FISCAL SUSTAINABILITY AND TAX SMOOTHING: A PRELIMINARY ANALYSIS OF THE CASE OF DENMARK

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1 Introduction[1]

The purpose of this paper is to assess the sustainability of fiscal policy in Denmark. Thus, in section 2, we develop a measure of fiscal sustainability and apply it to current tax and expenditure policies given the most recent official population forecast. The results indicate that Danish fiscal policy is not far from being sustainable, but the sensitivity analysis points to the considerable influence on fiscal sustainability arising from, e.g., key demographic assumptions and labor force participation.

In section 3 we take a closer look at one of the main motivations underlying the analysis of fiscal sustainability, namely tax smoothing. Using a dynamic, competitive, numerical general equilibrium model, we simulate the consequences of deviating from a policy of fiscal sustainability by cutting taxes initially and raising them later in order to cover the government's present value revenue requirement. It turns out that the impact on allocative efficiency is quite modest and may in fact be

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[1] The views expressed in this paper are those of the author and are not necessarily shared by the Ministry of Finance. I am grateful to several colleagues at the Ministry of Finance and to participants at the Banca d'Italia workshop on fiscal sustainability for comments and suggestions. The results in this paper are based on a preliminary version of Ministry of Finance (2000), chapter 5.

positive. The justification for pursuing a sustainable fiscal program will accordingly have to rely on other arguments, such as generational equity or "insurance" against the need to carry out future fiscal reform.

2 Fiscal Sustainability

We begin this section by developing the index of fiscal sustainability. We will use the subscript t to denote the base year of the calculations, while subscript s indicates any current or future period. Hence, $s \geq t$. The starting point is the intertemporal budget constraint of the government. This is derived by imposing present value solvency on the equation of motion for government debt,

$$(1) \quad B_s = (1 + i_s) B_{s-1} + G_s + S_s - T_s$$

where B_s is the outstanding stock of public debt at the end of period s, while G_s, S_s and T_s denote, respectively, government consumption, income transfers and tax receipts and i_s is the nominal rate of interest. The intertemporal budget constraint may then be written as

$$(2) \quad \left(\frac{1 + i_t}{1 + \gamma_t} \right) b_{t-1} \leq \sum_{s=t}^{\infty} \left\{ \prod_{j=t+1}^{s} \left(\frac{1 + \gamma_j}{1 + i_j} \right) z_s \right\}$$

where lower-case letters indicate that the relevant variables are expressed relative to GDP, where $Z_s \equiv T_s - G_s - S_s$ is the primary budget surplus, and γ_s is the period s nominal GDP growth rate.

Expressed in this form, the intertemporal budget constraint states that the present value of current and future primary surpluses must at least be equal to the outstanding stock of government debt liabilities, inclusive of growth-adjusted period t interest payments. Notice that the rate of discount applicable to future primary surpluses is also the growth-adjusted rate of interest.

Any given fiscal policy may or may not satisfy equation (2). We now define the *index of fiscal sustainability* δ as the permanent adjustment of the primary surplus required in order to just satisfy (2)[2]. We therefore insert into the intertemporal budget constraint the expression

$$(3)\quad \hat{z}_s = z_t - \Delta z_s - \delta$$

where $\hat{z}_s$ is the period s primary surplus required under the sustainable fiscal policy, while Δz_s denotes the forecasted change in the primary surplus from the base year t to period s. This latter term therefore captures the consequences of population ageing, and possibly other effects, for the government primary surplus.

Substituting (3) into (2), and rearranging, then produces

$$(4)\quad \delta = z_t - [\lambda_t]^{-1}\left(\left(\frac{1+i_t}{1+\gamma_t}\right)b_{t-1} + \sum_{s=t}^{\infty}\left\{\prod_{j=t+1}^{s}\left(\frac{1+\gamma_j}{1+i_j}\right)\Delta z_s\right\}\right)$$

where

$$(5)\quad \lambda_t \equiv \sum_{s=t}^{\infty}\left\{\prod_{j=t+1}^{s}\left(\frac{1+\gamma_j}{1+i_j}\right)\right\} = 1 + \left(\frac{1+\gamma_{t+1}}{1+i_{t+1}}\right) + \left(\frac{1+\gamma_{t+1}}{1+i_{t+1}}\right)\left(\frac{1+\gamma_{t+2}}{1+i_{t+2}}\right) + \ldots$$

Equation (4) expresses the index of fiscal sustainability as the difference between the actual, base year primary surplus and the one required for sustainability. Hence, if δ is negative, fiscal policy is not sustainable and the absolute value indicates the immediate and sustained

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2 In the terminology used by Balassone and Franco (2000), δ is the "tax gap".

tax increase or expenditure cut needed to ensure intertemporal solvency. If fiscal policy is just sustainable, i.e. if $\delta = 0$, we obtain

$$(6) \quad \hat{z}_t = [\lambda_t]^{-1}\left(\left(\frac{1+i_t}{1+\gamma_t}\right)b_{t-1} + \sum_{s=t}^{\infty}\left\{\prod_{j=t+1}^{s}\left(\frac{1+\gamma_j}{1+i_j}\right)\Delta z_s\right\}\right)$$

Thus the required primary surplus consists of two components. The first part is related to current government debt, while the second reflects the present value of projected future changes in the primary surplus. Accordingly, we may interpret the terms in soft brackets as total government debt, reflecting implicit as well as explicit liabilities, where the latter is simply the future budgetary consequences associated with currently legislated tax and expenditure policies.

The term $[\lambda_t]^{-1}$ is the economic burden of government debt liabilities, explicit as well as implicit. And as equation (5) shows, it depends on the entire future time path of growth and interest rates. If we assume that the rates of nominal growth and interest are constant, equation (6) reduces to

$$(7) \quad \hat{z}_t = \left(\frac{i-\gamma}{1+\gamma}\right)\left(b_{t-1} + \sum_{s=t}^{\infty}\left\{\left(\frac{1+\gamma}{1+i}\right)^{(s-t+1)}\Delta z_s\right\}\right)$$

If the second term in the soft brackets is zero, fiscal sustainability requires a primary surplus equal the growth-adjusted rate of return times the outstanding stock of government debt. When the primary surplus is expected to deteriorate, i.e. when the present value of the Δz_s's is positive, this serves to increase the period t required primary surplus. In order to smooth out the burden of the implicit debt, a fraction of these liabilities equal to the growth-adjusted rate of interest should thus be covered by the current primary surplus.

For technical as well as presentational reasons, it is useful to rewrite equation (4) in terms of the current budget surplus instead of the primary surplus. Using D_t to represent the current budget deficit in period t yields

$$(8) \quad D_t \equiv B_t - B_{t-1} = i_t B_{t-1} - Z_t \Rightarrow z_t = \left(\frac{i_t}{1+\gamma_t} \right) b_{t-1} - d_t$$

which upon substitution into equation (4) gives

$$(9) \quad \delta = \left[\frac{i_t}{1+\gamma_t} - [\lambda_t]^{-1} \left(\frac{1+i_t}{1+\gamma_t} \right) \right] b_{t-1} - [\lambda_t]^{-1} \sum_{s=t}^{\infty} \left\{ \prod_{j=t+1}^{s} \left(\frac{1+\gamma_j}{1+i_j} \right) \Delta z_s \right\} - d_t$$

Before turning to the detailed calculations, it is useful to consider again the case where the interest rate and nominal growth are both constant, and fiscal policy just satisfies the requirement of sustainability. Equation (9) then implies

$$(10) \quad \hat{d}_t = \left(\frac{\gamma}{1+\gamma} \right) b_{t-1} - \left(\frac{i-\gamma}{1+i} \right) \sum_{s=t}^{\infty} \left\{ \left(\frac{1+\gamma}{1+i} \right)^{(s-t)} \Delta z_s \right\}$$

In this situation, the base year government budget deficit equals the dilution of the real debt burden due to nominal GDP growth *minus* the surplus required to avoid the need for future policy revisions due to the projected changes in the primary surplus caused by, e.g., population ageing.

Below, we use equation (9) to compute the index of fiscal sustainability. To do this, we need information on the base year levels of government debt and budget surplus, and forecasts of future changes in the primary surplus as well as the rates of nominal interest and growth. The budgetary consequences of population ageing, and certain other key issues, are calculated taking as given tax rates and per capita expenditure levels as currently legislated. Thus our notion of fiscal sustainability is directly related to the government's tax and expenditure instruments.

Because sustainability is defined with the intertemporal budget constraint as the starting point, the time path of public debt implied by equation (1) will always converge under the sustainable fiscal policy. Within this framework, the government debt serves to smooth the intertemporal differences in tax revenue and expenditures. Having computed δ, we may accordingly run the government debt accumulation equation forward in time to obtain the time path of government debt consistent with fiscal sustainability.

The definition of fiscal sustainability adopted here is thus different from the one used in, e.g., Blanchard *et al.* (1990) and Jensen and Nielsen (1995)[3]. These authors impose the constraint that government debt must converge to some exogenously given level. In contrast, by extending the projection of the primary surplus over a very long horizon, the methodology in this paper effectively covers the entire transition until a steady state is reached.

Apart from involving a cleaner definition of sustainability, the advantage of the present approach is that the time path of government debt, including the level to which it eventually converges, is endogenous and accordingly provides further information about the nature of the sustainable fiscal strategy.

Results

Table 1 shows some of the key assumptions used to compute the index of fiscal sustainability. The demographic parameters reflect the latest official population forecast produced by Statistics Denmark. Thus, the rate of fertility increases gradually from its 1998 level of 1,72 to 1,8 in 2050. Life expectancy increases during the period 2000 to 2040, but more so for males than females. Finally, in line with recent experience, net immigration equals slightly more than 2 per 1000 population throughout the forecast period.

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3 Balassone and Franco (2000) discuss several alternative definitions of fiscal sustainability. However, they all seem to invoke ad hoc assumptions about the terminal value of government debt.

Table 1. Key Assumptions

	1998	2050
Population:		
Fertility (avg. number of children per female)..............	1,72	1,78
Immigration (per 1000 population)	2,1	2,6
Male life expectancy (years)	73,4	78,6
Female life expectancy (years)......................................	78,3	80,2
Other:		
Nominal growth rate (percentage points)......................	3,9	4,2
Nominal interest rate (percentage points)..............	5,5	5,9
Initial government debt (per cent of GDP)....................	48	-
Private pension fund assets (per cent of GDP)..............	93	185
Private financial assets (change, pct. of GDP)	-	42

Figure 1 portrays the resulting time path of key demographic variables. One remarkable aspect is that, if recent demographic trends continue, total population will in fact grow slightly throughout the century. This reflects that net immigration more than offsets the reproductive deficit embodied in the fertility assumptions. After 2030 population flattens out and remains almost stationary thereafter.

The ratio of elderly to total population is expected to increase from slightly above 30 per cent to approximately 40 per cent in 2040. Thereafter, this ratio drops off somewhat as the large cohorts from the mid- and late 60's pass through old age. Relative to the working age population, the ageing tendency is somewhat more pronounced, but still fairly moderate relative to the projected trends for other European countries.

Figure 1. Population Forecast 2000-2100

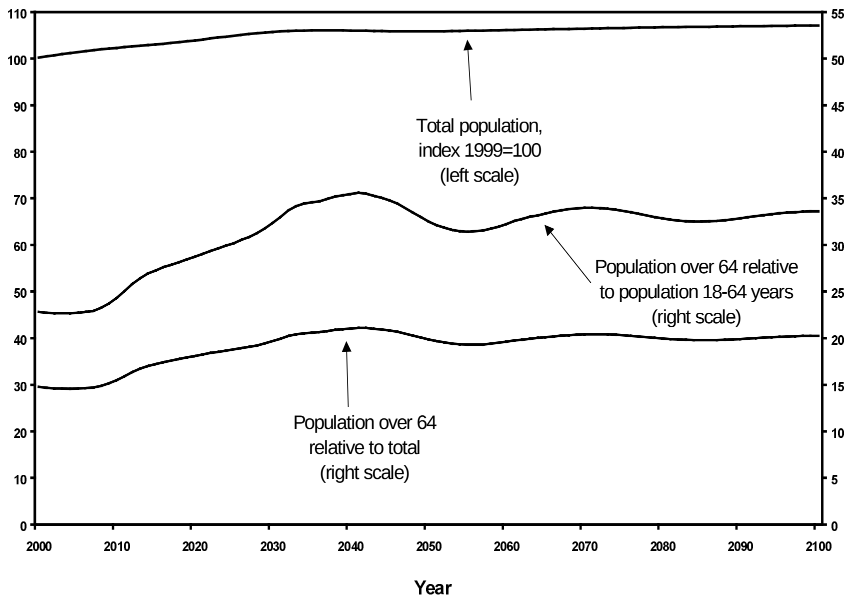

Figure 1 also reveals how the ageing process is particularly strong during the period 2015 to 2035. Thus, during the next approximately 15 years, the Danish economy, and in particular the government financial balance, will only be moderately affected by demographics. This feature plays an important role in shaping the sustainable fiscal policy that we analyze below.

For technical reasons, all relevant variables are forecasted for the period 1998 to 2200. The long time horizon is necessary for the evolution of demographic variables to approach steady state values at the end of the period. Throughout, we assume that labor productivity grows at 2 per cent annually, while inflation is 2 per cent also. Given the assumed nominal interest rate of 5,9 per cent, the growth adjusted market rate of return is 1,9 per cent.

Initial government debt equals 48 per cent of GDP, which is somewhat below officially reported figures. The difference is due to the fact that, for our purposes, we need a measure of government net nominal debt. Therefore, certain nominal asset holdings of central and local government are subtracted from public sector debt liabilities.

A feature of the Danish tax system which is very important from a sustainability view point is the (partial) consumption tax treatment of institutional savings. As table 1 shows, the underlying accumulation of pension fund assets equals about 90 per cent of GDP. Recently, net contributions to pension funds have equaled around 2-2,5 per cent of gross domestic product annually. During the next half century, these net pension contributions are gradually turned into net distributions of about 5 per cent of GDP as the pension system gradually matures. Hence, from a fiscal point of view, the build-up of pension assets will have a large impact on net tax receipts. Therefore, the computations in this paper involve an explicit treatment of the private pension sector.

In figure 2, we show some of the key influences on the primary budget surplus that are used to compute the index of fiscal sustainability. From 1998 until about 2040, government consumption thus increases by slightly in excess of 3 per cent of GDP. Transfers, net of taxes, increase by 2,8 per cent of GDP, reflecting primarily the rising expenditures on old age pension benefits[4].

The build-up of pension fund assets produces a long run, positive net contribution equal to about 2 per cent of GDP. Also, increased private pension benefits will result in lower government expenditures on old age benefits due to means testing. This produces long term net savings equal to 0,8 per cent of GDP.

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4 The impact on government expenditures is computed by combining the population forecast reported above and data for the age distribution of transfers and government consumption expenditures. Because of space limitations, we do not discuss here the details of the age profile of public expenditures. However, the calculations involve a complete age group break-down of transfers, while approximately 60 per cent of public consumption is age specific and hence influenced by the population forecast. The remaining 40 per cent are assumed to evolve in proportion to gross domestic product.

Figure 2. Sources of Change in the Primary Surplus 1998-2100

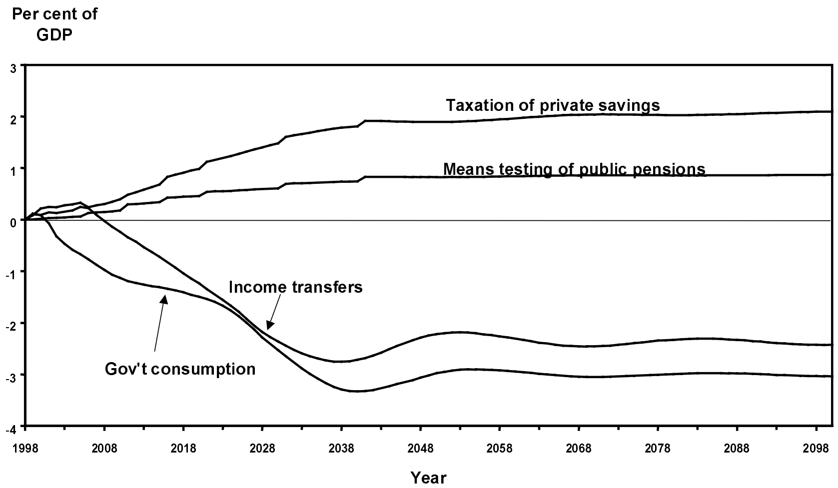
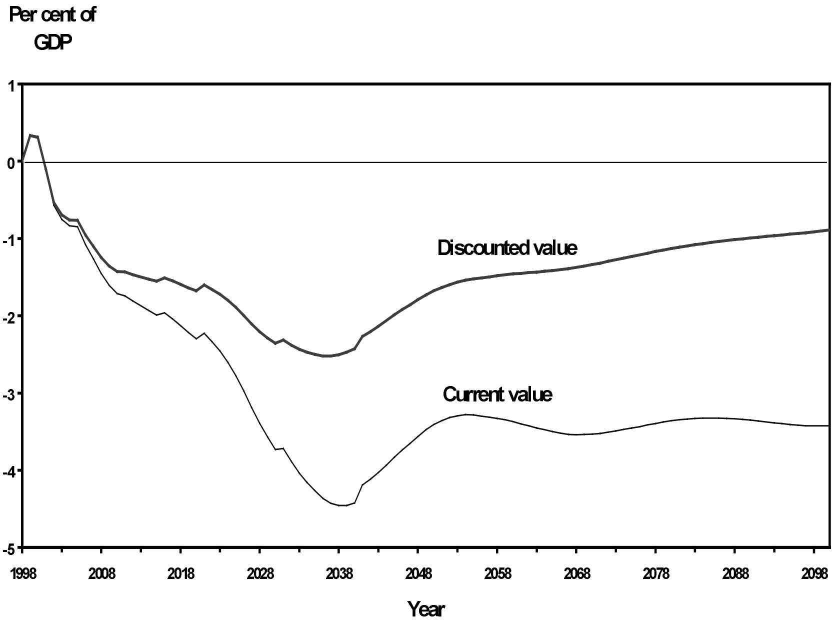


Figure 3 summarizes the net changes in the primary budget surplus. During the initial phase, the government budget balance is largely unaffected by demographic changes. However, as the demographic shifts gain speed the primary surplus is eventually reduced by almost 4,5 per cent of GDP. After about 2040, the impact levels off reflecting the modest decline in the share of elderly in the total population combined with the maturing of the pension system.

Figure 3 also shows the present value of future changes in the primary surplus, discounted back to the base year using the growth-adjusted rate of return. Thus, the diagram vividly illustrates the crucial importance of using a very long term forecast of the budgetary consequences of demographic changes. Accordingly, 48 per cent of the present value of the future changes in the primary surplus are attributable to changes occurring after 2050.

Having thus quantified the impact of demographic changes on government net receipts, we now apply equation (9) to compute the index of fiscal sustainability. Table 2 reports the results.

Figure 3. Change in Government Primary Surplus



In recent years, the consolidated government sector has been running sizable surpluses, in 1999 equal to 2,9 per cent of GDP. Of this amount, 1,4 per cent of GDP reflects the large current surplus of (primarily) certain government-run supplementary pension schemes. As these are essentially fully funded institutions, the asset holdings of which are mirrored by liabilities vis-a-vis contributing households, the fiscally relevant surplus amounts to about 1,5 per cent of GDP.

However, as equation (9) shows, to this amount must be added the dilution of the public debt burden due to nominal income growth. Other things equal, the "true" surplus is thus increased by approximately 1,7 per cent of GDP in 1999. An additional adjustment for the forecasted time path of growth-adjusted interest rates is also undertaken. This acts to spread out over the infinite horizon of the intertemporal budget constraint the cost and benefits of transitory variations in the growth-adjusted interest rate.

Table 2. Fiscal Sustainability 1998-2000, per cent of GDP

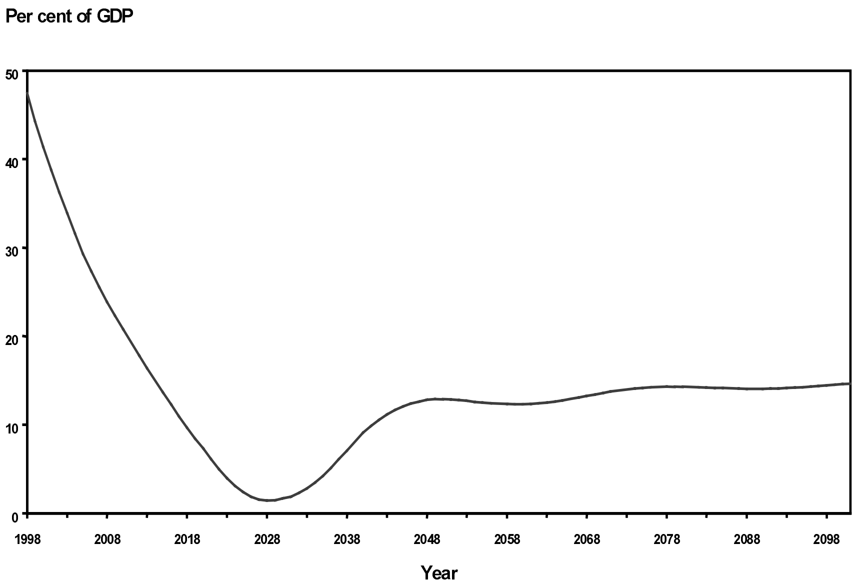
		1998	1999	2000
Accounting surplus				
Government sector NIPA surplus		0,88	2,86	2,29
Surplus of government supplementary pension funds		0,96	1,36	1,41
Adjustment for growth and inflation		1,89	1,67	1,82
Gov't surplus adjusted for growth and inflation		1,81	3,17	2,70
Government outlays		-3,07	-3,13	-3,20
of which	government consumption	-2,10	-2,14	-2,19
	income transfers	-1,56	-1,59	-1,63
	means testing of old age benefits.....	0,59	0,60	0,61
Tax revenue...		0,37	0,37	0,39
of which	net pension fund contributions	1,28	1,31	1,34
	private savings	0,07	0,07	0,07
	other factors	-0,99	-1,01	-1,02
Sustainability..		-0,90	0,42	-0,11
Sustainable primary surplus		3,61	3,62	3,63
of which	government debt.............................	0,91	0,87	0,82
	demographic factors.......................	1,72	1,75	1,79
	other factors	0,99	1,01	1,02

The impact on the expenditure side of the government budget of the demographic shifts now under way is equivalent to a permanent decline in net tax receipts of 3,8 per cent of GDP. However, the deferral of tax revenue associated with the build-up of private pension assets, and means testing of public pension benefits, translates into a permanent net gain of 2 per cent of GDP. Thus, about one-half of the fiscal burden associated with ageing is effectively covered through the budgetary consequences of private pension savings.

Finally, the current fiscal policy program, and certain technical adjustments, implies a decline in net tax receipts of about 1 per cent of GDP[5]. The net effect of these influences is that fiscal policy in Denmark, under the assumptions used in this paper, is quite close to being sustainable. In 2000, the government budget deficit, adjusted for sustainability, is thus equal to 0,1 per cent of GDP.

The final part of table 2 gives a break-down of the required primary surplus into the components attributable to the explicit and implicit parts of the government's liabilities. Hence, almost four-fifths of total debt obligations are due to future changes in the primary surplus, the remainder being accounted for by the explicit stock of government debt.

Figure 4. Government Debt under the Sustainable Fiscal Policy



[5] These include certain unfunded pension benefits accruing to government employees and the budgetary consequences of North Sea oil and gas extraction. Also included is currently legislated changes in tax revenue as well as an anticipated reduction in corporate tax receipts.

The interpretation of the index of fiscal sustainability is that of the permanent adjustment in the primary surplus which is required for the fiscal program to just satisfy the intertemporal budget constraint. Carrying out that adjustment, and computing the resulting sequence of primary surpluses, allows us to identify the time path of sustainable government debt through the application of equation (1). The result is shown in figure 4.

From the base year of 1998 until about 2030, government debt is almost entirely eliminated under the sustainable fiscal policy. This reflects the fact that the demographic shifts impact on the government budget only gradually. Hence, in order to smooth the time path of net tax receipts, government debt is reduced, while in the longer term, as expenditures on various old age benefits go up, interest payments are reduced. During the period 2030 to 2050, where the effects of demographic changes are at their peak, government debt is again increased somewhat. Hence, an important element in preparing the government financial balance for the consequences of ageing is a long period of sustained budget surpluses.

As noted above, computing the index of fiscal sustainability involves forecasting a number of key variables over a very long time horizon. Some of these magnitudes – such as, e.g., the number of elderly over the next three or four decades – may be predicted with considerable confidence. However, sizable uncertainty remains with respect to a number of crucial assumptions. This serves to underscore the importance of carrying out sensitivity analysis in order to determine the influence of the uncertainty with respect to the assumptions used. Table 3 below reports the consequences of altering six key magnitudes.

In the baseline scenario, *fertility* is assumed to increase from 1,7 to slightly less than 1,8. An additional increase of 0,1 in the average number of childbirths per female implies an increase in δ equal to 0,03 per cent of GDP. I.e., the higher fertility rate is equivalent to a permanent improvement in the primary surplus of this magnitude. This net effect is entirely due to the increased GDP growth rate, which alleviates the burden associated with the outstanding government debt, while the long term reduction in the dependency ratio is offset be the short to medium term increase in government expenditures on day care and education. In fact, the consequences for the government financial balance are negative during the first several decades. Because higher fertility tends to shift net tax receipts forward in time, the sustainable fiscal policy now involves less debt reduction initially. Thus, in the high fertility case, public debt is brought down from 48 to approximately 25 per cent of GDP in 2050.

Table 3. Fiscal Sustainability – Sensitivity Analysis

	Change relative to baseline in						
	Primary surplus				Fiscal sust. index	Debt burden	Sust. debt 2050
	2010	2030	2050	2200			
Fertility +0.1[1]	-0,17	-0,22	0,01	0,02	0,03	-0,04	9,9
Life expectancy +1 year[2]	-0,05	-0,41	-0,80	-0,85	-0,51	-0,00	-20,3
Life expectancy +1 year, transfers only [2]...	-0,02	-0,18	-0,35	-0,35	-0,22	-0,00	-8,4
Decline in participa-tion rates of elderly[3]..........	-0,76	-0,92	-0,78	-0,89	-0,78	0,01	-7,3
Decline in average hours of work[3]...........	-1,13	-1,25	-1,30	-1,35	-1,17	0,03	-11,4
Interest rate -½ Percentage point[4]........	0,00	-0,11	-0,14	-0,18	-0,06	-0,22	-3,9

1 Permanent change effective from 2000 onwards.
2 Life expectancy increased gradually by an additional 1 year over the period 2000 to 2040.
3 Trends in participation rates of over-60 year olds and hours of work from the period 1989-1999 continued for one more decade.
4 Permanent change effective from 2002 onwards.

Note: All numbers shown are expressed in per cent of GDP.

Changes in *life expectancy* have very pronounced effects on the government financial balance. An additional increase in life expectancy of one year for both males and females thus raises the required rate of fiscal consolidation in the base year by 0,5 per cent of GDP. Of this total, the increase in pension outlays accounts for slightly less than half. The effects on the primary surplus show up only gradually, however, and the mirror image is then a much sharper reduction in government debt. Under these assumptions, government debt is in fact turned into net assets equal to about 5 per cent of gross domestic product in 2050.

During the decade from 1989 to 1999, average (contractual) *hours of work* in the Danish labor market have declined by approximately 3 per cent. If this trend continues for another decade, fiscal sustainability requires permanent tax increases or expenditure cuts equal to almost 1,2 per cent of gross domestic product. Lower hours of work impact negatively on the government financial balance through the decline in the tax base and the increase in public sector employment needed to maintain a given level of publicly provided services. However, through the indexation of income transfers, this is moderated as the decline in average, annual earnings feeds into lower transfers.

Similarly, a continuation of the recent trend towards lower *labor force participation of the elderly* implies a substantial increase in the fiscal burden. This derives partly from the direct effect on the tax base, and partly from increased transfer payments. A decline in participation rates of over-60 year olds equal to the one witnessed since 1989 is thus equivalent to a permanent drop in net tax receipts of 0,8 per cent of GDP.

Table 4. Interest Rate Sensitivity of Fiscal Sustainability

		Fiscal sustainability
Baseline		-0,11
Interest rate ½ percentage point lower		-0,17
Difference		-0,06
of which	debt burden	+0,22
	personal capital income taxes	+0,15
	taxation of institutional savings	-0,27
	discounting of future net expenditures	-0,15

Note: All numbers shown are expressed in per cent of GDP at market prices.

In contrast, a change in the *rate of interest* has only a modest effect on fiscal sustainability. As detailed in table 4, this is the net result of several offsetting factors. First, a permanent reduction of ½ percentage point in the market rate of return reduces the burden of the current government debt by about 0,2 per cent of GDP. Also, the fact that the household sector has negative net capital income implies that a lower interest rate is beneficial for the government financial balance. At the same time, however, the return on pension fund assets, in which the government shares through the taxation of both the current return and the eventual pension disbursements, is also reduced, and this effect is equal to a permanent reduction in tax revenue of almost 0,3 per cent of GDP. Finally, a lower rate of discount implies that the future increase in government outlays has higher present value. On net, a lower rate of interest has (modestly) negative consequences for fiscal sustainability.

Finally, it is worth emphasizing that the results reported in this paper are *not* adjusted for business cycle conditions. Hence, our maintained (but implicit) working hypothesis has been that the state of the Danish economy in 1998 corresponds to that of an “average” year. While we do not here explicitly pursue this topic, the structural rate of unemployment is another key factor vital for the assessment of fiscal sustainability. Hence, if the rate of unemployment, on average, exceeds the 1998 level of 6,4 per cent, this will adversely affect fiscal sustainability.

Conclusion

From this analysis three major conclusions emerge. First, given projected population trends and a host of other assumptions, current fiscal policy in Denmark is likely to be consistent with sustainability.

Second, under the sustainable fiscal policy in the baseline scenario, government debt is almost eliminated during the next three decades. This requires maintaining significant surpluses on public sector budgets in order to forestall the need for changes in fiscal policy as the ageing of the population proceeds. Maintaining these surpluses for an extended period of time is a considerable policy challenge.

However, third, the relatively favorable fiscal outlook is sensitive to the underlying assumptions regarding population and labor force participation. If, e.g., the downward trend in average hours of work continues, or if life expectancy increases more than expected, substantial tax increases or expenditure cuts may become necessary.

3 The Gains from Tax Smoothing

In section 2, we saw how the (almost complete) elimination of government debt over the next couple of decades is a critical component of a sustainable fiscal package given current long term forecasts of the evolution of the government financial balance in Denmark.

In favor of such a policy, three key arguments might be put forward. First, under a sustainable fiscal policy, successive generations face identical tax rates and benefit from the same level of government spending on a per capita basis. Hence, in this sense, the net fiscal burden is equally distributed across generations.

Second, a sustainable fiscal strategy is designed to avoid the need to change fiscal policy as, e.g., demographic shifts unfold. Therefore, from the perspective of tax payers, sustainability may be viewed as an insurance policy against the need for future fiscal changes. Households may then plan their intertemporal consumption and labor supply on the basis of some confidence in the general fiscal environment in which they operate.

Third, time varying tax rates may be socially wasteful because the distortive costs of taxation increase with the square of the tax rate. By pre-empting the need for future tax increases as population ageing unfolds, a sustainable program of tax and expenditure instruments may contribute to minimizing the distortions to allocative efficiency caused by the tax system.

This section is devoted to a preliminary examination of the last of these issues. Below, we use a dynamic, general equilibrium simulation model to identify the macro-economic response of the economy to a policy involving a 20 year tax cut, followed by a permanent tax increase. This experiment may be thought of as capturing an alternative policy of "delayed adjustment" to demographic shifts. Particular attention is devoted to an assessment of the consequences for allocative efficiency. The model is deliberately kept close to textbook versions. Hence, the exercise below should be thought of as an attempt to add numbers to the impact of tax smoothing using a completely conventional framework combined with fairly conservative parameter assumptions.

The simulation model and its benchmark equilibrium[6]

The model used for the experiments in this section embodies a standard, overlapping generations structure following Blanchard (1985). It is a small, open economy model, where the domestically produced good is a perfect substitute for foreign goods. All markets are competitive, and there is perfect mobility of goods and financial capital between the domestic economy and the rest of the world. A representative business firm carries out productive activities using inputs of labor and capital. The accumulation of physical capital is subject to convex cost of installation, and this feature gives rise to a well-defined investment demand function.

The individual household faces a time invariant death probability, and in each period a new cohort of households appears in the model. Population is stationary, because the new generation is equal in size to the number of households who die. The economic decisions of the individual household involve how much labor to supply in each period and how to allocate labor supply over the planning horizon. Also, the household determines the optimal allocation of consumption expenditures over time and, hence, its savings and asset holdings. These decisions are influenced by the tax system, where the after-tax market wage rate is crucial for labor supply, while the post-tax interest rate determines the optimal intertemporal allocation of labor supply and consumption of goods. All decision makers in the model form their expectations rationally.

The government has at its disposal a fairly wide range of fiscal instruments. However, we will focus here mostly on the wage income tax. The government sector spends tax receipts on government consumption, consisting of public sector payroll, purchases of goods and services, and non-distortive income transfers to households as well as interest

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[6] A detailed presentation of the model and the simulation methodology is presented in Frederiksen (1994).

payments on the public debt. The government sector operates under the requirement of intertemporal solvency.

Table 5 shows key features of the baseline equilibrium, which is calibrated using 1995 data for the Danish economy and a range of empirical studies of the relevant behavioral parameters. For our purposes, the latter are simply the wage elasticity of labor supply and the interest rate elasticity of private savings.

Table 5. Key Parameters and the Baseline Equilibrium

Parameters:	*Baseline value*
Individual life expectancy (years)	29,9
Compensated wage elasticity of labor supply	0,112
Compensated interest elasticity of private savings	0,34
Tax rate of household interest income (per cent)	48,0
Effective tax rate on household wage income (per cent)	65,6
Effective tax rate on business investment (per cent)	0,8
World market rate of interest (per cent)	4
Baseline equilibrium:	*Per cent of GDP*
Private consumption	59,1
Government consumption	27,5
Private investment	12,0
Net exports	1,4
Household human wealth	1113
Household financial net wealth	159
Government debt	68
Net foreign assets	-34

The planning horizon of the individual household is approximately 30 years[7]. The compensated labor supply elasticity of 0,11 is an average of several recent studies based on Danish data. The savings response is calibrated to generate a 3 percentage point compensated, impact increase in the private savings rate in response to a 1 percentage point sustained increase in the after-tax interest rate. No Danish data seems to be available on this important parameter. The implied value of the elasticity of intertemporal substitution is 0,23.

For the purposes pursued here, the effective tax rates on labor income and savings are crucial for the impact on allocative efficiency. The 66 per cent marginal tax rate on labor income reflects the interaction of payroll and income as well as indirect taxes. The tax rate on interest income, and hence the return to household savings, is 48 per cent, while the baseline net influence of the tax system on business investment is almost zero.

Finally, as the model population is stationary, we ignore the effects of demographic changes per se as we wish to focus exclusively on the interaction between the key behavioral relationships in the model, and how these are influenced by the tax system.

The experiments to be discussed shortly are designed as follows. The model starts out from an initial steady state. We use that steady state to approximate a situation with a sustainable fiscal program in place. At time zero, the initial equilibrium is disturbed by a 20 year tax cut involving a 2 percentage point reduction in the proportional tax rate on labor income. After the 20 years have elapsed, the wage tax rate is increased permanently so as to balance the government budget in present value terms. Throughout, the government expenditure side is undisturbed – transfers, government employment and public sector purchases are thus kept at their baseline levels. The experiment therefore involves rearranging the government's tax receipts over time.

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7 While this number may seem low, it is worth recalling that average life expectancy in the 55-period life-cycle model of Auerbach and Kotlikoff (1987) is 27,5 years when population is stationary. The 29,9 year effective planning horizon used here reflects the 1993 average life expectancy for individuals 20 years or older in Denmark.

Simulation results

In this section, we first consider the consequences of the temporary tax cut policy for the evolution of the macro-economic equilibrium and the generational distribution of economic welfare. Figures 5 and 6 show these effects.

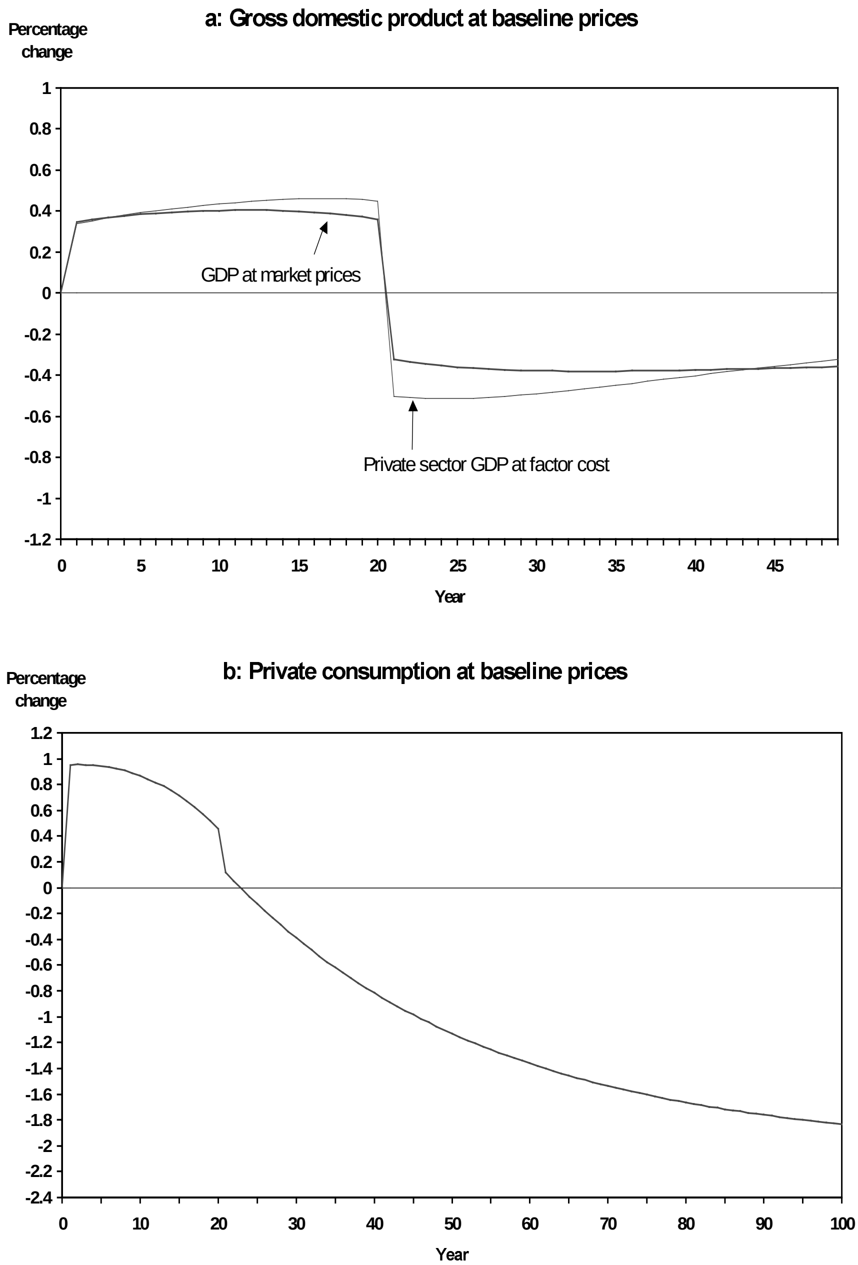
During the initial phase, while the tax cut is in place, domestic activity increases reflecting the higher labor supply due to the improved incentive to work. This is driven partly by the more favorable trade-off between leisure time and consumption of market goods available during the first 20 years, but also by intertemporal substitution in hours of work. Thus, households are encouraged to shift the enjoyment of leisure forward in time.

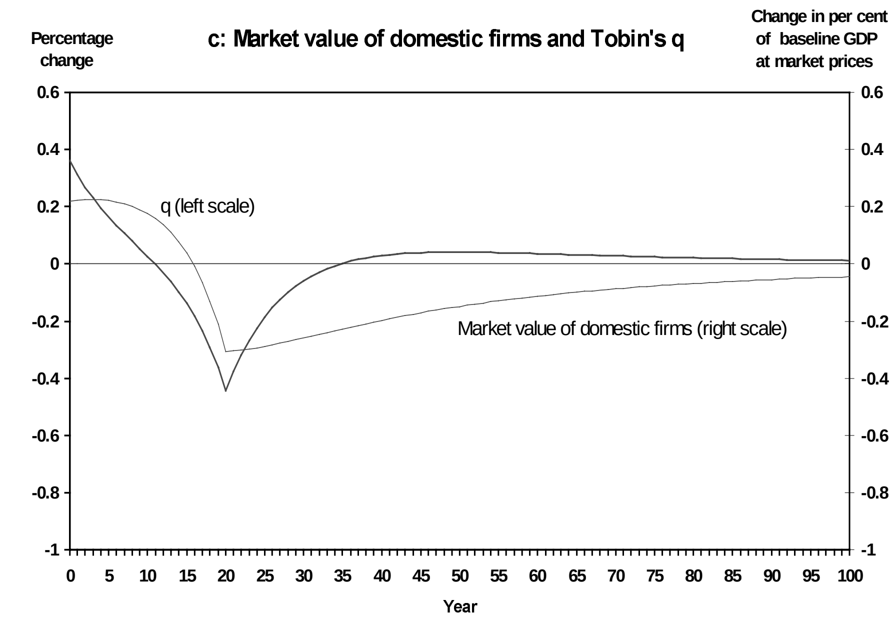
The deficits recorded in the government financial balance during the initial phase implies an increase in the government's outstanding debt liabilities equal to about 28 per cent of GDP. The policy experiment considered here may thus be thought of as devoting somewhat more than half of the projected government surplus during the next 20 years to lowering taxes.

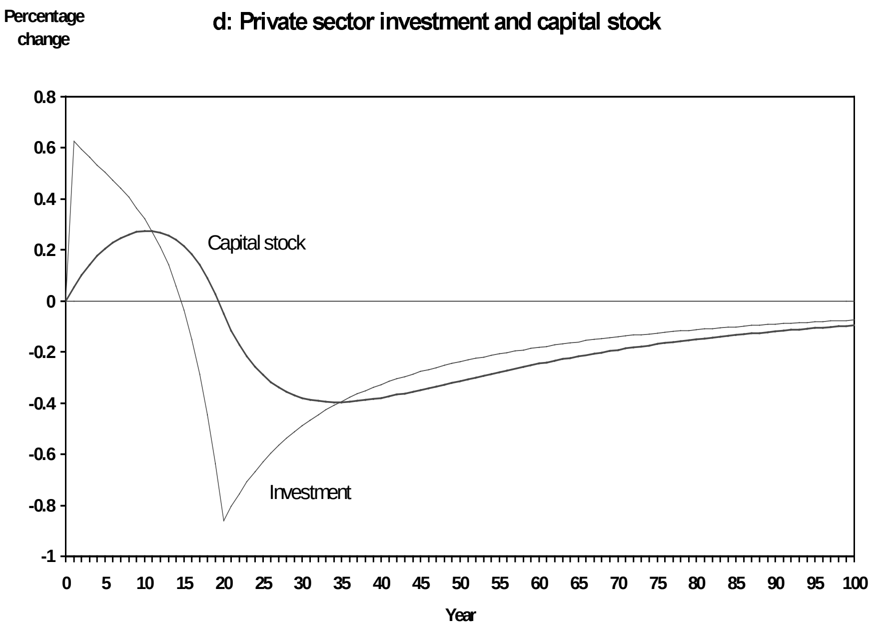
Unsurprisingly, the temporary tax cut implies substantial income redistribution from future generations to those currently alive as figure 6 indicates. A household entering the economy after the tax increase has been implemented thus suffers a net loss of life time resources equal to about 20 per cent of per capita gross domestic product. In contrast, those households who get to reap the full benefits of the tax cut gain by an amount equal to a one-time transfer of 10 per cent of per capita GDP.

The generational redistribution effects are important determinants behind the evolution of aggregate consumption and asset accumulation depicted in figure 5. Thus, the temporary consumption increase is largely driven by generational redistribution. Also, the net losses recorded by future generations induce these to demand fewer financial assets to sustain their intertemporal consumption plans. In the very long term, therefore, private financial assets drop below their initial steady state level as shown in figure 5.h.

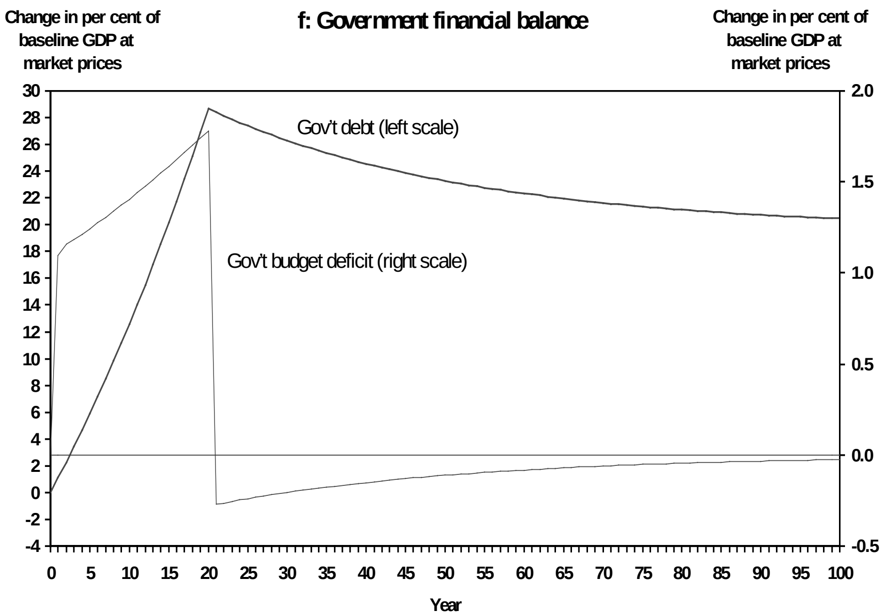
Figure 5. Macro-economic Impact of the Temporary Tax Cut

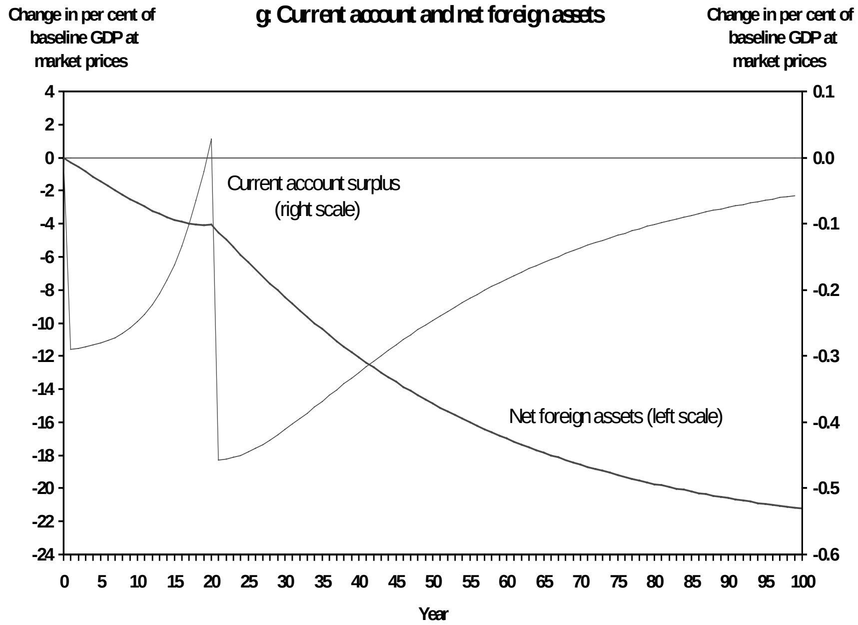



Percentage change
c: Market value of domestic firms and Tobin's q
Change in per cent of baseline GDP at market prices
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
q (left scale)
Market value of domestic firms (right scale)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Year


Percentage change
d: Private sector investment and capital stock
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Capital stock
Investment
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Year


Percentage change
e: Equilibrium wage rate and employment
Percentage change
Post-tax wage rate (right scale)
Labor supply (left scale)
Year


Change in per cent of baseline GDP at market prices
f: Government financial balance
Change in per cent of baseline GDP at market prices
Gov't debt (left scale)
Gov't budget deficit (right scale)
Year


g: Current account and net foreign assets
Change in per cent of baseline GDP at market prices
Change in per cent of baseline GDP at market prices
Current account surplus (right scale)
Net foreign assets (left scale)
Year

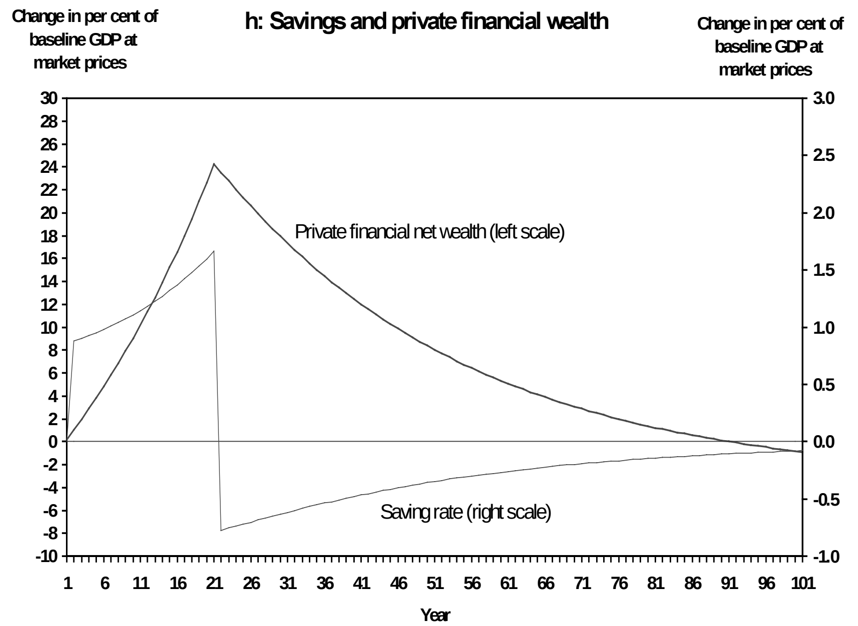
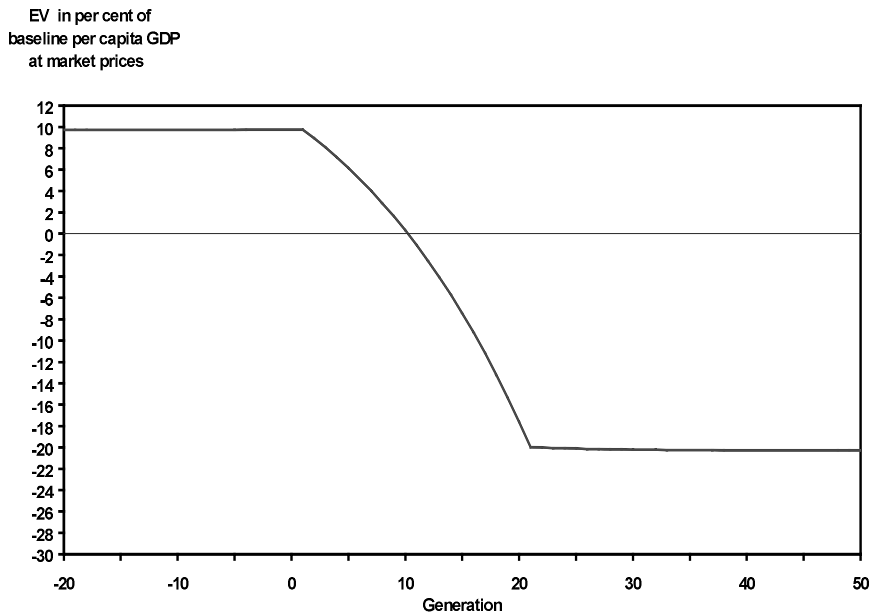

h: Savings and private financial wealth
Change in per cent of baseline GDP at market prices
Change in per cent of baseline GDP at market prices
Private financial net wealth (left scale)
Saving rate (right scale)
Year

Figure 6. Impact on Generational Welfare of Temporary tax Cut



However, figure 5.h also shows that, although Ricardian equivalence does not hold in this model, households build up substantial financial assets during the initial phase. While government debt rises above its initial level by 28 per cent of GDP, this is mirrored by an increase in private assets of 24 per cent GDP. The key feature underlying this outcome is of course the long horizon of the individual household combined with the assumption of rational expectations. Households correctly anticipate the future increase in taxes and therefore save a significant fraction of the tax cut.

Obviously, as figure 6 shows, the temporary tax cut policy involves winners and losers. Our purpose here, however, is to provide an assessment of the impact on allocative efficiency in order to draw conclusions about the validity of the tax smoothing argument alluded to above. We therefore proceed by considering the impact on efficiency using the sum of the equivalent variations to cancel out the purely redistributive elements in the experiment.

Technically, the measure of allocative efficiency is computed by adding the EV's pertaining to individual generations, and discounting those of future generations at the market rate of interest. The resulting aggregate efficiency numbers are then expressed as a permanent, percentage change in aggregate private consumption to give an impression of the magnitudes involved. The results are shown in table 6 along with the changes in the tax rates in each experiment.

In the baseline scenario portrayed in figures 5 and 6, the temporary tax cut necessitates a permanent tax increase of 1,63 percentage points after period 20. The net impact on allocative efficiency is fairly modest, but in fact *positive*. The policy of a temporary wage tax cut, compensated by a permanent increase is thus equivalent, in efficiency terms, to a sustained 0,097 per cent increase in aggregate private consumption.

This rather surprising outcome reflects primarily two offsetting factors. First, cutting and subsequently raising the labor income tax rate entails an efficiency loss due to the fact that the distortive costs of higher taxes rise more than proportionately with the tax rate. However, secondly, as figure 5.h shows, the private sector reaction involves a substantial, transitory increase in private savings reflecting the rationally anticipated future tax increase. Also, the intertemporal substitution in labor supply stimulates temporarily private savings. Through the taxation of the accrued interest, the government thereby gains substantial additional revenue. This revenue, in turn, reduces the need to increase the wage tax rate. In the baseline scenario, the latter effect dominates, and the temporary tax cut policy gives rise to a net efficiency gain.

Basically, this reflects the second best nature of the experiment. Viewed in isolation, time varying labor income tax rates are wasteful from an efficiency point of view. But, because the return to private savings is also taxed, the associated positive impact on household asset accumulation tends to produce a net efficiency gain despite the fact that the wage tax increase is permanent, while the increase in household savings is purely transitory.

The second row in table 6 shows the outcome if the compensated wage elasticity of labor supply is 0,2 instead of the baseline value of 0,1. In this case, the cost of "un-smoothing" the labor income tax rate goes up, but once again the gain in capital income tax revenue dominates.

Because labor supply now responds more strongly to changes in the after-tax wage rate, using this revenue to cut the wage tax rate becomes more important. Under these circumstances, the temporary tax reduction is equivalent to a permanent 0,16 per cent rise in private consumption.

Table 6. The Efficiency Effect of the Temporary Tax Cut – Sensitivity Analysis

Assumption	Initial tax cut (percentage points)	Long run tax increase (percentage points)	Efficiency effect (per cent of priv. cons.)
Baseline.......................................	2	1,63	0,097
High labor supply elasticity.........	2	1,55	0,158
Savings elasticity approx. zero....	2	1,66	0,070
Interest income tax zero	2	2,43	-0,028
Duration of tax cut 50 years........	2	8,20	0,129
Larger initial tax cut....................	4	3,32	0,148
Income tax.................................	2	1,65	0,030
Consumption tax	5,25	4,83	-0,166

Note: The efficiency effect is defined as the sum of EV's, discounted back to the base year using the market rate of interest and expressed as a permanent percentage of initial private consumption. The case of a high labor supply elasticity involves a compensated wage elasticity of 0,2. In the case of zero taxation of interest income, the corporate tax system is adjusted so as to keep investment incentives unchanged. The baseline is adjusted so that the base year equilibrium is identical across the experiments reported in the table. The consumption tax cut is scaled so that the initial increase in the net after-tax wage rate is equivalent to a 2 percentage point reduction in the wage tax rate.

As discussed above, the transitional increase in private savings derives from two sources. First, to some extent households behave in a Ricardian fashion and accumulate financial assets that are subsequently used to partly pay for the future tax increase. Also, intertemporal substitution of hours of work tends to raise private savings initially. This is so because the relatively low tax rate on labor income during the first 20 years induces households to work more initially, postponing their consumption of leisure time. The third and fourth rows in table 6 identify the relative importance of these two factors.

Selecting a value of the elasticity of intertemporal substitution (approximately) equal to zero shuts down the intertemporal substitution effect. As shown in table 6, this reduces the net efficiency gain by slightly less than one-third. But the temporary tax cut is still beneficial from an efficiency view point.

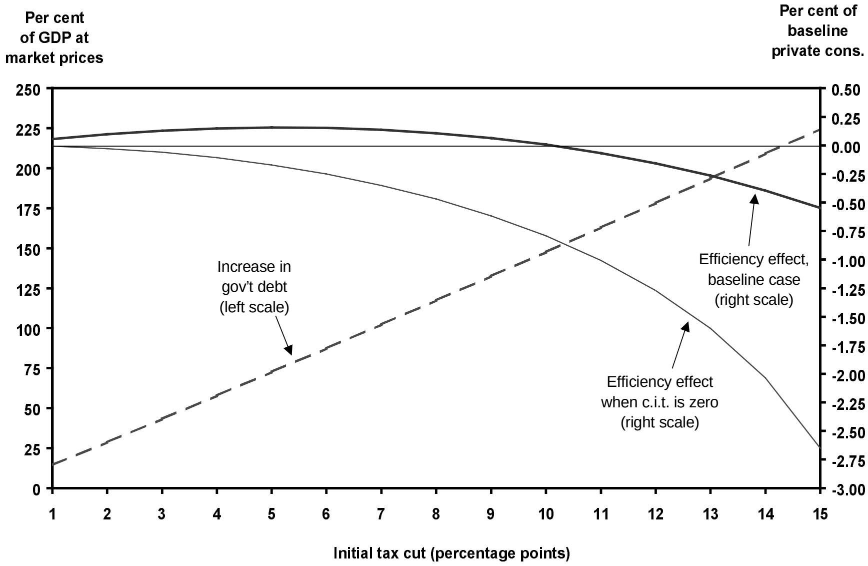
Eliminating the taxation of interest income implies that the government no longer gains tax revenue from the increase in private assets. The required long run wage tax increase is then equal to 2,4 percentage points and is thus 0,8 percentage point higher than in the baseline case. In this situation, the net impact on allocative efficiency is negative, thus confirming our a priori intuition.

The net loss is comparable to a permanent decline in private consumption of one-thirtieth of a per cent. Hence, another key conclusion is that, given the 0,1 wage elasticity of compensated labor supply, even fairly large intertemporal variations in tax policy and hence government debt, are not overly costly in terms of allocative efficiency. Within a standard model like the one used in this paper, the tax smoothing argument in favor of pursuing sustainable fiscal policies is thus, at best, a rather weak one.

Extending the tax cut to a 50 year horizon increases the intertemporal fluctuations in the wage tax rate. Thus, the required permanent increase is equal to 8,2 percentage points. This is not enough, however to overturn the net efficiency gain arising in this experiment. Neither does an increase in the size of the initial tax cut.

Finally, using a proportional income tax – and hence affecting the taxation of labor as well as interest income of domestic households – reduces significantly the impact on economic efficiency. This is primarily due to the fact that the distortionary effect on household savings is, at the margin, more severe than the one affecting labor supply. Therefore, if the government is forced to use income taxes instead of wage taxes, the efficiency case for tax smoothing is likely to be stronger. This may be of some significance since tax administrative and other efficiency considerations may make it difficult or undesirable to have wide differentials between wage and individual capital income tax rates.

Figure 7. Scale of the Initial Tax Cut and the Impact on Efficiency



The potential gains in allocative efficiency found above naturally raises the question of how large the maximum gains from a temporary tax cut may be. Figure 7 shows, that an initial tax cut of about 5 percentage points leads to a net gain equal to a permanent 0,16 per cent increase in private consumption. This may alternatively be obtained through a sustained, lump sum tax financed, 0,56 percentage point reduction in the labor income tax rate. In other words, the main conclusion drawn from the analysis in this section is that tax smoothing is approximately irrelevant for allocative efficiency for even very large intertemporal changes in tax rates.

Conclusion

We have thus identified here two key mechanisms through which deviations from a sustainable fiscal policy may affect allocative efficiency. First, through the time varying tax rates on wage income the overall distortive cost of the tax system increases. Second, anticipated future tax increases lead households to save in anticipation of the impending increase in their tax burden. And even in a non-Ricardian model like the one used here, this effect is rather pronounced.

In combination with taxation of the return to savings, then, a temporary tax cut may in fact improve allocative efficiency. The quantitative effects are, however, quite modest. A conservative conclusion based on the standard textbook, competitive OLG framework used in this paper is therefore that the efficiency case for tax smoothing is not likely to be a very important one.

4 Concluding Remarks

In this paper we have considered the issue of fiscal sustainability in Denmark. Given recent population trends, and the continuation of current tax and spending policies, the government fiscal program is quite close to sustainability. While the demographic changes under way will eventually drive considerable increases in government spending on old age transfers, health care and other services, this is alleviated by two key forces.

First, the tax-deferred accumulation of private pension assets implies a significant long run increase in tax receipts as current net contributions are turned into net disbursements. Second, on a growth- and inflation-adjusted basis, the government sector is currently running substantial budget surpluses. If these are maintained during the next few decades, until the process of population ageing speeds up, the reduction in government debt will make a sizable contribution to fiscal sustainability.

However, the results are quite sensitive to the underlying assumptions about, e.g., key demographic parameters and labor force participation. Even fairly modest changes in these assumptions in an unfavorable direction may necessitate substantial tax increases or expenditure cuts.

One of the possible motivations for pursuing sustainable fiscal policies is tax smoothing. Using a dynamic, general equilibrium simulation model, we performed a number of experiments in order to identify the impact of intertemporal variations in tax policy parameters. A temporary wage tax cut, followed by a permanent wage tax increase, turned out to be beneficial from an efficiency point of view. This reflects the dominance of the positive effects of the transitional build-up of financial assets over the increase in the distortive costs of the tax system due to non-smooth tax rates. The likely gains, however, are quite modest. The tentative conclusion from this part of the analysis is therefore that the desirability of sustainable fiscal policies must rather be judged by the impact on, e.g., generational equity.

REFERENCES

Auerbach, A.J. and L.J. Kotlikoff (1987), *Dynamic Fiscal Policy*, Cambridge, Mass., Cambridge University Press.

Balassone, F. and D. Franco, "Assessing Fiscal Sustainability: A Review of Methods with a View to EMU", in this volume.

Blanchard, O.J. (1985), "Debt, Deficits and Finite Horizons", *Journal of Political Economy,* No. 93.

Blanchard, O., J.-C. Chouraqui, R.P. Hagemann and N. Sartor (1990), "The Sustainability of Fiscal Policy: New Answers to an Old Question", *OECD Economic Studies*, No. 15.

Frederiksen, N.K. (1994), "A Dynamic General Equilibrium Simulation Model for Fiscal Policy Analysis", *EPRU Economic Studies* No. 1/1994, Copenhagen Business School.

Jensen, S., E. Hougaard and S.B. Nielsen (1995), "Population Ageing, Public Debt and Sustainable Fiscal Policy", *Fiscal Studies*, No. 16.

Danish Ministry of Finance (2000), *The Danish Economy – Medium Term Survey 2000*.