ORIGINAL PAPER

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Immigration, integration and fiscal sustainability

Abstract Economic theory points out that immigration of even low-skilled immigrants may improve public finances in Western welfare states, and it is sometimes suggested that fiscal sustainability problems in Western countries caused by ageing populations could be solved by increasing immigration. We examine consequences of various immigration scenarios using the large-scale computable general equilibrium model Danish rational economic agents model describing the Danish economy. It turns out that increased immigration will generally worsen the Danish fiscal sustainability problem. Improved economic integration of immigrants and their descendants, however, may alleviate the problems of the public sector considerably.

1 Introduction

The future ageing of the population in most of the Western world will present problems—sometimes severe—for fiscal sustainability in many countries. The growing awareness of the fiscal burden associated with the demographic changes has fuelled an interest in examinations of many reform proposals which may affect sustainability in various ways. One important factor which may modify predictions of future fiscal imbalances is that of immigration. In public debates and academic research, this issue has received increased attention in recent years.

One subject of academic interest has been the impact of low-skilled immigrants upon the budget in the long run. In a redistributive welfare state, such immigrants will typically be net beneficiaries, and consequently, in a static set-up, immigration

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will be costly for and resisted by the incumbent population. Razin and Sadka (2000), however, showed that this result may not hold in a dynamic set-up which includes a pay-as-you-go pension system, a typical feature of Western welfare states. The basic point utilizes the fact that the economy has an infinite horizon, even though each of the individuals of whom it consists is finitely lived. Initially, the immigrants who enter during their working-age years via tax payments give a net contribution to the pensioners of the same period. In the next period, the immigrants have retired and receive pensions, the present value of which may outweigh their positive contribution during the former period; however, this is offset by the fact that their children now make a positive contribution which is sufficient to cover the expenses of their parents. In this way, the burden of the first generation of immigrants is shifted forward indefinitely into the future, and the original inhabitants of the economy receive a one-time gain. If immigration is repeated in each period or the gain is spread out over all consecutive periods, all descendants of the incumbent population gain.

Other authors have modified the model of Razin and Sadka (2000) in various ways. Kemnitz (2003) introduces additionally labour market imperfections in the form of monopoly unions and an unemployment benefit system. He finds that immigration still benefits the native population as a whole, even when it increases the unemployment rate. In his set-up, a second beneficial (to natives) effect of immigration is that the wage gain to high-skilled workers following immigration more than offsets the losses to native low-skilled labour.

Krieger (2004) shows that relaxing the assumptions that immigrants have the same fertility rate as the native population or that their offspring has the same skill distribution as the natives' offspring may also change the conclusions by Razin and Sadka (2000).

Taken together, the literature lists several different channels through which immigration affects sustainability of public finances and economic welfare of the native population. Borjas (1994) already provided an overview of most of the issues. Among the important ones for present Western welfare states are:

1. Immigration changes the age composition of the population from the point of view of public finances typically in a positive direction, immigrants being usually in the labour market active ages when they arrive. At the same time, the propensity for immigrants to (re-) emigrate tends to be somewhat higher than for natives, implying that they have on average a shorter period as retirees, ceteris paribus, lowering public old-age-dependent consumption and possibly pension benefits.
2. Immigrants tend to have smaller participation rates for a given age and higher ratios in various public transfer systems, implying higher outlays for the government. The smaller participation rates together with a higher unemployment rate and lower wage level at the same time mean that immigrants tend to pay lower taxes, implying a relatively larger fiscal burden.
3. For a country with a government debt at the time of entry of the immigrants, the population increase means a dilution in the per capita debt, ceteris paribus, easing the debt burden of the incumbent population. Conversely, for a country with positive net government assets, also the private net assets of the immigrants at the time of immigration may typically differ from that of natives of the same sex and age.

4. There may be several general equilibrium effects. The literature often singles out the effect on the wage level: an increase in labour supply may lower wages relative to capital; some models distinguish between wages for high-skilled vs low-skilled labour, for instance.

5. Also the fertility behaviour of immigrants plays a role. In Denmark and similar countries, fertility rates of average immigrants are higher than that of the remaining population (RP). Importantly, also the economic behaviour of the children of immigrants differs from that of the RP. For instance, their wage levels tend to be relatively low.

Various empirical and numerical calculations have been undertaken to ascertain the sign and magnitude of budget implications of immigration. Storesletten (2000) builds a simple computable general equilibrium model to examine the effect of various immigration policies for the USA. He finds that increased immigration when the immigrants have characteristics identical to average immigrants already residing in the USA does not improve the long-term budget; specifically attracting larger immigration of certain immigrant groups with a particularly favourable skill and age, however, are beneficial for government finances.

Other studies concern developed Western European welfare states. Various empirical evidences are surveyed in Coleman and Rowthorn (2004) and Ederveen et al. (2004). Among the studies which are closest to the present calculations, Bonin et al. (2000) carry out an analysis for Germany in a generational accounting framework. They find that increased immigration of the currently average kind improves the fiscal position of Germany, but even high immigrant inflows will only be able to partially remove the present fiscal imbalance induced by ageing. Roodenburg et al. (2003) also perform generational accounting and find that the lifetime net contribution of average immigrants is negative in the Netherlands, and an increase in immigration rates would cause the necessary sustainable adjustment to public finances to increase. Storesletten (2003) performs a partial equilibrium analysis of fiscal implications of immigration to Sweden. He calculates the net present values (NPV) of various immigrant types and finds that average immigrants are costly, but some types, notably 20- to 30-year-old, improve the budget.

The aim of the present paper is to make a comprehensive judgement of the probable net effect of various conflicting effects of immigration upon the economy and sustainability of public finances in a well-developed Western European welfare state like Denmark. The calculations are carried out using the computable general equilibrium model DREAM (Danish rational economic agents model), which provides a detailed framework for long-term projections of economic conditions in Denmark. The model replicates the main features from the theoretical model of Razin and Sadka (2000), but in addition, introduces additional details which are meant to give a more realistic picture of the many ways in which immigration affects the economy. Besides taking into account general equilibrium effects of immigration upon the wage level, stock market values, etc., and providing a detailed modelling of the various potential revenue and expenditure channels through which immigration may affect the public sector, the calculations also incorporate the fact that the descendants of immigrants typically have an economic behaviour which is different from that of the incumbent population. Bonin et al. (2000), Roodenburg et al. (2003) and Storesletten (2003) do not incorporate gen-

eral equilibrium effects upon the wage level, etc. Another difference is the way in which descendants are modelled: Bonin et al. (2000) and Storesletten (2003) assume that all descendants of immigrants have the same characteristics as incumbent individuals. The study of Roodenburg et al. (2003) is closest to the present study in this respect, as they do assume different labour characteristics of descendants by employing the simple rule that children of immigrants have bridged half of the gap between the labour market performance of immigrants and the average Dutch. All grandchildren of immigrants are assumed to perform like the average incumbent population. Roodenburg et al. (2003), however, do not distinguish between immigrants of different genders or between countries of different origin.

After presenting macro-economic and budgetary consequences of increased immigration in Denmark, we examine another hypothetical experiment: full and immediate economic integration of all existing and future immigrants and their descendants. It turns out that the economic potential in this experiment is about the same size concerning gross domestic product (GDP) but quantitatively much larger —and even more importantly, of the opposite sign—for the public budget and consequently for the sustainability of fiscal policy.

2 Description of DREAM

The computable general equilibrium model DREAM features an overlapping generation structure with 17 generations of representative households. The model represents a small open economy with a fixed exchange rate regime and perfect international mobility of financial capital, so that the nominal interest rate is given by world bond markets. In the forecast described here, it is assumed to be always constant at the level of 4.75%. Foreign products, however, are considered an imperfect substitute for products produced at home (the Armington approach), so that goods prices and real wages may be influenced by the economic development at home. Households have perfect foresight and know their life income; they save partly to smoothen consumption possibilities over their lifetime and partly to leave a planned bequest (according to the joy-of-giving or warm-glow motive). The savings of the individual household take place in owner-occupied dwellings, free financial savings (stocks and bonds) and labour market and private pensions arrangements.

The monopolistically competitive private firms operate either in the construction sector or in the production sector of other goods. They hire labour and use materials and capital in a constant elasticity of substitution production function, maximizing the value of their assets. Optimal investments are undertaken, but installation of capital is subject to convex costs which give rise to gradual capital formation.

The public sector similarly produces goods which are mainly used for collective and individual public consumption. It levies taxes similar to the existing Danish tax system (the most important ones in terms of revenue being income taxes, value-added tax, excise duties, company taxation, property taxes and a tax on the yield of pensions funds) and pays transfers to the population. The government intertemporal budget constraint is respected, and sustainability is preserved by a one-time permanent change in collective public consumption as percentage of GDP in 2007.

2.1 Population

The size and composition of the population is based on a full projection of the Danish population. Immigrants are divided into two groups: immigrants from more developed countries (henceforth known as IMs; more developed countries being USA, Canada, Japan, New Zealand, Australia and countries in Europe except for Turkey, Cyprus and some countries of the former Soviet Union) and immigrants from less developed countries (ILs; the rest of the world). Furthermore, the descendants of immigrants are treated specially, forming two other groups: descendants of immigrants from more developed countries (DM) and descendants of immigrants from less developed countries (DL). Finally, the RP forms a group, so that there are altogether five different origin groups. Individuals are divided into the various groups in the following way: a person belongs to the group RP if at least one of his parents is a Danish citizen and is born in Denmark. If a person does not belong to the RP group, he is an immigrant if he himself is born outside Denmark and a descendant if he is born in Denmark. The five groups differ in their labour force participation and in demographic parameters concerning fertility and (re-) emigration propensity. Additionally, the two immigrant groups differ from the other population groups regarding their unemployment tendency, their productivity when at work and the extent to which they receive public transfers and enjoy individual public consumption. For these variables, the two descendant groups and the RP are treated as one group, however.

The population projection is formed using estimation of historical trends in fertility, mortality and emigration propensities. Gross immigration is also projected on the basis of historical developments but corrected for recent changes in Danish immigration rules and a supposed effect of the enlargement of the European Union, causing an increase in the immigration of IMs. The result of the projection is that total population falls from 5.4 million in 2003 to 5.1 million people in 2100. At the same time, the distribution of the population on the five population groups changes. In 2004, the two immigrant groups formed together 6.3% of the population, and the two groups of descendants formed 1.9%. In 2100, however, according to the forecast, immigrants will make up 12.9% and descendants 9.1% (Fig. 1). Immigrants from less developed countries (and, as a second-order effect, consequently descendants from less developed countries) grow in numbers relatively faster than those from more developed countries. This is true, even though gross immigration from more developed countries is larger than from less developed countries. The reason is that the propensity to re-emigrate is at the same time considerably higher for IMs.

2.2 The labour market

Age-, gender- and origin-specific participation rates in the model are assumed to stay constant at their 2001 levels, so that the number of people in the labour force during the projection is affected purely by the exogenous underlying demographic developments. Figures 2 and 3 show the participation rates for men and women for each origin group separately. For almost all ages, immigrants from less developed countries have the lowest participation rate and immigrants from more developed countries have the second lowest rate. Descendants of immigrants lie between
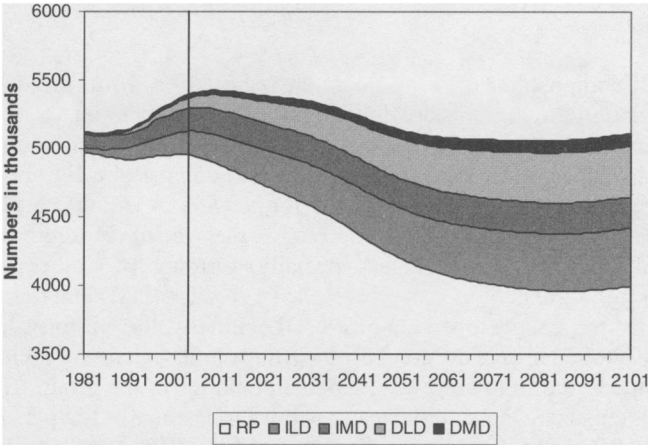
Fig. 1 Population after origin. *RP* Remaining population, *ILD* immigrants from less developed countries, *IMD* immigrants from more developed countries, *DLD* descendants from less developed countries, *DMD* descendants from more developed countries

immigrants and the RP. Note that for people who are older than 24 years, immigrants are treated as one group when determining participation rates because of insufficient data concerning immigrants from less developed countries.

Whereas participation rates are exogenous to the model, the number of hours worked per person and the unemployment rate are endogenous. The labour market

Fig. 2 Participation rates for men in 2001. For people who are 24 years and older, DLs and DMs are calculated as one group when measuring participation rates for each age. The diagram is presented for population intervals of 5 years, however. Composition effects because the age distribution of the two groups is not identical imply that the two graphs may differ slightly even after the age of 24
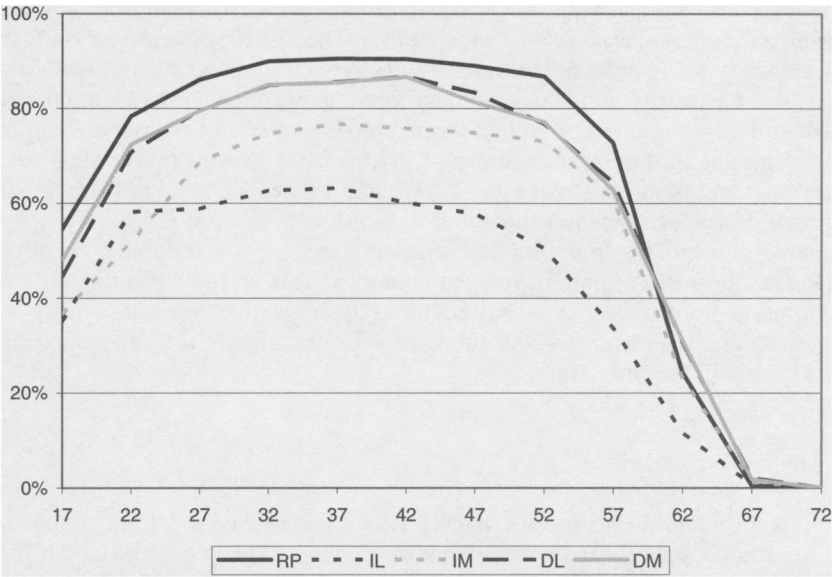
Fig. 3 Participation rates for women in 2001. For people who are 24 years and older, DLs and DMs are calculated as one group when measuring participation rates for each age. The diagram is presented for population intervals of 5 years, however. Composition effects because the age distribution of the two groups is not identical imply that the two graphs may differ slightly even after the age of 24
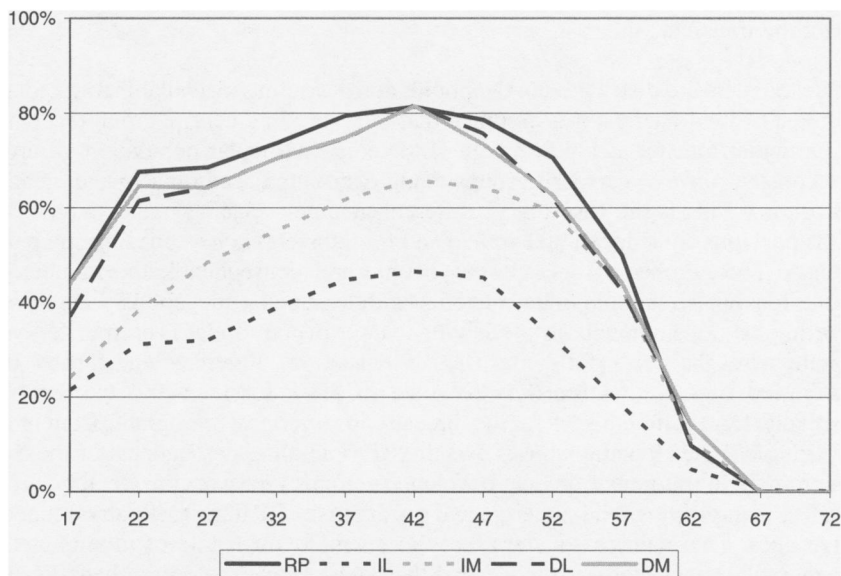
is assumed to be dominated by trade unions who effectively choose the actual employment level per person in the labour force, depending on the difference between after-tax real wages and after-tax unemployment benefits.

To replicate actual wage distributions, labour productivity per person is age-, gender- and origin-specific. Persons of different labour productivity are perfect substitutes for each other, in contrast to Kemnitz (2003). Immigrants earn much lower wages than RPs of the same sex and age and consequently are awarded a smaller labour productivity. Their labour income and direct and indirect tax payments, thus, also are somewhat smaller than that of corresponding RPs.

Immigrants in Denmark have a higher unemployment rate than RPs of the same sex and age. The reasons for this may be labour market imperfections which imply that differences in language and other educational skills cause employment differences rather than wage differences between groups; discrimination may also be part of the explanation. In DREAM, this difference is modelled by assuming that there are three different trade unions, each having its own labour supply function: one for ILs, one for IMs and one for the remaining groups (that is, due to lack of sufficient data, descendants of immigrants are not modelled separately but are merged with the RPs into one group for this purpose). The scale parameters of the labour supply function are calibrated separately for each group, effectively assuming that the leisure preferences of immigrants differ from that of the other population groups. This assumption ensures that the actual unemployment level of each of the three groups is reproduced in the calibration year.

2.3 Public transfers

Public transfers are distributed to the population according to available micro-data. For most of the transfers, it is assumed that the share of a certain group receiving the particular transfer as a percentage of the entire particular population group is kept constant for all years (the groups being distributed according to age, gender and origin). This is the case for 12 different income-replacing transfers (such as public pensions and educational grants) and for transfers such as housing and child benefits. The number of unemployed people and consequently the number of people receiving unemployment benefits is determined endogenously, however, according to developments in the labour market of the model. The transfers are all indexed to the wage (following Danish legislation). Figures 4 and 5 show the distribution of the total transfers received in 2001 for men and women, respectively, from different ages for the three groups of origin: immigrants from more and from less developed countries and the RP (including descendants of the first two groups). Immigrants from less developed countries receive considerably larger transfers than people of the same age and gender in the RP during the labour market active ages. The main reasons are that the unemployment rate of immigrants is considerably larger than for the RP and that they receive more cash benefits and participate in more active labour market programmes. After retirement age, however, the situation is reversed: an old immigrant costs less money for the state than an old RP, because fewer immigrants receive public pensions. In the future, public expenses to transfers will rise faster than GDP. This is because the population grows older, and elderly people receive the largest transfers, and because the share of immigrants rises. Moreover, the wage rate and consequently transfer rates will grow more quickly than GDP for several years as the wage rises in response to labour becoming relatively more scarce.
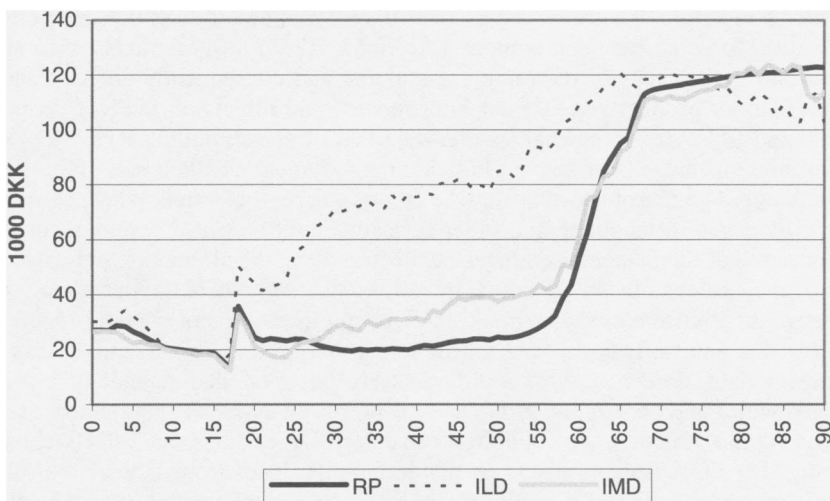

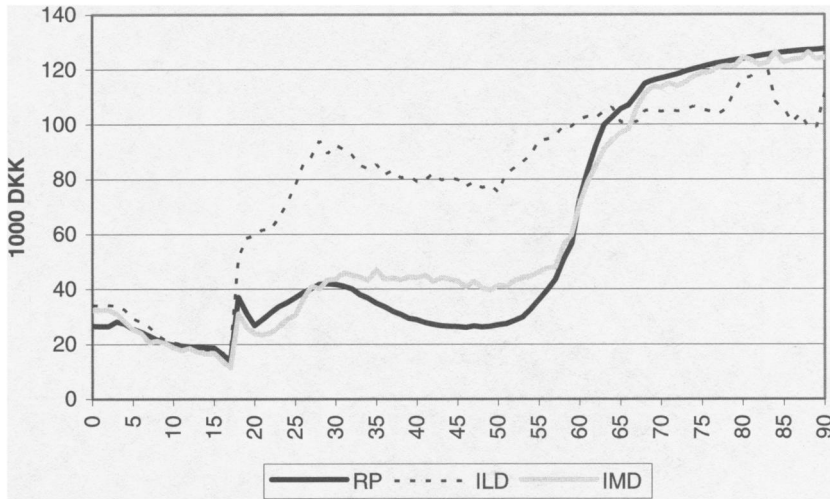**Fig. 4** Age-dependent public transfers for men in 2001

Fig. 5 Age-dependent public transfers for women in 2001

2.4 Public consumption

Public consumption is divided into collective and individual consumption, the first one being rival or partly rival goods. Individual public consumption consists mainly of expenses for hospitals, residential homes for elderly people, child care, education, etc. Like transfers, these are distributed to the population according to age, gender and origin, and it is assumed that these expenses will be constant per person in the same group. The expenses of individual public consumption per person are assumed to rise with the rate of exogenous Harrod neutral technological progress (i.e. 1.5% *pro anno*), which is faster than GDP growth. Figures 6 and 7 show the distribution of these expenses over ages for men and women. For persons less than 30 years of age, there is a tendency that RPs have higher expenses because they consume more education. For all groups during labour market ages, the consumption of individual services is relatively low, whereas from about 70 years of age, it rises drastically because of hospital and residential home expenses (because of insufficient data, for people more than 70 years of age, we do not distinguish between immigrants and the RP when projecting age-specific public consumption expenditure). Because of the relatively large service consumption by elderly people and because the indexation rule states that expenses for an identical user will rise more than proportionately with GDP, total expenditure for individual public consumption will also rise faster than GDP in the future years and consequently will become an increasing burden. However, the increase in the population share of immigrants will tend to dampen this burden because immigrants are cheaper with respect to public consumption than RPs.

Collective public consumption, which forms about one third of total public consumption in 2001, covers expenses for defense, public administration, roads, police and the judicial system. These expenses are assumed to rise with GDP, so that they make out a constant share of GDP from 2001, except that they undergo a one-time change in 2007 to make fiscal policy exactly sustainable. Collective public consumption is consequently the instrument we use to create sustainability,
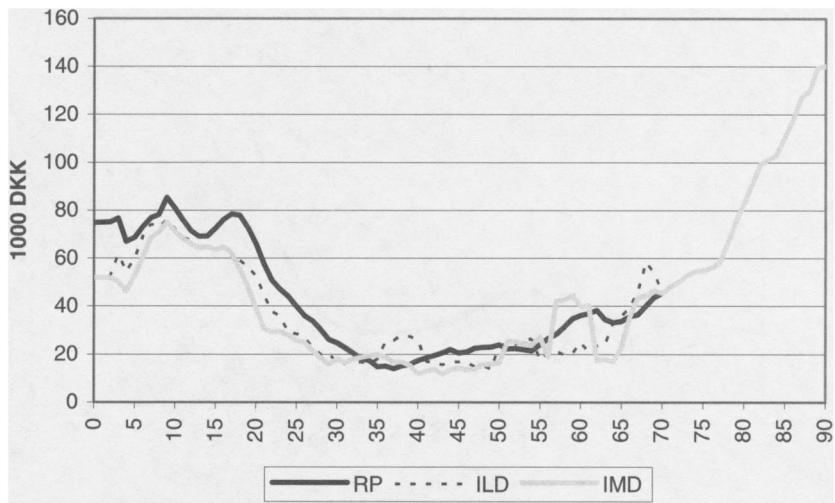
Fig. 6 Age-dependent public consumption for men in 2001

and, as a percentage of GDP, it is the measure we have of the sustainability cost or benefit of various scenarios or policy changes. Of course, it is an arbitrary assumption to choose this way of closing the public budget instead of, e.g. various tax adjustments or time-varying changes.

3 Macro-economic developments in the base-line scenario

To understand the workings of the model, it can be instructive to see the development of the economy in the base-line forecast. Technically, the model is solved in 5-year periods on the basis of a population projection until 2100, after which the
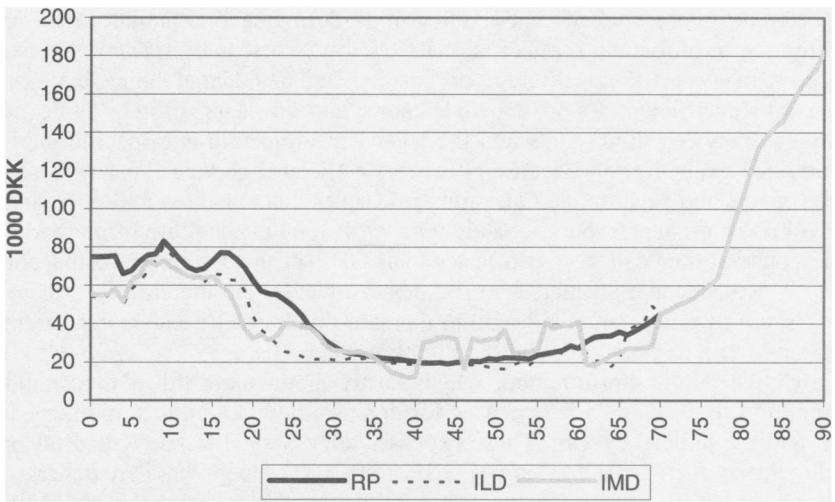
Fig. 7 Age-dependent public consumption for women in 2001

model reaches its steady state. The overall development of the economy is shown in Table 1. The main long-run changes are due to exogenous technological progress and to demographic changes. The labour force shrinks, because both the age and the ethnic composition of the population changes. The capital–labour ratio is roughly constant, so that GDP is determined by the size of the labour force plus technological progress. This is modified by two factors, however: there are convex capital installation costs, so that the adjustment of capital to labour force changes is not instantaneous, and the terms of trade are endogenous because of the Armington assumption that when Denmark produces fewer goods compared to the rest of the world because our labour force diminishes, Danish goods become more scarce and consequently their price rises. This causes also a modest real wage rise and a slight long-run rise in the capital–labour ratio. Moreover, the real wage rise leads to a fall in the unemployment ratio during the next decade because the difference between after-tax wages and after-tax unemployment benefits rises. Total employment, however, still falls by close to 15% during the next 40 years. In Sect. 6, a sensitivity analysis is carried out to see the effects of modifying the Armington assumption.

Because of technological progress, private consumption and GDP rise continually. To isolate the effects of the demographic changes, Table 2 shows the same figures as Table 1 but corrected for the annual exogenous growth rate of 1 1/2%. In growth-corrected terms, GDP falls by 12% until 2041. Private consumption also falls but only about 3%. One reason for this relative rise of the share of private consumption is that fiscal sustainability is created by cutting public (collective) consumption. Moreover, net exports fall in the long run. In 2001, Denmark has a large surplus in its trade with the rest of the world and a positive balance of payments. The foreign debt is paid off during the first decades and replaced by positive net foreign wealth amounting to almost 150% of GDP in 2101. In the steady state, this yields interest rate payments from abroad which are used to maintain a steady inflow of foreign consumption imports.

The three sectors of the economy react differently to the changes. In 2041, the fall in employment is largest in the private sector producing non-durable goods:

Table 1 Macro-economic development

	2001 Level (billion DKK)	2001	2006	2021	2041	2061	2101
		Index in fixed prices, 2001=100					
Private consumption	507.4	100	113.7	138.4	173.2	222.1	393.3
Real GDP at factor prices	1,139.1	100	107.6	129.2	157.0	198.9	349.4
Unemployment in per cent	5.2	5.2	5.1	5.0	5.1	5.3	5.2
Employment		100	99.7	94.6	86.1	81.6	81.0
Private non-construction sector		100	97.5	95.8	83.7	78.0	75.9
Construction sector		100	108.5	99.9	89.8	86.4	88.1
Public sector		100	101.8	90.6	89.9	88.1	89.8
Capital stock							
Private non-construction sector		100	110.0	135.4	161.2	201.6	348.3
Construction sector		100	124.0	146.8	179.7	232.7	422.3
Public sector		100	97.8	107.1	142.3	186.3	338.4
Net foreign assets (% of GDP)	−234.0	−17.7	−9.3	47.9	101.0	140.8	148.1

Table 2 Macro-economic development (growth-corrected)

	2001 Level (billion DKK)	2001	2006	2021	2041	2061	2101
		Index in fixed prices, 2001=100, growth-corrected					
Private consumption	507.4	100	105.7	103.6	97.1	93.2	92.6
Real GDP at factor prices	1,139.1	100	100.1	96.8	88.0	83.5	82.3
Unemployment in percent	5.2	5.2	5.1	5.0	5.1	5.3	5.2
Employment		100	99.7	94.6	86.1	81.6	81.0
Private non-construction sector		100	97.5	95.8	83.7	78.0	75.9
Construction sector		100	108.5	99.9	89.8	86.4	88.1
Public sector		100	101.8	90.6	89.9	88.1	89.8
Capital stock							
Private non-construction sector		100	102.3	101.4	90.4	84.6	82.0
Construction sector		100	115.3	109.9	100.7	97.7	99.4
Public sector		100	91.0	80.2	79.8	78.2	79.7
Net foreign assets (% of GDP)	−234.0	−17.7	−9.3	47.9	101.0	140.8	148.1

employment is more than 16% smaller than in 2001. This sector competes directly with foreign firms, so the price rises result in a substitution towards foreign goods. A similar substitution does not take place in the construction sector, so the fall in employment is around 10% in this sector. In the public sector, the fall is of the same size. Here, employment is basically governed by the development in the demand for individual and collective public consumption.

3.1 Public finances

Table 3 shows the development of public expenditure: in total, they grow from around 50% of GDP to 55% until 2041. Both public transfers and individual public consumption rise several percentage points. This is only partially offset by the sustainable adjustment in collective public consumption, which amounts to a permanent cut of 2.9% of GDP from 2007 onwards. Also tax revenues rise but less than expenditure: from 54.5% of GDP in 2001 to 55% in 2041. The reason is that gross (taxable) income of households falls less than GDP, partly because the amount of taxable transfers grows, partly because the large Danish pensions funds mature and issue more payments in the future to households.

4 Consequences of increased immigration

The fiscal and macro-economic consequences of increased immigration can be examined by conducting the following experiment: in addition to the base-line forecast of the population described above, it is assumed that gross immigration is increased each year from 2007 until 2101 by a number equal to 0.1% of the population in 2003 (corresponding to around 5,400 additional immigrants annually). With respect to age, sex and country of origin, the immigrants are distributed like the immigrants in 2002, except that later changes in Danish legislation concerning

Table 3 Public expenditure and revenue

	2001 Level (billion)	2001 % of GDP	2006	2021	2041	2061	2101
Expenditure	665.74	50.23	49.96	51.00	55.21	56.17	57.02
Public transfers	229.57	17.32	17.22	19.72	21.22	21.16	21.02
To Immigrants, LDC	10.63	0.80	0.90	1.41	2.23	2.71	3.04
To Immigrants, MDC	7.38	0.56	0.57	0.76	0.92	1.05	1.09
To descendants	1.98	0.15	0.18	0.36	0.70	1.20	1.72
Individual public consumption	241.98	18.26	18.32	19.44	22.06	23.07	23.99
To Immigrants, LDC	5.02	0.38	0.41	0.59	0.97	1.36	1.69
To Immigrants, MDC	5.35	0.40	0.42	0.51	0.65	0.77	0.86
To descendants	6.12	0.46	0.54	0.93	1.26	1.61	2.25
Collective public consumption	101.30	7.64	7.65	4.75	4.75	4.75	4.75
Other expenditure	92.89	7.01	6.76	7.10	7.18	7.18	7.26
Revenue	722.13	54.48	53.01	53.20	54.95	55.32	55.71
Primary budget surplus	56.39	4.25	3.05	2.20	−0.26	−0.84	−1.31
Net interest expenses	18.86	1.42	0.25	−1.94	−3.45	−4.40	−4.54
Net public debt	85.51	6.45	−8.66	−61.64	−88.67	−110.53	−111.61
GDP in 2001 prices	1,325.51	1,325.51	1,479.11	1,735.05	2,172.35	2,794.22	4,966.02

family reunion and admittance of refugees affecting future immigrant inflows are taken into account. The result is that of the extra immigrants: about two thirds immigrate from more developed countries and about one third from less developed countries. In 100 years' time, this leads to an increase in the Danish population of 389,000 people or 7.6%. Of these, 92,000 are classified as descendants, and 145,000 are classified as belonging to the RP (being children of descendants). Of the remaining 151,000 people, the majority are immigrants from less developed countries. Even though gross immigration in this experiment is chiefly from more developed countries, the re-emigration rate of IMs is considerably higher than that of ILs, so in the long run, immigration from less developed countries will dominate the additional immigrant stock.

The age of immigrants differs from that of the incumbent population, people in working ages being over-represented among the newcomers. The demographic dependency ratio, i.e. the ratio of people, less than 17 years or at least 65 years to those aged between 17 and 64 years, consequently falls as a result of the increased immigration inflow from 0.845 to 0.832 (the situation after 100 years). As fewer people in each age participate in the labour force, however, the average participation rate also falls. The labour-force-related dependency ratio (people outside the labour force relative to people in the labour force) consequently is practically unchanged: it rises slightly from 1.434 to 1.435 after 100 years. The long-run (i.e. the number in 2101) rise in the labour force as a result of the experiment is 171,000 people (an increase in 7.5%). The number of people receiving various kinds of public transfers rises with about 137,000 people, chiefly among these being people receiving public pensions and students' allowances.

The macro-economic development in this experiment is seen in Table 4, where the various variables are expressed as percentages of the corresponding values in the base-line scenario. Employment (in productivity-adjusted units) in the long run is 7% higher because of the larger labour force. The rise in employment measured in this way is smaller than the rise in the labour force, partly because the productivity is smaller for immigrants than for the RP and partly because the average unemployment rate rises slightly in this scenario because immigrants, who have a relatively large unemployment rate, make up a larger share of the labour force. The unemployment rate in 2101 is 5.3% in this scenario against 5.2% in the baseline. GDP at factor costs rises with 6.6%, which is again slightly smaller than the increase in employment. This corresponds to a minor decrease in the capital–labour ratio: the increase in labour force and consequently production makes home-produced goods relatively less scarce compared to foreign goods and causes a slight deterioration in the terms of trade, which again tends to make production less profitable and causes investment and the long-run capital stock to rise less than the labour force. Finally, private consumption rises only with 5.9% after 100 years. Initially, the rise in consumption is slightly higher than in production, so foreign assets fall as a percentage of GDP, which implies that in the long run, gross national income and, consequently, consumption rises less than GDP. Per capita income and production are smaller than in the base-line scenario because the immigrants contribute less to production than the incumbent population on average.

Looking at public finances, the long-run effect is that public tax revenue as a percentage of GDP falls slightly (0.2%). On the expenditure side, transfers measured in the same way are unchanged, whereas individual public consumption rises slightly. The main indicator of the consequences of immigration for public finances is the sustainability indicator, however: the necessary permanent cut in collective public consumption from 2007 in this scenario is 3.04% of GDP or 0.14% more than in the base-line. The net impact of immigration under these assumptions is thus slightly negative. The extra tax revenue generated by the immigrants and their descendants is exceeded by the extra costs for the government in terms of transfers,

Table 4 Macro-economic development in scenario with increased immigration

	2001	2011	2021	2041	2061	2101
	Index, base-line=100					
Private consumption	100	100.5	100.7	101.6	102.8	105.9
Real GDP at factor prices	100	100.2	100.7	101.9	103.3	106.6
Unemployment	100	100.2	100.9	102.5	102.9	102.8
Employment	100	100.2	100.7	102.0	103.5	107.0
Private non-construction sector	100	100.4	100.9	102.1	103.7	107.3
Construction sector	100	100.7	101.1	102.4	103.9	106.6
Public sector	100	99.7	100.3	101.6	103.1	106.5
Capital stock						
Private non-construction sector	100	100.3	100.8	101.9	103.3	106.6
Construction sector	100	100.6	101.0	102.1	103.5	105.8
Public sector	100	99.7	100.3	101.5	103.0	106.4
Net foreign assets (% of GDP)	−17.7	9.2	47.3	99.5	137.4	138.7

individual public consumption, etc. However, the effect on public finances is rather small relative to the impact on macro variables such as population and GDP size.

In an alternative experiment, consequences of increasing immigration with the same number of immigrants from less developed countries (only) annually from 2007 until 2101 are examined. The long-run effects of this population increase are considerably larger: in 2101, the population has grown to 668,000 people or 13% compared to the base-line. The reason for the much larger population increase is partly that the re-emigration rate of immigrants from less developed countries is smaller than that of IMs and partly that the fertility of ILs is considerably higher. The average participation rate, however, is smaller. The labour force rises with 279,000 people in the long run or 12.2% more than in the base-line. Productivity-adjusted employment rises with 10.9% and GDP at factor costs with 10.4% in 2101. The main economic mechanisms are the same as in the former experiment. Public finances are worse off in this case because the ILs pay less taxes and receive more transfers than other population groups, including IMs. Consequently, fiscal policy in the present case becomes less sustainable: the necessary cut in public collective consumption in 2007 now amounts to 3.43% of GDP or 0.53 percentage points more than in the base-line. The result from Razin and Sadka (2000) that immigration of less productive workers may still improve public finances thus does not hold in this more complex (and arguably more realistic) setting.

However, when restricting immigration to people from more developed countries, fiscal sustainability does improve, though just barely: increasing immigration of this group with 0.1% of the population annually from 2007 to 2101 results in a reduction in the necessary sustainable adjustment of public expenditure but only by 0.07% of GDP. The sign of the sustainability adjustment in this case, even though IMs still have lower participation rates and productivity than RPs, shows the relevance of Razin and Sadka's (2000) point, but the small magnitude also makes evident that immigration of this kind cannot be supposed to reduce the long-run problems of the public budget in a significant way.

These results are generally in line with Storesletten (2003), whose calculations of the effects of increased immigration to Sweden show that immigrants with average characteristics imply a net government loss, whereas immigration of more targeted groups of immigrants (in his case, 20- to 30-year-old) would make fiscal policy more sustainable. The results are also comparable with those of Roodenburg et al. (2003) for the Netherlands, whereas they are more negative than the studies by Storesletten (2000) for the USA and by Bonin et al. (2000) for Germany. As mentioned above, the various studies differ in methodological details which may account for some of the differences. With the exception of Storesletten (2000), these studies do not model general equilibrium effects. However, first-order effects (particularly labour force participation) also drive most of the results in the present study. Furthermore, the majority does not take into account the behaviour of descendants of immigrants which empirically differs from that of the incumbent population, as illustrated in the present study. Finally, the countries examined differ somewhat in their characteristics. In Denmark, Sweden and the Netherlands, the difference in participation rates between immigrants and the native population is larger than in Germany and particularly in the USA according to OECD (2004). Moreover, the three first-mentioned countries tend to have more generous pensions and other government-financed transfer arrangements from which immigrants may benefit, cf. Roodenburg et al. (2003) for a more detailed discussion of this point.

5 Economic consequences of perfect integration

It may be interesting to examine the effects of perfect (economic) integration of immigrants and their descendants with the RP; that is, to ask the question what would happen if the groups of immigrants and descendants in all economic matters had the same behaviour as RPs?

To answer the question, an experiment is conducted where it is assumed that from 2007, all immigrants and descendants already residing in the country as well as future newcomers to these groups will have the same behaviour as persons from the RP of the same age and sex in the following respects:

1. Participation rates and rates of receiving public transfers of all kinds
2. Labour productivity
3. Unemployment
4. Use of individual public consumption

The demographic behaviour of immigrants and descendants (fertility and re-emigration rates) is not considered to be changed in this experiment, so it will still differ from the demographic behaviour of the RPs. All future immigrants who enter the country during the forecast period are supposed to automatically and immediately acquire the same economic behaviour as the incumbent population. Clearly, this is not a realistic scenario. In the first place, even the most successful integration policy (including, e.g. acquisition of language skills) would take time to be effective. In the second place, a conscious and effective immigration policy would, presumably in itself, entail some educational and other costs on the side of the government, which would reduce the benefits in terms of the sustainability gain. Thus, the experiment should rather be taken as the expression of an upper limit to the economic gains that an effective integration process might potentially bring about.

The effects in this scenario are quite large: the number of individuals in the labour force rises at once (in 2007) with 83,000 persons or 3.1% compared to the base-line. After 100 years, the difference has risen to 123,000 people or about 5 1/2%. The difference in productivity-adjusted employment is even larger: 4% in 2007–2011 rising to 7.1% in 2101 because the productivity of the immigrant and descendant groups also rises and the unemployment rate of immigrants falls (Table 5). Again, GDP at factor costs rises a little less than employment, i.e. with 6.3% after 100 years. The improvement of the government budget is considerable. Immigrants and descendants now pay larger taxes because their income increases and they receive less transfers. The effect of total integration is that the sustainability problem is reduced to one fifth of its previous size: to satisfy its intertemporal budget constraint, the government now needs to reduce collective public consumption only by 0.66% of GDP from 2007. Consequently, total public consumption as a share of GDP rises compared to the base-line, whereas private consumption rises less than GDP. The income of the private sector rises less than GDP because of higher effective taxes and less transfers.

Of the various effects of integration, the most important one is the equalization of participation and transfer rates. The effects of equating productivity profiles and labour supply decisions (hence, unemployment levels) are comparatively minor, whereas integration in the area of take-up rates of individual public consumption

Table 5 Macro-economic development in scenario with perfect integration

	2001	2011	2021	2041	2061	2101
	Index, base-line=100					
Private consumption	100	101.4	101.5	102.0	102.3	102.5
Real GDP at market prices	100	102.7	103.8	105.1	106.0	106.3
Unemployment	100	88.3	86.1	83.4	82.4	81.7
Employment	100	104.0	104.7	106.0	106.9	107.1
Private non-construction sector	100	101.1	102.4	104.3	105.5	106.0
Construction sector	100	105.2	103.7	104.6	105.1	105.1
Public sector	100	110.5	110.2	109.9	109.9	109.7
Capital stock						
Private non-construction sector	100	100.8	102.2	103.9	105.0	105.5
Construction sector	100	104.0	103.5	104.2	104.6	104.5
Public sector	100	109.3	110.2	109.8	109.8	109.7
Net foreign assets (% of GDP)	−17.7	3.3	32.6	73.6	107.4	114.4

makes the economy more unsustainable: immigrants on average have a lower consumption level than that of the RPs, mainly because they consume less education.

6 Sensitivity analysis

The Armington assumption combined with the assumption that production in the rest of the world rises with the steady-state productivity growth rate implies that Denmark improves its terms of trade when goods made in Denmark become scarcer relative to foreign goods in the projection. This may be considered problematic if it is believed that Denmark's main trading partners are affected by ageing problems and shrinking production to an (at least) equally large extent. To understand the effects of this particular assumption, an alternative experiment is carried out where the elasticities of foreign trade are three times as high as in the main scenarios. This reduces the terms-of-trade effect considerably, and, in the resulting base-line scenario, GDP is smaller and the necessary adjustment to make fiscal policy sustainable increases to 3.24% of GDP. However, the marginal sustainability effects of the various immigration and integration experiments performed above hardly change. Increasing immigration by average immigrants corresponding to 0.1% of the population now increases the sustainability problem by 0.12%: for immigration exclusively from less developed countries, the corresponding number is 0.49% of GDP, whereas sustainability is improved by 0.08% of GDP if the immigrants are exclusively from more developed countries. The sensitivity analysis thus implies that the terms-of-trade gain is not important for the results in the main section.

7 Conclusion

In connection with the population ageing facing most Western economies and the resulting problems for fiscal sustainability, it is often discussed whether

increased immigration may improve the situation for public finances. Razin and Sadka (2000) show in a theoretical model that this may be the case, even when the immigrants are low-skilled compared to the incumbent population and are themselves net beneficiaries of payments from the welfare state.

We have examined the sustainability problem in a detailed model of the Danish economy as an example of a Western European welfare state with a large public sector. Using the computable general equilibrium model DREAM, we have analyzed various effects of immigration on the economy and its future development path. Present fiscal policy is unsustainable, and a cut in public consumption in the amount of 2.9% of GDP from 2007 is necessary to achieve sustainability. The role of immigrants is an important part of the picture to understand the projection of the Danish economy, as the share of immigrants and their descendants in the population rises in the future, and their economic and demographic behaviour, concerning age distribution, participation rates, wage/productivity levels, unemployment levels, take-up rates of public consumption and (re-) emigration and fertility rates, differs in various ways from that of the RP. These various differences may have opposite signs influencing the total effect of immigration upon sustainability of public finances.

A scenario examines the consequences of increasing immigration to Denmark annually from 2007 with a number corresponding to 0.1% of the population in 2003, giving the immigrants the same characteristics as average immigrants from recent historical years. The effect is an increase in GDP of about 6% after 100 years; sustainability, however, is slightly negatively affected (−0.14% of GDP). The NPV of the extra costs for the government following from immigration more than outweighs the NPV of extra tax revenues. This contrasts with results from Germany in Bonin et al. (2000), which may be due to the fact that participation rates for immigrants in Denmark are relatively lower compared to the native population than in Germany and the welfare system is relatively more generous. Results from the Netherlands (Roodenburg et al. 2003) and from Sweden (Storesletten 2003), countries which are in this respect closer to Denmark, are qualitatively similar, though these results are not derived from a general equilibrium model. The present analysis consequently confirms the result in a more general setting, also including the effects of descendants of immigrants.

Restricting immigration to immigrants from relatively developed countries affects sustainability positively, even though these immigrants still have participation and productivity levels which are below those of the native population. The effect on sustainability is very small, however, so that the conclusion that immigration on any realistic scale is not a solution to the fiscal sustainability problem connected with the ageing of the Danish population remains.

A full, costless and immediate economic integration of the immigrants and descendants in the base-line population forecast, however, results in a similar GDP increase (6.3%) after 100 years but a substantial improvement of sustainability conditions corresponding to 2.24% of GDP. This experiment should be interpreted as a benchmark illustration of the hypothetical benefits of economic integration rather than a realistic exercise. Nevertheless, the results of the paper indicate that increased general immigration will not solve the demographic problems of the ageing welfare state, but improved integration of existing and future immigrants may be a very important tool to ease future financing problems. In particular, labour market participation is an important determinant when calculating the impact of immigrants and descendants upon government finances, and a conscious

integration effort should first and foremost be directed against increasing participation rates for these population groups.

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