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GENERATIONAL ACCOUNTS FOR THE UNITED KINGDOM

Generational accounts show the net discounted life-time contribution, positive or negative, that people, as a function of their age, are expected to make to the Exchequer. Receipts include both welfare benefits and public consumption (allocated by age as far as possible) while payments are largely comprised of taxes.

Generational Accounts for the United Kingdom[1]

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Summary

Generational accounts show the net discounted life-time contribution, positive or negative, that people, as a function of their age, are expected to make to the Exchequer. Receipts include both welfare benefits and public consumption (allocated by age as far as possible) while payments are largely comprised of taxes.

The requirement that the government should be solvent- that its existing net assets plus the present discounted value of future receipts net of payments- should equal zero makes it possible to calculate the generational account of future generations consistent with this. Future generations are treated less favourably than current generations if the present discounted sum of payments by future generations is larger than that faced by current new-born children.

The framework of generational accounts makes it possible to estimate not only the generational imbalances described above, but also the tax changes needed. We distinguish the intergenerational balance gap from the intertemporal budget gap. The former assumes that current and future new-borns are all treated in the same way and calculates the tax change needed for this. The latter is the tax change needed for solvency without any requirement that all future generations should be treated in the same way.

We show that our results are not particularly sensitive to the existing national debt. This reflects the fact that the main driver of generational imbalance is pay as you go finance of age-related expenditures such as health and welfare benefits for old people rather than the past history of government borrowing.

However, estimates of the generational gaps are typically very sensitive to the interest rates used in the calculations. Nevertheless, the tax adjustments needed are not very sensitive to these and are therefore more satisfactory as indicators of possible budget imbalance.

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The calculations inevitably depend on assumptions about future population structure and about spending associated with people of different ages. Some components of spending, such as pension payments, are clearly policy driven. Others such as health spending are sensitive to need. We explore a number of alternatives, including different assumptions about benefit policies, and also compare the assumption that health spending on people aged 65 and over is age-related with the alternative that it is related to proximity to death and thus to mortality rates. All our simulations reflect the policy announcements made in the June 2010 Budget but not those made since then.

Our base simulation, with a real interest rate of 3% p.a. suggests that taxes need to rise by 15.4% to deliver intergenerational budget balance and by 17.1% to deliver intertemporal budget balance. This is equivalent to a shortfall of 6-7% of GDP. The results of the alternative simulations are compared to the base in

Table 1.

Table 1 Summary of Generational Accounts and Tax Changes required for Intergenerational and Intertemporal Balance

	Generational Account		Percentage change in taxes		Tax change as per cent of GDP	
	Current new-born child	Future new-born child	Intergen-erational balance	Intertem-poral balance	Intergen-erational balance	Intertem-poral balance
Base	£68,375	£159,668	15.4%	17.1%	5.9%	6.6%
No National Debt	£68,375	£150,299	13.7%	15.3%	5.3%	5.9%
Interest rate 2.2% p.a.	£46,146	£149,054	16.3%	14.5%	6.3%	5.6%
Mortality-related Health Spending	£82,557	£150,773	11.2%	12.9%	4.3%	4.9%
Non age-related benefits fixed in real terms	£119,300	£140,386	1.8%	-1.9%	0.7%	-0.7%
Retirement age 67 from 2027	£75,150	£155,759	13.3%	15.0%	5.1%	5.8%

Generational Accounts for the United Kingdom

1. Introduction

This article presents generational accounts for the United Kingdom based on the state of the economy as seen in the Office for Budget Responsibility Budget 2010 forecast together with information provided by a range of departments on the age profiles of tax revenues, benefit payments and government spending. The accounts themselves indicate the present discounted value of the net payments (i.e. taxes less benefits received and public spending to their benefit) that the average individual classified by age is expected to make to the exchequer over their remaining life-time. These figures reflect the fact that people tend to be net recipients before they start work and after retirement and net contributors while they are of working age; both the flow in any year and the generational account reflect this life-cycle pattern.

A key feature of these accounts is that, taken together with the constraint that, over time, even if not in any one year, the government's budget must balance means that, given knowledge about the overall contributions of people currently alive, the net overall contribution of future generations can also be worked out. This provides a means of assessing whether and how far fiscal policy favours current generations relative to future generations or *vice versa*. It is also possible to provide summary estimates of the fiscal adjustment needed so that after adjusting for expected economic growth current and future generations face an equivalent burden. However it always needs to be remembered that generational accounts provide only one possible means of assessing the long-term fiscal position.

This article begins by describing generational accounts formally and explaining how they can be used to provide an indicator of the fiscal position. This is followed by the presentation of results for the United Kingdom. These results show the position as we infer it in the light of the OBR report and also present some variants to illustrate the sensitivity of the results to different assumptions or to changes to the policy regime. A final section concludes.

2. The Basic Framework[5]

Generational accounts follow on from an analysis of the government's inter-temporal budget constraint. The implication of inter-temporal budget balance is that current and future government spending must be paid for out of 1) the current net wealth of the public sector (which may well be negative), 2) taxes net of transfers paid by people currently alive and 3) taxes net of transfers paid by people not yet alive.

Viewing the government's finances from this perspective offers a number of advantages over conventional government accounts. First of all, the method is invariant to changes in accounting conventions. National Insurance contributions are conventionally treated as current income and expenditure on benefits like state

[5] Sections 2 and 3 draw heavily on Cardarelli, Kotlikoff and Sefton (2000).

pensions as current expenditure. But it would be perfectly sensible to regard NI contributions as borrowing by the government which was then repaid as people drew their pensions. Plainly with this second approach reported government borrowing would be very different from the numbers that we are used to. Secondly, the method crystallises the issues associated with demographic change, because it takes account of the effects of changes in the number of people expected to be alive at any given age. Thirdly, it draws attention explicitly to the way in which the government budget may function as a means for transferring resources from future generations to the current and makes it possible, for example, to identify policy structures which do not have that property.

We define the generational account at time *t* of someone born in year *k* , $N_{t,k}$ as the average present discounted value of their net contribution to the exchequer, taking account not only of taxes and benefits but also of government consumption and investment provided for their benefit. Thus

$$(1) \qquad N_{t,k} = \sum_{s=\max(t,k)}^{k+D} T_{s,k}\left(P_{s,k}/P_{t,k}\right)(1+r)^{-(s-t)}$$

where κ=max(t,k). In expression (1) $T_{s,k}$ stands for the projected average tax payment, net of transfers and other public spending received by this representative individual to the government made in year s by a member of the generation born in year *k* measured in constant prices. The term $P_{s,k}$ stands for the number of surviving members of the cohort in year *s* who were born in year *k* and therefore the term $P_{s,k}/P_{t,k}$ indicates the proportion of members of cohort *k* alive at time *t* who will also be alive at time *s*. Hence, it represents the probability that a particular member of the year-*k* cohort who is alive in year t will survive to year *s* to pay the net taxes levied, on average, in that year on year-*k* cohort members. The term *r* is the government's real, before-tax, discount rate. Thus, $N_{t,k}$ is an actuarial present value. It represents the average present value of the amount of net taxes that members of cohort *k* will pay in the future, where the averaging is over not just net tax payments, but also over the probability of survival.

With this definition of the inter-temporal budget constraint, we can set out formally the intertemporal budget constraint in equation (2)[6]:

$$(2) \quad \sum_{s=0}^{D} N_{t,t-s}P_{t,t-s} + \sum_{s=1}^{\infty} N_{t,t+s}P_{t,t+s}(1+r)^{-s} = \sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t$$

The first summation on the left-hand side of (2) adds together the *generational accounts* of all people currently alive. The term $N_{t,k}$ stands for the present value of the average remaining lifetime net tax payment – the generational account measured on a per person basis -- at time *t* of the generation born in year *k*. The present value is formed as of year *t* for generations alive at time t and as of the year of birth for

[6] The constraint does not assume that government debt is ever fully paid off, merely that the debt grows less quickly than the rate of discount -- that it does not explode. Thus, it is consistent with the long-run existence of government deficits, as long as these deficits are smaller than the amount needed simply to service the level of outstanding debt.

generations not yet born. For example, $N_{t,t}$ is the time-t present value of lifetime net tax payments of those born at time t, i.e., it is the generational account of time-t newborns; $N_{t,t-65}$ is the present value of the average remaining lifetime net tax payments – the generational account -- of those who are 65 years olds at time t, and $N_{t,t+30}$ is the present value to the year of birth (t+30) of the average lifetime net tax payments – the generational account -- of those who will be born 30 years from year t.

The term $P_{t,k}$ stands for population of the generation born in year k. The index k in this summation runs from t-D (those aged D, the maximum length of life, in year 0) to t (those born in year 0). Thus this term adds together the generational accounts of each cohort weighted by the size of the cohort.

The second summation on the left side of (2) adds together the present values of the generational accounts of future generations, with k again representing the year of birth. As each of these generational accounts is expressed in pounds of the respective generation's birth year, they must be discounted back to year t in the summation using the government's real interest rate r.

On the right-hand side the first term shows those government purchases which are not allocated to individuals, again measured in real terms. In this summation the values of government purchases in year s, given by G_s, are also discounted to year t. The final term on the right-hand side, D_t^g, denotes the government's net debt – its financial liabilities minus the sum of its financial assets and the market value of its public enterprises.

It should be noted that the constraint does not assume that D_t^g is run down to zero. A government which is a net debtor does not need to pay off its debts in order to satisfy the inter-temporal budget constraint.

The basic set of generational accounts is simply the set of values of $N_{t,k}$. In principle these can be calculated separate for men and women. We carry out the underlying calculations separately for the two sexes; however we present only the results by age averaging across the sexes, with the averages reflecting the actual or projected population weights and survival factors.

3. Assessment of the Government's Fiscal Position.

This structure then offers a number of ways of exploring the sustainability of the fiscal position and the fiscal burden on future generations. We identify three indicators. First, we can compare the generational position of new-borns, $N_{t,t}$ with that required to balance the inter-temporal budget constraint. We denote the latter as $\overline{N}$ and assume that it grows in line with the trend rate of growth of real income *per capita*, g.

Then, to deliver inter-temporal balance we require

(3) $\sum_{s=0}^{D} N_{t,t-s} P_{t,t-s} + \sum_{s=1}^{\infty} \bar{N}(1+g)^s P_{t,t+s}(1+r)^{-s} = \sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t$ or

(4) $$\bar{N} = \frac{\sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t - \sum_{s=0}^{D} N_{t,t-s} P_{t,t-s}}{\sum_{s=1}^{\infty} (1+g)^s P_{t,t+s}(1+r)^{-s}}$$

If, now we find that $\bar{N} > N_{t,t}$, then the current fiscal position is unsustainable, in that, taking the generational accounts of current generations as given, future generations will have to make a net life-time burden larger than that imposed on them by current fiscal arrangements so as to meet the inter-temporal budget constraint.

It should be noted that the results of the calculation depend on the interest rate and the growth rate. If we assume that the long-run rate of growth of population is given as π, then the overall rate of growth of the economy exceeds the interest rate if $(1+g)(1+\pi)>1+r$.. In such circumstances the denominator in expression (4) is unbounded. This does not, however, imply that the value of $\bar{N}$ falls to zero, because it is likely that G_{t+s} will also grow at rate $(1+g)(1+\pi)$. Nevertheless, we can see that, with $(1+g)(1+\pi)>1+r$ the initial debt and the generational accounts of those currently alive have negligible impact on $\bar{N}$. All that matters is that, eventually, generational accounts are adequate to pay for future government spending.

Economists have long considered that the situation where $(1+g)(1+\pi)>1+r$ is unlikely to be observed in practice because a normal consequence of such a situation is that raising current consumption to reduce the current capital stock and thus drive up the interest rate results in higher consumption in both the short run and the long run (Phelps, 1961). However Abel *et al.* (1989) showed that this principle applied to the rate of return on productive capital and not to the rate of return on safe assets. It is perfectly possible for $(1+g)(1+\pi)$ to be lower than the rate of return on productive capital but higher than that on safe assets, and in such circumstances one might indeed entertain the idea that current circumstances have no implications for long-term sustainability.

We have assumed that all future generations face the same growth-adjusted fiscal burden. One might argue that it should increase with time since, with continuing productivity growth, those in the distant future are going to be more prosperous than those in the near future. But, as Barrell and Weale (2010) argue, from what we know about inter-temporal preferences of individuals, no strong case can be made for this.

This indicator of the fiscal position is open to the criticism that it does not distinguish between sustainability and generational imbalance, since the whole of the adjustment burden is borne by future generations. Thus they are expected to manage the aftermath arising from any extravagance on the part of current generations.

Alternatively one might focus on the intergenerational balance gap (IGG) conveniently measured as a proportion of current GDP. This is calculated on the assumption that before adjusting for the effects of economic growth, all future generations pay an amount $N_{t,t}$ in net taxes. This gives

(5)

$$IGG = \frac{\sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t - \sum_{s=0}^{D} N_{t,t-s}P_{t,t-s} - \sum_{s=1}^{\infty} N_{t,t}(1+g)^s P_{t,t+s}(1+r)^{-s}}{GDP}$$

A third possibility is not to make any assumption about the way in which the budgetary gap is closed, thus allowing for the generational accounts of generations in the distant future to be different from those of current new-borns. We denote this the inter-temporal budget gap (IBG)

$$(6)\quad IBG = \frac{\sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t - \sum_{s=0}^{D} N_{t,t-s}P_{t,t-s} - \sum_{s=1}^{\infty} N_{t,t+s}P_{t,t+s}(1+r)^{-s}}{GDP}$$

This might be the appropriate assumption if some policy change has been announced which has not yet come into effect. However, it should be noted that, since current new-borns are typically not substantial tax payers in the early years of their lives, the sort of policy change which would be relevant would have to be taking place many years in the future.

Finally, and perhaps most helpfully, it is desirable to focus on policy changes which , if introduced immediately, would have the effect of delivering inter-temporal budget balance. This is perhaps most helpfully done by considering the impact of a change to a broad tax rate like employers' National Insurance contributions or the standard rate of income tax. We denote the tax rate of concern as τ, and write each generational account as a function of τ. For inter-temporal balance we then require

(7)

$$\sum_{s=0}^{D} N_{t,t-s}(\tau)P_{t,t-s} + \sum_{s=1}^{\infty} N_{t,t}(\tau)(1+g)^s P_{t,t+s}(1+r)^{-s} = \sum_{s=0}^{\infty} G_{t+s}(1+r)^{-s} + D_t$$

The solution has to be found by studying the sensitivity of the relevant tax profile to the tax rate in question. If the tax in question is a simple proportionate tax, like employers' National Insurance contributions, then it can be assumed that the revenue profile is proportional to the tax rate in question. If, however the tax rate is a component of a more complicated tax structure, such as the standard rate of income tax, then rather more care is needed to establish the appropriate value of τ.

This indicator has a number of advantages over the alternatives. First of all, it is easily intelligible. Secondly, a considerable advantage of this indicator of fiscal imbalance is that, of the four measures discussed, it is relatively insensitive to the assumptions made about growth and interest rates. By contrast IBG and IGG are often very

sensitive to this as we show subsequently and the calculation of $\bar{N}$ can show considerable sensitivity. Thirdly, there is a general principle that policy should be run so that expected future tax rates are kept constant. Expectations of variations in future tax rates lead to people reallocating both labour effort and, if expenditure taxes are expected to change, expenditure over time. Flemming (1988) showed that this resulted in a lower level of welfare than if expected taxes were held constant. Thus the tax change generated by this calculation could be seen as an optimal response to a fiscal problem, at least taking the level of government spending as given and the remainder of the tax/transfer system as given. Nevertheless, it has to be remembered that, to the extent that fiscal problems arise because of other planned changes to the system, it may be better to remove these than to raise the tax rate.

Finally, the change implied by the indicator does have the effect that people currently alive, as well as future generations, bear the adjustment, at least insofar as they are affected by the tax[7]. The adjustment does not address the past history of generational transfers- and the national debt may be a consequence of generous transfers in the past. And if a tax is considered which, like national insurance contributions, does not affect people much beyond a given (retirement) age, then the impact of the adjustment will be borne only by people younger than the threshold age. But subject to these caveats, the adjustment is borne by both current and future generations and all future generations are treated in the same way as current new-borns. Thus, subject to the caveats above, the tax change is broadly consistent with the idea that each generation should pay its own way. It is thus consistent with an idea of fairness that the state should not promote transfers between generations.

Nevertheless, one limitation of generational accounts needs to be discussed in this context. The analysis resulting from generational accounts does not pay any regard to people's responses to their economic environment. If taxes are raised to meet an inter-temporal budget deficit a reasonable expectation is that there would be some contraction of the tax base. As a result the increase in tax which an analysis based on generational accounts suggested would be adequate to deliver inter-temporal solvency would in fact be too small to deliver this. To explore this further a proper behavioural model such as that developed by Sefton, van de Ven and Weale (2008) is needed. This does not make the analysis based on generational accounts worthless. Users do, however, need to be reminded that it does not reflect any behavioural responses and that generational accounts provide only one of a range of possible indicators of the underlying fiscal position.

4. Construction of Generational Accounts

As the preceding analysis has made clear, the core to generational accounting is the calculation of net payments as a function of age. In general our estimates of this are built up by components, using age profiles which show the amount paid, for each type of tax paid transfer etc. received, as a function of age. In principle one could construct generational accounts from these alone, provided satisfactory account can be taken of policies and other factors which are likely to affect these profiles. However, there may be separate information which indicates that particular types of taxes or benefits are likely to grow unusually quickly or slowly, perhaps as a result of

[7] National Insurance contributions are not collected in respect of people beyond the state pension age.

announced government policy or because the economy is expected to grow slower or faster than trend. Obviously such information, which is often presented as projections for the time path of taxes or expenditures of a particular type, also needs to be taken into account.

In this section we present illustrative age profiles and also discuss the data on the expected time profiles and revenues and expenditures.

5. Age Profiles

Our results are based on age profiles of revenue and expenditure for the categories listed in Table 5 of Appendix 2. This table also shows the sources of the expenditure profiles. Each profile shows the proportion of total revenue/expenditure as a function of age for a population uniformly distributed over the range 0 to 101. Since there are 92 profiles for each of mean and women, we display only a small number of these so as to illustrate their key characteristics.

Profiles for Education Spending

Figure 1: School and Higher Education for Males, Net Intermediate Consumption

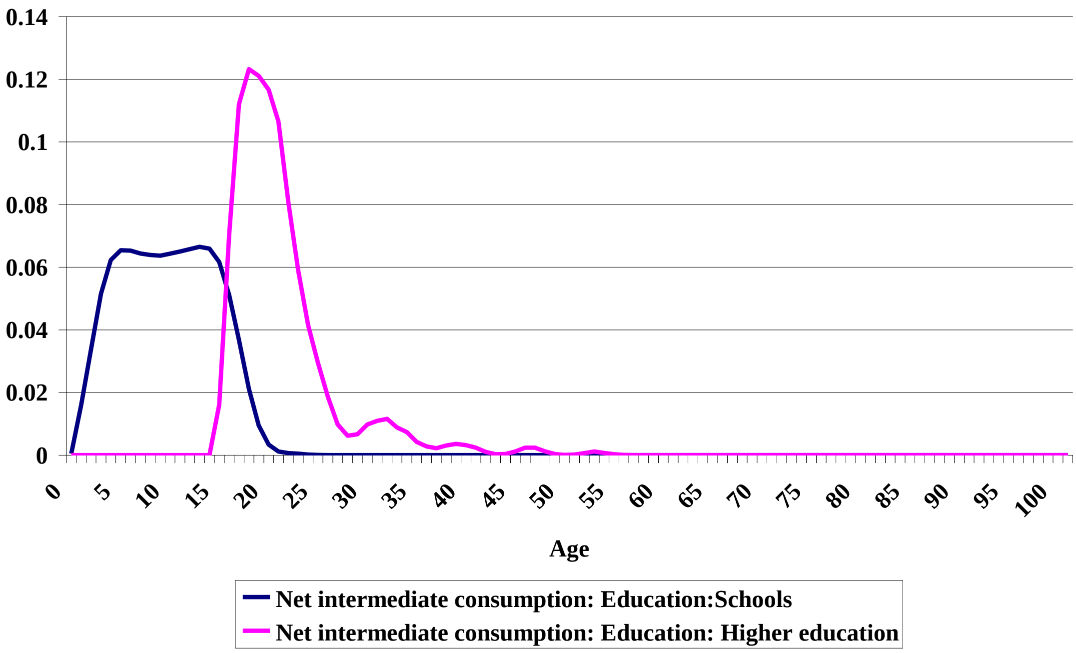
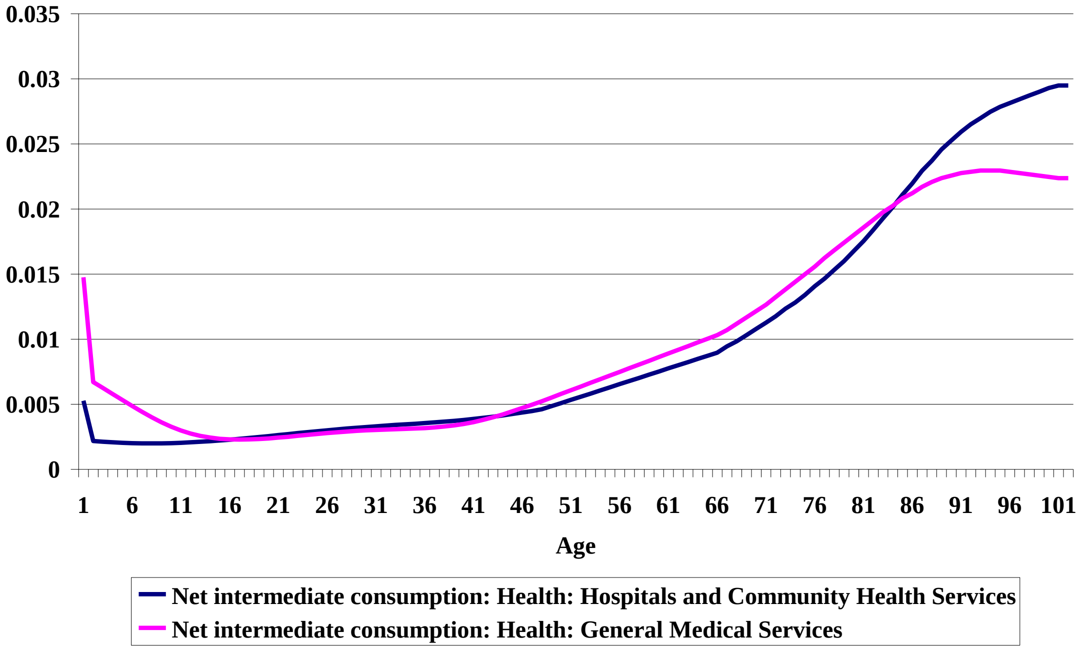


Figure 2 Hospitals and Community Health Services and General Medical Services for Females: Net Intermediate Consumption



These two charts illustrate the intuitive properties of the age profiles very clearly. Education spending is associated predominantly with children and young adults. School spending falls on children of school age but with some spending on children of pre-school age included. Higher education spending is associated mainly with people in their late teens and early twenties; however, there are significant numbers of mature students, and this is reflected in the profile. No significant spending is associated with old people because it is rare for people older than say sixty to receive higher education.

In contrast the profiles for health spending show high levels of spending associated with old age. Both profiles also show relatively high levels of spending associated with babies and expenditure on general medical services declines only gradually for pre- teenage children. These patterns are consistent with the view that young and prime age adults on average require relatively little medical treatment.

Given the importance of health spending overall, a key determinant of the generational balance is the assumption made about whether and how health expenditure profiles change as mortality rates decline. We subsequently consider two assumptions. In the first the expenditure profiles are assumed not to be linked to mortality rates. In the second we use the relationship between the health profiles and mortality rates by age for people aged 65 and over in 2008 to assess the relationship between mortality and health spending. We then assume that future health spending as a function of age is determined by the age-dependent future mortality rate as projected by the Office for National Statistics. Thus we assume that health spending is death-related rather than age related. The derivation of the relevant profiles is discussed in Appendix C.

There are other profiles to which careful attention has to be given to reflect policy-induced changes. These are predominantly those associated with benefit payments to people at or above the current state pension age. These profiles are changed in line with government policy, and may be further changed to reflect additional policy experiments.

6. Time Profiles of Revenue and Expenditure

If no separate information exists on the time profiles of revenue and expenditure, the programme generates values for each category based on i) the forecast age structure of the population ii) expenditure as a function of age in 2008 and iii) the assumed growth rate of the latter in real terms. However, in the near term the Office for Budget Responsibility has produced projections of both revenue and expenditure. These reflect the effects of the current business cycle and also indicate at least the broad outline of the government's expenditure plans. It makes obvious sense to use these as far as they go.

Thus, up to 2015, instead of computing expenditure from the age structure of the population, we take a given planned amount of expenditure and allocate it by age using i) the age profile and ii) the population structure forecast. This generates, in each of the years up to 2015 an amount of expenditure by age; we use the 2015 rather than the 2008 levels of expenditure as a function of age as the starting point for our projections of expenditure beyond 2015.

Revenues are treated in the same way. Planned changes to taxes are implemented by adjusting the level of revenue as a function of age. It is not generally possible to identify changes in age profiles which result from changes to tax structures but where changes to the age profiles can be identified they are implemented as described in the previous section.

A major determinant of the intergenerational balance is the assumed rate of growth of expenditures beyond 2015 relative to that of revenues. In the long run the latter, as a function of age, can be assumed to grow in line with *per capita* income. The former, of course, represent policy; in particular various governments have, from time to time adopted policies of linking benefits to prices rather than to wages. There is a question- as the debate on pensions in the UK over the last fifteen years shows- whether such policies are politically sustainable[8]. Nevertheless, in our exploration of variants to the baseline generational accounts we examine the impact of different policies with regard to state benefits.

7. Baseline Generational Accounts

In the baseline generational accounts nearly all *per capita* revenues and expenditures are assumed to grow in real terms at a rate of 2% p.a. from 2015 onwards. There are

[8] In 1980 the government adopted a policy of linking the state pension to prices rather than to wages. Partly as a consequence pensioner poverty became an increasing controversial issue and, with the change of government in 1997 the pension credit was introduced as an additional wage-linked benefit. More recently the link to wages has been restored although possibly not indefinitely.

two minor exceptions, in that contributions to public sector pension schemes (including imputed contributions) are assumed to grow at 2.095% p.a.

There are also some major exceptions reflecting government policy. However the analysis reflects announced plans for changes to state pension age for both men and women and related changes to SERPS payments and pension credit. It also takes into account changes to incapacity benefits, disability living allowance, income support and rent rebates and allowances. These changes are all introduced as changes to the age profiles of expenditure. Separately the growth rate of payments under SERPS at any age is assumed to reflect the build-up of past entitlements, giving *per capita* rates for those people entitled to SERPS of up to 4.5% p.a. later in this decade and not falling off to 2% p.a. until 2053.

Other key assumptions are that the real interest rate is assumed to be 3% p.a. and that the population projections are the central projection of the Office for National Statistics. Beyond 2058 the population is assumed to be stable (although as Lee and Anderson (2005)) show, this is not an innocent assumption).

In Figure 3 we can see the projected paths for revenue and expenditure (excluding interest payments) as proportions of GDP. The chart shows that the succession of budget measures including those announced in the June budget have the effect of closing the gap between revenue and expenditure in the short term. But the changing demographic structure of the population means that in the long term a gap re-emerges which has to be closed by means of some combination of tax increases and spending cuts; this graph in effect summarises the fiscal problem described by the generational accounts.

Figure 3 Projections for Revenue and Expenditure excluding Interest Payments as Proportions of GDP

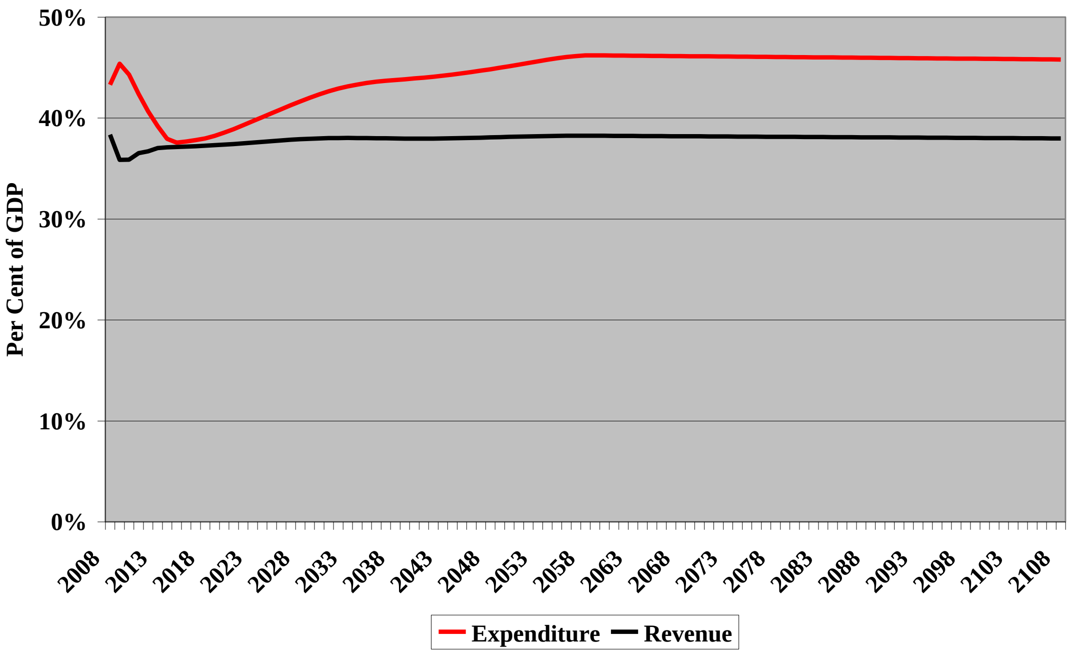
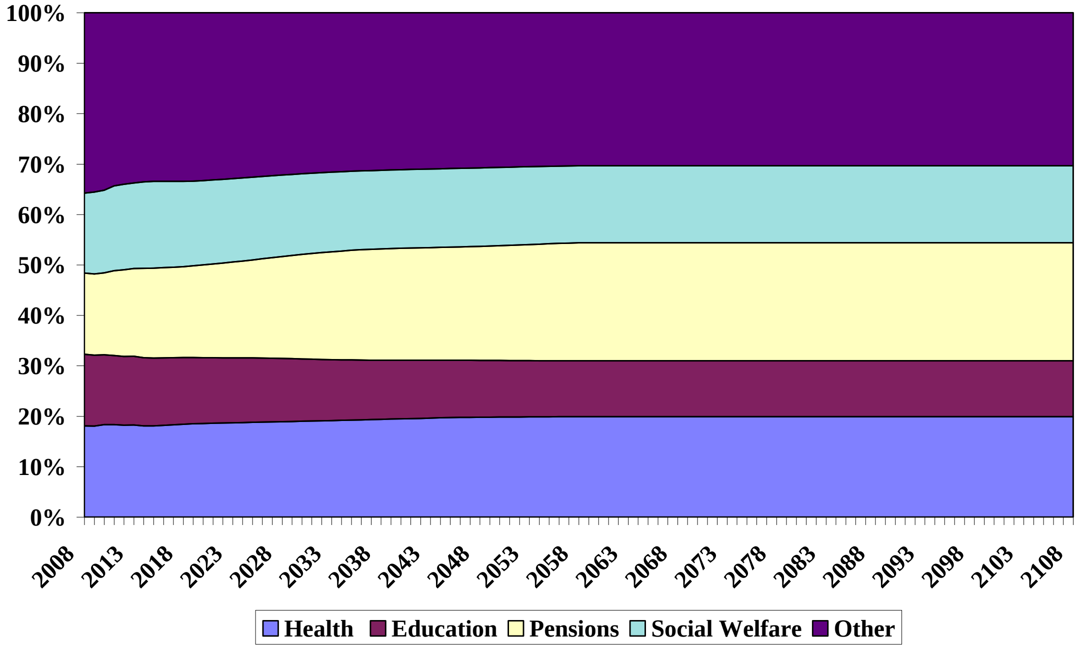


Figure 4 shows the projected composition of government spending up to 2058; beyond then since the population is held constant the spending structure does not change. Up to 2058 increases in the share of health and pension spending are clearly visible, while a smaller proportion of children in the population means that the share of expenditure on education declines. The share of spending on social welfare spending rises in the early part of the period and then, as a result of the policy changes already announced declines. The share of other expenditure declines to accommodate these trends.

Figure 4 The Projected Composition of Government Expenditure excluding Interest Payments



With this background, Table 2 shows the generational accounts of the current population as a function of age, and also the present value of the net contribution that each future new-born will have to make in order to make the government solvent. The table indicates that a current new-born baby will make an average net discounted contribution to the exchequer of £68,375 over its life-time. The table provides details both of what taxes will be paid and what benefits will be received.

One might think that, in a steady state, the net contribution would be zero. However, there is a past history of pay-as you-go benefits which has allowed earlier generations to receive more from the state than they have contributed over their life-times and it is inevitable that there is now a net contribution which has to be paid. The table also shows, however, that this contribution is not adequate to balance the budget. If the government is to meet its budget constraint, then future generations have to contribute £159,668 discounted back to 2008, but growing at 2% a year reflecting the assumed growth rate of the economy.

This can also be seen in aggregate terms. The present value of net transfers to be paid by the government is £6811.9bn. Adding this to net government debt of £800.1bn gives the total intergenerational budget imbalance, £7612bn or the total value of required future contributions to the exchequer over and above what those currently alive and future generations are to receive from the public purse. Seen in these terms the total burden is just over five times GDP. Not surprisingly this number is considerably larger than those which have focused on only one aspect of government expenditure such as Civil Service pensions (Public Sector Pensions Commission, 2010), and it gives a better indication of long-term fiscal problems than does a focus on only one aspect of spending.

The intergenerational budget imbalance, the burden which will be faced by future generations, bearing in mind that current children are already set to be net contributions. This is slightly larger at £7797bn. These aggregate figures are, however, very sensitive to the assumed interest rate (relative to the assumed growth rate); this is an inevitable feature of calculations of this type and we subsequently address the implications of a lower interest rate.

An alternative and in many ways more helpful way to look at the problem is to examine the increases in taxes needed to restore either intergenerational budget balance or intertemporal budget balance. We find that for the former all taxes need to rise by 15.4% and for the latter they need to rise by 17.1%. relative to the tax increases already planned. This points to further tax increases or spending reductions of around 6-6½ % of GDP over an above what was announced in the June 2010 Budget.

Table 2 Base Generational Accounts for the United Kingdom 2008 prices

£	Present	1	2	3	4	5	6	7	8	9	10
	Total	Income Taxes	Production Taxes	Social Security	Other Current Taxes	Other Receipts	Health	Education	Pensions	Social Welfare	Other
0	68375	185937	162813	105814	28065	605	-97286	-84054	-99138	-88379	-46002
5	79151	208916	177933	118217	32206	629	-109472	-80723	-120423	-95786	-52346
10	106868	214902	177112	121688	32941	599	-108462	-64469	-120990	-94232	-52222
15	143165	222432	176536	126413	33806	568	-106613	-47106	-118940	-92011	-51921
20	157700	210679	163527	119437	32333	510	-100363	-20180	-113558	-85404	-49280
25	124486	188883	146281	105726	29869	454	-98709	-6100	-117130	-77117	-47672
30	67684	165298	132273	89908	27998	417	-101299	-3400	-125197	-70539	-47774
35	29832	140823	117553	74758	25441	376	-97370	-1990	-122741	-61130	-45889
40	-11925	116689	105451	61122	23139	343	-95838	-1312	-125064	-52625	-43829
45	-58601	92564	93644	47705	20919	313	-95601	-895	-128811	-46391	-42049
50	-105011	68902	81086	34205	18622	280	-94238	-398	-132239	-41241	-39990
55	-155058	45561	68463	20933	16455	250	-92747	-169	-139669	-36364	-37771
60	-198930	26152	55373	9814	14004	217	-88205	-96	-150746	-30645	-34799
65	-223183	14720	43770	4309	11687	187	-84436	-57	-152334	-27965	-33063
70	-206912	9827	33943	2848	9539	157	-78861	-33	-129289	-26270	-28776
75	-177732	7165	25016	2032	7438	124	-69391	-18	-103037	-23590	-23472
80	-143375	5364	17428	1530	5514	93	-58735	-9	-76743	-20782	-17038
85	-114636	3968	12206	1155	3936	69	-48766	-3	-53878	-18082	-15240
90	-86040	2997	8653	886	2851	52	-40058	-1	-37718	-14248	-9454
95	-57721	2085	5491	616	1853	35	-28216	-1	-24879	-10151	-4555
Future Generations	159668										

8. The Role of the National Debt

The role of the existing national debt in these calculations is a topic of obvious interest. We illustrate this by setting the initial national debt to zero instead of, as in the base run, the value actually observed in 2008. The intertemporal budget imbalance is now reduced to £6812bn since there is no national debt, and the intergenerational imbalance also falls by the amount of the national debt, to £6996bn. The generational accounts of people currently alive are not changed by the removal of the national debt because these are the outcome of tax and benefit structures and spending policies. However the discounted life-time contribution faced by future generations falls from the figure of £159,668 in the base run to £150,299.

The tax increase needed to restore intergenerational imbalance falls to 13.7% and that needed for intertemporal balance to 15.3%, in the range of 5-6% of GDP. Thus the tax increases needed fall in the same proportion as the reductions in the measures of imbalance. The overall impact of the national debt on the required tax changes is relatively small because the national debt is a relatively small component of the imbalances identified in our generational accounts. .

9. The Impact of the Real Interest Rate

One of the unusual features of the economy at present is the low level of interest rates. If the rate of interest is lower than the rate of growth, as it is at present, then, as discussed earlier, the calculation of the generational position of new-borns consistent with the budget constraint may be very distorted. The curious anomaly is created whereby, if the government aims to keep the debt to GDP ratio constant, the larger is the government debt, the larger is the primary deficit it is able to run. Thus government debt appears more than to pay for itself. It is difficult to imagine that such a situation can be sustained and generational accounting is, in any case, in such circumstances, impossible.

We therefore do not attempt to present full generational accounts based on today's exceptionally low interest rates, but assume that the real interest rate of 3% p.a. used above is replaced by one of 2.2% p.a. This serves to illustrate which components of our analysis become distorted as the real interest rate is brought close to the real rate of growth of the economy.

As expected, the measures of the intertemporal position are substantially affected by the change. With lower discounting the deficits shown at the right of Figure 3 have much more influence on the total, and the intertemporal budget balance rises to twenty-three times GDP. The intergenerational budget balance rises further, to thirty-one times GDP. These numbers provide due caution against paying too much attention to the aggregate measures of generational imbalance.

The effect on the net contributions of current new-born babies and future generations is appreciably smaller. The net contribution of new baby falls to £46,196 while that of the average member of each future generation falls to £149,054.

Although the impact of future deficits bears heavily on the intertemporal and intergenerational budget balances, its impact on the tax change needed to deliver fiscal solvency is much smaller. This reflects the fact that, with lower discounting future tax revenues are worth much more than they were in the base case. Thus taxes need to rise by 16.3% to restore intergenerational budget balance and by 14.5% to restore intertemporal budget balance. The increase needed for intergenerational budget balance is more than in the base case while that needed for intertemporal budget balance is less than in the base case. In the former case the adjustment is 6.3%

of GDP while in the latter case it is 5.6% of GDP. Thus, although the intergenerational aggregates are very sensitive to the assumed interest rate, and particularly so when the interest rate falls close to the growth rate, the tax changes needed to restore generational balance are not very sensitive to this, suggestion that attention should be focused on the latter.

10. An Alternative View of Health Spending.

As discussed above, in the base projection it is assumed that health spending is age related. A popular alternative is that it is related to proximity to death, and we represent that notion by linking health spending to projected mortality. In Appendix 1, we discuss how we have given effect to this assumption and explore its implications for the profiles.

Health spending was 7.8% of GDP in 2008 falling to 6.7% of GDP by 2018 and then rising to settle at 7.6% of GDP. As a share of total spending it is stable at about 18% of GDP from 2008 to 2022, then falling slightly to 17.2% of total spending. In contrast, in the base simulation it eventually settles at 9.1% of GDP or 20.0% of total spending. With this change, the generational account of a current new-born child rises to £82,557 because receipts of government-provided health services are lower. As a consequence of this increase, the required generational account of a future child falls to £150,773. We find that the tax increase needed to restore intergenerational budget balance falls to 11.2% (4.3% of GDP) while that needed for intertemporal budget balance drops to 12.9% (4.9% of GDP).

Thus, the assumption made about pressures on health spending associated with an ageing population has a substantial impact on perceptions of the fiscal position. At the same time it should be noted that the income elasticity of demand for health expenditure is assumed to be one. Should there be political pressures to increase health spending more than in line with rising incomes, then larger and possibly much larger tax increases would be needed to restore balance even if the health spending is linked to mortality rates rather than to age.

11. Keeping Benefit Levels Constant in Real Terms.

An alternative policy which we explore, without any suggestion that it is politically feasible, is to keep all benefits except those specifically associated with old age (i.e. the basic state pension, SERPS, the second state pension, the pension credit and the minimum income guarantee) fixed in real terms at their 2008 levels.

This has a very powerful effect. The generational account of a current new-born child rises to £119,300 while that of a future new-born child falls to £140,386. Thus this policy does have the merit that it brings the public sector burden of current and future generations into much closer balance than we observed in our base run. Intergenerational budget balance can be restored with a tax cut of 1.8% of current taxes (0.7% of GDP) while intertemporal budget balance can be restored with a reduction in taxes of 1.9% (a reduction of 0.7% of GDP).

These results do not, of course, in themselves imply that holding benefits constant in real terms is a desirable solution to the budgetary problems identified by our analysis. Rather they indicate that large increases in taxation can be avoided only by means of spending cuts, and the policy of holding benefits constant in real terms is best seen as one form of spending cut relative to our base run.

12. Later Retirement

Finally we examined the effects of raising the state pension age to 68 for both men and women from 2027 onwards. In addition to later payment of the basic state pension we assumed that the age from which pension credit and the second state pension are paid is increased to 68. Offsetting this, income support for unretired people is assumed to be payable up to the age of 67. Our analysis does not, however, take any account of the possibility that people's labour incomes and therefore tax payments may be higher as a result of delayed retirement; nor does it allow for the possibility that their consumption levels might also be increased. In that sense we offer a minimal view of the effects of later retirement.

We find that delayed retirement raises the generational account of a current new-born child to £75,950 while that required from a future new-born child falls to £155,759. It has the effect of reducing the tax increase required for intergenerational budget balance to 13.3% while that needed for intertemporal budget balance is reduced to 15%. These are 5-6% of GDP. Thus the benefits derived from delaying pension payments are, in themselves, only one part of solving long-run fiscal problems our generational accounts identify.

13. Summary of Results

Table 3 brings together the key results from the simulations described above.

Table 3 Summary of Generational Accounts and Tax Changes required for Intergenerational and Intertemporal Balance

	Generational Account		Percentage change in taxes		Tax change as per cent of GDP	
	Current new-born child	Future new-born child	Intergen-erational balance	Intertem-poral balance	Intergen-erational balance	Intertem-poral balance
Base	£68,375	£159,668	15.4%	17.1%	5.9%	6.6%
No National Debt	£68,375	£150,299	13.7%	15.3%	5.3%	5.9%
Interest rate 2.2% p.a.	£46,196	£149,054	16.3%	14.5%	6.3%	5.6%
Mortality-related Health Spending	£82,557	£150,773	11.2%	12.9%	4.3%	4.9%
Non age-related benefits fixed in real terms	£119,300	£140,386	1.8%	-1.9%	0.7%	-0.7%
Retirement age 67 from 2027	£75,950	£155,759	13.3%	15.0%	5.1%	5.8%

14. Conclusions

The key finding from this work is that forthcoming demographic change should be expected to have substantial budgetary implications. Our basic simulations suggest that taxes need to rise by about 6% of GDP over and above the changes announced in the June 2010 Budget in order to put the United Kingdom's public finances on a sustainable footing. The effect is mitigated if health spending associated with old people turns out to be linked to mortality rates, which are projected to decline in the future, rather than simply to age. And it can also be reduced by raising the retiring age further. It is probable that our analysis understates the full benefits of this because the system of generational accounts is not a full model of the economy and does not therefore show possible effects of later retirement on income tax and national insurance contributions.

But even if retirement is delayed and health spending is related to mortality rather than to age, it does seem likely that substantial further tax increases/spending cuts will be needed for the public finances to be sustainable. The generational accounting framework says nothing about the desirable timing of these. However the framework does show that if people currently alive enjoy the existing structure of taxes and benefits, then future generations will have to face a much less favourable framework in order to deliver public sector balance. Unless there are good welfare arguments for imposing a larger burden on future generations, this observation does suggest that the adjustments needed to stabilise the fiscal position should be made sooner rather than later.

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16. APPENDIX 2: Health Profiles and Declining Mortality

Mortality rates are projected to fall sharply, and there is obviously a question whether, as people live longer, it is sensible to project health expenditure as a function only of age. It is sometimes observed that health expenditure depends not so much on age as on proximity to death. To the extent that this is the case, some allowance needs to be made for this in projecting health expenditure forward.

One way of doing this is to relate health expenditure associated with people aged sixty-five and over to forecasts of mortality rates. ONS has supplied past mortality rates by age together with its forecasts to 2058, and we use these to project health profiles in one variant.

Health expenditure is allocated to three categories, hospitals and community health services, pharmaceuticals and general medical services. In figures 1 to 6 we plot the log of the health profile against the log of the mortality rate, with both variables relating to 2004. The data relate to people aged 65 to 92 since for older people expenditures are assumed to be age-invariant.

Figure 5: Male Mortality and the Expenditure Profile for Acute Care

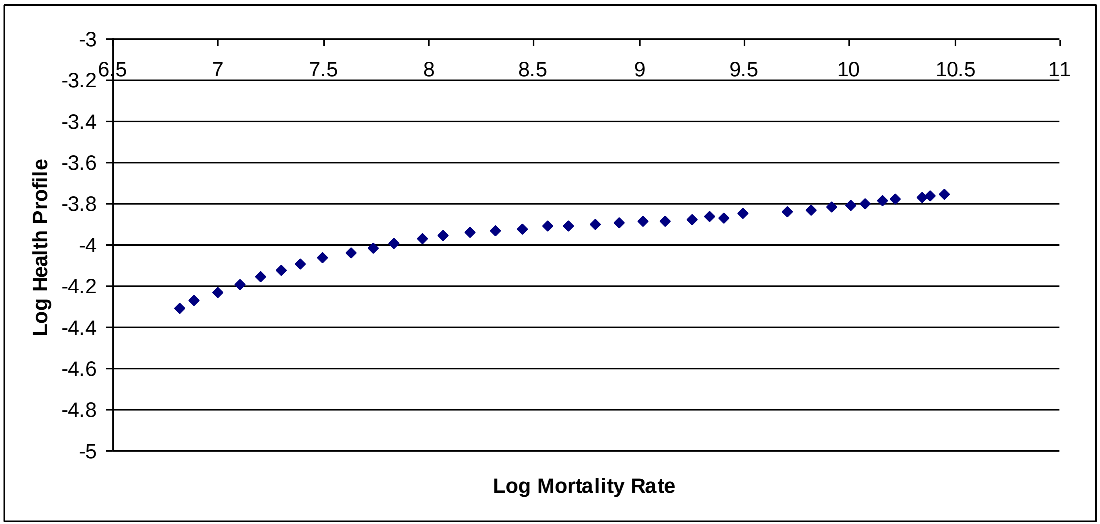
Figure 6: Female Mortality and the Expenditure Profile for Acute Care

Figure 7: Male Mortality and the Expenditure Profile on Primary Care

Figure 8: Female Mortality and the Expenditure Profile on Primary Care

Figure 9: Male Mortality and the Expenditure Profile on Pharmaceuticals

Figure 10: Female Mortality and the Expenditure Profile on Pharmaceuticals



Inspection suggests that, with hospitals and pharmaceuticals there is a strong relationship between the profiles and mortality rates, at least once it is taken as a given that mortality rates rather than say age are the main driver of the profiles. For men the relationship between the variables is approximately linear while for women there is clearer evidence of curvature. Expenditure on general medical services rises slightly with mortality (or age) at low levels of mortality but is subsequently stable. In the input data it is assumed not to change beyond the age of 84.

In order to represent the curvature for the first two profiles for men and women, we assume that the profiles can be explained by mortality and mortality squared and we estimate a regression to explain this on data for people aged 65 to 92. For general medical services we do the same thing, but only using data for people aged up to 84. New profiles can then be obtained for each subsequent year by using the mortality rates forecast by the Office for National Statistics.

The regression coefficients are shown in Table 4

Table 4 Regression Models Linking Health Expenditure to Mortality

Men	Acute Care		Primary Care		Drugs	
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
Ln Mortality	1.343	0.128	1.903	0.023	1.016	0.076
Ln Mortality^2	-0.051	0.007	-0.095	0.001	-0.046	0.004
Constant	-11.813	0.567	-13.335	0.103	-9.212	0.335
S.E.	0.036		0.0066		0.021	

Women	Acute Care		Primary Care		Drugs	
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
Ln Mortality	1.172	0.074	1.576	0.033	0.727	0.095
Ln Mortality^2	-0.048	0.004	-0.079	0.002	-0.035	0.005
Constant	-10.429	0.326	-11.656	0.145	-7.584	0.422
S.E.	0.021		0.0092		0.027	

The impact of declining mortality on the assumption that the profiles are driven by the equations shown in Table 4 are shown in Figure 11 to Figure 16. The slightly erratic structure of some of the profiles for 2058 arises because there are sharp jumps in the mortality rates in the data for 2008, particularly for people in their late eighties. This generates erratic jumps in the residuals of the regression equations and these are then visible in the computed profiles for 2058 once the residuals are added back to the values generated by the equations of Table 4.

Figure 11 Profiles for Acute Care for Men, 2008 and 2058

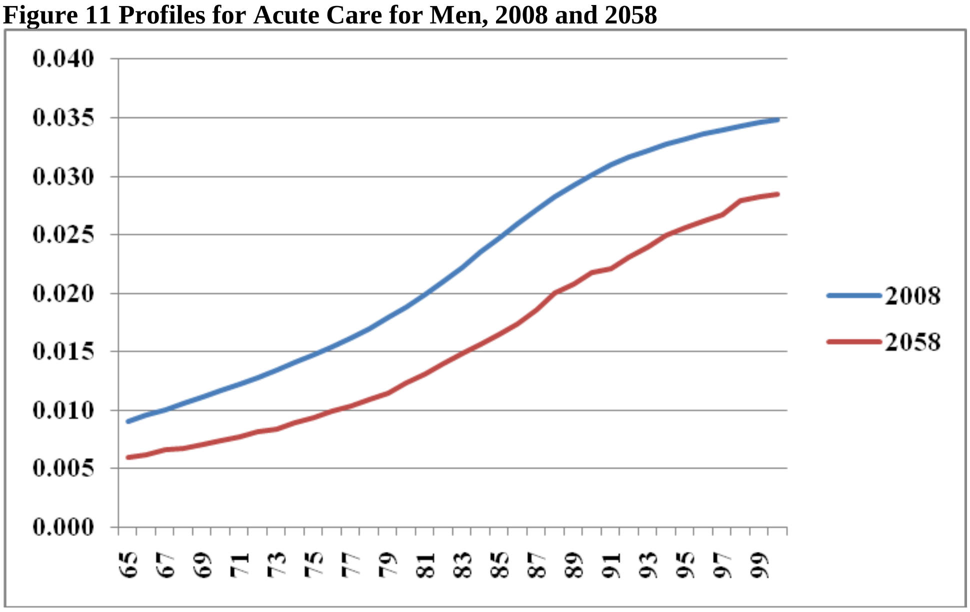


Figure 12 Profiles for Primary Care for Men, 2008 and 2058

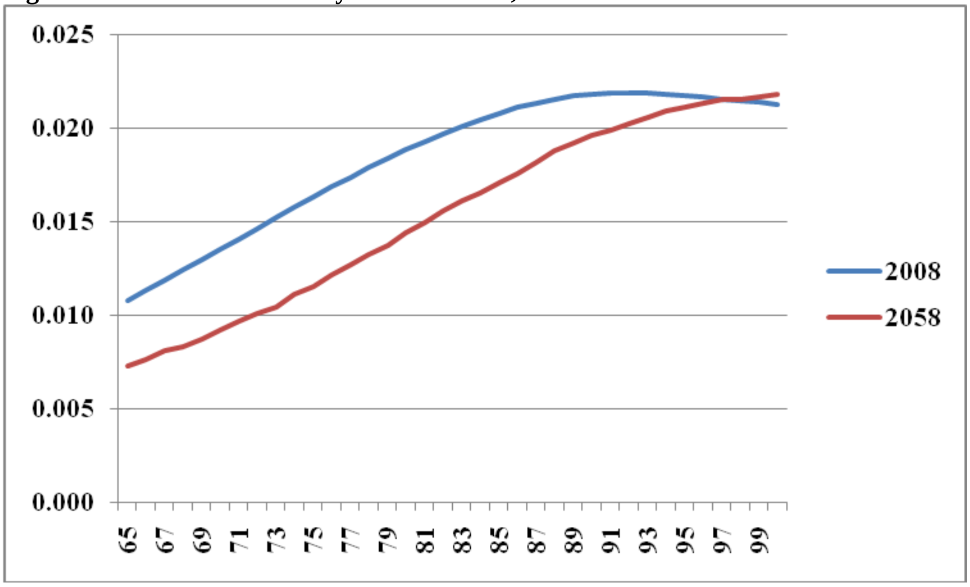


Figure 13 Profiles for Drug Consumption for Men, 2008 and 2058

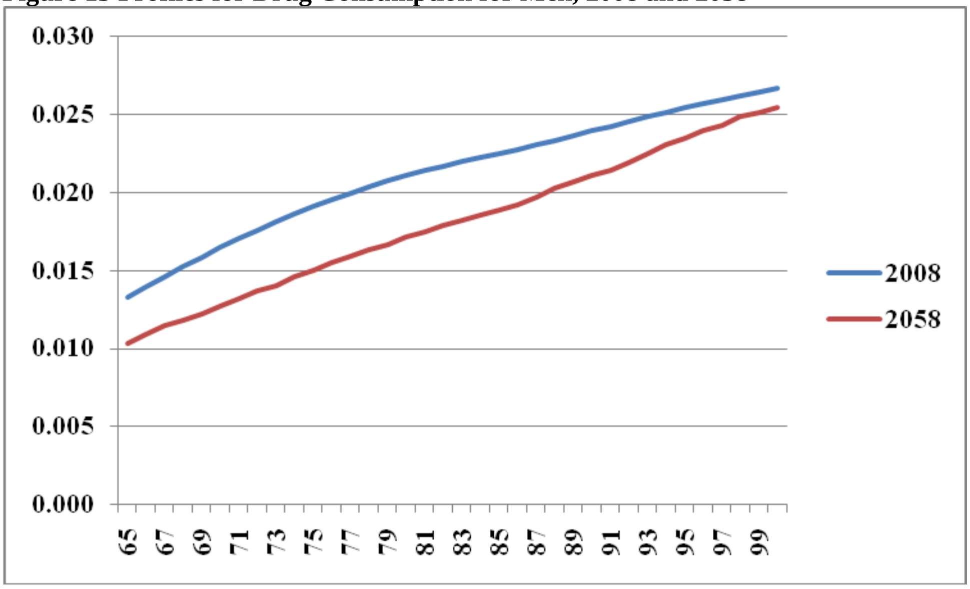


Figure 14 Profiles for Acute Care for Women, 2008 and 2058

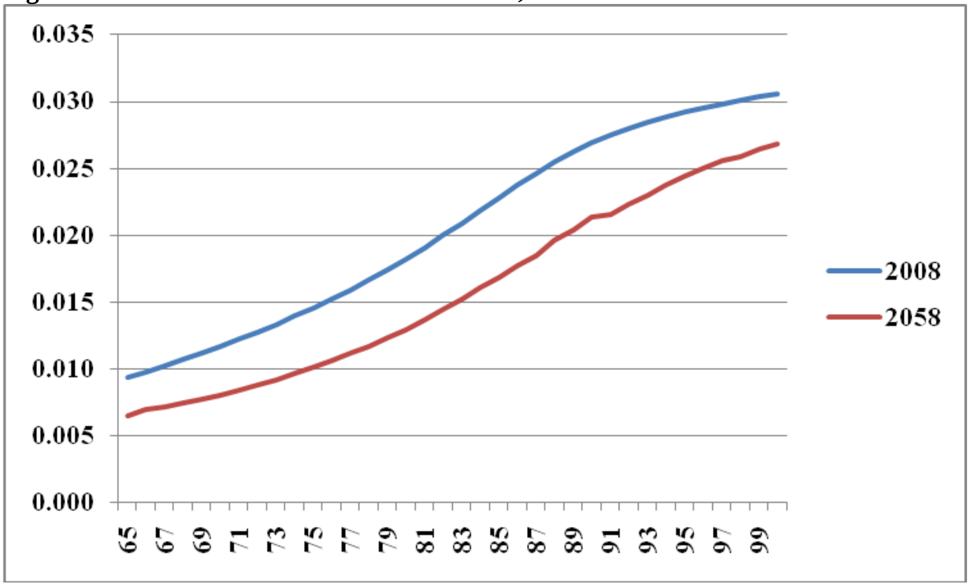


Figure 15 Profiles for Primary Care for Women, 2008 and 2058

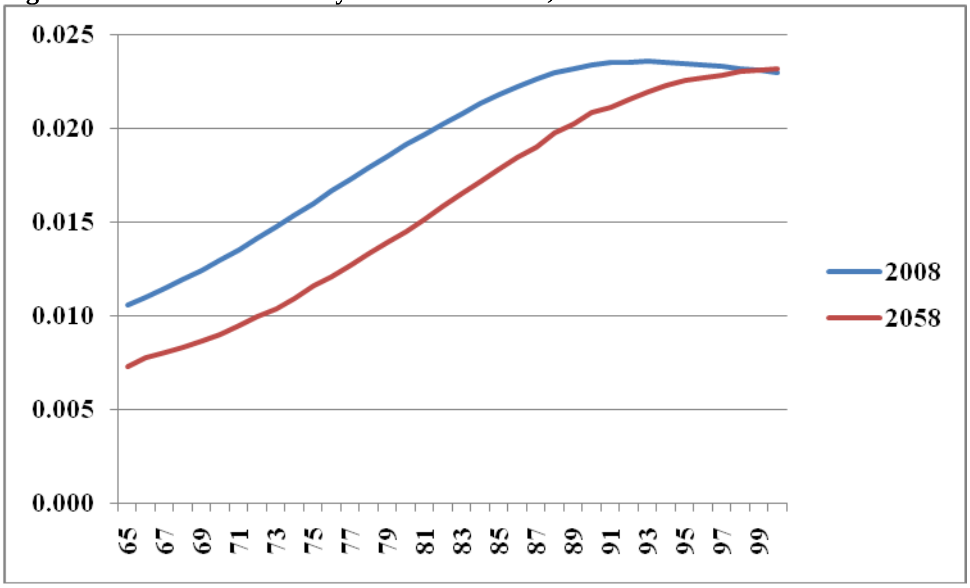
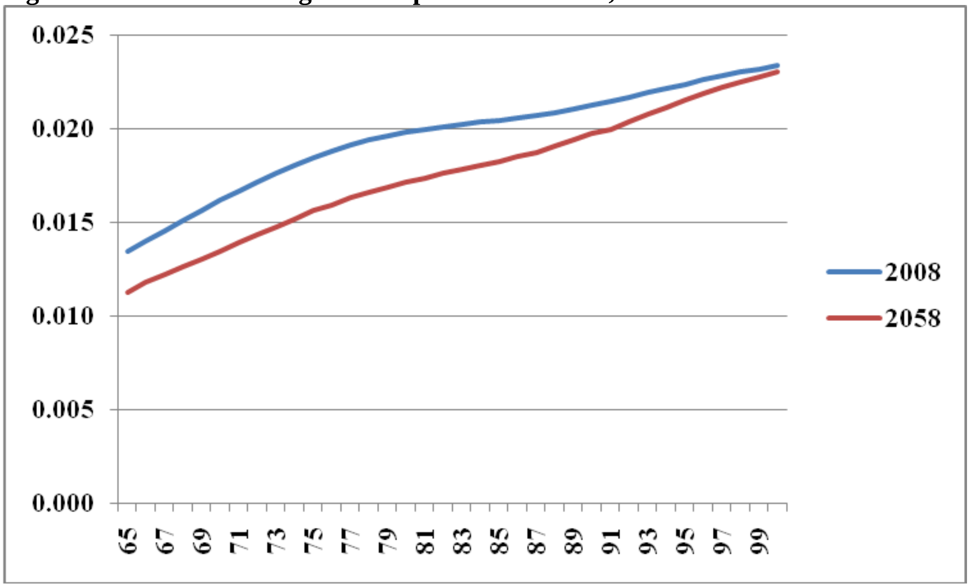


Figure 16 Profiles for Drug Consumption for Women, 2008 and 2058



17. APPENDIX 2: Data Sources

Table 5 Profile Sources

	Revenue/Expenditure Item	Source
1	Income Tax	FRS
2	Other Corporate Taxes	FRS
3	Taxes on capital gains	FRS
4	SS Contributions to the NIF: Employers	FRS
5	SS Contributions to the NIF Employees	FRS
6	SS Contributions to the NIF Self-employed and others	FRS
7	Notionally funded and unfunded schemes: employers	FRS
8	Notionally funded and unfunded schemes: employees	FRS
9	Imputed contributions	FRS
10	VAT	FES
11	Alcohol	FES
12	Tobacco	FES
13	Hydrocarbons oil	FES
14	Stamp duties	FES
15	Betting, gaming and lottery	FES
16	Insurance premium tax	FES
17	Payment to National lottery distribution fund	FES
18	Other customs and excise duties	FES
19	National non domestic rates	FRS
20	Vehicle Excise duty paid by business	FRS
21	Other taxes on production	FRS
22	Council Tax	FRS
23	Vehicle Excise duty paid by households	FRS
24	Inheritance tax	HMRC Statistics
25	Net Transfers from Current international Cooperation	Flat

26	Subsidies on Production	FRS
27	Retirement Pensions: Basic	DWP
28	Retirement Pensions:SERPS	DWP
29	Second State Pension	DWP
30	Widows benefits and Guardian Allowances	DWP
31	Jobseeker's allowance (contributory)	FRS
32	Incapacity benefits	DWP
33	Maternity Benefits	DWP
34	Statutory sick pay	DWP
35	Statutory maternity pay	DWP
36	Social Fund Benefits	DWP
37	War Pensions	DWP
38	Child benefit	DWP
39	Income support-Unretired	FRS
40	Minimum Income Guarantee	DWP
41	Disability living allowances	DWP
42	Attendance allowances	DWP
43	Invalid care allowance	DWP
44	Jobseeker's Allowance - income-based	FRS
45	Other social assistance benefits in cash	DWP
46	Income tax relief (WFTC)	HMRC
47	Pension Credit	DWP
48	Students grants	OECD
49	Rent rebates/allowances	DWP
50	Unfunded employees social benefits	Set equal to 28
51	Net intermediate consumption: Education:Schools	OECD
52	Net intermediate consumption: Education: Higher education	OECD
53	Net intermediate consumption: Education: Further education	OECD
54	Net intermediate consumption: Health:Hospitals and Community Health Services	DoH + GHS
55	Net intermediate consumption: Health: General medical Services	DoH + GHS
56	Net intermediate consumption: Health: Pharmaceutical	DoH + GHS
57	Net intermediate consumption: Social Protection: Old Age	PSSRU
58	Net Intermediate Consumption: Social Protection ex Old Age	BIS
59	Compensation of employees: Wages: Education:Schools	OECD
60	Compensation of employees: Wages: Education: Higher education	OECD
61	Compensation of employees: Wages: Education: Further education	OECD
62	Compensation of Employees: Health:Hospitals and Community Health Services	OECD
63	Compensation of Employees: Health: General medical Services	DoH + GHS
64	Compensation of Employees: Health: Pharmaceutical	DoH + GHS
65	Compensation of Employees: Social Protection: Old Age	PSSRU
66	Compensation of Employees: Social Protection ex Old Age	BIS
67	Compensation of employees: Unfunded Contributions: Education	Set Equal to 7/8
68	Compensation of employees: Unfunded Contributions: Health	Set Equal to 7/8
69	Compensation of employees: Unfunded Contributions: Social Protection	Set Equal to 7/8
70	Miscellaneous current transfers: grants to schools for Compensation of Employees	OECD
71	Miscellaneous current transfers: grants to schools for Intermediate Consumption	OECD

72	**Miscellaneous current transfers: grants to higher education for Compensation of Employees**	**OECD**
73	**Miscellaneous current transfers: grants to higher education for Intermediate Consumption**	**OECD**
74	**Miscellaneous current transfers: grants to further education for Compensation of employees**	**OECD**
75	**Miscellaneous current transfers: grants to further education for Intermediate Consumption**	**OECD**
76	**Miscellaneous current transfers: other grants to non-profit institutions (mainly EU Budget)**	**Flat**
77	**Miscellaneous current transfers: grants to NHS for Intermediate Consumption**	**OECD**
78	**Gross capital formation: Education**	**OECD**
79	**Gross capital formation: Health**	**DoH + GHS**
80	**Gross capital formation: Housing**	**DWP**
81	**Compensation of employees: Unfunded Contributions: Other**	**Set Equal to 7/8**
82	**Net intermediate consumption: Other**	**Flat**
83	**Compensation of employees: Wages: Other**	**Flat**
84	**Capital transfers payable: Education**	**OECD**
85	**Capital transfers payable: Health**	**DoH + GHS**
86	**Capital transfers payable: Housing**	**DWP**
87	**Capital transfers payable: Other Public and Private Non-Financial Corporations**	**Flat**
88	**Gross capital formation: Other**	**Flat**
89	**Operating Surplus**	**Flat**
90	**Petrol Revenue Tax**	**Flat**
91	**Property Income and Other Transfers**	**Flat**
92	**Banking Levy**	**Flat**

Key

DoH	Department of Health
DWP	Department of Work and Pensions
FES	Family Expenditure Survey
FRS	Family Resources Survey
GHS	General Household Survey
OECD	Organisation for Economic Co-operation and Development
PSSRU	Personal Social Services Research Unit