Danmarks Statistik
MODELGRUPPEN

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# Fiscal Reaction function for ADAM targeting primary surplus and unemployment gap

**Resumé:**

*We extend the fiscal rule presented in* 'Fiscal reaction function for ADAM' *by including ADAM's unemployment gap as an additional target for the fiscal authority. The idea is that, ceteris paribus, the income tax rate responds by a fall whenever the public primary surplus is positive and whenever the unemployment rate is higher than the long-run unemployment rate. To illustrate the effect of including the unemployment gap, we repeat the experiments in* 'Fiscal reaction function for ADAM' *with the new extended fiscal rule included in ADAM. Including the unemployment gap in the fiscal rule makes the tax instrument attain its steady state solution almost without overshooting. In addition, the labor market reaction becomes less cyclical in the short and medium run.*

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

## Introduction

In the typical macro model, a fiscal reaction function would be used to stabilize the public budget and debt ratio, while a monetary reaction function would be used to stabilize the output gap. Consequently, monetary policy will speed up the adjustment to the long-term steady state while fiscal policy may be pro-cyclical and slow down the adjustment to the long term. In the wake of the financial crisis, this long-term assignment of fiscal policy has been criticized because of the lower bound on interest rates. In a situation with negative output gap, high unemployment and limited scope for monetary expansion, one can argue that the fiscal policy of a country should not be tightened too much or too quickly in the short term.

Given the Danish fixed exchange rate policy, one may argue that our fiscal policy should as a rule always consider the output gap and 'lean against the wind' whenever that is needed. Thus, there is a case for taking the business cycle into consideration when determining the fiscal reaction in ADAM.

The fiscal policy reaction function suggested in a previous paper incorporates forward-looking expectations, which seems crucial to reduce the inherent pro-cyclicality of a fiscal policy that tries to stabilize the public budget. Without forward-looking expectations in the fiscal reaction function, the fiscal reaction can easily make ADAM produce a volatile on even unstable path for economic activity. With forward-looking expectations in the reaction function, we do get long-run stable solutions where the produced cycles in activity are reduced over the decades.

However, it would seem optimal to reduce the activity cycles more effectively and to that end we incorporate the unemployment gap in the fiscal reaction function so that the function will not just respond to the public primary surplus but also to the rate of unemployment.

### Fiscal reaction function

This paper extends the fiscal reaction function presented and used in the paper 'Fiscal reaction function for ADAM'. The extended fiscal reaction function includes the unemployment gap as a target determining the basic income tax rate $tsysp1$ (bundskat) as a function of not only past and future income tax rates and the contemporaneous primary surplus but also as a function of the contemporaneous unemployment gap. Thus, the extension consists in the last square bracket in the fiscal reaction function below:

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

Where $tsysp1$ basic income tax rate, central government

$Tfn\_o$ public net lending

$Tin\_o$ public interest income, net
$Tirn\_o$ public rent income
$Y$ Gross Domestic Product (GDP)
$bulb$ unemployment (gross concept)
$bulbw$ long-run unemployment (derived from wage equation)

The other central government income tax rate $tsysp2$ (topskat) is made proportional to $tsysp1$, so that both tax rates react. The primary surplus is corrected toward its target, $bt$, which is zero as long as we have a growth-corrected interest rate of zero and so far we have had that in all ADAM scenarios. As in the previous paper, we are here using a corrected primary surplus equal to the official primary surplus, $Tfn\_o - Tin\_o$, plus rent, $Tirn\_o$, which is part of $Tin\_o$ but not related to the public net asset, so we move it to the primary surplus. In addition, the tax rates also respond to deviations of unemployment gap from its target, $ut$. The unemployment gap target, $ut$, is exogenously calculated as the difference between unemployment rate and long run unemployment rate $(ut = bulb - bulbw)$, and $ut$ is zero in steady state if the constant term in the Phillips curve balances the impact from inflation and productivity growth in steady state. The error correction coefficient, $-cu$, is negative so that the higher the unemployment gap, the lower the income tax rate. In the previous paper, the parameter $ctsysp1$ was $0.5$ (and $cu$ was zero as the last term was not included). In this paper, the error correction coefficients for primary surplus and unemployment gap are both set to minus 0.05. Higher parameters $(e.g.\ ctsysp1 = cu = 0.5)$, makes the income tax rate overshoot in the short run and slightly undershoot in the medium run.

**Five ADAM experiments with new extended fiscal reaction function**

Using the same baseline as in the working paper 'Fiscal reaction function for ADAM' and using the same okt14 ADAM version with slight revisions in the interest income relations and inserting the new fiscal reaction function, we undertake five multiplier experiments. The five permanent shocks are: higher public purchase of goods and services, higher public employment, higher public building investments, reduced early retirement, and higher foreign demand.

The results are illustrated in the following sections. Even though most of the results are very similar, we note the different response of 1) income tax rates and 2) labor market. With the new extended reaction function, the income tax rate attain its steady state more smoothly, and the labor market reaction becomes a little less volatile in the short and medium run.

*Government purchase of goods (mul1)*
Public expenditure is increased permanently by 1 percent relative to the baseline corresponding to 1000 million kroner 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. With the new extended fiscal reaction function, the tax increase is attained over a few years practically without overshooting.

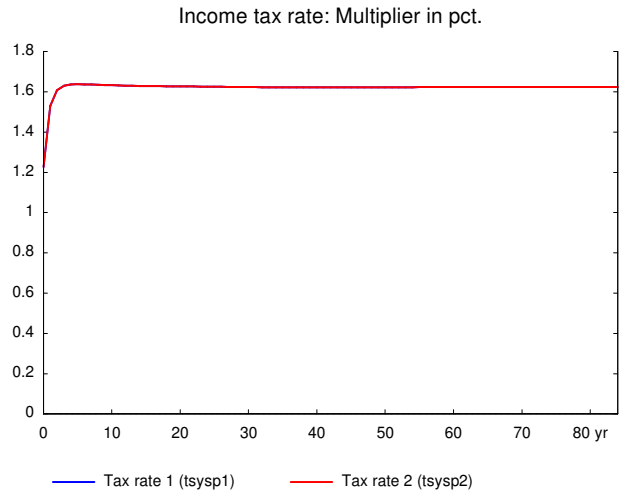
In the first year, the labor market reacts as in 'Fiscal reaction function for ADAM', however, over the short to medium run, the labor response is less volatile because the tax rate change is less volatile. The difference is not drastic, but it does appear that the unemployment gap in the reaction function makes the employment and unemployment response less volatile.

The following figures compare the fiscal reaction functions. The new extended function[1] is illustrated in left panel (figure 1, 4, 6 and 8), the old function is shown in right panel (figure 2, 5,7 and 9). Figure 3, shows the reaction of the tax rate, if the coefficient for the primary surplus were reduced to 0.05 in the old reaction function.

Comparing figure 1 to 2 shows that the new function produces a tax change without visible over- and undershooting. The degree of over- and undershooting in is partly reduced by reducing the error-correcting parameter for the primary surplus, cf. figure 3, and including the unemployment gap removes the volatility almost completely. Comparing figure 4 to 5 illustrates that the new reaction function reduces the volatility of the employment response, e.g. the negative second round effect is reduced from above 800 to below 800 people.

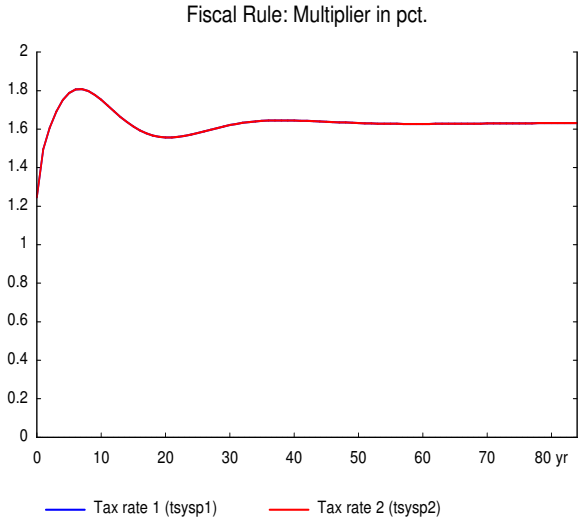
new function

Figure 1: $\left( ctsysp1 = cu = 0.05 \right)$




old function

Figure 2: $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$




[1] Old reaction function only targets primary surplus whereas the new reaction function targets both primary surplus and unemployment gap. For the reaction function presented on page two, parameters $ctsysp1 = cu = 0.05$ represents the new fiscal reaction function, whereas $ctsysp1 = 0.5 \ and \ cu = 0$ is the old reaction function and $ctsysp1 = 0.05 \ and \ cu = 0$ is a hybrid illustrating the effect of reducing ctsysp1 without introducing the unemployment gap.

Memo

Figure 3: $\left( ctsysp1 = 0.05 \ and \ cu = 0 \right)$

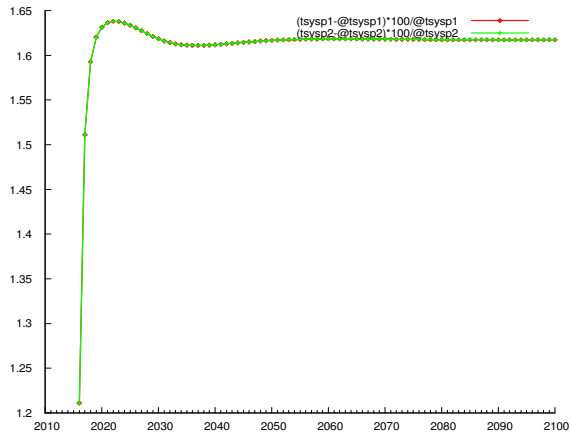



Figure 4 $\left( ctsysp1 = cu = 0.05 \right)$

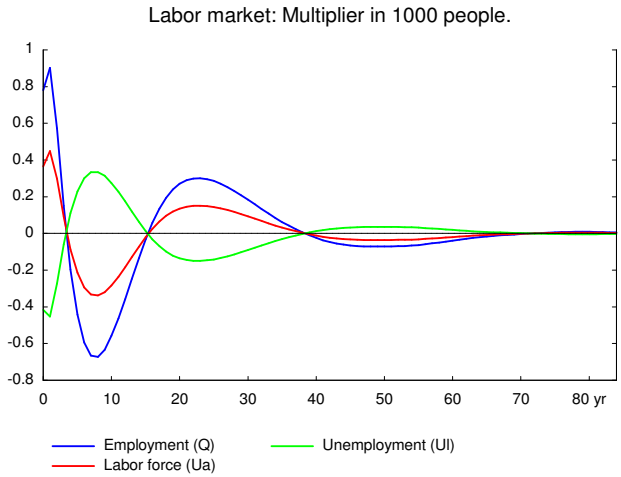



Figure 5 $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

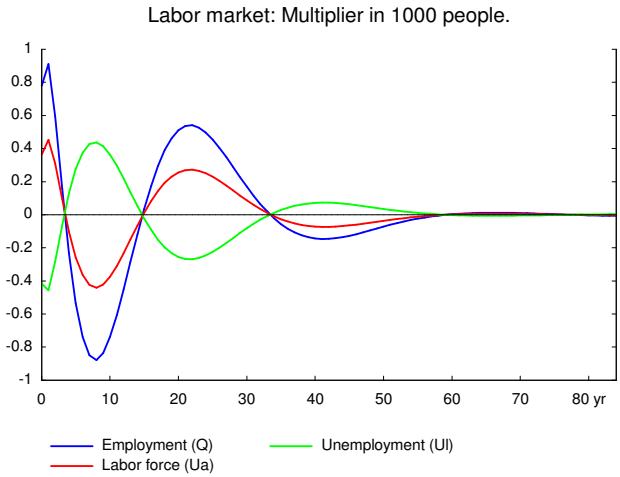



Figure 6 $\left( ctsysp1 = cu = 0.05 \right)$

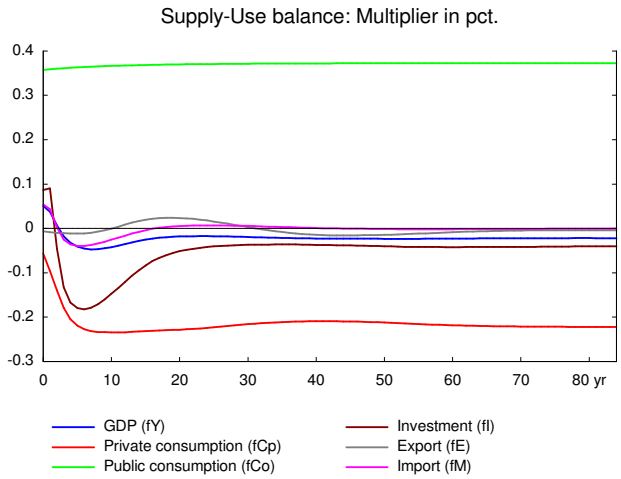



Figure 7 $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

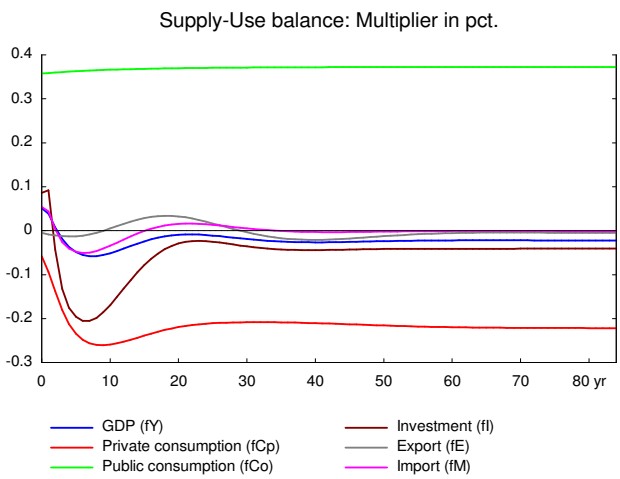


Figure 8 $\left( ctsysp1 = cu = 0.05 \right)$

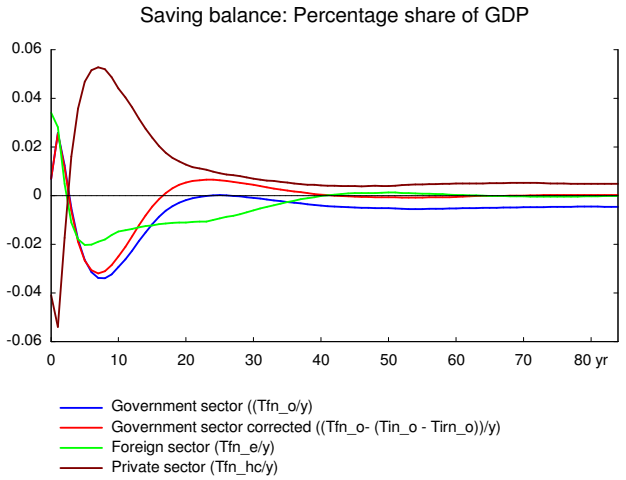
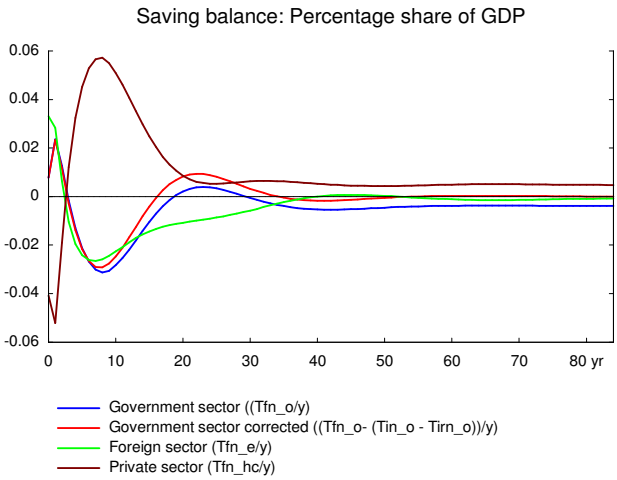



Figure 9 $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$



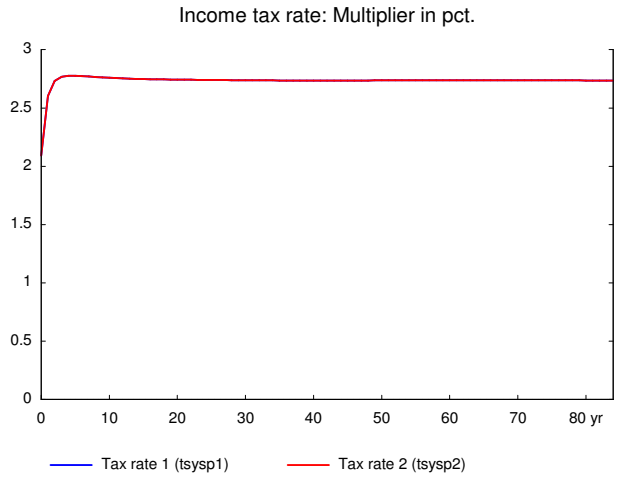

*General government employment (mul2)*

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 4353 persons or 0.164 percent of total employment in the first year.

As in the public purchase experiment, the reaction in the tax rate and the response on the labor market become less volatile with the new reaction function.

new function

Figure : $\left( ctsysp1 = cu = 0.05 \right)$




old function

Figure : $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

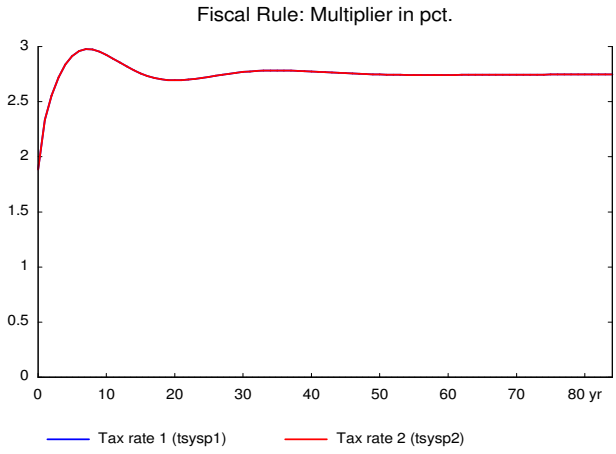
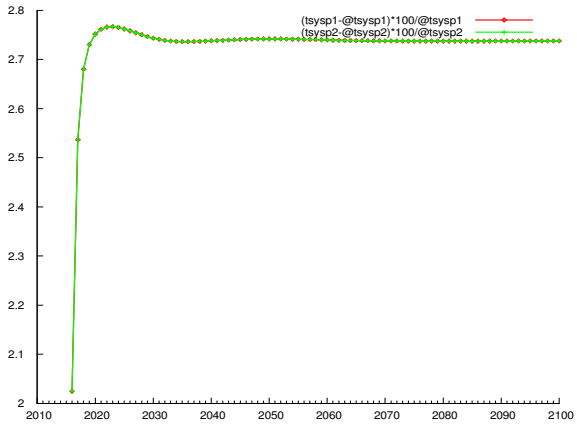


Figure : $\left( ctsysp1 = 0.05 \ and \ cu = 0 \right)$

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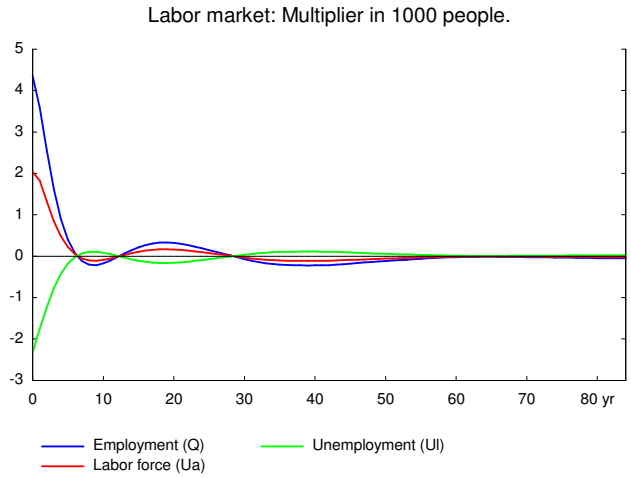


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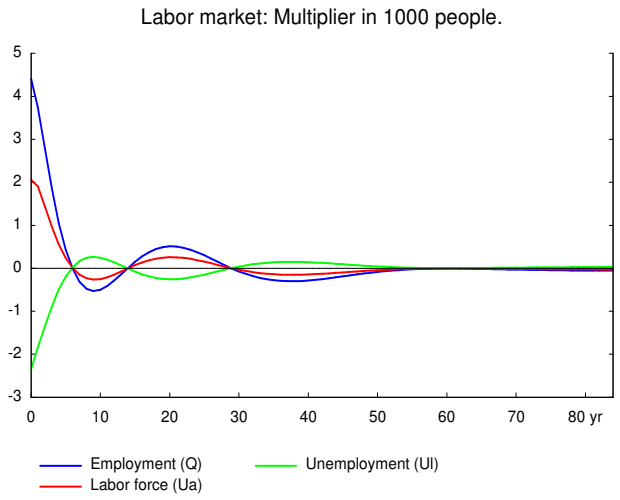


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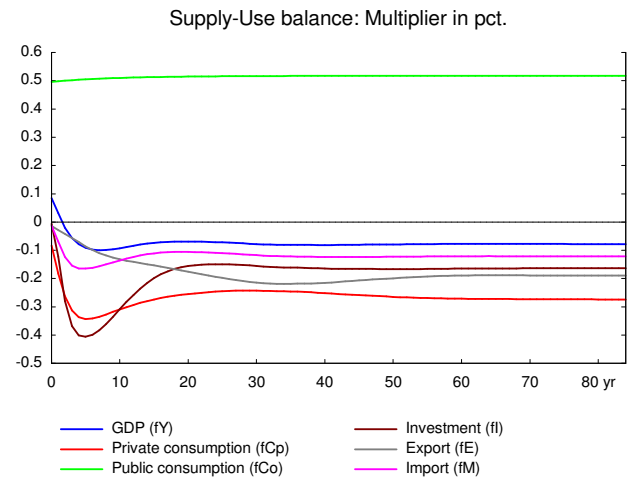
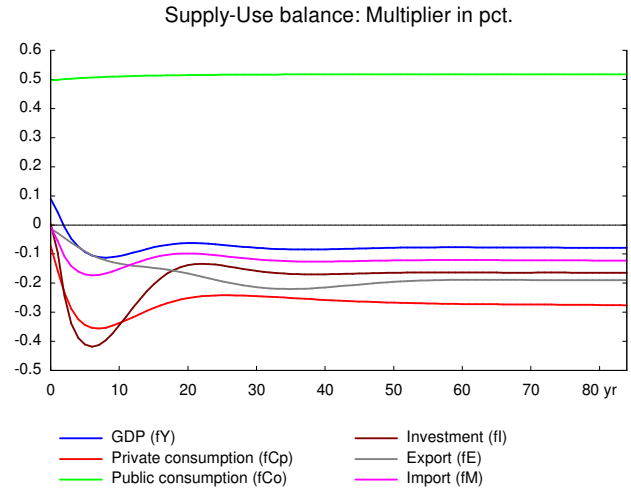



Figure: $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$



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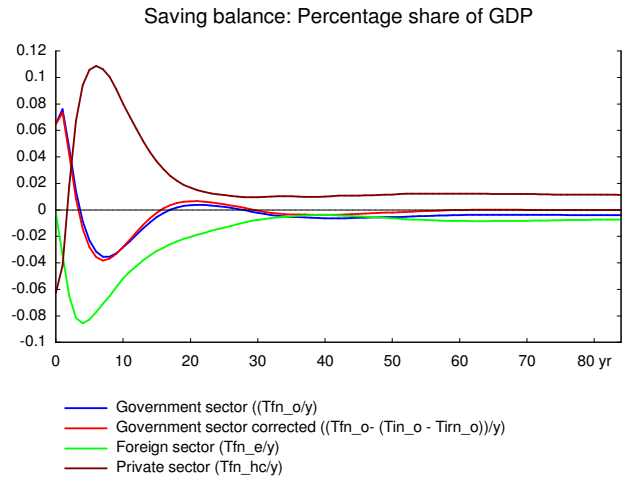


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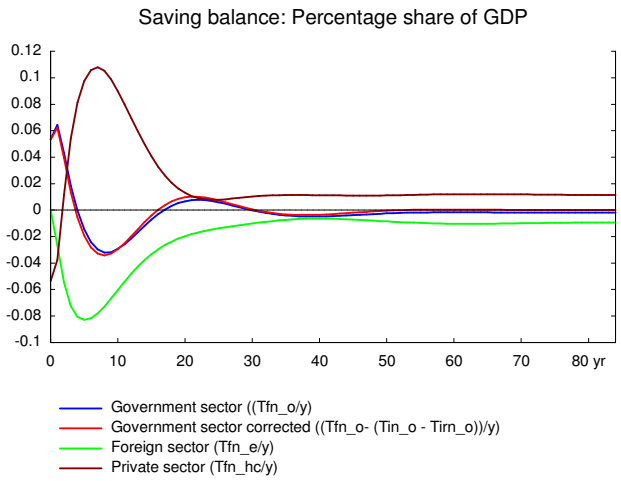


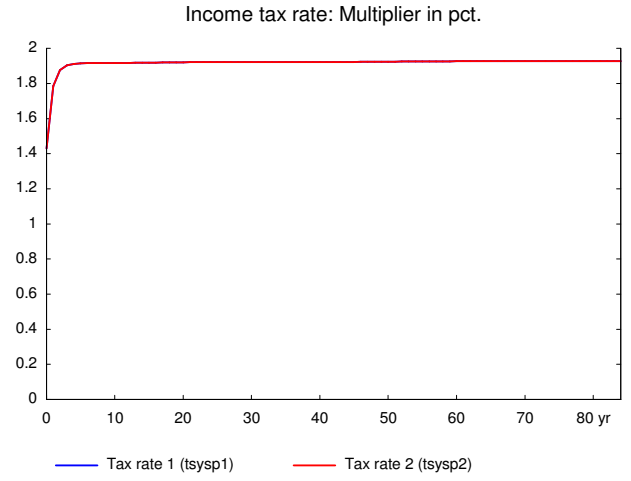

*General government investment in buildings (mul3)*

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.

Also in the public investment experiment we avoid overshooting in the tax rate and reduce the volatility in the labor market reaction when we use the new fiscal reaction function.

new function

Figure: $\left( ctsysp1 = cu = 0.05 \right)$




old function

Figure: $\left( ctsysp1 = 0.5 \ and \ \ cu = 0 \right)$

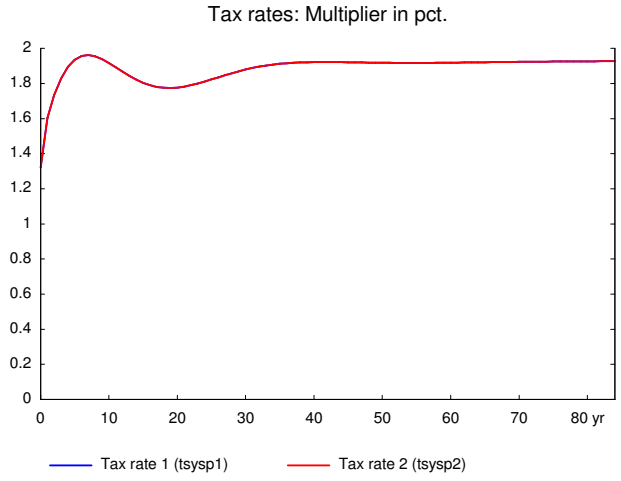
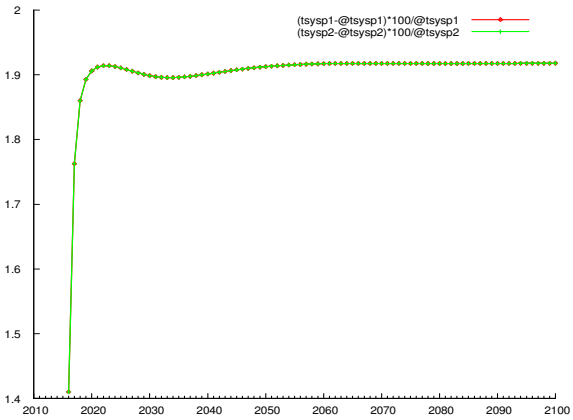


Figure: $\left( ctsysp1 = 0.05 \ and \ cu = 0 \right)$

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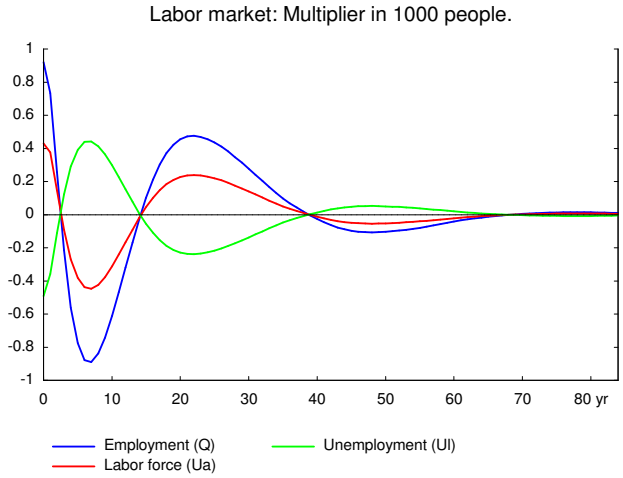


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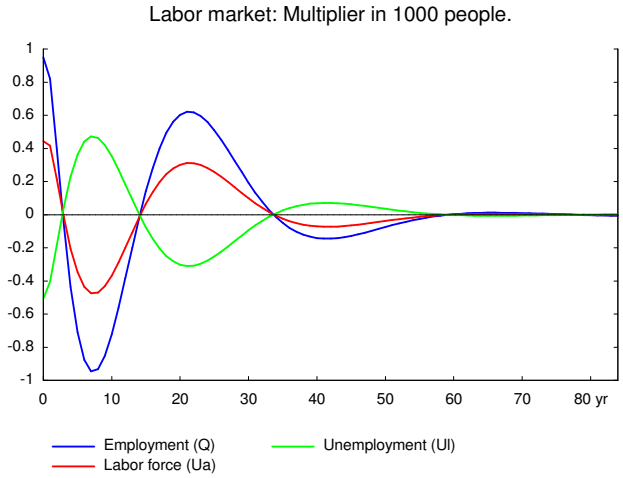


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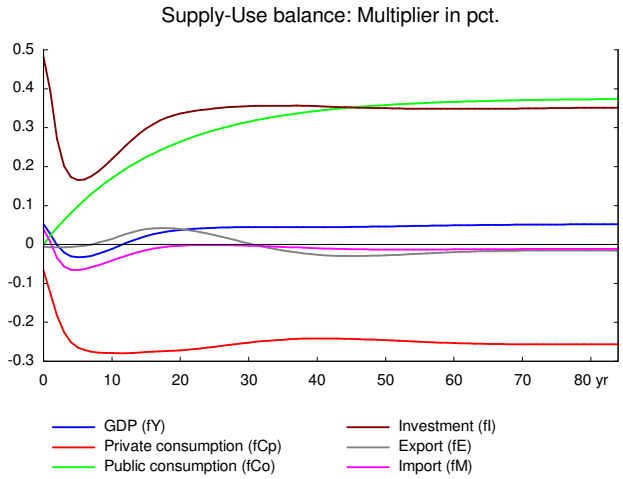


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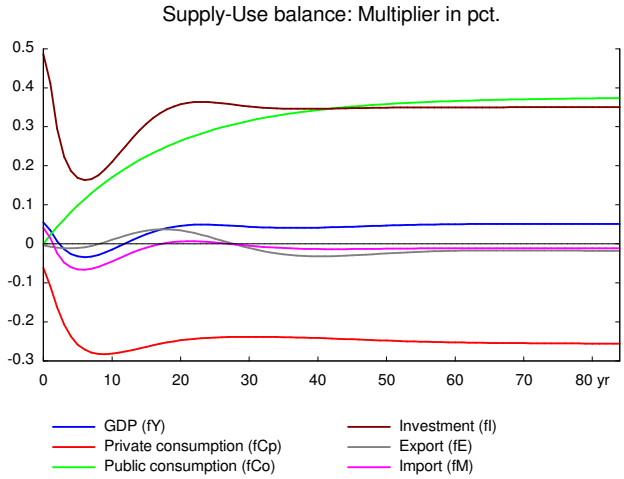

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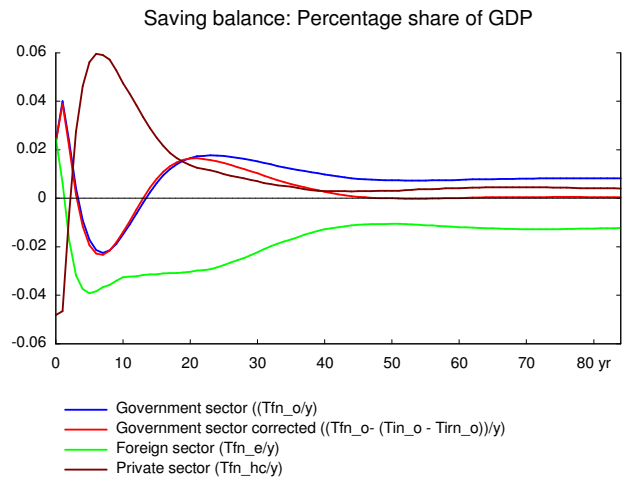


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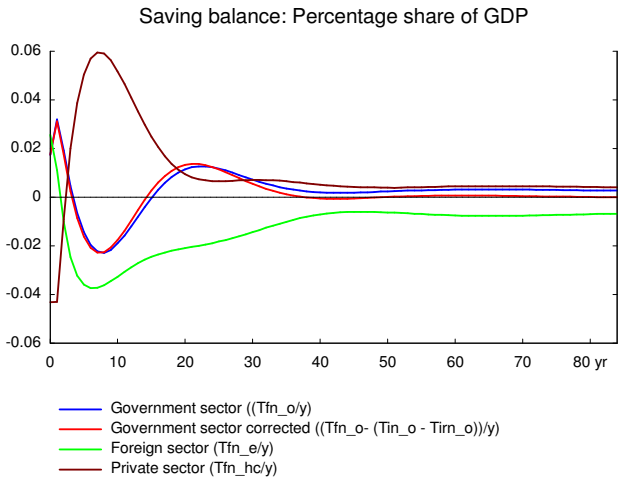


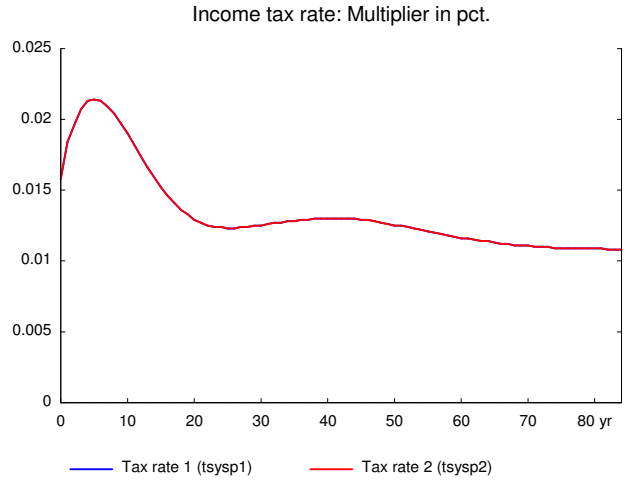

*Foreign demand (mul5)*

With the old fiscal reaction function, the permanent increase in foreign demand produces a more volatile tax rate response than a permanent change in public demand. The first round effect with the old function is a tax reduction while the higher activity improves the public budget. When the initial activity impact is crowded out, there is no base for a lower tax rate and in the long run we end up with a higher government income tax rate to compensate for a relative fall in the corporate and indirect taxes. Thus we shift between a negative and a positive tax change, with the old reaction function.

This distinct combination of under- and overshooting is not removed but clearly reduced in size if the parameter $ctsysp1$ is reduced from 0.5 to 0.05 in the old reaction function. And the initial undershooting is fully removed and replaced by a modest overshooting when we use the new extended reaction function. With the new reaction function there is also a slight reduction in the volatility of the labor market response. The following graphs present the effects of a permanent 0.096 percent increase in foreign demand. The shock implies a 1000 million kr. increase in exports in 2010 prices in the first year.

new function

Figure: $\left( ctsysp1 = cu = 0.05 \right)$




old function

Figure: $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

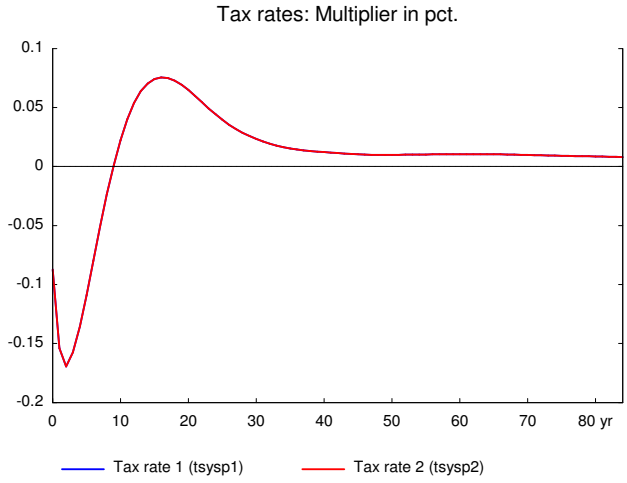
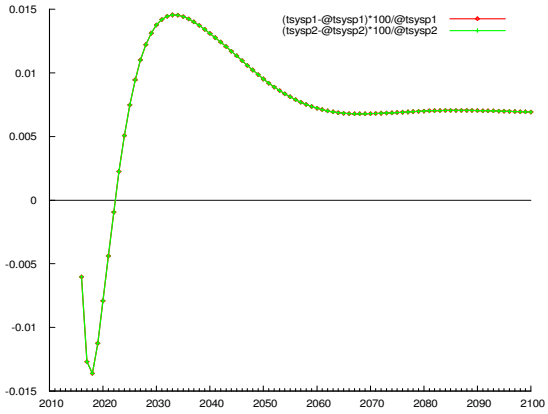



Figure: $\left( ctsysp1 = 0.05 \ and \ cu = 0 \right)$

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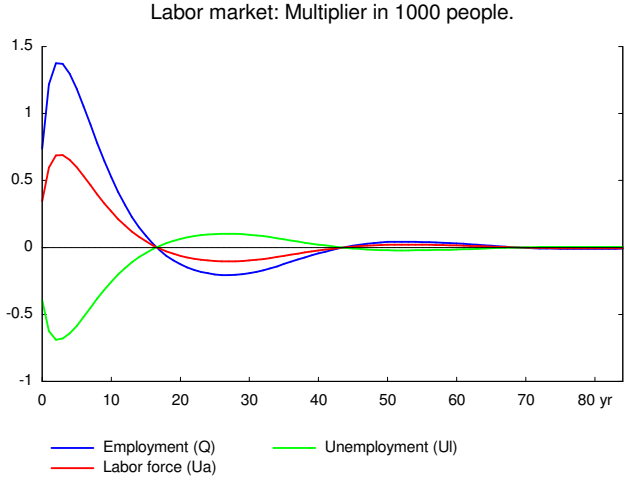


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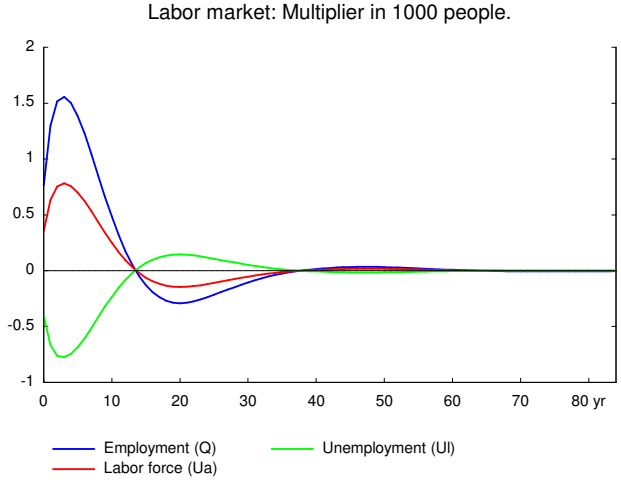


Figure: $\left( ctsysp1 = cu = 0.05 \right)$

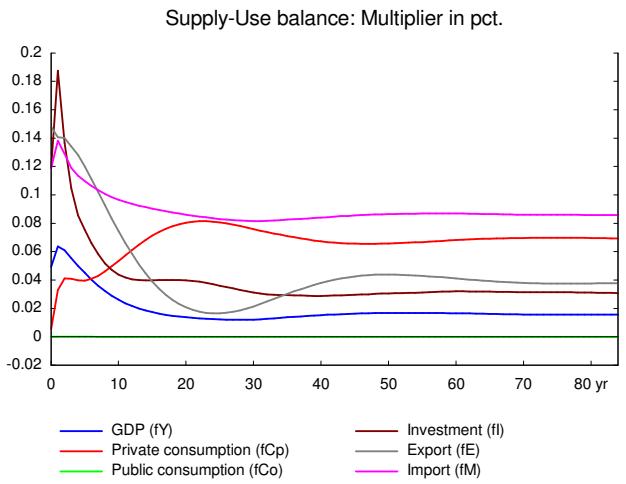
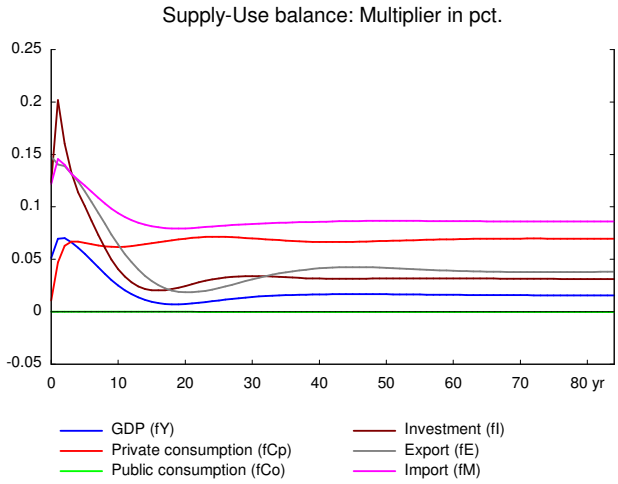



Figure: $\left( ctsysp1 = 0.5 \; and \; cu = 0 \right)$

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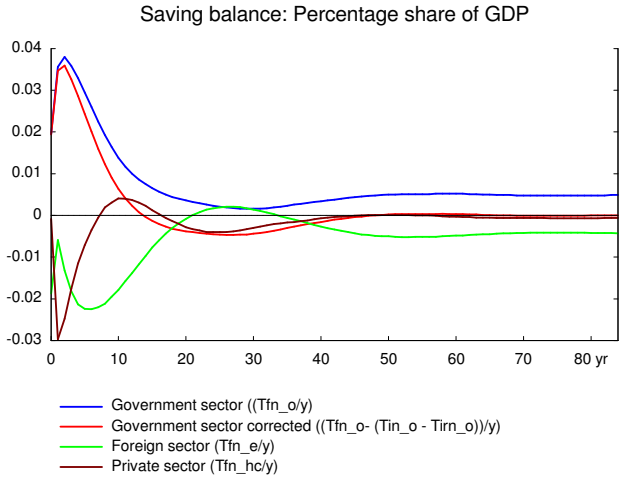


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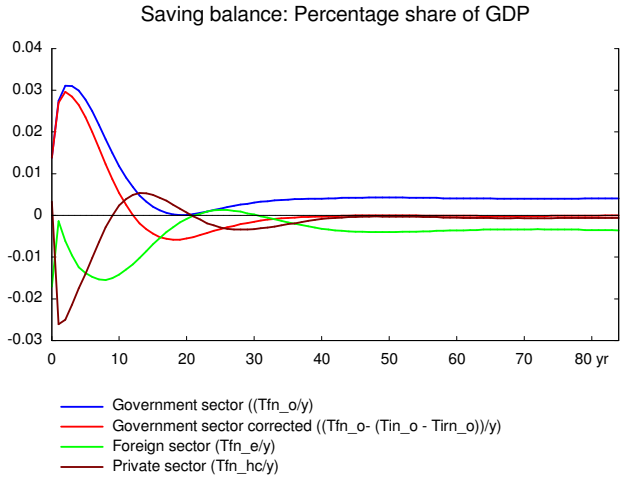
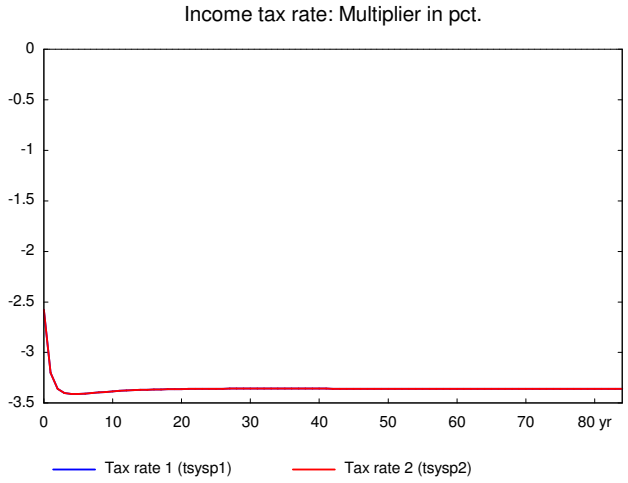



*Labor supply, early retirement scheme (mul19)*

The number of people in the early retirement scheme is reduced by 10000. The new extended fiscal reaction function almost removes the overshooting in the tax rate reaction, and we also see that the positive employment reaction becomes a little less volatile.

new function

Figure: $\left( ctsysp1 = cu = 0.05 \right)$




old function

Figure: $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

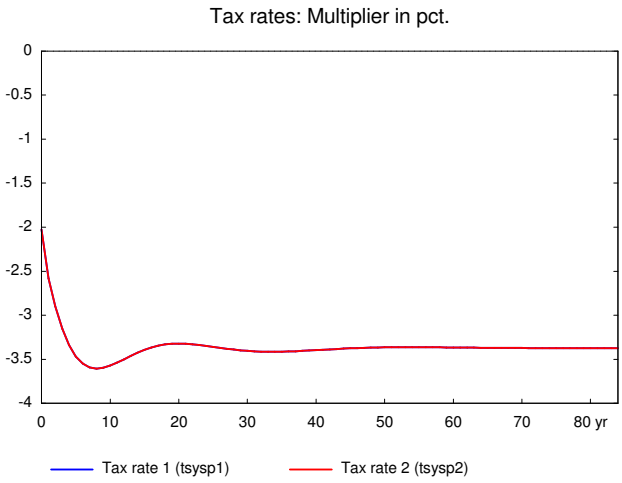



Figure: $\left( ctsysp1 = 0.05 \ and \ cu = 0 \right)$

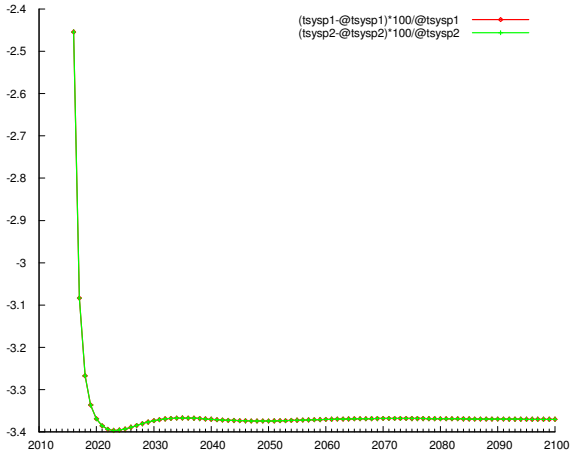



Figure: $\left( ctsysp1 = cu = 0.05 \right)$

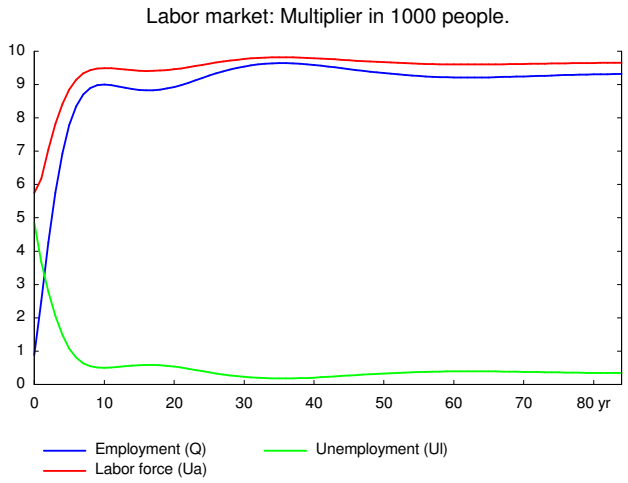



Figure: $\left( ctsysp1 = 0.5 \ and \ cu = 0 \right)$

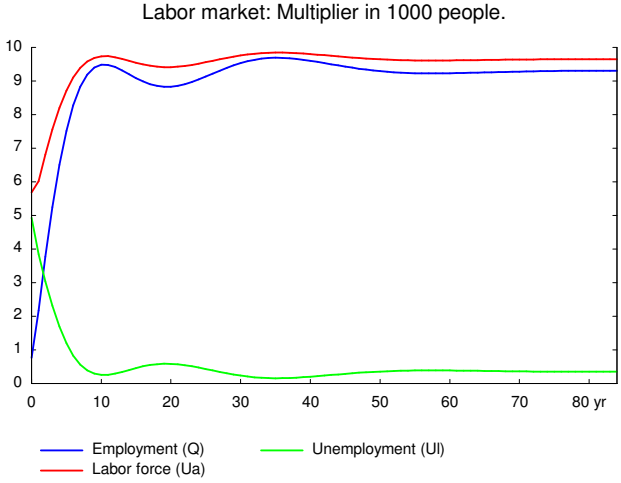


Figure: $\left( ctsysp1 = cu = 0.05 \right)$

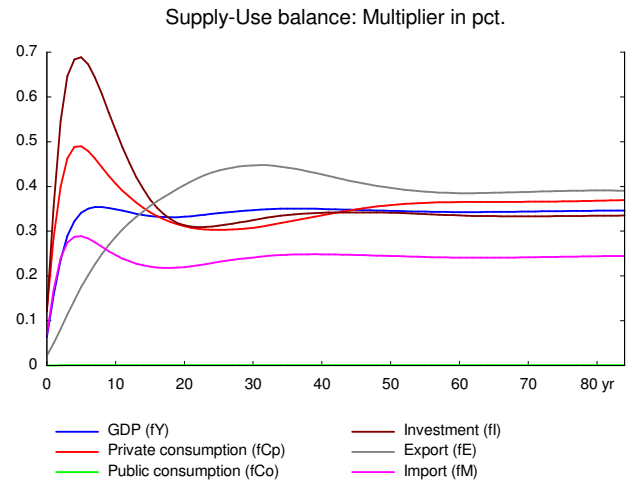



Figure: $\left( ctsysp1 = 0.5 \ and \ \ cu = 0 \right)$

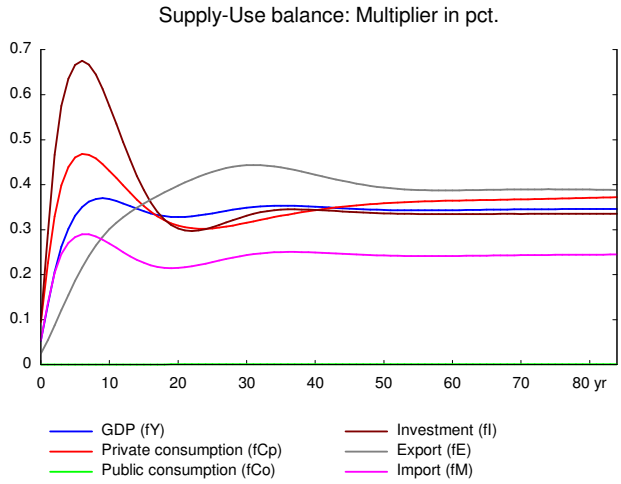



Figure: $\left( ctsysp1 = cu = 0.05 \right)$

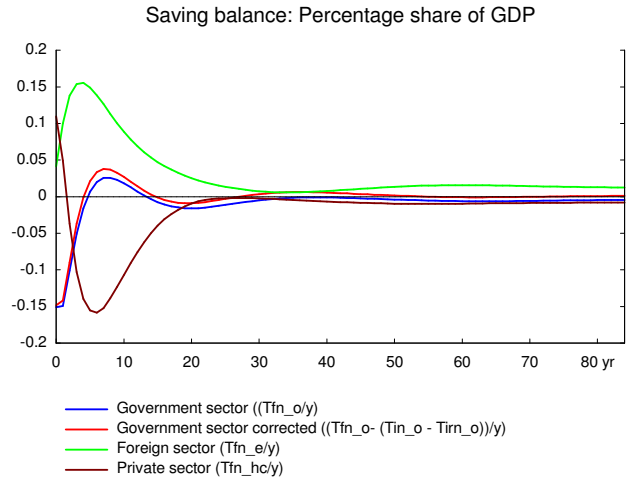
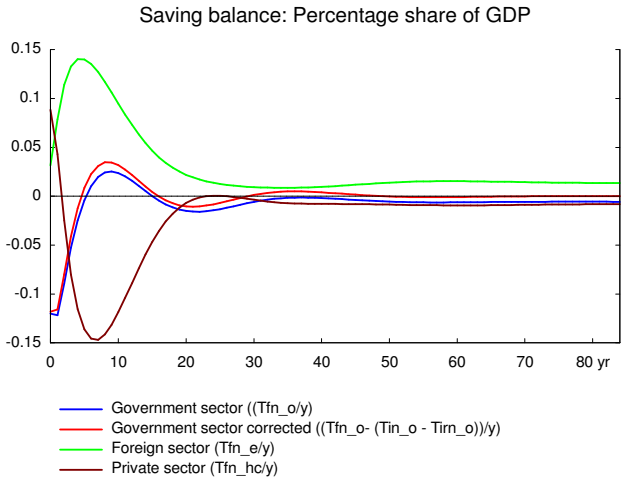



Figure: $\left( ctsysp1 = 0.5 \ and \ \ cu = 0 \right)$




## Conclusion

This paper has extended the fiscal reaction function used and presented in the paper 'Fiscal reaction function for ADAM' by including the unemployment gap as an additional target for the fiscal authority. Thus, the new reaction function adjusts income tax in order to make public finances long-run sustainable and to dampen the cyclical deviations of the labor market from its long-run equilibrium. In the short and medium run, the resulting tax rate will reflect the result of following an average of two goals, i.e. public debt ratio constant and unemployment gap closed. In the long run, the latter goal will be obtained via the crowding mechanism, and the resulting long run tax change will be the tax change necessary to make the debt ratio constant. Thus, the new fiscal reaction function produces the same long-run tax rate as the previous fiscal function. Compared to the results for the previous fiscal reaction function, there are two main differences. The new fiscal rule reduces significantly or removes the volatility of the tax rate reaction and it reduces moderately the volatility of the labor market reaction.

It is not really necessary to have a fiscal reaction function in ADAM because the model user can always set up a sustainable policy without a fiscal reaction function, and some users may turn off a function that endogenizes one of the fiscal instruments. However, it does seem an advantage to have a fiscal reaction function available in ADAM. It can make it easier to formulate a sustainable economic policy, and it may be advantageous to shift the focus from unfinanced to financed policy measures. Besides, it is international standard to have a fiscal reaction function available in a macro model.

The problem has been that a fiscal rule that stabilizes the public budget and debt relative to GDP will also be pro-cyclical, amplify the economic cycles, and destabilize economic activity in an ADAM calculation. It is to avoid this that the fiscal reaction function is based on forward-looking expectation. Including the unemployment gap should in principle strengthen the stability, and the model experiments in this paper do suggest that the impact on unemployment is less volatile with the unemployment gap in the fiscal reaction function.

We do not have a clear-cut criteria for formulating the fiscal reaction function and set the weight for the unemployment gap in the function. Thus, it may be an idea to test alternative specifications. And in order to make the fiscal function available to the model users, it seems necessary to make some minor changes in the financial equations in order to make sure that the growth-corrected interest rate on public debt is zero.

**References:**

Amenu Temesgen Kitesa and Dan Knudsen (2015), Fiscal reaction function for ADAM, working paper, Denmark Statistics.

Jonathan Portes and Simon Wren-Lewis (2014), Issues in the Design of Fiscal Policy Rules, Discussion Paper Series, No. 704, University of Oxford, Department of Economics.