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A Simulation Model of the Fiscal Effects of Immigration, Fertility and Employment

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Abstract

This paper uses a simple simulation model to examine the fiscal consequences of ageing in a low fertility, low employment economy. It explores how employment growth, fertility and immigration influence the tax rates required to ensure government solvency. It identifies the pitfalls involved in using "generational accounting" in a low fertility, low employment economy. Although highly stylized, the model provides valuable insights and indicates the orders of magnitude involved in various alternatives. The main conclusions are as follows. In the kind of economy considered, the fiscal gain from a higher rate of employment is much greater than the gain from immigration or a higher the birth rate. The large fiscal gain from immigration that some researchers find is due to their unrealistic assumptions regarding the generational incidence of higher taxes. With more realistic assumptions, the fiscal impact of immigration is much smaller and of indeterminate sign.

Keywords: Ageing, taxation, migration, generational accounting.

JEL Classification: H62, J19, F22.

A Simulation Model of the Fiscal Effects of Immigration, Fertility and Employment

This paper is concerned with the fiscal problems caused by ageing in a low fertility, low employment economy. It considers how various factors influence the tax rates required to ensure government solvency in such an economy. These factors include employment growth, fertility and immigration. It also explores some of the pitfalls involved in using "generational accounting" to analyze these issues. The paper begins with a survey of the issues and empirical evidence. It then uses a simulation model to explore some of the issues arising from this survey. Although highly stylized, the model gives insights which are qualitatively valuable and indicates the orders of magnitude involved.

I. Overview

There is widespread concern in Europe about low birth rates and their impact on the size and age structure of national populations. In every European country, both east and west, birth rates have fallen in recent decades and are now below the replacement rate. If current birth rates persist, then all European countries will eventually experience a decline in population unless they augment their numbers through immigration. However, there are wide differences in the prospective timing and pace of decline. In France, the UK and most of Northern Europe, the expected decline is rather slow over the next few decades and many people would welcome it. In Southern and much of Eastern Europe, the prospective decline is much faster. For example, the UN has predicted that in the absence of immigration the population of Italy will shrink from 57 million in 2000 to 41 million in 2050 (UN 2001). Such a decline would be unprecedented in modern times, although it would still leave Italy with a much larger population than it had in 1900. The fall in numbers will be accompanied by an ageing of the population. Europe is getting older. In most countries the process will accelerate in the next thirty years or so, after which the age structure will stabilize. In the future Europe, the proportion of over-65s will be approximately twice as high as it is today.

One widely advocated response to low birth rates is the mass importation of young, fertile immigrants. The aim would be to boost the total population and the number of people of working age and to slow down the ageing process. It is often claimed by politicians, journalists and migrant lobby groups that this would have substantial fiscal benefits. Being relatively young, immigrants would pay far more in tax than they absorbed in public expenditure. They would "support us in our old age". There have been a number of academic studies seeking to evaluate this claim empirically[1]. Their conclusions are as follows. The impact of highly skilled or talented immigrants is

[1] Acess Economics (2001), Auerbach and Oreopoulos (2000), Bonin et al (2000), Bonin (2002), Borjas (1990), Collado et al (2003), Ekberg (1998), Fehr et al (2004a,b), Gott and Johnsokn (2002), Huddle (1993), Immigration Research Programme (1999), Lee and Miller (1998, 2000) , Moscarola (2001), Passel (1994), Pederson (2002), Roodernburg et al (2003), Rothman and Espenshade (1992), Storesletten (2000, 2003) , Ter Rele (2003), Wadensjö (1999), Weber and Straubhaar (1996). The papers by Ekberg and by Weber and Staubhaar contain summaries of earlier studies on the fiscal impact of migration.

normally positive because their earnings are relatively high and they receive few welfare benefits. Conversely, the impact of unskilled immigrants is often negative, especially if they fail to find employment, as in the case of many asylum seekers and spouses from developing countries. Such immigrants pay relatively little tax and may receive a substantial amount in the form of welfare benefits and public services. In the case of large-scale immigration, there will normally be a broad spectrum of immigrants, some of whom make a positive fiscal contribution and others a negative contribution. Most of these individual effects cancel out, which explains why most studies find that the aggregate impact of large-scale immigration on public finances is relatively small, typically within the range ± 1% of GDP.

These findings are summarized by the Dutch economist Rooderburg (2003) as follows

> "Taking into account the fact that immigrants usually have families, their long-term fiscal impact turns out to be practically zero. Thus, immigration will not solve the budgetary problem. This calculation assumes that immigrants show the same economic performance as the average Dutch resident. If, however, their average employment rate and income were lower, as it is for the present non-Western immigrant population, immigration would aggravate rather than alleviate the financial burden of ageing. Only if immigrants outperform the average Dutch resident on the labour market, will their fiscal impact be clearly positive. However, assuming we would be able to attract these high performers, it would still take millions of them to make a substantial contribution to the required budgetary adjustment. Given these findings, immigration does not seem to be an effective way to alleviate the financial burden of ageing" (p. 3).

Demographic Collapse

Until recently, empirical studies of immigration were normally backward–looking and concerned with the taxes and expenditures associated with the stock of immigrants who had already arrived. This situation has changed somewhat in recent years and there have been a number of forward-looking studies which seek to evaluate the potential fiscal contribution of future immigrants. The majority of these studies are concerned with countries where birth rates are still comparatively high and the demographic problem is less serious than elsewhere (the USA and North West Europe). They find that the potential fiscal contribution of immigrants in such countries is small and may be positive or negative, depending on the nature of the immigrants concerned. This conclusion is echoed by two recent papers by Fehr et al (2004a, b) dealing with immigration into the EU. These papers argue that, taken as a single entity, the EU has a severe demographic problem and that massive tax increases will be required to preserve the fiscal viability of the Union in future. However, they also find that,

> "Increased immigration also proves to be a false elixir, if our model is to be believed. Even an immediate and sustained doubling of immigration – an extreme

response by most policy makers standards – does very little to mitigate the fiscal stresses facing the developed world"[2]

.

There are also a few forward-looking studies which are specifically devoted to countries with very low birth rates and which find that the potential contribution of future immigrants may be large[3]. These studies are all based on a method known as "generational accounting". This is a method which allows the investigator to explore the fiscal implications of ageing and immigration under different assumptions about the allocation of the tax burden across generations. The findings of these studies are summarized in table 1. All of them find that higher taxes will be required to preserve

Table 1: Change in Taxes Required for Fiscal Sustainability

	All Burden on Future Generations	**Immediate Change**
EU (Fehr et al 2004 a, b)[1]		
Base Case	+ 27.0 % points	
Double Immigration	+ 24.6 % points	
Italy (Moscarola 2001)[2]		
Zero Immigration	+ 24.75%	
50,000 Immigration	+ 20.17%	
Germany (Bonin et al 2000)[3]		
Zero Immigration	+ $244,600 life-time	
200,000 Immigration	+ $176,400 life-time	
Spain (Collado et al 2003)[4]		
Zero Immigration	+ 47.8%	+ 8.8%
60,000 Immigration	+ 34.5%	+ 7.9%

Notes: 1. Social security plus wage tax; the changes shown occur over the period 2000-2100; they are taken from table 10 of Fehr et al (2004a); identical figures are given in table 4 of Fehr et al (2004b). 2. Moscarola (2001), table 2, Low Demographic Scenario. 3. Bonin et al (2000), page 16. 4. Collado et al (2003), table 3.

government solvency in the future. However, the size of the required tax increase depends on how the burden is spread between generations. If fiscal reform is implemented immediately then existing generations bear much of the cost of adjustment, and the required increase in tax rates is quite small even in countries facing demographic collapse. The potential contribution of immigrants is also quite small under these conditions. An alternative approach is to assume that the entire cost of adjustment is born by future generations, i.e. natives who have not yet been born and immigrants who have not yet arrived. This means that existing immigrants and natives pay none of the costs required to preserve solvency. Under these conditions, the burden on future generations

[2] This quotation is taken from the October 2003 version of a paper which is no longer available on the internet. It has been cut out of the shorter abstract which is printed in (Fehr et al 2004a).

[3] Bonin (2000, 2001), Moscarola (2001) and Collado (2003).

of natives is much greater. The fiscal contribution of immigration is also much greater since future immigrants, like future natives, will be heavily taxed.

II. Simulations

The literature surveyed above raises many different issues. In section we use a simple simulation model to explore some of them. Specifically, we consider how the following factors influence the scale and timing of the tax changes required to maintain government solvency:

- The allocation of the fiscal burden between generations.
- Immigration.
- The future birth rate.
- The future growth of employment.

The model we use for our simulations is a stylized version of a low fertility, low employment economy. With regard to these variables our model economy is similar to some of the countries of Southern Europe such as Italy and Spain. However, this analogy should be treated with caution. The model is highly simplified and is not intended to be an accurate reflection of any actual economy.

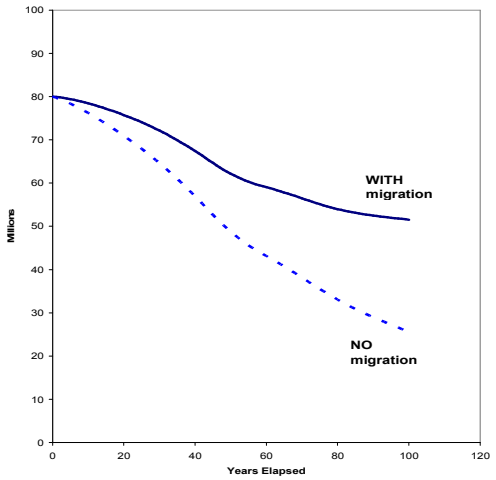
The Main Scenario

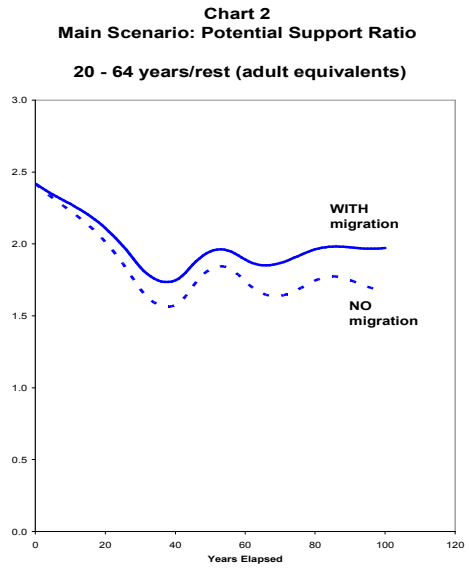
We begin by exploring the role of tax reform and immigration policy in a hypothetical economy that has permanently low fertility and permanently low employment. These assumptions will be modified later. Full details about the assumptions and methods used to generate our results are given in an appendix. Here we present only the bare outlines.

The hypothetical economy has a population in the base year of 80 million, of which an unspecified number are immigrants. All members of this initial population are classified as natives. It is assumed that future immigrants and their descendants form a distinct population that does not interbreed with the initial native population and its descendants. For simplicity, we shall refer to the former group as immigrants and the latter group as natives. This terminology is unambiguous since there is no interbreeding between the two groups. The total fertility rate of natives in the future is assumed to be 1.4 in perpetuity and that of immigrants to be 2.1 in perpetuity. Thus, there is no convergence in the fertility of the two groups. These are somewhat unrealistic assumptions but they simplify the analysis without greatly affecting the results.

The age structure of the population in the base year reflects the fact that the birth rate has fallen sharply in the recent past. There are relatively few young or old people and there is a bulge in the middle years. In the absence of immigration the society will age in the near future and the population will decline. Over the longer run the age structure will stabilize but the population will continue to fall. Charts 1 and 2 show what happens to population and the age structure of society during the first century following the base year. The indicator of age structure shown in chart 2 is a variant of the "potential support ratio".

The variant shown here is more informative than the conventional version because it takes into account children in addition to older people.





To explore the implications of immigration we assume net inward migration of 300 thousand a year. Most immigrants are between 20 and 40 years of age and half of them are female. As can be seen from charts 1 and 2, immigration on this scale is not sufficient to prevent a substantial decline in population over the period shown, nor does it prevent a significant ageing of the population. Even so, it produces a dramatic change in the character of the society. Within a hundred years immigrants outnumber natives.

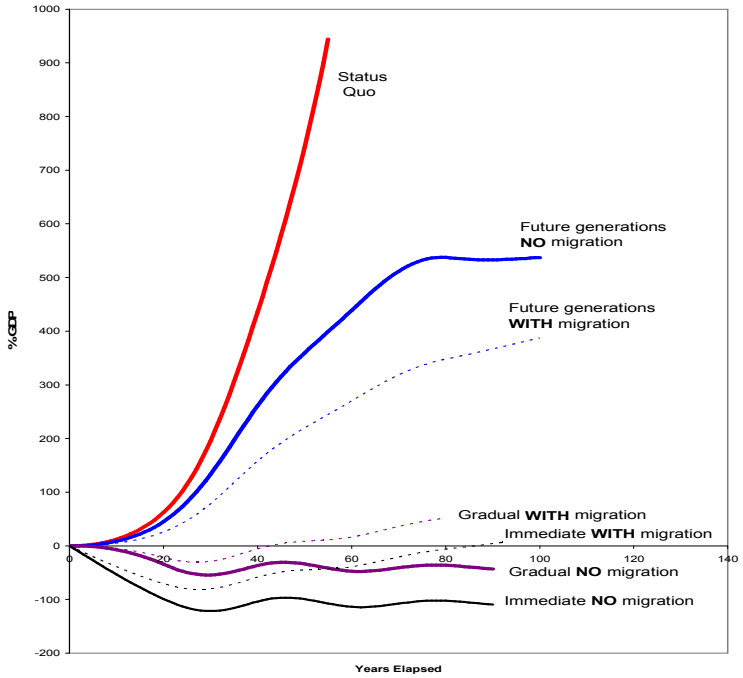
We also make the following assumptions. Output per employed person ('productivity') and real earnings rise at 1.5% per annum. Non-employed persons aged 60 years and over and the parents of children under 20 years of age receive a transfer payment from the government. There are no other government transfer payments. Government consumption is a constant fraction of GDP. All employment earnings and transfers are taxed at the same uniform rate. The real rate of interest on future government debt is assumed to be 4% per annum. There is no tax on government interest payments. In the base year, tax revenue is exactly equal to public expenditure and the government debt is zero. To achieve this result the tax rate in the base year is set equal to 39.7%.

Immigration is assumed to have no impact on the employment and wages of natives. Thus, any employment that immigrants obtain is strictly additional to the jobs that natives would have had in the absence of immigration. Immigrant workers are assumed to have the same productivity and receive the same wages as native workers; moreover, immigrants and natives have the same employment rates. In each case, 65% of 20–59 year olds and 25% of 60-64 year olds have a job. These percentages remain constant through time. No-one else is employed. These assumptions imply that 56.2% of the population aged 15-64 years of age are employed in the base year. This is similar to the

figure currently observed in Italy. Immigrants and natives pay the same tax rates and have the same transfer entitlements.

Sustainability.
The scenario we are considering here has a number of variants. Under the "Status Quo" variant there is no immigration and no future alteration in tax rates, or in the rules governing transfer payments or in the share of government consumption in GDP. The initial tax rate of 39.7% may be sufficient to ensure that government revenue covers expenditure in the base year, but it is not adequate for this purpose in later years. As the population ages, there is a rapid increase in the amount paid out in pensions, and at current tax rates there is a reduction in tax revenue as the workforce shrinks. These effects greatly outweigh the savings on transfer payments for children arising from the low birth rate. The government budget develops a growing deficit which must be covered by borrowing. As a result, the ratio of government debt to GDP explodes without limit (Chart 3).

Chart 3
Government Debt under Alternative Tax Regimes
Main Scenario



Such a situation is unsustainable and to prevent an explosion in public debt there must be an improvement in government finances. This can be achieved in a variety of ways. Here we shall consider two possibilities: higher taxes and immigration. We shall continue to assume that there is no change in the share of government consumption in GDP and that the rules governing pre-tax transfer payments are unchanged. Likewise, there is no change in employment and fertility rates amongst natives and immigrants. Table 2 presents a number of ways in which the financial viability of the government can be restored through some combination of immigration and tax reform. In each case, it shows what tax rate is required to prevent an indefinite explosion in the ratio of

government debt to GDP[4]. Three basic variants are shown, each of them with and without migration. The first variant assumes that anyone who was already in the country in the base year is exempt from additional taxation. Such people may have been born in the country or abroad. Either way, they belong to "present generations" and they pay no extra tax under this variant. The entire cost of adjustment is born by future generations, consisting of natives not yet born and the future immigrant community. Such adjustment takes the form of a supplementary tax levied proportionately on the earnings and transfers received by all future generations. This is the variant normally stressed by the exponents of Generational Accounting. The second variant assumes that there is an immediate increase in tax rates affecting present and future generations alike. In the third variant taxes are increased gradually over a twenty year period.

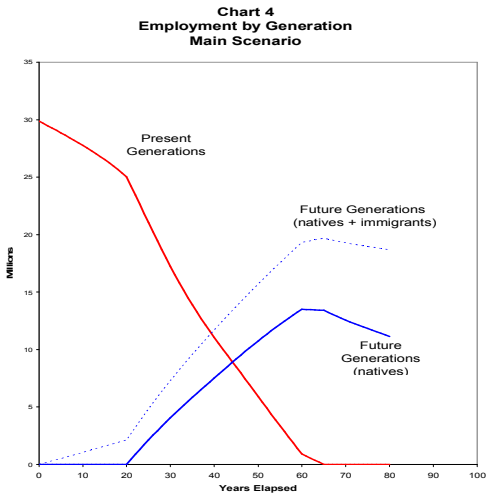
Table 2: The Main Scenario - Tax Rates

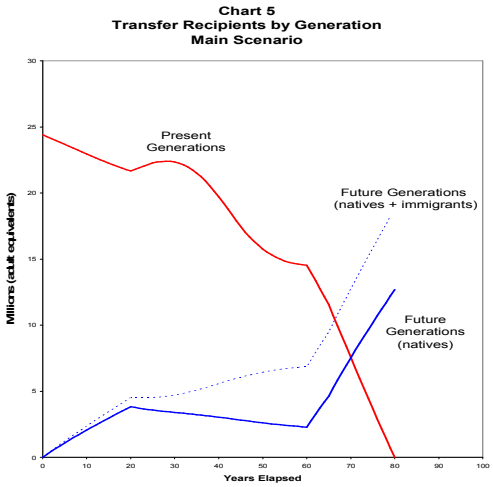
	No Migration	With Migration	Effect of Migration
Status Quo	39.7		
Future Generations	59.3	48.8	-10.5
Immediate	43.7	42.7	-1.0
Gradual	45.3	43.7	-1.6

Only Future Generations Pay

If only future generations shoulder the burden a huge tax increase is required to balance the books. The tax rate must rise from 39.7% to 59.3% when there is no migration and to 48.8% when there is migration. The explanation for such large tax increases is as follows. Under this variant the burden of adjustment is born entirely by future generations who have either not yet been born or not yet arrived in the country. As a result, the bulk of the population during the initial decades following the tax reform consists of people whose earnings and transfer receipts are exempt from extra taxation. Depending on whether or not there is migration, present generations account for a majority of the employed workforce during the first 40 to 45 years and they absorb a majority of transfer payments during the first 65 to 70 years (Charts 4 and 5). Since these people do not pay any additional taxes, the effect of the tax reform will only really be felt after some decades when future generations begin to appear on the scene in large numbers. In the meantime, the tax reform will have little effect on the public deficit and the growth of government debt (Chart 3).

[4] The required figure is calculated by finding the tax rate that makes the discounted sum of primary government expenditure equal to the discounted sum of government receipts. The summation is done over a period of 500 years.





The fiscal contribution of immigrants under this variant is substantial. During the early decades they are almost the only people who pay the large tax supplement that is levied on future generations. Moreover, because the newcomers are mostly of working age they initially receive few transfers from the government. The immigrants therefore generate a large fiscal surplus which helps to slow down the build up of government debt during the initial decades. However, the government must still borrow heavily during this period and it ends up with a huge debt which must eventually be serviced. To pay the interest on this debt requires a huge surplus of taxes over transfers and government consumption. In the absence of immigration interest payments on the government debt eventually rise to more than 20% of GDP. With immigration the figure is around 10% of GDP. These are the payments that higher taxes must finance.

The above argument can be summarized as follows. If only future generations shoulder the burden of tax reform there is only a small number of people whose taxes can be increased during the initial decades of the reform programme. As a result, the government budget remains in deficit for long time and there is a huge build up of debt which future generations must eventually service. The importation of working-age migrants helps to ease this problem, but it remains very serious even with a high and sustained level of immigration.

Critique and Alternatives

The assumption that only future generations pay is unrealistic for two reasons. Firstly, it implies a spectacular build up of government debt that would never be allowed to occur in practice. Within a few years the government would be forced to do something about it. Secondly, the tax policy implies that people working alongside each other with similar incomes would pay very different tax rates. Likewise, there would be very different tax rates levied on the transfers received by people of similar ages and economic circumstances. Moreover, future immigrants would have to pay much higher taxes than present generation natives of the same age and in the same economic situation. This kind

of policy exists in Singapore, where immigrants must pay a fee for the right to work, but it is not the practice in Europe. If working immigrants and their families are treated in the same way as natives from the present generations, then most of the benefits from immigration disappear. The large fiscal surplus from immigration in this variant arises from the fact that immigrants pay much higher taxes than present generations of natives. None of these points is brought out in the generational accounting literature on the fiscal implications of low birth rates.

If taxes are raised immediately and uniformly for all generations, then a relatively small increase is required - from 39.7% to 43.7% without migration and to 42.7% with migration. Alternatively, taxes can be phased in gradually to ease the pain. If there is 20 year transition period, the eventual tax rate is 45.3% without migration and 43.7% with migration. There are fairly large increases but they are much smaller than the huge changes that are required when it is assumed that only future generations pay. They are also similar in magnitude to the kind of increases that have been observed in some European countries in the not too distant past. It must also be taken into account that real incomes are rising all the time in this model because of productivity growth. In the absence of tax reform, the real value of net earnings and transfers would rise at a steady 1.5% per annum. With the gradual reform program envisaged, the rate of increase would be reduced to 1.0% per annum during the first twenty years without migration and 1.15% with migration, after which earnings and transfers would resume their trend growth rate. In practice, changes of this magnitude would be achieved through a complex of measures of which tax increases would be only a part. We shall not explore this issue here.

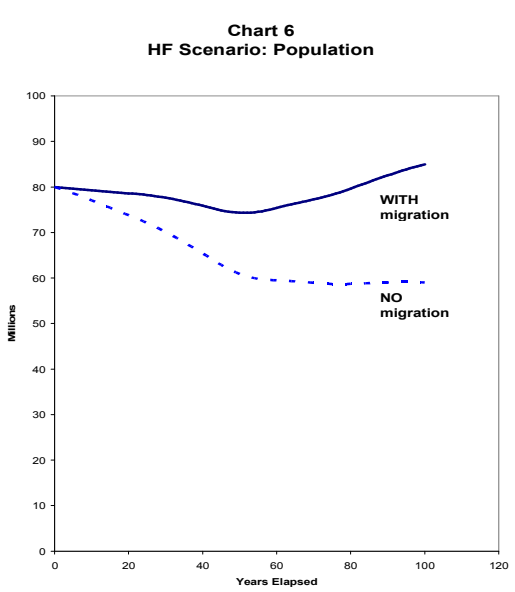
The reason why the required tax increases are relatively small under these variants is simple. By bringing present generations into the tax net they multiply many-fold the number of people who are subject to higher taxes during the initial decades. As a result, only a relatively small tax rise is needed to generate a large amount of revenue. Indeed, there is so much additional revenue that the government runs a primary surplus which enables it to become a net creditor and build up a substantial financial reserve of "negative debt" (chart 3). The fact that tax rates are relatively low under these variants also explains why the fiscal benefits of immigration are relatively small. Most of the taxes paid by the immigrant community return to this community in the form of transfers and government services. Tax rates are much higher under the "only future generations pay" variants with the result that future generations, both native and immigrant, pay far more in taxes than they receive back from the government. This surplus is used service the huge debts incurred by the government during the early decades when it borrowed heavily to finance the pensions of the early generations of natives. Immigrants are valuable because they share the large fiscal burden that falls on future generations. Under the alternative variants the government does not incur a huge debt and the fiscal burden on future generations is relatively small. Immigrants are less valuable because the burden which they share is much smaller.

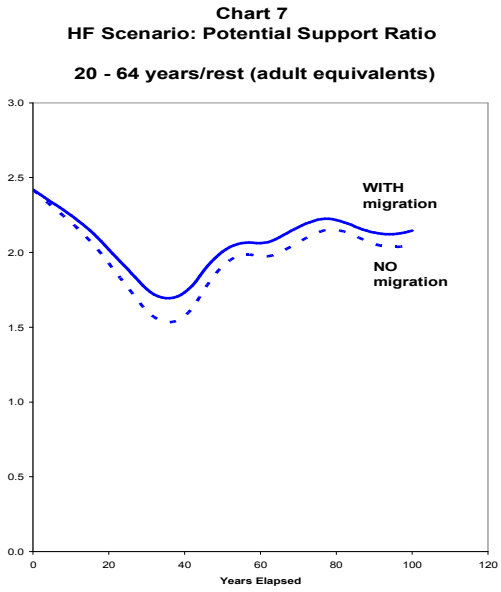
Alternative Scenarios

We shall now explore some alternative scenarios. These are derived from the Main Scenario by modifying the assumptions about future fertility and employment.

The HF(High Fertility) Scenario.

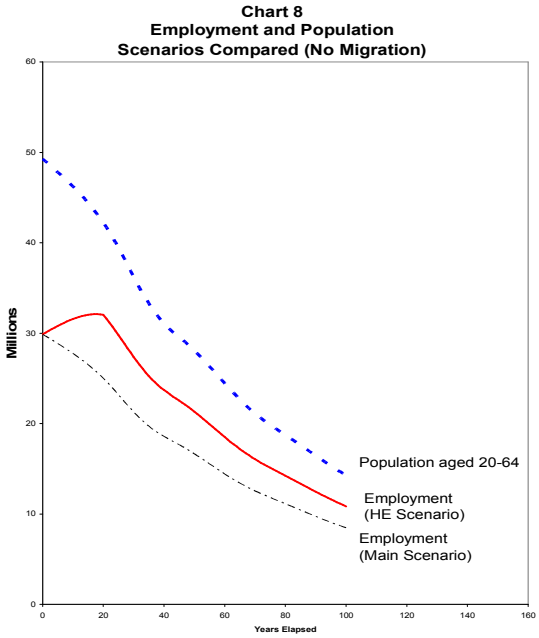
Under this scenario, the total fertility rate of the native population gradually increases from 1.4 in the base year to reach 2.1 after 20 years, after which it remains constant at the new level. The effect of this on population and age structure is shown in charts 6 and 7. As in the Main Scenario there is still a rapid decline in the native population in the initial decades, but this eventually comes to a halt and the native population levels out at about 60 million. There is also a sharp decline in the potential support ratio but this is partially reversed after a few decades. It is interesting to note that under this scenario immigration has a considerable effect on population size but not much affect on the long-run age structure. The latter result is due to the fact that the fertility of immigrants and natives eventually converges.

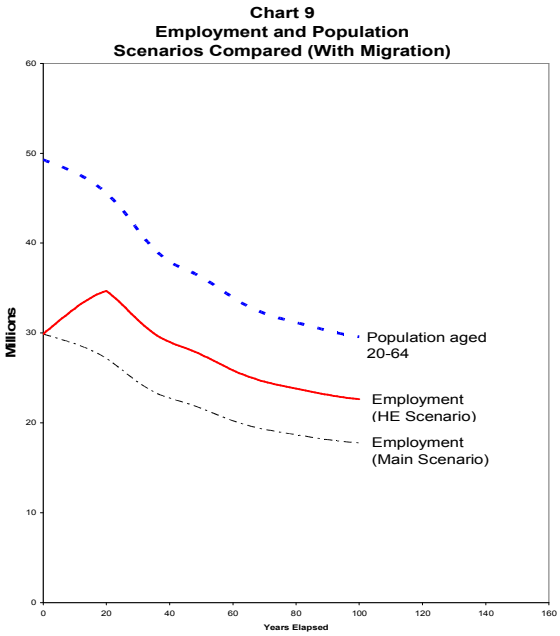




The HE (High Employment) Scenario

Under the Main Scenario native employment falls roughly in line with the working age population at a rate of 0.88% per annum during the first twenty years. Under the HE Scenario we assume that native employment increases at 0.35% per annum during this period. Since the working age population is falling, this results in a substantial increase in the proportion of natives in this age group who have a job. If there is immigration it is assumed that age-specific employment rates amongst immigrants increase in line with those of the native population. To achieve such an outcome, total employment in the economy as a whole must increase at 0.75% per annum during the first twenty years. Charts 8 and 9 plot what happens to employment under this scenario.





Results

The effects of these modifications are shown in table 3. This table also presents the results of other modifications that are discussed below.

The main points to note are as follows. The impact on taxes of higher fertility is much less than the impact of higher employment. Only a modest increase in the absolute level of employment in the first twenty years is enough to restore government solvency without any immigration at all and without any rise in tax rates. Yet even a complete recovery in fertility to the replacement level is nowhere near sufficient on its own to restore solvency. Indeed, if we focus on the immediate and gradual variants, which are the most realistic, the impact of higher fertility is very small. It reduces the required tax rates by 0.3 to 0.9 percentage points. Raising the birth rate of natives may be an effective way of boosting population, but its fiscal impact is quite small.

Migration

The above simulations are based on an optimistic view of migration. They assume that immigrants and their descendants are in every way the same as natives except that they are on average younger and have higher age-specific fertility rates. They also assume that there are no fiscal costs or economic dislocation arising from immigration and that the path of future native employment is totally unaffected by immigration. These assumptions guarantee that immigration generates a fiscal surplus for the native population. The positive fiscal effects shown in the upper part of table 3 derive entirely from the fact that immigrants and their descendants are on average younger than the native population. These effects do not incorporate the potentially negative aspects of migration.

Table3: Tax Rates Under Alternative Scenarios			
	No Migration	With Migration	Effect of Migration
Status Quo	**39.7**		
Main Scenario			
Future Generations	59.3	48.8	-10.5
Immediate	43.7	42.7	-1.0
Gradual	45.3	43.7	-1.6
HF (High Fertility) Scenario			
Future Generations	51.3	46.3	-5.0
Immediate	43.2	42.4	-0.8
Gradual	44.4	43.1	-1.3
HE (High Employment) Scenario			
Future Generations	39.7	36.2	-3.5
Immediate	39.7	38.4	-1.3
Gradual	39.7	38.3	-1.4
HEC (High Employment, Costly Immigration) Scenario			
Future Generations	39.7	42.7	+3.0
Immediate	39.7	40.3	+0.6
Gradual	39.7	40.7	+1.0

In practice, immigration on the scale assumed in this paper often contains a high proportion of people with low educational qualifications and language difficulties. There is often a low participation rate amongst women, while both men and women may face discrimination from the native population. As a result, employment rates may be comparatively low amongst the immigrants and they may require a great deal of financial support from the government. When they do get jobs this may be at the expense of native workers whose employment opportunities are thereby reduced. In the course of time there may be partial or complete assimilation so that natives and immigrants become very similar. Indeed, they may gradually merge into one undifferentiated population. In this way, many of the negative features of large-scale immigration may gradually disappear. However, such a development is not without its problems. One of the attractions of immigration is that immigrants may have relatively high age-specific fertility rates which help to offset the low birth rates of natives. If the immigrants assimilate, then their birth rates will decline and they may eventually come to resemble those of the natives, thereby removing one of the fiscal attractions of immigration. More generally, whether the immigrants assimilate or not, their entry may depress employment amongst natives. If there is a shortage of workers, the possibility of boosting the labour force through immigration may divert attention from the need to encourage more natives to enter the labour force and seek employment.

There are many different ways in which the analysis could be modified to take account of these points. Here we shall simply present a scenario in which immigration has a

negative fiscal impact. This is a modified version of the HE Scenario which is called the HEC (High Employment, Costly Immigration) Scenario. The modifications are as follows. In the original HE Scenario it is assumed that immigrants and natives have the same age-specific employment rates, wage rates and productivity. In the modified version these variables are all lower by a factor of 0.8 for immigrants than for natives. Moreover, total employment does not increase as a result of immigration, so that any jobs that immigrants get would otherwise have been taken by natives. Finally, the total fertility rate of immigrants is 1.8 instead of 2.1 as in the HE Scenario. Remember that the term 'immigrant' includes the descendants of immigrants as well as new arrivals. These are quite extreme assumptions. They do not cover the whole gamut of problems associated with large scale immigration but they are a substantial departure from the optimistic assumptions which underlay the preceding analysis.

The effect of these modifications on government finances can be seen in Table 3. As expected, immigration under the HEC Scenario has a harmful fiscal effect. However, if we ignore the unrealistic Future Generations variant and confine attention to the other more realistic variants, the net burden of immigration is small: at most 1 extra percentage point on the tax rate. This is an interesting result considering the very pessimistic assumptions about migration that underlie the HEC Scenario. More generally, the results shown in table 3 suggest that migration does not have a very big fiscal effect either way, positive or negative. If we ignore the unrealistic Future Generations variant, the effect of migration is to alter the tax rate by -1.6 to +1.0 percentage points, depending on the scenario concerned. This is small in comparison with the scale of migration involved and its impact on total population and social composition.

III Conclusions

This paper has explored the fiscal problems caused by ageing in a low fertility, low employment economy. It has considered how various factors influence the tax increases required to ensure government solvency. Of these factors by far the most important is employment growth. Raising the growth rate of employment quickly widens the tax base and reduces the volume of government transfers. In a low employment economy the scale of such an effect may be so great as to eliminate entirely the need for higher tax rates. The fiscal effects of a higher birth rate or immigration are relatively small because they require such a long time to come on stream. Under the conditions assumed in the model, an increase in the birth rate has a positive fiscal effect, whereas the effect of migration may be positive or negative depending on the type of immigration and the extent to which immigrants are absorbed into the labour market without displacing local workers.

The paper has also explained why it is misleading to use the standard assumption of Generational Accounting that only future generations shoulder the burden of fiscal adjustment. In an economy with low fertility and low employment, this assumption may give rise to a huge and unsustainable increase in public debt during the initial years despite the implementation of tax reform. Moreover, the resulting tax regime would contravene the basic non-discriminatory principles that currently inform tax policy in

western democracies. The assumption that only future generations pay leads to an exaggerated view of the fiscal crisis due to ageing. It is also leads to an exaggerated estimate of the fiscal contribution of immigrants. Under the more realistic assumption that present generations share in the cost of adjustment, a much smaller tax increase is required to ensure government solvency, and the estimated contribution of future immigrants shrinks accordingly.

Bibliography

Access Economics (2001), *Impact of Migrants on the Commonwealth Budget*, Summary Report, 2000-01 Update, Canberra, Department of Immigration and Multicultural Affairs,

Auerbach, A. and P. Oreopoulos (2000),"The Fiscal Effects of U.S. Immigration: A Generational-Accounting Perspective", in J. Poterba, (ed.), *Tax Policy and the Economy* 14, 123-56.

Bonin (2000), H., B. Raffelhűschen and J. Walliser, "Can Immigration Alleviate the Demographic Burden", *FinanzArchiv* 57(1), pp. 1-21.

Bonin, H. B. (2001), *Fiskalische Effecte der Zuwanderung nach Deutschland: Eine Generationenbilanz***,** Discussion Paper No. 305, April, IZA Bonn.

.

Borjas, G. J. (1994), "The Economics of Immigration", *Journal of Economic Literature*, 32, December, pp. 1667-1717.

Collado, M. D., Iturbe-Ormaetxe, I. and G. Valera (2003), "Quantifying the Impact of Immigration in the Welfare State", Mimeo.

Ekberg, J. (1999). "Immigration and the Public Sector: Income Effects for the Native Population in Sweden." *Journal of Population Economics* 12 (278 - 297).

Fehr, H., Jokish, S. and L. Kotlikoff (2004a), "The Developed World's Demographic Transition – The Roles of Capital Flows, Immigration , and Policy", forthcoming in R. Brooks and A. Razin (ed.), *The Politics and Finance of Social Security Reform,* Cambridge, Cambridge University Press.

Fehr, H., Jokish, S. and L. Kotlikoff (2004b), "The Role Immigration in Dealing with the Developed World's Demographic Transition",Working paper 10512, National Bureau of Economic Research

Gott, C. and Johnson, K. (2002) *The Migrant Population in the UK: fiscal effects*. Home Office Research, Development and Statistics Directorate Occasional Paper No 77. London, Home Office.

Huddle, D. (1993), "The Net National Cost of Immigration", Houston, Rice University, mimeo.

Immigration Research Programme (1999), *Fiscal Impacts of Migrants to New Zealand,* Department of Labour, New Zealand.

.

Lee, R. and T. Miller (1998), "The Current fiscal Impact of Immigrants: Beyond the Immigrant Household", in J. Smith and B. Edmonston (eds.) *The Immigration Debate*, Washington, DD, National Academy Press.

Lee, R. and T. Miller (2000), "Immigration, Social Security, and Broader Fiscal Impacts", *American Economic Review: Papers and, Proceedings*, Vol. 90, No. 2, 350-354.

Moscarola, F. C. (2001), "The Effects of Immigration Inflows on the Sustainability of the Italian Welfare State", CEPR Working Paper 6/01, Center for Research on Pensions and Welfare Policies, Turin.

Passel, J. S., (1994), *Immigration and Taxes, a Reappraisal of Huddle's The Cost of Immigrants*, Washington, DC, The Urban Institute, mimeo.

Pederson, L. H. (2002), "Ageing, Immigration, and fiscal Sustainability", DREAM, Copenhagen, mimeo.

Roodenburg H. J., Euwals, R. and H. Ter Rele, (2003), *Immigration and the Dutch Economy'*, The Hague, CPB Special Publications, Sdu. http://www.cpb.nl/eng/pub/bijzonder/47/bijz47.pdf

Roodenburg H. J. (2003), "Immigration", CPB Report 2003/2, The Hague, CPB, p.3

Rothman, E. S. and T. J. Espenshade (1992). "Fiscal Impacts of Immigration to the United States." *Population Index* 58(3): 381 - 415.

Smith, J. P. and B. Edmonston, Eds. (1997). *The New Americans. Economic, Demographic and Fiscal Effects of Immigration*. Washington DC, National Academy Press.

Storesletten, K. (2000), "Sustaining Fiscal Policy through Immigration," Journal of Political Economy, vol 108 (2), pp 300-324.

Storesletten, K. (2003), "Fiscal Implications of Immigration—A Net Present Value Calculation", *Scandinavian Journal of Economics*, September, Vol. 105 (3), pp. 487-506.

Ter Rele, H. (2003), "The fiscal Impact of Immigration", CPB Report 2003/2, The Hague, CPB, pp 23-28.

United Nations (2001). *Replacement Migration: Is it a Solution to Declining and Ageing Populations?* New York, United Nations.

Wadensjö, E. 'Economic Effects of Immigration' in Coleman, D. A. and E. Wadensjö (1999). *Immigration to Denmark: International and national perspectives*. Aarhus, Aarhus University Press. pp.290-328.

Weber, R. and T. Straubhaar (1996), "Immigration and the Public Transfer System: Some Empirical Evidence for Switzerland", *Weltwirtschaftliches Archiv,* Vol. 132 (2), 330-355.

Appendix: Description of the simulations

The major assumptions that underlie the simulations are described below. Most of them are common to all simulations although individual assumptions are modified as required in order to explore a particular issue.

Population and Fertility. In the base year ($t = 0$) the national population is 80 million, of which half are men and half women. All persons living in the country at this time are classified as natives. Future immigrants are assumed to form a distinct community that does not interbreed with the native population. The native population consists of anyone who was in the country at time $t = 0$ or is descended from such a person. The immigrant community consists of anyone who entered the country after that date or is descended from such a person. Each woman in the age range 20-39 years has one child in year t with probability $TFR_{native}(t)/20$ if she is a native and $TFR_{immigrant}(t)/20$ if she is a member of the immigrant community, where TFR stands for "total fertility rate". Half of all children are female and the probability that a given child will die immediately after birth is equal to 0.1/2.1. Children who die at birth are not included in the population total. All surviving children live to exactly 80 years of age and then die. These assumptions ensure that for any sub-population (native or immigrant) with a constant TFR equal to 2.1, its long-run natural growth rate is zero. Under the most scenarios the TFR of natives is equal to 1.4 and that of immigrants is equal to 2.1 from the base year onwards. Under the HF Scenario the birth rates of natives increase linearly over a twenty year period by the same proportionate amount for all age groups and remain constant thereafter. Under the HEC Scenario the TFR of immigrants is equal to 1.8.

Age Distribution. Unless otherwise specified, the age distribution in the base year ($t = 0$) is determined as follows. At time $t = -30$ the population is distributed in the equilibrium proportions corresponding to a TFR of 2.5. This means that there are more young people than old. Over the next fifteen years the TFR falls linearly to a new value 1.4 and remains constant until $t = 0$. The effect of immigration on the age structure during this period is ignored. These assumptions imply that there are relatively few old and young people in the base year population. There is a bulge in middle range. The future age distribution depends on total fertility rates and on the scale and age composition of immigration. It is assumed that 15% of newly arrived immigrants are in the age range 0-19 years, 70% in the range 20-39 years and 15% in the range 40-79 years. Within these ranges the age distribution of newly arrived immigrants is distributed uniformly.

Wages, Productivity and Employment. All income generated in production is distributed in the form of wages. At time $t = 0$, productivity (output per employed person) and wages are both equal to 1. From then onwards the productivity and wages of native workers grow at the constant rate of 1.5% a year. In most scenarios, the wages and productivity of workers from the immigrant community, and age-specific employment rates in the community, are assumed to equal to those of the native population. It is also assumed that there are no fiscal costs or economic dislocation arising from immigration and that the path of future native employment is totally unaffected by immigration. The assumptions regarding immigration are modified in the HEC Scenario. In particular, it is

assumed in the HEC Scenario that no additional employment is created when immigration is permitted, so that any jobs that migrants obtain are at the expense of natives.

Government Accounts. Public consumption absorbs 15% of GDP. Non-working adults aged 60 years or over receive a transfer payment which is equal to 50% of the pre-tax wage and there is a transfer for each child less than 20 years of age equal to one third of the pension. There are no other transfer payments. Transfer payments are taxed as the same rate as earnings. The government begins with zero net assets and with a zero budget balance at time $t = 0$. In future years, it earns (or pays) a real interest rate equal to 4% p.a. on its net assets. Government interest payments are not taxed, and interest payments to the government are not subject to tax relief.

The above assumptions are summarized in Table A1. In addition to the Main Scenario, information is provided about the following scenarios: HF (High Fertility), HE (High Employment), and HEC (High Employment, Costly Immigration). These scenarios are the same as in the Main Scenario except where otherwise indicated.

Finding the Tax Rates

The net present value of government net revenues over the time period [*0, T*] *is* given by the following equation

$$NPV(T) = \sum_{t=0}^{t=T} (1+r)^{-t} (R_t - E_t)$$

where R_t and E_t are gross tax revenue and expenditure in year t. It is a standard proposition of public finance that tax rates must be such that $NPV(T)$ tends to zero as T tends to infinity. In practice this is taken to mean that $NPV(T) = 0$ for some large value of T. In this paper we take $T = 500$. The task is then to find tax rates that satisfy the conditions of the problem and ensures that $NPV(500) = 0$. These are the tax rates shown in Tables 1 and 2. Note that in the Future Generations variant, present generations pay the status quo tax rate and it only the future generations who pay the new tax rates.

Table A1
Major Assumptions

	Alternative Scenarios			
	Main	***HF***	***HE***	***HEC***
Productivity & wage growth	1.5 % p.a.			
Real interest rate	4.0% p.a.			
Government consumption	15% GDP			
Pension	50% average pre-tax wage			
Child benefit	1/3 pension			
Net immigration	200,000 p.a.			
Native TFR	1.4	Rising to: 2.1		
Immigrant TFR	2.1			1.8
Native employment (% age group): 0-19 years 20-59 years 60-64 years 65+	 0 65.0 25.0 0		Rising to: 0 80.2 50.0 0	Total employment the same as native employment under HEC
Immigrant employment	Additional to native employment			Replaces native employment
Immigrant/native age-specific employment rates	1.0			0.8
Immigrant/native wage ratio	1.0			0.8
Immigrant/native productivity ratio	1.0			0.8
Base Year (t = 0)				
Population	80 million			
Government budget balance	0			
Net government debt	0			
Wage rate	1			
Output per employed person	1			
Tax rate (%)	39.7			