1997) and similar to the model developed by Walmsley and Winters (2005), which takes into account bilateral labor flows rather than the latter's global migrant pool. It is a companion paper to Parson et al. (2007) in which the new bilateral data that make the approach possible are described and summarized. The new model and data are used to repeat Walmsley and Winters (2005) exercise on the impact of liberalizing the temporary movement of natural persons: Quotas on both skilled and unskilled temporary

labor in the developed economies are increased by 3% of their labor forces, with the additional labor being supplied by the developing economies in proportion to their shares of the stocks of migrants around the year 2000. Section 2 of the paper outlines the model and data, while section 3 discusses the experiments undertaken. Section 4 presents some results and conclusions are drawn in section 5. The exposition focuses on changes from our previous work, in order that readers can judge the extent to which having bilateral data changes our perceptions. The new data also allow us to answer some new questions – e.g. on the effects of regional labor agreements – but these are left to another occasion.

2. The GMig2 Model and Data Base

GATS Mode 4 can be modelled either from the perspective of pure labor migration or as being analogous to greater trade in goods. Here we choose to consider it as an increase in the labor force endowment of the destination region.

We use a standard global applied general equilibrium model (GTAP, Hertel, 1997) which has been adjusted to take into account bilateral labor flows. The model, termed GMig2, is based on the model used in Walmsley and Winters (2005). In that model, Walmsley and Winters had to hypothesize a global pool of labor to intermediate the flow of labor between receiving and sending countries in order to circumvent the lack of bilateral data on migration between individual countries. As a result of Parsons, Skeldon, Walmsley and Winters (2007), however, we now have a data base for the bilateral stocks of migrants (defined as foreign born), which the GMig2 Model exploits to allow us to track labor movements between particular countries.

2.1. The GMig2 Data Base

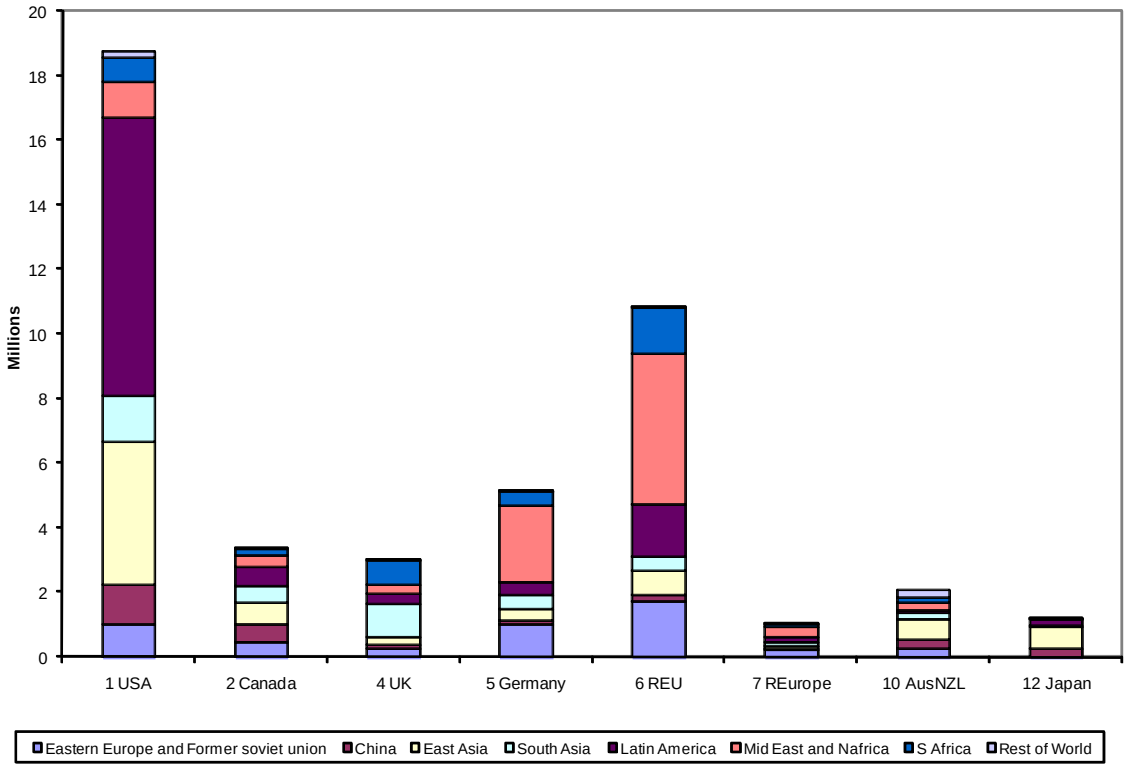
The data base used with the Bilateral Labor Migration Model (GMig2) is based on the GTAP 6 Data Base (Dimaranan and McDougall, 2005)[5] and is augmented with the bilateral migration data base developed by Parsons et al (2007) and remittance data from the World Bank (Ratha, 2003). Like the GTAP Data Base, the GMig2 Data Base also covers 87 regions and 57 sectors and can be extended as the number of regions in the GTAP data base increases[6]. The GMig2 data base construction process is documented

[5] Note that the Walmsley and Winters (2005) paper is based on version 5 data with reference year 1997. The version 6 Data Base is based on 2001.
[6] The new headers in the GMig2 Data Base and sets files are listed in Appendix 1.

Walmsley, Ahmed and Parsons (2005); and readers interested in learning more about the underlying data are referred to this document.

The GMig2 Data Base is then aggregated into 21 regions and 22 commodities for the purpose of this paper. The resulting aggregated data are depicted below: bilateral labor (Figure 1), remittances (Figure 2) and wages (Figures 3 and 4)[7].

Figure 1. Number of Foreigners by Host Region (for selected home regions)



Source: Parsons, Skeldon, Walmsley and Winters (2007).

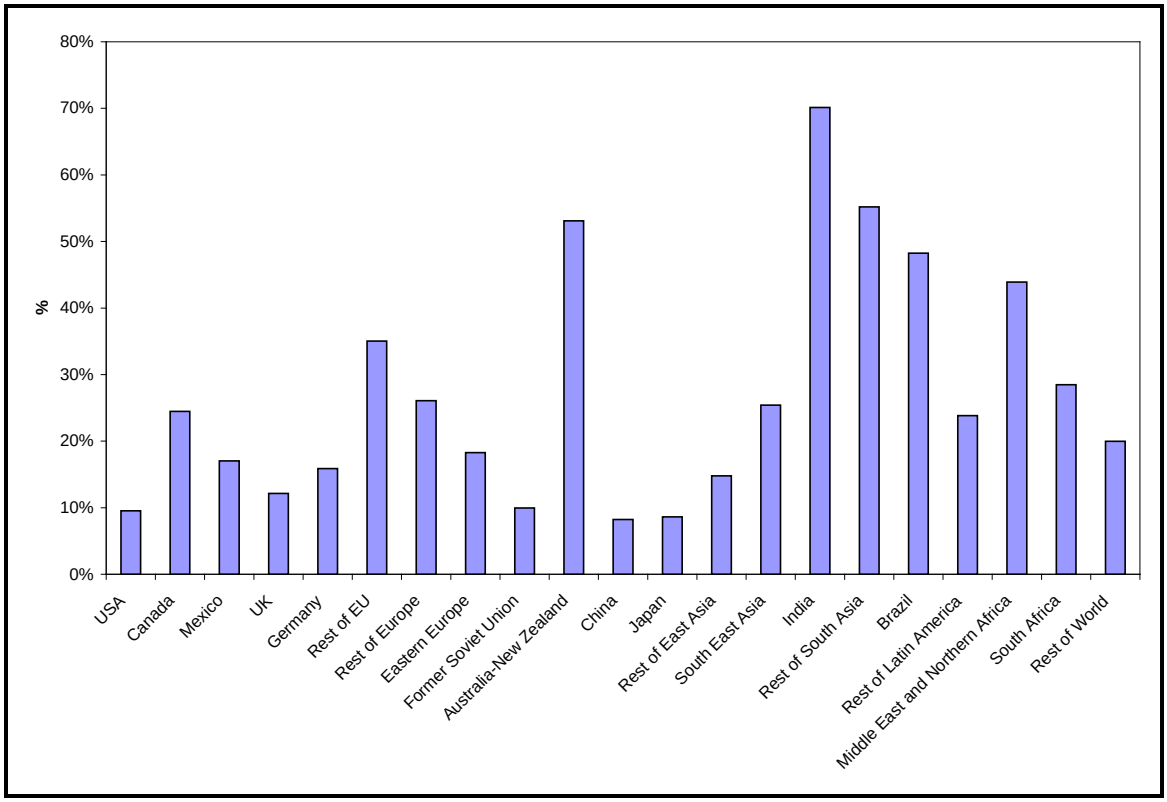
Figure 1 shows the current (approximately 2000-2002) stocks of foreign population by slected home regions in the eight host countries investigated in this paper. The USA has by far the highest number of foreigners, although relative to the size of the host population, only 10% are foreign born. Figure 1 also demonstrates the well know fact that migration is regional, with most foreign workers in the USA coming from Latin America and Mexico, while foreign workers in Europe are from Eastern Europe and the Middle east/Northern Africa. The exceptions are Canada where there does not appear to be a dominant source for migrants; and the UK, where the origins of migrants appears to be at

[7] Note that the wages data are based on GTAP data and estiates of labour force participation, and skill splits. In some cases estimates may not result in accurate estimates of wages.

least partially related to its historical ties with the Commonwealth countries, for example its ties to South Asia.

The proportion of remittances to income sent home by migrants is depicted in Figure 2. In the GMig2 Data Base, South Asians have particularly high remittance rates[8] as a share of income. If this behaviour extends to new migrants, permanent residents in South Asia are likely to gain considerably as a result of allowing more migration from South Asia to these destination economies. Chinese migrants, on the other hand, send only a small share of their income home. The difference between India and China is surprising given that both export substantial numbers of skilled workers to developed economies, such as the USA. Kapur and McHale (2005) suggest that it is primarily due to differences in incentives, and in particular tax incentives. They argue that Chinese migrants tend to send money home in the form of foreign direct investment, and in particular for the purchase of real estate, rather than as remittances.

Figure 2. Ratio of Remittances (to Labor Income) sent home by Migrants from each Region in the initial Data Base (%)[9]



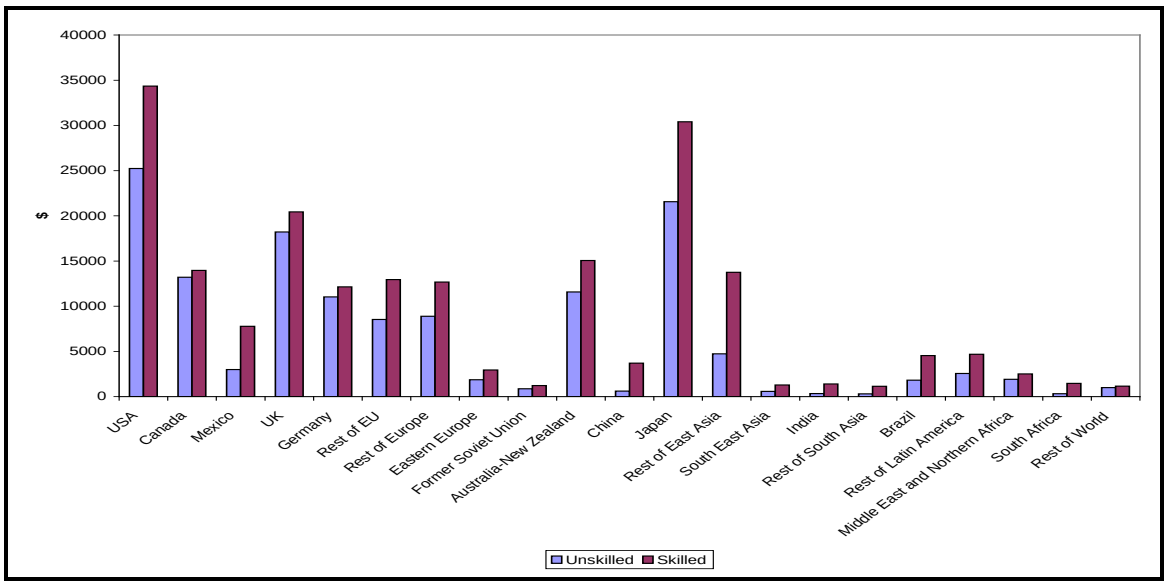
[8] This is the result of hign remittances in obtained from Ratha (2003) relative the the low estimated wages of migrant workers (as estimated in Walmsley, Ahmed and Parsons (2005).

[9] This is the sum of remittances from all host regions flowing into the home region, divided by the total income of those migrants earned in their host regions.

Source: GMig2 Data Base: Walmsley, Ahmed and Parsons (2005)

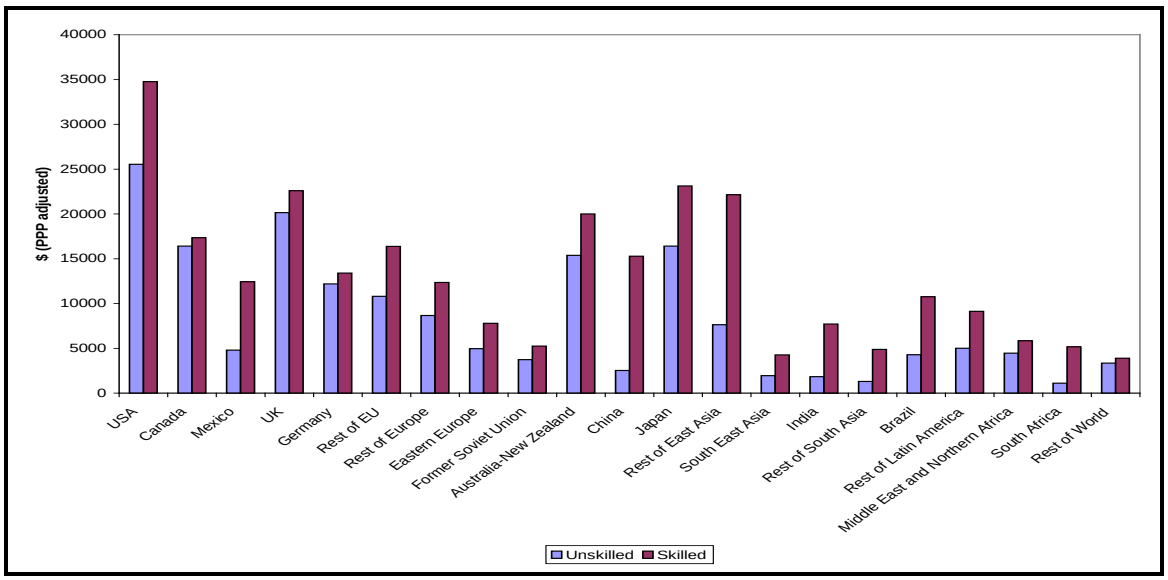
Figures 3 and 4 depict the average nominal and real wages of permanent residents by skill level in each region in the base data. Real wages are the nominal wages adjusted using purchasing power indexes (PPP) depicted in Figure 5 and supplied by the World Bank. The purchasing power parity index indicate the purchasing power within each of the regions relative to the USA (PPP=1), hence a PPP in China of four means that the price of a bundle of goods and services in China costs one-quarter of cost of the same goods in the USA. As expected skilled workers earn more than unskilled workers and wages are higher in developed economies for both skilled and unskilled workers. The United States has by far the highest wages for both skilled and unskilled. When we examine real wages however the differences between developed and developing are smaller although still evident in most of the countries.

Figure 3. Average Nominal Wages of Permanent Residents by Region in the Base Data (at market exchange rates) $US, 2001



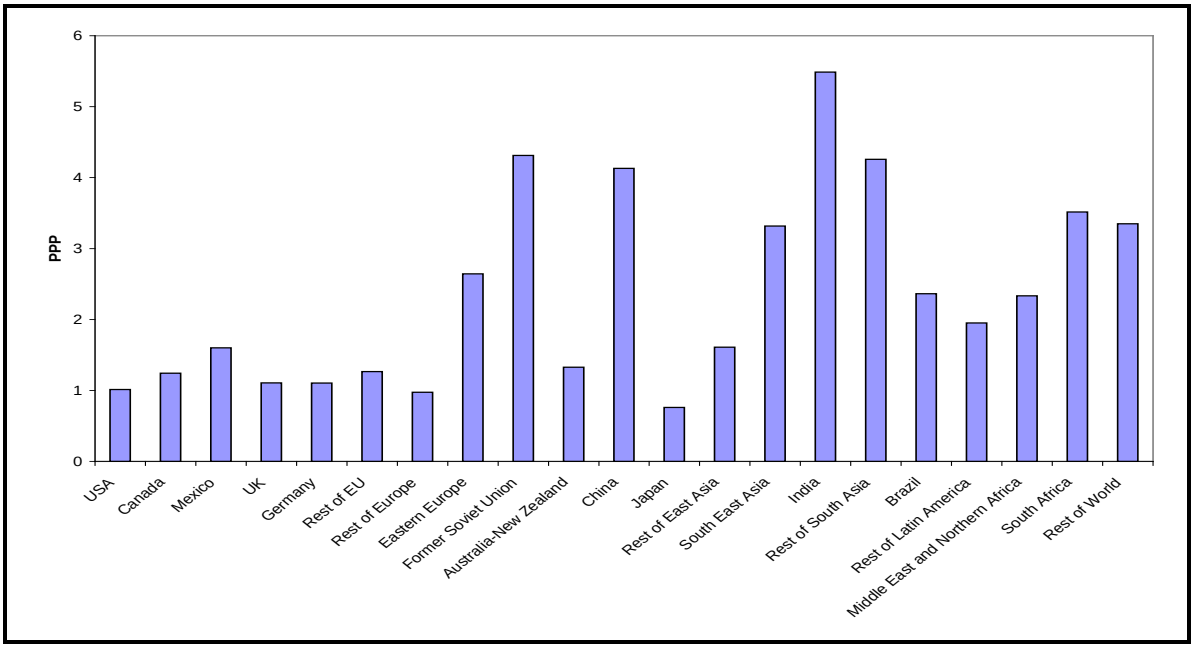
Source: GMig2 Data Base: Walmsley, Ahmed and Parsons (2005)

Figure 4. Average Real (PPP) Wages of Permanent Residents by Region in the base data



Source: GMig2 Data Base: Walmsley, Ahmed and Parsons (2005)

Figure 5. Purchasing Power Parity Indexes (USA = 1.0)



A number of assumptions were made in creating the GMig2 Data Base which are important to note before discussing the details of the model. These assumptions are outlined in Box 1.

Box1: Assumptions made in the construction of the GMig2 Data Base

a. Migrant labor force participation rates are the same as in their home region in the initial data base reflecting the fact that the underlying data are foreign born.

$$LF_{r,c}/POP_{r,c} = LF_r/POP_r \qquad \text{(B1)}$$

where: r is the home region and c is the host region, LF is labor force and POP is population.

b. Migrant labor is divided into skilled and unskilled using data on the education levels obtained from Docquier (2004) for the OECD countries.

c. Nominal wages of migrants ($W_{i,r,c}$) in the base data are equal to the home wage ($W_{i,r,r}$) plus a proportion (β) of the difference between host ($W_{i,c,c}$) and home wage ($W_{i,r,r}$):

$$W_{i,r,c} = W_{i,r,r} + \beta.(W_{i,c,c} - W_{i,r,r}) \qquad \text{(B2)}$$

where: β is the proportion of the difference obtained by a person of labor type i migrating from region r to region c. β is equal to 0.75 where wages rise between the home and the host, and 0.3 where wages fall.

Note that the nominal wages of migrants and permanent residents are solved simultaneously while ensuring that total wage payments within the region remain constant. The value of β can significantly affect the results. We examine the impact of different values of β later in this paper.

d. A constant remittance to income ratio is used to determine bilateral remittances in the data base (in the model we assume that remittances remain a constant proportion of income);

$$\frac{RM_{r,c}}{YS_{r,c}} = \frac{RM_r}{YS_r} \qquad \text{(B3)}$$

where: RM are remittances, YS is income earned by permanent residents of r temporarily residing in c (or aggregated across all locations c).

e. All other income (from capital, land etc) is assumed to accrue to permanent residents.

f. Tax is paid by both foreign-born and domestic residents. Tax revenues accrue to the regional household, as in the GTAP Model (Hertel, 1997), but are included only in the income of the permanent residents, hence permanent residents gain the benefits from the public goods purchased with tax revenues. In practice migrants also receive some of the benefits of the public goods produced with these taxes, but this is difficult to measure. We discuss the implications of this assumption later in the paper.

g. With the inclusion of remittances flows saving must be adjusted in the GTAP 6 Data Base to ensure that all income is allocated or spent.

2.2. The GMig2 Model

As in the GMig2 Data Base, the model tracks both the "home" and "host" region of each person and worker. The *home* region is defined as the permanent residence of the person/worker; in the data base this is their place of birth. The *host* region is the region in which the person resides/works. This section is divided up into a number of sub-sections to explain the model: labor and population flows; wages; income and remittances; sector specific migration; and return migrants.

2.2.1. Labor and Population flows

The labor force of skill i, located in region r ($LF_{i,r}$), and available to firms for production, is therefore the sum across *home* regions (c) of all workers located in the *host* region r (equation (1)); similarly for population, Equation (2).

$$LF_{i,r} = \sum_{c} LF_{i,c,r} \tag{1}$$

$$POP_{r} = \sum_{c} POP_{c,r} \tag{2}$$

An increase in the number of migrant workers from region c to region r would reduce the number of workers in the developing labor supplying regions ($LF_{i,c,c}$ would fall) and increases the labor force of the developed labor importing region ($LF_{i,c,r}$ would rise). The populations would change in similar ways. While in the underlying GMig2 Data Base it was assumed that migrant workers moved with their families, in the model the user can specify through a change in parameters whether or not the migrant's families migrate[10].

Changes in the number of migrants can occur in two ways[11]:

a) Exogenous shocks to the labor supply

   Shocks can be made to: a) the number of migrants from region c who move to region r directly ($LF_{i,c,r}$) to simulate a bilateral movement of labor[12]; b) the total labor supply in the host region ($LF_{i,r}$) to simulate an increase in the quotas of the host region[13]; or c) the total supply of labor in the home region to simulate an exodus of migrants or the return of migrants[14]. In the second case the change in quota is assumed to be filled by migrants from countries in the same proportions

[10] TEMP in the basedata = 1 if families do not migrate; and 0 if families do.
[11] See Appendix 2 for a list of possible closures.
[12] See Appendix 2, Standard Closure.
[13] See Appendix 2, Increase in quotas of Labor Importing Region.
[14] See Appendix 2, Increase in exodus from Labor Exporting Region.

as the current stock of migrants in the current data base; similarly migrant workers are assumed to move to host regions in the same shares as the current migrants. It is assumed that there is excess demand for quotas and hence quotas are completely filled.

b) Endogenous movements[15]

In this case movements in migrant workers are endogenous. Migrants are assumed to respond to differences in the real wages between the home ($RW_{i,c,c}$) and host ($RW_{i,c,r}$) region. ESUBMIG is a parameter reflecting the extent to which migrants respond to differences in real wages. This parameter might also reflect the extent to which migrants can move in response to real wages given restrictions, such as quotas. ESUBMIG can also be shocked, reflecting a change in policy or ability of people to move in response to wages[16].

$$LF_{i,c,r} = A_{i,c,r} \times \left[\frac{RW_{i,c,r}}{RW_{i,c,c}} \right]^{ESUBMIG_{i,r,s}} \quad (3)$$

Note that with endogenous movements responding to changes in real wages, migrants can both migrate and return home. For convenience we distinguish between the flow of new migrants relocating to the host region ($NM_{i,c,r}$) and return migrants going home ($RM_{i,c,r}$)[17]. Hence the change in migrants from region c in region r increases with new migrants and falls with returning migrants (equation (4)):

$$\Delta LF_{i,c,r} = NM_{i,c,r} - RM_{i,c,r} \quad (4)$$

while permanent residents of region r decreases with new migrants and rises with returning migrants (equation (5)).

$$\Delta LF_{i,c,c} = -NM_{i,c,r} + RM_{i,c,r} \quad (5)$$

[15] See Appendix 2, Endogenous Movement of Labor.
[16] See Ojeda, McCleery, De Paolis and Walmsley (2007).
[17] We can distinguish between new and returning migrants using closure swaps. In the case where changes in the labor force are determined exogenously, the number of return migrants would be exogenously (a in section 2.2.1) set to zero (or determined by the equations set out in section 2.2.5) and hence the number of new migrants would be found endogenously through equation 4. Where changes in the labor force are determined endogenously (b in section 2.2.1) then a complementarity is used to ensure that either new migrants or return migrants equals the change in labor force depending on the direction of the flow of the labor.

2.2.2. Wages

In the GMig2 Data Base, migrant workers are assumed to gain a portion of the difference between their nominal wages at home and the nominal wages in the host region, reflecting the fact that their productivities have also changed[18]. This data provides the ***initial*** wages of the migrant workers.

$$W_{i,r,c} = W_{i,r,r} + \text{BETA} \times (W_{i,c,c} - W_{i,r,r}) \qquad (6)$$

Any changes in the labor force are allocated across sectors so as to equalize the percentage change in the wage earned by all workers (domestic and foreign). Foreign and domestic labor are assumed to be perfect substitutes (although their wages and marginal products are not equal)[19].

The model is consistent with standard trade theory – countries benefiting from inward migration experience a decline in the marginal product/wage of labor as they move down their marginal product curves, and production increases as firms gain greater access to cheaper labor. Returns to capital increase as capital becomes scarce relative to labor. The reverse is true for those countries experiencing outward migration.

2.2.3. Income and Remittances

Given the emphasis of the model on migration and the impact on migrants of various trade and migration-related policies, it is important to show the changes in the incomes of the various agents in the model: permanent residents, existing migrants, new migrants and return migrants.

Permanent Residents

$$\Delta Y_{r,r} = \sum_{f \in NLAB} \Delta FY_{f,r,r} + \sum_{l \in LAB} \Delta FY_{l,r,r} - \Delta D_r + \Delta T_r + \sum_{c \in REG} \Delta RM_{r,c} \qquad (7)$$

The income of permanent residents (equation (7)) depends on the change in income from non-labor and labor endowments (*FY*), plus remittances (*RM*) received from migrant workers abroad. Since permanent residents receive all the income on capital,

[18] There are a number of alternative ways of determining wages. All migrants could receive a proportion of the host country wage (perhaps depending on the development of their home country). This method allows us to take into account both the home and host country wages in determining the migrants' wages. It could also be argued that BETA should depend on the home and host region. For instance, migrants from developed countries who are expatriated to developing economies might get further benefits which increase their nominal wage above the nominal wage they would have received at home. Since data on the value of BETA is scarce and we concentrate on migration from the south to the north we have chosen not to take this possibility into account.

[19] Note that it is also possible to alter (via a shock) the relative productivities of workers.

depreciation (*D*) is also taken out and permanent residents are assumed to receive the tax revenue (*T*). To obtain the change in real income the change in income is then reduced by the effect of any changes in prices. This method determines the real change in income at market exchange rates and is comparable to real income as calculated in the standard GTAP Model or in Timmer and van der Mensbrugghe (2006)[20].

Existing Migrants

$$\Delta Y^{E}_{r,c} = \sum_{l \in LAB} \Delta FY^{E}_{l,r,c} - \Delta RM_{r,c} \qquad (8)$$

The income of existing migrants (equation (8)) depends on the income from their endowment of labor (FY^{E}_{l}), less remittances (RM^{E}) sent home. To obtain real income the change in income is then adjusted for changes in prices to obtain the change in real income at market exchange rate.

New Migrants

$$\Delta RY^{N}_{r,c} = \frac{PPP(c)}{PPP(r)} \times \left[\sum_{l \in LAB} FY^{N}_{l,r,c} - RM^{N}_{r,c} \right] - \left[\sum_{l \in LAB} IFY^{N}_{l,r,r} \right] \qquad (9)$$

The change in real income of new migrants (equation (9)) equals the final income obtained in their new country of residence from their endowment of labor (FY^{N}_{l}) (less remittances (RM^{N}) sent home), less the labor income they received before they migrated (IFY^{N}, where *I* in *IFY* stands for initial)[21]. Following Timmer and van der Mensbrugghe (2006) the final income is discounted by *PPP* in their new residence relative to the *PPP* in their home country so that the final income is converted back to equivalent income in the home country and hence the change in real income at the home[22] country's market exchange rate is obtained. The reason for this adjustment is that prices faced by the new migrants change as a result of moving between countries which have different underlying price levels[23].

Return Migrants

[20] In Appendix 3 a second method is outlined which determines the real change in income at PPP and compares the market exchange rate (MER) and purchasing power parity (PPP) methods.
[21] Note that we do not consider changes in income from other endowments – it is assumed that any gains or losses on other endowments affect the incomes of permanent residents only.
[22] Alternatively initial income could be converted to the host country, however we choose not to do this so that the change in real income of new migrants can be compared to those permanent residents they left behind. This is not an issue when discounting by PPP.
[23] Note that PPP also adjusts as the CPI changes.

$$\Delta RY^{R}_{r,c} = \left[\sum_{l \in LAB} FY^{R}_{l,r,r}\right] - \frac{PPP(c)}{PPP(r)} \times \left[\sum_{l \in LAB} IFY^{R}_{l,r,c} - IRM^{R}_{r,c}\right] \quad (10)$$

The change in real income of return migrants (equation (10)) equals the final income obtained in their home country from their endowment of labor (FY^{R}_{l}), less the initial labor income they received from their host country, prior to returning home (IFY^{R}) less remittances (IRM^{R}, again *I* in *IRM* stands for initial). In this case the initial income is discounted by *PPP* in their host country and any change is prices in the home country are applied to obtain the change in real income at the home[24] country's market exchange rate.

In the GMig2 Data Base and in the GMig2 Model, remittances flowing out of the host country back to the home country are assumed to be a constant proportion of income. Hence as the number of new migrants or their wages increase, remittances increase. Remittances then flow back to the permanent residents of the home country of the migrant. Remittances therefore reduce the income of the migrants and increase the incomes of permanent residents back home. For the purposes of determining income spent in the host economy this is ideal[25]; however, as a measure of the gain made by the new migrants there are a few deficiencies: a) new migrants may have supported the same family members before moving as they are sending remittances to after migrating; b) although they do not spend the money, new migrants gain utility from sending money home; and c) remittances sent home may be invested on the new migrants behalf. For these reasons we also calculate gross income of new migrants in which remittances are not taken out.

Remittance flows also affect a county's balance of payments. In GTAP (11) and GMig2 (12) respectively:

$$Y = C + I + G + X - M = C + S + G \quad (11)$$

$$Y = C + I + G + X - M + NREM = C + S + G \quad (12)$$

The current account balance in GMig2 is therefore given by:

$$CAB = X - M + NREM \quad (12)$$

[24] Alternatively initial income could be converted to the host country, however we choose not to do this so that the change in real income of new migrants can be compared to those permanent residents they left behind. This is not an issue when discounting by PPP.

[25] In each country, incomes earned by both domestic and foreign-born residents are collected by the regional household and allocated across consumption, government and saving in the host region; that is, migrants adopt their host countries' consumption patterns.

As remittances rise, the current account balance rises. This is offset by an appreciation of the real exchange rate and a decline in the trade balance, maintaining balance of payments equilibrium.

2.2.4. Sector Specific Migration

In the standard GTAP Model, labor moves across sectors to equalise the percentage change in the wage; thus labor moves to the sectors with the highest demand for labor. This is also the standard closure for GMig2. On the other hand, since Mode 4 is restricted to services and since particular service sectors in the developed economies, e.g. the computing sector in the USA, are interested in obtaining skilled temporary workers, it is interesting to think what happens if the labor movement is restricted to specific sectors.

This is achieved in the model by dividing the sectors into two groups[26]: one group of sectors which does not employ the migrant workers (A); and a second group of sectors which does (B). The supply of labor to each group must equal its demand, and labor can flow freely within each group but not between them. All migrant workers are supplied to the group of sectors which accept temporary labor (B), while the supply of labor to the other group (A) is held fixed. This approach also has implications for permanent labor, since the inflow of migrant workers is assumed not to be off-set by outflow of permanent labor. Hence labor is not perfectly mobile, except between sectors of the same group, and hence wages differ between the two groups. We note that Borjas and Freeman (1992) found that permanent residents do tend, in fact, to move out of geographical areas in which there has been an influx of foreign workers, leaving the total labor force unchanged, so our assumption of the opposite for TMNP should be considered rather carefully.

2.2.5. Return Migrants

In a comparative static framework, such as GMig2, we can think of temporary labor continually entering and returning to their home countries – the revolving door approach[27] – such that the net change in migrants is given by the exogenous shock and no changes in productivities are assumed upon their return home. When migration is

[26] This is done via the header PRDG and PMAP in the sets file, see Appendix 1.

[27] The results are the comparative static short/medium run impacts of these policies. That is, they show how much better (or worse) off the residents of each region are in the short/medium run, before capital has had time to respond to changes in the rates of return. The shock to the labor forces of the home and host regions are permanent in that the host country labor force is now higher and the home country labor force is lower. However the people filling those positions change through time: this is the revolving door approach.

endogenous, movements may occur in both directions in response to wage differentials, in GMig2 migrants are separated into new and return migrants depending on the direction of the endogenous migration.

According to the literature, return migration can contribute significantly to the home economy, as migrants returning from abroad bring with them new skills obtained abroad – brain gain. Return migration is therefore an important issue when examining migration policies. In GMig2, the model is comparative static and represents a medium run of approximately 3-5 years. The user can allow a proportion of the new migrants to return with higher productivities during this period[28]. The proportion of migrants returning during the period can be set by the user; and the productivity gained by return migrants is set in the data base[29].

3. Experiments

In this paper, changes in migration are modelled by 'shocking' the allocation of workers across countries in the model. This shock then reduces the number of workers in the developing labor supplying regions and increases the labor force of the developed labor importing region, in our case by 3%.

A number of simulations were undertaken using the GMig2 Model to examine how relaxing restrictions on the temporary movement of natural persons (TMNP) is likely to affect developed and developing countries. The rest of the paper focuses on a single simulation of an increase in developed country quotas on the numbers of skilled and unskilled temporary workers. Following this the effects of other issues, such as changing the sectoral allocation, the size of the shock and sensitivity analysis on the parameters are examined.

Quotas on the temporary movement of natural persons are assumed to increase in a number of traditionally developed labor-importing regions, and to be filled by labor from a number of traditionally developing labor-exporting countries according to the current shares of migrants in the host countries labor force[30]. Table 1 divides the regions used in

[28] See Appendix 1, Increase in quotas of Labor Importing Region with return migration.
[29] In the data base it is assumed that 50% of the gain made from moving is kept on return.
[30] This is the critical difference from the Walmsley and Winters (2005), where we had to allocate the 'new' immigration places proportionately to developing (home) countries labor forces emigration stocks. Thus lots of Mexicans went to Europe and Moroccans to the USA.

this analysis into developed labor-importing and developing labor-exporting regions (columns II and III respectively)[31]. The numbers in Table 1 represent the percentage of the labor force which are foreign (II) and the percentage of the labor force which work abroad (III). From Table 1 we see that nearly 20% of Australia/New Zealand's labor force are foreign born, while only 1% of Japan's labor force is foreign born. More than 9% of Mexican's work abroad while only 0.5% of Chinese work abroad (Parsons, et al., 2007).

Tables 2A and 2B depict the changes in the number of temporary foreign workers assumed in our experiment by home and host. It is assumed that the host regions increase their labor force by 3% and that these are supplied by the home regions in the same proportions as current foreign workers. Hence the USA increases the number of skilled and unskilled workers by 1.5m and 3m respectively and these are primarily supplied by Mexico and Latin America[32]. The increase in the labor force of the developed labor importing region by 3% is the same as the shock applied in Walmsley and Winters (2005) except that the underlying data has improved significantly. These improvements in the underlying data base have led to the following improvements in the shocks themselves:

a) Improved estimates of skill shares have resulted in less skilled migrants overall (4.3m as opposed to 8m).

b) Improved estimates of bilateral relations – e.g., more workers flow from Mexico and Latin America to the USA and from Eastern Europe to Europe.

c) Improved estimates of skill shares for migrants – e.g., Mexico supplies mostly unskilled workers, while East Asia supplies more skilled.

[31] The decision of whether a region was a labor-exporter or importer was based on wage rates (high wages were expected in labor-importing countries and low wages in labor-exporters), data on the quantities of temporary migrants relative to temporary workers and the level of development.

[32] Note that the home regions of the new skilled and unskilled foreign workers may differ due to the fact that the initial data base may indicate that a host country obtains foreign skilled workers from different counties than they obtained unskilled workers e.g. the USA obtains most of its unskilled workers from Mexico but gets more skilled workers from East Asia. The skill splits in the underlying data were obtained from Docquier and Markouk (2005).

Table 1. Regions

I All Regions	II Percentage of Labor force born abroad[a]	III Percentage of labor force living abroad[b]
USA	10.95%	0.88%
Canada	16.57%	4.79%
Mexico	0.58%	9.24%
UK	7.73%	7.11%
Germany	10.74%	5.33%
Rest of EU	7.55%	5.75%
Rest of Europe	9.91%	12.26%
Eastern Europe	3.13%	6.93%
Former Soviet Union	9.65%	11.07%
Australia-New Zealand	19.61%	5.00%
China	0.23%	0.49%
Japan	0.99%	0.69%
Rest of East Asia	0.62%	2.71%
South East Asia	0.92%	1.88%
India	0.65%	0.88%
Rest of South Asia	1.91%	4.17%
Brazil	0.32%	0.55%
Rest of Latin America	2.07%	5.92%
Middle East and Northern Africa	6.08%	4.97%
Southern Africa	2.18%	2.53%
Rest of World	3.82%	7.41%

a. Percentage of the labor force in the initial data base which are foreign. Shaded figures represent the labor importers.

b. Percentage of the labor force in the initial data base which work abroad. Shaded figures represent the labor exporters.

Table 2A. Changes in the number of unskilled workers by home and host regions (Millions)

Host Countries										
Home Countries	**USA**	**Canada**	**UK**	**Germany**	**Rest of EU**	**Rest of Europe**	**Australia-New Zealand**	**Japan**	**Total Unskilled labor lost**	**Total Unskilled labor lost as share of labor force**
Mexico	1.28	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.29	3.16%
Eastern Europe	0.10	0.04	0.04	0.13	0.36	0.06	0.04	0.00	0.78	1.64%
Former Soviet Union	0.06	0.01	0.01	0.10	0.08	0.01	0.00	0.00	0.27	0.21%
China	0.12	0.08	0.03	0.02	0.05	0.01	0.03	0.35	0.68	0.09%
Rest of East Asia	0.09	0.01	0.00	0.00	0.01	0.00	0.01	0.62	0.75	1.75%
South East Asia	0.26	0.05	0.03	0.03	0.14	0.02	0.06	0.17	0.77	0.32%
India	0.04	0.03	0.09	0.02	0.03	0.01	0.01	0.01	0.22	0.05%
Rest of South Asia	0.02	0.02	0.12	0.02	0.05	0.02	0.01	0.02	0.28	0.18%
Brazil	0.02	0.00	0.00	0.00	0.03	0.01	0.00	0.20	0.26	0.39%
Rest of Latin America	0.86	0.05	0.07	0.03	0.27	0.02	0.01	0.04	1.35	1.45%
Middle East and Northern Africa	0.06	0.02	0.04	0.35	0.91	0.08	0.02	0.01	1.50	1.28%
Southern Africa	0.04	0.02	0.12	0.06	0.29	0.03	0.01	0.00	0.57	0.19%
Rest of World	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.07	2.12%
Total Unskilled workers gained	2.94	0.35	0.55	0.77	2.24	0.27	0.24	1.43	8.78	12.84%
Total Unskilled labor gained as share of the unskilled labor force	3%	3%	3%	3%	3%	3%	3%	3%		

Table 2B. Changes in the number of skilled workers by home and host regions (Millions)

Host Countries										
Home Country	**USA**	**Canada**	**UK**	**Germany**	**Rest of EU**	**Rest of Europe**	**Australia-New Zealand**	**Japan**	**Total skilled labor lost**	**Total skilled labor lost as share of labor force**
Mexico	0.17	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.19	2.72%
Eastern Europe	0.07	0.02	0.03	0.07	0.18	0.03	0.01	0.00	0.42	3.41%
Former Soviet Union	0.08	0.01	0.01	0.07	0.06	0.01	0.00	0.00	0.24	1.10%
China	0.12	0.03	0.03	0.02	0.03	0.01	0.02	0.15	0.39	1.19%
Rest of East Asia	0.12	0.01	0.00	0.01	0.02	0.00	0.01	0.27	0.44	5.69%
South East Asia	0.25	0.02	0.03	0.04	0.09	0.01	0.03	0.07	0.55	1.50%
India	0.11	0.01	0.05	0.02	0.02	0.01	0.01	0.00	0.23	0.71%
Rest of South Asia	0.03	0.01	0.03	0.03	0.02	0.01	0.01	0.01	0.15	1.65%
Brazil	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.09	0.14	0.89%
Rest of Latin America	0.40	0.02	0.03	0.05	0.16	0.01	0.00	0.02	0.69	3.30%
Middle East and Northern Africa	0.08	0.01	0.03	0.10	0.25	0.02	0.01	0.00	0.51	1.50%
Southern Africa	0.07	0.01	0.11	0.04	0.17	0.02	0.01	0.00	0.42	2.32%
Rest of World	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	2.23%
Total Skilled workers gained	1.54	0.16	0.35	0.45	1.02	0.14	0.13	0.62	4.38	
Total Skilled labor gained as share of skilled labor force	3%	3%	3%	3%	3%	3%	3%	3%		

4. The Results

The increase in the quotas of the developed labor-importing economies, equivalent to 3% of their labor forces, is found to have an overall positive impact on world income as people move from low to high productivity locations. In the first section the macro impact of the movement of labor on real GDP, the terms of trade, imports, exports, factor returns etc by region is investigated. Next the sectoral implications of the movement of labor in both the labor-importing and labor-exporting regions are examined. In the third sub-section changes in the real income of the permanent residents; and the existing and new migrants is investigated. Finally, we undertake some sensitivity analysis with respect to our choice of β – the productivity boost parameter -- and the size of the shock, amongst others.

4.1. Macroeconomic Effects

Table 3 depicts some of the macro results from the increased quotas, separated into the impact of raising quotas on unskilled and skilled migrant labor respectively. The labor-importing developed economies experience increases in real GDP as a result of the increased supply of labor which can be used in production. Given the fact that the number of new unskilled migrants is more than double that of new skilled migrants while their wage is more than half, it is not surprising that the Real GDP of the labor importing economies increases more as a result of unskilled labor migration. The gains from unskilled migration, however, are not double those of skilled, suggesting that, per migrant worker, skilled migration is more beneficial to the developed labor importing economies.

As expected the wages of unskilled and skilled workers fall with the increase in supply due to the raising of quotas. When the quotas on skilled and unskilled are considered separately, a rise in unskilled migration lowers the return to unskilled workers and raises the return to skilled workers; likewise a rise in skilled migration lowers the return to skilled workers and raises the return to unskilled workers. In some cases the wages of skilled and unskilled move in the same direction from the skilled/unskilled migration, this is due to the impact of remittances and changes in the terms of trade. The addition of

these effects gives the change in wages when both skilled and unskilled migration takes place; as expected the wages of skilled and unskilled both fall by approximately 1.5%.

The increased supply of labor also causes an increase in output and results in losses in the terms of trade and real exchange rate[33]. With the exception of Japan, this depreciation in the real exchange rate causes exports to increase. In the case of Japan the increase in supply of labor is minimal and hence the deterioration in the terms of trade is minimal, when compared to its trading partners; exports fall. Imports also rise in the developed labor importing countries due to the increase in income and numbers of consumers.

The trade balance of the labor-importing developed economies tends to rise as the decrease in prices and the resulting increase in demand for exports outweighs the increase in demand for imports. The current account on the other hand, which takes into account remittance flows, tends to decline as more remittances leave the country. Returns to capital increase as greater labor supply and demand for goods increase the demand for capital. The increased return to capital causes investment to increase, and in the long-term this would result in even higher capital stocks and production (not modelled here).

In the labor-exporting developing economies the reverse is true. As the supply of labor falls, real wages rise and real GDP falls. Again, even though the loses are greatest from the loss of unskilled workers, when we consider the fact that more unskilled workers migrate than skilled, it is the loss of skilled workers which has the greatest impact per migrant. This can be seen in the figures for Real GDP and in the changes in real wages of skilled and unskilled; the real wages of skilled rise significantly more than those of unskilled workers, despite the fact that more unskilled workers migrate under this scenario. The rise in real wages also results in an increase in the real exchange rate and a fall in the trade balance. This is offset by the remittances which cause the current account balance to rise.

[33] In some cases the rise in the price of capital may offset the decline in wages and hence the real exchange rate and terms of trade may not change or increase slightly.

Table 3. Macroeconomic Results (Difference from base) due to the unskilled and skilled movement of labor

	Real GDP (%)		Terms of Trade (%)		Change in Trade Balance ($US Millions)		Change in Current Account Balance ($US Millions)		Exports (%)		Imports (%)		Investment (%)		Real wages of unskilled[34] (%)		Real wages of skilled (%)		Real return to capital (%)	
	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill	Unsk	Skill
USA	0.85	0.61	-0.28	-0.24	7090	7238	-4167	-2556	1.43	1.18	0.23	0.08	0.54	0.3	-1.3	0.4	0.52	-1.48	0.66	0.48
Canada	0.94	0.49	0.02	0.05	256	364	-604	-42	1.13	0.58	1.16	0.55	1.11	0.32	-1.24	0.27	0.6	-1.71	0.72	0.32
Mexico	-0.76	-0.28	0.49	0.16	-1467	95	2552	861	-1.81	-0.19	-0.51	-0.1	-1.88	-0.67	2.35	-0.16	0.03	2.29	-0.47	-0.19
UK	0.86	0.62	-0.12	-0.11	1452	839	-1226	-868	1.36	0.85	0.72	0.43	0.68	0.45	-1.17	0.38	0.56	-1.49	0.63	0.43
Germany	0.8	0.52	-0.07	-0.07	-953	292	-2191	-786	0.79	0.57	0.95	0.51	1.06	0.45	-1.34	0.31	0.49	-1.54	0.59	0.32
Rest of EU	0.72	0.5	-0.08	-0.05	3464	2639	-684	-28	1.04	0.62	0.75	0.41	0.41	0.18	-1.34	0.28	0.42	-1.58	0.48	0.31
Rest of Europe	1.1	0.62	0.03	0.01	-349	-165	-995	-532	0.82	0.47	1.19	0.65	1.83	0.99	-1.61	0.34	0.64	-1.47	0.82	0.44
E. Europe	-0.61	-0.51	0.19	0.15	118	-109	1619	920	-0.67	-0.53	-0.48	-0.3	-1.57	-0.88	0.99	-0.27	-0.26	2.87	-0.36	-0.27
F Soviet Union	-0.09	-0.11	0.08	0.08	904	299	1216	697	0.33	0.06	-0.2	-0.06	-1.3	-0.68	-0.06	-0.14	-0.18	0.69	-0.19	-0.1
Australia-New Zealand	0.81	0.59	0.02	0.01	228	214	-259	-154	0.92	0.6	0.72	0.4	0.73	0.4	-1.36	0.31	0.43	-1.72	0.61	0.42
China	-0.04	-0.14	-0.01	0.02	1705	790	2593	1465	0.27	-0.01	-0.1	-0.18	-0.53	-0.37	0	-0.09	-0.08	0.84	-0.09	-0.11
Japan	0.89	0.55	-0.05	-0.03	-5341	-4343	-10012	-7232	-0.14	-0.29	1.08	0.69	1.38	0.98	-1.21	0.28	0.46	-1.41	0.65	0.39
Rest of East Asia	-0.64	-1.08	0.07	0.12	564	378	2043	1675	-0.45	-0.74	-0.63	-0.85	-1.54	-1.55	1	-0.64	-0.33	4.14	-0.45	-0.84
S. East Asia	-0.09	-0.14	0.12	0.11	-643	-1350	1867	1514	-0.44	-0.63	-0.21	-0.25	-0.75	-0.44	0.19	-0.07	0.04	1.16	-0.08	-0.1
India	-0.02	-0.06	0.21	0.5	-746	-1820	1142	1066	-1.15	-2.72	0.24	0.64	-0.61	-0.29	-0.03	-0.02	0.05	0.75	-0.13	-0.11
Rest of South Asia	-0.02	-0.11	0.72	0.52	-1306	-895	525	336	-3.98	-2.82	1.03	0.64	-0.43	-0.26	0.16	-0.02	0.38	1.24	-0.05	-0.09
Brazil	-0.13	-0.17	0.25	0.24	-568	-571	1348	806	-0.95	-0.86	0.1	0.18	-1.08	-0.62	0.31	-0.01	0.17	0.86	-0.21	-0.18
Rest of Latin America	-0.48	-0.45	0.5	0.34	-2402	-1508	2188	1289	-1.78	-1.13	0.03	0.03	-1.15	-0.66	0.98	-0.21	-0.02	2.75	-0.35	-0.3
Middle East and N. Africa	-0.39	-0.17	0.39	0.24	-1182	-1348	2395	1107	-0.8	-0.52	-0.05	0.13	-0.96	-0.31	0.82	-0.05	-0.09	1.16	-0.25	-0.06
Southern Africa	-0.06	-0.24	0.31	0.28	-658	-931	680	494	-0.67	-0.91	0.24	0.22	-0.81	-0.55	0.16	-0.06	0.14	1.74	-0.07	-0.13
Rest of World	-0.46	-0.18	0.84	0.48	-166	-108	-31	-30	-2.94	-1.6	0.43	0.42	0.07	0.27	1.68	0.15	0.47	1.68	0.17	0.17

[34] Non-Migrants include permanent residents of the region and exiting migrants who have not moved countries as a result of the simulation.

When compared to the result in Walmsley and Winters (2005) the gains in real GDP are larger for the developed labor importing economies due to the fact that the data is more recent (2001 as opposed to 1997) and the productivities of the new migrants are higher. The real wages of skilled workers tend to fall less given the fact that overall there is less skilled migration, while the wages of unskilled workers fall further. The differences between the results for the labor exporting economies are more mixed, reflecting several differences between the data and the two models:

- A more recent base year tends to cause larger reductions in the Real GDP and real wages of the developing labor exporting countries;
- higher remittances (Ratha, 2003) tend to raise real GDP and real wages;
- and improved bilateral relations can increase or decrease the changes in real GDP and real wages depending on the direction of the change. For instance more migrants are supplied by Mexico, Latin America and Eastern Europe and hence real GDP and real wages are more adversely affected.

4.2. Sectoral Effects

Table 4 shows the output gains, to the labor importing economies across all sectors from the new unskilled and skilled migrants. The gains in output are greatest to the manufacturing and services sectors. The relative size of the sectoral output gains from increased unskilled and skilled workers depends on the relative use of skilled and unskilled labor by the sector. Hence there is a tendency for agricultural and light manufacturing sectors to gain more from unskilled migrants than skilled and for services and other manufacturing to gain more from skilled labor per new migrant worker in the labor-importing developed economies.

Table 4. Sectoral Results of Developed Labor-Importers: Percent changes in output as a result of increase in unskilled and skilled quotas respectively

	USA		Canada		UK		Germany		Rest of EU		Rest of Europe		Australia-New Zealand		Japan	
	Unskilled	Skilled	unskilled	Skilled	Unskilled	skilled	unskilled	skilled	unskilled	skilled	unskilled	skilled	unskilled	Skilled	unskilled	Skilled
Crops	0.96	0.40	1.17	0.54	1.73	0.79	1.41	0.60	1.78	0.67	1.11	0.33	1.29	0.50	1.34	0.48
Livestock	1.31	0.64	1.01	0.34	1.39	0.67	1.19	0.57	1.38	0.60	1.24	0.57	1.14	0.48	1.08	0.50
Meat	1.32	0.64	1.01	0.36	1.32	0.76	1.19	0.64	1.32	0.61	1.36	0.67	1.48	0.72	1.07	0.51
Dairy	1.17	0.63	1.32	0.56	1.21	0.69	1.03	0.51	1.36	0.64	1.21	0.56	1.46	0.64	1.29	0.61
Food	1.22	0.67	1.38	0.57	1.25	0.73	1.08	0.64	1.24	0.63	1.41	0.72	1.33	0.73	1.30	0.63
Other Primary	0.59	0.33	0.42	0.23	0.21	0.14	0.43	0.19	0.51	0.22	0.14	0.07	0.35	0.19	0.65	0.27
Wood and paper	1.00	0.61	1.01	0.37	1.12	0.72	0.99	0.57	0.96	0.56	1.33	0.89	1.04	0.69	0.95	0.60
Textiles and wearing apparel	2.05	0.89	2.38	0.76	2.00	0.91	1.81	0.97	1.90	0.90	2.31	0.92	1.86	1.10	1.38	0.50
Chemicals and Minerals	1.04	0.67	0.85	0.37	1.08	0.64	0.96	0.67	0.95	0.55	0.81	0.49	0.88	0.58	0.81	0.46
Metals	1.31	0.79	1.19	0.40	1.43	0.76	1.07	0.63	1.02	0.55	1.36	0.76	0.70	0.49	0.74	0.48
Autos	1.07	0.61	1.18	0.56	1.13	0.58	0.76	0.44	0.95	0.50	1.44	0.80	0.85	0.49	0.55	0.38
Electronics	1.47	1.37	1.78	1.15	1.25	0.82	1.31	0.95	0.95	0.63	1.47	0.93	1.14	0.84	0.69	0.32
Other manufactures	1.21	0.97	1.34	0.67	1.42	0.76	1.08	0.73	0.81	0.43	0.98	0.62	1.16	0.68	0.49	0.21
Household Utilities	0.45	0.29	0.43	0.21	0.38	0.29	0.79	0.56	0.47	0.33	0.80	0.39	0.42	0.28	0.44	0.30
Construction	0.64	0.37	1.07	0.33	0.69	0.45	0.93	0.42	0.47	0.25	1.58	0.86	0.74	0.41	1.31	0.92
Trade	0.93	0.49	1.07	0.44	0.83	0.46	0.88	0.48	0.68	0.39	1.18	0.69	0.89	0.54	0.96	0.62
Transport	1.10	0.59	1.19	0.48	0.91	0.55	0.87	0.51	0.78	0.46	0.87	0.59	0.98	0.63	0.93	0.58
Communications	0.76	0.61	1.09	0.61	0.79	0.62	0.79	0.56	0.75	0.59	1.13	0.57	0.88	0.63	0.93	0.58
Financial Services	0.67	0.63	1.02	0.49	0.78	0.58	0.59	0.56	0.70	0.52	0.82	0.36	0.71	0.54	0.84	0.51
Insurance	0.81	0.89	1.42	0.84	0.76	0.62	0.67	0.50	0.68	0.58	1.18	0.56	0.82	0.65	0.98	0.63
Business services	0.75	0.60	1.09	0.55	0.91	0.72	0.20	0.13	0.58	0.46	1.56	0.76	0.88	0.64	0.94	0.59
Other service	0.80	0.73	0.72	0.70	0.71	0.85	0.76	0.58	0.62	0.65	1.24	0.76	0.73	0.95	0.97	0.60

Table 5. Sectoral Results of Developing Labor-Exporters: Percent changes in output as a result of increase in unskilled and skilled quotas respectively

	Mexico		Eastern Europe		China		Rest of East Asia		India		Rest of South Asia		Rest of Latin America		Southern Africa	
	Unskill	Skill	Unskill	Skill	Unskill	Skill	Unskill	Skill	Unskill	Skill	Unskill	Skill	Unskill	Skill	Unskill	Skill
Crops	-0.80	0.16	-0.46	-0.09	0.11	0.06	-0.32	-0.06	0.06	0.01	-0.08	-0.04	-0.40	0.01	0.11	0.10
Livestock	-0.84	0.11	-0.41	-0.07	0.16	0.16	-0.71	-0.57	0.09	0.07	0.37	0.21	-0.50	-0.24	0.42	0.31
Meat	-0.93	-0.16	-0.53	-0.18	0.00	-0.02	-0.77	-0.66	0.19	0.25	0.94	0.63	-0.54	-0.23	0.27	0.20
Dairy	-1.04	-0.16	-0.52	-0.21	0.02	0.04	-0.87	-0.77	0.45	0.70	1.05	0.67	-0.51	-0.23	-0.26	-0.30
Food	-0.79	-0.14	-0.49	-0.24	0.04	-0.02	-0.68	-0.67	0.15	0.11	0.42	0.26	-0.46	-0.26	0.19	0.10
Other Primary	-0.02	0.13	-0.13	-0.02	0.13	0.02	-0.10	-0.03	0.06	-0.18	0.22	0.09	-0.15	-0.10	0.13	-0.01
Wood and paper	-1.27	-0.32	-0.92	-0.50	-0.05	-0.14	-0.82	-1.12	-0.24	-0.35	-0.52	-0.43	-1.15	-0.74	-0.51	-0.63
Textiles and wearing apparel	-1.52	0.03	-0.99	-0.14	0.33	0.28	-0.64	-0.10	-0.42	-1.07	-3.16	-2.14	-1.51	-0.73	-0.40	-0.52
Chemicals and Minerals	-1.06	-0.29	-0.85	-0.59	-0.06	-0.16	-0.62	-0.79	-0.24	-0.45	-0.81	-0.64	-1.22	-0.84	-0.39	-0.52
Metals	-2.30	-0.49	-1.58	-0.80	-0.29	-0.29	-1.11	-1.02	-0.80	-1.11	-1.66	-1.17	-2.98	-1.57	-1.52	-1.46
Autos	-1.65	-0.40	-0.76	-0.48	-0.29	-0.31	-1.04	-1.10	-0.58	-0.51	-1.24	-0.89	-1.45	-0.93	-0.94	-1.04
Electronics	-2.33	-0.40	-1.17	-1.15	-0.02	-0.41	-0.49	-1.09	-0.95	-1.34	-2.18	-1.71	-2.67	-2.00	-2.42	-2.93
Other manufactures	-2.81	-0.85	-1.66	-1.18	-0.32	-0.42	-1.30	-1.55	-1.02	-1.44	-2.39	-1.78	-2.83	-1.89	-1.80	-1.99
Household Utilities	-0.61	-0.20	-0.39	-0.34	-0.01	-0.12	-0.31	-0.69	0.15	0.20	0.92	0.52	-0.20	-0.14	-0.05	-0.21
Construction	-1.88	-0.67	-1.19	-0.73	-0.50	-0.36	-1.38	-1.45	-0.47	-0.19	-0.29	-0.19	-1.09	-0.65	-0.49	-0.39
Trade	-0.38	-0.19	-0.38	-0.26	-0.01	-0.11	-0.63	-1.04	0.02	0.04	0.12	0.00	-0.22	-0.19	0.03	-0.08
Transport	-0.45	-0.15	-0.51	-0.29	0.03	-0.09	-0.47	-0.66	0.00	-0.01	0.32	0.11	-0.66	-0.44	-0.11	-0.26
Communications	-0.24	-0.25	-0.39	-0.53	-0.06	-0.20	-0.53	-1.03	0.01	0.00	-0.13	-0.41	-0.29	-0.48	0.08	-0.22
Financial Services	-0.27	-0.34	-0.53	-0.61	0.00	-0.19	-0.50	-1.05	-0.03	-0.08	-0.04	-0.17	-0.39	-0.51	0.07	-0.17
Insurance	-0.94	-0.87	-0.47	-0.55	0.04	-0.30	-0.56	-1.18	-0.34	-0.63	-1.31	-1.49	-0.48	-0.85	-0.10	-0.64
Business services	-0.36	-0.26	-0.30	-0.45	0.18	-0.16	-0.59	-1.21	0.00	-0.80	-0.03	-0.44	-0.46	-0.55	-0.14	-0.59
Other service	0.18	-0.45	-0.24	-0.87	0.03	-0.23	-0.43	-1.61	0.34	0.33	0.96	0.32	0.01	-0.66	0.39	-0.18

The sectoral results for the developing labor-exporting economies are depicted in Table 5. Again the losses are greatest in the manufacturing and services sectors, and the loss of unskilled labor has a greater impact on those sectors which use unskilled labor most intensively and likewise for skilled. While output does decline in most sectors, China and India in particular experience some considerable gains. While it may seem counter inutuitive that loss of labor would result in sectoral expansion, there is an expansion of domestic and foreign demand which is occuring with the increased migration. As a result of the higher income at home from remittances, there is a greater demand for certain commodities both by private households and firms. In the case of India, increases in remittances are coming from the higher numbers of unskilled migrants overseas. India therefore sees massive sectoral output gains in household utilities and other services, while China experiences output increases in the textiles and business services sectors, due to increased demand from foreigners.

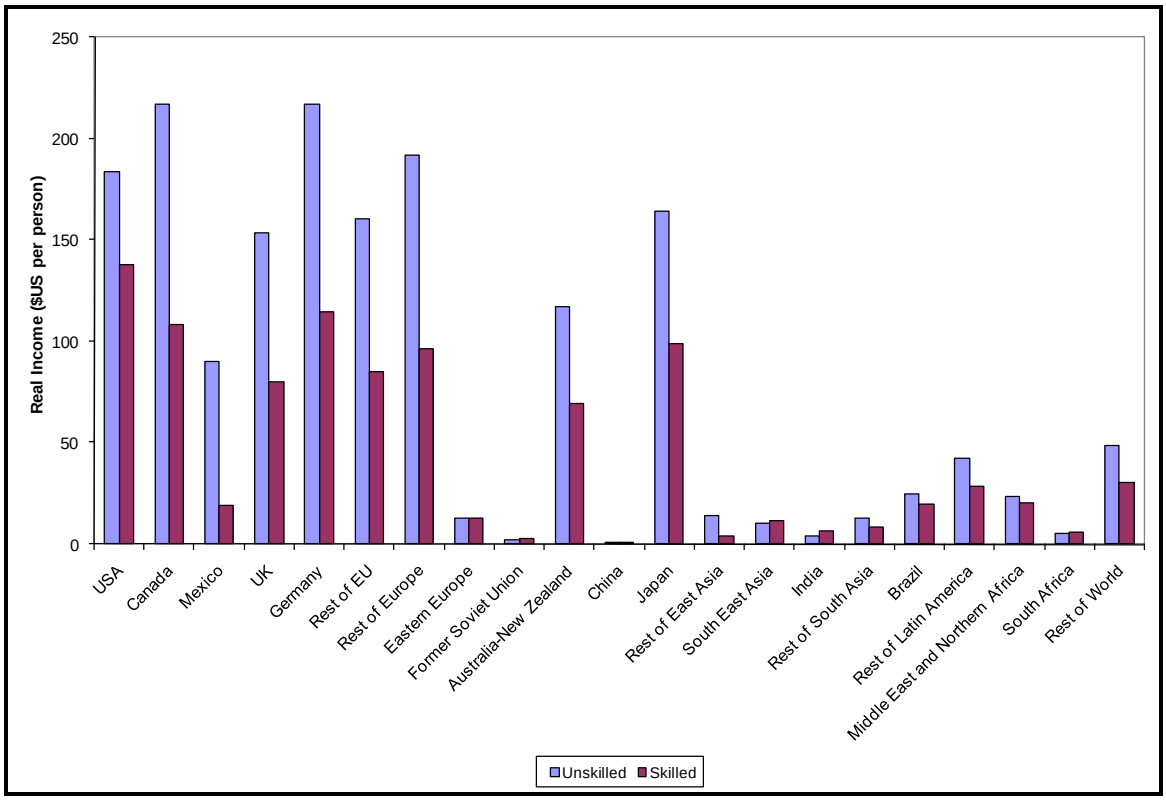
The results also show that an increase of 3% of the labor force, which is equivalent to a rise of 27% in the number of migrants in the USA, raises exports by 4.03% and imports by only 0.55%. These estimates are likely to underestimate the impact of the movement of people on trade for two reasons: a) it is assumed that migrants have the same preferences for domestic and imported goods and hence the same purchasing patterns as local permanent residents; and b) the model does not take into account the fact that migrants have country specific information and links which may result in increased trade between the two countries. Jansen and Piermartini (2004) used econometrics to estimate the impact of the movement of labor under Mode 4 on exports and imports. They estimated that a 10% increase in the number of migrants from another country in the USA increased imports from the home country by 3% and exports by 1.8-2.7%; this change in imports is far higher than the estimates presented here.

4.3. Real Incomes

The model tracks the incomes of permanent residents by region and of existing and new migrants by home and host region. In this section we examine all three.

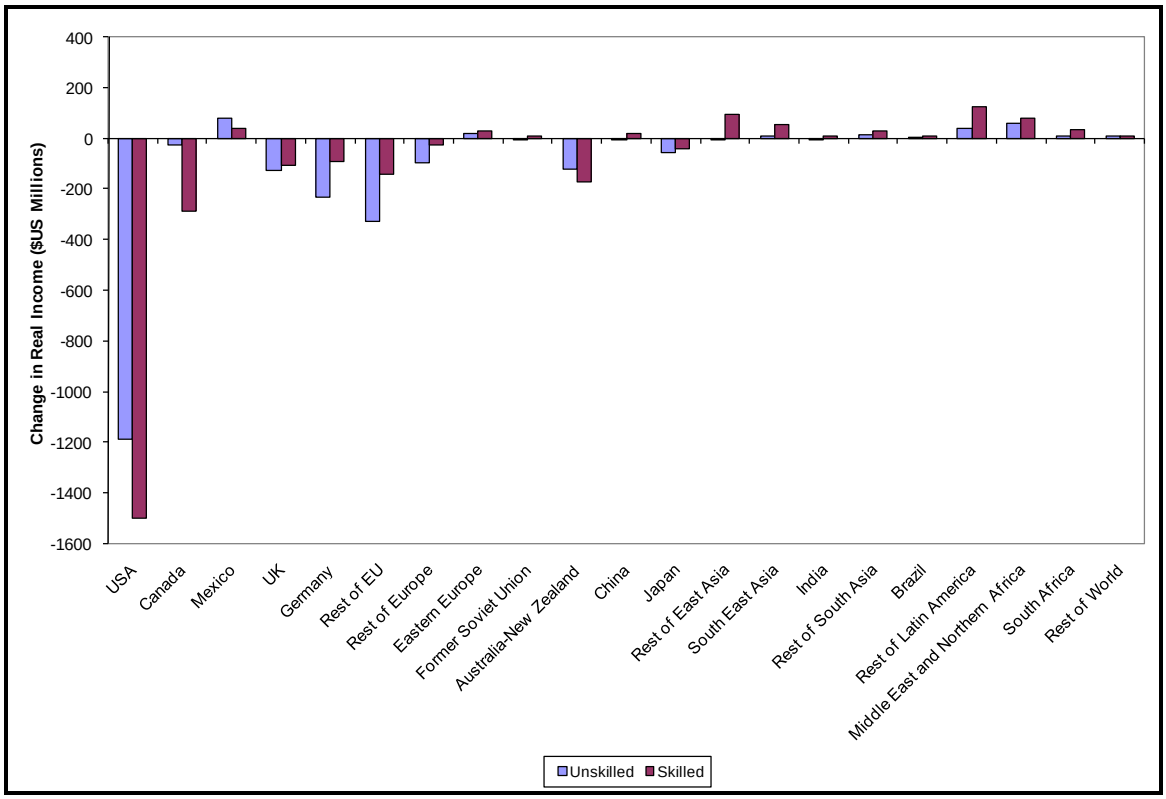
All permanent residents of the labor-importing developed and labor-exporting developing countries (or country groups) gain in terms of real incomes as a result of the increased migration (Figure 6). The labor exporting economies gain from increased remittances and wages, while the labor importing economies gain from increased returns to capital and increased tax incomes. Hence we find no brain drain effects; this is also due to the fact that we do not include many of the externalities discussed in the literature. The labor importing developed economies gain the most (per permanent resident) in terms of real income from unskilled migration. The main reason for this is that more unskilled workers migrate. If we take into account the fact that more unskilled workers are imported the results are mixed with some countries (UK, Germany and Rest of Europe) gaining more from unskilled workers than from skilled workers. The results for the developing labor exporting economies, however, are mixed. Many of the large developing labor exporting economies (South East Asia, India, and the Former Soviet Union) gain more from the migration of skilled labor than from unskilled migration. This is due to the fact that they already supply a large number of skilled workers and will continue to do so as a result of the liberalisation; while Latin America and Africa gain more from the increase in unskilled migration (Figure 6). When the number of skilled and unskilled imported and exported are taken into account the gains are largest from skilled workers.

Figure 6. Changes in Real Income of Permanent Residents due to unskilled and skilled migration respectively per permanent resident



With the assumption of perfect substitutability between foreign and domestic workers, the wages of existing migrants are affected in the same way as those of permanent resident workers. For example, the existing migrants in developed economies experience the same declines in their wages as permanent residents; however they do not get the benefits (or losses) of increased (decreased) returns to capital; which are assumed to be owned by the permanent residents. As a result the per capita real income of the average existing migrants in the developed labor-importing economies declines (Figure 7). The average existing migrants in the developing economies gain as the supply of labor falls and wages rise. Some of these increases in wages are significant (e.g. Mexico and Rest of East Asia) where the loss of labor is greatest.

Figure 7. Changes in Real Income of Existing Migrants due to unskilled and skilled migration respectively



Finally we consider the impact of the increased quotas on the new migrants. We measure the impact of the policy on the new migrants by examining the change in their real incomes (Equation (9)) after remittances are removed. In Tables 7A and 7B the change in real new migrant income/wage (per new migrant) is shown. The following equation is included to assist our understanding of the results for the change in real new migrant income/wage (per new migrant) ($\Delta w_{r,s}$):

$$\Delta w_{r,s} = (1 - r_r) w_{r,s} - w_{r,r} \qquad (13)$$

Where: $w_{r,s}$ is the final real wage of migrants from region r, earned in region s (note that these wages initially depend on both the home and host country via equation (B2));

$w_{r,r}$ is the intial real wage earned at home; and

r_r is the remittance rate for people from region r.

Almost all of the new unskilled and skilled migrant workers gain in terms of real income with the largest gains being made by those new migrants who move to the USA, followed by Japan and then the other economies (Table 6A and 6B). This is due to the fact that real wages are highest in the USA, followed by these other economies (Figure 4). The declines in real incomes are due to a combination of factors:

a) Real wage differentials between the home and host regions for skilled workers are generally smaller than for unskilled workers, and in some cases the real wages may even be lower at home than they are abroad (e.g., The Rest of East Asia).

b) Remittances are now sent back home. This lowers the real income of the migrants even further and in some cases real incomes fall (Figure 2). It is possible that the removal of remittances might cause real income to fall, where large portions of income are sent back home as remittances. It could be argued that remittances should not be taken out of the real incomes of new migrants since these migrants do gain in terms of utility from sending these remittances. Furthermore prior to moving the same proportion of their income may have been used to support their families. If we include remittances in the income of migrants, real incomes rise in all cases for unskilled workers and in almost all cases for skilled workers. But at the expense of lower rises for permanent residents in exporting countries.

The bilateral data, which in principle allow us to estimate the change for every home-host country pair, make this table far richer than we would contemplate in the original work, Walmsley and Winters (2005). This is not, however, because the difference in wages between i and j is conceptually different from previously (i.e$\Delta w_{ij} = w_i - w_j$, in obvious notation), but because we have a better handle on the numbers flowing from j to i.

Table 6A. Percent Change in Real Income (net of remittances) of new migrants by Home and Host Regions relative to their real home income (prior to migration) as a result of the movement of unskilled workers (%)[35]

	Host Region							
Home Region	**USA**	**Canada**	**UK**	**Germany**	**Rest of EU**	**Rest of Europe**	**Australia-New Zealand**	**Japan**
Mexico	237	122	170	64	44	55	106	119
Eastern Europe	220	107	172	46	37	13	119	122
Former Soviet Union	362	204	268	118	115	79	198	200
China	599	389	551	249	187	284	348	337
Rest of East Asia	123	52	83	12	30	57	25	50
South East Asia	684	405	516	267	250	370	401	336
India	214	100	145	48	35	48	82	100
Rest of South Asia	559	352	414	221	222	319	334	208
Brazil	134	53	86	13	-9	55	45	51
Rest of Latin America	193	121	171	53	36	58	132	98
Middle East and Northern Africa	155	55	128	77	19	45	20	122
Southern Africa	1,116	746	890	511	438	549	687	679
Rest of World	364	257	294	113	0	246	148	216

[35] This is equal to the change in real income of new migrants (c_cRYnmigs) divided by the initial income of those same new migrants (c_INCnmigsI) mulitplied by 100.

Table 6B. Percent Change in Real Income (net of remittances) of new migrants by Home and Host Regions relative to their real home income (prior to migration) as a result of the movement of skilled workers (%)[36]

Home Region	Host Region							
	USA	Canada	UK	Germany	Rest of EU	Rest of Europe	Australia-New Zealand	Japan
Mexico	83	-5	22	-26	-14	6	12	22
Eastern Europe	180	43	95	9	43	12	76	99
Former Soviet Union	346	127	194	70	132	56	165	200
China	65	14	40	-31	-11	-26	22	4
Rest of East Asia	14	-17	-13	-47	-41	-36	-5	-26
South East Asia	336	115	213	84	129	70	188	179
India	1	-50	-34	-61	-47	-69	-41	-33
Rest of South Asia	138	27	55	-5	43	-21	53	17
Brazil	29	-33	-14	-48	-31	-36	-20	-13
Rest of Latin America	125	31	69	-7	21	-9	64	53
Middle East and Northern Africa	149	14	92	24	17	19	3	137
Southern Africa	262	93	144	46	102	28	128	137
Rest of World	439	221	271	100	88	205	187	281

[36] This is equal to the change in real income of new migrants (c_cRYnmigs) divided by the initial income of those same new migrants (c_INCnmigsI) m,ulitplied by 100.

A significant difference between these results and those obtained in Walmsley and Winters (2005) is the larger gains to the permanent residents and the smaller gains to the actual migrants themselves. Most of this can be attributed to the fact that we are using remittances data from Ratha (2003) which are substantially higher than those used in the previous study - which were obtained from IMF data.

4.4. Sensitivity Analysis and Qualifications to the Results

In this final section we undertake some basic systematic sensitivity analysis to examine how sensitive the results are to changes in the size of the shocks, the proportion of wages assumed to be gained by the new migrants and the impact of allocating these new migrants directly into the services sectors. Rather than include all the results here, we concentrate on a comparison of the implications on real income of the permanent residents (Table 8). Overall the results of the sensitivity analysis concur with those found in Walmsley and Winters (2005).

The results show that the gains to permanent residents roughly double as the size of the shock increases from 3% to 6%. This assumes that there is still sufficient demand for the quota places.

When we alter the intial value of β (equation B2 in Box 1), and re-calibrate the intial data, we find that the real income of the migrants in the labor-importing countries changes[37]. If β is raised the productivities (wages) of the migrants is higher and the developed economies gain more. The impact on the labor-exporting economies from changes in the β is minimal and the direction of the impact is mixed. Changes in β do not alter the remittances sent home. This is because, as β is raised, remittances as a share of income falls. Therefore with a higher β (and higher income) the new migrants just send home a lower share of their income.

[37] Changing the BETA as part of the simulation provides different results, see Ojeda, McCleery, De Paolis and Walmsley (2007).

Finally, we examine the impact of restricting the movement of workers across sectors, i.e. the new migrant workers are given jobs in the services sectors[38] and permanent resident labor is assumed not to move out of these sectors. In the standard GMig2 Model and closure the new migrants increase the total supply of labor and this additional labor is then allocated across sectors so that the percentage change in the wage is equal across sectors. The reason for this closure is that even if migrants are not permitted to work in all sectors of the economy, permanent residents are permitted and are likely to move to other sectors in response to more migrant workers entering a sector. As in Walmsley and Winters (2005) we also consider the case where labor is restricted to specific sectors. As discussed above this is achieved in the model by dividing the sectors into two groups: one group of sectors which employ temporary labor (A); and a second group of sectors which do not (B). The supply of labor to each group must equal its demand; the supply is fixed exogenously for each group and labor can flow freely within each group but not between them. All temporary labor flows are added to the supply for the group of sectors which accept temporary labor (A), while the supply of labor to the other group (B) is held at its original level. Overall we find that the gains are much lower in the labor importing economies, than in the case where labor movement across sectors is not restricted. This is not surprising since allowing labor to allocate itself across sectors leads to a more efficient allocation of resources and would lower prices across all commodities, rather than just services. It should be noted that while real incomes of the labor importing countries with sector restriction is not as high in the unrestricted base case, the developing country labor exporters gain considerably more in terms of real income. This is due to the fact that the labor exporting economies will be able to gain from the production and export of goods produced by the non-services sectors and the considerable improvement in their terms of trade. The permanent residents of the USA, on the other hand, experience gains as a result of the sectoral restrictions, this is due to the gains resulting from the very large decline in prices.

[38] Transport, Communications, Financial services, Insurance and Business Services.

There are a number of other assumptions that are critical to apportioning the gains of migration across permanent residents, and new and existing migrants. Many of these assumptions were considered by van der Mensbrugghe in the World Bank (2006) report on international migration and remittances, including the role of perfect substitutability, the implications of the fiscal assumptions and the role of substitutability between capital, skilled labor and unskilled labor.

Table 7. Comparison of Percent Change in Real Income of Permanent Residents by Host Region under alternative assumptions

	3% shock	6% shock	Increased β (3% shock)	Services Sectors (3% shock)
USA	0.49	0.98	0.58	0.61
Canada	0.75	1.51	0.87	0.26
Mexico	0.85	1.66	0.84	1.64
UK	0.51	1.03	0.61	-0.24
Germany	0.76	1.51	0.89	0.13
Rest of EU	0.61	1.23	0.72	0.14
Rest of Europe	0.93	1.85	1.09	-0.01
Eastern Europe	0.37	0.70	0.36	1.29
Former Soviet Union	0.17	0.35	0.19	0.75
Australia-New Zealand	0.55	1.11	0.63	0.07
China	0.09	0.19	0.10	0.42
Japan	0.50	0.99	0.59	-0.48
Rest of East Asia	0.13	0.20	0.12	0.11
South East Asia	1.06	2.08	1.05	2.19
India	1.08	2.13	1.09	2.19
Rest of South Asia	2.39	4.68	2.46	4.71
Brazil	0.82	1.61	0.81	2.31
Rest of Latin America	0.96	1.88	0.96	2.24
Middle East and Northern Africa	0.69	1.37	0.72	1.71
Southern Africa	1.16	2.29	1.18	2.61
Rest of World	2.19	4.32	2.22	4.42

World Bank (2006) assume that domestic and foreign migrant workers are not perfect substitutes and therefore find that native workers could be (partially) isolated from a wage decline thereby raising their welfare (relative to the perfect substitution assumption made in this model). Existing migrants, on the other hand, are more negatively impacted

since the supply shock becomes relatively larger. In its report on international migration and remittances the World Bank (2006)[1] did not come to a conclusion on the degree of substitution as the literature on this is not conclusive, but sensitivity analysis indicates its importance.

Secondly, in this paper we assume that new migrants pay taxes, but do not obtain any of the benefits accruing from those taxes. In the World Bank (2006) report sensitivity analysis was undertaken to show how their welfare results differed under different assumptions:

1) Fiscal neutrality (new migrants received the same value of benefits as their taxes);

2) No public benefits accrue to new migrants but they pay taxes; and

3) New migrants receive the same per capita public benefits as native workers.

They found that the move from (1) to (2) nearly doubled the welfare gains for native workers and raised the global gains (because public benefits accruing to new migrants are adjusted by a cost-of-living factor that reduces the value of those benefits to the new migrants). Under assumption (3) we might expect that the welfare gains of the permennt residents would be even lower, as migrants receive benefits greater than the value of their taxes. Walmsley and Winters (2005) found a similar result when they incorporated taxes into the GTAP 5 Data Base; the USA IO table used in the GTAP 5 Data Base did not include income taxes. In this paper, the GTAP 6 Data Base is used and taxes are collected from migrants.

Finally, in the standard GTAP Model substitution occurs across natural resources, land, capital, and skilled and unskilled labor. There is an emerging view that unskilled labor is a substitute for a skilled-capital composite factor and that skilled labor is a near complement with capital. Under this latter assumption, it may be the case that returns to capital increase even more relative to the default assumption as the relative scarcity of capital increases with the rise in skilled labor—again changing the distribution of the welfare gains.

5. Conclusion

It is increasingly recognised that the removal of restrictions on the movement of labor across country borders could contribute significantly to the real incomes and development of developing economies. This paper contributes further to the current literature by extending the global applied general equilibrium model (GMig), developed by Walmsley and Winters (2005), to include bilateral labor flows and hence provide further evidence of the potential gains from the relaxation of these restrictions to the world as a whole.

The development of a bilateral labor migration model (GMig2) has allowed for improved analysis of the movement of labor in a number of important ways. In Walmsley and Winters (2005) all migrants were assumed to have the same characteristics. With bilateral data however we can distinguish between the migrant workers by both their host and home countries. Hence a migrant worker in the USA will differ from a migrant worker in Europe due to the fact that their home country is likely to differ. These differences in their home country will be reflected in their productivities, wages, skill levels, and remittance rates which in turn will affect how the movement of labor across international borders will impact the host and home economies. Moreover we can distinguish between permanent residents; and new and existing migrant workers and hence examine the impact of policies on each of these types of workers.

In our main exercise, quotas on the number of temporary workers permitted into the developed economies are increased by 3% of the developed economies' labor forces. The real income of permanent residents in the developed economies increases significantly; with most of those gains arising from the lifting of quotas on unskilled labor. The permanent residents of developing countries also gain in terms of real incomes from sending unskilled labor and skill labor, although the gains from skilled are lower. While results differ across developing economies, most gain as a result of the higher remittances sent home.

In general the results found here are consistent with those obtained by Walmsley and Winters (2005), there are significant gains to be made from the liberalization of the

movement of labor and most of these gains accrue from the movement of unskilled workers. The improved data however has led to a significant increase in the gains expected from liberalization. This is due to the fact that we assume that migrants obtain a larger proportion of the differences in wages and hence productivities between the home and host region and that we are using the GTAP 6 Data Base, based on a reference year of 2001. Moreover more of the gains from liberalization accrue to the labor exporting developing economies in this paper due to the fact that remittances are higher in the underlying data base (Ratha, 2003).

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Appendices

The purpose of Appendicies 1 and 2 is to assist those wishing to replicate and/or run their own application of the GMig2 Model. The GMig2 application outlined in this technical paper are provided as a RunGTAP application with this technical paper, and aggregations can be obtained from the Center. Appendix 1 lists the additional headers required in the GMig2 sets, data and parameters files; while Appendix 2 outlines the various closures which can be used with the model.

Appendix 1. Data and Sets

The GMig2 Data Base used in this technical paper is based on the GTAP 6 Data Base. The additional headers required for the GMig2 Data Base are outlined below:

Additional Headers in GMig2 Sets file

Header	Type	Dimension	Name
LAB	1C	2 length 12	Labor types
IREG	1C	8 length 12	Labor importing regions
XREG	1C	13 length 12	Labor Exporting Regions
PRDG	1C	1 length 12	Number of groups for restricting labor flows between sectoral groups. In the standard closure there is only 1 group.
PMAP	1C	23 length 12	Mapping of sectors to the groups (PRDG).

Additional Headers in GMig2 Data Base

Header	Type	Dimension	Name
POP	RE	REG*REG	Population from r in s
Q	RE	LAB*REG*REG	No. of labor force from r in s
REM	RE	REG*REG	Remittances of people from r in s
VFAS	RE	ENDW_COMM * REG * REG	Value of firms purchases of endowments owned by people from r located in s at agent prices
VOMS	RE	ENDW_COMM*REG*REG	Value of endowments owned by people from r located in s at market prices
VOAS	RE	ENDW_COMM*REG*REG	Value of firms purchases of endowments owned by people from r located in s at agents prices

PPP	RE	REG	Purchasing Power Parity
PRTM	RE	LAB*REG*REG	Extra productivity of migrants returning from s to r
EMIG	RE	LAB*21*21	Elasticity of labor to relative real wages
TEMP	RE	1	TEMP = 1 if migrants do not bring families; TEMP = 0 if do.

Additional Headers in GMig2 Parameters file

Header	Type	Dimension	Coeff	Total	Name
PRMG	RE	LAB*21*21	RETMIG	88.20	Rate of Return Migrants

Appendix 2. Closures and Shocks

The GMig2 Model is based on the standard GTAP Model, with some additional equations and features which allow for the movement of labor. In this appendix we list the standard closure and outline some alternative closures and shocks which are available to users in the GMig2 Model.

a. The Standard GMig2 Closure

The exogenous variables in the GMig2 Model which correspond to those in the standard GTAP Model (Hertel, 2007) include:

pfactwld	*Numeraire*
psaveslack profitslack incomeslack endwslack incomeslacks cgdslack tradslack	*Slack variables*
ams atm atf ats atd aosec aoreg avasec avareg afcom afsec afreg afecom afesec afereg aoall afall afeall	*Technology variables*
au dppriv dpgov dpsave	*Distribution parameters*
to tp tm tms tx txs	*Policy variables*
qo(NLAB_ENDW,REG)	*Non-labor endowments*

The new exogenous variables in for the GMig2 Model are:

c_MIGNOSP	*Change in the number of Migrants of skill i from r in s.*
c_smigin	*slack used to endogenise no. of new migs entering s*
c_smigout	*slack used to endogenise no. of new migs leaving r*
tos	*Income tax in region s levied on labor i from r*
grpslack	*slack variable in endowment market clearing condition*
shiftrem	*shift to exogenise remittances*
c_RMIGS	*No. of effective return migrants by skill returing to r from s*
c_shiftlf	*Slack variable to change the labor force without changing the number of migrants (e.g., to incorporate forecasts of changes in labor force unrelated to migration.)*
p_ESUBMIG	*Change in the elasticity of supply of migrants with respect to wages*
p_BETA	*Percent change in the ratio of wages of migrants relative the wages of permanent residents. This BETA is defined differently to the BETA used in calibrating the wages of migrants.*
p_RWAGEI	*Percent change in the initial real wage.*
p_LFNOSPI	*Percent change in the initial labor force.*

Under the standard closure of the GMig2 Model the user can increase the flow of labor of skill i, from the labor exporting region r to the labor importing region s by shocking c_MIGNOSP(i,r,s). Note that the labor exporting and labor importing regions must be defined in sets.har (see appendix A).

b. Alternative closures

It is unlikely that a user will always want to shock the change in number of migrants (c_MIGNOSP(i,r,s)) directly. Below are some alternative mechanisms for implementing changes in migration.

i. Increase in quotas of Labor Importing Region

If a user wishes to increase the quota of migrants of skill i entering region s then the following closure swaps[39] and shock can be implemented. In this case the labor force of

[39] A closure swap is a command in gemapck used to change the closure. The standard closure is placed on the closure page, followed by a closure swap statement. The closure swap statement tells the program to

the labor importing region increases by the amount of the shock and these are supplied by all the labor exporting regions (r) according to the share of migrants currently from region r located in region s.

Closure changes:

swap c_MIGNOSP(LAB_COMM,LEXP_REG,LIMP_REG) = c_slackmigin(LAB_COMM,LEXP_REG,LIMP_REG) ;

swap qop(LAB_COMM,LIMP_REG) = c_smigin(LAB_COMM,LIMP_REG) ;

Shocks:

qop(i,s), where s is a labor importing region (i.e., an element of the set of LIMP_REG in sets.har).

Users can also include automatic return migration (Ahmed and Walmsley, 2007) by implementing the following additional closure swap. This causes a proportion (determined by header PRMG) of the new migrants to return with higher productivities (determined by header PRTM).

swap c_SLACKRMIGS(LAB_COMM,LEXP_REG,LIMP_REG) = c_RMIGS(LAB_COMM,LEXP_REG,LIMP_REG) ;

ii. Increase in exodus from Labor Exporting Region

If a user wishes to increase the exodus of migrants of skill i leaving region r then the following closure swap and shock can be implemented. In this case the labor force of the labor exporting region falls by the amount of the shock and these new migrants migrate to all the labor importing regions (s) according to the share of migrants from region r, currently located in region s.

Closure changes:

swap c_MIGNOSP(LAB_COMM,LEXP_REG,LIMP_REG) = c_slackmigout(LAB_COMM,LEXP_REG,LIMP_REG) ;

swap qop(LAB_COMM,LEXP_REG) = c_smigout(LAB_COMM,LIMP_REG) ;

Shocks:

qop(i,r), where r is a labor exporting region (i.e., an element of the set of LEXP_REG in sets.har).

iii. Endogenous Movement of Labor

If a user wishes to endogenise the movement of migrants based on changes in real wages then the following closure swap and shock can be implemented.

Closure changes:

---

edit the above closure by swapping the exognenous variable listed for the endogenous variable. Note that the ordering does not matter. This allows the user to see exactly how the special closure differs from the standard closure.

swap c_MIGNOSP(LAB_COMM,LEXP_REG,LIMP_REG) =
SLACKENDMIG(LAB_COMM,LEXP_REG,LIMP_REG) ;

Shocks:

In order to create endogenous changes in migration the user will need to implement a shock to trade, technology or some other variable. The user could also shock the elasticity of labor migration with respect to wage differentials or the productivity of migrants as a means of implementing policy changes with respect to migration (Ojeda, McCleery, De Paolis and Walmsley, 2007):

shock p_ESUBMIG(LAB_COMM,LEXP_REG,LIMP_REG)[40]

shock p_BETA(LAB_COMM,LEXP_REG,LIMP_REG)

Appendix 3. Purchasing Power Parity (PPP) verses Market Exchange Rates (MER)

In addition to obtaining the changes in real income per permanent resident at market exchange rates, changes in real incomes are also determined at purchasing power parity. A comparison of the results is shown below. As expected the changes in real incomes are larger when purchasing power parity is taken into account, except in the case of Japan and Rest of Europe where prices are high relative to the other economies and hence the real changes in income at PPP are lower relative to MER. In percentage change terms (relative to intial income values at MER and PPP respectively) the results are the same for permanent residents.

[40] Note that shocking the slope alone will not change any of the results.

Figure A3.1. Changes in Real Income of Permanent Residents due to migration respectively per permanent resident (PPP v MER)