Danmarks Statistik
MODELGRUPPEN

Arbejdspapir*

Amenu Temesgen Kitesa
Dan Knudsen

29. June 2015

Fiscal Reaction function for ADAM

Resumé:

We apply a fiscal reaction function in ADAM for a number of experiments in order to test the reaction function. The reaction function makes public finances sustainable in the long run by changing the income tax rate. Sustainability is here defined as a constant GDP ratio of public net debt. More specifically, the reaction function targets the general government primary surplus and makes it zero in steady state by changing the central government income tax. If the primary surplus is positive, the tax rate is reduced and vice versa if the surplus is negative. The sustainable primary surplus is always zero in steady state because the growth-corrected interest rate is zero in ADAM's baselines.

Stabilizing the public primary surplus is pro cyclical and the resulting balanced budget multiplier could be quite cyclical and instable for decades considering the possible tax response during the adjustment period between instrument change and steady state impact. However, the reaction function is forward looking, and the calculated tax instrument does not respond much to the cyclical disturbances in the adjustment period, which makes it easier to find a steady state with constant public debt ratio and constant tax rate.

We also test public building investments as instrument instead of income taxes. Public building investments as GDP ratio can, just like the income tax rate, be used to make the primary surplus zero in steady state. If the public primary surplus is positive, the reaction function increases public building investments. However, the impact of higher public investments is slightly more complicated than the impact of lower income taxes, because higher public investments generate higher public capital, higher public output and consequently higher public consumption.

Keywords: fiscal reaction function, steady state, public debt ratio, primary surplus

Introduction

Fiscal policy rules have become common in macroeconomic models, for both theoretical and practical reasons. Most fiscal reaction rules use taxes to prevent either the debt-to-GDP ratio or the deficit-to-GDP ratio from exploding, cf. Peter R. Mitchell, et al (2000). The choice of fiscal reaction rule is not irrelevant, it will affect the time path of taxes, and the development in tax rates will influence the business cycle and also the economic efficiency and distribution of wealth across generations.

The optimal fiscal rule should adjust the tax instrument to its necessary long run position and keep the public debt ratio constant in steady state without causing "too many" disturbances for employment and activity. The use of quotes, ", reflects that we are not trying to optimize the cyclical response with reference to a pre-set social welfare function. The exercise is more informal.

Primary surplus is targeted

The situation for public finances may be characterized both by the long-run public budget and by the long-run public net asset, as proportions of GDP, and the policy maker may have a desired value for any of those ratios. In any case, we shall focus on the primary surplus when formulating the necessary permanent change in income taxes.

In a steady state with zero growth-corrected interest rate, i.e. interest rate = growth, the public primary surplus has to be zero in steady state in order to keep both budget and net asset GDP ratios constant in the long run. Thus, we know that the steady-state primary surplus is always zero in the special case of interest rate = growth rate, and it is natural to focus in the primary surplus.

The following simple arithmetic shows how primary surplus in general can be formulated as a function of steady state net asset and steady state budget.

We have the notation $Y = GDP$, P = primary surplus, B = government budget, N = net asset, i = nominal interest rate and g is the nominal growth rate of GDP, $g = \frac{Y}{Y_{-1}} - 1$. Moreover, the primary surplus ratio $p = \frac{P}{Y}$, budget ratio to GDP is, $b = \frac{B}{Y}$ and net asset to GDP, $n = \frac{N}{Y}$. We can now indicate the steady-state primary surplus ratio p^* as a function of either desired steady-state-net asset ratio n^* or desired steady-state budget ratio b^* plus rate variables i and g. All variables are constant in steady state where all nominal values grow by g.

Nominal GDP follows the equation

$$Y = Y_{-1} + g \; Y_{-1} = (1+g) Y_{-1} \text{ ----------1}$$

The net asset at time t depends on the $t-1$ net asset, the interest rate, and the primary surplus, P :-

$$N = N_{-1} + iN_{-1} + P = (1+i) N_{-1} + P \text{ ---------- 2}$$

Dividing by Y and introducing the steady state growth rate g, we get

$$\frac{N}{Y}=\frac{(1+i)}{(1+g)}\frac{N_{-1}}{Y_{-1}}+\frac{P}{Y} \text{ ----------3}$$

$$n=\left(\frac{1+i}{1+g}\right)n_{-1}+p \text{ ----------4}$$

At steady state, the time dependent variables have an asterisk

$$n^{*}=\left(\frac{1+i}{1+g}\right)n_{-1}^{*}+p^{*} \text{ ----------5}$$

Using $n^{*}=n_{-1}^{*}$ in steady state, we get

$$p^{*}=\left(\frac{g-i}{1+g}\right)n^{*} \text{ ----------6}$$

This defines steady state primary surplus as a function of desired net asset, and it follows that when $i=g$, the steady state primary surplus is zero, no matter what the desired public net asset level is.

We now express the steady state primary surplus as a function of desired steady-state budget. The budget is determined by:

$$B=P+i*N_{-1} \text{ ----------7}$$

$$\frac{B}{Y}=\frac{P}{Y}+\frac{i}{(1+g)}\frac{N_{-1}}{Y_{-1}} \text{ ----------8}$$

$$b=p+\frac{i}{1+g}n_{-1} \text{ ----------9}$$

We solve for p

$$p=b-\frac{i}{1+g}n_{-1} \text{ ----------10}$$

And substitute equation 10 into equation 4

$$n=\left(\frac{1+i}{1+g}\right)n_{-1}+b-\frac{i}{1+g}n_{-1} \text{ ----------11}$$

$$n=\frac{1}{1+g}n_{-1}+b \text{ ----------12}$$

Inserting steady-state desired values and using $n^{*}=n_{-1}^{*}$, we get

$$n^{*}=\frac{1+g}{g}b^{*} \text{ ----------13}$$

This equation expresses the desired net asset ratio as a simple function of the desired budget ratio. Consequently, a choice of b* can be converted into a choice of n* and vice versa.

We now substitute n* by b* in 6:

$$p^* = \left(\frac{g-i}{1+g}\right)\left(\frac{1+g}{g}\right)b^* = \left(\frac{g-i}{g}\right)b^* \text{ ----------14}$$

This equation (14) defines steady state primary surplus as a function of steady-state desired budget balance just like 6 defines steady-state primary surplus as a function of the desired steady state net asset. It follows from equation (14), like it follows from equation 6 that whenever $i = g$, the steady-state primary surplus is zero, and all budget and net asset goals are translated into a primary surplus goal of zero. To reach a specific goal for the public budget or net asset for $i = g$, we can use a temporary change in the tax rate implying a temporary change in the primary surplus.

More specifically, the primary surplus target in 14 concerns a corrected primary surplus $bt = \frac{\left(tfn\_o - \left(Tin\_o - Tirn\_o\right)\right)}{Y}$, where $Tirn\_o$ is the income for land and rights. Thus, $Tirn\_o$ enters the wealth-income variable Tin_o without counterpart in the financial wealth Wn_o and it is better to correct and re-define the primary surplus in the model by transforming $Tirn\_o$ from wealth income to income affecting the primary surplus. In relation to the equations above and their simple interpretation, which is also a simple interpretation of ADAM, it is crucial that public wealth income is determined as a yield rate multiplied by net wealth.

Fiscal reaction function

The fiscal reaction function determines the basic income tax rate tsysp1 (bundskat) as an average of past and future income tax rates and contemporaneous primary surplus, cf. Dessie (2015).

$$tsysp1 = \frac{\left(5 * tsysp1_{-1} + \sum_{i=1}^{i=15} tsysp1_i\right)}{20} - ctsysp1\left[\frac{\left(tfn\_o - \left(Tin\_o - Tirn\_o\right)\right)}{Y} - bt\right] \text{ ---------- 15}$$

The other income tax rate tsysp2 (topskat) is made proportional to tsysp1, so that both tax rates react to deviations between the primary surplus and its target bt, which is zero as long as we have a growth-corrected interest rate of zero and we have that in all ADAM scenarios so far.

The income tax rate $tsysp2$, is determined by

$$tsysp2 = \frac{tsysp2_{-1} * tsysp1}{tsysp1_{-1}}$$

The use of future tax rates makes the reaction function forward-looking. It seems essential that the rule is forward looking due to the time lag between instrument change and full activity impact. A backward-looking rule makes fiscal policy pro cyclical and this tends to amplify the ADAM-generated cycles significantly. It is not rational for a fiscal authority that is using ADAM to create these cycles.

Thus, it stands to reason that we shall have forward-looking expectations in the fiscal reaction function. However, the formulation in (15) may not be the best. It may, for instance, not be robust and it is a good idea to try other formulations. For example, we may try to introduce either the lagged or the leaded primary surplus, i.e.

$$tsysp1 = \frac{\left(5 * tsysp1_{-1} + \sum_{i=1}^{i=15} tsysp1_i\right)}{20} - ctsysp1\left[\frac{\left(tfn\_o(-1) - \left(Tin\_o(-1) - Tirn\_o(-1)\right)\right)}{Y(-1)} - bt(-1)\right]$$

or

$$tsysp1 = \frac{\left(5 * tsysp1_{-1} + \sum_{i=1}^{i=15} tsysp1_i\right)}{20} - ctsysp1\left[\frac{\left(tfn\_o(+1) - \left(Tin\_o(+1) - Tirn\_o(+1)\right)\right)}{Y(+1)} - bt(+1)\right]$$

Using the formulation with contemporaneous surplus seems to minimize the volatility of the tax instrument but there is not much difference between the three alternatives. Apparently it does not warrant a new value of the error correction parameter, *ctsysp*1 to lag or lead the primary surplus.

Alternative policy instrument

It is standard for fiscal reaction functions to have a broad tax rate as instrument. Of course, the model user may sometimes prefer another instrument, for instance public building investments. This can be modeled in the same way. We introduce the GDP ratio of public building investments, $bfibo1 = fibo1/fy$, and use this ratio as a (negative) tax ratio in the fiscal reaction function, see below. Thus, we have a slightly changed reaction function plus an auxiliary equation for the hitherto exogenous public building investments.

$$bfibo1_t = \frac{\left(5 * bfibo1_{-1} + \sum_{i=1}^{i=15} bfibo1_i\right)}{20} + cbfibo1\left[\frac{\left(tfn\_o - \left(Tin\_o - Tirn\_o\right)\right)}{Y} - bt\right]$$

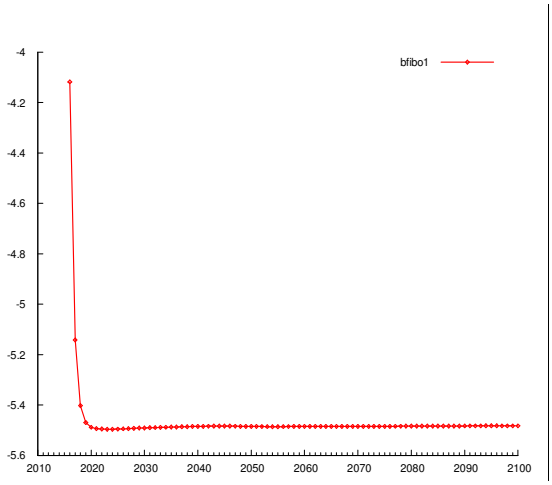
$$fibo1_t = bfibo1_t * fy$$

The error-correction coefficient *cbfibo*1 is positive implying that a positive primary surplus triggers an increase in building investments. The auxiliary equation for public building investments can be switched off if we are not using the reaction function.

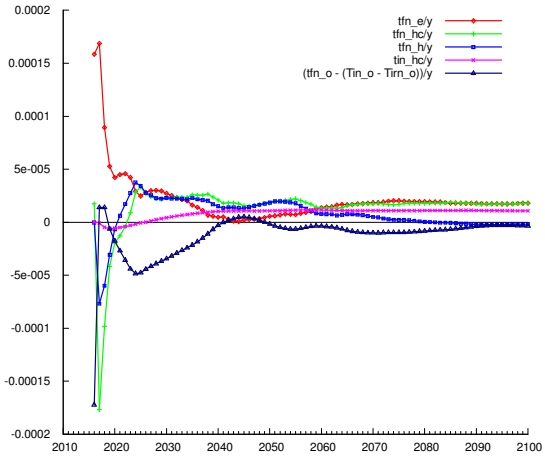
To test this alternative reaction function we introduce a permanent 1.25 percent increase in government consumption of energy and materials (fvo1) after exogenizing it. The latter is done to avoid the dynamic interaction of fvo1 with the value added in production of the government sector.

The error correction coefficient *cbfibo*1 is set to 0.02 (lower than the *ctysp*1 of 0.5 in equation 15), and this new reaction function is able to make the public net asset ratio constant in steady state.

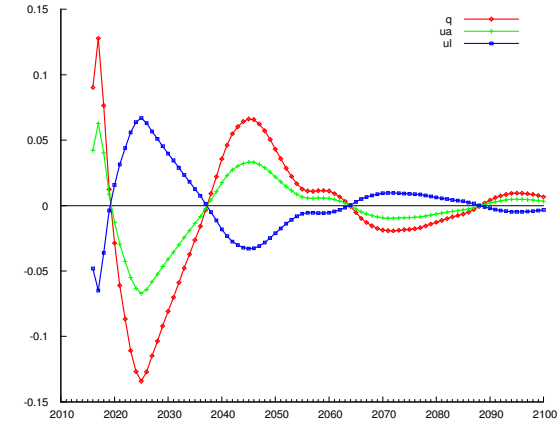
Multiplier in pct



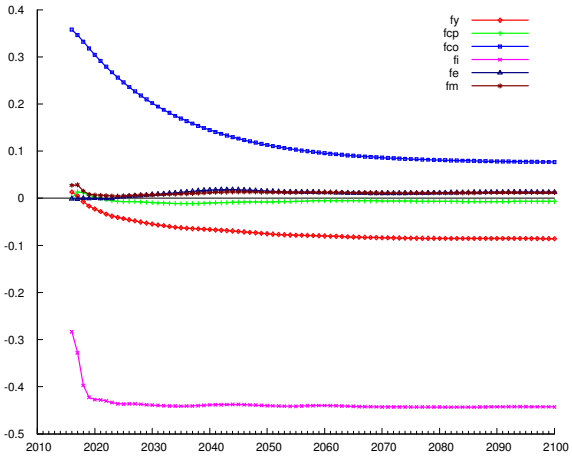
Multiplier in difference



Multiplier in difference



Multiplier in percent



In this model experiment with the alternative fiscal reaction function, the higher public purchase of goods and services implies 5½ percent lower public building investments, which makes it a balanced budget experiment in the long run. The labor market fluctuates around its structural employment and unemployment levels, and the fluctuations are gradually dampened. It resembles the outcome of a similar shock to ADAM with a tax-related fiscal reaction function, cf. the next section on six experiments.

Total investments fall permanently due to the fall in government building investments, and the lower investment level makes public building capital fall over a long period. Consequently, depreciation will fall over a long period and so will public output and public consumption. In this sense, the final steady state is far way and is only reached towards the end of the long calculation period, cf. the long-lasting impact on public consumption and GDP. One way of describing it, is

that the derived consequences for public output and consumption makes the public investment instrument look complicated. However, the falling public consumption is per se balanced by a falling GDP without noteworthy impact on either employment or private demand.

Our experiment illustrates the outcome of reducing the necessary capital stock in the public sector. In a specific experiment, the model user may assume that an unchanged public consumption can be provided by a lower building stock and focus on consumption exclusive of depreciation.

Six ADAM experiments with fiscal reaction function

Using the same baseline as in the working paper 'Minor Adjustments and implicit interest rate in ADAM' and using the okt14 ADAM version plus the fiscal reaction function with tax rate as instrument, we now undertake six multiplier experiments. The six permanent shocks are: higher public purchase of goods and services, higher public building investments, lower indirect tax (VAT), reduced early retirement, and higher foreign demand. The following graphs show the reaction of income tax rates and other variables to these long-run balanced-budget shocks.

Government purchase of goods (mul1)

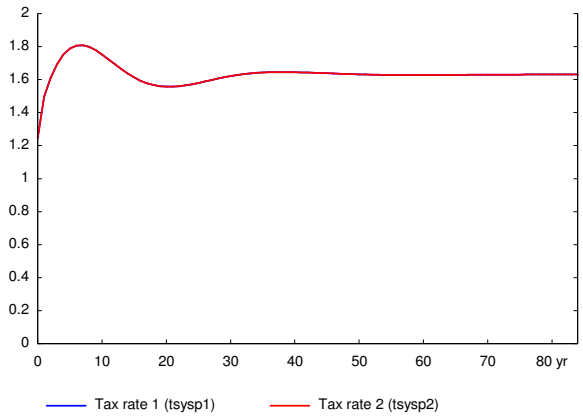
Public expenditure is increased permanently by 1 percent relative to the baseline corresponding to 1000 million kroner in 2010 prices in the first year of the experiment. The experiment triggers a permanent increase of around 1.6 percent in the income tax rate to finance the higher purchase. This keeps the government sector's net wealth and savings balance constant as GDP shares.

In the first years the higher government purchase dominates the tax increase and we have a higher demand for private output as first-round effect. Consequently, private employment rises in the short run, but in the long run, there is no effect on private employment.

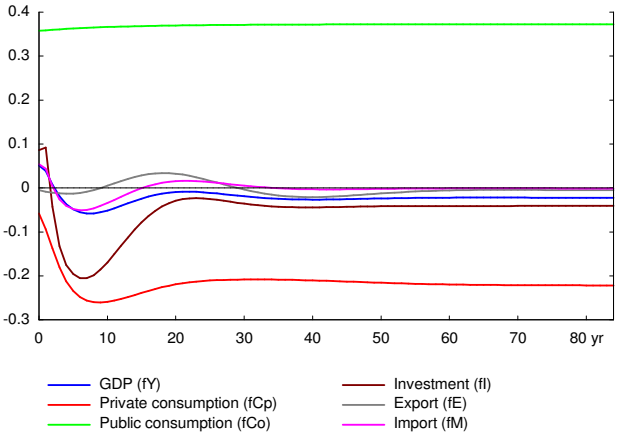
Without the fiscal reaction in taxes, private consumption is stimulated by the so-called Herberger-Larusen-Metzler effect when the crowding out mechanism increases the domestic wage and price level. And without the fiscal reaction, the permanently higher domestic demand is eventually balanced by a significant loss of market shares and exports. With the fiscal reaction function, the higher income tax rate induces a permanently lower private consumption to balance the higher public purchase, and exports are hardly changed from its baseline in the long run. Thus, the crowding out of the additional public demand in the present experiment has not involved a higher wage rate, competitiveness has not deteriorated, and we have a sustainable long term solution where public and foreign savings balances have hardly changed from their baseline in steady state.

More specifically, the public primary surplus expressed as GDP ratio does not change visibly in steady state, but we detect a minor deterioration in the public net asset and consequently in the public budget that includes public wealth income. It just takes a one-off increase in the income tax rate or in any public revenue instrument to remove the slight net asset deterioration, which reflects that the cumulated cyclical impact on the primary surplus is negative, cf. box 11.2 in the ADAM book. As mentioned earlier, government primary surplus is defined in the reaction function as (tfn_o – (tin_o – tirn_o))/y, cf. figure on savings balances.

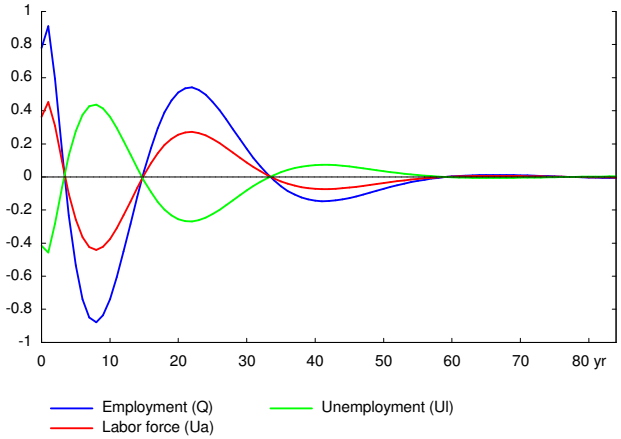
Fiscal Rule: Multiplier in pct.



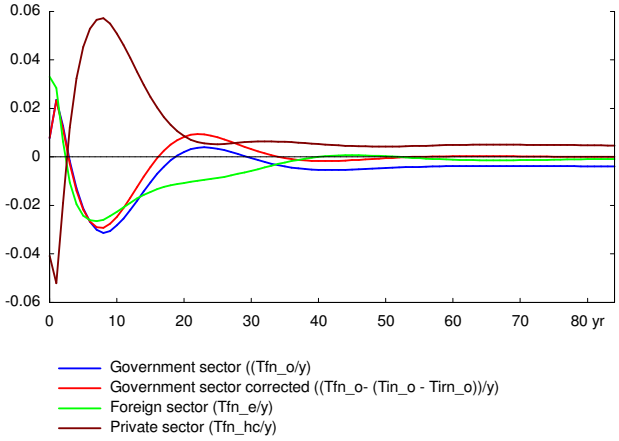
Supply-Use balance: Multiplier in pct.



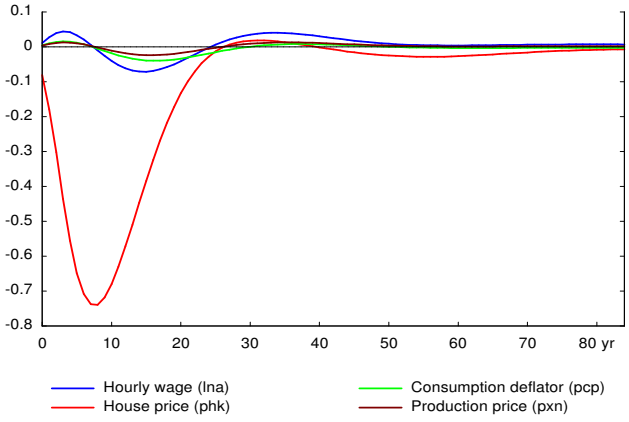
Labor market: Multiplier in 1000 people.



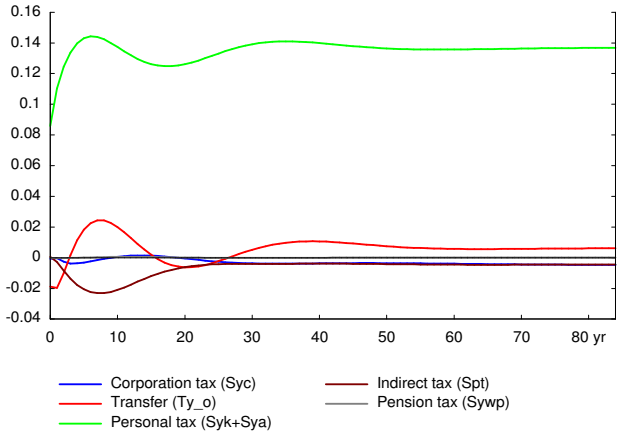
Saving balance: Percentage share of GDP

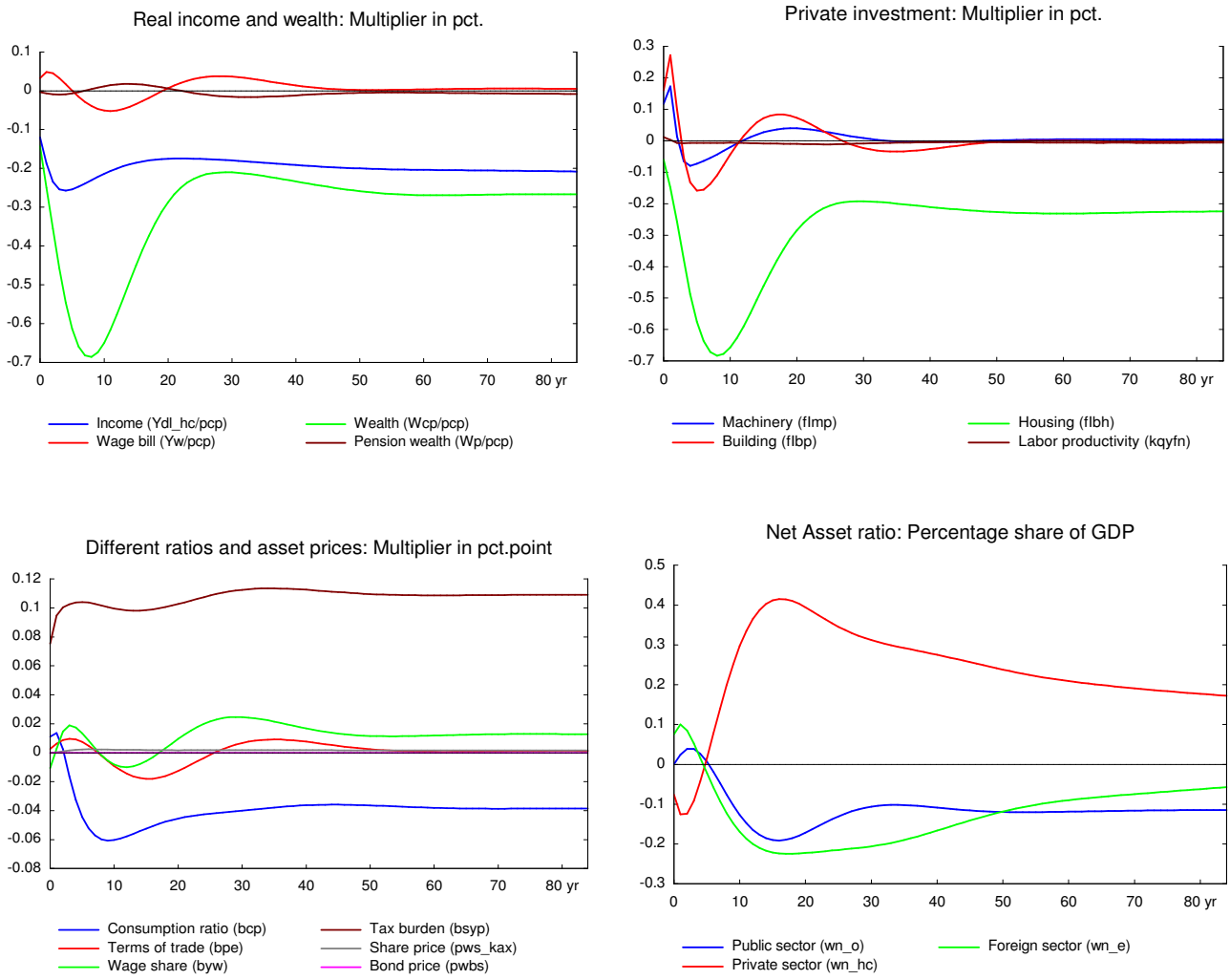


Wage and prices: Multiplier in pct.



Taxes and income transfers: Percentage share of GDP

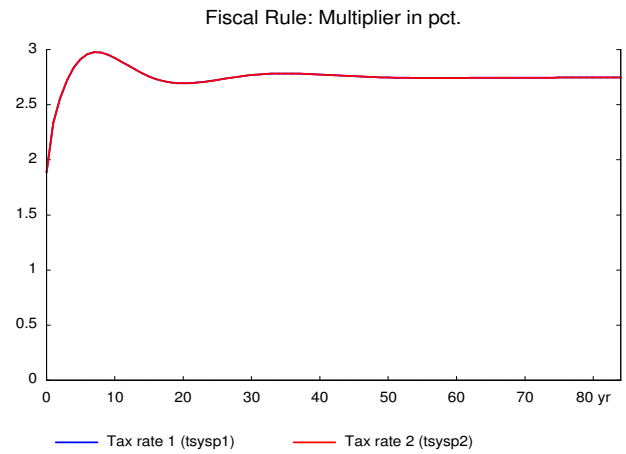


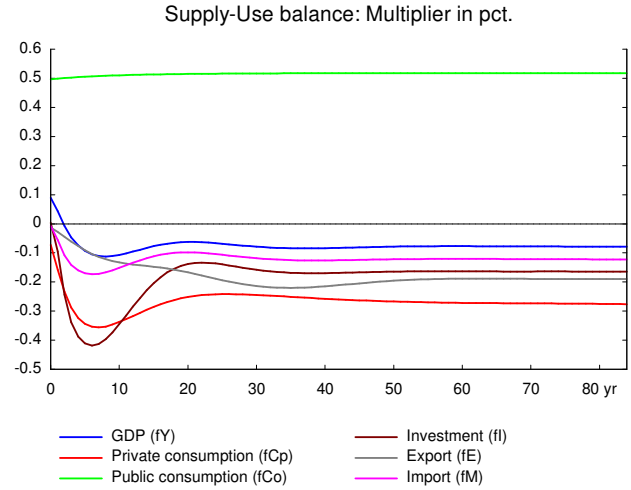


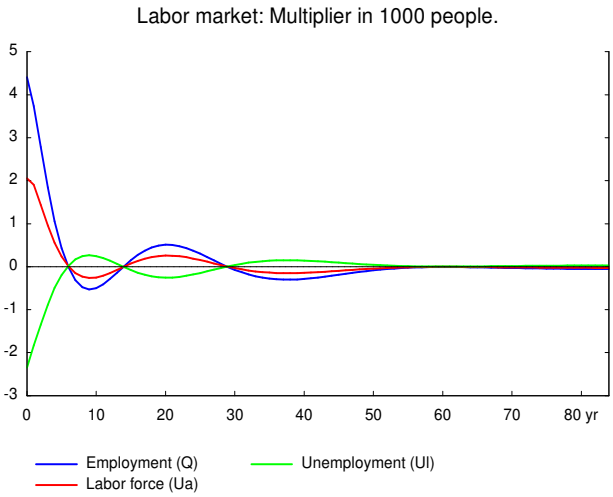
General government employment (mul2)

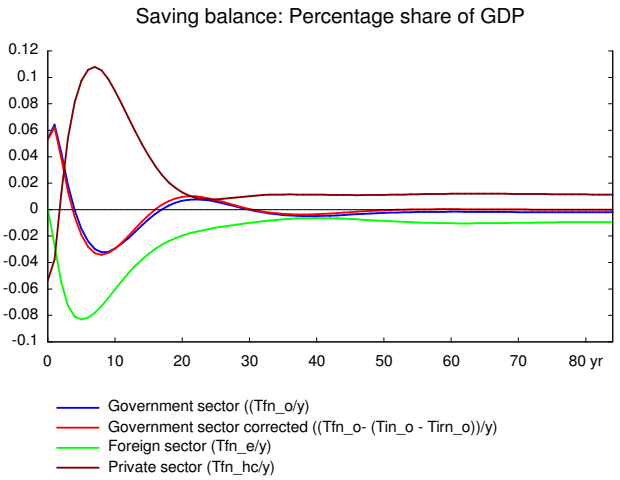
Salaries are a major part of general government expenditures. In this experiment, general government employment is raised permanently. The payroll in the public sector is increased by 1000 million kroner in 2010 prices, which provides an additional employment in the public sector of 4849 persons or 0.18 percent of total employment in the first year. The higher public employment is financed by around 2½ percent higher income tax rate. Higher public employment dominates in the first round where total employment and GDP increases, especially the GDP increase is short lived. However, as the government finances the extra employment by higher taxes, we have the same sort of crowding out mechanism as with higher public purchase. Private consumption falls leading to lower GDP at market prices in steady state, but GDP at factor cost (fYf) is less affected in the long run and falls by less than GDP at market prices. In many respects, the reaction to higher public employment resembles the reaction to higher public purchases, but there are differences. For instance, we now get a negative long run effect on exports instead of a close to zero effect.

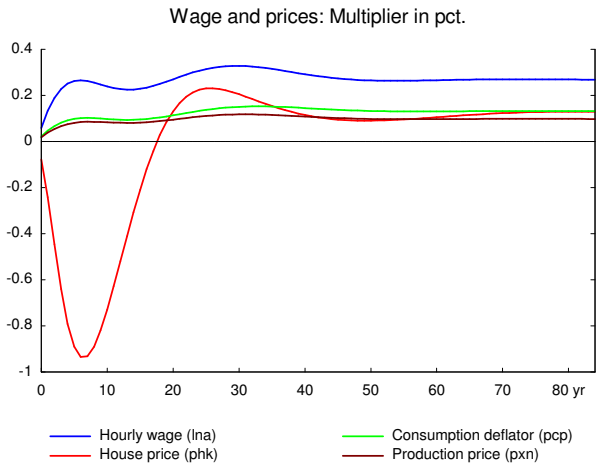
Compared to the public purchase experiment, higher government employment put a higher upward pressure on wages and prices. Higher domestic prices make Danish products less competitive in the international market resulting in lower export. At the same time, the higher wage level reduces the negative impact on consumption and we end up with a relatively smaller negative impact on private demand compared to the public purchase experiment.

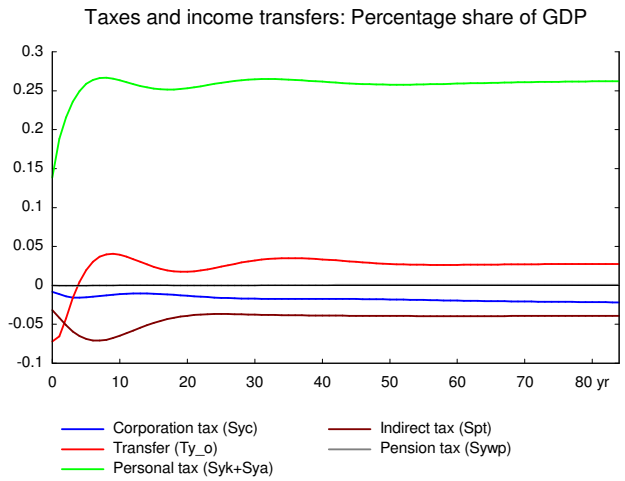


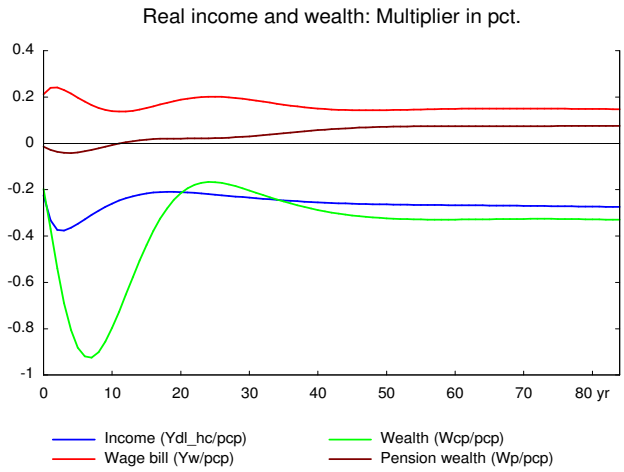


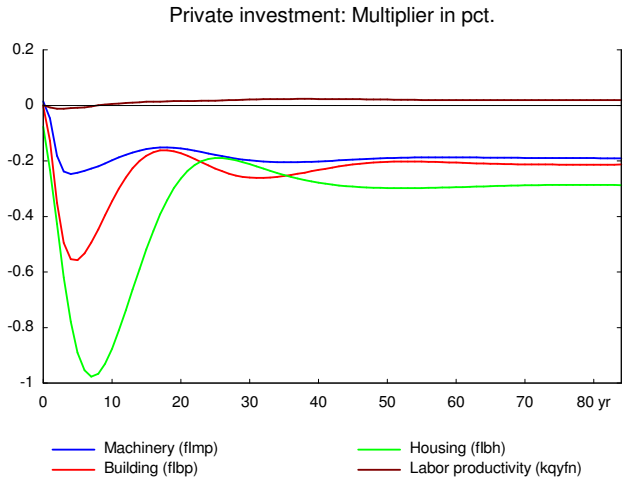


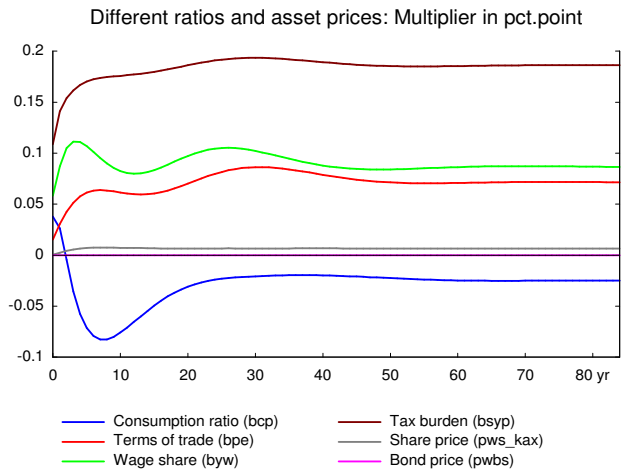


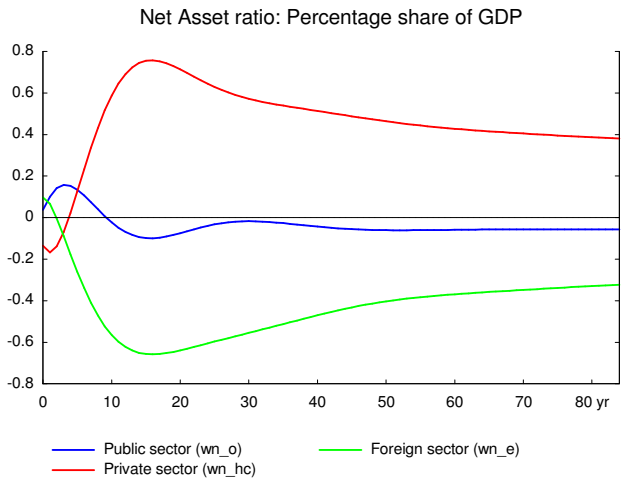

Wage and prices: Multiplier in pct.
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 10 20 30 40 50 60 70 80 yr
Hourly wage (lna)
House price (phk)
Consumption deflator (pcp)
Production price (pxn)


Taxes and income transfers: Percentage share of GDP
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0 10 20 30 40 50 60 70 80 yr
Corporation tax (Syc)
Transfer (Ty_o)
Personal tax (Syk+Sya)
Indirect tax (Spt)
Pension tax (Sywp)


Real income and wealth: Multiplier in pct.
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 10 20 30 40 50 60 70 80 yr
Income (Ydl_hc/pcp)
Wage bill (Yw/pcp)
Wealth (Wcp/pcp)
Pension wealth (Wp/pcp)

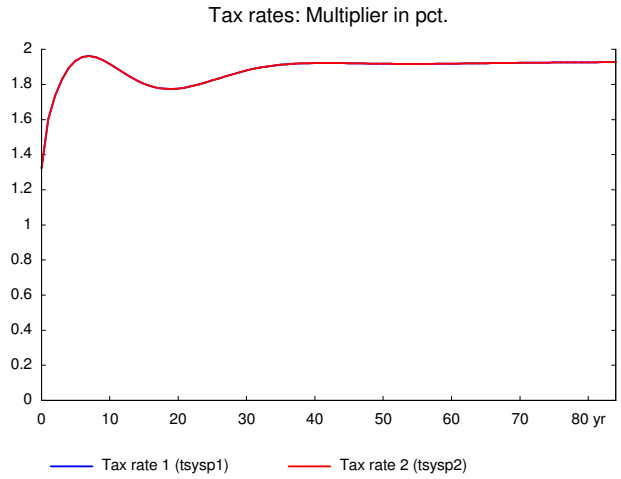

Private investment: Multiplier in pct.
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 10 20 30 40 50 60 70 80 yr
Machinery (flmp)
Building (flbp)
Housing (flbh)
Labor productivity (kqyfn)

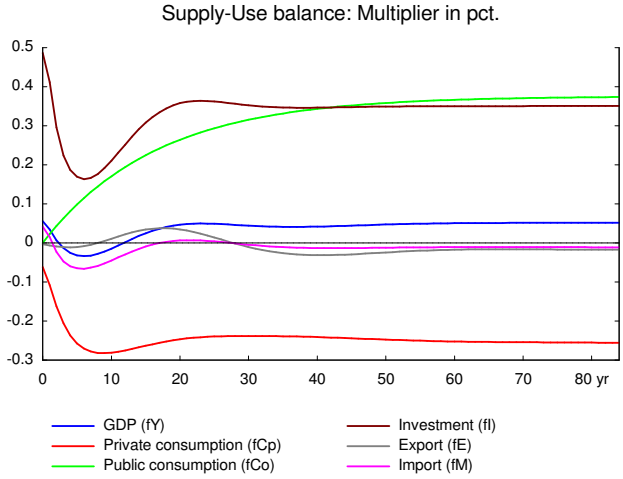

Different ratios and asset prices: Multiplier in pct.point
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0 10 20 30 40 50 60 70 80 yr
Consumption ratio (bcp)
Terms of trade (bpe)
Wage share (byw)
Tax burden (bsyp)
Share price (pws_kax)
Bond price (pwbs)

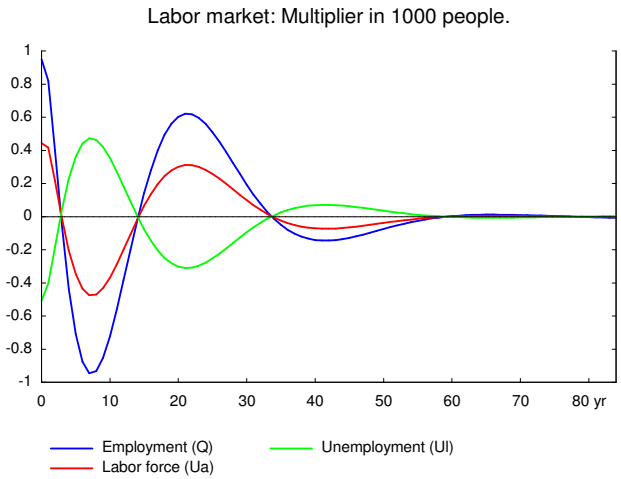

Net Asset ratio: Percentage share of GDP
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0 10 20 30 40 50 60 70 80 yr
Public sector (wn_o)
Private sector (wn_hc)
Foreign sector (wn_e)

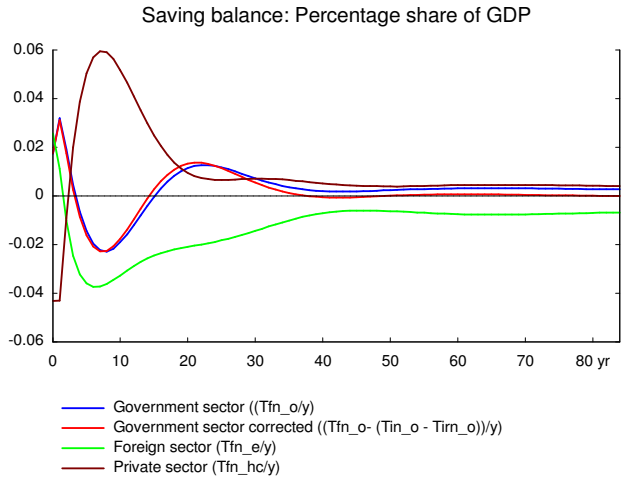
General government investment in buildings (mul3)

Government investments in buildings are increased permanently by 5 percent relative to the baseline, which corresponds to 1000 million kroner in 2010 prices in the first year. Government building investments are often used to boost demand in a weak economy due to the high labor content and because it is easier to expand and contract investments than consumption. The tax-financed expansion of government investment permanently reduces private consumption due to the fall in disposable income. The permanently higher public investment level triggers a long-lasting growth in capital, and it takes most of the long scenario before the public building capital is becoming stable relative to its baseline. The increasing capital lifts public output and public consumption. More specifically, capital depreciation is part of public gross value added and public consumption. The growing public consumption is per se balanced by a slightly growing GDP without having visible consequences for neither employment nor private demand.

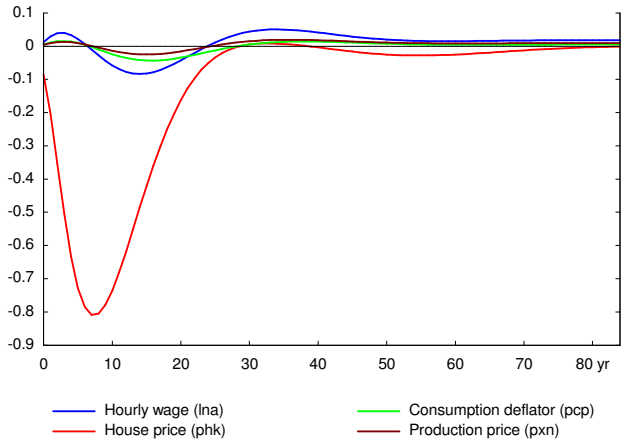




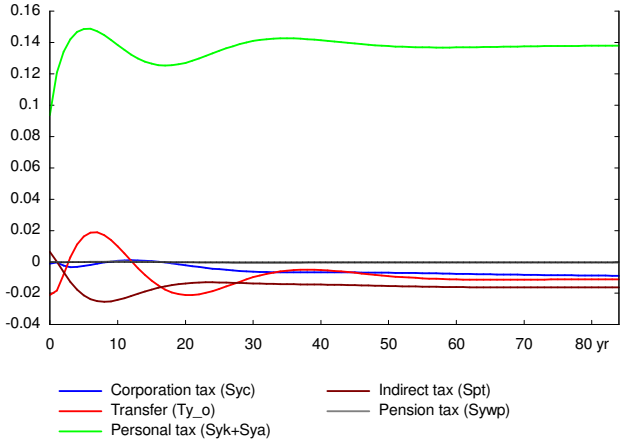




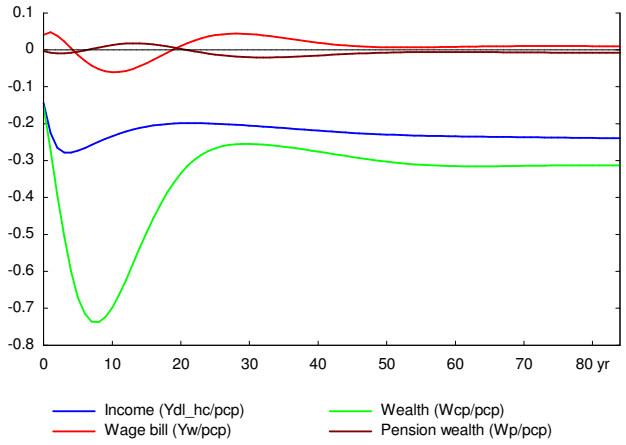
Wage and prices: Multiplier in pct.



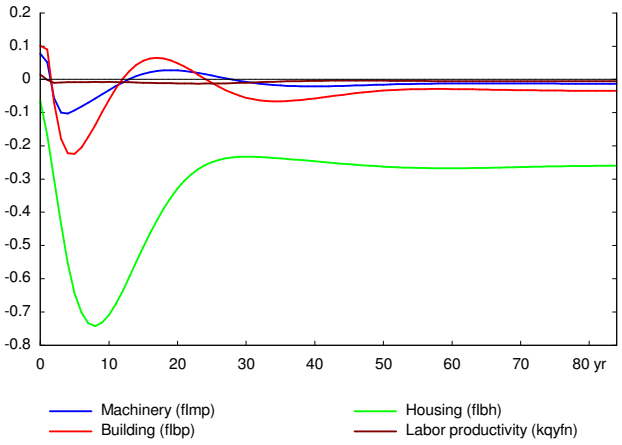
Taxes and income transfers: Percentage share of GDP



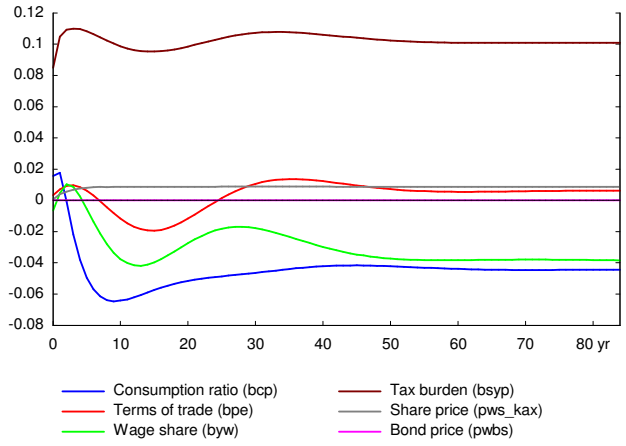
Real income and wealth: Multiplier in pct.



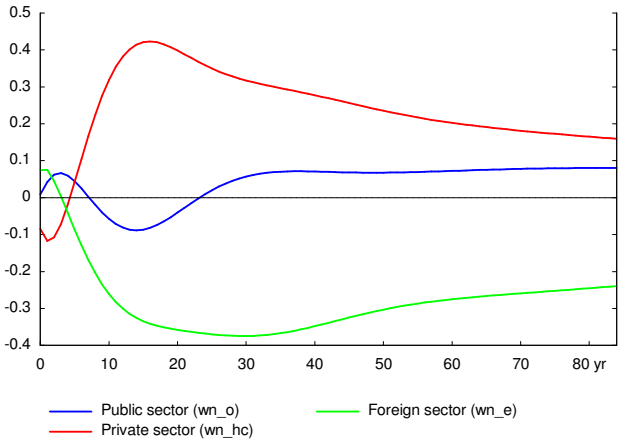
Private investment: Multiplier in pct.



Different ratios and asset prices: Multiplier in pct.point

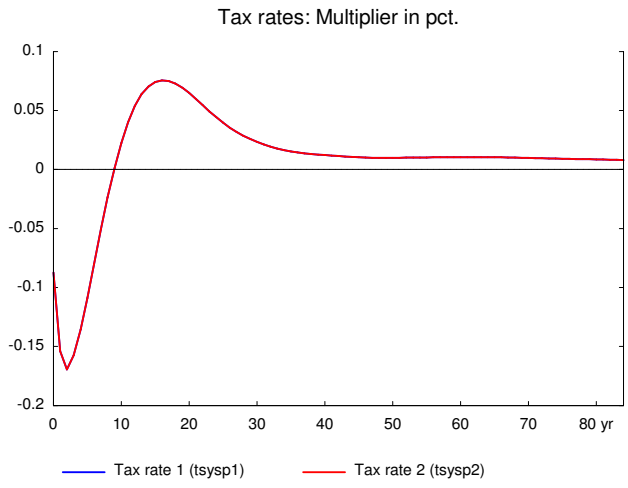


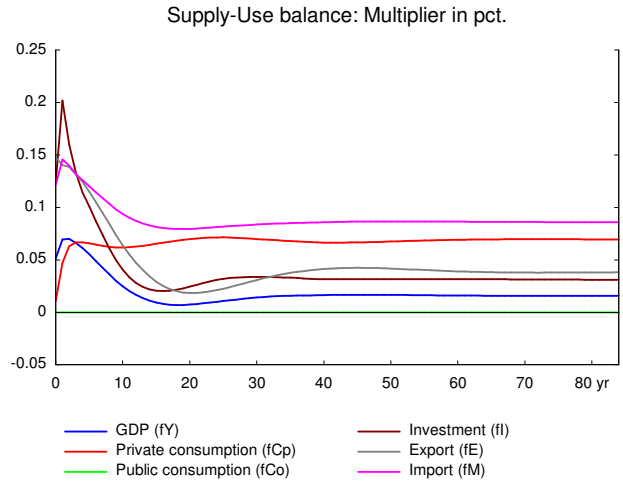
Net Asset ratio: Percentage share of GDP

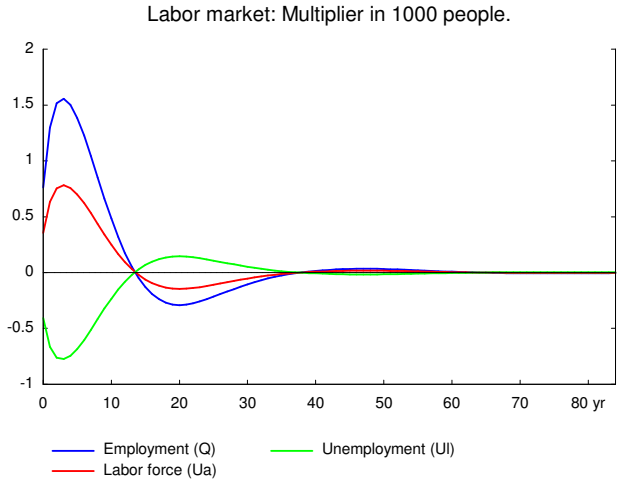


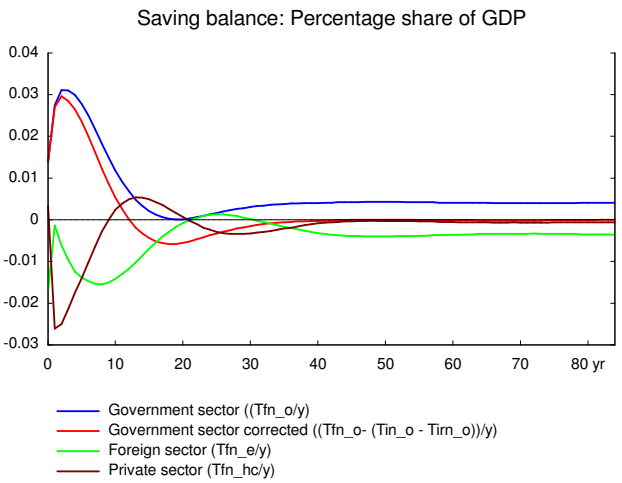
Foreign demand (mul5)

An increase in foreign demand for Danish products expands private output and has a positive short-run impact on employment. The following graphs presents the effects of a permanent 0.096 percent increase in foreign demand without accompanying change in foreign prices and foreign interest rates. The shock amounts to a 1000 million kroner increase in exports in 2010 prices in the first year. Higher foreign demand stimulates production and domestic prices. In the long run, mainly prices are stimulated. The shock has a positive first round impact on public finances due to the smaller unemployment and larger tax base, and the fiscal reaction function produces a lower tax rate during the first 10 years. In the long run, the tax rate is higher than its baseline, which reflects higher tax burden. Both corporate and indirect taxes are below their baseline in steady state which can explain that the income tax rate is higher in the long run.

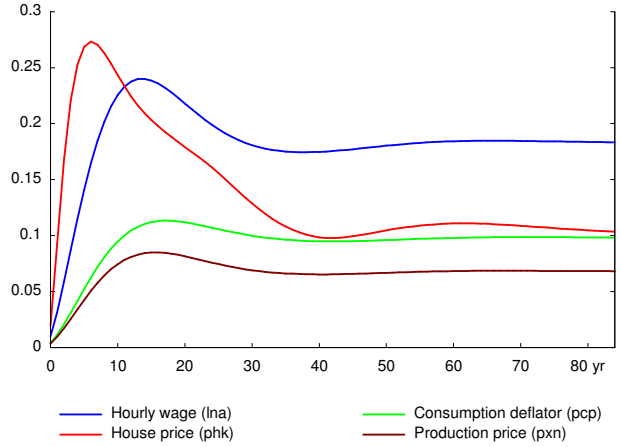




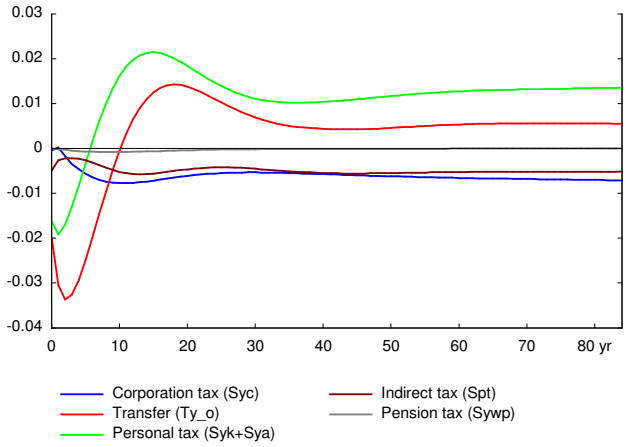




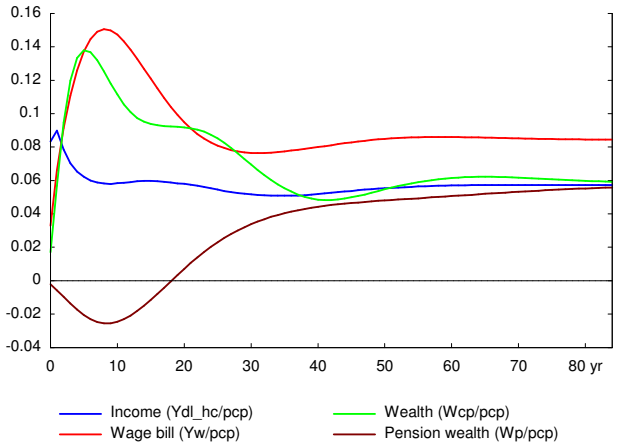
Wage and prices: Multiplier in pct.



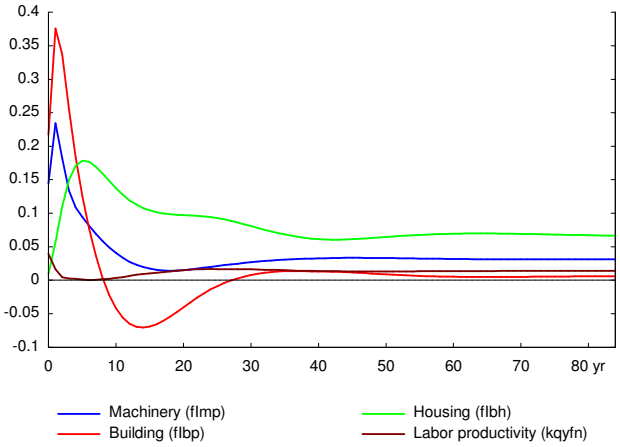
Taxes and income transfers: Percentage share of GDP



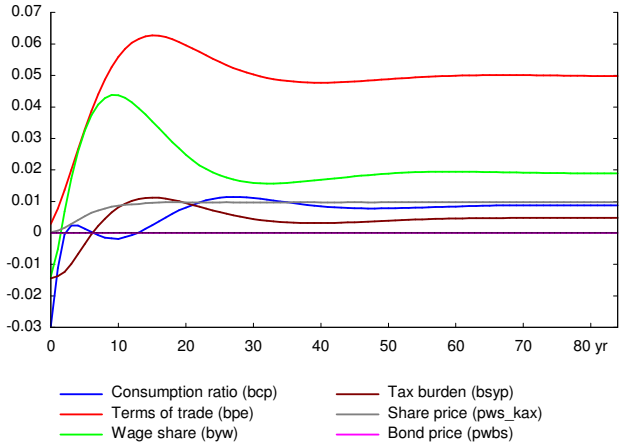
Real income and wealth: Multiplier in pct.



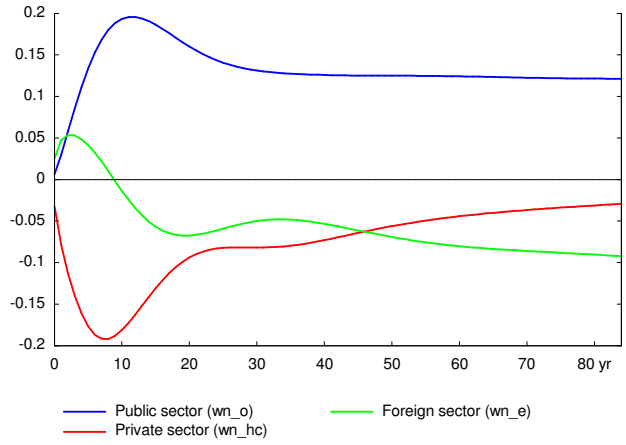
Private investment: Multiplier in pct.



Different ratios and asset prices: Multiplier in pct.point



Net Asset ratio: Percentage share of GDP

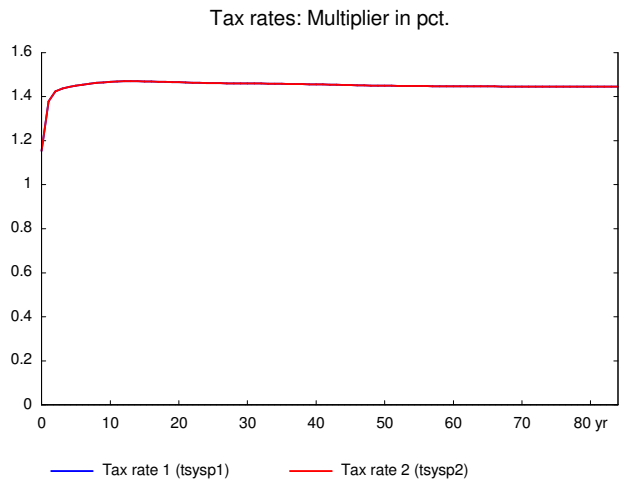


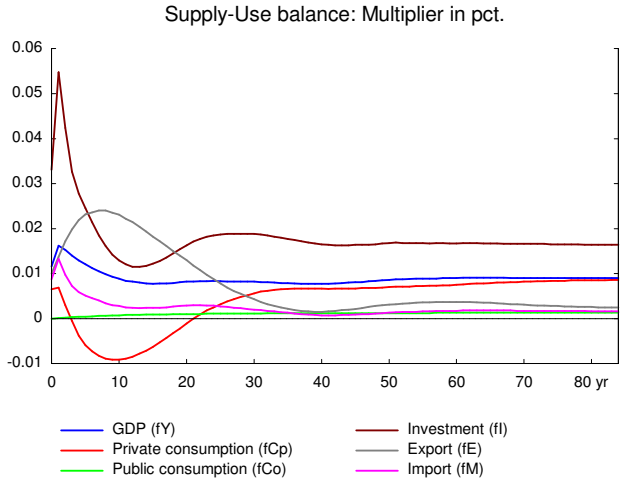
Indirect tax (mul7)

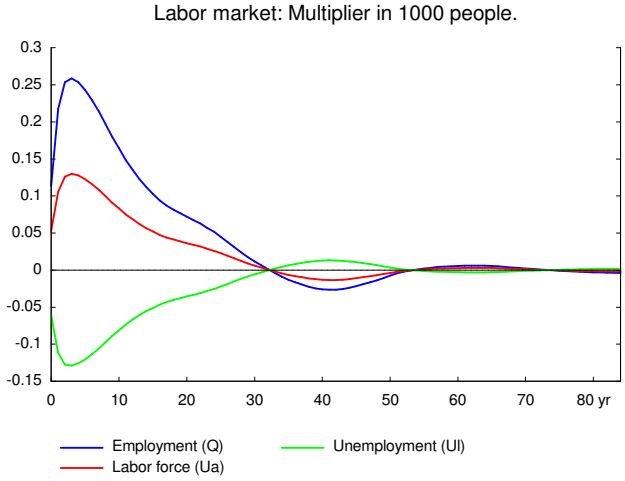
Governments can reduce indirect taxes (VAT) to create expansionary effects in the economy. The effect of this fiscal shock comes via a reduction in final prices. The VAT rate is reduced by approximately 0.14 percentage points, which corresponds to an immediate loss in revenue of 1000 million kroner in 2010 prices. The loss in government is compensated by a permanent increase in the income tax rate of a little more than 1.4 percent.

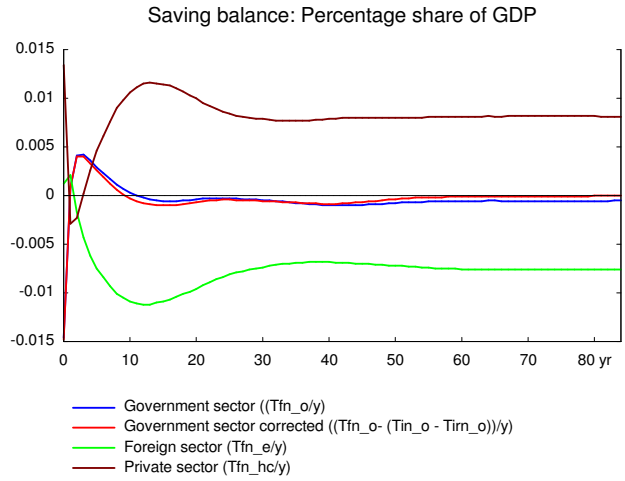
The first round positive impact on private consumption reflects that the VAT-driven price reduction dominates the higher income tax in short run. The first round is followed by a period of negative private consumption impact. The lower VAT implies a drop in the consumption deflator and in the house price while the hourly wage is pushed upwards by the first round drop in unemployment.

In the long run, private consumption lies marginally above its baseline and so does public consumption. The latter seems to reflect a technical effect of the VAT reduction. Anyway, the somewhat dubious consumption effects are small in comparison to the consumption effects in the other experiments and could be ignored.

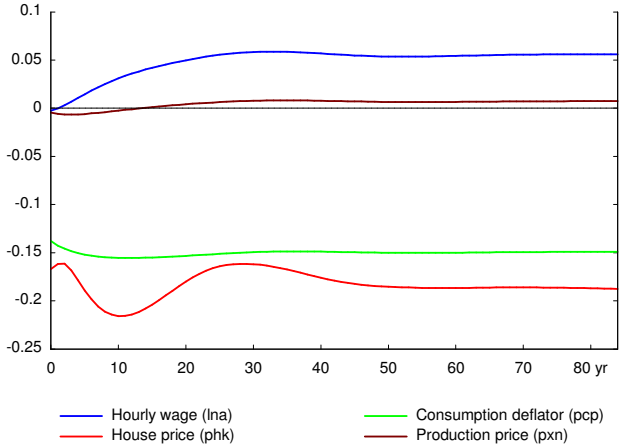




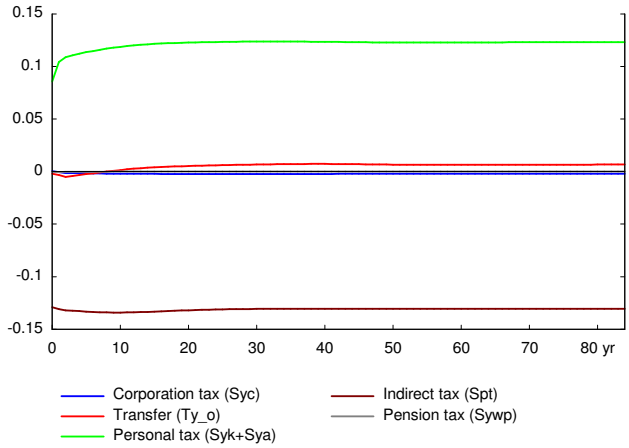




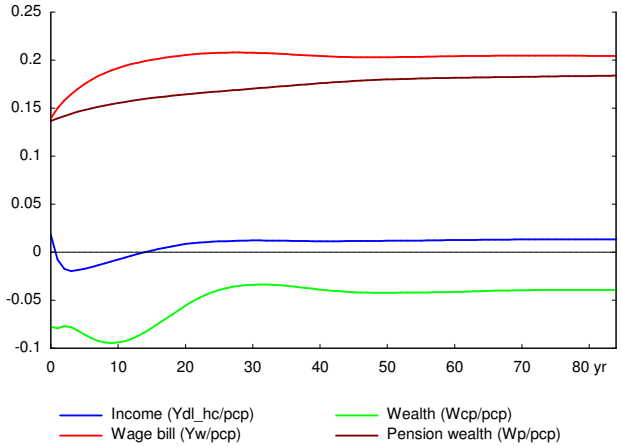
Wage and prices: Multiplier in pct.



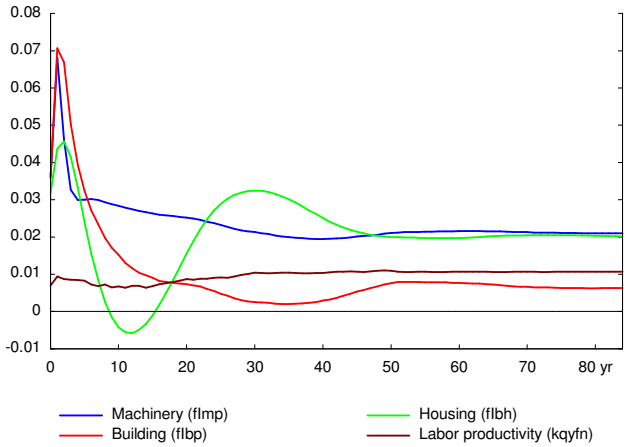
Taxes and income transfers: Percentage share of GDP



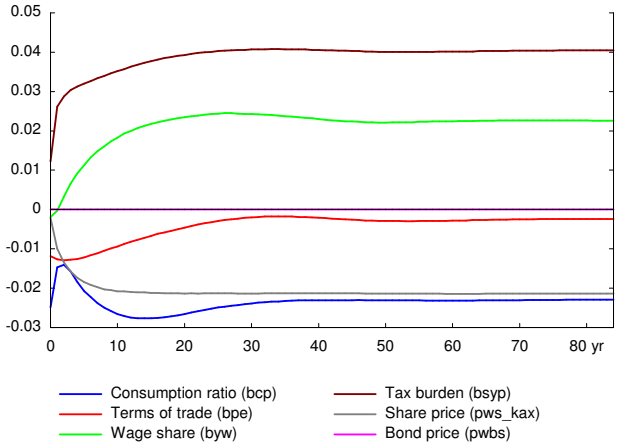
Real income and wealth: Multiplier in pct.



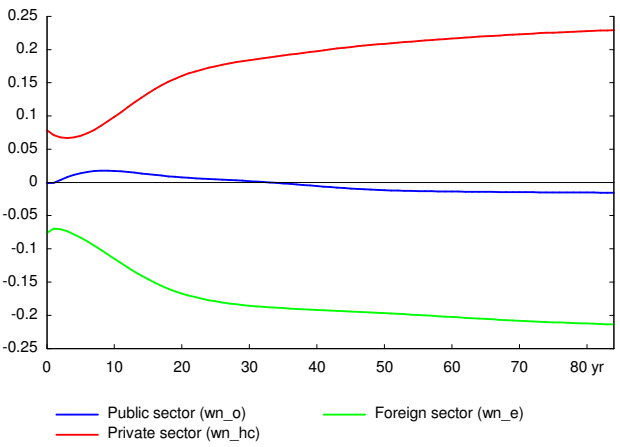
Private investment: Multiplier in pct.



Different ratios and asset prices: Multiplier in pct.point

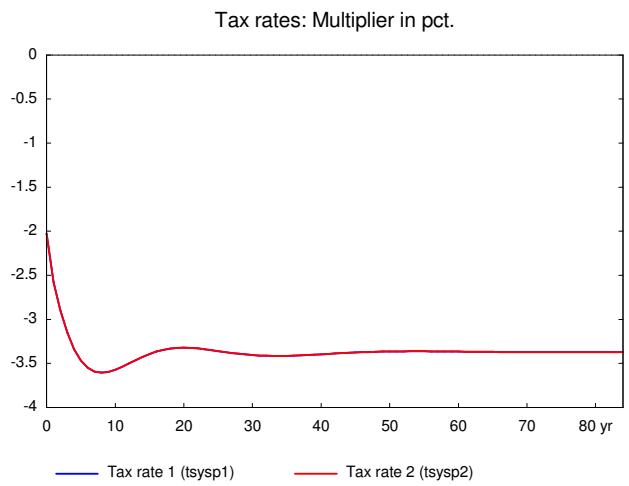


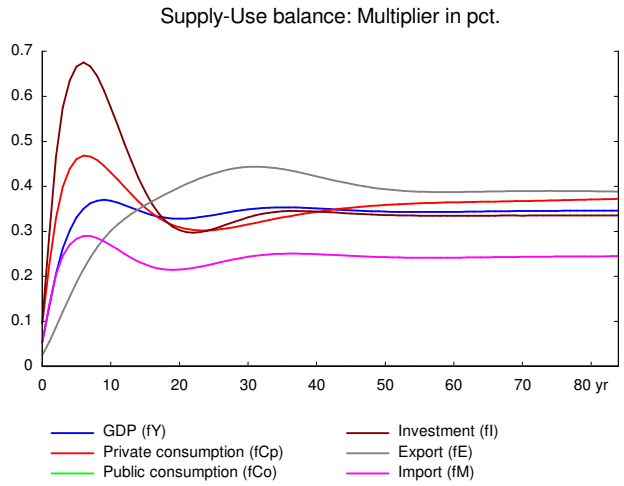
Net Asset ratio: Percentage share of GDP

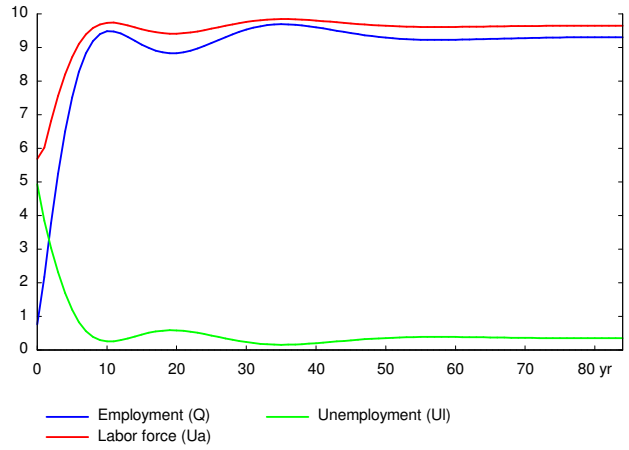


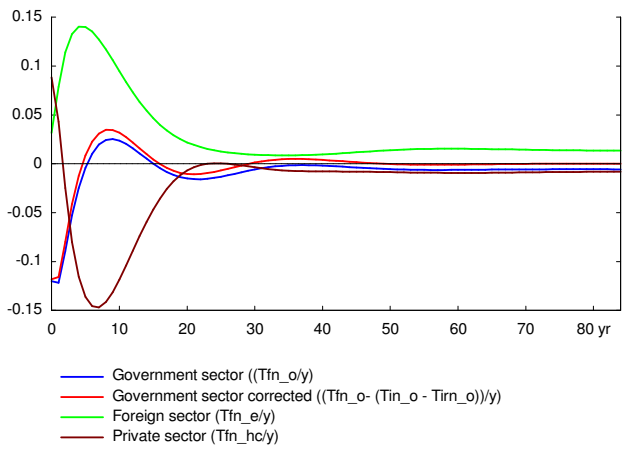
Labor supply, early retirement scheme (mul19)

The number of people in early retirement scheme is reduced by 10000. The lower public expenditure and higher tax base permanently reduces the income tax rate, which helps to lift the demand in the economy by increasing private disposable income. The lower income tax rate reflects that the fiscal rule keeps the public budget balanced. The permanent increase in employment and output trigger higher investments and a higher capital stock. Without the fiscal reaction function households' disposable income would fall permanently, the wage rate would be lower, export would be higher, and the public net asset would be growing continuously relative to GDP.

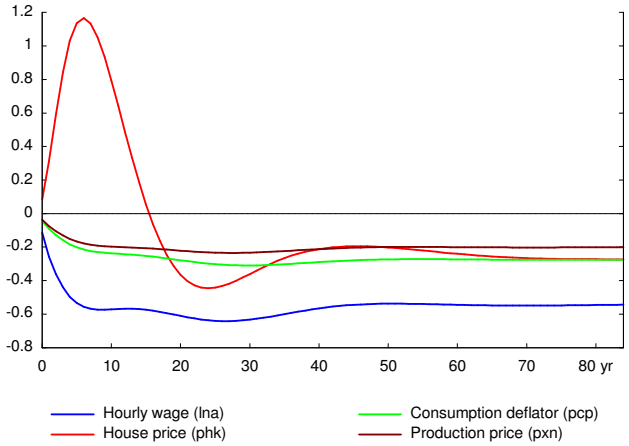




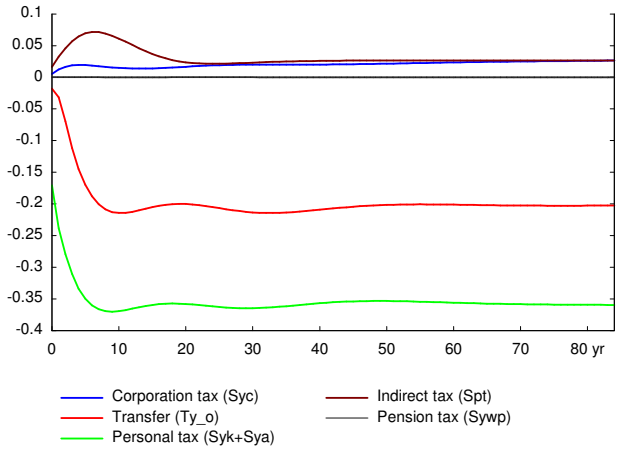




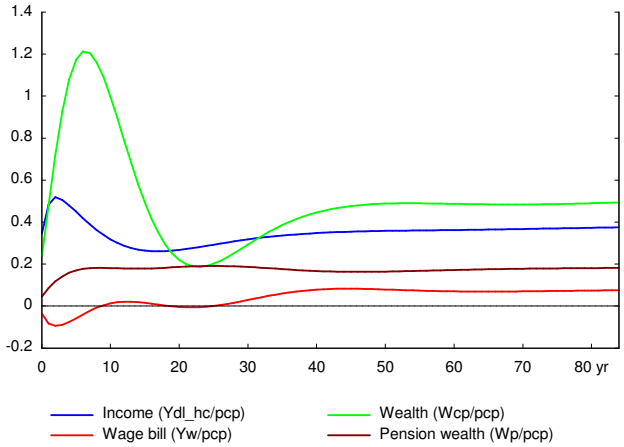
Wage and prices: Multiplier in pct.



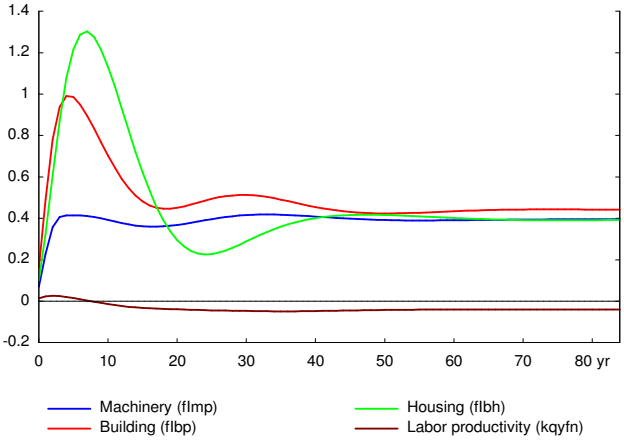
Taxes and income transfers: Percentage share of GDP



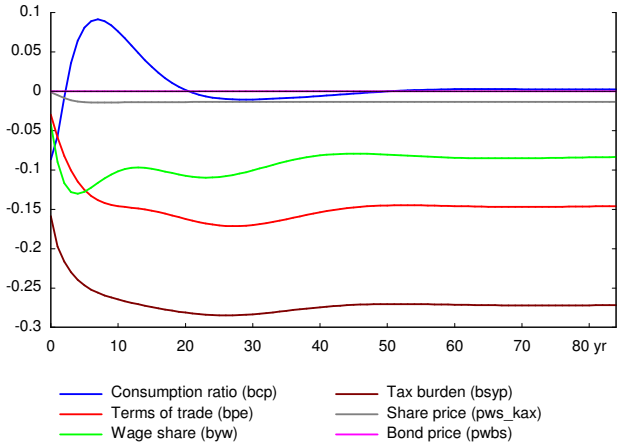
Real income and wealth: Multiplier in pct.



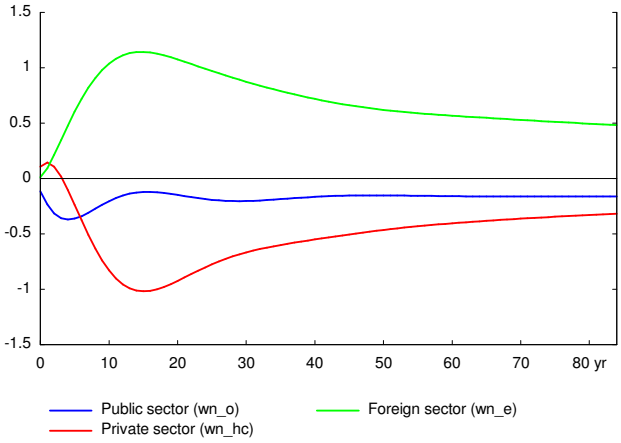
Private investment: Multiplier in pct.



Different ratios and asset prices: Multiplier in pct.point



Net Asset ratio: Percentage share of GDP



Recap on long-run consumption and wage effects

The largest positive long-run effect on private and total consumption comes when labor supply is expanded (mul19), and this is reflecting the higher output and income creating capacity that comes with a higher labor force.

The second-largest effect on private and total consumption comes when foreign demand is expanded (mul5). A higher foreign demand does not increase the output capacity of the economy, but higher foreign demand is balanced by higher domestic wages and prices, and the higher terms of trade increases real income and consumption (Harberger-Laursern-Metzler effect).

The third-largest effect on private consumption comes when VAT is reduced (mul7). The lower VAT is balanced by higher income taxes, and this shift between tax instruments has practically no long-run effect on neither private nor public consumption. Actually, there is a small positive impact on consumption but it is only just visible in figure 1 below.

The remaining three effects on private consumption are all negative. In all three experiments, public demand is increased permanently.

In two of the three experiments (mul1 and mul2), public consumption is increased permanently and it is balanced by higher taxes and lower private consumption. In these two experiments, there is practically no long-run effect on total consumption.

In the third experiment (mul3), public investments are increased permanently, and there is a long-run negative effect on total consumption. We note that this negative effect on total consumption is gradually reduced over some decades, while the growing public capital increases public output and public consumption, cf. figure 2.

Figure 1: Private consumption: Multiplier in percent

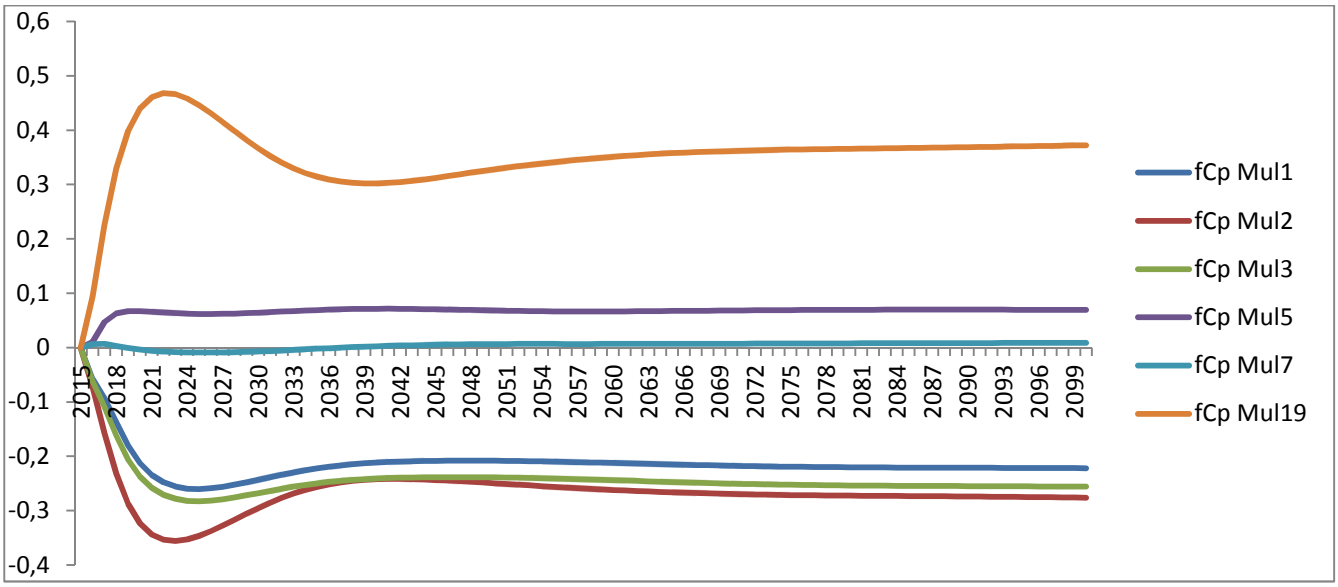


Figure 2: Public consumption: Multiplier in percent

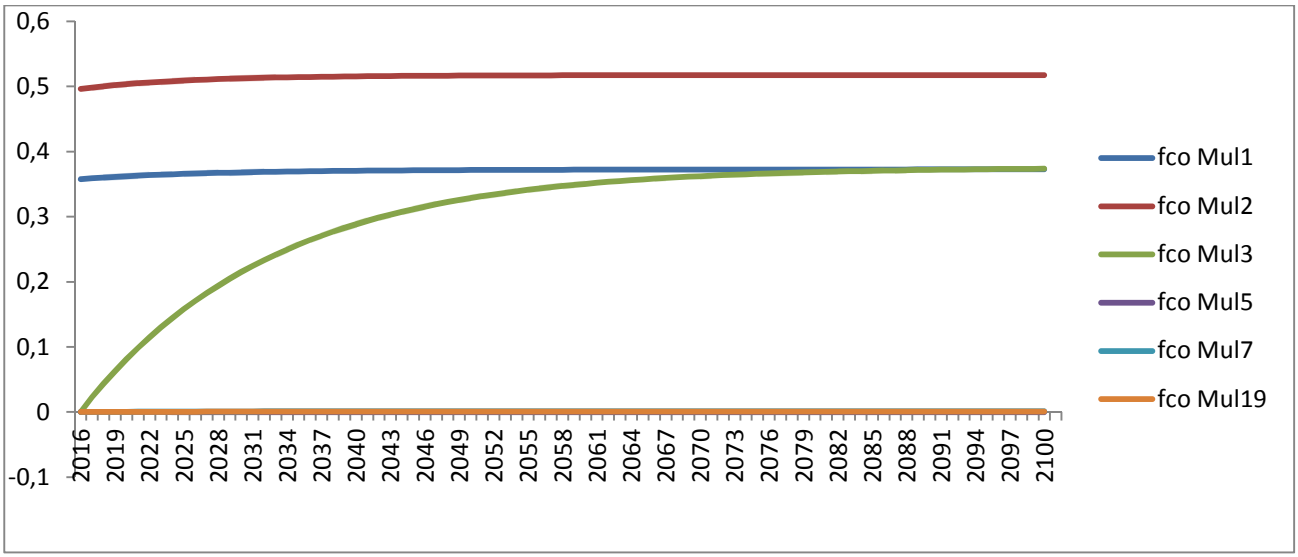
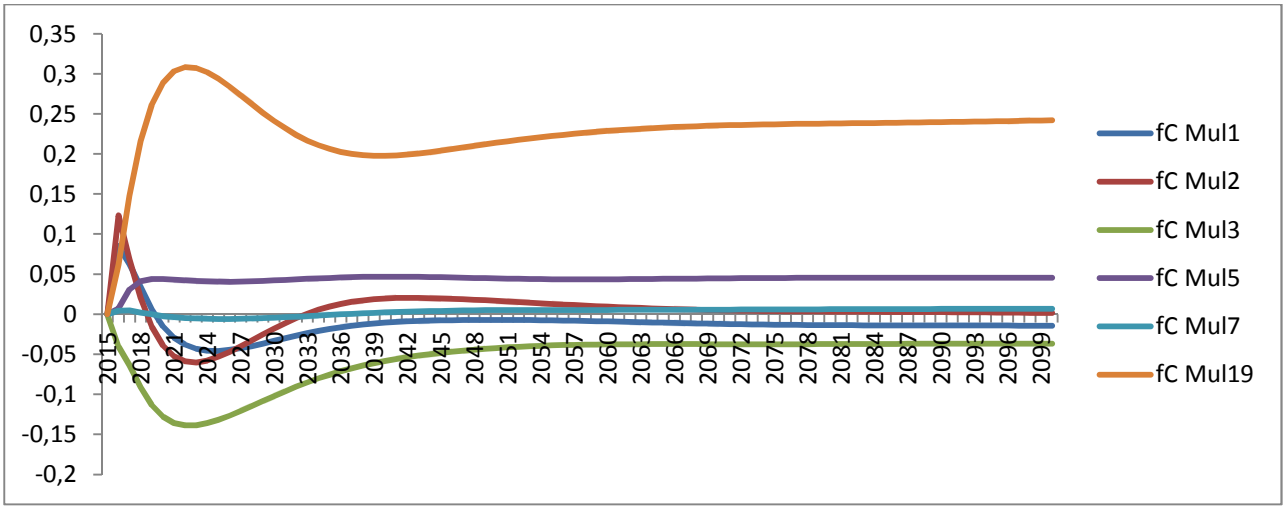


Figure 3: Total consumption: Multiplier in percent



The largest long-run wage effect is produced by the permanently higher public employment (mul2). As the labor force remains unchanged in the long run, the higher public employment crowds out private employment and part of this crowding out reduces the Danish market shares. The tax financing and the implied lower private consumption does decrease private employment, but part of the consumption reduction concerns imports. At unchanged wage competitiveness, this would leave us with an employment above structural employment. Consequently, we have a

period with higher wage increases than abroad and in the long-run steady state, the wage rate is above and exports are below its baseline in the mul2 experiment.

The second-largest long-run wage effect is created by higher foreign demand (mul5). The permanently higher foreign demand increases the steady state wage rate and lowers the steady state level of Danish market shares. Instead, the Danish economy can increase its consumption and pay with higher export prices.

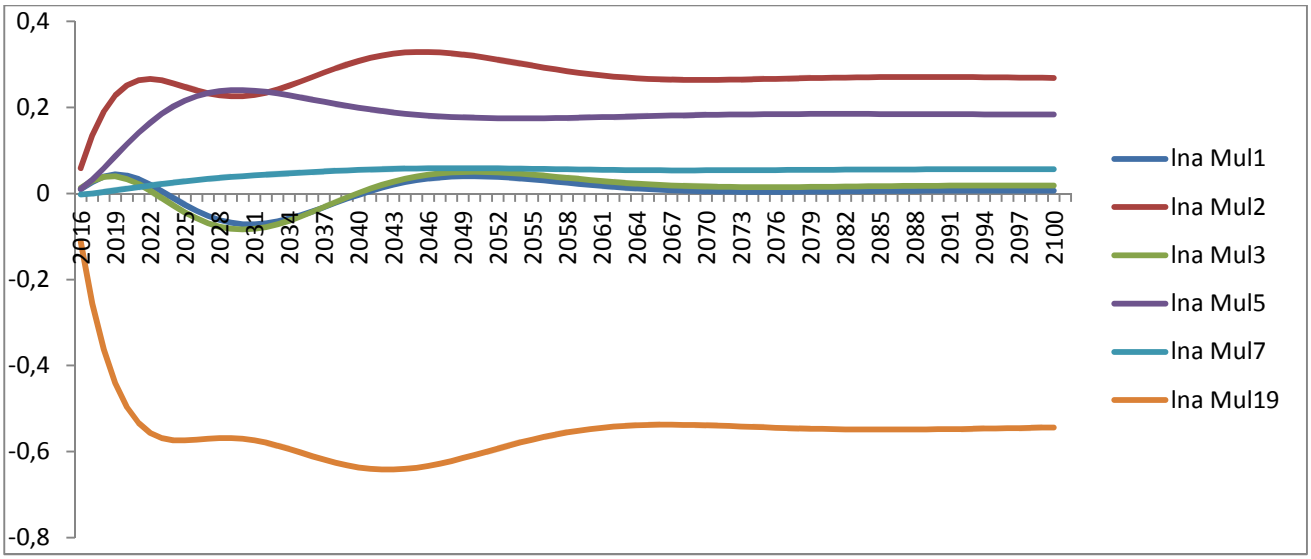
The third-largest long-run wage effect follows the permanent decrease in VAT (mul7). The lower VAT increases exports by making Denmark lowering the prices foreign tourists pay in Denmark. In the long-run steady state, part of this increased price competitiveness is balanced by a higher wage rate.

The remaining three long-run wage effects are close to zero or negative.

The wage effects produced by higher public purchase (mul1) and by higher public building investments (mul3) are both close to zero in the long run. Thus, in these two experiments the crowding out of the employment effect is basically done by the tax financing lowering private consumption.

The only long-run negative wage effect comes when the labor force is increased. Without the fiscal reaction function to lower taxes, the need for higher market shares and lower wage would be even greater. Now, the higher consumption helps to increase employment, but part of the consumption is imported, so that employment does not grow as much as the labor force falls. The higher consumption has to be supplemented by higher wage competitiveness and exports, and the wage rate will fall relative to its baseline until employment equals structural employment.

Figure 4: Hourly wage: Multiplier in percent



Conclusion

This paper uses a fiscal reaction function that targets the primary surplus and keeps the public net asset ratio from exploding. The primary surplus is zero in the long run in a standard ADAM calculation and the reaction function fiscal reacts to any deviations from zero. In addition, the rule is forward looking as it seems essential due to the time lag between instrument change and full impact on economy it makes.

We perform six multiplier experiments on ADAM and the reaction function seems to work and secure a sustainable fiscal policy. The public net asset GDP ratio looks constant in the steady state but the private sector net asset ratio is not correspondingly stable over the long run, which might suggest that the private consumption function is not correcting the saving ratio sufficiently. The private net asset ratio should be stable in steady state because the private consumption function is basically correcting the private net asset ratio in the long run. This is not a problem with the fiscal reaction.

We have also considered government investment in buildings as an alternative instrument to the income tax rate. The government investment in buildings is modeled as an instrument in the same way the income tax rate is modeled and the result seems interpretable. One difference to the tax instrument is that public capital and output will adapt to another level if public investment is changed.

Thus, we have done a little testing of the fiscal reaction function but it goes without saying that there are many possible specifications. One feature to consider is the dynamic over- and undershooting in the tax rate instrument of the reaction function. One specification to try is a reaction function that is not just adjusting fiscal policy to make public finances long-run sustainable but also adjusting fiscal policy to dampen the cyclical deviations of the output gap from zero.

References:

Denmark Statistics (2013), ADAM – a model of the Danish economy.

Dessie Tarko Ambaw and Dan Knudsen (2015), Collecting inspiration to develop a fiscal reaction rule for ADAM, working paper, Denmark Statistics.

Peter R. Mitchell, Joanne E. Sault, and Kenneth F. Wallis (2000), Fiscal Policy rules in macroeconomic models: principles and practice, Economic modelling, No.17, ESRC Macroeconomic Modelling Bureau.