MENA-to-EU migration and labor market imbalances*

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Abstract. In this report, we analyze the consequences of increasing MENA-to-EU migration flows on both sending and receiving regions. We first characterize the structure of MENA emigration and show that EU27 is a major destination for 9 MENA countries, including Algeria, Egypt, Morocco and Tunisia. Potential increased flows of MENA-to-EU migration in the future would in all probability particularly impact these countries. Then, we analyze the demographic trends in these regions and conclude that replacement migration policies encouraging MENA-to-EU flows of working-age people would need to be temporary, as MENA countries themselves will be facing labor shortages in the future. Replacement migration policies will need to be limited in size and in time (not beyond 2050). We then analyze the economic effects of increased migration using generational accounting techniques and general equilibrium modeling. We show that increasing MENA-to-EU migration would generate significant changes in EU tax rates and GNI per capita, smoothing the fiscal and economic burdens of aging. Compared to a non selective immigration shock, selecting immigrants has a moderate impact in reducing tax rates, but leads to a greater impact on GNI per capita in the EU. On the other hand, increases in emigration, without some compensating policies on education, would have a strong detrimental impact on MENA tax rates, especially if emigrants are skilled. Regarding GNI per capita and inequality in MENA, increasing unskilled emigration leads to strong improvements (mainly due to remittances) while increasing skilled emigration induces detrimental consequences. Finally the negative effects of a selective migration policy in MENA may be considerably mitigated if the brain drain leads to side-effects or is accompanied by increased education attainment at origin. In particular, our results suggest that a stronger partnership between EU15 and selected MENA countries, involving more skilled migration and a greater cooperation in human capital formation, can raise the welfare of all parties concerned. Such an initiative could be designed in the framework of the Union pour la Méditerranée whose explicit goal is to promote a development of the Euromediterranean Partnership.

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1 Introduction

The decrease in fertility and mortality rates induces a progressive and inescapable greying of European nations. The economic effects of an aging population are considerable. Changes in the demographic structure are likely to affect the amount of capital per worker (with induced effects on interest rates and wages), the demand for some types of goods or the rate of economic growth. However population aging also raises the average amount of public expenditures per capita. The largest areas of public expenditure in many countries are now health care and pension benefits. Both are expected to increase dramatically as the population ages. Governments then face hard choices between higher taxes (including a possible reweighting of taxes from earnings to consumption), increasing debt (which could jeopardize the welfare of future generations) and a reduced government role in providing health care and social security.

Another option is to find policies that increase the supply of labor and the tax basis. Over the last years, economists and policymakers have discussed the opportunity to define a new labor-market oriented policy of immigration. Immigration appears as a potential solution to reduce the burden of aging. This is especially the case in Europe where the European Commission has suggested to conduct a blue card policy facilitating the entry of foreign skilled workers. Following the examples of the German green card or UK points-based system, many countries are now considering the possibility to select immigrants, although such a policy reform could be delayed if the current financial crisis persists. Clearly, we should not expect immigration to totally solve the problem. In their report on replacement migration, the United Nations (2000) demonstrate that keeping the dependency ratio constant over the period 2000-2050 requires multiplying European annual immigration flows by 50 (by 15 in the United States). In many countries, the immigration rates would then reach unrealistic values that are not politically sustainable.

Nonetheless, a decent increase in immigration flows or a change in the schooling level of immigrants could attenuate the burden supported by future generations of European natives. Given its economic (low skill premia, high tax rates, generous welfare programs) and linguistic characteristics, it is very hard to believe that continental European nations are able to attract many (skilled) migrants from the rest of the world. However, given its colonial links and geographical proximity, European countries are the main destinations of African emigrants, especially those from the Maghreb and a couple of Middle East countries. With large diasporas resulting from guest-worker bilateral programs of the post-World War II, European countries could probably increase the number of immigrants from the Middle East and Northern Africa (MENA) or even conduct more selective policies towards these immigrants. Would such policies be optimal for European countries? What would be their implications for MENA origin countries? These are the questions addressed in this report.

The main insights of our analysis can be summarized as following:
The MENA region sends about 15 million emigrants abroad, including 5.1 million to the 27 countries of the European Union. For 9 countries of the region, the EU27 is a particularly important destination. We refer to MENA9 a group which includes Algeria, Djibouti, Egypt, Iran, Lebanon, Libya, Malta, Morocco and Tunisia. These 9 countries send 9.2 million adult emigrants abroad, and for more than half (50.5 percent of them), the EU27 is the migration destination. Within this group, there is a subset of countries we refer to as MENA4, including Algeria, Morocco, Tunisia, and Egypt, in which the flows to EU27 as a group are particularly high (either in numbers or proportions of their population). MENA4 sends 4.2 million migrants to Europe, representing 56 percent of their diaspora. In any discussions about increased migration flows from MENA to Europe, these are the countries which would be particularly affected.

Previous macroeconometric studies suggest that the “brain drain” – the loss of high skilled labor to migration – begins to demonstrate harmful impacts on development if it exceeds a threshold of 10-15 percent (see Docquier, 2007). With the exceptions of Djibouti, Libya and Egypt, all of the MENA9 are already above that level (Lebanon, Malta, Morocco; Algeria, Egypt and Iran are at the border). As a result, for the sending countries of MENA, increasing the levels of high skilled migration are likely to have damaging impacts on growth and development without accompanying policies to mitigate these harmful effects.

Demographically, increasing migration flows from MENA4 or MENA9 to EU27 countries would clearly attenuate the deterioration of the European population structure. However, MENA countries themselves expect serious demographic strains after 2030 and will need pension reforms to minimize the risk of a financial crisis. The MENA4 aged-dependency ratio in 2050 will exceed the current ratio observed in the EU. Hence, “replacement or selective migration” policies encouraging MENA-to-EU flows of working-age people should ideally be structured to be temporary (not beyond 2050).

Generational accounting models reveal that the benefits from immigration policy reforms are relatively low compared to the expected burden of aging. On the one hand, changing the size of immigration has a small and ambiguous impact on fiscal sustainability. On the other hand, changing the structure of immigration induces stronger fiscal effects.

However, a general equilibrium analysis does not confirm these results. It reveals that an increased MENA-to-EU migration would generate significant changes in EU tax rates and GNI per capita, significantly smoothing the fiscal and economic burdens of aging. Contrary to pure fiscal studies (such as generational accounting), selecting immigrants has only a moderate impact on tax rates. This can be explained by induced effects on wage rates, skill premia and interest rates. However, selection has a strong and positive impact on GNI per capita. In MENA, however, increases in emigration have a strong detrimental impact on tax rates, especially if emigrants are skilled.
Moreover increasing unskilled emigration in MENA leads to improvements in GNI per capita and inequality (mainly due to remittances) while increasing skilled emigration induces detrimental consequences.

- The analysis also accounts for different variants of the skilled migration scenario. A “Brain Waste” variant (in which skilled migrants are employed as unskilled at destination) combines the worst effects of the selective and non selective shocks, since MENA loses its most productive workers, who are employed as unskilled in Europe and thus contribute poorly to the EU’s economy. In a second variant accounting for positive externalities of the brain drain, we mitigate the negative impact of skilled migration on income per capita and inequality in MENA. Still, MENA would suffer from an enlarged brain drain.

- Finally, we consider a possibility where MENA countries prepare for greater skilled migration to Europe by accelerating their human capital formation. In this case, a skilled emigration shock could go along with a rise in education levels of the MENA population and income per capita. This suggests that a stronger partnership between EU15 and MENA countries, involving more skilled migration and a greater cooperation in human capital formation, can raise the welfare of all parties concerned. For instance, such an initiative could be designed in the framework of the “Union pour la Méditerranée” initiated in late July by French President Nicolas Sarkozy. The goal of this Union is explicitly to promote a development of the Euromediterranean Partnership.

The remainder of this report is organized as following. First, we provide a detailed snapshot of the current MENA-to-EU labor mobility by education level and by gender, determining the proportion of the MENA brain drain due to the EU (Section 2). Section 3 characterizes the demographic evolution in the EU and MENA regions. Then, in Section 4, we use a generational accounting model to quantify the fiscal impact of aging on European countries, discussing the potential impact of immigration by comparing immigrants' tax-transfer profiles per age and education level to natives' profiles. In Section 5, we will use a CGE model of the world economy to simulate the impact of increased migration flows from MENA to the EU on tax rates (reflecting the burden of aging), productivity, GDP-GNI levels and demographic variables in both regions.

2 Quantifying MENA-to-EU migration

One of the major constraints to monitoring the scope and impact of the brain drain in developing countries has been the lack of harmonized international data on migration by country of origin and education level. Until recently, despite numerous case studies and anecdotal evidence, there has been no systematic assessment of the bilateral structure of international migration and its educational structure. In this section, we take advantage of two recent studies sponsored by the World Bank, to quantify and characterize the structure of MENA-to-EU migration.
2.1 Global situation in 2000

To evaluate the magnitude of MENA-to-EU migration, we first rely on the data set described in Parsons et al. (2007). They provide a 226x226 matrix of origin-destination stocks by country and territories. The data are generated by disaggregating the information on migrant stock in each destination country or economy as given in its census. The reference period is the 2000 round of population censuses, so the data do not refer to precisely the same time period. The data set provides stocks of migrants, not flows.

Four versions of the database are available, giving increasing levels of completeness, but decreasing levels of accuracy as the missing data are added via assumption and interpolation with each successive version. In the first three versions, information is reported on both place of birth and citizenship, compiled in separate matrices, to maintain the clear distinction between the data, which are clearly based on different concepts. Version 4 combines the two concepts to create a single comprehensive bilateral matrix of stocks. Our analysis is based on this latter version. Results are provided in Tables 2.1 and 2.2.

From Table 2.1, we see that the 21 MENA countries sent 15 million emigrants abroad in 2000. Since the resident population amounted to 316 million, this gives an emigration "rate" of 4.5%. Countries of the Gulf Cooperation Council (GCC) send 1 million emigrants abroad, representing 3.3% of the native population. Countries with the highest emigration rates are West Bank and Gaza (33.8 percent), Malta (28.9 percent), Kuwait (21.8 percent) and Bahrain (19.2 percent). As shown in Docquier, Lohest and Marfouk (2007), there is an obvious link between population size in country of origin and number of migrants abroad. In absolute numbers, the main emigration countries are the largest ones while the smallest number of emigrants come from small countries. However, an increase in population generates a less than proportional increase in emigration. The emigration rate decreases with population size in the country of origin. Table 2.1 confirms this result. In absolute terms, the main exporters of migrants are large countries such as Morocco, Egypt and Algeria. In relative terms, these countries exhibit lower emigration rates. In the fourth column, we also report a concentration index of emigrants by country of destination (Herfindahl index). Emigrants from Algeria, Israel, Tunisia, Yemen and West Bank and Gaza are highly concentrated. On the contrary, emigrants from Lebanon, Libya, Syria, Iran and Morocco are more geographically dispersed.

Unsurprisingly, the main destination varies by country. France is the main destination of emigrants from Algeria, Djibouti, Morocco and Tunisia. Emigrants from Bahrain, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates are mostly residing in West Bank and Gaza. Saudi Arabia and the US appear twice in the list of main destinations. For Algeria, the main destination drains 64.4 percent of total emigration. On the contrary, the main destination represents less than one fourth of the total emigration stock originating from Lebanon and Libya.

Table 2.2 provides more details on the location of emigrants. We distinguish emigration to the members of the OECD, including the EU15, North America, Oceania (i.e. New Zealand and...
Australia), the EU27 and other MENA countries (including GCC members). Migration to the OECD (South-North migration) is dominant in 7 cases: Algeria, Djibouti, Iran, Lebanon, Malta, Morocco and Tunisia. In all these cases, the share of EU27 host countries is important. If we add Libya (sending one fourth of emigrants to the EU27) and Egypt (sending about 200,000 migrants to the EU27) to the above 7 countries, we can define a MENA9 sub-group for which EU27 is an important destination, in absolute or relative terms. Within this group, we define the MENA4 sub-group including four important emigration countries (Morocco, Algeria, Tunisia and Egypt). In 2000, MENA4 sent 4.15 million emigrants to EU27, i.e. 90 percent of MENA9 and 81.5 percent of MENA emigrants to EU27.

If one had to increase the flows of MENA-to-EU migration in the future, these sub-groups countries would be seriously concerned. The other 12 countries mainly send migrants to other MENA nations. In particular, GCC countries attract the majority of emigrants from Yemen and, to a lower extent, Syria, Kuwait and Jordan.

Table 2.1. Emigration from MENA countries in 2000

<table>
<thead>
<tr>
<th>MENA4</th>
<th>Total migration</th>
<th>Main destination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stock</td>
<td>Rate</td>
</tr>
<tr>
<td>Algeria</td>
<td>2070840</td>
<td>6.8%</td>
</tr>
<tr>
<td>Egypt</td>
<td>2173711</td>
<td>3.2%</td>
</tr>
<tr>
<td>Morocco</td>
<td>2589108</td>
<td>8.9%</td>
</tr>
<tr>
<td>Tunisia</td>
<td>607491</td>
<td>6.4%</td>
</tr>
<tr>
<td>MENA9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djibouti</td>
<td>16990</td>
<td>2.4%</td>
</tr>
<tr>
<td>Iran</td>
<td>926312</td>
<td>1.4%</td>
</tr>
<tr>
<td>Lebanon</td>
<td>577123</td>
<td>17.0%</td>
</tr>
<tr>
<td>Libya</td>
<td>78109</td>
<td>1.5%</td>
</tr>
<tr>
<td>Malta</td>
<td>113094</td>
<td>28.9%</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td>128719</td>
<td>19.2%</td>
</tr>
<tr>
<td>Iraq</td>
<td>1109957</td>
<td>4.4%</td>
</tr>
<tr>
<td>Israel</td>
<td>956959</td>
<td>15.7%</td>
</tr>
<tr>
<td>Jordan</td>
<td>667754</td>
<td>13.4%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>486861</td>
<td>21.8%</td>
</tr>
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<td>Oman</td>
<td>17881</td>
<td>0.7%</td>
</tr>
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<td>Qatar</td>
<td>15958</td>
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<td>Saudi Arabia</td>
<td>243258</td>
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</tr>
<tr>
<td>Syria</td>
<td>423764</td>
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</tr>
<tr>
<td>United Arab Em</td>
<td>123886</td>
<td>3.8%</td>
</tr>
<tr>
<td>W.Bank Gaza</td>
<td>1065224</td>
<td>33.8%</td>
</tr>
<tr>
<td>Yemen</td>
<td>603173</td>
<td>3.4%</td>
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</table>

Source: Parsons et alii (2007)
Table 2.2. Location of MENA emigrants in 2000

<table>
<thead>
<tr>
<th></th>
<th>OECD</th>
<th>EU15</th>
<th>NAM</th>
<th>PAC</th>
<th>EU27</th>
<th>MENA</th>
<th>GCC</th>
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<tr>
<td><strong>MENA4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Algeria</td>
<td>81.0%</td>
<td>79.0%</td>
<td>1.8%</td>
<td>0.1%</td>
<td>79.1%</td>
<td>9.2%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Egypt</td>
<td>17.8%</td>
<td>8.7%</td>
<td>7.4%</td>
<td>1.6%</td>
<td>8.9%</td>
<td>75.8%</td>
<td>51.6%</td>
</tr>
<tr>
<td>Morocco</td>
<td>74.9%</td>
<td>71.9%</td>
<td>2.8%</td>
<td>0.1%</td>
<td>71.9%</td>
<td>16.5%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Tunisia</td>
<td>77.7%</td>
<td>75.0%</td>
<td>2.3%</td>
<td>0.1%</td>
<td>75.1%</td>
<td>12.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td><strong>MENA9</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djibouti</td>
<td>51.3%</td>
<td>46.1%</td>
<td>4.7%</td>
<td>0.4%</td>
<td>46.1%</td>
<td>11.2%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Iran</td>
<td>76.3%</td>
<td>31.4%</td>
<td>39.6%</td>
<td>2.2%</td>
<td>31.5%</td>
<td>45.9%</td>
<td>1.5%</td>
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<td>Lebanon</td>
<td>64.7%</td>
<td>20.3%</td>
<td>31.2%</td>
<td>12.4%</td>
<td>20.9%</td>
<td>38.9%</td>
<td>9.0%</td>
</tr>
<tr>
<td>Libya</td>
<td>45.0%</td>
<td>23.4%</td>
<td>14.7%</td>
<td>2.0%</td>
<td>24.6%</td>
<td>53.2%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Malta</td>
<td>92.8%</td>
<td>34.3%</td>
<td>16.5%</td>
<td>41.9%</td>
<td>34.4%</td>
<td>9.5%</td>
<td>0.7%</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td>8.5%</td>
<td>4.7%</td>
<td>3.1%</td>
<td>0.7%</td>
<td>4.8%</td>
<td>57.7%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Iraq</td>
<td>34.9%</td>
<td>19.3%</td>
<td>10.7%</td>
<td>2.7%</td>
<td>19.5%</td>
<td>66.7%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Israel</td>
<td>21.5%</td>
<td>5.5%</td>
<td>14.6%</td>
<td>0.7%</td>
<td>5.8%</td>
<td>83.4%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Jordan</td>
<td>11.9%</td>
<td>2.9%</td>
<td>8.2%</td>
<td>0.5%</td>
<td>3.0%</td>
<td>88.3%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>10.2%</td>
<td>3.0%</td>
<td>6.5%</td>
<td>0.6%</td>
<td>3.1%</td>
<td>86.6%</td>
<td>25.1%</td>
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<td>Oman</td>
<td>30.1%</td>
<td>16.6%</td>
<td>10.7%</td>
<td>2.5%</td>
<td>16.7%</td>
<td>72.1%</td>
<td>5.7%</td>
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<td>Qatar</td>
<td>32.4%</td>
<td>11.5%</td>
<td>18.4%</td>
<td>1.9%</td>
<td>11.8%</td>
<td>73.7%</td>
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<td>Saudi Arabia</td>
<td>25.5%</td>
<td>7.2%</td>
<td>15.5%</td>
<td>0.8%</td>
<td>7.2%</td>
<td>74.5%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Syria</td>
<td>36.8%</td>
<td>16.2%</td>
<td>17.0%</td>
<td>1.6%</td>
<td>18.0%</td>
<td>62.1%</td>
<td>28.1%</td>
</tr>
<tr>
<td>United Arab Em</td>
<td>20.6%</td>
<td>7.3%</td>
<td>11.5%</td>
<td>1.5%</td>
<td>7.5%</td>
<td>64.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td>W.Bank Gaza</td>
<td>2.6%</td>
<td>1.7%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>1.7%</td>
<td>90.6%</td>
<td>12.2%</td>
</tr>
<tr>
<td>Yemen</td>
<td>7.7%</td>
<td>3.9%</td>
<td>3.6%</td>
<td>0.1%</td>
<td>4.0%</td>
<td>88.7%</td>
<td>63.3%</td>
</tr>
</tbody>
</table>

Legend: NAM = US+Canada; PAC=Australia+New Zealand

Source: Parsons et alii (2007)

2.2 Data by educational attainment

To characterize the skill structure of migration, we build on Docquier, Lowell and Marfouk (2007) who use data on the immigration structure by educational attainment and country of birth from all OECD receiving countries.

Their data set (henceforth labeled DLM) is based on the aggregation of harmonized immigration data collected in host countries, where information about the birth country, gender, age and educational attainment of immigrants is available. This information is found in national population censuses (or samples of them) and registers. More precisely, DLM collected gender-disaggregated data from the 30 members of the OECD, with the highest level of detail on birth countries and three levels of educational attainment: s=m for
immigrants with upper-secondary education, \( s=h \) for those with post-secondary education and \( s=l \) for those with less than upper-secondary education (including lower-secondary, primary and no schooling). Let \( M^{i,j}_{t,s} \) denote the stock of adults 25+ born in \( j \), of skill \( s \), living in country \( j \) at time \( t \). Aggregating these numbers over destination countries \( j \) gives the stock of emigrants from country \( i \):

\[
M^{i}_{t,s} = \sum_{j} M^{i,j}_{t,s}.
\]

Obviously, the stock of skilled emigrants (absolute measure brain drain) is positively correlated with the size of the country and its level of development (reflecting the average educational level of natives). The pressure exerted on the sending country’s labor market is better captured by comparing the emigration stocks to the total number of people born in the source country and belonging to the same gender and educational category. Hence, the DLM data set also provides a relative measure of the brain drain, defined as the ratio of the stock of skilled emigrants to the educated population born in the source country. Although their analysis is based on stocks (rather than flows), DLM refer to these proportions as emigration rates. Denoting \( N^{i}_{t,s,g} \) as the stock of individuals aged 25+ at time \( t \), of skill \( s \), gender \( g \), born in source country \( i \), the emigration rate is defined as

\[
m^{i}_{t,s,g} = \frac{M^{i}_{t,s,g}}{N^{i}_{t,s,g}}
\]

where the native population \( N^{i}_{t,s,g} \) is proxied by the sum of the resident population living in country \( i \) (\( R^{i}_{t,g,s} \)) and the stock of emigrants: \( N^{i}_{t,g,s} \equiv R^{i}_{t,g,s} + M^{i}_{t,g,s} \). To compute \( R^{i}_{t,g,s} \), DLM use population data by age provided by the United Nations and several sources on the average educational attainment of the resident population. A more detailed description of the methodology can be found in Appendix 8.1.

In this report, we have extended DLM work by adding immigration data and estimates for 14 non-OECD host countries:

- the OECD group includes 19 EU countries. We have added 8 non-OECD EU countries (Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta\(^1\), Romania and Slovenia) to have a comprehensive view of the brain drain to the EU27;

- we have also added estimates of the immigration structure for the GCC. For Saudi Arabia, we have collected labor force survey data on the age and education level of guest workers in 1990 and 2000. In the remaining GCC countries (Bahrain, Kuwait, Oman, Qatar and United Arab Emirates), we start from Parsons et al. bilateral stocks and apply the age and educational structure observed in Saudi Arabia. This gives reasonable estimates of the brain drain to GCC nations.

\(^1\) Malta belongs to both EU27 and MENA groups. Obviously, we do not count Malta residents as migrants from MENA to EU27.
Table 2.3 presents the results. The first column gives the total brain drain rates to the 44 host countries (30 OECD + 14 non-OECD). Skilled emigration rates are particularly high in Malta, Lebanon, Yemen or West Bank and Gaza. The brain drain is quite important in large countries such as, Iran, Morocco or Algeria. Given its size, Egypt is also suffering from a relatively high brain drain.

<table>
<thead>
<tr>
<th>MENA4</th>
<th>Total</th>
<th>to EU27</th>
<th>to NA</th>
<th>to GCC</th>
<th>to OECD</th>
<th>EU27%</th>
</tr>
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<tr>
<td>Algeria</td>
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<td>7.1%</td>
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<td>0.2%</td>
<td>9.4%</td>
<td>73.7%</td>
</tr>
<tr>
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<td>8.3%</td>
<td>0.9%</td>
<td>3.5%</td>
<td>3.8%</td>
<td>4.5%</td>
<td>11.3%</td>
</tr>
<tr>
<td>Morocco</td>
<td>18.5%</td>
<td>13.3%</td>
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<td>17.9%</td>
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</tr>
<tr>
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<td>12.9%</td>
<td>9.6%</td>
<td>2.3%</td>
<td>0.6%</td>
<td>12.3%</td>
<td>74.6%</td>
</tr>
<tr>
<td>MENA9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djibouti</td>
<td>3.9%</td>
<td>3.0%</td>
<td>0.7%</td>
<td>0.1%</td>
<td>3.8%</td>
<td>77.0%</td>
</tr>
<tr>
<td>Iran</td>
<td>14.4%</td>
<td>3.3%</td>
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<td>4.3%</td>
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<td>24.7%</td>
<td>32.8%</td>
<td>0.2%</td>
<td>58.1%</td>
<td>42.3%</td>
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<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td>6.0%</td>
<td>1.8%</td>
<td>3.3%</td>
<td>0.9%</td>
<td>5.1%</td>
<td>30.0%</td>
</tr>
<tr>
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<td>11.5%</td>
<td>5.1%</td>
<td>5.6%</td>
<td>0.4%</td>
<td>10.8%</td>
<td>44.2%</td>
</tr>
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<td>6.7%</td>
<td>0.3%</td>
<td>7.8%</td>
<td>12.3%</td>
</tr>
<tr>
<td>Jordan</td>
<td>11.3%</td>
<td>1.5%</td>
<td>5.8%</td>
<td>4.0%</td>
<td>7.1%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>12.6%</td>
<td>0.8%</td>
<td>5.9%</td>
<td>5.9%</td>
<td>6.7%</td>
<td>6.1%</td>
</tr>
<tr>
<td>Oman</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.4%</td>
<td>34.1%</td>
</tr>
<tr>
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<td>1.7%</td>
<td>0.2%</td>
<td>2.0%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Saudi Arabia</td>
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<td>0.1%</td>
<td>0.8%</td>
<td>0.1%</td>
<td>0.9%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Syria</td>
<td>7.8%</td>
<td>2.3%</td>
<td>3.8%</td>
<td>1.5%</td>
<td>6.0%</td>
<td>29.7%</td>
</tr>
<tr>
<td>United Arab Em</td>
<td>0.9%</td>
<td>0.2%</td>
<td>0.6%</td>
<td>0.1%</td>
<td>0.7%</td>
<td>20.1%</td>
</tr>
<tr>
<td>W. Bank Gaza</td>
<td>19.3%</td>
<td>1.0%</td>
<td>9.9%</td>
<td>8.2%</td>
<td>11.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Yemen</td>
<td>31.3%</td>
<td>1.9%</td>
<td>2.5%</td>
<td>26.8%</td>
<td>4.4%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

Source: Docquier, Lowell and Marfouk (2007)

There is a hot debate in the literature on the global implications of the brain drain for developing countries. It is more than likely that skilled migration induces some positive effects on developing countries. The question is: Are these effects significant and sufficiently large to turn the brain drain into a brain gain? Recent empirical studies based on aggregate data suggest that these positive effects are of significant size. From the macroeconometric studies reviewed in Docquier (2007), the average threshold emigration rate above which the brain drain becomes harmful for development can be estimated to 10-15 percent in developing countries. The "optimal emigration rate" (which maximizes country gains) probably lies
between 5 and 10 percent. Except Djibouti, Libya and Egypt, all MENA9 are above the potentially optimal level and many are above the maximal level (Lebanon, Malta, Morocco, Iran is at the border). Increasing the brain drain from these countries could have damaging effects on the economy.

### 2.3 Brain drain by gender

So far, little research has addressed the issue of female migration. Women have generally been viewed as dependents, moving as wives, mothers or daughters of male migrants. This is ironic since the share of women in international migration increased over the last decades (see United Nations, 2005). By 2005, the stock of female international immigrants outnumbered the stock of males in developed countries, including Europe and North America. A more recent report of the United Nations (2006) also shows that women predominate men in migration annual outflows from many developing countries.

The “feminization of international migration” raises specific economic issues related to the gendered determinants and consequences of migration. In particular, women's brain drain is likely to affect sending countries in a very peculiar way. Many studies have emphasized the role of female education in raising labor productivity and economic growth, suggesting that educational gender gaps are an impediment to economic development\(^2\). Klasen (1999) or Dollar and Gatti (1999) demonstrated that gender inequality acts as a significant constraint on growth in cross-country regressions, a result confirmed by Blackden et al. (2006) in the case of sub-Saharan Africa. In sum, societies that have a preference for not investing in girls or that lose a high proportion of skilled women through emigration may experience slower growth and reduced income.

Docquier, Lowell and Marfouk (2007) also characterize the gender composition of skilled and unskilled migration of all the world countries to the OECD. They confirm the feminization of international migration and show that skilled women exhibit higher emigration rates than skilled men, suggesting that skilled women have higher propensities to emigrate.

In this report, we have extended the data set by adding the same 14 non-OECD host countries as above. Table 2.4 compares the brain drain of women and men from MENA countries. Women's brain drain exceed men's brain drain in many cases. However, for countries sending their migrants to other MENA nations, skilled males are more migratory than skilled females (Egypt, Bahrain, Iraq, Saudi Arabia, Syria and West Bank-Gaza).

---

\(^2\) See Coulombe and Tremblay (2006)
Table 2.4. Gendered brain drain of MENA countries in 2000

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th></th>
<th>Men</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total incl EU27 incl GCC</td>
<td>Total incl EU27 incl GCC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MENA4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algeria</td>
<td>11.0% 8.2% 0.2%</td>
<td>9.0% 6.6% 0.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>6.6% 0.8% 15.5%</td>
<td>9.0% 1.0% 4.8%</td>
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<td></td>
</tr>
<tr>
<td>Morocco</td>
<td>19.8% 14.2% 0.4%</td>
<td>17.8% 12.9% 0.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td>11.4% 8.6% 0.3%</td>
<td>13.8% 10.2% 0.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MENA9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Djibouti</td>
<td>4.1% 2.6% 0.1%</td>
<td>3.8% 3.2% 0.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>16.7% 3.6% 0.1%</td>
<td>13.2% 3.2% 0.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lebanon</td>
<td>47.4% 9.7% 0.7%</td>
<td>43.9% 10.9% 2.4%</td>
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<td></td>
</tr>
<tr>
<td>Libya</td>
<td>6.2% 3.0% 0.1%</td>
<td>4.2% 1.9% 0.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td>60.6% 28.8% 0.2%</td>
<td>56.9% 21.8% 0.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td>5.8% 2.1% 0.6%</td>
<td>6.1% 1.6% 1.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iraq</td>
<td>11.2% 4.8% 0.3%</td>
<td>11.6% 5.2% 0.4%</td>
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</tr>
<tr>
<td>Israel</td>
<td>7.0% 0.8% 0.2%</td>
<td>9.4% 1.2% 0.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jordan</td>
<td>7.0% 0.8% 1.4%</td>
<td>14.3% 1.9% 5.7%</td>
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<td></td>
</tr>
<tr>
<td>Kuwait</td>
<td>9.6% 0.9% 2.3%</td>
<td>14.1% 0.7% 7.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oman</td>
<td>0.5% 0.1% 0.1%</td>
<td>0.4% 0.2% 0.1%</td>
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</tr>
<tr>
<td>Qatar</td>
<td>3.1% 0.6% 0.1%</td>
<td>1.9% 0.4% 0.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>0.8% 0.1% 0.1%</td>
<td>1.3% 0.1% 0.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syria</td>
<td>6.8% 2.0% 0.5%</td>
<td>8.4% 2.5% 2.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Arab Em</td>
<td>1.2% 0.3% 0.1%</td>
<td>0.7% 0.1% 0.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W. Bank Gaza</td>
<td>16.4% 0.7% 3.8%</td>
<td>20.8% 1.1% 10.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yemen</td>
<td>15.3% 2.3% 11.2%</td>
<td>37.9% 1.7% 33.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Docquier, Lowell and Marfouk (2007)

3 Aging in European and MENA countries

The decrease in fertility and mortality rates induces a progressive and inescapable greying of European nations. On the contrary, all countries in the MENA share a relatively young population. However, a rapid increase in old-age dependency ratios will take place in 15 to 20 years, putting the pension systems under growing financial stress. In this section, we briefly analyze the demographic trends in the EU and in the MENA. Our analysis relies on the 2006 Revision, which is the twentieth round of official United Nations population estimates and projections prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.

The direct impact of demographic change occurs through the so-called dependency ratio. The total dependency ratio (TDR) is the ratio of the economically dependent part of the population
to the productive part. The economically dependent part is recognized to be children who are too young to work, and individuals that are too old, that is, generally, individuals under the age of 15 and over the age of 65. The productive part makes up the gap in between (ages 15-64). The TDR is expressed as a percentage. This gives:

$$TDR = \frac{POP_{15-64}}{POP_{15-64}}$$

This ratio is important because as it increases, there is increased strain on the productive part of the population to support the upbringing and the pensions of the economically dependent. There are direct impacts on financial elements like social security.

The (total) dependency ratio can be partitioned into the child dependency ratio and the aged dependency ratio ($ADR$). The latter is defined by

$$ADR = \frac{POP_{65+}}{POP_{15-64}}$$

Figure 3.1 shows that the total dependency ratio has been higher in the MENA than in the EU since 1950 and is still expected to remain higher until 2020. After 2020, the rise in life expectancy will push the EU ratio upward while the drop in fertility rates will push the MENA ratio downwards. The conclusion obtained for the EU15 or EU27 are very similar. In the same vein, the evolutions observed in the MENA4 and MENA9 groups are almost identical.

In the EU, the deterioration of the dependency ratio is exclusively due to the greying of populations. Figure 3.2 shows that the EU aged-dependency ratio is expected to double between 2010 and 2050, after having doubled between 1950 and 2010. In the MENA, aging is hardly perceptible before 2030. But after 2030, the aged dependency ratio will be multiplied by 3 in the MENA4 and MENA9.

Figures 3.3 and 3.4 identify the most affected countries in these two groups. In the EU, aging will be highest in Italy, Spain, Austria, Germany or Portugal. In the MENA, the most affected countries are Malta, Tunisia or Lebanon. They all belong to the MENA9 group. Generally speaking, the greying of population will be important in Maghreb countries (Tunisia, Algeria and Morocco) after 2030. It will be lower in Egypt.

Figure 3.5 and 3.6 gives the evolution of total and aged dependency ratios for consolidated regions, i.e. aggregating EU and MENA4 or MENA9 countries. Clearly, this consolidation smoothes the trends and attenuates the rise in dependency. However, the change observed in the EU27+MENA4 hypothetical region remains important. This can be explained by the relative size of these regions. The population of the EU27 is around 500 million. Although the 21 countries of the MENA represent more than 300 million inhabitants, the population of the MENA4 group amounts to 136.5 million, i.e. about 27 percent of the EU27. The population of the MENA9 group (212.7 million) represents 42.5 percent of the EU27.
Fig. 3.1. Total dependency ratio (TDR) by region (1950-2050)

Fig. 3.2. Aged dependency ratio (ADR) by region (1950-2050)
Fig. 3.3. Aged dependency ratio (ADR) in EU country (1950-2050)

Fig. 3.4. Aged dependency ratio (ADR) in MENA countries (1950-2050)
Fig. 3.5. Total dependency ratio (TDR) by consolidated region

Fig. 3.6. Aged dependency ratio (ADR) by consolidated region
From these figures, we conclude that increasing migration flows from MENA4 or MENA9 to EU27 countries would clearly attenuate the deterioration of the European demographic structure. However, we should keep in mind that MENA countries also expect serious demographic problems after 2030 and need pension reforms to minimize a financial crisis (see Robalino, 2005). In particular, the MENA aged-dependency ratio in 2050 will approximately be equal to the current aged-dependency ratio observed in the EU. Hence, "replacement or selective migration" policies encouraging MENA-to-EU flows of working-age people should not be permanent. It should be limited in size and in time (not beyond 2050).

4 Migration and the aging debate in Europe

Suppose EU countries increase immigration. How would it affect their economic performances? Immigrants induce many effects on the welfare of natives through the capital market, the markets for skilled and unskilled labor, and through public finance. These direct effects can be reinforced by natives' behavioral responses. The main effects are:

- First, immigration can be seen as a supply shock on the labor market, thus impacting on the productivity of factors supplied by natives (and hence on wages and the return on saving). For a given stock of physical capital, an increase in labor supply reduces the capital by worker, leading to decreasing wages and increasing interest rates. It follows a redistribution from the suppliers of labor to the suppliers of capital.

- Second, the redistribution from wage earners to capitalists is accompanied by a general rise in income of the indigenous population in the host country, the well-known immigration surplus. This surplus is captured by the fact that capitalists' gains exceed workers' losses. The size of the surplus depends on the host country's characteristics, such as the elasticity of the wage rate to labor supply, the proportion of labor income in total income and the proportion of migrants in the workforce.

- Third, as workers are not homogenous in skills, the skill structure of immigration also induces important redistributive effects between workers. New immigrants are competing with natives on specific segments of the labor market: skilled immigrants compete with skilled natives while unskilled migrants compete with unskilled natives. Immigration impacts on income inequality.

- Finally, immigration affects the public deficit. In many developed countries, immigrants are less educated than natives and are particularly prone to using welfare programs, especially if immigrants select their location on the basis of welfare generosity, as argued by Borjas (1999). But they are characterized by a younger age structure and higher fertility rates. Hence, immigration has a beneficial effect on the ratio of tax payers to beneficiaries of the welfare state.
In the aging debate, the latter effect is the most important one. In this section, we concentrate on the fiscal impact of immigration, leaving the other effects for the next section. We use a partial equilibrium analysis.

It is usually argued that expected demographic changes threaten the sustainability of fiscal policies. Indeed, in most industrialized countries, social policies involve considerable transfers from young cohorts to old cohorts. If the number of old beneficiaries increases, the financial viability of the system is obviously questioned. By instantaneously affecting the dependency ratio, immigration can potentially have a strong impact on the sustainability of public finance. Existing studies reveal that the fiscal impact of immigration depends on whether one uses a short-run or a long-run approach. In the US case, Lee and Miller (2000) showed that newcomers exert a pressure on public finance during the first years of residence in the United States. This is due to the fact that labor market integration takes time and immigrants send many children to public schools. After 16 years of residence, the impact becomes positive. Hence, accounting for expenditures incurred and tax collected, immigrants initially create a burden for native taxpayers in the short-run. As they assimilate, have children and grand-children, the immigrants’ contribution to the economy becomes positive: a long-run fiscal gain is likely to be obtained according to these authors. The fiscal gain is maximized for immigrants arrived in the United States between age 15 and age 30.

4.1 Immigration in generational accounting

Since the seminal works of Auerbach, Gokhale and Kotlikoff (1991, 1994), and Kotlikoff (1992), generational accounting has been perceived as a meaningful way to evaluate the sustainability of fiscal policy and the fiscal impact of immigration. It builds on an intertemporal treatment of the government budget constraint: at any date, the present value of government purchases must be covered by the current net public wealth, the present value of net taxes which will be paid by living generations over the rest of their lifetime and the present value of net taxes which will be paid by future generations over their whole lifetime. The basic questions are: what burden must the government leave on future generations to remain solvent? Is the resulting fiscal treatment of future generations’ members identical to that of the current newborns?

As described in Appendix 8.2, the starting point of the generational accounting technique is the government intertemporal budget constraint. At the base year $t$, the sum of the public net wealth and the present value of prospective aggregate net payments by living and future generations must equalize the present value of prospective public purchases:

$$PV_{L_t} + PVF_t + NW_t = PVG_t,$$

where:

- $PV_{L_t}$ measures the present value of net tax payments by living generations over the rest of their life. This amount is obtained by summing the present value of net taxes
these generations will pay to the government over the rest of their life (i.e. summing the generational accounts of living cohorts).

- $PVF_t$ is the present value of net tax payments by future generations.

- $PVG_t$ stands for the present value of prospective government purchases of goods and services, i.e. the discounted value of public purchases projected at time $s \geq t$. In the long-run, it is assumed that $G$ grows at the same rate as the growth rate of the total factor productivity, $g$.

- $NW_t$ is the net public wealth at year $t$, i.e. the amount of public assets minus the public debt. This amount is usually negative.

The strategy is simple. Assuming a constant fiscal policy for living generations and forecasting government purchases, it is possible to compute $PVG_t$, $PVL_t$ as well as the generational account of a newborn at year $t$. Dividing the newborns' average generation account by their expected lifetime income gives the fiscal pressure on newborns. Since $NW_t$ is observed, the only unknown in the above equation is $PVF_t$. Once $PVF_t$ is determined, we divide this aggregate amount by the discounted wealth of future cohorts to obtain the average fiscal pressure on future cohorts. If the fiscal pressure on future cohorts is lower or equal to the fiscal pressure imposed on current newborns, the fiscal policy is sustainable. Otherwise, it is not and fiscal adjustments are required to restore sustainability. There are three ways to adjust the current policy: increasing taxes, decreasing transfers or combining both.

Introducing immigration generates multiple changes in the generational accounting framework. First (i), it affects the number of living individuals at time $t$. Second (ii), immigrants are characterized by specific profiles of net taxes. Channels (i) and (ii) affect $PVL_t$. Third (iii), future immigration impacts on demographic forecasts and on the discounted wealth of future cohorts. For a given $PVF_t$, future immigration reduces the burden per capita left to future generations. Finally (iv), immigration can increase the demand for government consumption expenditures. For example, if military expenditures are proportional to population, an increase in population stimulates $PVG_t$.

Most general accounting exercises show that the current fiscal policy is not sustainable. Due to aging, governments are urged to increase taxation (through tax rates or retirement age) and/or reduce social expenditures. The impact of immigration on the fiscal burden of aging has been examined in several studies:

- Auerbach and Oreopoulos (2000) showed that immigration slightly reduces the burden left to future generations in the United States;

- Bonin, Raffelhüschen and Walliser (2000) found a more important effect in Germany;

- Iturbe-Ormaetxe and Valera (2003) obtained a similar result for Spain.
All these studies reveal that a decent increase in immigration flows would generate a small effect on generational accounts. They all disregard the educational level of future immigrants. However, Docquier and Chojnicki (2007) showed that changes in educational attainment of future residents can strongly modify the conclusions. This idea can be transposed to immigration. In the next sub-section, we account for possible changes in the selection of immigrants and compute the generational accounts under several immigration scenarios. Our analysis, based on Chojnicki (2006), focuses on the French case.

4.2 The French case

A generational accounting exercise requires many data from different sources, including fiscal data and census data on the number, age, gender and educational structure of immigration. The French case presented in this section is based on the situation at the last census year, 1999.

First, as in many developed countries, the age structure of the immigrant population differs from that of the native population. As shown on Figure 4.1, the immigrant population is mostly concentrated in the age groups 25 to 55. Obviously, the structure depends on the history of immigration flows. The mass immigration to Europe was a consequence of post-World War II guest-worker programs, based on bilateral agreements with Portugal or Maghreb countries. Backed by friendly politicians and sympathetic judges, foreign workers, who were supposed to stay temporarily, benefited from family reunification programs and became permanent. Successive waves of immigrants formed a sea of descendants. Figure 4.1 clearly shows that the proportion of aged immigrants is very similar to the proportion of aged natives. As immigrants also benefit from welfare programs, they increase the burden of aging.

Nevertheless, as shown on Figure 4.2, the flow of net immigration is highly concentrated in two age groups, 10-20 for children and 25-35 for adults. A permanent immigration policy leads to an increase in the proportion of working-age people in the economy and reduces population aging. Hence, reducing future flows of immigration would have a considerable impact on the sustainability of fiscal policies.

Figure 4.3 compares the profile of net taxes of immigrants and natives (natives are in bold grey and immigrants in bold black). Clearly, immigrants and natives are net fiscal contributors between age 21 and 60. Before age 20 and after age 60, they become net beneficiaries. It is worth noticing that immigrants become net beneficiaries a few years before natives. In addition, the net contribution of immigrants is much lower than the contribution of working-age natives. The explanation is that immigrants are on average less skilled than natives. They can also suffer from discriminations on the labor market or from the lack of transferrability of human capital acquired abroad, both resulting in lower employment rates and wages.

How does immigration impact on the fiscal policy? Table 4.1 assesses the impact of immigration on generational accounts. The first line gives the baseline predictions based on official demographic forecasts. Regarding immigration, the baseline assumes a permanent
entry of 50,000 immigrants a year. The proportion of skilled is identical to that in 1999. The French fiscal policy in 1999 was not sustainable. Balancing the intertemporal budget requires increasing taxes by 11.63 percent, or decreasing transfers by 12.96 percent, or adjusting both (i.e. increasing taxes and decreasing transfers) by 6.13 percent.

Starting from the baseline forecasts, it is possible to simulate the effect of two alternative immigration policies: cutting or doubling immigration flows after 1999. The fiscal impact of these policies depends on their implications on government consumption expenditures (mainly military expenditures). When government expenditures are proportional to the population size (constant government consumption per capita), more immigration involves increasing the aggregate amount of government expenditures. Consequently, Table 4.1 shows that cutting (resp. doubling) immigration slightly reduces (resp. increases) the burden of aging.

On the contrary, when the amount of aggregate government expenditures is fixed (constant government consumption), cutting (resp. doubling) immigration slightly worsens (resp. attenuates) the burden of aging. However, the magnitude of the immigration impact of the fiscal policy is extremely small, as in the US case analyzed by Auerbach and Oreopoulos (2000).

The above pessimistic results have to do with the relatively small average contribution of working-age immigrants to the French budget. Would a more selective immigration policy affect the results?

The generational accounting study of Chojnicki and Docquier (2007) suggests that the educational structure plays a crucial role. They disaggregated US profiles of taxes and transfers per schooling level and showed that the impact of educational attainment is mainly perceptible for taxes: at age 60, the taxes paid by a high-skill individual are six times as large as the amount paid by a low skill individual. Smaller differences are also appearing in benefit profiles. In terms of net taxes, low skilled agents are obviously the main beneficiaries of the fiscal policy whilst medium and highly skilled agents are net contributors on their lifetime. At age 60, the ratio of net taxes between a highly skilled and a medium skilled is about 3.5. Hence, it makes no doubt that changes in the educational structure can affect the sustainability of the current fiscal policy.

Figure 4.3 comforts this prediction. The French net-tax profiles of immigrants are disaggregated per schooling level. It appears that low-skill immigrants exhibit a very modest contribution between age 30 and 50. Medium-skill immigrants are similar to natives after age 50, but contribute less between age 25 and 50. On the contrary, the contribution of high-skill immigrants (with post-secondary education) is bigger than that of natives, especially between age 40 and 65.
Fig. 4.1. Age structure of native and immigrant population in 1999

Fig. 4.2. Age structure of net immigration flows (1990-1999)
Figure 4.3: A profiles of net taxes for natives and for immigrants in 1999 (in €)

![Graph showing profiles of net taxes](image)

Table 4.1. Results for France

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Restoring generational balance through:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tax</td>
</tr>
<tr>
<td>Baseline (50,000/year, 17% of skilled)</td>
<td>+11.63%</td>
</tr>
<tr>
<td>Changing the size of future immigration flows</td>
<td></td>
</tr>
<tr>
<td>Constant government consumption per capita</td>
<td></td>
</tr>
<tr>
<td>Cutting immigration after 1999</td>
<td>+11.11%</td>
</tr>
<tr>
<td>Doubling immigration flows after 1999</td>
<td>+11.65%</td>
</tr>
<tr>
<td>Constant government consumption</td>
<td></td>
</tr>
<tr>
<td>Cutting immigration after 1999</td>
<td>+11.69%</td>
</tr>
<tr>
<td>Doubling immigration flows after 1999</td>
<td>+11.27%</td>
</tr>
<tr>
<td>Changing the structure of future immigration flows</td>
<td></td>
</tr>
<tr>
<td>Constant government consumption per capita</td>
<td></td>
</tr>
<tr>
<td>After 1999, 100% of high-skill immigrants</td>
<td>+7.91%</td>
</tr>
<tr>
<td>After 1999, 50% of high-skill immigrants</td>
<td>+9.74%</td>
</tr>
<tr>
<td>After 1999, 30% of high-skill immigrants</td>
<td>+10.49%</td>
</tr>
</tbody>
</table>

Source: Chojnicki (2006)
Coming back to Table 4.1, we can evaluate the impact of a stronger selection on the fiscal adjustment required in 1999. Assuming the same size of immigration than in the baseline, but with 30 percent of high-skill (rather than 17 percent), restoring the fiscal balance requires increasing taxes by 10.49 percent (rather than 11.63), or decreasing transfers by 11.81 percent (rather than 12.96), or adjusting both by 5.56 percent (rather than 6.13). With 50 percent of skilled in future immigration flows, the adjustments become +9.74, -11.05 and +5.18 percent, respectively. The long-run educational structure of immigration would then be similar to the Canadian or Australian ones. In the extreme and unrealistic scenario where 100 percent of future migrants are skilled, the adjustments become +7.91, -9.12 and +4.23 percent, respectively. These results are obtained by considering a constant amount of government consumption per capita.

In conclusion, there is no miracle associated with immigration policies: the effect of policy changes remains relatively low compared to the cost of aging. In a partial equilibrium framework with constant prices, changing the size of immigration has a small and ambiguous impact on fiscal sustainability, depending on the effect on government consumption expenditures. Changing the structure of immigration can significantly improve the situation. Do these results resist a general equilibrium analysis with endogenous wages, pension benefits and interest rates? What would be the consequences of a change in immigration policy for sending countries? These are the issues we address in the next section.

5 A general equilibrium analysis

Our purpose here is to simulate the impact of doubling migration flows from MENA to EU15 on demographic variables, tax rates, GDP-GNI per capita and skilled-to-unskilled income ratio in both regions. The shock occurs between 2000 and 2050. We distinguish various scenarios regarding the education level of additional migrants, the way educated migrants are “economically assimilated” at destination, the ties between migrants and their origin country (affecting the feedback effects of international migration) and the progress in education attainment in the MENA region.

For this purpose, we use a computable general equilibrium (CGE) model with overlapping generations of individuals who are heterogeneous in skills, date and place of birth. In the model, countries from MENA and EU15 are aggregated into two regions: we disregard the heterogeneity between countries and compute the impact on the aggregate MENA and EU15 regions. As MENA4 accounts for about 80 percent of MENA-to-EU migration, the impact on each MENA4 country can be approximated by multiplying the MENA deviations from the baseline by 1.25. Similarly, as MENA9 accounts for about 91 percent of MENA-to-EU migration, the impact on each MENA9 country can be approximated by multiplying the MENA deviations by 1.10.
We provide a brief introduction of the model structure in Section 5.1 (a complete description can be found in Appendix 8.3). Section 5.2 describes our five alternative scenarios. The demographic effect of our shock is constant across scenarios; it is discussed in Section 5.3. Then, in Section 5.4, we first analyze the economic impact at origin and destination comparing two simple scenarios: one considers that additional migrants are skilled and one in which they are unskilled. Our comparison disregards two types of feedback effects of international migration that have been stressed in the literature (i.e. diaspora externalities and brain gain mechanisms) and assumes that human capital acquired in the MENA is perfectly transferrable to the EU15 labor market. In Section 5.5, we focus on the case of skilled migration and relax the above hypotheses in three alternative scenarios, one in which additional migrants are skilled but employed as unskilled laborers in the EU, one based on the recent literature on the beneficial effects of the brain drain and one assuming that MENA experiences a stronger rise in the education levels of its native population.

5.1 The model

The model draws from the framework of Marchiori (2007, 2008) and Docquier et al. (2008). Each region has three types of agents: households, firms and the public sector. The adult population is divided into 8 overlapping generations, from age 15-24 to age 85-94. Individuals have uncertain lifetime and can die at the end of every period. In each generation, we have time-varying proportions of unskilled and skilled individuals. Due to data availability constraints, the skilled are those with post-secondary education completed. Migration occurs at the first period of life and is permanent.

Migrants remit a fraction of their consumption. This proportion is calibrated in order to match the amounts remitted by the migrants from MENA living in developed countries to their origin country. While skilled migrants remit a larger amount than unskilled migrants, it is assumed, based on Faini (2007) or Niimi et al. (2008), that their propensity to remit is lower (only 70%) than the one of unskilled migrants.

The production process of the firms in each region is characterized by a constant elasticity of substitution (CES) transformation function for efficient labor which defines the mix of skilled and unskilled labor forces to produce a homogenous good. The parameters of the production process are dynamically calibrated in order to match the income disparities between and within regions (i.e. distance to the frontier and skill premium).

The government levies taxes on labor earnings and consumption expenditures to finance general public consumption, pension benefits and other welfare transfers. Moreover, the government issues bonds and pays interests on public debt. The government's budget constraint is satisfied each period by adjusting the tax rate on labor income.

Finally, capital is perfectly mobile in the model and the arbitrage condition on capital markets requires the equality of the expected returns to capital given region-specific risk premia.
5.2 Scenarios

In the baseline, the model is calibrated in such a way that it matches the world disparities between and within regions over the period 1950-2000. Our period of interest is 2000-2100. Our baseline predictions are based on the official demographic forecasts and extrapolates the trends observed in the last decades (in terms of educational attainment, productivity growth, public consumptions and generosity of welfare programs, etc.). More precisely, the evolution of the population is based on the United Nations Population Projections, which cover the period 1950 to 2050. These forecasts are calibrated through the growth rate of the youngest cohort of individuals. After 2050 the growth rate of this cohort is held constant over time. Since individuals live for 8 periods of 10 years, the population structure reaches a steady state in 2130 (see details in Appendix 8.3). In the baseline scenario, the technical progress of each region (expressed as a percentage to North-America) is assumed to be constant after 2000. In addition, we hold the proportion of skilled individuals among each new generation constant from 2000 onwards. As young cohorts are more educated than older cohorts, it implies that the proportion of educated workers in the MENA will progressively increase from 11.5 percent in 2000 to 15 percent in 2050. Note that this rise in educational attainment is very similar to the one observed in the MENA between 1975 and 2000 (+3.5 points of percentage as well).

Our immigration shock consists in a 100 percent increase (i.e. doubling) in the emigration flows from the MENA to EU compared to the baseline over the period 2000-2050. In the baseline, the estimated migration flow from the MENA to EU15 corresponds to 1.67 million in 2010, 1.73 million in 2020 and 1.79 million from 2030 onwards. Thus, doubling these flows over the period 2000-2050 implies that an additional number of 8.77 million migrants from MENA would arrive to the EU by 2050. These newcomers emigrate in the first period of their life and acquire higher education in the EU. Hence, in case of skilled migration, we underestimate the actual fiscal cost of the MENA brain drain.

Along with the magnitude of this migration shock, the skill structure of the additional migrants might also play a role. Four immigration shocks are considered; they mainly differ with respect to the skill composition of the additional migrants and their assimilation in EU host countries:

- **The “Skilled” scenario** assumes that the 8.77 million additional migrants arriving from MENA to the EU between 2010 and 2050 are skilled and employed as skilled workers in the EU (i.e. perfect assimilation).

- **The “Unskilled” scenario** assumes that all additional migrants are unskilled and employed as unskilled workers in the EU.

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3 U.N. Population Projections provide the estimated number of migrant flows to the EU15 for the first half of the 21st century. We can retrieve the number of migrants coming from the MENA by applying the shares of migrants by origin of Docquier, Lowell and Marfouk (2007). From these datasets we can also compute the total number of migrants (stock) from MENA living in the EU15 in the baseline: 8.14 million in 2000, 9.56 million in 2010, 10.98 million in 2030 and increases up to 16.08 million after 2100.
- The “Brain Waste” scenario assumes that all additional migrants are skilled and employed as unskilled workers in the EU.

- The “Brain Gain” scenario is similar to the “skilled” scenario but accounts for the ex-ante effect of skilled migration prospects on human capital formation at origin and various diaspora externalities.

- The “Expansionary” scenario is similar to the “skilled” scenario but assumes that the population in MENA regions becomes more and more educated during the first half of the 21st century. In the baseline, the proportion of skilled among youngest cohort is constant at 15% from 2000 onwards. This means that the proportion of skilled in the workforce and in the population reaches 15% in the long run. In this scenario, a brain drain occurs while the share of skilled among the youngest cohort continues to rise after 2000 to reach 20% in 2030, with the consequence that 20% of the population will be educated in the long run.

The latter three scenarios will be explained in more details in Section 5.5. The “Brain Gain” scenario is technically described in Appendix 8.3.3.

Our period of interest is 2000-2100, or the year before the first wave of additional migrants in the developed regions to the year when the last wave is entirely retired. In the figures below, we distinguish the impact on EU and MENA regions. As said above, we first on the demographic (section 5.3) and economic (section 5.4) impacts of the «Skilled” and ‘unskilled’ scenarios and then turn to the consequences of different variants of the skilled scenario (section 5.5).

5.3 Demographic impact

Before turning to the implications on economic indicators, let us comment the forecasted demographic situation in EU and MENA during the 21st century and the impact of our migration shock. Indeed, the skill composition of future migration flows has a negligible impact on demographic indicators\(^4\). In this section, we disregard differences in skill composition and compare demographic trends obtained in the baseline and after doubling immigration flows.

Our baseline relies on UN forecasts, which predict that the share of foreigners in the EU population increases from 5.5 percent in 2000, 8.3 percent in 2050 and to 9.6 percent in 2100 (figure 5.1). If migration flows from MENA to EU are doubled between 2000 and 2050, this ratio will reach 10.1 percent in 2050 instead of 8.3 percent in the baseline. After 2050, the stock of immigrants progressively converges to its initial value. Since children of additional migrants are considered as EU natives, our shock progressively increases the EU population.

\(^4\) The only variable to be slightly affected is the support ratio. This is due to the fact that, in the first period of life, skilled immigrants supply less labor than unskilled ones as they spend more time in schools. However, the difference between the skilled and unskilled scenarios is hardly perceptible.
size. Hence, after migration flows come back to their baseline value, the proportion of foreigners in the EU population falls slightly below the baseline value in 2100.

In MENA, the global emigration rate to the North (which comprises all OECD countries) is around 2.5 percent during the 21st century (figure 5.2). Doubling migration flows to EU would bring the emigration rate to more than 4 percent in 2050.

The support ratios (i.e. the share of working aged-to-total population) are depicted on figures 5.3 and 5.4. The baseline is calibrated on the UN Population Projections until 2050 and the population growth is nil afterwards. The forecasts reveal that both regions will face an aging of their population during the 21st century. Increasing MENA-to-EU migration will obviously improve the support ratio in EU and deteriorate it in MENA. In EU, the effect of immigration is rather low compared to general impact of aging. It becomes significant between 2040 and 2100. In the MENA, the effect of emigration is very low. Our shock is compatible with our recommendations to limit MENA emigration in size and in time explained in Section 3.

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5 The support ratio in EU increases again after 2050 because of our assumption that the population is constant after 2050 while population growth is negative before 2050.
Fig. 5.1. Share of foreigners in EU15 (in percent)

Fig. 5.2. Emigration rate in MENA (in percent)
Fig. 5.3. Support ratio in EU15 (Population aged 15-64 / Total population)

Fig. 5.4. Support ratio in MENA (Population aged 15-64 / Total population)
5.4 Economic impact – skilled versus unskilled migration

In this section we analyze the impact of the first two scenarios (“Skilled” versus “Unskilled”) on key economic indicators. When dealing with the economic consequences of migration and contrary to the previous section, the skill composition of immigration flows is non crucial.

**Tax rate.** As said above, the labor income tax rate balances the government budget. The main driving force of the model over the 21st century is the evolution of the population structure. In particular, aging will put a strong pressure on pension systems which will be reflected by rising tax rates. The bold line on Figures 5.5 and 5.6 depicts the evolution of the income tax rate in the baseline.

In the EU, the income tax rate must be multiplied by 1.3 between 2000 and 2050 to maintain the generosity of the welfare state as in 2000 (figure 5.5). In the long-run, the fiscal impact is mainly explained by the progressive rise in life expectancy. The peak observed between 2020 and 2060 is due to the greying of baby boom generations.

Since the population is younger in MENA, increasing migration flows from MENA to EU could help to mitigate the consequences of aging on European pension systems. However, the aging process of the population will be also a critical issue for MENA countries. In fact, as shown on figure 5.6, the tax rate also augments in the MENA. In absolute or relative terms, the long-run fiscal change is bigger for MENA than for EU. The main difference is observed in the transition: MENA will not suffer from the retirement of a large baby boom cohort.

Increasing MENA-to-EU migration raises (resp. reduces) the size of youngest cohorts at destination (resp. origin). On figures 5.7 and 5.8, we represent the resulting changes in tax rates as deviation in percentage points from the baseline (while following figures depict a percent deviation compared to the baseline). We see that both immigration shocks reduce the tax rate in the EU and raise it in MENA. At destination, the “Skilled” scenario is unsurprisingly the most effective one to relieve the pressure on the pension systems since skilled individuals contribute more to, and benefit less from welfare programs. In 2050, increasing skilled immigration induces a reduction in the EU tax rate that is 0.97 points of percentage higher than the one induced by the “Unskilled” immigration shock (a 6.07 percentage point decrease compared to the baseline under a “Skilled” versus 5.10 percentage point under the “Unskilled” scenario). Obviously the immigration policies undergone in Europe have reversed consequences in migrants' origin region. In fact, MENA will have to cope with a higher tax rate if it looses part of its labor force and the “Skilled” scenario will have the worst fiscal implications.

However, Figures 5.5 and 5.6 show that the difference between these two scenarios is relatively small. This contrasts with the generational accounting study presented in Section 4. What explains this result? Compared to the previous section, we now have general equilibrium effects that come into play. In fact, when the additional immigrants are skilled,

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6 The fact that after 2050 the tax rate is decreasing in EU and stagnant in MENA, is due to our assumption that population growth rate is nil after 2050. According to the U.N. Population Projections, during the first half of the 21st century the population growth is around or below 0 in EU, while it is positive in MENA.
the skill premium decreases (-6.27 percentage change compared to the baseline in 2050) and this reduces the average contribution of a skilled worker in financing pension systems. Conversely, when the additional migrants are unskilled, a skilled worker will pay more taxes since the skill premium is enhanced (+3.86 percent in 2050).

Another feature of the model is that the debt is defined as a fraction of GDP assuming a constant debt/GDP ratio. When additional migrants come to Europe (or leave MENA), it leads to an increase (decrease) in GDP and thus in the debt. Since GDP rises more rapidly under the “Skilled” scenario (11.20 percent in 2050) than under the “Unskilled” scenario (8.37 percent), the public deficit to be financed will be larger when additional migrants are skilled. To assess the magnitude of this mechanism, we simulated our model assuming that the public debt is held constant at the baseline level. It comes out that this effect is less important than the general equilibrium effect on wages and skill premia. Still, a skilled emigration shock would reduce taxes by more than 1.74 percentage points an unskilled immigration shock in 2050 when the debt is held constant at the baseline level.

To be complete, another general equilibrium effect is that the inflow of workers will raise the interest rate which contributes to increase the public deficit. Again, this hardly affects the difference between the “Skilled” and “Unskilled” scenarios since the interest rate is determined at the international level. The increment in the interest rate is however larger under the “Unskilled” scenario until 2050, because additional unskilled migrants participate more to the labor force when young (they represent 3.19 percent of the labor force in 2050 compared to 3.03 percent under a brain drain). After 2050, it is slightly higher under the “Skilled” scenario since skilled individuals work longer, and the difference disappears after 2100 when additional migrants retire.

With the “Skilled” scenario the variations in the tax rate are of -5.97 percentage points in 2050 when the debt is constant and of -6.07 percentage points when the debt varies with the GDP; with unskilled migration these changes are respectively -4.94 percentage points and -5.10 percentage points.
Fig. 5.5. Tax rate in EU15 – “Skilled” vs “Unskilled” (in percent)

Fig. 5.6. Tax rate in MENA – “Skilled” vs “Unskilled” (in percent)
Fig. 5.7. Tax rate in EU15 – “Skilled” vs “Unskilled” (dev. in % points from baseline)

Fig. 5.8. Tax rate in MENA – “Skilled” vs “Unskilled” (dev. in % points from baseline)
**GDP per capita.** Figures 5.9 and 5.10 show the impact of the two immigration shocks on GDP per capita, which is defined as total domestic production divided by total population. The reallocation of labor from EU to MENA leads to higher returns to capital in Europe. Since Europe is technologically more advanced, labor outflows from MENA induce a more than proportional reallocation of physical capital to Europe. Thus, increased migration to the EU acts to enhance GDP per capita (see Figure 5.9) and to reduce it in the MENA (see Figure 5.10). This effect is particularly strong if the migrants are skilled and employed as such at destination (‘Skilled’ scenario). This is obviously due to the fact that skilled workers are more productive. In addition, the agglomeration of skilled labor in EU increases the marginal productivity of capital in this region.

It can be observed that, in the first periods of the intensification in migration flows, the impact on GDP per capita in the EU is quite small (lower than 1 percent) and even slightly negative in the “Unskilled” scenario until 2020 (-0.07 percent). One obvious reason is that the number of additional migrants is relatively low in the beginning of the concerned period. Another explanation is that when they are young, migrants spend part of their time educating and do not add fully to the labor force in the EU, while contributing to increase the population (and thus the denominator in GDP per capita).

The impact of additional migrants on GDP per capita turns to be positive and considerable when they become fully ‘operational’ and reach a critical mass. In MENA, similar reasons explain the relatively small initial effects on GDP per capita and the slight increase in it when additional migrants are unskilled.

**GNI per capita.** GNI is composed of GDP minus consumption taxes plus foreign aid, remittances and net inflows of capital income, divided by total population. The channels at work are the same as for GDP per capita, except that remittances also come into play.

From the perspective of the sending region, the direct impact of an enlarged diaspora (see figure 5.11) is to increase the amount of remittances receipts (see Figure 5.12). Note that the increase in remittances is surprisingly similar under both migration shocks, “Skilled” or “Unskilled”. The explanation hinges on general equilibrium effects. The selection of immigrants affects the skill premium at destination. Under a “Skilled” scenario the skill premium drops and skilled individuals earn less while unskilled earn more than in the baseline. Thus, the amount of remittances sent back by a skilled migrant is lower than in the baseline and the one of an unskilled migrant is higher than in the baseline. The reverse is true under an ‘unskilled’ migration shock. Consequently, the increase in the amounts remittances is equivalent across scenarios.

Then GNI per capita will follow a similar pattern than GDP per capita, but compared to the change in GDP per capita, the change in GNI per capita shifts down for the EU (Figure 5.13) and shifts up for MENA (Figure 5.14).
Fig. 5.9. GDP p.c. in EU (percent deviation from the baseline) – “Skilled” vs “Unskilled”

Fig. 5.10. GDP p.c. in MENA (percent deviation from the baseline) – “Skilled” vs “Unskilled”
Fig. 5.11. Total diaspora from MENA

Fig. 5.12. Remittances to MENA – “Skilled” vs “Unskilled” (in % dev. from baseline)
Fig. 5.13. GNI p.c. in Europe – “Skilled” vs “Unskilled” (in % dev. from baseline)

Fig. 5.14. GNI p.c. in MENA – “Skilled” vs “Unskilled” (in % dev. from baseline)
The reason is that because larger amounts of remittances flow from the EU to MENA, the increase in GNI per capita will be lower than the one in GDP per capita for the EU, while for the MENA, the reduction in GNI per capita is lower than in GDP per capita. Then because in the first periods, GDP per capita experiences small changes due to additional migration remittances contribute to depress GNI per capita in the EU and to increase it in MENA. But still these transitory effects are relatively small (lower than 1 percent) compared to the longer run effects when changes in GDP per capita are larger. We observe however that under “Unskilled” scenario in MENA, changes GNI per capita remain below a 1 percent change in the first periods of the shock as well as in the later periods.

*Skilled/unskilled inequality.* Finally, skilled/unskilled inequality is defined as the ratio of skilled to unskilled GNI per capita. Figures 5.15 and 5.16 show that immigration shocks have different effects on the skilled-to-unskilled income inequality. The impact is mainly driven by the change in the skill premium since the immigration policies affect the skill composition of the labor force. For instance, under the “Skilled” scenario, skilled labor becomes scarcer in the MENA, the skill premium goes up and skilled-to-unskilled income inequality worsens, while in the EU skilled labor becomes more abundant leading to less inequality since the skill premium declines. On the contrary, an “Unskilled” policy will deteriorate inequality in the EU and improve it in the MENA.

The conclusion of the CGE analysis is that increasing immigration leads to a considerable beneficial impact in terms of fiscal pressure and GDP/GNI per capita in Europe. However selecting immigrants has not much more tax relieving effects: an inflow of skilled migrants leads to less than 1 percentage point higher tax-cut than an inflow of unskilled ones. However the rise in GDP per capita and GNI per capita would more than twice as high with a brain drain as with a non-selective policy.

In MENA, the loss of workers renders the financing of the fiscal systems more complicated and the situation would be even more dramatic when selecting immigrants. Moreover, differences in the skill composition of migration flows yield considerable differences in income. GNI per capita is strongly reduced by increased skilled emigration but only slightly by an unskilled immigration policy and would even be enhanced by the latter policy at the beginning of the increased migration period.
Fig. 5.15. Inequality in Europe – “Skilled” vs “Unskilled” (in % dev. from baseline)

Fig. 5.16. Inequality in MENA – “Skilled” vs “Unskilled” (in % dev. from baseline)
5.5 Variants of the skilled scenario

The previous section shows that selecting migrants generates much more positive (resp. negative) effects on GDP/GNI per capita at destination (resp. at origin) than increasing unskilled migration. Several factors could affect the magnitude of the responses in both sending and receiving regions. First, it is widely documented that skilled migrants are not necessarily employed as skilled workers at destination. Second, the recent “brain drain literature” claims that the movement of skilled people goes along with diverse positive side-effects incurred by the countries of origin. Third, an increased movement of skilled workers from MENA to EU15 could be accompanied by a more generous assistance or a greater cooperation in education policies. In other words, we might also take into account the fact the population in MENA could become more and more educated. How do these aspects alter the consequences of increased skilled migration in MENA?

This section examines different variants of increased skilled emigration. We only consider the case of skilled migration and compare the different variants described in Section 5.2, i.e. the traditional “Skilled”, the “Brain Waste”, “Brain Gain” and “Expansionary” scenarios. Let us explain the differences between these scenarios in more details.

The “Brain waste” scenario is simple. It assumes that skilled migrants are employed as unskilled at destination.

The “Brain Gain” scenario deserves more explanations. It is basically identical to the “Skilled” scenario in terms of numbers of skilled people who migrate, but differs from it in that it follows the recent literature and takes into account three externalities associated with skilled emigration and studied in the recent literature:

- A first externality of the brain drain is the role of skilled diasporas in reducing transaction costs, informational costs and risk. It follows a lower risk premium in MENA countries. In the model, the risk premium is represented by a governmental tax on investment and a lower risk premium then leads to higher capital inflows.

- Second, total productivity may be affected in two ways by skilled emigrants living in rich countries: either directly because they induce improvements in the capacity of their origin country to adopt modern technologies via a diaspora externality and indirectly by affecting the level of human capital which is essential for productivity.

- Finally, selective immigration policies at destination induce a higher probability for educated people to leave their home country than for non-educated people and therefore raise the expected returns to skills. As a consequence a brain drain may enhance the formation of human capital at origin (incentive mechanism). This ex-ante additional skill acquisition may alleviate the ex-post loss of skilled individuals.

The effect of skilled emigration on human capital formation, risk premium and technology is computed outside the core of the micro-founded model, using elasticities estimated in the empirical literature. The resulting paths of these three variables are then introduced into the
model along with the migration shock. A more detailed description of the different side-effects of skilled emigration considered here can be found in Appendix 8.3.3.

Table 5.1 presents the change in technology adoption and in network effects under a brain gain scenario. While technology is deteriorated due to increased skilled emigration, information costs are reduced and FDI to MENA are favored by skilled emigration. In Table 5.2, we see that the ratio of skilled to total labor force (human capital) drops under the “Brain Gain” but less than under the “Skilled” scenario.

Table 5.1. Skilled migration externality on technology (A) and network effects (\( \pi \))

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2010</th>
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<td>-0.15</td>
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</tr>
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<td>( \pi )</td>
<td>0.00</td>
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<td>-7.21</td>
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<td>-12.25</td>
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<td>-8.07</td>
<td>-5.53</td>
</tr>
</tbody>
</table>

The table displays percentage point differences to the baseline.

Source: Docquier and Lodigiani (2008), Lodigiani (2007) and own computations.

Table 5.2. Human capital in the “Skilled” (S), “Brain Waste” (BW) “Brain Gain” (BG) and “Expansionary” (EXP) scenarios

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
<th>2060</th>
<th>2070</th>
<th>2080</th>
<th>2090</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>S=BW</td>
<td>0.00</td>
<td>-0.48</td>
<td>-0.81</td>
<td>-1.06</td>
<td>-1.30</td>
<td>-1.58</td>
<td>-1.27</td>
<td>-0.94</td>
<td>-0.63</td>
<td>-0.31</td>
<td>0.00</td>
</tr>
<tr>
<td>BG</td>
<td>0.00</td>
<td>-0.41</td>
<td>-0.63</td>
<td>-0.72</td>
<td>-0.76</td>
<td>-0.79</td>
<td>-0.54</td>
<td>-0.32</td>
<td>-0.16</td>
<td>-0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>EXP</td>
<td>0.00</td>
<td>0.05</td>
<td>0.50</td>
<td>1.29</td>
<td>1.94</td>
<td>2.57</td>
<td>3.51</td>
<td>4.11</td>
<td>4.40</td>
<td>4.71</td>
<td>5.00</td>
</tr>
</tbody>
</table>

The table displays percentage point differences to the baseline.

Source: Beine, Docquier and Rapoport (2008) and own computations.

Finally, the “Expansionary” scenario is another variant of the “Skilled” scenario. It is similar to the latter scenario but assumes that the population in MENA becomes more and more educated during the first half of the 21st century. In the baseline, the proportion of skilled among youngest cohort is constant at 15 percent from 2000 onwards, which means that the proportion of skilled in the workforce and in the population reaches 15 percent in the long run. In the “Expansionary” scenario, a brain drain occurs while the share of skilled among the youngest cohort continues to rise after 2000. It is assumed that 16.7 percent of the youngest individuals become educated in 2010, 18.4 percent in 2020 and finally 20 percent from 2030 onwards. Consequently, 20 percent of the labor force will be skilled in the long run. As stated above, the rationale of this human capital expansion is that an increased movement of skilled
workers from MENA to EU15 could be accompanied by a more generous assistance or a greater cooperation in education policies. Under the “Expansionary” scenario, even with the increased departure of skilled individuals, human capital is improved compared to the baseline (see the last line of table 5.2).

In the EU, the “Brain Gain” and the “Expansionary” scenarios have an identical impact than the “Skilled” scenario, while a “Brain Waste” would lead to less optimistic results and has actually the same impact as the “Unskilled” scenario (figures 5.17, 5.19 and 5.21). If skilled migrants arrive in EU under the “Brain Waste” scenario, they will be employed as unskilled and will have a similar contribution as the latter ones in financing the public budget and in improving the GNI per capita.

In MENA, a “Brain Waste” scenario has a similar impact as the “Skilled” scenario, because the same people leave this region but are employed differently at destination. The other reason is that, as shown on Figure 5.12, the equilibrium amount remitted by skilled and unskilled workers are roughly the same.

The ‘Brain Gain’ scenario has a less damaging impact in MENA than the “Skilled” scenario. The improvement in the risk premium and in human capital partly compensates the negative side-effect of skilled emigration on technology adoption, labor and capital productivity. We see that the tax rate increases less (figure 5.18) and GNI is less reduced when considering the side-effects of skilled emigration (figure 5.20). Finally since more individuals acquire high skilled education, inequality increases less under the “Brain Gain” scenario (figure 5.22).

The “Expansionary” scenario generates a much lower rise in the tax rate than the “Skilled” scenario since the level of human capital is enhanced even compared to the baseline (see table 5.2). Obviously, in such a context, as per worker productivity increases, income per capita improves (in contrast to a drop in GNI per capita obtained in the “Skilled” scenario). This scenario also results in a reduction in inter-household inequality as more people belong to the better-off group. The “Expansionary” scenario involves a win-win situation, since besides improving the situation in MENA it also leads to similar beneficial effects in the EU as the “Skilled” scenario. Clearly, this suggests that a stronger partnership between EU15 and MENA countries, involving more skilled migration and a greater cooperation in human capital formation, can raise the welfare of all parties concerned. For instance, such an initiative could be designed in the framework of the “Union pour la Méditerranée” initiated in late July by French President Nicolas Sarkozy. Indeed, the goal of this Union is to promote a development of the Euromediterranean Partnership.

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8 In theory, some general equilibrium effects could induce differences between these scenarios; in practice, these differences are negligible.
Fig. 5.17. Tax rate in Europe – Brain drain variants (dev. in % points from baseline)

Fig. 5.18. Tax rate in MENA – Brain drain variants (dev. in % points from baseline)
Fig. 5.19. GNI per cap. in Europe – Brain drain variants (in % dev. from baseline)

- Skilled = Brain Gain = Expansionary
- Brain Waste

Fig. 5.20. GNI per cap. in MENA – Brain drain variants (in % dev. from baseline)

- Skilled = Brain Waste
- Brain Gain
- Expansionary
Fig. 5.21. Inequality in Europe – Brain drain variants (in % dev. from baseline)

Fig. 5.22. Inequality in MENA – Brain drain variants (in % dev. from baseline)
6 Conclusion

This report examines the consequences of increasing MENA-to-EU migration flows in the coming decades on both sending and receiving regions. Different approaches are adopted to address this issue. First, from a pure demographic point of view, replacement migration policies encouraging MENA-to-EU flows of working-age people should not be permanent and be limited in size and in time. The reason is that, as Europe, MENA will also have to cope with the aging of its population.

Second, the report also bases its conclusions on generational accounting techniques and general equilibrium modeling. In Europe, increased immigration would help to relieve the pressure on pension systems and to raise GDP and GNI per capita. The general equilibrium analysis reveals some important insights. While selecting immigrants has a small additional impact in reducing tax rates (compared to a non-selective policy), it leads to significant additional increments in income in aging Europe. In MENA, emigration increases the economic burdens of aging, and even more if emigrants are skilled. Thus while skilled emigration would contribute to alleviate the aging problem in Europe, it would have negative consequences in terms of tax rates and income in MENA.

Finally, we consider different variants of a selective policy within our analysis. The reasons are that skilled migrants might not necessarily be employed as skilled workers at destination, that skilled emigration entails different side-effects on origin countries, and that education in MENA countries could be boosted by an increased cooperation with Europe. The first variant of scenario combines the worst effects of the selective and non-selective policies explained before, since, under such a brain waste, skilled migrants leave MENA and contribute as unskilled workers to the European economy. The two other variants affect Europe in the same manner than a selective immigration policy, but considerably mitigate its effects in MENA. The side-effects of skilled emigration contribute to moderate the increase in the tax rate, the drop in income per capita and the rise in inequality.

In a scenario in which skilled emigration is accompanied by an increase in education levels of the MENA labor force, income per capita would be even positively affected and inequality reduced. Such a situation results in a win-win situation, since besides improving the situation in MENA it also leads to similar beneficial effects in the EU as skilled migration alone. However it leaves the question open on how such education improvements can be achieved. An increasing cooperation in education policies and managed migration flows could be designed in the framework of the “Union pour la Méditerranée” whose explicit goal is to promote a development of the Euromediterranean Partnership.
7 References


8 Technical appendices

8.1 Methodology used in DLM

Emigration stocks. It is well documented that statistics provided by source countries do not provide a realistic picture of emigration. When available, which is very rare, they are incomplete and imprecise. Whilst detailed immigration data are not easy to collect on an homogeneous basis, information on emigration can only be captured by aggregating consistent immigration data collected in receiving countries, where information about the birth country, gender and education of natives and immigrants is available from national population censuses and registers (or samples of them). More specifically, the receiving country j’s census usually identifies individuals on the basis of age, gender g, country of birth i, and skill level s. The DLM method consists in collecting (census or registers) gender-disaggregated data from a large set of receiving countries, with the highest level of detail on birth countries and three levels of educational attainment: s=h for high-skilled, s=m for medium-skilled and s=l for low-skilled. Let \( M_{t,g,s}^{i,j} \), denote the stock of adults 25+ born in j, of gender g, skill s, living in country j at time t. Aggregating these numbers over destination countries j gives the stock of emigrants from country i: \( M_{t,g,s}^{i} = \sum_{j} M_{t,g,s}^{i,j} \).
By focusing on census and register data, the methodology badly captures illegal immigration for which systematic statistics by education level and country of birth are not available\(^9\), except in the USA. Demographic evidence indicates most US illegal residents are captured in the census. However, there is no accurate data about the educational structure of these illegal migrants. Hence, the number of unskilled in the immigrant population is probably underestimated, assuming that most illegal immigrants are uneducated. Nevertheless, this limitation should not significantly distort the estimates of the migration rate of highly-skilled workers.

Here are the main methodological choices of DLM:

- The term "source country" usually designates independent states. They distinguish 195 source countries: 191 UN member states, Holy See, Taiwan, Hong Kong, Macao and Palestinian Territories. They aggregate North and South Korea, West and East Germany and the Democratic Republic and the Republic of Yemen. They consider the same set of source countries in 1990 and 2000, although some of them had no legal existence in 1990 (before the secession of the Soviet block, former Yugoslavia, former Czechoslovakia and the German and Yemen reunifications) or became independent after January 1, 1990 (Eritrea, East-Timor, Namibia, Marshall Islands, Micronesia, Palau). In these cases, the 1990 estimated stock is obtained by multiplying the 1990 value for the pre-secession state by the 2000 country share in the stock of immigrants (the share is gender- and skill-specific).

- The set of receiving countries is restricted to OECD nations. Generally speaking, the skill level of immigrants in non-OECD countries is expected to be very low, except in a few countries such as South Africa, the six member states of the Gulf Cooperation Council, some Eastern Asian countries. To allow comparisons between 1990 and 2000, they consider the same 30 receiving countries in 1990 and 2000. Consequently, Czechoslovakia, Hungary, Korea, Poland and Mexico are considered as receiving countries in 1990 despite the fact that they were not members of the OECD.

- They only consider the adult population aged 25 and over. This excludes students who temporarily emigrate to complete their education. In addition, as it will appear in the next section, it allows to compare the numbers of migrants with data on educational attainment in source countries.

- Migration is defined on the basis of the country of birth rather than citizenship. Whilst citizenship characterizes the foreign population, the "foreign-born" concept better captures the decision to emigrate\(^{10}\). Usually, the number of foreign-born is much higher than the number of foreign citizens (twice as large in countries such as

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\(^9\) Hatton and Williamson (2002) estimate that illegal immigrants residing in OECD countries represent 10 to 15 percent of the total stock.

\(^{10}\) In some receiving countries such as Germany, immigrants' children (i.e. the second generation) usually keep their foreign citizenship.
Hungary, the Netherlands, and Sweden). Another reason is that the concept of country of birth is time invariant (contrary to citizenship which changes with naturalization) and independent of the changes in policies regarding naturalization. The number of foreign-born can be obtained for a large majority of OECD countries although in a limited number of cases the national census only gives immigrants' citizenship (Germany, Hungary, Italy, Japan and Korea). It is worth noting that the concept of foreign born is not fully homogeneous across OECD countries. In most receiving countries, foreign born are individual born abroad with foreign citizenship at birth. In a couple of countries, “foreign-born” means "overseas-born", i.e. an individual simply born abroad.

- They distinguish three levels of education. Medium-skilled migrants are those with upper-secondary education completed. Low-skilled migrants are those with less than upper-secondary education, including those with lower-secondary and primary education or those who did not go to school. High-skilled migrants are those with post-secondary education. This assumption is compatible with Barro and Lee's human capital indicators (based on the 1976-ISCED classification). Some migrants did not report their education level. As in DM06, they classify these unknowns as low-skilled migrants. Educational categories are built on the basis of country specific information and are compatible with human capital indicators available for all sending countries. A mapping between the country educational classification is sometimes required to harmonize the data.

**Emigration rates.** They count as migrants all adult (25 and over) foreign-born individuals living in an OECD country. A more meaningful measure can then be obtained by comparing the emigration stocks to the total number of people born in the source country and belonging to the same gender and educational category. This method allows to evaluate the pressure imposed on the labor market in the source country.

In the spirit of Carrington and Detragiache (1998), Adams (2003), Docquier and Marfouk (2006) or Dumont and Lemaitre (2006), the second step consists in calculating the brain drain as a proportion of the total educated population born in the source country. Although their analysis is based on stocks (rather than flows), they refer to these proportions as emigration rates. Denoting \( R_{i,g,s}^t \) as the stock of resident individuals aged 25+, of skill \( s \), gender \( g \), living in source country \( i \), at time \( t \), emigration rates are defined as

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11 By contrast, in other OECD countries with a restricted access to nationality (such as Japan, Korea, and Switzerland), the foreign population is important (about 20 percent in Switzerland).
12 The OECD statistics report that 14.4 million foreign born individuals were naturalized between 1991 and 2000. Countries with a particularly high number of acquisitions of citizenship are the US (5.6 million), Germany (2.2 million), Canada (1.6 million), and Australia and France (1.1 million).
13 In the US case, this includes those with one year of college.
14 Country specific data by occupation reveal that the occupational structure of those with unknown education is very similar to the structure of low-skilled workers (and strongly different from that of high-skilled workers). See Debuisson et al. (2004) on Belgium data.
15 For example, Australian data mix information about the highest degree and number of years of schooling.
In particular, \( m_{t,g,s}^i \) can be used as a proxy of the brain drain in the source country \( i \).

This step requires using data on the size and the skill and gender structure of the adult population in the source countries. Population data by age are provided by the United Nations\(^\text{16}\). They focus on the population aged 25 and more. Data are missing for a couple of countries but can be estimated using the CIA world factbook\(^\text{17}\). Population data are split across educational group using international human capital indicators. Several sources based on attainment and/or enrollment variables can be found in the literature. As in Docquier and Marfouk (2006), human capital indicators are taken from De La Fuente and Domenech (2002) for OECD countries and from Barro and Lee (2001) for non-OECD countries. For countries where Barro and Lee measures are missing, they predict the proportion of educated using Cohen-Soto's measures (see Cohen and Soto, 2007). In the remaining countries where both Barro-Lee and Cohen-Soto data are missing (about 70 countries in 2000), they transpose the skill sharing of the neighboring country with the closest enrollment rate in secondary/tertiary education, the closest gender gap in enrollment rates and/or the closed GDP per capita.

### 8.2 The GA model with heterogeneous agents

The starting point of the generational accounting technique is the government intertemporal budget constraint. At the base year \( t \), the sum of the public net wealth and the present value of prospective aggregate net payments by living and future generations must equalize the present value of prospective public purchases:

\[
PVL_t + PVF_t + NW_t = PVG_t
\]

where \( PVL_t \) measures the present value of net tax payments by living generations over the rest of their life, \( PVF_t \) is the present value of net tax payments by future generations, \( PVG_t \) stands for the present value of prospective government purchases of goods and services and \( NW_t \) is the net public wealth.

The net wealth at time \( t \) is observed. Two of the remaining terms are projected using contemporaneous observations and official projections, \( PVG_t \) and \( PVL_t \). The fourth term, \( PVF_t \), can thus be calculated as the residual burden bequeathed to future generations.

The present value of government purchases is the discounted sum of public expenditures:

\[
m_{t,g,s}^i = \frac{M_{t,g,s}^i}{R_{t,g,s}^i + M_{t,g,s}^i}
\]

---

\(^\text{16}\) See http://esa.un.org/unpp.

\(^\text{17}\) See http://www.cia.gov/cia/publications/factbook.
where $G_s$ is the amount of public purchases projected at time $s \geq t$; $i$ denotes the interest rate.

In practice, the path of $G_s$ can be partly projected on the basis of budgetary forecasts (i.e. between $t$ and $t^*$) and partly projected using balanced growth assumptions (between $t^*$ and $\infty$). In the long-run, it is assumed that $G_s$ grows at the same rate as the growth rate of the total factor productivity, $g$.

The present value of net tax payments by living generations can be obtained by summing the present value of net taxes these generations will pay to the government over the rest of their life, i.e. summing the generational accounts of living cohorts. We distinguish three educational levels ($L =$ low level, $M =$ mean level and $H =$ high level) and suppose that each individual can live a maximum of $D$ years. The present value of payments by living generations, $PVL_t$, can be written as

$$PVL_t = \sum_{j=0}^{D} (n^L_{j,t} p^L_{j,t} + n^M_{j,t} p^M_{j,t} + n^H_{j,t} p^H_{j,t})$$

where $p^X_{j,t}$ stands for the size of type-$X$ population ($X=L,M,H$) of age $j$ at time $t$ and $n^X_{j,t}$ measures the generational account of these agents.

Generational accounts sum up the amount of net taxes to be paid by each type of individual over the rest of his life:

$$n^X_{j,t} = \frac{1}{p^X_{j,t+k-j}} \frac{\theta^X_{k,t+k-j} \cdot p^X_{k,t+k-j}}{(1+i)^{k-j}} \quad j = 0, \ldots, D$$

where $\theta^X_{k,t+k-j}$ is the amount of net tax payment by an agent of type $X$ and age $k$ at time $t+k-j$.

In practice, $p^X_{k,t+k-j}$ can be projected using demographic forecasts (including mortality and net immigration flows), data on schooling levels per age, and estimates for the educational attainment of the young living generations after completion of their education. The net taxes $\theta^X_{k,t+k-j}$ can be partly extrapolated on the basis of short-run forecasts (taking account of official budgetary projections and potential fiscal reforms between $t$ and $t^*$) and partly extrapolated using balanced growth assumptions (between $t^*$ and $\infty$). Typically, different assumptions can be considered for the items of $\theta^X_{k,t+k-j}$.

It should be noted that the generational accounts of the newborns, measuring the present value of net taxes they expect to pay over their whole lifetime, need not to be of the same sign. It can be negative for low skill individuals and positive for the high skilled. These generational accounts can be expressed as percentage of the discounted lifetime labor income, denoted by
$W_{0,t}^X$ for a newborn agent of type $X$. In the line of GPS, this defines the lifetime net tax rate of the newborns:

$$LNR_{0,t}^X = \frac{n_{0,t}^X}{W_{0,t}^X}$$

The basic issue of the generational accounting is the financial sustainability of public policies. Given the generational account of the newborns at time $t$ ($n_{0,t}^X$), will it be possible to be so generous with future generations? The present value of net tax payment by future generations, $PVF_t$, does not itself give an answer to this question. To go further, one needs to transform this aggregate burden into an individual amount, the average account of future cohorts.

One way to proceed is to compute the hypothetical generational accounts of future cohorts under the current fiscal policy. Using the same methodology than for living cohorts, we write:

$$PVF^*_t = \sum_{s=t+1}^{\infty} \sum_{j=0}^{\text{Min}(s-t+1, D)} \theta_{j,s}^L p_{j,s}^L + \theta_{j,s}^M p_{j,s}^M + \theta_{j,s}^H p_{j,s}^H (1 + i)^{s-t}$$

where $PVF^*_t$ measures the present value of net payments by future generations under the assumption that the current fiscal policy is sustainable.

This hypothetical value $PVF^*_t$ can then be compared to the residual value $PVF_t$ computed from the intertemporal budget constraint:

- if $PVF^*_t = PVF_t$, the policy is sustainable and there is no need of fiscal adjustment;
- if $PVF^*_t > PVF_t$, the government budget is in surplus and benefits could be increased for the same levels of taxes;
- if $PVF^*_t < PVF_t$, the current policy is not sustainable or not generationally balanced: it implies that either future generations must pay different net taxes than current generations or current policy must be adjusted to restore sustainability.

In case of unsustainability, the basic methodology suggests to adjust taxes and/or transfers at some date. In this paper, we use an adjustment method which concerns all the members of all the generations. If a gap has to be financed (in case of deficit) or allocated (in case of surplus), we compute the proportional adjustment in all taxes (or in all transfers) required to balance the budget[^18].

[^18]: Our strategy slightly differs from GPS who compute the changes in taxes and/or benefits so as to equalize the lifetime net tax rates of current and future generations. It should be noted that, in the line of GPS, the balance can also be restored through changes in government purchases.
Let us decompose the net taxes on all generations in two basic components, taxes and benefits: \( \theta_{x,j,s}^T \equiv \theta_{x,j,s}^T - \theta_{x,j,s}^B \). A time-invariant adjustment factor can be applied to each of these components (\( \gamma_T \) for taxes and \( \gamma_B \) for benefits) so as to restore sustainability. We then apply these proportional changes to both living generations (over the rest of their lifetime) and future generations so as to balance the budget constraint. Our adjustment rule is then summarized by the following set of equations:

\[
P_{VF_t}^{adj} = \sum_{j=0}^{D} \sum_{k=0}^{D} \sum \left[ \theta_{x,k,s}^T (1 - \gamma_T) - \theta_{x,k,s}^B (1 - \gamma_B) \right] P_{k,j,s}^T (1 + i)^{k-j}
\]

\[
P_{VL_t}^{adj} + P_{VF_t}^{adj} + NW_t = PVG_t
\]

There is a continuum of pairs \((\gamma_T, \gamma_B)\) restoring the balance. Two specific pairs are usually considered, one with \( \gamma_T = 0 \) if the balance is achieved through transfer cuts and one with \( \gamma_B = 0 \) if the balance is achieved through tax increases. For each scenario, the lifetime net tax rate of future generations can be computed and compared to that of the current newborns.

**8.3 Description of the CGE model**

The CGE analysis can be resumed in three different steps: calibration of the demography, construction of the CGE model and introducing the side-effects of skilled migration. Before focusing on the CGE model, we constructed the evolution of the population over the 2000-2100 period based on UN population forecasts. The evolution of the population (as well as of international migration) enters then the model and determines the path of the economy over the 21st century. The CGE model is characterized by overlapping generations of individuals with skill heterogeneity, a production sector and a government. At this point, we provide first evaluations of the implications of increased migration on destination and origin regions. A last step is to include in the model diverse side-effects of skilled emigration on source countries. The elasticities used for such an analysis were estimated in various articles of the brain drain literature.

**8.3.1 Demography**

The population structure relies on the UN Population projections which are available between 1950 to 2050. We also use this data to identify the migrants from developing to developed regions.
Population. Individuals reaching age 0 at year t belong to the generation t. The size of the young generation increases over time at an exogenous growth rate:

\[ N_{0,t} = m_{t-1}N_{0,t-1}, \]

where \( N_{0,t} \) measures the initial size of generation \( t \) and \( m_{t-1} \) is one plus the demographic growth rate, including both fertility and migration.

At every period, agents of the same age class \((a=0,1,\ldots,7)\) face an identical cumulative survival probability, which decreases with age. Hence, the size of each generation declines deterministically over time:

\[ N_{a,t+a} = P_{a,t+a}N_{0,t}, \]

where \( 0 \leq P_{a,t+a} \leq 1 \) is the fraction of generation \( t \) alive at age \( a \) (at period \( t+a \)). Obviously, we have \( P_{0,t} = 1 \).

Denoting by \( \phi_t \) the proportion of skilled (post-secondary educated) among the first cohort, the skilled and unskilled cohort sizes are given by:

\[ N_{0,t}^s = \phi_t N_{0,t}, \]
\[ N_{0,t}^u = (1 - \phi_t)N_{0,t}. \]

We assume an exogenous participation profile per age and education group, \( \lambda_{a,t}^j \). Hence, labor supply of type \( j \) at time \( t \) is given by

\[ L_t^j = \sum_a \lambda_{a,t}^j N_{a,t}^j, \quad j = u, s. \]

Specifically, we assume full participation except for the following three groups. First, young skilled spend a fraction of their time in obtaining education and do not fully participate in the labor market \((0 \leq \lambda_{0,t}^i \leq 1)\). Second, part of the population aged 55 to 64 years old are retired \((0 \leq \lambda_{4,t}^j \leq 1)\). Lastly, all individuals aged above 65 are retired \((\lambda_{a,t}^j = 0 \text{ for all } a > 0)\).

Demographic changes affect the economic performances of the economy (GDP or GNI per capita) through the support ratio, defined as the ratio of labor force to population:

\[ SR_t = \frac{\sum_a \sum_j \lambda_{a,t}^j N_{a,t}^j}{\sum_a \sum_j N_{a,t}^j}, \]

An through human capital, defined as the proportion of skilled in the residents labor force:
\[ HC_t = \frac{\sum_a \sum_j \lambda_{a,t}^j N_{a,t}^j}{\sum_a \sum_j T_{a,t}^j N_{a,t}^j} \]

In the baseline, we compute \( P_{a,t+a} \), the probability for an individual of generation \( t \) of being alive at time \( t + a \) and the population growth rate \( m_t \) for the period 1950 to 2050 from the United Nations data of World Population Prospects, the 2000 Revision. In order to compute the share of skilled individuals of a generation \( \phi_t \), we use the Barro-Lee Dataset (2001), which provides data on the educational attainment of individuals aged 25 to 74 for the years 1950 to 2000 per country. In the future, we assume that the young cohorts are educated as the young one in 2000.

**South-North migration.** In order to calibrate migration stocks and flows for the baseline, we explicitly track migrants from the seven developing regions into the three developed regions. North-North and South-South migrants are implicitly dealt with through the U.N. population data and forecasts. Our calibration strategy is based on immigrant-to-population ratios, or the proportions of stock of immigrants to total population observed in the three developed regions. To begin with, we use statistics on the number, age structure and education levels of immigrants in 2000 (combining the U.N. and the Docquier-Marfouk datasets). From the gross number of immigrant stock in each region, we subtract the number of 0 to 14 years old migrants, and then we subtract all North-to-North migrants. Based on the Docquier-Marfouk dataset, we calibrate the shares of immigrants by education level and by region of origin. To construct the number of migrants before 2000, we use survival probabilities as well as the growth rate of the immigrant population. For immigration forecasts, we start from the 2000 numbers and let migrants die according to the survival probability forecasts. Assuming that all future migrants are aged 15-24, we let the change in the stock of immigrants follow the UN forecasts (from which we subtract the 0-14 years old and North-to-North migrants using the 2000 proportions). We assume that future migrants are distributed by educational level and by origin as in 2000.

### 8.3.2 The model's structure

19 We firstly aggregate this data set by region and then partition it to obtain shares of skilled per age group. We proceed as follows in order to dis-aggregate the Barro-Lee data by age group. First, it is reasonable to assume that, at each period, the share of skilled individuals is higher for the younger age class. In particular, we assume that the share of skilled individuals aged 85 to 94 corresponds arbitrarily to 80% of the share of skilled aged 75 to 84, which in turn is equal to 80% of that of the next younger age class, and so forth. As all the shares of skilled per age class then depend on the share of skilled aged 25 to 34, we compute this share in order to matches the total share of skilled in 1950, as given by the Barro-Lee Dataset. Second, we report the values of the shares of the age classes 25-34 to 65-74 of the following years. For example, the share of skilled aged 35 to 44 in 1960 is equal to the share of skilled aged 25-34 in 1950, as we assume that the skilled and unskilled individuals have the same probability to be alive at the beginning of each period. Third, for all the following years, we compute the share of skilled aged 25 to 34 in the same way as for the year 1950. Lastly, the share of skilled aged 15 to 24 in 1950 is simply equal to the share of skilled aged 25 to 34 in 1960.
Preferences. The expected utility function of our agents is assumed to be time-separable and logarithmic:

\[ E(U_j^t) = \sum_{a=0}^{T} P_{a,t+a} \ln(c_{a,t+a}^j), \quad j = s, u \]

where \( c_{a,t+a}^j \) represents expenditures of age class \( a \) at time \( t+a \). For natives in both developing and developed regions, \( c_{a,t+a}^j \) is equivalent to goods consumption. However, for immigrants in the developed regions, \( c_{a,t+a}^j \) is a Cobb-Douglas combination of goods consumption \((c_{a,t+a}^{M,j})\) and remittances \((RM_{a,t+a}^{M,j})\).

\[ c_{a,t+a}^j = (c_{a,t+a}^{M,j})^{1-\gamma_j^t} (RM_{a,t+a}^{M,j})^{\gamma_j^t}, \quad j = s, u \]

where \( \gamma_j^t \) is an age-invariant propensity to remit that determines the proportion of expenditures a migrant of generation \( t \) and skill group \( j \) sends as remittance to his/her region of origin. Moreover, we assume that this parameter varies with country of origin.

Furthermore, following de la Croix and Docquier (2003), we postulate the existence of an insurance mechanism à la Arrow-Debreu. As an individual dies, her/his assets are equally distributed among individuals belonging to the same age class. Individuals thus maximize their expected utility subject to a budget constraint requiring equality between the discounted expected value of expenditures and the discounted expected value of income, which consists of net labor income, pension benefits, other welfare transfers and/or net remittances.

Firms. At each period of time and in each region, a representative and profit-maximizing firm uses efficient labor \((L_t)\) and physical capital \((K_t)\) to produce a composite good \((Y_t)\). We assume a Cobb-Douglas production function with constant returns to scale,

\[ Y_t = K_t^\alpha (A_t L_t)^{1-\alpha}, \]

where \( \alpha \) measures the share of capital returns in the national product, and \( A_t \) is an exogenous process representing the Harrod neutral technological progress. Total efficient labor force combines the demands of skilled \((L_t^s)\) and of unskilled labor \((L_t^u)\) according to the transformation function characterized by a constant elasticity of substitution (CES):

\[ L_t = [\upsilon_t (L_t^s)^{\sigma} + (1-\upsilon_t)(L_t^u)]^{\frac{1}{\sigma}}, \quad \sigma < 1 \]

where \( \upsilon_t \) is an exogenous skill-biased technological progress, and \( \sigma \) is defined as \( \sigma = 1 - (1/\epsilon) \), with \( \epsilon \) being the elasticity of substitution between skilled and unskilled labor. The capital share in output \( \alpha \) is set to one third, as estimated in the growth accounting.

---

We model remittances in this way so that migrants and natives have identical asset accumulations. The age-invariance of propensity to remit comes from our assumption that there is no remittances decay.
literature. We follow Acemoglu (2002) in fixing the elasticity of substitution to 1.4 and thus the parameter $\sigma$ equals to 0.2857 in the CES function.

There is one leading regional economy, North America (NAM), in the sense that the Harrod neutral technological progress of each region is a fraction of $A_t^{NAM}$, namely that the leader is always ahead of other regions in terms of production technology. Exogenous paths for the Harrod neutral technological progress $A_t$, the skill-biased technical change $\nu_t$ and growth of the leading economy are unobservable and/or must be properly calibrated.

To obtain $A_t$ for non-leading regions, we use the observed paths of GDP ratio, $Y_t/Y_t^{NAM}$, where $Y_t^{NAM}$ is the leader's GDP. We proceed as in de la Croix and Docquier (2007), who use a back-solving identification method to calibrate total factor productivity. It consists of swapping the unobserved exogenous variables $A_t$ for the observed endogenous variables $Y_t/Y_t^{NAM}$ and then solving the identification step with the Dynare algorithm (Juillard, 1996). The ratio of GDP's is computed by employing the data of the GDP per purchasing power parity from the World Development Indicators (WDI) for the three years 1980, 1990 and 2000. We adopt the value of 1980 for the years preceding 1980 and the value of 2000 for those following 2000. We apply the same procedures for skill-biased technological change by using skill wage premiums, $h_t = w_t^s/w_t^u$. The skill premiums for each region in year 2000 are arbitrarily fixed.\footnote{21 $h_{2000}$ is fixed at 2.35 in EU and 3 in MENA.}

Then, we let these values vary according to the pattern of the US college wage premium for the period 1950-2000 in Acemoglu (2003). Finally, the leader's growth of Harrod neutral technological progress, is calibrated on real observations, and for future years, the value is calibrated such that the annual growth rate is equal to 1.84 percent.

**Government.** The government levies taxes on labor earnings and on consumption expenditures in order to finance general public consumption, pension benefits and other welfare transfers. The government surplus ($S_t$) can be written as (for $j = s, u$):

\[
S_t = \tau_t^w \sum_{j=s,u} L_t w_t^j + \tau_t^c \sum_{j=x,a} \sum_{a=0}^{7} \phi_{t-a}^j N_{a,t} e_{a,t}^j - \sum_{j=x,a} \sum_{a=0}^{7} b_t^j \sum_{j=x,a} \phi_{t-a}^j N_{a,t} (1-e_t^j)(1-\lambda_{a,t}^j) - \psi_t \sum_{j=x,a} \sum_{a=0}^{7} \phi_{t-a}^j N_{a,t} (1-e_t^j) \zeta_t^j - c_t^g Y_t,
\]

where $\lambda_{a,t}^j$ is the labor participation rate for a $j$ type individual of age class $a$, $w_t$ is labor income, $\tau_t^w$ is consumption tax, $\tau_t^c$ income tax, $b_t^j$ (individual) pension benefits, $\zeta_t^j$ are other welfare transfers received by an individual of type $j$ and they are represented as a time-constant fraction of labor income, the generosity factor $\psi_t$ is the factor by which these other welfare transfers are multiplied at time $t$, $c_t^g$ is a part of national income used to finance
Education is exogenous and individuals spend a fraction \( e_j \) of their total time (which is only positive in their first period of life), \( \phi_j \) is the proportion of individuals of skill type \( j \) among generation \( t \) (\( \phi_j = \phi \) when \( j = s \) and \( \phi_j = 1 - \phi \) when \( j = u \)).

The government also issues bonds and pays interests on public debt. The government's budget constraint is satisfied at each period by adjusting the wage tax rate \( \tau^w_t \). Public debt \( d_t \) is computed from the WDI Database.

**Equilibrium.** A competitive equilibrium of the economy with perfect capital mobility is characterized by (i) households' and firms' first order conditions, (ii) market-clearing conditions on the goods and labor markets, (iii) budget balance for each regional government, (iv) the equality between the aggregate quantity of world assets and the quantity of the world capital stock plus the sum of public debts of all regions, and finally (v) the arbitrage condition of the rates of return to capital. The equilibrium on the goods market is achieved by Walras' law.

The arbitrage condition in an integrated economy with perfect capital mobility requires the equality of the expected returns to capital up to region specific risk premium.

### 8.3.3 Side-effects of migration

Migration, and especially skilled migration, has been found to have diverse side-effects on migrants source countries. In particular, human capital formation, technology adoption and informational costs can be affected by skilled emigration. The following paragraphs we explain how we integrate these effects in the “Brain Gain” scenario.

**Human capital.** A recent wave of theoretical contributions demonstrates that skilled migration can raise the average of human capital in the sending countries (Mountford, 1997, Stark et al., 1997, 1998, Vidal, 1998, Beine et al., 2001 and Stark and Wang, 2002). These papers assume that the return to education is higher abroad and that skilled workers have a much higher probability to emigrate than unskilled workers (a hypothesis strongly supported by the data). Hence, migration prospects raise the expected return to human capital and induce more people to invest in education at origin. Ex-ante, more people opt for education. Ex-post, some of them will be leaving. Under certain conditions detailed in these models, the incentive effect (or brain effect) dominates that of actual emigration (or drain effect), which creates the possibility of a net brain gain for the source country.

Beine et al. (2008) found evidence that the prospect of skilled migration is positively associated with gross (pre-migration) human capital levels in cross-country regressions. They used a \( \beta \)-convergence empirical specification:

\[
\Delta \ln(HC_i) = \alpha - \beta \ln(HC_i) + \gamma \ln(m_i) + \sum \eta_i X_{i,i}
\]
where $\Delta \ln(HC^a_t)$ is the growth rate of human capital between $t$ and $t+1$, $HC^a_t$ denotes human capital measured as the proportion of skilled among natives at time $t$ (superscript $a$ stands for natives, or human capital ex-ante, before emigration occurs), $m^t_i$ is the skilled emigration rate, $X_{it}$ is a vector of other control variables, $(\alpha, \beta, \gamma, \eta_i)$ is a set of parameters. The long-run elasticity of natives' human capital to the skilled emigration rate is equal to $\gamma/\beta$. It amounts to 9.6 percent in the parsimonious IV model.

In our simulations, we build on Docquier, Lowell and Marfouk’s data and compute the relative change in skilled emigration rates resulting from the rise in emigration flows to the North. We assume that these relative changes are experienced by all the countries belonging to the region. Using the above long-run elasticity, we compute the change in human capital of natives and residents (natives minus migrants). Assuming that the long-run level of human capital is reached in 2050, we compute the proportion of skilled among remaining residents, denoted by $HC^r_t$. We first do it country by country and then aggregate countries by region. The convergence to the 2050 level of human capital level is linear. Finally, we compute the change in $\phi_t$ required to obtain the desired levels of human capital. After 2060, the skilled emigration rates and the $\phi_t$ come back to their baseline value.

**Total Factor Productivity (TFP).** Following Benhabib and Spiegel (2005), themselves building on Nelson and Phelps (1966), we consider an endogenous Harrod-neutral technical progress of the neo Schumpeterian type. Technical changes are determined by the regional capacity to innovate and to adopt modern technologies. Vandenbussche, Aghion and Meghir (2006), henceforth VAM, estimated a neo-Schumpeterian model using panel data on OECD countries. More recently, Lodigiani (2008) has extended the framework by adding a diaspora externality: skilled emigrants living in rich countries increase the capacity to adopt modern technologies. She re-estimated the model on a larger sample of countries (including developing countries) and obtained the following specification:

$$
\Delta \ln(A_t) = .59 - .28 \ln\left(\frac{A_t}{A^*_t}\right) + 1.43HC^r_t - 0.10\ln(M^r_t)
$$

$$
+ .87 \ln\left(\frac{A_t}{A^*_t}\right)HC^r_t - 0.06 \ln(M^r_t) + \varepsilon_t
$$

where $\Delta \ln(A_t)$ is the rate of technical progress, $A^*_t$ is the technological level of the leader (typically, the NAM region), $M^r_t$ is the stock of skilled emigrants living in the leading economy and $\varepsilon_t$ is an exogenous component. Confirming VAM, the interaction effect between proximity and the proportion of workers with tertiary education is positive, meaning that skilled workers are more important for growth in economies closer to the frontier. On the contrary, the interaction effect between proximity and the log of skilled emigrants is negative, implying that skilled emigration has a decreasing effect on growth when a country approaches
the frontier, or that migration is more important for countries far from the frontier. Backward countries, that rely more on adoption, can benefit more from skilled diaspora as it facilitates technology and knowledge transfer from abroad.

In the baseline, we plug the human capital and migration forecasts in the above equation to predict the evolution of the technology. On the period 1950-2000, we calibrate \( \epsilon \), so that our baseline simulations perfectly match the GDP observations (as percentage of the leading economy). The calibrated path for \( \epsilon \) is rather stationary and distributed around zero.

Since our shock modifies human capital and the number of skilled emigrants abroad, it affects the rate of technical progress as well. Given the specification above, \( \Delta \ln(A_t) \) increases in \( HC \), when \( \ln \left( \frac{A_t}{A_t^*} \right) > -1.64 \), i.e. when the economy is not too far from the frontier. Moreover, \( \Delta \ln(A_t) \) increases in \( M_t^s \) if \( \ln \left( \frac{A_t}{A_t^*} \right) < -1.67 \), i.e. when is far from the frontier.

**Risk premium.** A large sociological literature emphasizes that the creation of migrants' networks facilitates the further movement of persons, the movement of goods, factors, and ideas between the migrants' host and home countries. Several studies investigated whether FDI and migration are substitutes (as one would expect) or complements. Using cross-section data, Docquier and Lodigiani (2008) find evidence of significant network externalities in a dynamic empirical model of FDI-funded capital accumulation. Their analysis confirms that business networks are mostly driven by skilled migration. Using bilateral FDI and migration data, Kugler and Rapoport (2007) also found strong evidence of a complementarity between FDI and skilled migration with a similar elasticity.

In our model, we assume that physical capital is mobile across regions, the optimal marginal productivity of capital is equal to the international interest rate \( r_t^* \) augmented of country-specific premium \( \pi_t \), reflecting informational costs or risks. The premium level is endogenous and depends on the size of the skilled diaspora abroad \( M_t^s \). We have:

\[
\begin{align*}
  r_t^* (1 + \pi_t) &= \alpha K_t^{\alpha-1} (A_t L_t)^{1-\alpha} - d \\
  (1 + \pi_t) &= (1 + \pi_{0,t}) (M_t^s)^{-\varphi}
\end{align*}
\]

where \( d \) is the capital depreciation rate, \( \pi_{0,t} \) is an exogenous variables used to calibrate the baseline level of the premium and \( -\varphi \) is the elasticity of the premium to the skilled diaspora size.

Using panel data, Docquier and Lodigiani (2008) have estimated that the long-run elasticity of foreign direct investments to the skilled diaspora is equal to 0.75. Using the specifications above and relying on the fact that foreign direct investments represent 12.5 percent of total investments in developing countries, the calibrated value for \( \varphi \) is equal to 0.05.
In the year 2000, we calibrate $\pi_{0,2000}$ in such a way that the regional premium reflects country risk rating. The risk premium is modeled here as a governmental tax on investment. In a risky region, a part of an investor's returns to capital is collected by the government, who uses it for non productive purposes (e.g. extra-goods consumed by corrupted civil servants). We use data available from the OECD for region specific risk, which in turn rely upon the Knaepen Package methodology. To compute the risk classification per region, we take an arithmetic mean of ratings of the available countries. In the baseline scenario, $\pi_{0,t}$ is adjusted to keep the regional premium constant over time.

The Knaepen Package is a system for assessing country credit risk and classifies countries into eight country risk categories (0 - 7), from no risk (0) to high risk (7). Basically, it measures the credit risk of a country. In our calibration, there is no risks for EU whereas the the risk classification of MENA is of 4.2.