Danmarks Statistik
MODELGRUPPEN

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Experiment with public purchases of goods and services

Resumé:

The paper looks at the macroeconomic effects of a permanent increase in government purchases. The wage relation is illustrated by plotting the unemployment and wage growth effects against each other. The experiment represents a demand shock that can be compared to the supply shock in a previous paper. In the demand shock there is no shift in the Philips curve and no permanent impact on labour supply. Consequently, there is no lasting effect on employment. The experiment raises labour productivity, which can be related to the higher relative price of labour and the production function's elasticity of substitution between labour and machinery.

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Key words: public purchase, simulation

1. Introduction

It is of interest to investigate the effects of public purchase of goods and services on main variables such as production, consumption, unemployment rates and wages. In the experiment, public purchase increases permanently by 1% and in the short run this makes production and employment rise and unemployment fall. In the long run, however, both unemployment and inflation return to baseline. The lower unemployment rate increases wages, which reduces competitiveness and results in a permanent loss of market share. Since the import price remains constant and the domestic wage increases, consumption rises permanently due to the permanently higher real wage and purchasing power. It is also observed that the composition of value added change away from manufacturing and towards services.

2. Discussion of the experiment

We start by specifying the experiment. This is followed by a section on wages and unemployment, which illustrates the Phillips curve by the effects on wage increase and employment. Then comes a section on consumption, a section that illustrates the substitutions effect on factor demand, a short section on public debt and finally there is a conclusion.

2.1 Implementation of shock

As shown below, the public's purchase of goods and services (fvmo) for input in the public industry is determined in a simple equation, which makes fvmo directly proportional to gross value added in public services. Thus, public purchases is endogenous in standard ADAM. However, in the experiment we exogenize the public purchase of inputs by setting the dummy dfvmo to 1 and change the exogenous fvmo variable (specifically, we change zfvmo, which is equivalent to the base line value of public purchase of inputs). The shock makes fvmo increase permanently by 1%. In each year, public purchases, fvmo, in the experiment are proportional to the baseline, and the proportionality factor is 1.01. The base line is taken from an existing ADAM - baseline bank and the first year of experiment is 2010. Last year is 2049, 40 years later. The ADAM-equation for fvmo is:

Fvmo = ((fvmo (-1)*fyfo/fyfo (-1) +fvmox+jdvmo)*(1.0+jrfvmo))*(1.0-dfvmo) +dfvmo*zfvmo$

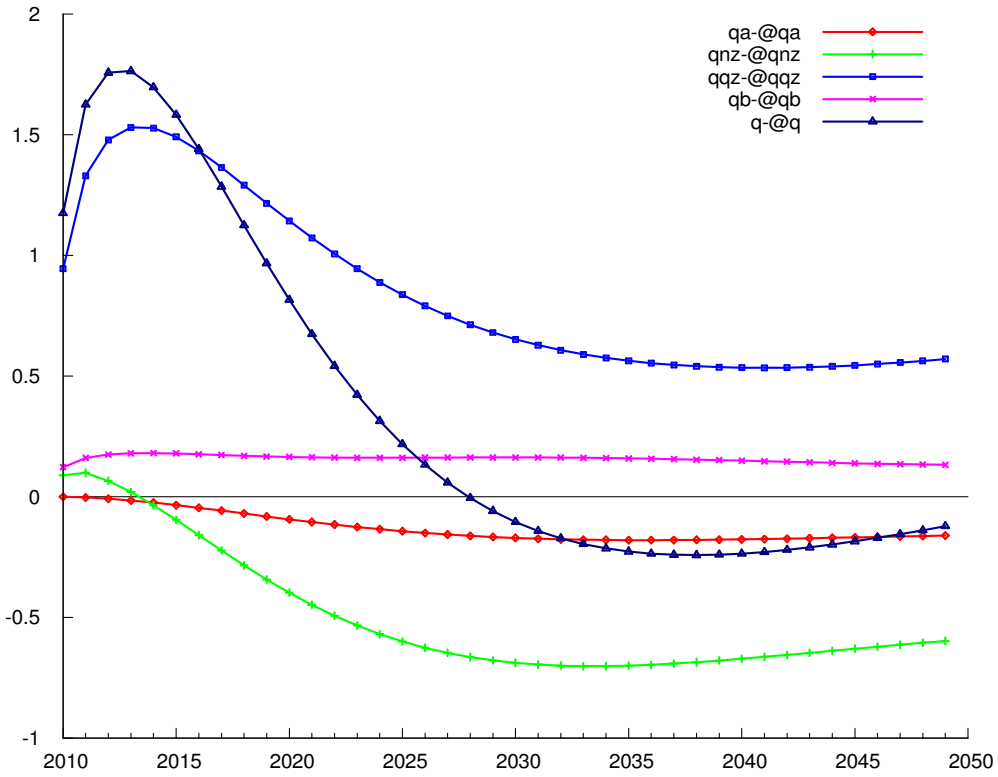
Where,
Fvmo= public purchase of goods and services
Fyfo = gross value added in public industry o
Fvmox= auxiliary variable that secures consistency in chain-indexing
Jrfvmo= adjustment term for specifying changes in fvmo.

2.2 Effects on employment and wages

ADAM is Keynesian in the short run, where the government purchase of input at first raises employment significantly. In the long run, the increase in employment evaporates, but though total employment returns to baseline in

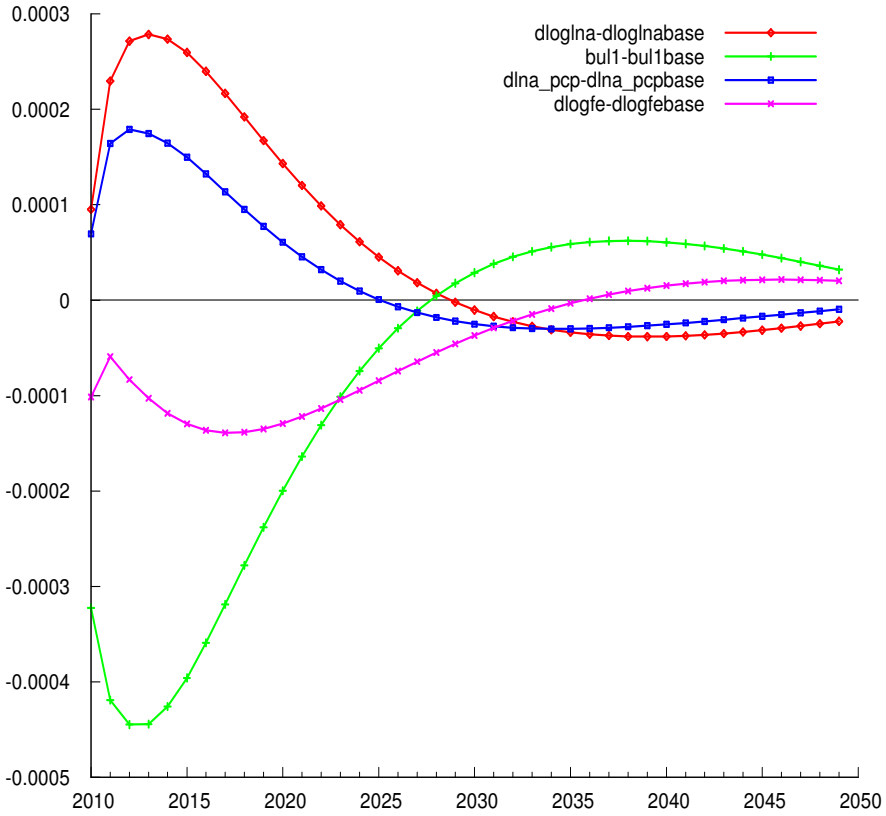
the long-run steady state, the composition of employment changes permanently, mainly from the manufacturing sector (i.e. nz) to the non-financial service sector, qz cf. figure 1.

Figure 1:Compostion of employment, public purchase + 1%



In the new steady state, wages are permanently higher than in the baseline. But in the long run, wages grow at the same rate in the alternative scenario and in the baseline scenario cf. figure 2. The new real wage is permanently higher than in the baseline.

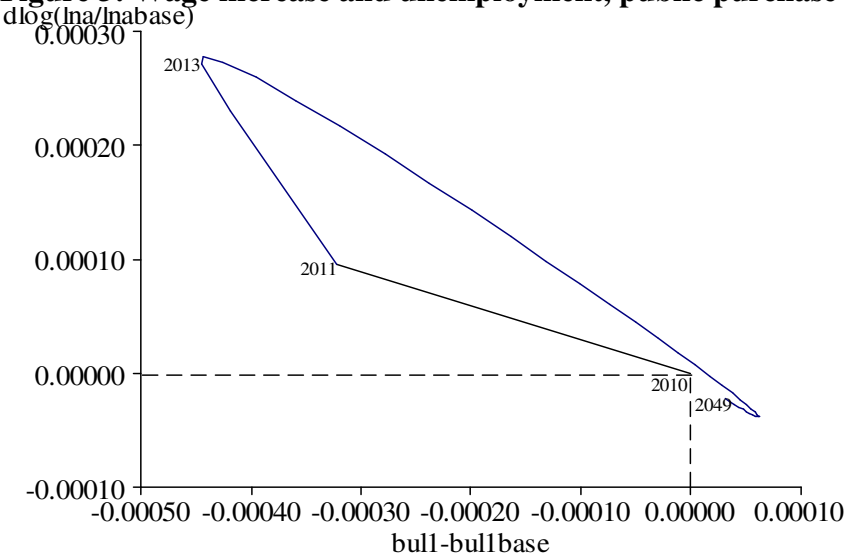
Figure 2: Unemployment, wage and export, public purchase +1%



As it reported in figure 2, the export growth rate also converges to baseline growth in the long run. The level of export stays permanently lower than the base line export, which explains the permanently lower production in manufacturing. In the long run, the permanently higher price of labor leads to higher prices of exports as the manufacturing sector determines its output price by a constant markup on total unit cost including wage costs.

Figure 3 shows the inverse relation between the effects on unemployment rate and wage inflation. As depicted in the figure, there is no long-run shift in the Phillips curve. The observed effects on wage increases and unemployment basically move up and down depicting a linear Phillips curve. Before the shock, baseline observations are close to origo i.e. locus (0, 0) indicated in figure 3. The higher public purchase decreases the unemployment rate relative to the baseline by 0.32% in year 1. The lower unemployment rate increases the wage growth by 0.1% in year 1 compared to the baseline. Thus, the implied coefficient for the first year is minus 0.33 (=0.1/0.32). That is numerically smaller than the coefficient of -0.55 for the lagged unemployment rate in the model's wage relation, reflecting that the coefficient for the contemporaneous unemployment change is numerically smaller than the 0.55.

Figure 3: Wage increase and unemployment, public purchase + 1%



Over time, the wage increase catches up with the long-term effect of the wage relation implied by the mentioned unemployment coefficient in the relation. We draw a solid line that relates the initial locus of the Philips curve with the observed points spanning the total experiment period from 2010-2049. In order to clarify figure 3, we present ADAM's wage relation:

```
Dlog(lna)  =  0.32045*ddloglna
                +0.30000*Dlog(pcpn**.5*pyfbx**.5)
                -0.25918*Dif(bul) + 0.02075 * d8587
                -0.55000*(bul1(-1)-bulw(-1))
                +glna $
```

Wage is lna, unemployment rate is bul1. Structural unemployment (bulw) is defined as bulw=0.76*btyd +constant.
Had the Phillips curve been simply, dlog(lna)=-0.55 (bul-bulw) + constant, and nothing else, figure 3 would have reported a straight line. Now, the dynamics of ADAM's Philips curve produces a cycle whioch ends up depicting a straight line, and in the long run we are back at locus (0, 0). In the long run, wage and price increases and unemployment will eventually return completely to the baseline, and also the wage compensation ratio, btyd, determining structural unemployment will return to baseline due to the wage indexation of benefits.

In figure 3, we end up overshooting a little by having a marginally higher unemployment and marginally lower wage increase than in the base line. If we extended the experiment period beyond 2049; the depicted 'Phillips curve' of observations would end up in the initial locus (0,0).

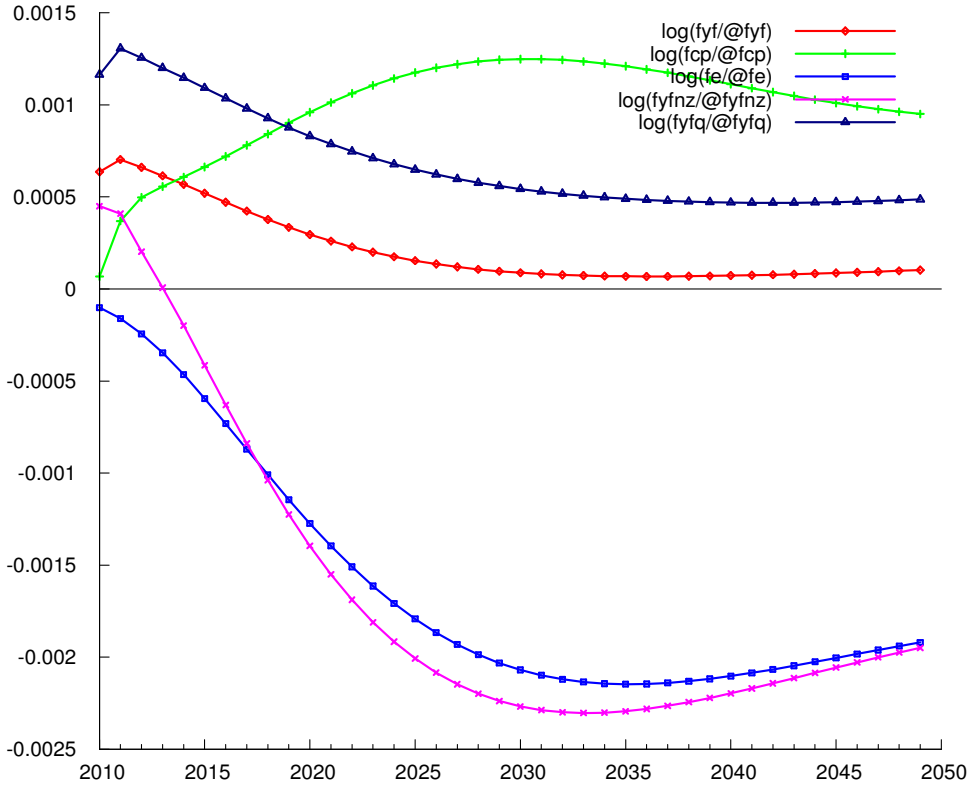
It can be added that in case of a, say negative, supply shock, the Philips curve shifts to the right because the constant term in the Phillips curve is increased. Thus, with a supply shock, we would not return to locus (0, 0) but to (Δbulw, 0), where the first coordinate represents the change in structural

unemployment. Note that the wage level ends up being permanently higher than the baseline, both in case of a permanent demand and a permanent supply shock.

2.2 Effects on consumption and value added

Consumption increases slightly in year 1, and figure 4 indicates that there is a long-run increase in consumption due to the permanent lift in real wages.

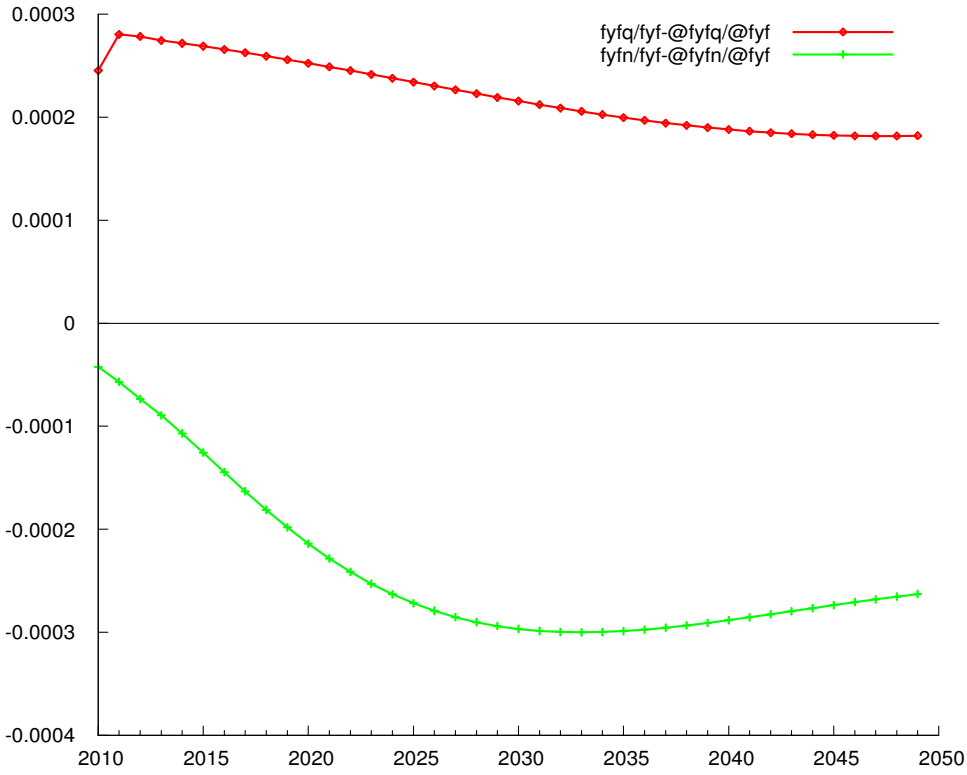
Figure 4: Value added, consumption and export, public purchase + 1%



Total value added is also higher than its baseline in the long run cf. figure 4. Especially value added in services (qz) is larger than the baseline, while value added in manufacturing (nz) is below baseline for most of the period. Specifically, the share of manufacturing in total value added is below the base line for the entire period. Thus, the shock to public purchase affects the composition of value added as shown in figure 5. The lower share of manufacturing reflects the loss of manufacturing export from the nz industry.

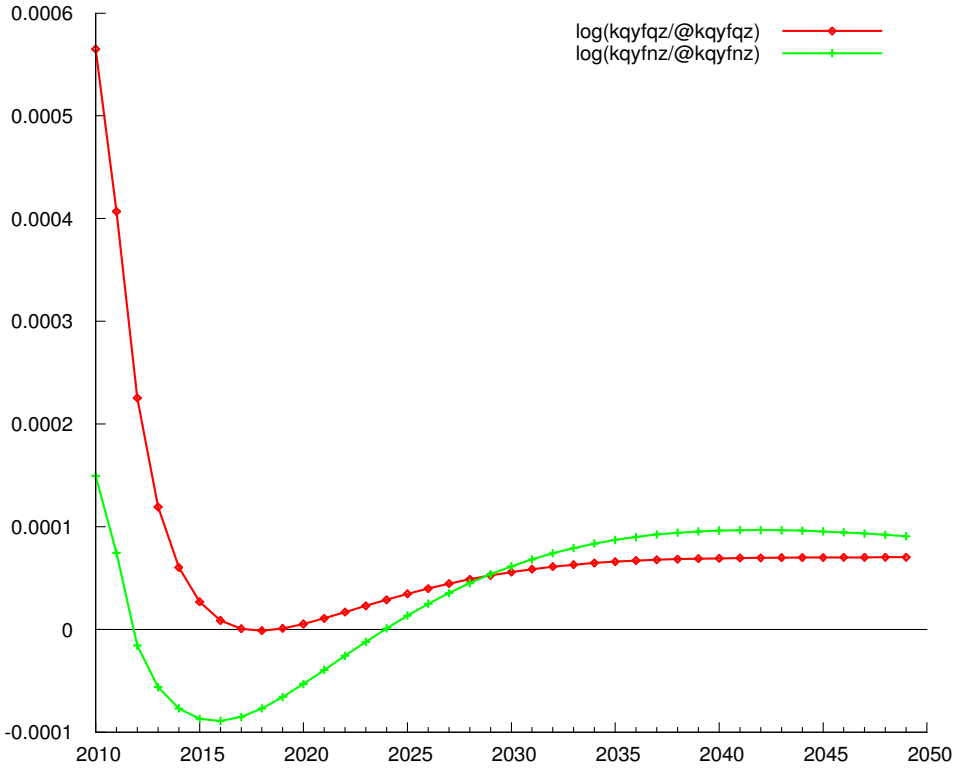
The permanent increase in the wage level increases the demand for capital relative to labor, which in turn increases value added per employed. This explains why total value added stays above its baseline level in the steady state. Thus, the gain in value added in private services is higher than the loss of value added in manufacturing sector, cf. figure 5. The public purchase of goods and services, i.e. the fvmo variable, is used as input in public production, so public production increases but public value added does not change significantly in the experiment period.

Figure 5: Compostion of value added, public purchase + 1%



The higher public purchase also affects the composition of inputs and both manufacturing and service industries become more capital intensive. This change in the composition of inputs raises the simple labor productivity, which raise potential production. In the first 5 years, as shown in figure 6, the cyclical impact on labor productivity is stronger in the service sector than in manufacturing sector. Note that both industries start with a labor-hoarding induced jump in the productivity in year 1. In the long-run steady state, however, there is not much difference in productivity reaction between the two industries. In both industries, labor productivity is higher than its baseline in the long run. We look into this in the following section.

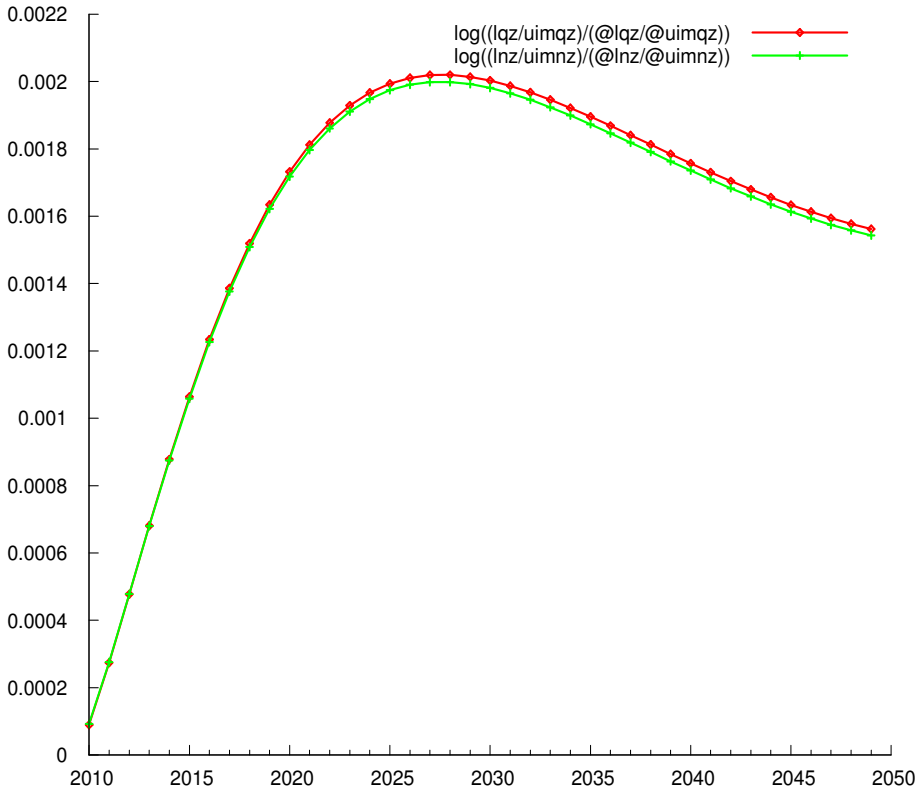
Figure 6: Labor productivity manufacture & service, public purchase +1%



2.3 Analyzing the effect on productivity

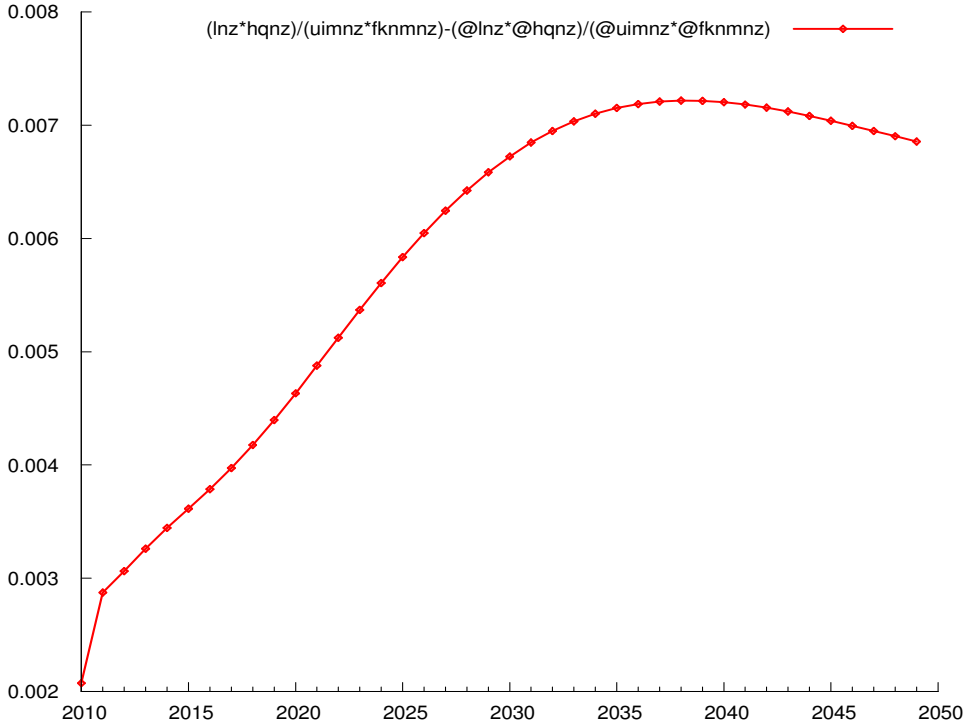
Labor productivity is defined as the ratio of value added over total hours worked. The long-term change in the labor productivity of a specific industry is driven by the relative factor prices of labor and capital, which is here machinery. The overall productivity of the economy may also reflect that the composition change as the level of value added relative to labor varies between sectors. As reported in figure 7, for the nz and qz indutries, the price of labor relative to capital is permanently higher in the long run, so labor becomes more expensive relative to capital.

Figure 7: Relative price of labor manufacture & service, public purchase +1%



According to the estimated CES function, the elasticity of substitutions between labor and capital in manufacturing and service industries are 0.32 and 0.31 respectively. This is clearly lower than one and we do see an increase in the costs of labor relative to capital in figure 8 (manufacturing) and 10 (services). The ratio of labor to capital, L/K, is a decreasing function of the relative price of labor, and as expected the L/K-ratio is below its baseline in the steady state, cf. figure 9 (manufacturing) and 10 (services).

Figure 8: Labor over capital costs in manufacturing



In the long run, labor productivity is determined by elasticity of substitution, factor income share and the relative price of labor to capital. Consequently, we can quantify the long-run change in labor productivity using the estimated Constant Elasticity of Substitution (CES) production function.

We begin by defining the elasticity of substitution (σ) between labor and machinery as follows for the service industry (qz):

σ = dlog(fknmqz/hqqz)/dlog(lqz/uimqz)

This implies equation (1) for the ADAM-calculated effect on K/L.

log(fknmqz/@fknmqz)-log(hqqz/@hqqz) = σ* dlog(lqz/uimqz)……(1)

In order to simplify, we refer to value added rather than to total production. The change in value added is the sum of changes in demand of labor and machinery weighted by their output shares. Thus, we have:

α*log(fknmqz/@fknmqz)+(1-α)*log(hqqz/@hqqz)= log(fyfqz/@fyfqz).....(2)

Strictly speaking, (2) is an approximation to ADAM's CES function. Equation (2) is a pretty close approximation cf. figure 12 where the long-run baseline cost shares of 0.15 and 0.85 are used for respectively labor and machinery (uimqz*fknmqz/(uimqz*fknmqz+lqz*hqqz) =0.85)

If we solve for the change in capital from (1) and subtitute it into (2), the change in labor productivity can be written as:

log(fyfqz/@fyfqz)-log(hqqz/@hqqz) = α* σ* dlog(lqz/uimqz)……(3)

$$= \alpha^* \sigma^* \log((lqz/uimqz)/(@lqz/@uimqz))$$
$$=0.15*0.31*0.00156=0.000072$$

The long run baseline income share of labor and the elasticity of substitution in the service industry are 0.15 and 0.31 respectively, and the long run effect on the relative factor price is 0.00156. The calculated increase in labor productivity of 0.000072 is close to the ADAM-calculated productivity change previously reported in figure 6, which seems to indicate about 0.00007 in the long run.

Similarly, we can use (3) to calculate the change in labor productivity for the manufacturing industry.

$$\log(fyfnz/@fyfnz)-\log(hqnz/@hqnz) = \alpha^* \sigma^* \log((lnz/uimnz)/(@lnz/@uimnz))$$
$$=0.14*0.32*0.001558=0.00007$$

The income share of labor, the elasticity of substitution and the long-term effect on the relative factor price in the nz industry are 0.14, 0.32 and 0.001558 respectively. This is close to the values used for the service industry, and the calculated productivity response is close to that of the service industry.

Figure 9: L/K-ratio in manufacturing, public purchase + 1%

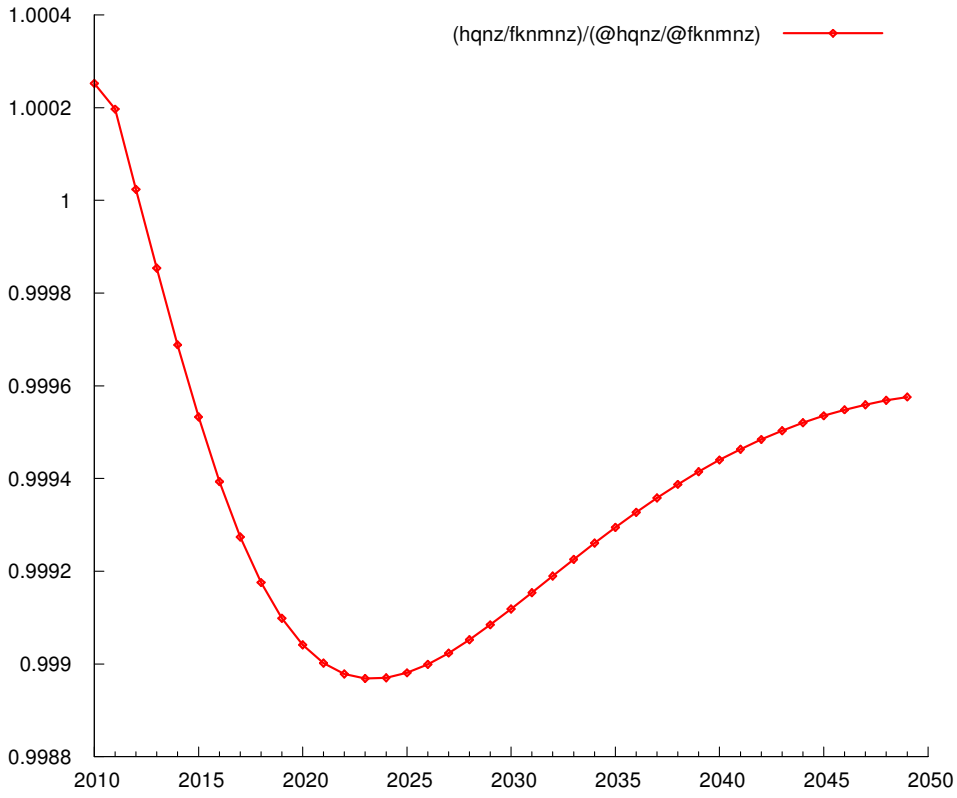
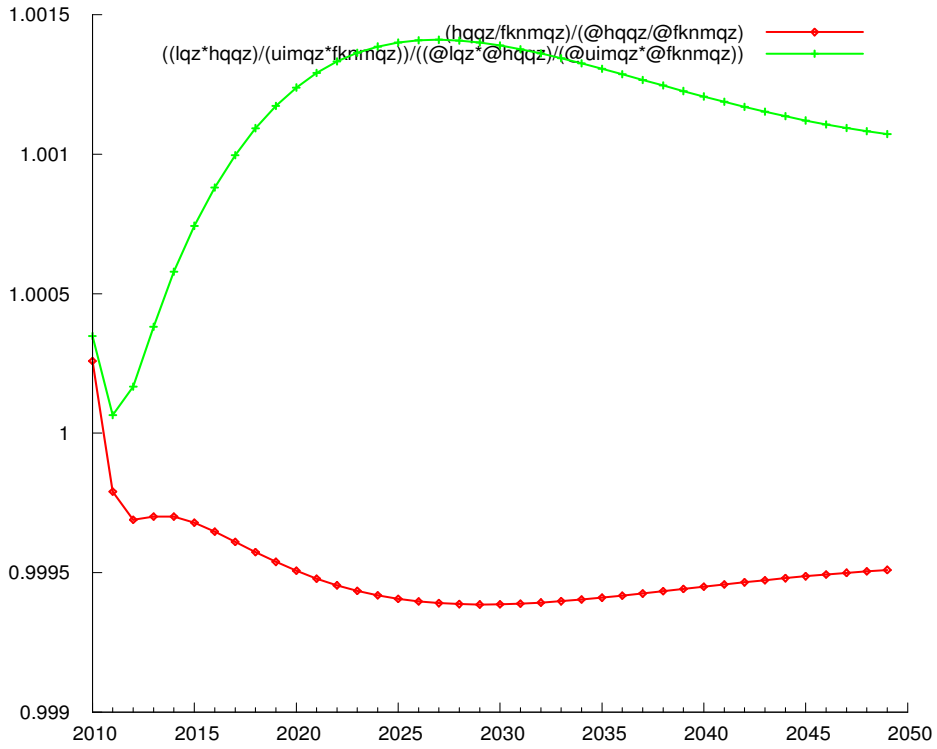


Figure 10: L/K ratio and labor over capital costs in manufacturing, public purchase + 1%



The previous figure 6 indicates an ADAM-calculated long-run productivity increase 0.00009 in the nz industry. The modest discrepancy to the productivity response of 0.00007 just calculated on the basis of (3) reflects a modest discrepancy concerning the relation in (2), where the baseline factor shares of 0.14 and 0.86 have been inserted in figure 11. The ADAM-calculated decline in value added is smaller than the decline indicated by (2), indicating that some other endogenous inputs affect the long-run value added. For the service sector, the condition in (2) holds almost exact as demonstrated in figure 12.

Figure 11: ADAM-calculated fyfnz compared to nz-value-added based on (2)

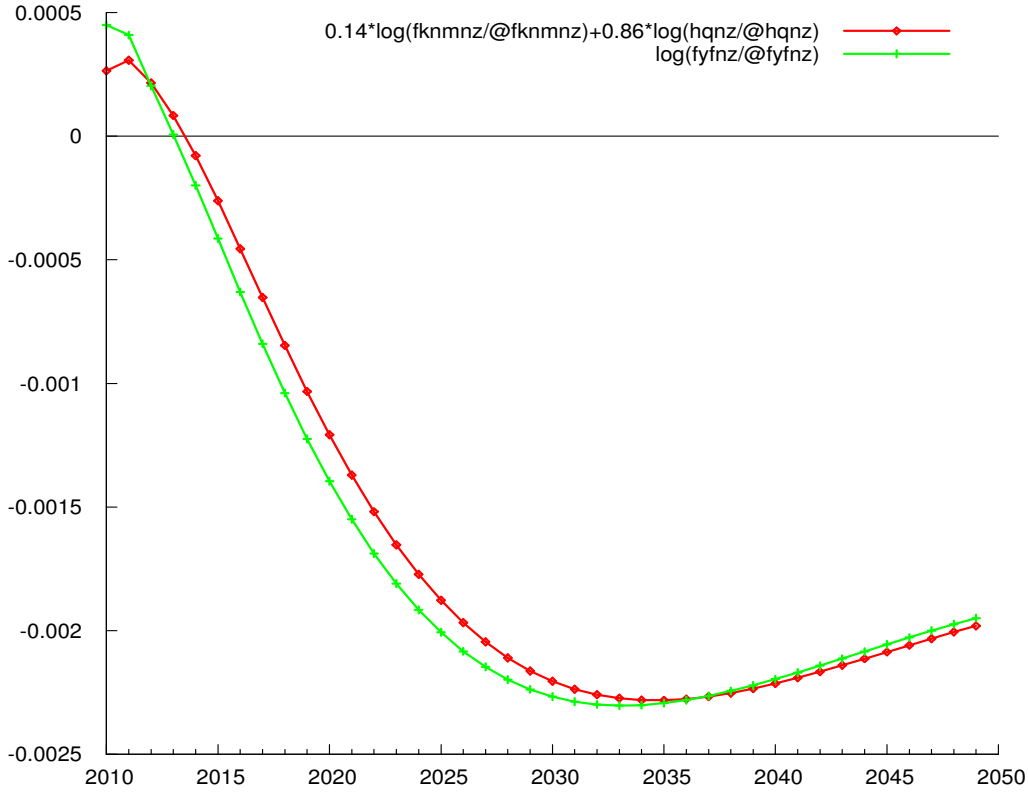
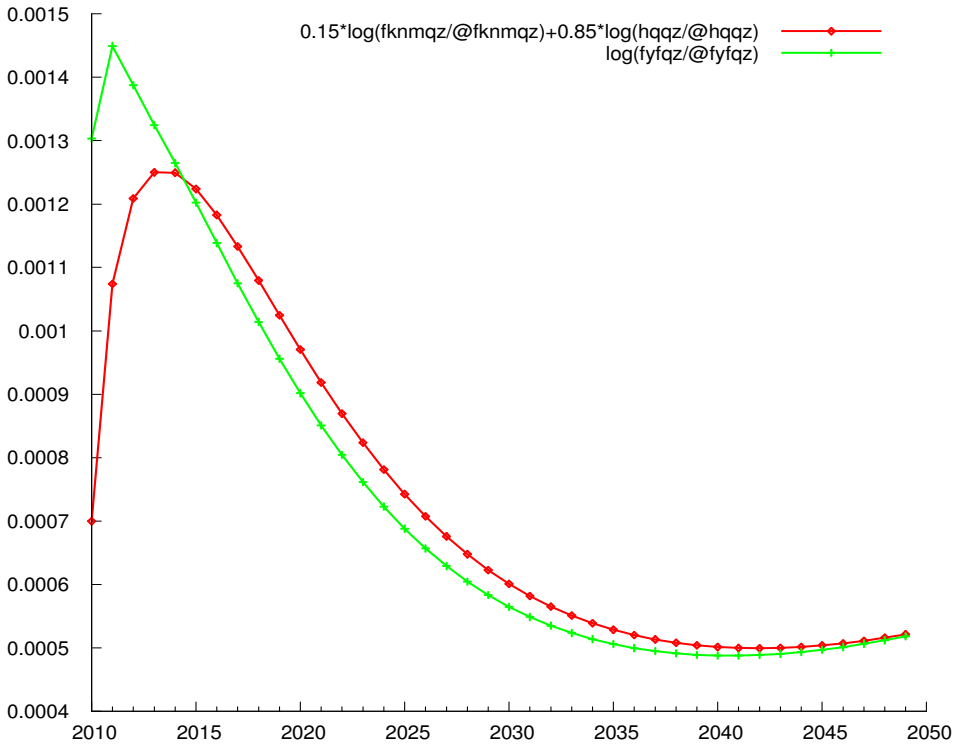


Figure 12: ADAM-calculated fyfqz compared to qz-value-added based on (2)



2.4 Effect on public debt

Higher public purchases deteriorate the public budget balance and increases public debt. The rise in public debt is represented by a decline in the public net asset, Wn_o in ADAM. The effect on public debt and public budget balance accumulates over time as shares of GDP due to the accompanying development in interest expenditures cf. figure 13. The effect on public consumption is a one off increase as share of GDP.

Tax-financing the increase in public purchases can keep the public debt share unchanged in the long run. Needless to say, tax-financing would also reduce private consumption and, more or less, remove the negative impact on competitiveness and exports.

Figure 13: Public debt as share of GDP, public purchase + 1%

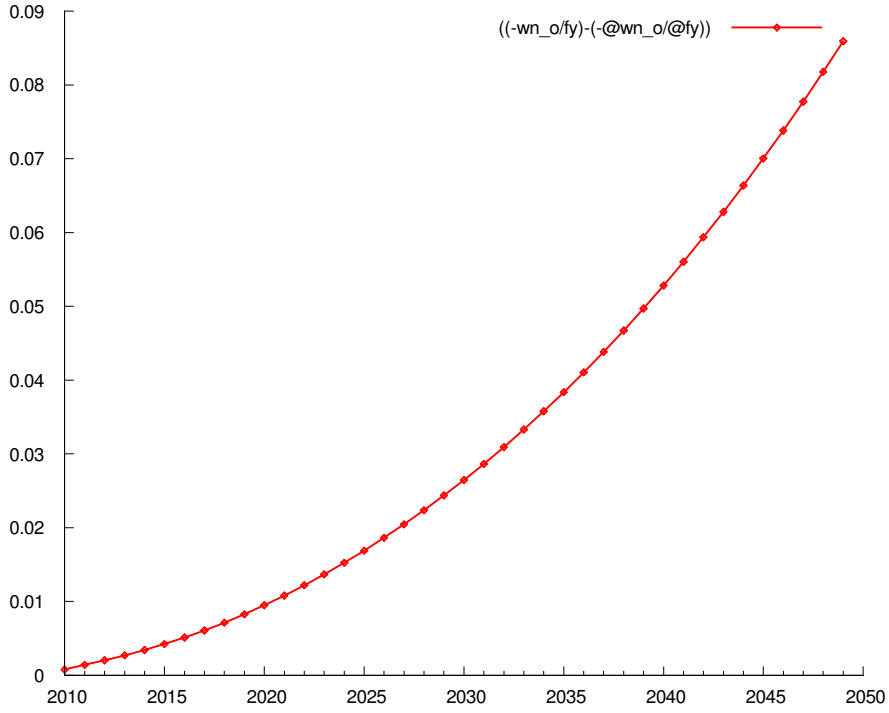
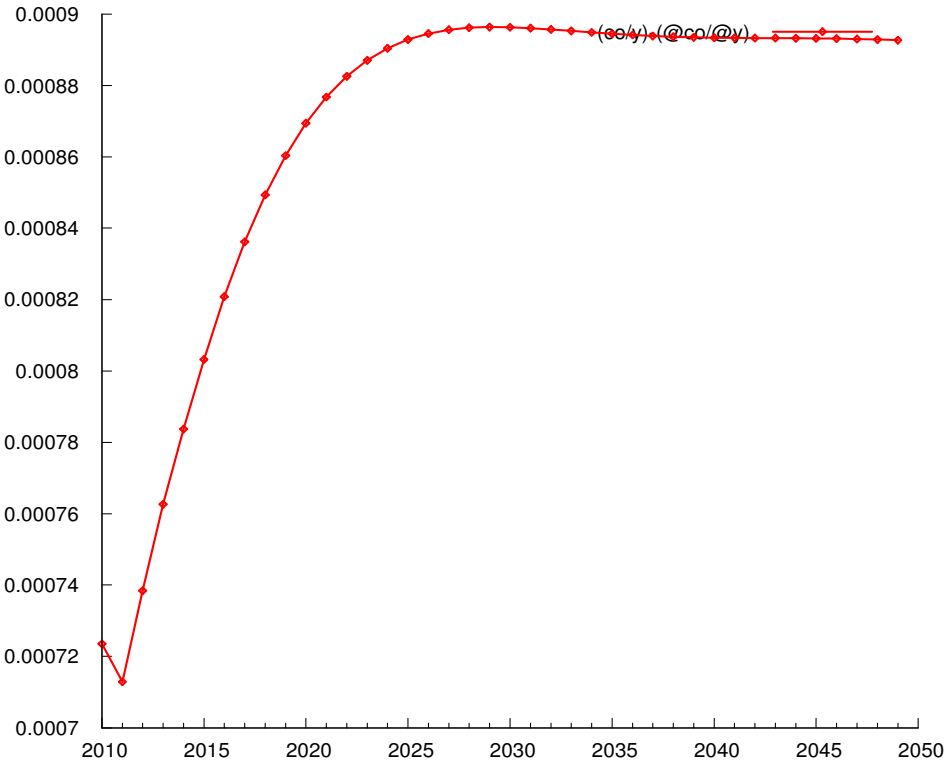


Figure 14: Public consumption as share of GDP, public purchase + 1%



3. Conclusions

The paper has examined the effects of a permanent increase in the public purchase of goods and services. The overall effects are standard for a non-financed fiscal expenditure shock. Unemployment falls in the short run. In the long run competitiveness and exports fall, while the effect on unemployment disappears. We were able to illustrate ADAM's Phillips curve by plotting unemployment and wage growth effects against each other, and we were able to illustrate the effect on labor productivity by a 'back-of-the-envelope' calculation on the relevant substitutions elasticity and factor shares.