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Economic consequences of zero international migration in the EU

An assessment for Europe based on the Eurostat population projections

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Economic consequences of zero international migration in the EU - An assessment for Europe based on the Eurostat population projections

Without international migration the EU28 population by 2060 would be reduced by 76 million people, with a higher median age. This study explores how much EU28 and members states long-term economic growth would be affected in case there would not be international migration to the EU28 countries from now to the year 2060.

Contents

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Authors

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Executive summary

Purpose and policy context

The EU ageing society constitutes a formidable policy challenge for years to come. International migration, also a hot current policy issue, can partly mitigate that trend.

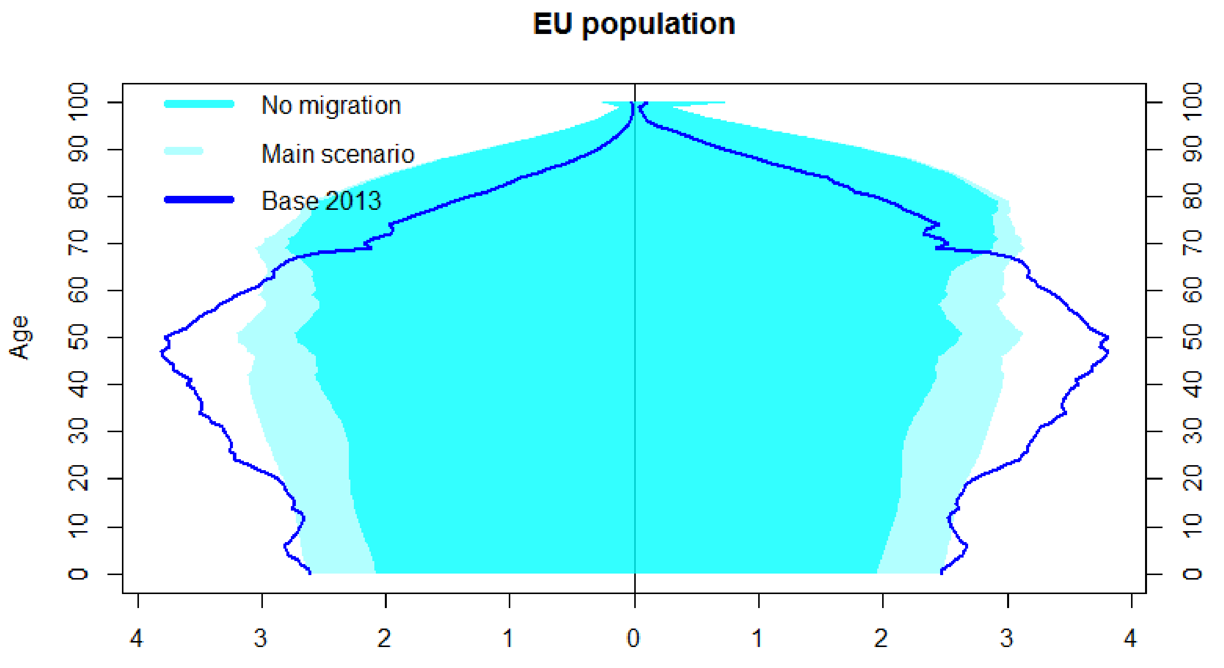
Let imagine that the EU would not receive any international migrant from today up to the year 2060, a kind of zero migration case, what would that mean for the EU economy?

- *Would the EU experience a significant GDP loss?*
- *Would EU long-term economic growth prospects be largely affected?*
- *What would happen to the EU GDP per capita?*
- *What would be those implications for the EU member states?*
- *Would all of them be equally affected?*

Those are the issues this study intends to address.

The analysis has indeed been motivated by the fact that international migration is a key implicit component of long-term demographic projections (Figure A). Eurostat foresees an average yearly net migration flow to the EU of around one million. It can be estimated that without extra-EU migration the population of the EU28 in 2060 would be 75 million lower than with migration, i.e. a 14% population reduction; the working age population would be 20% lower.

Figure A: Population pyramid in 2013 and in 2060 under the "Main scenario" (with migration) and "No migration" case



Methodology

In this study, an economic growth model is used to explore how EU long-term economic growth would be affected in a no-migration scenario. The model is estimated using a large set of public data covering more than 160 countries across almost five decades. It considers both the immediate effects due to the reduced labour supply and the dynamic effects via lower capital accumulation, as well as the change of both savings decisions and productivity levels.

Main findings

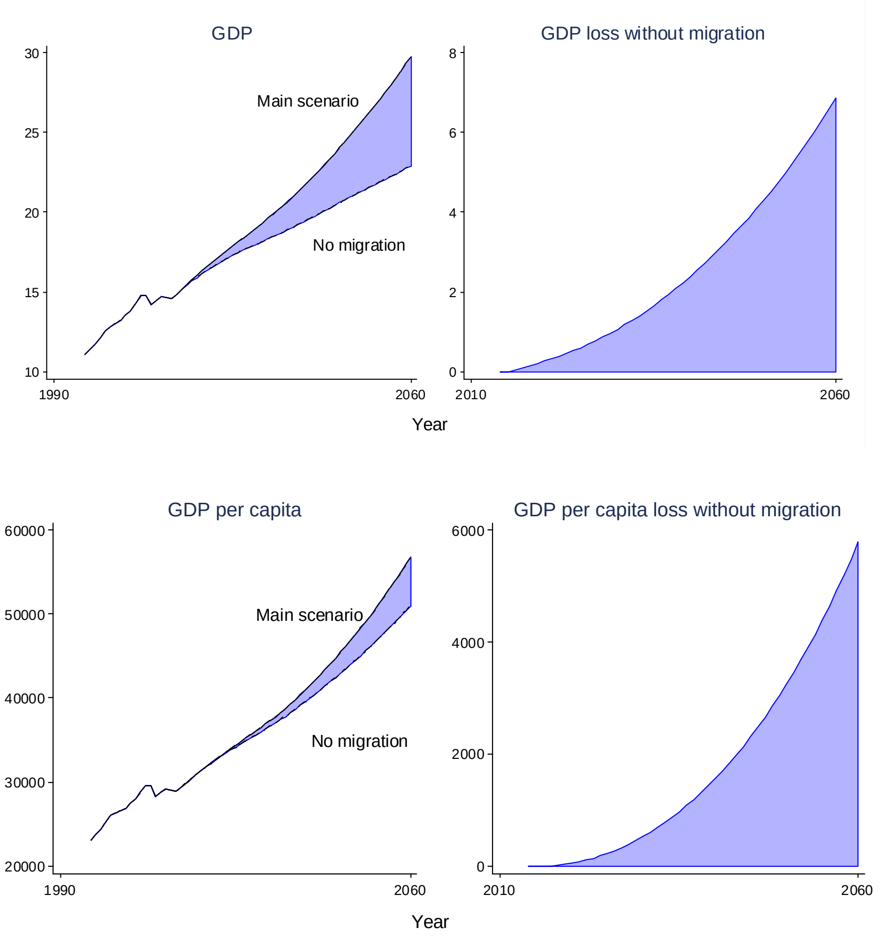
Without international migration:

- The 2060 EU production or output (real GDP) would be 23% lower (Italy -33%, Spain -28%, UK -19%, Germany -35%, France -18%), compared to the projection with migration.
- In 2060 there could be an estimated output loss of almost 7 trillion US$, compared to the scenario with migration (Figure B).
- The cumulative output loss for the entire projection period would be around 47 trillion US$ (discounted at a 3% rate).
- That would mean losing almost twenty years of economic growth: the 2043 EU output which could be reached with migration would be only attained without migration in 2060.
- The annual EU growth rate would fall over the long term (for the 2013-2060 period) from 1.5% to less than 1.0%.
- In 2060 the EU output per capita with migration flows would be around 57,000 US$, but it would fall to around 51,000 US$ without migration (around 10%). Most of the EU population would be worse off.

Key conclusions

Migration can be largely beneficial for EU long-term economic growth: it increases labour supply, favours capital accumulation and it has an overall positive effect on savings rate and productivity levels as it reduces the EU population ageing. This analysis can be relevant for the on-going EU debate regarding migration policy.

Figure B: GDP and GDP per capita projections



1 Introduction

The study of the interactions between the economy, the energy system and the environment is one of the main policy support activities of the Joint Research Center, using quantative tools like the global energy model POLES or the GEM-E3 economic multi-sector model. The analysis of climate change actually requires a long-term framework where demography is a key driver. Demographic trends directly affect the long-term evolution of the economic system, with effects on the energy system and the environment. This article focuses on the relationship between demographics (migration) and economic growth.

Since the 1990s, net migration in Europe has played a prominent role as a driver of EU population change and nowadays explains most (i.e. up to 80% in the last few years) of the overall EU population growth. Statistics also support the evidence that migration counteracts population ageing in Europe, due to increasing life expectancy and decreasing fertility rates, and for both reasons might have profound impacts on the overall economic performance in EU Member States. An ageing population impacts negatively on growth, via savings, productivity, consumption, taxation, and pensions.

An interesting overview of the socioeconomic implications of population ageing is given in Harper (2014). Existing literature on this topic provides indications of the effects of migration and ageing on the economic activity (GDP), comparing the adverse vs. positive consequences. For instance, in a recent paper Sanchez-Martinez et al. use a coupled overlapping generation and computable general equilibrium (OLG-CGE) model of the UK to quantify the long-term growth impacts of migration. The authors explore the implications of a case in which net migration to the UK would be reduced by a factor of two, in line with the policy proposal of the Conservative Party. They find that by 2060 GDP and GDP per capita would fall by 11% and 2.7%, respectively, compared to the baseline (Sanchez-Martinez et al., 2013). Holtz-Eakin comes to similar conclusions for the US, when he quantifies the economic benefits of the immigration reforms proposed in 2013 to the US Congress (increasing immigration to the US). The author finds that in the near term the reform would raise the GDP growth rate by 0.9 percentage points, increase GDP per capita and reduce the cumulative federal deficit (Holtz-Eakin, 2013). Fehr et al. analyse to what extent migration can be seen as a solution to the adverse economic effects of demographic transition in developed countries. Using a three-region (US, Europe and Japan) dynamic general equilibrium life-cycle model, the authors find that the positive effects of migration due to an increase of labour supply and faster capital accumulation are offset by a decline in real wages and an increase of the demand for public goods and government welfare (Fehr et al., 2004).

Migration in the EU Member States has also become an urgent humanitarian issue because of e.g. the war in Syria and the overall extremely fragile socioeconomic condition in the Middle East which have led to a large increase in the number of refugees to Europe. More recently, Kancs and Lecca used the European Commission's RHOMOLO CGE regional model to assess the macroeconomic implications of different scenarios of refugees' integration in Europe. The authors find that the initial pressure on public finances due to the costs of integration is offset in the medium-long term by the associated socioeconomic and fiscal benefits (Kancs and Lecca, 2016).

Regarding the effects of population ageing, Lindh and Malmberg studied how and to what extent the demographic age structure affects the long-term GDP growth rates in the OECD countries. The authors apply an augmented neoclassical growth model to OECD data from 1950 to 1990 and confirm the micro-economic evidence of a hump-shaped relationship between age and growth rates of GDP per worker, with the largest positive contribution at the middle-age cohort (Lindh and Malmberg, 1999). Skirbekk conducts a literature survey and concludes that individual productivity starts to decrease from 50 years of age (Skirbekk, 2004). However, Acemoglu and Restrepo arrive at different conclusions. These authors conduct a panel data analysis for 169 countries in the 1990-2015 period and find no evidence of an inverse relationship between ageing and economic growth. Acemoglu and Restrepo emphasize the evidence that countries undergoing fast ageing have also adopted more robots, which might explain the absence of such an inverse relationship (Acemoglu and Restrepo, 2017).

The objective of this study is to explore the economic consequences of a hypothetical scenario in which there would not be migration from now to the year 2060. Effects like the implications in terms of economic growth (GDP) can be significant if the scale of the migration assumption in the population projections is large. The perspective of the analysis is long-term, so for instance refugees problems are not dealt with.

In that respect, Eurostat has recently published demographic projections (Eurostat, 2017) that include a sensitivity case where net migration flows towards the individual EU countries until the year 2080 are set to zero. From these projections, it can be estimated that without migration the EU population would be substantially reduced in the 2015-2060 time horizon: by 14% in 2060.

The MaGE econometric growth model is used to ascertain the role of migratory flows in the long term evolution of economic growth. Changes in migration would modify the labour supply of the economy and the age structure of the population. The model analyses how those changes would affect economic growth, considering also the effects on savings and domestic investments.

Section 2 presents the demographic projections used in this paper. Section 3 explains the economic growth model. Results are discussed in Section 4, while Section 5 concludes.

2 Eurostat population scenarios

Two demographic scenarios are considered in this study: "Main scenario" and "No migration". The "Main scenario" includes both resident population and population with foreign background, i.e. migrants and their descendants, and maintains the recent developments in population trends (business as usual). On the contrary, the "No migration" scenario includes only resident population and population with a EU background, but does not include the stock of population with extra-EU background. More information on how the scenarios are constructed is given in the appendix.

2.1 Population and working age projections

Table 1 shows the projections of the population and working age population under the two scenarios ("Main scenario" and "No migration") for each of the EU countries and the EU as a whole. In 2013, the total EU population was 505 million. In 2060 it is projected to be around 525 million under the "Main scenario", i.e. roughly a 4% increase compared to the 2013 figures, and around 450 million under the "No migration", i.e. 14% lower than in the "Main scenario". Inward international migration to Europe is therefore expected to contribute substantially to the overall EU population by 2060.

Yet the EU aggregate figures hide large variability across EU Member States. For the largest population countries, compared to the 2013 population, the "Main Scenario" assumes a strong population growth in UK (24%) and France (15%), and a lower increase in Spain (6%). Germany is assumed to have a stable population pathway, while Poland could lose 14% of its population and Italy 5%.

When the stock of extra-EU migrants is subtracted from the "Main scenario", all big countries, with the exception of Poland (for which almost no immigration is projected) would experience large population reductions, relative to the 'Main scenario' in 2060: 18% for Spain, 14% for France, 11% for UK, 22% for Italy and 23% for Germany.

The working age population, i.e. the population comprised between 15 and 64 years old, is projected to decrease by 12% in the "Main scenario" and by 29% in the "No migration", compared to 2013. The "No migration" scenario would mean a 20% reduction when compared to the "Main scenario", for the year 2060.

Again the member states would see relatively larger changes in the working age distribution: 25% for Spain, 15% for UK, 17% for France, 31% for Italy and 32% for Germany.

2.2 Population projections and age distribution

The change in the overall population is not the only difference between the two scenarios; in fact, according to the Eurostat projections, the ageing of the population would accelerate without migration.

Figure 1 shows the population pyramid, with the age distribution of the population in 2013, in blue line, and in 2060 under the two scenarios, blue area for the "Main scenario" and darker blue area for the "No migration". In both scenarios the population over 80 is projected to increase substantially relative to 2013. The share of the migration in the total population grows with the younger cohorts.

Figure 2 shows the evolution of the population and the dependency ratio (defined as the ratio between non active, i.e. too old or too young to work, and the active population between 15 and 64 years old). The ratio rises substantially: from a value of around 50 by the befinning of the XXI century to close to 80 in the "Main Scenario" and to around 90 in the "No migration" case. Ageing of the population is confirmed by the gradual increase of the median age of the population. In 2013 median age of EU28 population is registered to be 41 for males and 43 for females. In 2060 median age is expected to increase to 48 and 45 for females and males, respectively, in the "Main scenario", and to 51 and 47 in the "No migration".

Table 1: EU countries population and working age population projections for 2060 under the "Main scenario" and the "No migration" scenarios.

	Total population (thousands)			Active population aged 15 to 64 (thousands)		
	2013	2060 (Main scenario)	2060 (No migration)	2013	2060 (Main scenario)	2060 (No migration)
Austria	8,452	10,231	7,877	5,705	5,838	4,036
Belgium	11,162	13,581	11,988	7,304	7,946	6,702
Bulgaria	7,285	5,226	5,001	4,899	2,755	2,583
Croatia	4,262	3,534	3,428	2,852	1,999	1,921
Cyprus	866	1,012	907	610	577	492
Czech Republic	10,516	10,308	9,250	7,188	5,603	4,721
Denmark	5,603	6,756	5,793	3,625	3,956	3,207
Estonia	1,320	1,221	601	875	666	249
Finland	5,427	5,655	5,152	3,517	3,218	2,810
France	65,600	75,525	64,848	41,883	43,646	36,190
Germany	80,524	80,832	62,565	53,126	44,960	30,657
Greece	11,004	8,295	6,179	7,180	4,365	2,835
Hungary	9,909	9,120	8,870	6,776	5,077	4,870
Ireland	4,591	5,898	5,414	3,024	3,352	2,935
Italy	59,685	56,949	44,670	38,697	31,046	21,566
Latvia	2,024	1,427	606	1,352	721	246
Lithuania	2,972	1,838	1,791	1,993	943	914
Luxembourg	537	993	850	371	585	475
Malta	421	519	435	288	288	220
Netherlands	16,780	19,323	17,876	11,077	11,333	10,160
Poland	38,063	32,848	32,218	26,843	17,269	16,719
Portugal	10,487	8,552	7,573	6,904	4,602	3,763
Romania	20,020	15,699	15,487	13,622	8,489	8,306
Slovak Republic	5,411	5,115	5,063	3,870	2,755	2,713
Slovenia	2,059	2,000	1,667	1,409	1,097	831
Spain	46,728	49,557	40,855	31,376	27,170	20,379
Sweden	9,556	13,285	11,518	6,116	7,682	6,325
United Kingdom	63,905	79,339	70,778	41,658	46,390	39,436
EU28	505,167	524,636	449,264	334,142	294,331	236,261

Figure 1: Population age distribution in 2013 (blue line) and in 2060 under the "Main scenario"(light blue area) and "No migration" scenarios (dark blue area)

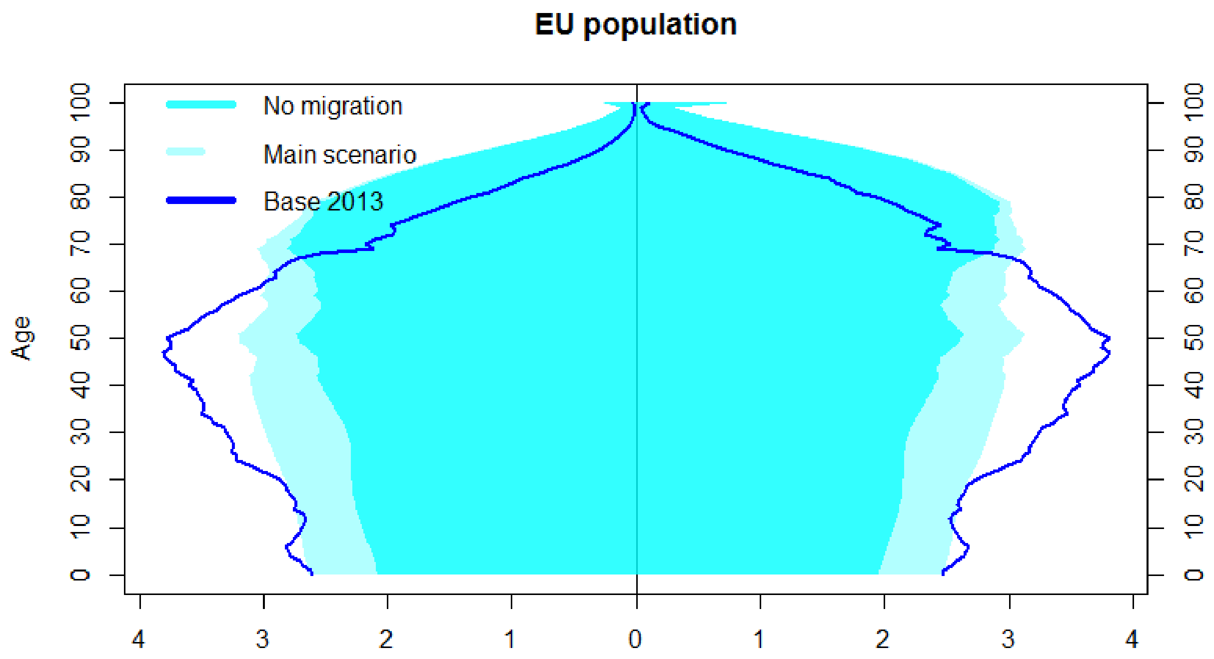
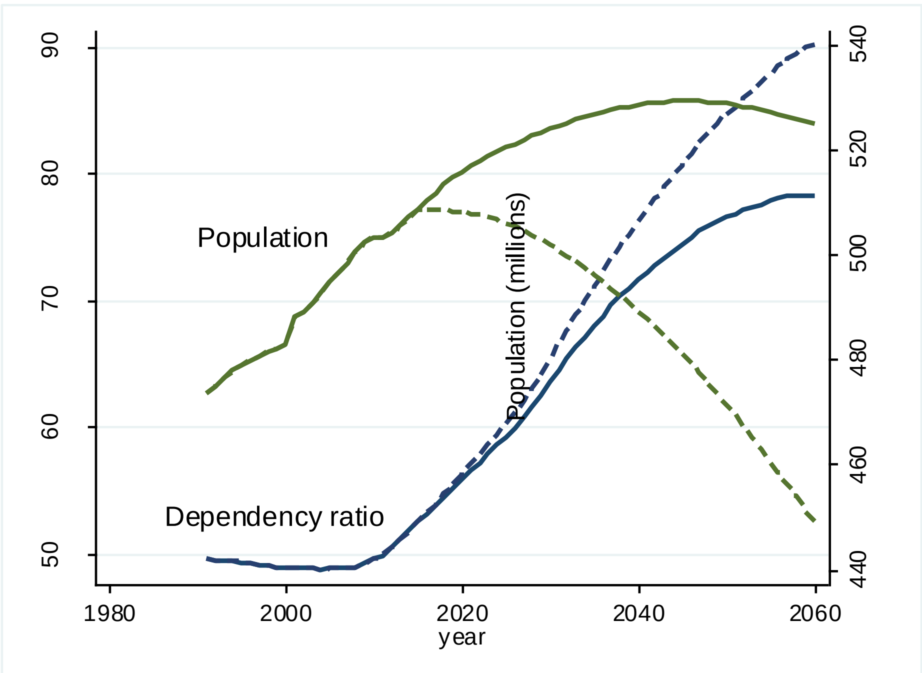


Figure 2: Population and dependency ratio projections for EU in the "No migration" (dotted lines) and the "Main scenario" (solid lines)



3 Methodology

The economic impact of migration is quantified with the growth model MaGE, which is an econometric long term growth model for the world economy, estimated with data from the World Bank and the United Nations (Fouré et al., 2013). The model explicitly considers both the impact of migration on labour supply and on the age structure of the population affecting savings and domestic investments (see Annex 2 for a detailed description of the model equations).

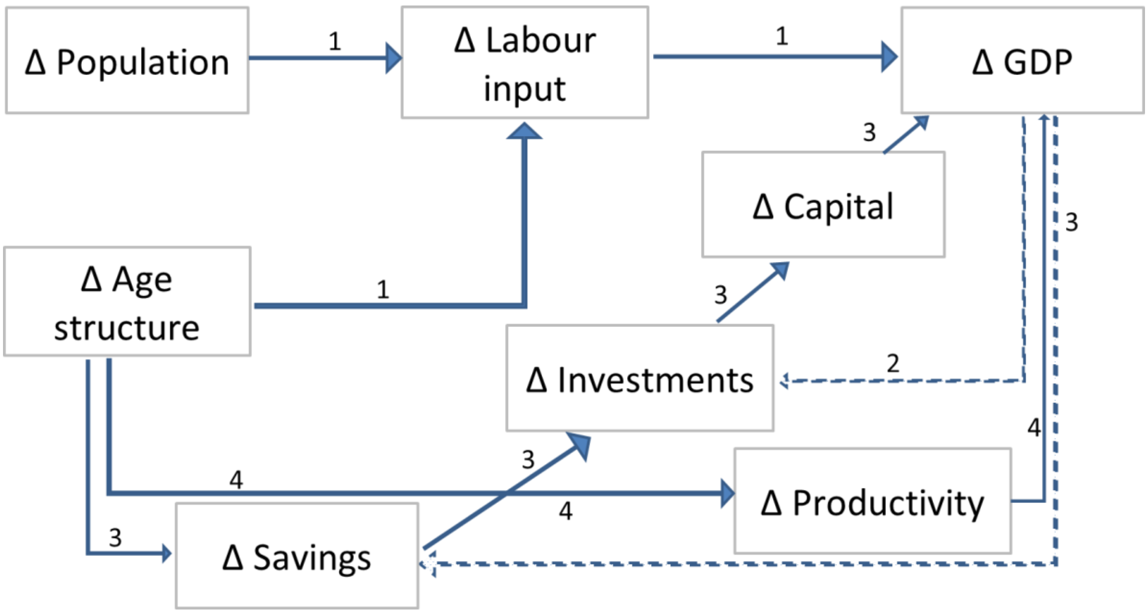
The model captures the effects of migration on long term economic growth via four transmission mechanisms. **Figure 3** represents them in a schematic way (the numbers next to the arrows indicate the transmission mechanisms).

1. Labour: migration impacts on the overall working age population and the labour supply and, therefore, output;
2. Capital: a gradually shrinking output lowers investments, which reduces the capital stock, decreasing output in the subsequent period;
3. Savings: a change of the age structure affects the saving rates and therefore investments.
4. Productivity: a change of the age structure and of the proportion of unskilled population affects productivity.

It is interesting to note the dynamic nature of the model induced mainly by the process of capital accumulation. The Capital mechanism introduces significant feedback effects on the overall output growth. The capital stock of the current year is equal to the stock of the previous year minus the depreciated stock plus investments. As investment is computed as a fraction of total output, a lower output due to lower Labour availability leads to a proportionate reduction in investment, then to a reduction of the capital stock and in turn to a lower output in the next period. Moreover, the fraction of the output that corresponds to investment, i.e. the investment rate, is calculated as a function of savings, which shrink due to the ageing population and exacerbates the overall effect on the capital stock and on the total output.

The four transmission mechanisms described in this section are assessed in order to have a decomposition of the overall effect of total output.

Figure 3: schematic description of the modelling framework



It is assumed that the participation rates to the labour market are the same both in the "Main scenario" and in the "No migration". Moreover, there are two other key assumptions in the model: firstly, retirement age is at 65 for all countries; secondly, in absence of origin/destination information about the migration flows, the skill structure of migrants is assumed to be the one of the resident population. One scenario will explore the signficance of this assumption.

Economic output or GDP is considered as potential output, that is, without the influence of the business cycle.

4 Results

4.1 Definition of scenarios

The growth model described in the previous sections is used to quantify the impact on total output and output per capita, both at country level and for the EU as a whole, in the "Main scenario" and in a set of four cases for the "No migration" scenario plus one sensitivity case for the "Main scenario".

Without migration there would be a general reduction in EU output, similar in scale to the reduction in working age population. The overall output reduction can be decomposed into different components, corresponding to the four macroeconomic transmission mechanisms discussed in the previous section, i.e. labour supply, capital accumulation, savings and productivity. Therefore, in order to quantify the contribution of each of these components, the output projections corresponding to the "Main Scenario" are compared to those obtained with the population projections of the "No migration" in a set of four different configurations of the model, where the macroeconomic transmission mechanisms are added one by one.

1. "Labour": only labour supply is changed;
2. "Capital": the effect on capital accumulation is added;
3. "Savings": the effect of age structure on savings rates is added;
4. "Productivity": the effect of ageing and proportion of unskilled population on productivity growth are added;

The output projections for these four cases are cumulative. For instance, those obtained in the case "Capital" include both the effects of labour supply shortage and capital accumulation; the case "Savings" includes the effects of the two previous ones and so on.

An additional scenario is also added in order to test the sensitivity of the model to one of the basic assumptions regarding the skill structure of the migrants. In the "Main scenario" both nationals and non-nationals are assumed to have the same skill structure and therefore to contribute equally to the deployment of capital and labour productivity. In the "Main scenario (unskilled) " case it is assumed that all migrants and the population stock of non-nationals are unskilled and thus reduces the productivity growth rate.

4.2 GDP results

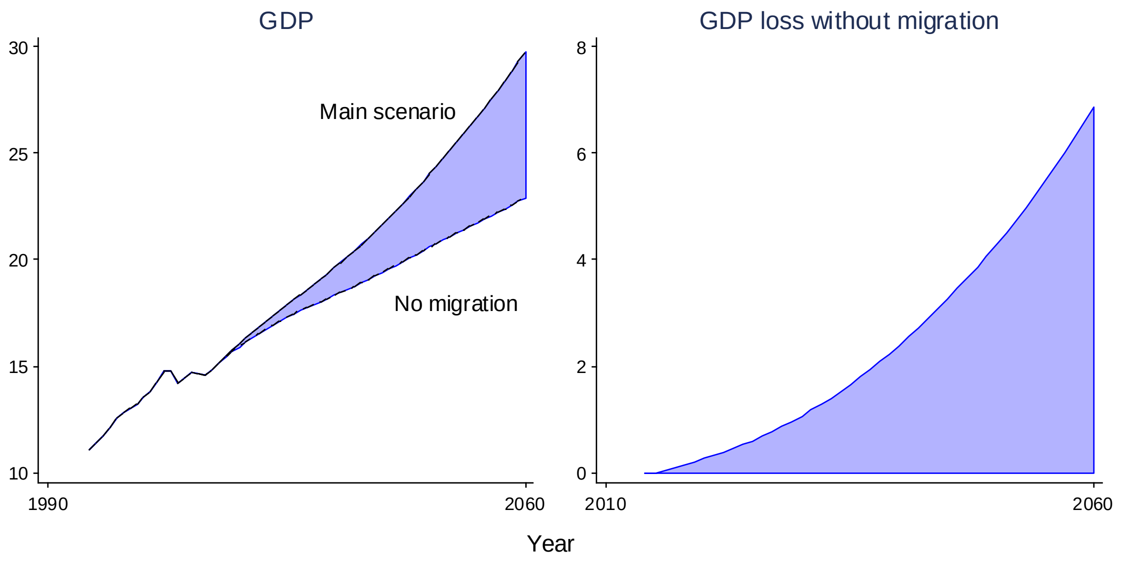
Table 2 presents the GDP values for the reference year and the "Main scenario", with the changes in the GDP of the mentioned cases with respect to the "Main scenario" (i.e., "Main scenario (unskilled) ", "Labour", "Capital", "Savings", "Productivity"). The EU GDP would fall by 23% without migration (the "Productivity" case). The "Main scenario" with unskilled migrants would reduce GDP by 3%, not a big difference.

Table 2: EU and country total output projections for 2060 under the "Main scenario", "Main scenario (unskilled)", "Labour", "Capital", "Savings", "Productivity"

	2013 Reference (bill. US$)	Main scenario (bill. US$)	% change relative to the main scenario in 2060				
			Main scenario (unskilled)	Labour	Capital	Savings	Productivity
Austria	343	765	-5	-24	-28	-29	-35
Belgium	416	1,007	-7	-13	-15	-16	-20
Bulgaria	34	61	0	-5	-6	-6	-6
Croatia	44	220	-1	-3	-4	-4	-4
Cyprus	15	24	-2	-10	-12	-12	-20
Czech Republic	143	284	-3	-12	-15	-15	-18
Denmark	255	538	-4	-14	-17	-18	-23
Estonia	16	55	1	-54	-60	-60	-59
Finland	209	506	-2	-10	-12	-12	-16
France	2,297	5,244	-2	-13	-17	-17	-18
Germany	3,069	5,159	-2	-24	-28	-28	-35
Greece	191	279	0	-29	-33	-33	-34
Hungary	107	202	-1	-3	-4	-4	-5
Ireland	213	525	2	-10	-12	-12	-18
Italy	1,666	2,236	-2	-25	-29	-29	-33
Latvia	18	46	3	-60	-67	-67	-63
Lithuania	29	63	7	-2	-3	-3	-3
Luxembourg	45	139	-7	-16	-19	-20	-24
Malta	7	14	-2	-20	-24	-24	-31
Netherlands	694	1,640	-2	-8	-10	-10	-13
Poland	405	723	-1	-3	-3	-3	-4
Portugal	171	199	-1	-14	-17	-17	-21
Romania	101	153	0	-2	-2	-2	-3
Slovak Republic	82	168	0	-1	-2	-2	-2
Slovenia	37	76	-1	-20	-24	-24	-27
Spain	1,171	2,001	-3	-20	-24	-24	-28
Sweden	414	1,127	-5	-13	-16	-16	-22
United Kingdom	2,393	6,325	-6	-11	-14	-14	-19
EU28	14,586	29,778	-3	-16	-19	-19	-23

Figure 4 shows the time path of the EU GDP and output loss projections for the "Main scenario" and the "No migration". The output loss is estimated to amount to be around 7 trillion US$ by 2060. The cumulative output loss for the entire projection period would be 47 trillion US$, once discounted at a 3% rate. The annual economic growth rate for the whole period would fall from 1.5% to less than 1%. Moreover, the 2043 EU total output that could be reached with migration would be only attained in 2060 without migration; that would mean losing almost 20 years of economic growth. The GDP losses in Table 2 (referring to the year 2060) are the result of the direct effect of that year and the indirect dynamic effects of the previous years. The indirect are induced by the dynamic nature of the economic system, which is captured in the model with the recursive interaction between some of the variables, e.g. investments and capital, investments and savings and investments and GDP.

Figure 4: EU total output projections



At country level (**Table 2**), regarding the six biggest economies Germany would have the largest GDP loss, 35%. Italy, Spain, UK and France would have a drop equal to 33%, 28%, 19% and 18% respectively, while Poland would have a relatively small 4% reduction. Belgium and Austria would have also a big GDP loss (20% and 35% respectively). Latvia and Estonia would see the highest GDP loss within the EU (63% and 59%). Some countries would have smaller GDP losses, like Romania, Slovak Republic, Bulgaria, Hungary.

It is interesting to note that, as a rule of thumb, the model predicts a bit more than one percentage point less of GDP for each percentage point less of labour (Table 3). With an output elasticity of Labour equal to 0.7 (a standard assumption in this type of economic models), one unit less of Labour should produce approximately a loss of 0.7 units of output. However, the model also captures the effect on GDP due to the other three transmission mechanisms: a slower capital accumulation and the effects of less savings and lower productivity due to the ageing population; these additional mechanisms add a 30% to 40% to the overall impacts on GDP.

Only for Estonia and Latvia, the percentage loss of GDP is lower than the percentage loss of Labor. This is due to the age distribution of their population with extra-EU background, which has the peak for the age range of 55 to 69 years. The "No migration" scenario implies a younger population which triggers positive effects on GDP via higher productivity growth and more savings that mitigate the negative effects on GDP due to the Labor input reduction.

Table 3: Labour and GDP in the "No Migration" case versus the "Man scenario" (% change)

	GDP (% loss)	Labour (% loss)
Austria	-35	-32
Belgium	-20	-17
Bulgaria	-6	-7
Croatia	-4	-4
Cyprus	-20	-14
Czech Republic	-18	-17
Denmark	-23	-20
Estonia	-59	-67
Finland	-16	-13
France	-18	-19
Germany	-35	-32
Greece	-34	-38
Hungary	-5	-4
Ireland	-18	-13
Italy	-33	-34
Latvia	-63	-73
Lithuania	-3	-3
Luxembourg	-24	-22
Malta	-31	-28
Netherlands	-13	-11
Poland	-4	-4
Portugal	-21	-20
Romania	-3	-2
Slovak Republic	-2	-2
Slovenia	-27	-27
Spain	-28	-27
Sweden	-22	-18
United Kingdom	-19	-16
EU28	-23	-21

4.3 GDP per capita results

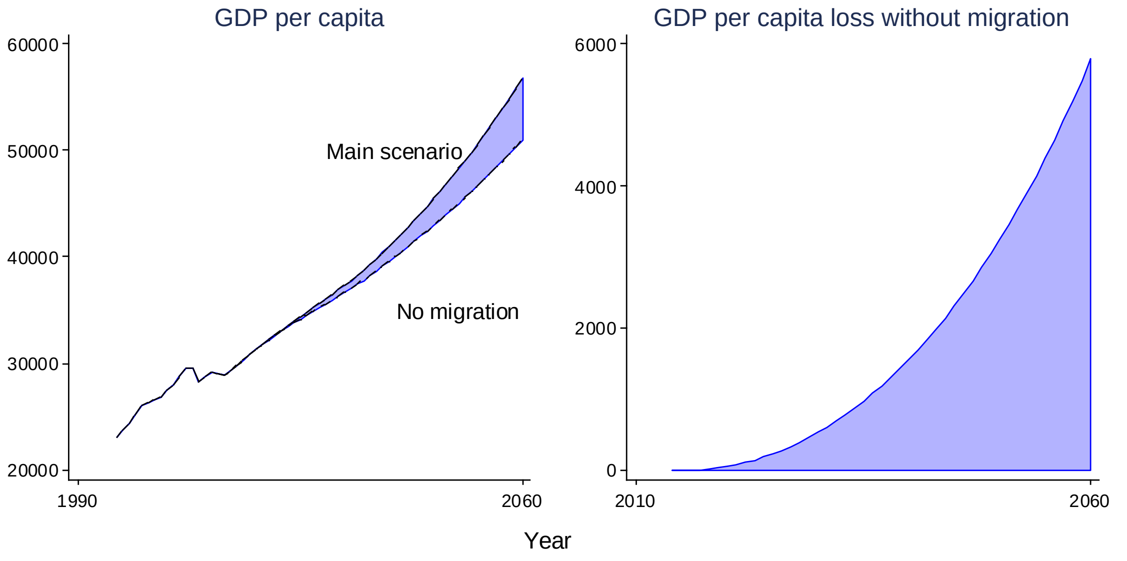
Table 4 presents the output per capita changes for each country and the EU as a whole, with the contribution of each macroeconomic transmission mechanism (analysed with the different configurations of the model) to the overall loss of per capita output. The largest part of the loss is due to a slower accumulation of capital and to the drop in the productivity growth rate.

The overall decrease and ageing of the EU population would cause the EU output per capita to be around 10% lower in 2060 in the "No migration" case than in the "Main scenario"; it would fall from around 57,000 US$ under the "Main scenario" to around 51,000 US$ in the "No migration" case including all the macroeconomic effects, i.e. "Productivity" case. Figure 5 shows their time evolution and the yearly losses.

Table 4: EU and country output per capita projections for 2060 under the "Main scenario", "Main scenario (unskilled)", "Labour", "Capital", "Savings", "Productivity"

	2013 Reference (bill. US$)	Main scenario (bill.	% change relative to the main scenario in 2060				
			Main scenario	Labour	Capital	Savings	Productivity
Austria	40,606	74,812	-5	-1	-7	-7	-15
Belgium	37,308	74,165	-7	-1	-4	-5	-9
Bulgaria	4,708	11,757	0	0	-1	-1	-2
Croatia	10,353	62,266	-1	0	-1	-1	-1
Cyprus	17,392	23,270	-2	0	-2	-2	-11
Czech Republic	13,636	27,505	-3	-2	-5	-5	-8
Denmark	45,531	79,695	-4	0	-4	-4	-10
Estonia	12,195	45,186	1	-6	-19	-19	-17
Finland	38,535	89,562	-2	-1	-3	-3	-8
France	35,011	69,428	-2	1	-3	-3	-5
Germany	38,114	63,820	-2	-2	-7	-7	-16
Greece	17,327	33,657	0	-4	-10	-11	-12
Hungary	10,792	22,150	-1	0	-1	-1	-2
Ireland	46,392	88,950	2	-1	-4	-4	-10
Italy	27,920	39,270	-2	-5	-10	-10	-15
Latvia	8,682	32,063	3	-6	-22	-22	-14
Lithuania	9,846	34,156	7	0	0	0	0
Luxembourg	82,985	139,587	-7	-1	-6	-6	-11
Malta	16,329	27,300	-2	-5	-10	-10	-17
Netherlands	41,367	84,870	-2	0	-2	-3	-6
Poland	10,630	21,996	-1	-1	-1	-1	-2
Portugal	16,348	23,250	-1	-3	-6	-6	-11
Romania	5,043	9,746	0	0	0	0	-1
Slovak Republic	15,155	32,801	0	0	-1	-1	-1
Slovenia	17,933	38,232	-1	-4	-8	-9	-13
Spain	25,066	40,381	-3	-3	-7	-8	-13
Sweden	43,336	84,798	-5	0	-3	-4	-10
United Kingdom	37,440	79,720	-6	-1	-4	-4	-9
EU28	28,874	56,759	-3	-1	-5	-6	-10

Figure 5: EU per capita output and relative loss projections



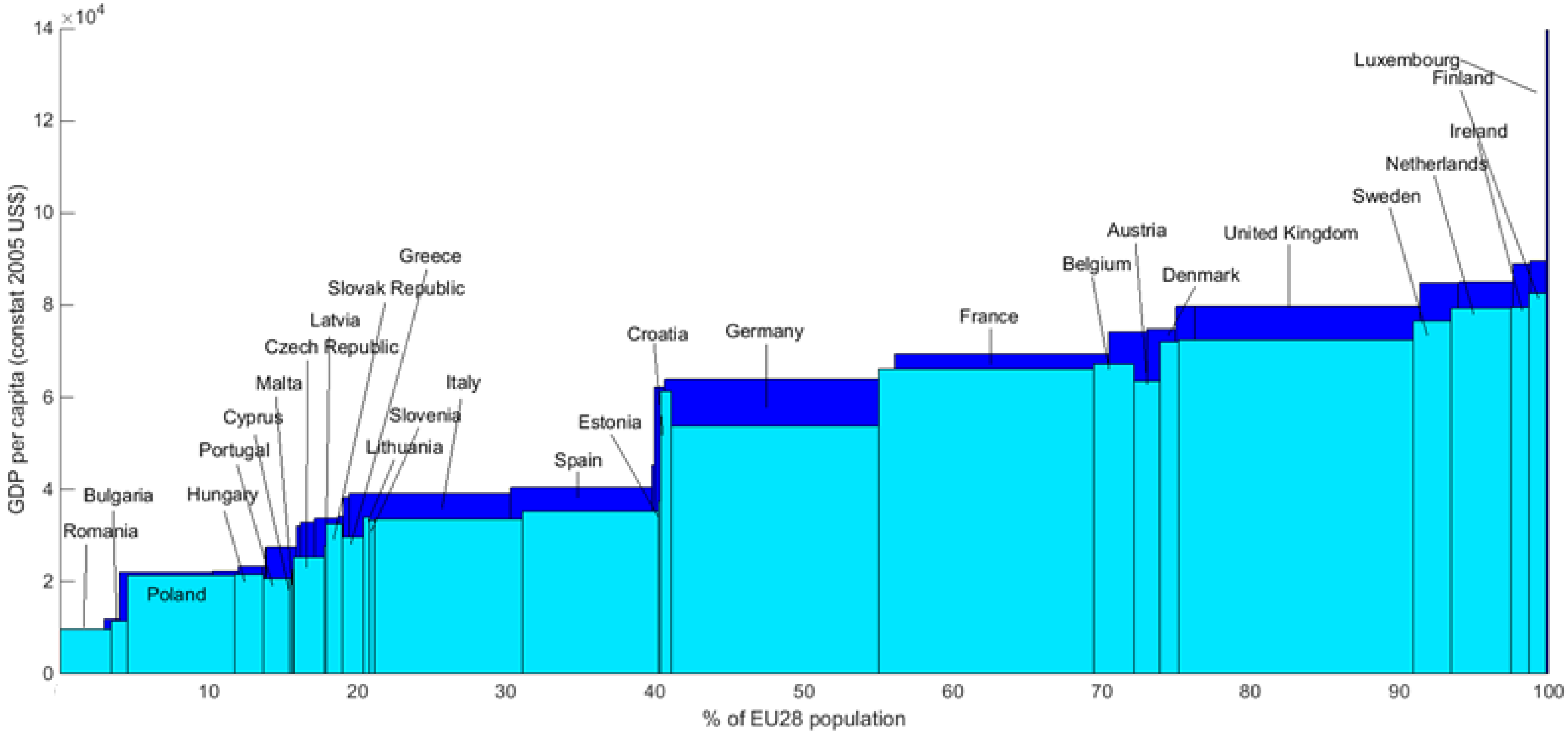
The labour supply reduction (column 'Labour') would have an overall effect on the level of EU output per capita of around 1%. However, including the other macroeconomic effects does affect the level of output per capita significantly.

The "Main scenario (unskilled)", where all migrants would have the secondary education level (rather than that of the population), would yield a level of output per capita higher than the one without migration (including the effects on capital accumulation, savings and productivity), a reduction of EU output per capita of 3.1% versus a reduction of 10%, respectively.

For most of the countries, the fall in output per capita is larger or equal to 8% and for half of the EU countries, including countries like Austria, Belgium, Spain, Italy, Germany and Sweden, could be larger or equal to 10%.

Figure 6 plots the output per capita in 2060 as projected in the "Main scenario" (dark blue areas) and in the "No migration" case (light blue areas). The horizontal axis represent the percentage of the EU population and countries are ordered from low to higher GDP per capita (left to right). The graph shows that a "No migration" scenario where labour supply, savings and productivity are affected would produce a generalized decrease of the output per capita. Assuming that the output per capita is the same for all citizens of any country, on average around 90% of the EU population would be worse off.

Figure 6: Output per capita and population shares calculated for the "Main scenario"and "Productivity"



5 Conclusions

Europe has experienced an ageing of its population over the last few decades. According to the most recent Eurostat demographic projections, ageing is expected to continue and intensify. International migration flows could mitigate the ageing population, sustain economic growth, mainly boosting working age population, and could have a significant positive impact on the European long-term economic prospects.

The present study has concluded that without migration by 2060 the EU would lose a fifth of the output that could be achieved with migration, with a 7 trillion US$ GDP loss by 2060. The cumulative output loss for the entire projection period would be 47 trillion US$, once discounted at a 3% rate. The long-term annual economic growth rate would fall from 1.5% to less than 1%. In terms of output per capita, the overall impact for the aggregate EU could be larger than 10%. Around 90% of the EU population could be worse off. The overall EU total and per capita output losses would potentially have major geopolitical consequences, jeopardising the EU economic relevance in the international arena.

The results are preliminary and focus on the total and per capita output perspectives, offering a partial, although probably a very relevant view on the topic of migration and long term development. Nevertheless, some caveats are to be considered when interpreting the results. The distribution of the total stock of population with extra-EU background across countries and for each country across age groups is maintained fixed throughout the projections period.

Other possible transmission mechanisms like how economic growth might affect migration, the age structure and the participation rates are not considered.

This study does not account either for the impacts at sectoral level. Some sectors in some countries might experience a reduction of the income per worker, due to the increase of labour supply, so that some incumbent workers could be worse off. The linkage of MaGE with a multisectoral model might help shedding light on these aspects. Moreover, this analysis could be further improved with better assumptions and additional data on the country of origin of the migrants. In this respect the matrices on the origin-destination of the migration flows published by the UN could be used in combination with the Eurostat data, in order to a have a better measurement of the skilled/unskilled proportion of the population and a more precise analysis of the effects on capital-labour productivity.

Due to the current set up of the model and to the characteristics of the input data used to modify the demographic assumptions, the present study does not take into account some other economic impacts of the migration phenomenon. For instance, key aspects to be considered relate to the fiscal impacts and also to the impacts on the social security and pension system. The analysis does not consider any cost due to the integration of the migrants, as well as it does not consider the benefits deriving from a more sustainable social security and pension system. The integration of the migrants is likely to have a short-run fiscal impact, due to increasing taxes and an increase in public education and social security costs. However, the effects could be positive in the long-run with successful integration (Melander et al., 2016).

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List of abbreviations and definitions

JRC	Joint Research Centre
POLES	Prospective Outlook on Long-term Energy Systems
GEM-E3	General Equilibrium Model for Economy-Energy-Environment
GDP	Gross Domestic Product
OLG-CGE	Overlapping Generations Computable General Equilibrium
CGE	Computable General Equilibrium
OECD	Organisation for Economic Co-operation and Development
MaGE	Macro-econometrics for the Global Economy
CES	Constant Elasticity of Substitution
ECM	Error Correction Model specification
TFP	Total Factor Productivity

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Annexes

Annex 1. Demographic scenarios construction details

The two population scenarios used in this analysis are derived from the Eurostat population projections by sex and age, with and without migration (Eurostat 2017). In particular, the projections without migration do not consider both intra-EU and extra-EU migration at country level, therefore in order to construct a "No migration"scenario for each EU countries where only the population with extra-EU background is not included, further assumptions needed to be made.

The first assumption is that the intra-EU migrants maintain in the country of destination the same fertility and mortality rates of their country of origin; under this assumption the sum across EU countries of the intra-EU migration stock is equal to zero and the difference between the overall EU population under the two scenarios is equal to the total stock of population with extra-EU background, i.e. non EU immigrants and their descendants.

The overall stock of population with extra-EU background is allocated to each Member States according to the percentages reported in Table 5. In the absence of better data, these percentages are kept fixed throughout the projection period. We might foresee a certain degree of convergence of these percentages across countries which might give different results. However, we do not expect this convergence to give a very different picture and patterns of results.

Table 5: Shares by EU28 country of total extra-EU immigrant stock to EU28

	female (%)	male (%)
Belgium	2.1	2.1
Bulgaria	0.3	0.3
Czech Republic	1.3	1.5
Denmark	1.3	1.2
Germany	23.2	25.2
Estonia	0.8	0.8
Ireland	0.6	0.6
Greece	2.8	2.8
Spain	11.9	11.1
France	14.4	13.9
Croatia	0.2	0.1
Italy	16.3	16.2
Cyprus	0.2	0.1
Latvia	1.4	1.2
Lithuania	0.1	0.1
Luxembourg	0.2	0.2
Hungary	0.3	0.4
Malta	0.1	0.1
Netherlands	2.0	1.9
Austria	3.0	3.3
Poland	0.7	0.9
Portugal	1.4	1.2
Romania	0.2	0.3
Slovenia	0.3	0.6
Slovak Republic	0.1	0.1
Finland	0.6	0.7
Sweden	2.2	2.5
United Kingdom	12.0	10.7

Once computed, the stock of population with extra-EU background of each country is allocated to 18 age groups (0-4; 5-9; …; 80+ years old) according to the shares as provided by Eurostat (Eurostat 2017). Also these shares are maintained fixed thoughout the entire projection period. According to Eurostat statistics, the majority of the population with extra-EU background is comprised between 20 and 40 years of age. However, Estonia and Latvia represent an exception as for them the majority of population with extra-EU background is comprised in the range 55 to 69 years of age. The stock of population with extra-EU background for each country and 18 age groups is subtracted from the country projections of the "Main scenario" thus giving the "No migration" projections at country level.

Annex 2. The MaGE model

MaGE is an econometric long term growth model for the world economy, estimated with data from the World Bank and the United Nations (Fouré et al., 2013). The main equation of the model is a production function where Labour and Capital (which are combined to form a composite input) are imperfect substitutes for Energy. The production function also has two forms of technical change: one specifically for the productivity of Energy and the other one for the Capital-Labour composite. The Energy productivity variable is assumed to be exogenous and to follow a convergence process. Countries with higher initial Energy productivity levels grow more slowly (i.e. around 1 or 1.5% growth per year) than countries with lower initial levels, where productivity grows faster (i.e. between 2.5, 3% per year).

The capital-labour productivity variable (from now on referred as productivity) is endogenous in the model and depends on the distance from the maximum of productivity level (kept exogenous), the age structure of the overall population and the proportion of unskilled labour in the population. Labour supply to production is exogenous. For this analysis, the labour assumptions of MaGE for the EU countries (corresponding usually to those of the UN World Population Prospects), are replaced by the Eurostat population scenarios (Eurostat, 2017). Both the male and female participation rates to the labour market are exogenous in these scenarios; for males they are taken from the official projections of the International Labour Organization (ILO) while for females they are projected on the basis of an econometric relation between female participation rates and education. The education levels for each country, on which the proportion of skilled vs. unskilled labour depends on, are projected as a pure convergence process following a logistic function (Fouré et al., 2013).

Another relevant part of the model is the set of equations relating the savings rates to the age structure of the population, according to the Modigliani's life cycle hypothesis, and the Feldstein-Horioka equation that associates domestic savings with domestic investments (Modigliani and Brumberg, 1954; Deaton, 2005; Feldstein and Horioka, 1980). MaGE departs from the extreme assumptions of a financially closed economy or of perfect capital international mobility and assumes that domestic savings only finance a part of the domestic investments, depending on the degrees of openness of the economy. Investments eventually contribute to the capital stock formation of the economy, represented in the model with a recursive equation where the capital stock in the current year depends on the capital stock of the previous year, minus the stock that has depreciated plus the investments.

The demographic projections are therefore a fundamental input to the model as the labour availability to production, the savings rates of the economy and productivity depend on the overall population, its age structure and the proportion of unskilled labour in the economy.

The most relevant parameters of the model are:

1. the output elasticity of the labour input;
2. the relationship between productivity and both the age structure and the proportion of un-skilled workers;
3. the relationship between the saving rates and the age structure;
4. the degree of openness of the economy;
5. the rate of depreciation of the capital stock.

The output elasticity to Labour is assumed to be 0.7, which means that if labour supply decreases by 10% total output decreases by 7%. In the model, Labour is combined with Capital in a way that assumes perfect substitution between the two factor inputs, as well as constant return to scale, which implies that the output elasticity for Capital is equal to 0.3.

The savings rate depends on the level of the income per capita and the age structure, the latter is modelled with a non-linear mathematical formulation.

The degree of financial openness (represented by the elasticity between savings and investment rates) is econometrically estimated to be equal to 0.19 if the country is not a member of the OECD or 0.52 otherwise. Therefore, EU countries being part of the OECD are relatively more dependent on domestic savings.

The last relevant parameter is the depreciation rate for the capital stock, which is equal to 0.06 for all countries. Each year the capital stock loses 6% of its value, a fraction that is replaced by the investments that are calculated as a share of the available national income.

The next equations represent the core functioning of the model. The following text explains each of them in turn.

$$\boldsymbol{Y_t} = \{[\boldsymbol{A_t K_t^{\alpha} L_t^{1-\alpha}}]^{\rho} + [\boldsymbol{B_t E_t}]^{\rho}\}^{1/\rho} \quad (1)$$

$$\boldsymbol{A_t} = \boldsymbol{e^{r_t} A_{t-1}} \quad (2)$$

$$\boldsymbol{r_t} = \ln\left(\frac{A_t}{A_{t-1}}\right) = \boldsymbol{\omega_1} + \boldsymbol{\beta_1}\left(\frac{A_{t-1}}{maxA_{t-1}}\right) + \sum_{k=1}^{K} \boldsymbol{\varphi_k d_{k,t}} + \boldsymbol{\beta_2}\, \boldsymbol{unskilled_t} \quad (3)$$

$$\boldsymbol{K_t} = (1 - \boldsymbol{\delta})\boldsymbol{K_{t-1}} + \boldsymbol{I_{t-1}} \quad (4)$$

$$\Delta\left(\frac{I}{Y}\right)_t = \boldsymbol{\omega_2} + \boldsymbol{\theta}\left\{\left(\frac{I}{Y}\right)_{t-1} - \boldsymbol{\beta_3} - \boldsymbol{\beta_4}\left(\frac{S}{Y}\right)_{t-1}\right\} + \boldsymbol{\beta_5}\Delta\left(\frac{S}{Y}\right)_t \quad (5)$$

$$\left(\frac{S}{Y}\right)_t = \boldsymbol{\omega_3} + \boldsymbol{\beta_6}\ln\left(\frac{y_{us,t-1}}{y_{t-1}}\right) + \boldsymbol{\beta_7 g_{t-1}} + \sum_{k=1}^{K} \boldsymbol{\lambda_k d_k\, g_{t-1}} \quad (6)$$

$$\boldsymbol{g_t} = \Delta \boldsymbol{Y_t} - \Delta \boldsymbol{Pop_t} \quad (7)$$

The core of the model is a two-level Constant Elasticity of Substitution (CES) with two different types of augmenting technical progress (related to capital-labour and energy); it is used in other similar growth models as an improvement relative to the simpler Cobb-Douglas function representation (Van der Werf, 2008; Markandya and Pedroso-Galinato, 2007). In the first level, output (GDP, represented by $\boldsymbol{Y_t}$) is obtained from a composite of capital (K_t) and labour (L_t) used in combination with energy (E_t). The second level is a Cobb-Douglas production function of capital and labour. Equation 1 represents the overall production function including the three factors of production and the two forms of technical change. Variable A_t, i.e. capital-labour productivity, grows annually at a rate equal to r_t (Equation 2), which is explained in the present analysis by equation 3. The growth rate of capital-labour productivity depends on the distance to the frontier $\frac{A_{t-1}}{maxA_{t-1}}$, on the age structure of the population $d_{k,t}$ and the proportion of unskilled population $\boldsymbol{unskilled_t}$ calculated as the part of the population holding up to a diploma of secondary education.

In order to have a parsimonious representation of the age structure of the population, we use the method proposed by (Fair and Dominguez, 1987); the $d_{k,t}$ with *k* equal to 3 are the parameters of a polynomial representation of the age of the population as proposed in the cited paper. Equation 4 refers to the accumulation of capital stock that depends on the depreciation rate δ, which is assumed constant over time, and the previous period investments I_{t-1}. Investments share growth rates $\Delta\left(\frac{I}{Y}\right)_t$ are explained in equation 5 as a function of the saving rate $\left(\frac{S}{Y}\right)_{t-1}$ with an Error Correction Model specification (ECM, Engle and Granger, 1987). The saving rate is projected with equation 6 as a function of $\frac{y_{us,t-1}}{y_{t-1}}$, i.e. country GDP per capita relative to the US level, g_{t-1} growth of GDP per capita, $d_{k,t}$ age structure of the population using the same variables as in equation 3 and the interaction between these last two covariates. The last equation (number 7) refers to the variable g_t growth of GDP per capita.

In order to account for the effects of migration on productivity growth rates, the equation of MaGE for this variable has been replaced with an equation that includes as explanatory variables the demographic structure, the distance to the maximum productivity level and the proportion of unskilled population. We present further details for this part of the model in Annex 3.

Annex 3. Capital-labour productivity equation

The equation for capital-labour productivity has been replaced in this version of the MaGE model with one that accounts for the effects of the age structure of the population. This modification intends to capture the possible association between the age structure of the population and productivity.

For instance, Feyrer (2007) looks at the correlation between the age structure of the population and different measures of productivity. He found that the age cohort comprised between 40 and 49 is the one with the largest positive impact on productivity. Feyrer uses these results to explain the productivity boom occurred in the US during the seventies and found that 2% of that productivity increase was explained by the entry of the baby boom into the workforce (Feyrer, 2007). More recently, Aiyar et al. and Liu and Westelius from the IMF, explored the same research topic for Europe and Japan respectively (Aiyar et al., 2016; Liu and Westelius 2017). Aiyar et al. found that in Europe, workforce ageing has negative impacts mainly via the effect on Total Factor Productivity (TFP) growth. They also estimated that the expected workforce ageing could reduce the TFP growth by an average of 0.2 percentage points every year for the next two decades. Westelius et al. conducted a similar analysis for Japan and also found that workforce ageing slows down TFP productivity growth. In particular they found that in Japan, the shift in the age distribution occurred between 1990 and 2005 reduced annual TFP growth by 0.7-0.9 percent (e.g. if TPF was growing at 1%, it would grow at 0.1 to 0.3%).

In this section we present and discuss the result of the estimation of the capital-labour productivity equation (Eq.3). As dependent variable we use the growth rate of capital-labour productivity, the latter calculated as a Solow residual from the CES production function by assuming firms profit maximization. We then calculate the growth rates of the Solow residual as the first difference in logarithms. The covariates of Eq. 3 are the first lag of the dependent variable, the distance of a country's Solow residual from the average of the Solow residuals of the four best performing countries, which is assumed as the technological frontier, the proportion of unskilled population over total population and a measure of the age distribution of the population that uses a polynomial representation as explained in (Fair and Dominguez, 1987).

The data used for the estimation are taken from the UN population statistics for the age structure of the population, e.g. medium variant of World Population Prospects: The 2015 Revision, and from Barro and Lee for education and skilled unskilled population (Barro and Lee, 2013; United Nations et al., 2015). The proportion of unskilled population corresponds to the part of the population that has attained secondary education or less; the data for of education attainment are from the Barro and Lee dataset (2010, revision 1.2) and are available for five year intervals from 1950 to 2010. For this analysis the education data have been linearly interpolated to have yearly data in order to match the rest of the dataset.

The estimated model also includes time and country dummies to account for specific year shocks or permanent differences between countries respectively. The new equation has been estimated using a panel data for the EU countries from 1960 to 2010.

Table 6 presents econometric results of the estimation of the parameters of the models. The parameters of the equations for the Feldstein-Horioka model, i.e. the relationship between investments and savings, and the equation for the saving rates were already part of MaGE, while the parameters for the capital-labour productivity equation have been estimated for this specific analysis.

We estimated the model using a sample EU countries plus the US. The model specification does not show a good statistical fit for a larger sample with a global geographical coverage, meaning that this model specification is not able to explain TFP growth dynamics for a very heterogeneous sample. However, when the sample is restricted to the OECD countries only or to EU and USA together, the fit improves substantially. The estimated parameters have all the expected sign. The reported standard errors are robust to both heteroscedasticity and panel serial-correlation. The response to an increase of the proportion of unskilled population is negative (Di Maria and Lazarova, 2012), while the parameters for the age structure of the population are consistent with the findings in (Feyrer, 2007), young population in age cohort 30-35 and old population, i.e. above 55 years old, are the those most contributing to productivity growth.

Table 6: Econometric results

	1 Feld. Horioka	2 Savings	3 Capital-Labour prod.
β_5 (growth sav. rate)	0.644*** (-0.024)		
θ (ecm)	-0.196*** (-0.017)		
ω_2	-0.001** (-0.001)		
β_6 (GDPcap. rel. US)		0.118*** (-0.022)	
β_7 (GDPcap. growth)		0.857*** (-0.201)	
λ_1 (dem1 x GDPcap. growth)		-9.955*** (-2.954)	
λ_2 (dem2 x GDPcap. growth)		1.856*** (-0.478)	
λ_3 (dem3 x GDPcap. growth)		-0.088*** (-0.021)	
ω_3		0.141*** (-0.006)	
LDV1 (lagged dep. var. 1st)			0.370*** (-0.0381)
LDV2 (lagged dep. var. 2nd)			0.0745** (-0.0266)
β_1 (distance)			-0.0819*** (-0.00842)
β_2 (unskilled)			-0.0104* (-0.00494)
φ_1 (dem1)			0.293** (-0.0983)
φ_2 (dem2)			-0.0377* (-0.0151)
φ_3 (dem3)			0.00137* (-0.000647)
ω_1			-0.00521 (-0.0161)
R-sq	0.418	0.089	0.5146 (Adj.)
N	1302	1097	1015

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: projected participation rates for male and female population aged from 15 to 64 for each EU country

	2013		2020		2040		2060	
	female	male	female	male	female	male	female	male
Austria	65	77	66	76	67	75	67	73
Belgium	58	69	59	69	61	70	62	69
Bulgaria	57	69	57	70	54	67	55	69
Cyorus	63	77	64	78	61	77	64	77
Czech Republic	57	73	59	73	55	68	57	69
Germany	68	78	68	76	70	76	71	76
Denmark	70	78	71	78	71	78	71	78
Spain	60	78	60	76	59	72	66	77
Estonia	66	76	65	75	64	72	65	74
Finland	67	72	67	72	69	74	68	73
France	61	70	61	69	64	70	67	71
Great Britain	65	77	66	78	67	77	68	76
Greece	51	73	50	71	47	67	50	69
Croatia	55	67	55	65	55	63	56	62
Hungary	50	64	51	64	49	61	50	61
Ireland	61	77	61	75	61	74	66	77
Italy	48	69	48	68	48	64	50	64
Lithuania	60	68	60	67	54	62	56	64
Luxemburg	58	70	59	69	62	69	62	66
Latvia	66	78	67	78	65	77	67	80
Malta	36	72	38	73	39	71	40	69
Nederland	70	80	72	80	75	81	77	81
Poland	53	66	53	65	49	61	50	61
Portugal	65	75	64	72	63	70	65	71
Romania	50	64	48	62	44	56	44	56
Slovakia	58	74	58	73	56	69	56	68
Slovenia	62	71	60	69	58	67	62	70
Sweden	72	78	74	79	74	79	75	80

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