

The properties of okt16 model with supply effects

Resumé:

The paper is a continuation of two other working papers: dsi080816 – using a gravity model provides empirical motivation for including supply factors in the determination of exports and dsi111116 – shows how the estimated supply effects can be incorporated in ADAM's export relations. The present paper focuses on the short-term and long-term properties of okt16 model in connection with the supply effects introduced in exports. We start by comparing okt16 with the previous model version okt15. To facilitate understanding of the supply effects, we also consider different supply elasticities. We use a shock to labor supply to examine the properties of okt16. The labor supply shocks take three forms – changes in number of workers, changes in working hours and changes in labor productivity.

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Nøgleord: export equation, supply effect, labor supply shock, multiplier analysis

Modelgruppepapirer er interne arbejdsrapporter. De konklusioner, der drages i papirerne, er ikke endelige og kan være ændret inden opstillingen af nye modelversioner. Det henstilles derfor, at der kun citeres fra modelgruppepapirerne efter aftale med Danmarks Statistik.

1. Background

The current model version okt16 has introduced supply effects in the determination of exports, cf. e.g. Krugman (1989). Empirical motivation is provided in the working paper *dsi080816* that presents a gravity model for Danish exports. The estimated equation takes the following form:

$$\begin{aligned} \log(E_{jt}) = & \alpha + c_i + \theta \cdot \log(Y_t) + \varphi \cdot \log(Y_{jt}) \\ & + \tau \cdot \log(\text{Dist}_j) + \sum_k \gamma_k \cdot \text{Dum}_k + \epsilon_{jt} \\ & t = 1, 2, \dots, T \ \& \ j = 1, 2, \dots, N \end{aligned} \quad (1)$$

Where E_{jt} is Danish exports to partner- j in value, Y_t is Danish GDP, Y_{jt} is partner j 's GDP, Dist_{jt} is distance between Denmark and partner- j , Dum_k is list of control dummies, c_i is time invariant unobserved effect, and ϵ_{jt} is error term.

The model is originally used in Tinbergen (1962), and Anderson and van Wincoop (2003) provide theoretical motivations. The gravity equation is one of the most widely used and most rewarding model in international trade. It has been applied for different purposes, such as for analyzing the effects of the eastward expansions of the EU and Brexit.

The gravity model explicitly models supply effects on exports. The coefficient on domestic income measures supply effects, the so-called growth-led-exports. While the size of the supply elasticity can be open to discussion, its presence is inarguable. Currently, the supply elasticity is estimated at 0.7, which is not far from estimates elsewhere.

In a consequent working paper, *dsi111116*, we have showed how the gravity estimate for supply effects can be incorporated into the export equations in ADAM that are based on Armington (1969) model. While the work on supply effects will continue, the initial findings are already included in okt16 model. The export relation in okt16 takes the following form:

$$\begin{aligned} \text{Dlog}(fE_t) = & \Gamma_1 \text{Dlog}(fEe_t) + \Gamma_2 \text{Dlog}\left(\frac{pe_t}{pee_t}\right) \\ & - \gamma \left[\log\left(\frac{fE_{t-1}}{fEe_{t-1}}\right) + \beta \log\left(\frac{pe_{t-1}}{pee_{t-1}}\right) - \theta \log\left(\frac{Q_t \cdot Hg_t \cdot kqyf_t}{Q_t^0 \cdot Hg_t^0 \cdot kqyf_t^0}\right) \right] \\ & + k + \epsilon_t \end{aligned} \quad (2)$$

Where fE_t is Danish exports in fixed prices, fEe_t is market index, pe_t is export prices, pee_t is market price, $Q_t \cdot Hg_t \cdot kqyf_t$ is value added (=employees*working hours*hourly productivity) and $Q_t^0 \cdot Hg_t^0 \cdot kqyf_t^0$ is value added in the baseline solution.

The supply elasticity $\theta = 0.7$ is taken from equation (1). Whenever $\theta > 0$, an increase in labor supply (in number or hours) and productivity raises the export market share. If $\theta = 1$ there is a full-pass through to exports, it implies if labor supply increases by 1 percent market share will also increase by 1 percent.

In the present paper, we examine the implications of the supply effects on the overall properties of the okt16 model. We start by comparing okt16 with the previous model version okt15. We present different forms of labor supply shocks and examine the short and long-term properties of okt16. In particular, we consider the following shocks to labor supply:

- Increase in number of workers – the additional labor comes from people not receiving transfers from the public, so there is no effect on social transfer payments.
- Increase in working hours – the working hours of all types of workers is increased and the change does not affect hourly productivity.
- Increase in productivity – productivity per hour increases in all branches including the public sector. No mechanism is provided for raising productivity, it is simply assumed that all types of labor increase their productivity.

In all experiments, the shock is permanent that begins from the first period and continues throughout the calculation period.

The additional labor generates tax revenues for the public sector that can be used to finance public expenditures. In the following, it is assumed that the higher labor supply leads to an expansion in public expenditures, so that in the long run there is no distinction between private and public consumption. Proportionality between the public and private demand is established by including the following two equations in the model:

$$Qo1 = Qo1_{-1} * \left(\frac{Qp}{Qp_{-1}}\right) \quad (3)$$

$$fio1 = fio1_{-1} * \left(\frac{fip}{fip_{-1}}\right) \quad (4)$$

Where $Qo1$ and $fio1$ are employment and investment in the public sector, and Qp and fip are employment and investment in the private sector. The two relations ensure that public employment and investment grow *pari passu* with private employment and investment. Endogenizing the public sector limits the effect of the labor supply shock on the public saving.

In the following sections, we present the multiplier experiments mentioned above, beginning with a comparison of okt16 and okt15 models.

2. Multiplier exercise

(A) Comparing okt16 with okt15

The stochastic relations in okt16 are re-estimated using a new data from the national accounts and the specification of some of the relations are also changed. The composition of the economy has also changed, which affects the baseline projection and hence the overall properties of the model. These changes can bring some differences between okt16 and the previous model okt15. However, the crucial change in okt16 is the inclusion of supply effects in the export relations and most of the differences in the overall properties of

the two models can be attributed to the supply effects in okt16. Below, we compare the properties of the two models to a labor supply shock.

The number of people outside the labor force not receiving transfers is reduced, which increase the labor force. The shock is calibrated to give a 1 percent increase in employment in the long run.

The experiment

<p>okt15: no supply effects $Uq = @Uq - (0.01/0.93)*Q$ $tsysp1 = @tsysp1 - 0.00225$ $fE3x, fXe, flbe, fess * 1.01$ $zSpz_xo1, zSpzu_xo1, Spzv, Spzco2, Spzuqr, Spzueuz, tspzaud * 1.01$</p>
<p>okt16: with supply effects $Uq = @Uq - (0.01/0.93)*Q$ $tsysp1 = @tsysp1 - 0.00225$ $elfyfu = 1;$ $fE3x, fXe, flbe * 1.01$ $zSpz_xo1, zSpzu_xo1, Spzv, Spzco2, Spzuqr, Spzueuz, tspzaud * 1.01$</p>

The additional labors are assumed to have the same profile as those in the labor market. Social transfers are not reduced at the same time and the average labor productivity is assumed to be unchanged. It is also assumed that no cost is incurred to bring more people to the labor market. In the long run, the wage relation ensures that the unemployment rate is unchanged.

The higher employment generates tax revenues to the government, but at the same time expenditure on public services expands. Since public transfers are unchanged, the positive effect on public finance dominates and to neutralize these positive effect income taxes are reduced by 0.2 percent permanently.

Note that some exogenous variables such as excise taxes and production in the Xe-sector are raised by 1 percent to reduce composition effects. For example, revenues from excise taxes are set to follow inflation. If excise taxes do not follow the nominal income like other taxes, it will give some distortion in consumption.

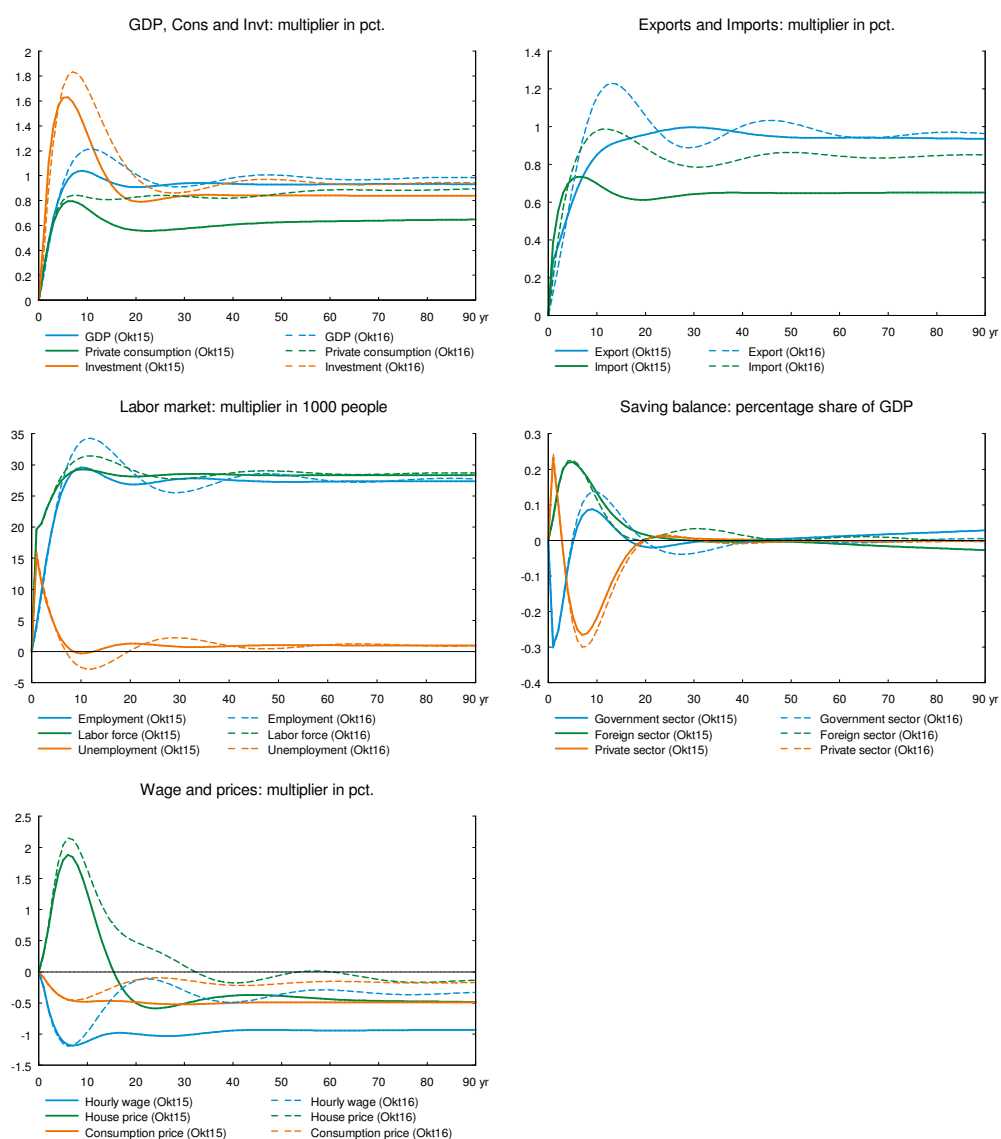
Figure 1 presents the effects of the labor supply shock in okt15 and okt16. In the immediate term, the difference between the two models is negligible. The supply effect on exports is included in the long-term relations, which implies that the impact on exports and hence on employment is slowed down by the error-correction mechanism. The pass-through of the supply effect is delayed by the error-correcting coefficient of 0.15 in the export relations. The short term effect on GDP is slightly strong in okt15 reflecting the stronger investment response, which originates from a change in the factor block determining the demand for production factors. The change in this part of the model illustrates that the re-estimation and some minor re-specifications contribute to the difference between okt15 and okt16.

In the medium to long term, the expansive impact is higher in okt16 confirming the long-run importance of the supply effects included in the export relations of okt16. In the long term, the 1 percent increase in employment leads to approximately a 1 percent increase in GDP and exports in okt16 owing to the

direct supply effects. The effect is slightly less than 1 percent because the supply elasticity is set to 0.7. If the supply elasticity is set to 1, there will be a 1 percent effect on income and consumption in the long run, see the experiments below. There is a small negative effect on wages, which leads to a shift toward domestic products and imports increase by less than 1 percent. The degree of factor substitution in okt16 is also limited.

The increase in exports is lower in okt15 as there are no supply effects. For exports to increase by 1 percent, additional improvement in competitiveness is required. The fall in domestic wage and prices is larger in okt15, which leads to a larger substitution effect between domestic and foreign products. The negative real wage effect reduces the positive effect on consumption, which increases less than the increase in okt16.

Figure 1. The effect of a permanent increase in labor supply, 1 % of employment

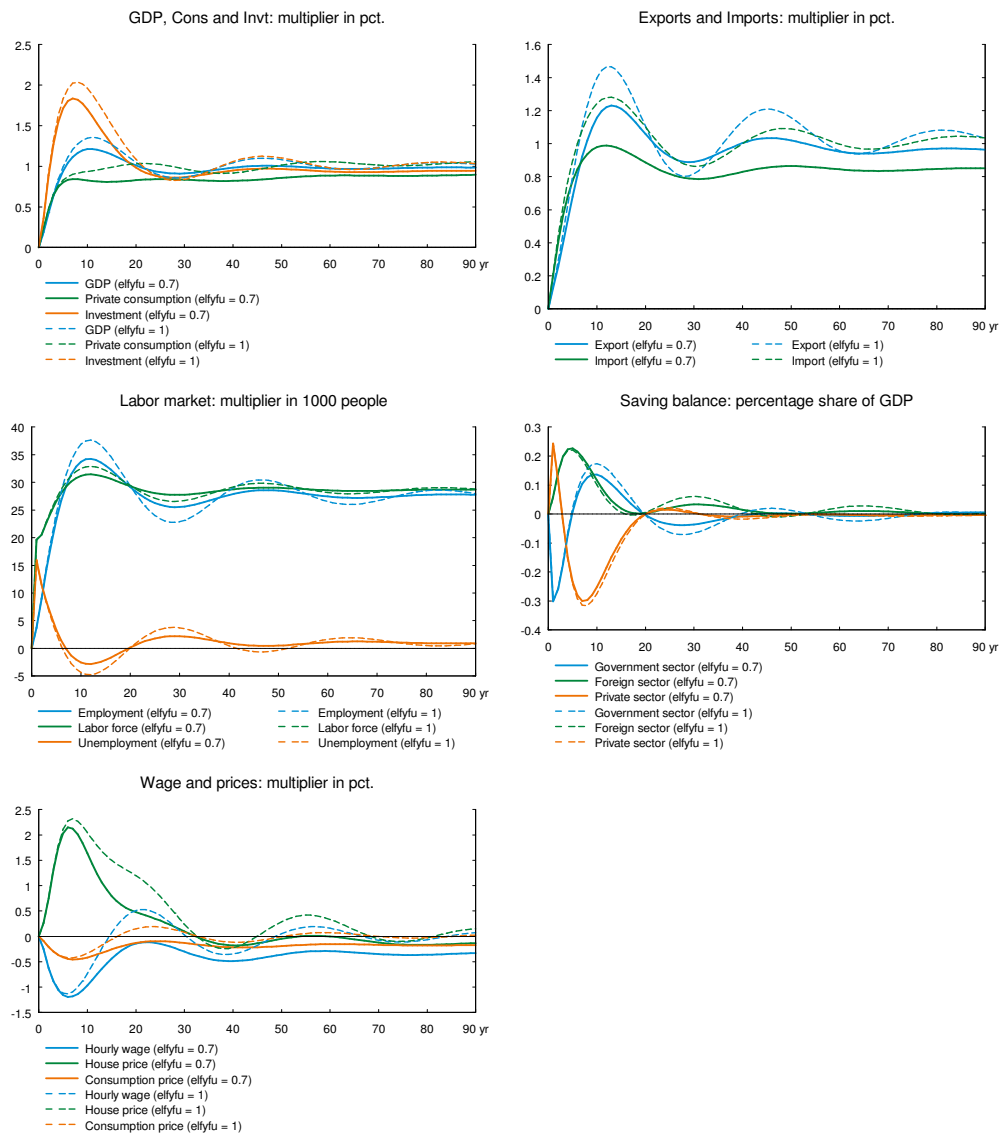


(B) Changing the supply elasticity

The point with supply effects can be made more clear by considering different supply elasticities. We consider here two elasticities, 0.7 and 1, and repeat the labor supply shock from above in okt16 model.

During the first 5 years, changing the supply elasticity makes no noticeable difference to the outcome. Thereafter, we can see that the expansive impact on GDP and employment becomes stronger with a supply elasticity of 1. The stronger the impact on employment, the more moderate is the wage reduction. The long term supply elasticity of $el_{fyfu} = 1$ leads to a 1 percent increase in production and exports, and the supply elasticity of 0.7 limits the supply effect resulting in a less than 1 percent increase in production and exports, see also section (A). With a unit supply elasticity, there is no effect on wage and prices in the long run, which limits factor substitution and the substitution between domestic and foreign products. The unit supply elasticity has desirable properties, but the empirical evidence points toward a lower elasticity.

Figure 2. The effect of a permanent increase in labor supply, 1 % of employment



(C) Increase in working hours

For demonstration purpose, in the following two exercises we set the supply elasticity to 1, and no comparison is made with okt15.

Labor hours is permanently increased by 1 percent for all employees. No special consideration is made for specific types of employees, such as part-time employee and self-employed. Effects on average productivity, income distribution, etc. are not taken into consideration, all employees increase their working hours by 1 percent irrespective of job types, without any change in hourly productivity.

The experiment

$Ha * 1.01;$
 $fE3x, fXe, flbe * 1.01$
 $zSpz_x01, zSpzu_x01, Spzv, Spzco2, Spzuqr, Spzueuz, tspzaud * 1.01$

Excise duties and production, e.g. in the Xe-sector are increased by 1 percent to avoid composition effects, see also section (A).

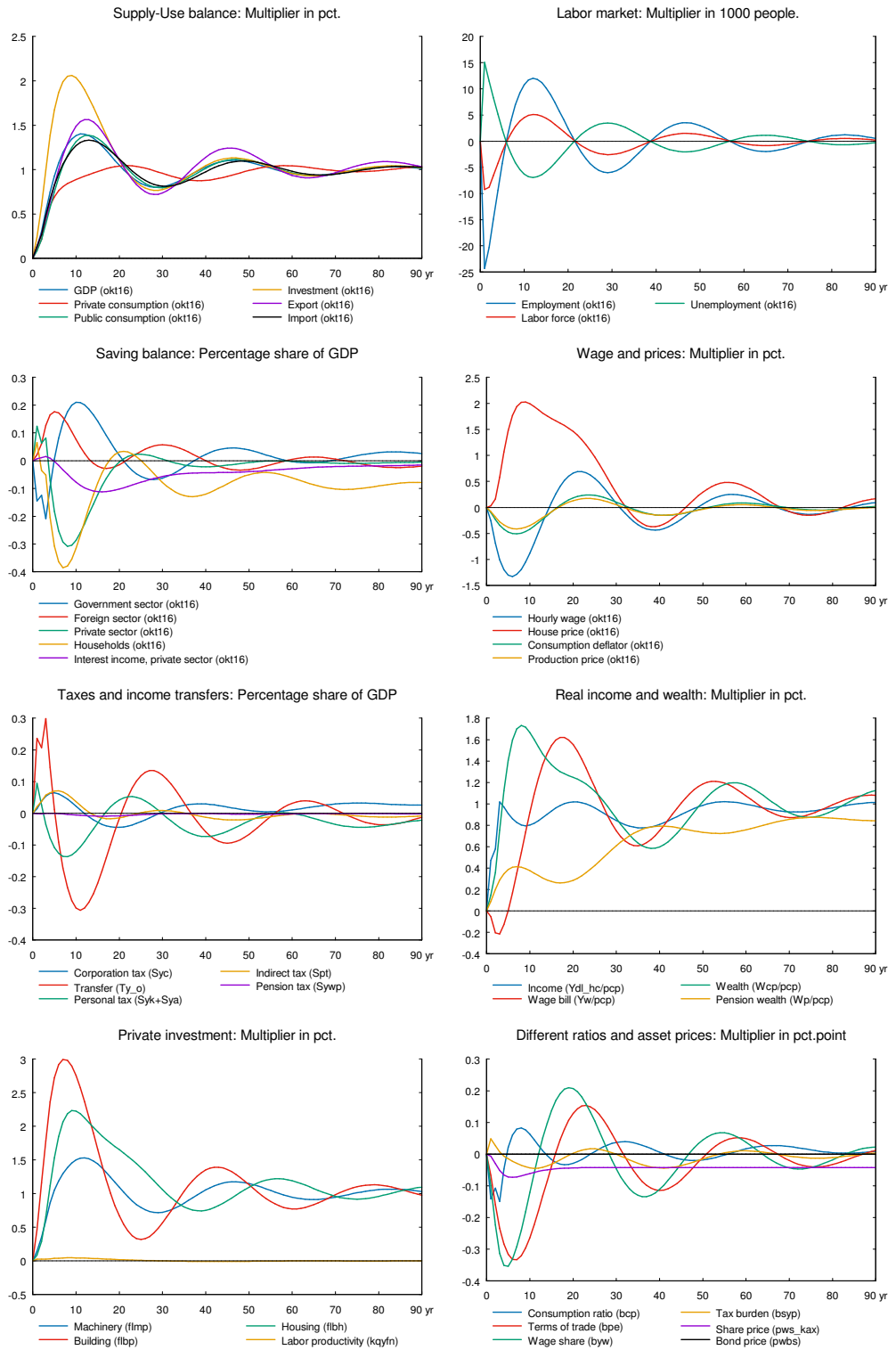
In the short run, there is no change in demand and the same output can be produced with fewer labor, which leads to firing and increase in unemployment. Public spending on welfare increases as unemployment increases.

Gradually demand for Danish goods abroad increases partly due to the supply effects and partly due to the improvement in competitiveness as the higher unemployment dampens wage growth at home. In the long run, foreign demand for Danish goods increases by 1 percent, and competitiveness is more or less unchanged.

With a supply elasticity of 1, GDP, consumption, investment and trade increase by 1 percent in the long run. Wage and prices are almost unchanged in the long run. The substitution between capital and labor is limited as there is no change in relative factor prices. There is no substitution between domestic and foreign production, as domestic prices relative to foreign prices are unchanged.

Without supply effects, wage competitiveness alone brings equilibrium. The crowding out process will be long and wages will fall permanently. The fall in wages and prices will also affect relative factor prices and factor substitution. The negative real wage effect will have also reduced consumption. These effects are reduced when supply effects are included in exports with elasticity of 0.7 and a supply elasticity of 1 more or less avoids these effects.

Figure 3. The effects of a permanent 1% increase in working hours



(D) Increase in productivity

In the following labor productivity is increased by 1 percent in all sectors including the public sector.

The experiment

dlla, dtlb, dile, dilh, dilne, dilnf, dtlng, dtlnz, dtlqf, dtlqz, dtlqs, dtlo1 * 1.01
fE3x, fXe, flbe * 1.01
zSpz_xo1, zSpzu_xo1, Spzv, Spzco2, Spzuqr, Spzueuz, tspzaud * 1.01

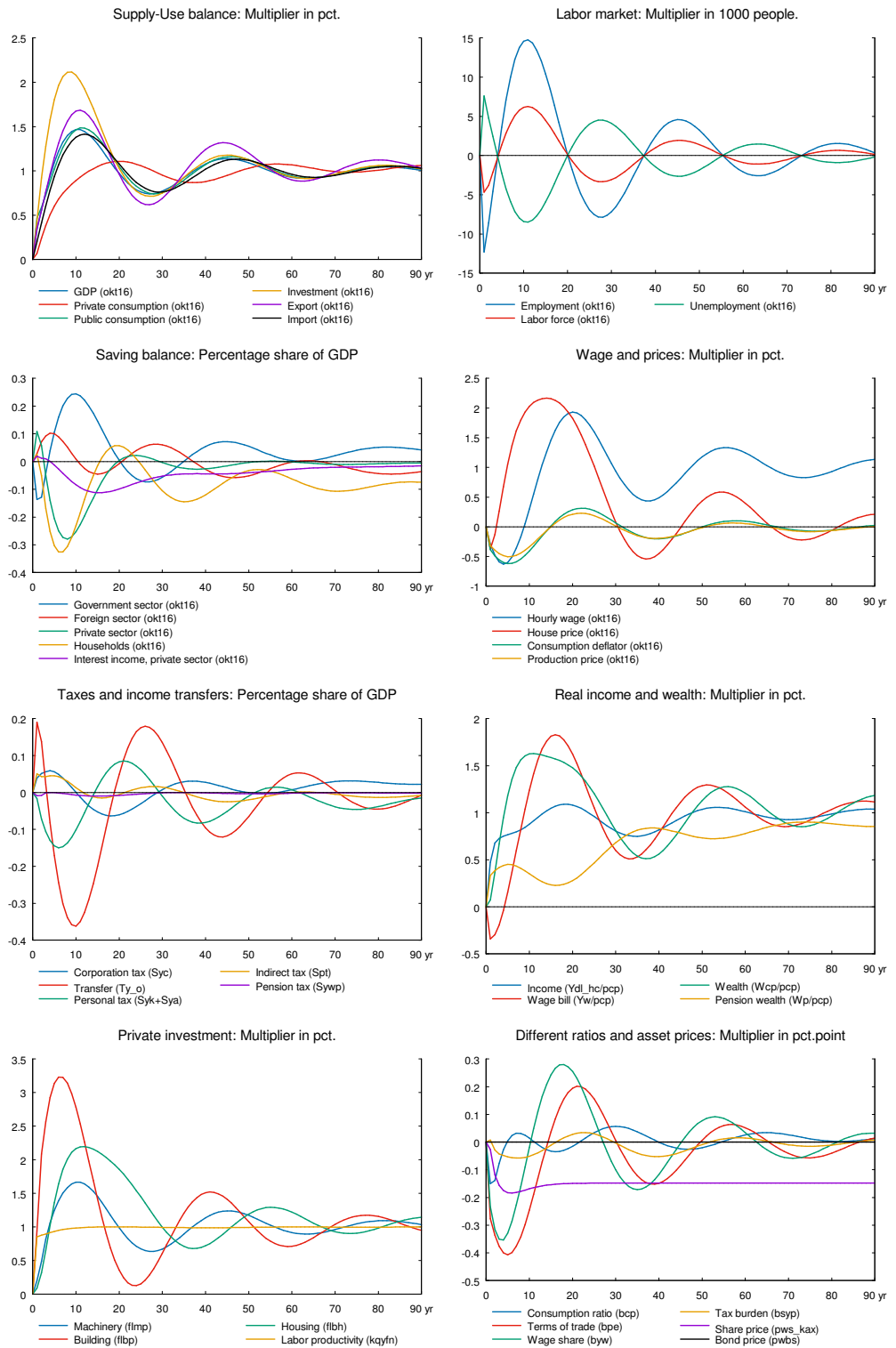
There is no special consideration for any particular types of employees such as part-time employee and self-employed. No special consideration on the average productivity, income distribution etc., all employees increase productivity by 1 percent irrespective of job types. Note also that some exogenous variables are increased by 1 percent to avoid composition effects.

Fewer employees can now produce the same amount of output, and as demand is unchanged in the short run, unemployment increases. The higher unemployment reduces wages and improves competitiveness. The improved competitiveness and the supply effects increase the demand for Danish goods in the long run, as a result unemployment returns to the baseline.

In the long run, income, consumption and GDP increase by 1 percent. Prices are in the long run unchanged, the 1 percent increase in productivity is translated into a 1 percent increase in (real) wages.

Public spending on social benefits increases immediately as unemployment increases. There is no need for additional taxes to increase the provision of public services by 1 percent, as productivity in the public sector increases. The higher public spending implies that public consumption and investment keep their relative size in GDP. In the long run, employment returns to the baseline, and expenditure on the unemployed disappears.

Figure 4. The effects of a permanent 1 % increase in productivity



3. Conclusion

With a supply elasticity of 1, a 1 percent increase in labor supply (number of workers, hours worked, productivity) raise income, consumption and GDP by 1 percent. If the supply elasticity is set to the estimated value of 0.7, the effect will be lower than 1 percent. But with no supply effects, the crowding out mechanism would have to be solely driven by changes in wages. The adjustment process will be slower. There will also be change in the relative factor prices leading to factor substitution. Domestic prices relative to foreign prices will also change leading to a substitution between domestic and foreign products.

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