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PALKANSAAJIEN TUTKIMUSLAITOS · TYÖPAPEREITA
LABOUR INSTITUTE FOR ECONOMIC RESEARCH · DISCUSSION PAPERS

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This paper is based on the Licentiate's Thesis approved at the University of Turku in 2009. In addition to my supervisor Professor Matti Virén, I would like to thank Eero Lehto and Jukka Pirttilä for their helpful comments. Financial support from the Yrjö Jahnsson foundation and Palkansaajasäätiö is gratefully acknowledged. Paul A. Dillingham has kindly checked the language.

PALKANSAAJA-SÄÄTIÖ

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Helsinki 2009

ISBN 978–952–209–066–9
ISSN 1795–1801

ABSTRACT

In this study, we scrutinize the effect of labour taxation on employment and growth. We also analyze the effect of other fiscal policy instruments, e.g. the effect of public spending. In this context, our special interest is in the fiscal policy simulations that are neutralized for the government budget. The analysis will be performed with a macroeconomic model (EMMA) developed at the Labour Institute for Economic Research. The study finds that a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by 0.58 and employment by 0.25 per cent in the long run. Also, a one percentage point decrease in the income tax rate which is neutralized for the government budget by reducing public purchases produces a long-run increase in GDP and employment of a similar magnitude, even though its short-run effect on both variables is negative.

Keywords: labour taxation, macro models, fiscal policy.

TIIVISTELMÄ

Tässä tutkimuksessa tarkastellaan työn verotuksen vaikutusta työllisyyteen ja kasvuun. Työssä analysoidaan myös miten muut finanssipolitiikan instrumentit, kuten julkinen kulutus, vaikuttavat talouteen. Erityisen kiinnostuksen kohteena ovat politiikkamuutokset, joiden vaikutus julkisen sektorin alijäämään neutralisoidaan sitomalla julkisen sektorin käyttäytyminen finanssipolitiikan sääntöihin. Analyysi tehdään EMMA-makromallilla, joka on kehitetty Palkansaajien tutkimuslaitoksessa. Tutkimuksen mukaan tuloveron alennus yhdellä prosenttiyksiköllä kasvattaa työllisyyttä 0.25 ja bruttokansantuotetta 0.58 prosenttia pitkällä aikavälillä. Kun samansuuruinen tuloveronalennus toteutetaan niin, että valtion budjetti tasapainotetaan julkisia menoja vähentämällä, saadaan yhtä suuri pitkän aikavälin vaikutus työllisyyteen ja bruttokansantuotteeseen. Veronkevennyksen vaikutukset ovat kuitenkin lyhyellä aikavälillä negatiivisia tasapainotetun budjetin oloissa.

Avainsanat: työn verotus, makromallit, finanssipolitiikka

1. INTRODUCTION

The government of Finland has gradually reduced the income tax level from the year 1997 until recently. During this period the income taxes of an average production worker have declined by nearly 8 percentage points. Since short-term tightening at the beginning of the 1990s, the employers' contribution rate to social security has also been reduced by the government. These reforms have produced a major decrease in the level of the tax wedge. One of the main arguments for the tax reductions has been to improve employment in Finland. However, there are practically no empirical Finnish studies for the subject that captures all the dynamic effects – both demand and supply side – of the tax cuts.

In this study for the Finnish economy, we aim to answer the question as to what degree tax reductions improve employment and economic growth. We also analyze the effects of other fiscal policy instruments, e.g. the effects of public spending. The analysis will be performed with the empirical macroeconomic model (EMMA) developed at the Labour Institute of Economic Research. EMMA is a quarterly model for the Finnish economy, which is based on Keynesian behaviour (output determined by aggregate demand) in the short run, but neoclassical (output determined by aggregate supply) in the long run. A substantial feature of the model is that it includes a relatively detailed description of the public sector. The parameters of the model are mostly estimated from data.

The effects of income tax reductions are first compared with those of simply increasing public purchases or working hours. Hence in these simulations fiscal policy changes are financed by increasing government debt. Yet another issue relating to our topic is how to balance the government budget. Thus, in our study, we especially examine budget-neutral changes in labour taxation and public expenditures (namely purchases and working hours). We also do an experiment by changing the structure of taxation. Again, the change in the tax structure is neutralized for the government budget. Finally, we do a sensitivity analysis for the parameter elasticities of the labour demand and wage formation.

The paper is organized as follows. Section 2 summarizes the empirical evidence from both domestic and international studies with an emphasis on the former. Section 3 presents the structure of our macro model used in the analysis. Section 4 peruses the results gained in this study, and compares the effects of various fiscal policy changes and discusses them. The final section concludes.

2. LABOUR TAXATION AND EMPLOYMENT

2.1. Overview

Traditionally, Finland has been among the countries where labour is taxed relatively heavily. However, the government of Finland has gradually reduced the average labour tax rates from the year 1997 until recently. During this period the taxes of an average production worker have declined by nearly 8 percentage points. Since short-term tightening at the beginning of the 1990s, the employers' contribution rate to social security has also been reduced by the government. One of the main arguments for these tax reductions has been to improve employment in Finland.

Figure 1. Income tax rate (%) of an average production worker.[1]

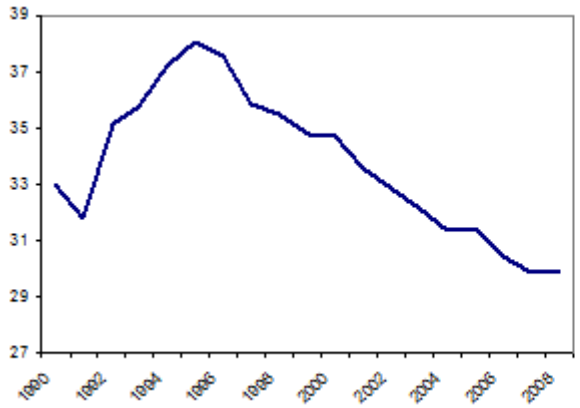
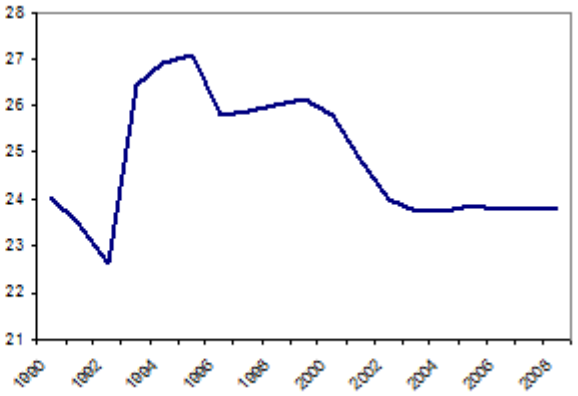


Figure 2. Employers' contribution rate (%) to social security.[2]



At the same period, the Finnish economy first confronted a deep depression at the beginning of the 1990s. Since then, the economy has recovered rapidly when the old structures have given room to the new branches of industries. At this period, unemployment first rose from 3% up to 17 % but then has decreased below the average European level. Hence in Finland we can see gradual reductions in the tax wedge and rapid economic growth at the same time.

[1] Employees' contribution to social security included. Source: VATT.

[2] Source: VATT.

Figure 3. Employment (1000 persons).

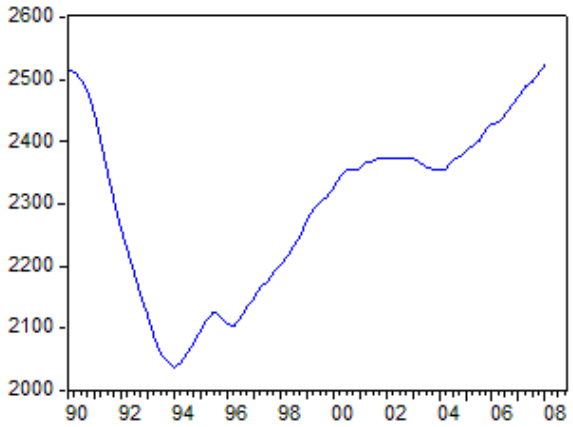
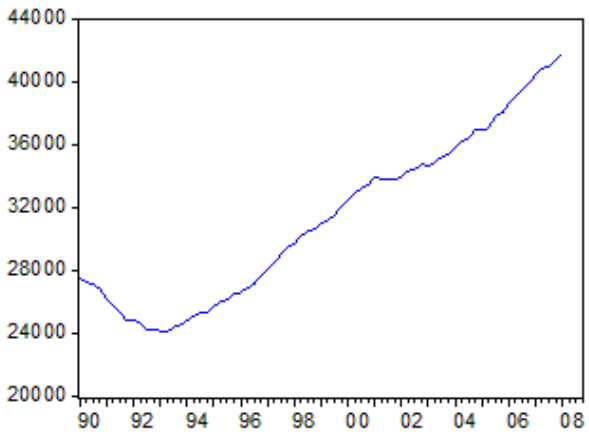
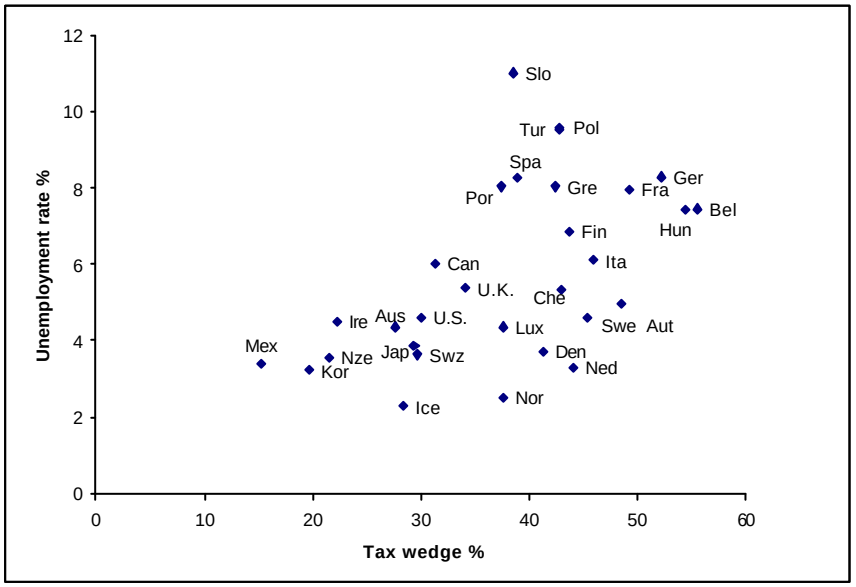


Figure 4. GDP (quarterly, 2005 prices).



In general, we know that there are huge differences in unemployment and labour taxation levels between OECD countries. This can be verified from the following figure, which shows a country's unemployment rate and tax wedge.[3]

Figure 5. Unemployment and tax wedge in OECD countries.[4]



[3] Tax wedge = employer's contribution rate + income tax rate of an average production worker. More or less broader definitions for the tax wedge may also be used; for instance, consumption taxes are ometimes included in the wedge.

[4] Source: OECD database.

Some economists, for instance Prescott (2004), argue that the main reason for high unemployment in Europe is the distortive effects caused by the high tax level. On the basis of the figure(s) 1-5, Prescott's point appears attractive. However, it is more sensible to explain the improvement in Finnish employment by the good international economic trends and some kind of creative destruction caused by the recession. Also, when scrutinizing figure 5 more carefully, one observes countries like Denmark and the Netherlands that have high taxes but low unemployment. The next chapter gives a survey of the empirical evidence of the impacts of the tax cuts. The stress is on the studies for the Finnish economy.

2.2. Empirical evidence

The impact of taxes on employment has been scrutinized in several studies. A large number of international studies about the subject have been done with panel data. The basic idea in these studies is to explain the changes in employment and unemployment by the changes in the tax level. Recent studies have discovered that taxes have an effect on employment in the long run. Nickell (2004) summarizes the results from different studies and argues that a 10 percentage point rise in the tax wedge reduces labour input by somewhere between 1 and 3 per cent. An average point estimate such as 2 per cent is relatively small but by no means insignificant. However, this is no consensus result, and, for instance, Nickell himself (2004) stresses the short-run effects of the tax cuts. Also, one has to remember that considerable differences as regards the level or the structure of taxation make the comparison between countries complicated.

Another outcome from international research is that taxes affect employment more in continental Europe where trade unions are strong but wages are negotiated independently. In these countries, trade unions are able to push taxes into wages. Instead, research finds that taxes affect employment modestly in countries like Finland where wages are negotiated co-ordinately between trade unions and employers' organizations (Koskela, Pirttilä, Uusitalo 2004.).

In Finland, the impact of taxes on employment has typically been examined in times series and labour supply studies. One of the recent time series studies is Honkapohja, Koskela and Uusitalo (1999). In this study the wages are explained by a so-called trade union model estimated for each sector separately. Sinko (2002) exploits the estimates of Honkapohja et al. (1999), and calculates that the tax cuts made from 1997 onwards explain 10% of the employment growth in the Finnish economy in the period 1997-2002. Laine & Uusitalo (2001) concentrate on labour supply in their study. In this study, the effect of incentive reforms on labour supply and the benefits from working are examined. The results are that the effects of incentive reforms are small but distinctly positive.

To capture the dynamic effects of tax cuts, Alho, Kaitila & Kotilainen (2006) construct a computable general equilibrium model of the Finnish labour markets and the economy. The results of the study show that tax policies alone are not a sufficient way to enhance employment because the expansionary and contractionary effects of average tax reductions often neutralize each other. However, in this study, tax cuts do not affect the demand side of the economy.

Kilponen & Vilmunen (2007) scrutinize the effect of budget-neutral income tax cuts with the Bank of Finland's dynamic general equilibrium macro model (AINO). In their study, the income tax cuts are financed by a rise in the value-added tax rate. They find that one percentage point decrease in income taxes raises the output more than 0.5 per cent and employment 0.25 per cent in the long run. They also find that the value-added tax-compensated increase in the income transfers decreases output and employment in the long run. In Kilponen & Vilmunen (2007) income tax changes mainly have an effect via labour supply. This is due to the theory-based DSGE model they use.[5]

Although they do not concern Finland, some recent studies are worth mentioning from the point of view of our analysis. Coenen & McAdam (2008) use a dynamic equililibrium macro model (NAWM) to examine the effects of reducing labour-market distortions caused by tax structures in the Euro area. They find that lowering tax wedges in the Euro area to levels prevaling in the United States would lead to a rise in hours worked and output by more than 10 per cent in the long run. Blanchard & Perotti (2002) use a mixed structural VAR/event study approach to characterize the dynamic effects of shocks in government spending and taxes in the United States in the post war period. The study finds that in most cases the (Keynesian) multipliers are small, often close to one. Romer & Romer (2007) use the narrative record to identify the size, timing, and principal motivation for all major postwar tax policy actions. They find that the effects of tax changes are strongly significant, highly robust, and much larger than those obtained using broader measures of tax changes.[6]

Sinko (2002) states that in order to get reliable estimates of the effects of tax cuts in Finland, a large econometric framework that includes the essential causalities should be used. Also, Böckerman & Jäntti (2004) argue that is a mistake to focus the discussion that addresses employment policies on only labour supply. In their study they examine the role of supply and demand factors in individual-level hours of work, using panel data on workers in Finnish manufacturing industries from 1989 to 1995. The result of their study is that demand really matters. They argue that empirical results that neglect variations in labour demand may give biased estimates of the labour supply response to tax

[5] See also Kilponen & Ripatti (2006).

[6] The Joint Committee of Taxation (2006) reports the work they have done to build a macroeconomic model best suitable for the purpose of analyzing tax-level changes. Finally, they estimate the effects of tax reforms with both the standard neoclassical macroeconomic model and the computable equilibrium model. When the simulations are made with the former, in the long run, the amount of growth predicted by a tax cut is crucially dependent on whether the tax cut is debt-financed, or financed by a cut in spending or a future increase in taxes.

reforms. The motivation for our study comes from these arguments: we use a macroecometric model to capture all the dynamic effects of the tax cuts, and, also, our model captures both the demand and the supply-side effects of the tax changes.

3. THE METHODS

3.1. One-equation models vs. macro models

The effect of taxes on employment is examined in most studies in the framework of a one- or two-equation model. For instance, Prescott (2004) captures the effects of taxes on employment by calibrating the parameter values in the labour supply equation derived from the household maximization problem, and then uses it to generate labour supply for seven OECD countries, whereas in a basic time series study Honkapohja, Koskela and Uusitalo (1999) scrutinize the effects of tax cuts on the basis of two equations. First, they express the wage formulation by the following function:

$$w = g(p, q, b, 1-t, 1+s, u) \tag{1}$$

where p is the consumption prices, q is the producer prices, b is the outside option of the unemployed, t and s are tax parameters for employee and employer, and u is unemployment. In the same way, labour demand is a function:

$$L = h\left(\frac{w(1+s)}{q}, \frac{r}{q}, z\right) \tag{2}$$

where z is the exogenous demand variable that is independent of prices, and r symbolizes interest rates. Honkapohja et al. (1999) estimate equations (1) and (2) in a dynamic form for ten sectors of the economy. After one knows the elasticity parameters in these two equations, the effect of the tax change on employment can easily be calculated.

Coenen & Adam (2008) criticize Prescott's approach by stating that it "neglects the intertemporal aspects associated with capital accumulation, the acquisition of foreign assets and the presence of nominal and real rigidities. It also disregards the effects of changes in both domestic and international relative prices. As a result, it ignores several important margins and does not provide insights into the transitional dynamics triggered by reductions in the tax wedge. Moreover, it neglects other important

factors that influence labour-market outcomes in reality such as distortions arising from monopolistic competition and other institutional factors that would increase the real wage above the competitive level".

As well as Coenen & Adam (2008), we study the effect of taxes on employment, using a macro-economic model. Unlike the one- or two-equation approaches just described, macromodels try to capture the whole functions of the economy. However, unlike Coenen & Adam, our study uses a macroeconometric model, not a microtheory-based DSGE macromodel. The following section reports the structure of our macromodel. The first-version of the model was also reported in Lehmus (2007), and the next chapter follows the analysis presented there.[7] Because of our topic, extra attention is paid to explain how tax parameters are introduced in the model system.

3.2. The model

The basis of our model structure is Keynesian, although the treatment of the supply side and prices is based on neoclassical economic theory. For this reason the model can be seen to follow the standard routes of neoclassical synthesis. The model is backward-looking in the sense that it uses historical data. The parameters of the equations are mostly estimated.

The model consists of 77 endogenous and 72 exogenous variables. In the core are behavioural equations, the number of which is 17. The public sector identities, in particular, enlarge the model. The level of aggregation in the model structure corresponds to many recently built macromodels: the economy consists of two blocks, the private and public sector. The equations of the model can be divided into four blocks: production function and factor demand equations, aggregate demand equations, price and wage equations, and public sector identities. The production function is modelled with the conventional Cobb-Douglas function. The model also includes the output gap, which is based on the NAIRU rate. The NAIRU rate is assumed to depend on long-term unemployment.

The model equations are estimated with OLS (ordinary least squares). The long-run equilibrium relationships and short-term dynamic corrections of the behavioural equations are estimated using an error correction model (ECM) framework. From the point of view of time-series analysis, these correspond to the two-stage Engle-Granger (1987) method.

The most demanding part in modelling the Finnish economy in the period 1990-2007 is the deep recession in the years 1991-1994. Owing to the recession, it is difficult to get reasonable estimates for the coefficients of the equations. To solve this problem, we use the Kalman filter to estimate a time-

varying parameter included in the scale of the production function. This parameter is used later on as a ”recession dummy” variable in many model equations. In this way the shock caused by the recession is controlled. The solution can be regarded as an indispensable compromise to deal with one of the deepest recessions in western countries during modern times. Other methods, for instance the use of different dummies indicating structural change, would have probably led to impractical and complicated applications. This novel feature also brings this traditional model closer to the new, calibrated macromodels.

The relation of the tax wedge to all the model variables is carefully considered. The income tax rate, which is the main exogenous policy variable in the analysis, directly affects the standard private wage rate index, the households' disposable income, labour supply, and the public sector tax revenues. Thus, all its relevant effects are captured.

3.2.1. The Data

The data of the macroeconomic model covers the years 1990-2007. We use quarterly data that is based mainly on the national accounts of Statistics Finland. Other data sources have been the Bank of Finland, VATT (the Government Institute for Economic Research), Eurostat, and the World Bank. Eurostat and the World Bank have been used to collect the data from foreign countries; the money and interest rate series come from the Bank of Finland. The tax rate data is based on the calculations of VATT. The seasonally unadjusted series have been adjusted with the Tramo/Seats method.

The data not available quarterly but only yearly has been disaggregated with the help of relevant reference series. This has been done with the Ecotrim program developed in Eurostat. The model system operates in the Eviews environment but some calculations, mainly concerning the public sector and the foreign environment, have been done outside the actual model. These ”satellite calculations” are found in Excel. Chapters 3.2.3 and 3.2.5 will illustrate the public sector and foreign sector calculations further.

3.2.2. The production function and potential output

The problem regarding the optimal production function form is widely discussed in the literature. The familiar question is: Should it be the CES or the Cobb-Douglas function?[8] In our case, it turned out to

[7] Lehmus (2007) also reports the full details and equations of the (EMMA) macro model.

[8] The explicit form of CD is $Q = A(L^{b}K^{1-b})$. CES is $Q = Ae^{lt}\left[\left(dK^{\frac{s-1}{s}} + (1-d)L^{\frac{s-1}{s}}\right)\right]^{\frac{s}{s-1}}$

be more convenient to operate with the Cobb-Douglas function. The Cobb-Douglas function is a special case of the CES function in which the elasticity of substitution between labour and capital is unity. It is assumed that the technical development is Hicks-Neutral and the returns to scale are constant. Nevertheless, the deep recession in Finland in the early years of the 1990s causes a fall in production and other volumes. To solve this problem, we estimate a time-varying parameter with the Kalman-Filter in the scale of the production function. In our production function this parameter indicates a negative technological shock. Later on, this parameter is used as a dummy in many model equations to control the deep recession.

The factor shares of the production function have been calibrated so that the share of labour is assumed to be 0.6 and that of capital 0.4.[9] The final form of the production function in our model is then:

$$VAQP = Ae^{GF*t}\left((LHP)^{0.6} KP^{1-0.6}\right) \tag{3}$$

$VAQP$ is the volume of production in the private sector, LHP denotes private labour (in hours worked), and KP is the net capital stock of the private sector. A is a parameter of scale and t is a trend. GF is the Kalman-filtered coefficient of the trend. GF falls in the recession but is constant during the last years when it obtains the quarterly value of 0.006, which means 2.4% technical progress in a year.

When we consider the CES production function, the first-order conditions with respect to capital and labour lead to the following demand equations:[10]

$$\log(KP) = k_0 + \log(VAQP) - s\,\log(UCC) + l(s-1)t \tag{4}$$

$$\log(LHP) = n_0 + \log(VAQP) - s\,\log(WPQ) + l(s-1)t \tag{5}$$

where UCC is the user cost of capital and WPQ is the real (product) wage. To formulate explicitly: $k_0 = s\,\log\left((1-d)A^{\frac{s-1}{s}}\right)$ and $n_0 = s\,\log\left(dA^{\frac{s-1}{s}}\right)$. Thus, the constant terms are functions of the

[9] This is a standard assumption in economic theory.

[10] See, for instance, Szeto (2001). We derive the factor demand equations from the CES function to illustrate its relation to the Cobb-Douglas function.

parameters of the production function. In the Cobb-Douglas case, the elasticity parameter of s should be unity.

Defining the user cost of capital (UCC) is ambiguous. The complexity of the definition is studied, for instance, in the pioneering work of Jorgenson (1963).[11] The main issue is that the user cost of capital can be calculated in many ways, depending on how we define the relative price and the real interest rate of capital. Another problem, at least with the Finnish data, is the volatility of the series. In our model, the user cost of capital is as follows:

$$UCC = (pi / pqp) * (r10 * 0.01 - \log(cpi / cpi(-4)) + depr), \quad (6)$$

where UCC is the user cost of capital, pi is the investment deflator, pqp is the private sector value added deflator, $r10$ is the interest rate, cpi is the consumer price index and $depr$ symbolizes the depreciation rate of private capital.

To obtain a reasonable estimate for capital formation, we model investments instead of capital stock. Yet the net capital stock is endogenous and depends on investments. We also model the "real investments", meaning the domestic investments plus net direct investments abroad. To put it explicitly, the dependent variable in the investment equation is $IPQ + 0.25(DI / PI)$, where IPQ is the private investments, DI the direct investments abroad in current terms, and PI the private investment prices. This formulation implies that the direct investments abroad display the domestic investments, although with a relatively small weight (0.25).[12]

The labour demand equation (5) is important in our analysis of the effects of tax reforms on employment. A tax change affects the total demand and the real wage, at least temporarily. We obtain the elasticity of real (product) wages as a value of 0.21 (parameter s in equation (5)). Although this estimation result is not fully consistent with the Cobb-Douglas assumption, i.e. s =1, we allow this deviation.[13] However, the estimated elasticity for private value added is close to unity. Kiander, Vilmunen & Viren (2005) find slightly bigger estimates in their study that uses micro data, and so do Honkapohja et al. (1999). Later on, we do a sensitivity analysis for the wage elasticity to check the robustness of the results for a different parameterization.

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[11] See also Chirinko (1993).

[12] The studies of the relationship between outward foreign direct investment and domestic investment produce different results. Sauramo (2008) finds a one-to-one trade-off in his study with Finnish macro data.

[13] Note also that the elasticity found is typically lower in macro studies.

The production function gives the private sector supply. The output gap is also included in the model structure. We assume that potential output is defined by the NAIRU rate; the NAIRU rate is derived from using data on the long-term unemployed. The result is a time-varying series, flatter than the actual unemployment rate series, but a series which is still affected by the economic recession at the beginning of the '90s. NAIRU is exogenous in our model. Hence, the output gap constructed actually mimics the difference between unemployment and long-term unemployment. The output gap of the private sector also represents the output gap of the whole economy, while the public sector size (working hours) is regarded as an exogenous policy instrument.

We also model the labour supply. Among the demography variables it is typical that the labour supply equation includes the so-called discouraged worker effect in the form of the unemployment rate. In our model, (lagged) employment is used as a proxy for labour market opportunites for a job seeker. The labour supply is also explained by the tax wedge, which has a negative effect on the participation rate in the labour markets. WEDGE consists of the tax rate of an average production worker and the worker's and employer's contribution to social security, and also the consumption tax rate. Hence, we use a broad definition for the wedge variable, in which all the relevant tax rates are included. The broad definition for the wedge variable is motivated by the standard derivation result for the labour supply of a utility-maximizing household (e.g. Prescott (2004)). The labour supply equation resembles the following:

$$\log(LS) = h + b\log(POP1564) + (1-b)\log(LN(-2)) + d(WEDGE) \qquad (7)$$

where POP1564 is population in the age range 15-64, LN is total employment and WEDGE is the wedge variable just discussed. The estimation gives the coefficient for the wedge a value of -0.04, according to which the labour supply is quite inelastic with respect to the tax wedge.

Despite the well defined supply, the basis of the model is Keynesian; demand defines the output in the short run. Nevertheless, because the prices and wages depend on the output gap (the difference between unemployment and long-term unemployment), demand equals supply in the long run.

3.2.3. Aggregate demand

Aggregate demand consists of consumption, investments, and net exports. We begin with household consumption. There are assumed to be two different consumer groups in our model: those who are liquidity constrained and those who are not. The consumption of the former group depends on disposable income, whereas people in the latter group maximize their utility intertemporarily and their consumption follows the predictions of the permanent income life-cycle hypothesis. For the latter

group, consumption follows the changes in their wealth, though, for the former group, consumption does not straightforwardly follow their disposable income either, as their consumption depends on the history of their disposable income, too. To put this analysis formally, we have a convex combination of the following kind:

$$CQ = l\left((YHQ_t / PC_t + YHQ_{t-1} / PC_{t-1} + ... + YHQ_{t-6} / PC_{t-6}) / 7\right) + (1 - l)\,HW\,, \tag{8}$$

where CQ is the private consumption, YHQ symbols the disposable income, PC is the deflator of consumption and HW is the real wealth. The estimation results give the parameter l a value of 0.9. The household wealth is assumed to follow the apartment prices index. We can motivate the use of the apartment price index with the fact that the wealth of Finnish people mainly consists of apartments. Also, compared with other indicators, for instance the stock prices, this indicator is clearly more plausible.[14] The former analysis only concerns the private sector. For public consumption there is no behavioural relation; it is modelled as an identity which sums up real wages paid in the public sector and government purchases (residual term).

For export and import, long-run homogeneity in terms of scale variable(s) has been imposed on the equations. Import is modelled as a convex combination of domestic demand and export volume. The connection from export to import is based on the fact that export industries use a lot of imported inputs. Both export and import are also affected by the price term which measures the price competitiveness of export and import items in their markets. Thus, the import volume is affected by the ratio between the import prices and the domestic value added prices, and, the export volume by the ratio between the export prices and the foreign prices.

Still, there are some special features of our export equation that are worth mentioning. Foreign demand reflects the weighted average of the GDPs in the most important countries for Finnish exports. Respectively, the foreign price level, the determinant of the evaluated price competitiveness, is obtained from the weighted average of the import prices of these countries. In this calculation import prices are converted into euro denomination units. Exports are then modelled:

$$\log(XQ) = a + \log(IMU30) - g\,\log\left(\frac{PX}{PWI30}\right) + k\,(GF), \tag{9}$$

[14] See Mayes & Virén (2001).

where XQ is the export volume, $IMU30$ is the combination of the gross domestic product of 30 countries and $PWI30$ is the combination of the import prices (in euros) of the same countries. PX is the domestic export prices and GF is the recession dummy described earlier.

3.2.4. Prices and Wages

All variables that determine GDP on the demand side are expressed in real and nominal values. For that reason, we also need to model the prices. The price block in our model is based on the law of one price. Thus, static homogeneity has been imposed, which is equivalent to expressing the long-run equations in terms of relative prices.

Prices are usually combinations of (private) value-added prices and foreign/import prices. The weights of individual prices have been estimated from data in all but the investment and consumption price equations. In these equations the weights have been calibrated. It is assumed that PWI30 defined in the previous chapter approximates to the foreign prices. Despite the fact that PWI30 also explains the export price level, our export price equation's fit in terms of R2 remains rather poor. In the price block, there is a connection from wages to other prices: private value-added prices are assumed to follow private sector wages (positively) and average productivity (negatively). Then, private consumption prices react to the changes in the value added prices. This induces a degree of sluggishness in the response of private consumption prices to changes in the wage rate.

In addition to the private value added and import prices, the private consumption prices are also affected by the (effective) value added tax rate. Thus, a private consumption prices equation is the following:

$$\log(PC) = l + b\log(PQP) - (1-b)\log(PM) + d(ALV) + gt, \qquad (10)$$

where PC is the private consumption prices, PQP is the private value added prices, PM is the import prices, ALV is the value added tax rate, and t is the trend. We calibrate parameter b to the value of 0.7, and thus consumption prices are mainly affected by the domestic price level (PQP). The estimation gives d a value of 0.9 which, means that consumption prices respond sharply to a change in the value-added tax rate.

Traditionally, wages are modelled with the Phillips curve relationship (1958), in which wages depend on the previous period's inflation and output gap. We notice that wage formation in Finland contains the familiar Scandinavian features: wages are negotiated in a centralized way together with employer

and employee organisations and the government.[15] As a result, wages are quite rigid and inelastic. This is why we first model the wage drifts, and the equation for them is as follows:

$$\log(WRP) = a + \log(PWS) + b\log(PROD) - g(UGAP) - m(DI / IPV(-1)), \quad (11)$$

where WRP is the private wage rate index, PWS is the standard private wage rate index, $PROD$ the productivity of labour, $UGAP$ the unemployment gap, DI the net direct investment abroad (in current prices) and IPV private investments (in current prices). Thus, the unemployment gap, i.e. the difference between unemployment and long-term unemployment, affects wages negatively. The last term, net direct investments abroad as a share of private investments, demands further explanation. Despite the rigidities in Finnish wage formation it has been assumed that direct investments abroad create a negative pressure on domestic wages. According to the data the impact is rather small, but statistically significant.

To capture the labour market effects properly, we also endogenise the standard private (gross) wage rate. It is modelled using a partial adjustment model where the standard private wage rate index is explained by the combination of its lagged value and the private consumption prices, the unemployment gap, and the tax wedge. The equation is as follows:

$$\log(PWS\_Q) = a + b * \log(PWS\_Q(-1)) + (1-b)\log(PC(-1)) + g(UGAP) + m(WEDGE2), \quad (12)$$

where PWS_Q is the standard private (gross) wage rate index, PC the private consumption prices, and $UGAP$ the unemployment gap. As regards the unemployment gap, we use a one-year moving average. The coefficient of the tax wedge obtains an estimate of 0.036. Because the equation includes a lagged dependent variable with its coefficient calibrated to 0.95, the long-run multiplier of the wedge variable can be calculated by a standard formula: $m/(1-0.95)$. This means that, in the long-run, a one percentage point increase in the tax twedge puts the standard private (gross) wage rate index up by approximately 0.7 percent. The elasticity gained is a little higher than that of, for instance, Honkapohja et al. (1999) but because of the partial adjustment model structure it takes time for wages to adjust.

[15] However, employer organizations are talking of decentralizing the currect system to decrease rigidities.

In equation (12) we have a wedge variable which includes the tax rate of an average production worker and the employer's and employee's contribution to social security. Hence, it has to be noted that the wedge variable is narrower than that in (7) because it does not consist of the consumption taxes. Nevertheless, the consumption taxes are also included in the model system through the consumption price equation (10).

3.2.5. Income accounting and the public sector

The public sector, its revenues and expenditures, is mainly modelled with identities. The same applies to the income accounting of households. To avoid making the model system too complicated, some identities have been constructed outside the model. For instance, employers' contributions to social security were originally calculated in Excel by adding up the employer's actual and imputed social contributions.

When the public sector and income accounting identities were being constructed, the main aim was to make them consistent with the national accounts data. The identities also describe the legal and institutional framework of the public sector. Public sector linkages are important in all policy simulations. In the public sector, behavioural equations are estimated only for value added, wages, and consumption prices. Still, this is not the whole truth, since the parameters in the public sector identities are usually estimated from the data. The residual terms received from the estimations are added to the public sector identities. The typical form of a public sector identity then is

$$\log(TAXQM) = a + b\log(ALV * CV) + RESID, \tag{13}$$

where $TAXQM$ denotes the production and import taxes collected by the public sector. They depend on current private consumption (CV) and the value added tax rate (ALV); the parameter b has been estimated from the data. $RESID$ is the residual term which makes the right side of the equation consistent with the left side.

Several items constitute the income accounting of households. When analyzing the labour tax effects, our interest is in particular in the instant taxes paid by households. Through this link the direct taxes affect the private consumption, and also the total demand in the economy. The income taxes paid by households are modelled as an identity-type equation that combines both the property income and the earned income. The equation is as follows:

$$(TAX\_IN) = a + b(TAX\_APW * EARN) + TAX\_K * PROP + RESID, \tag{14}$$

where TAX_IN denotes the income taxes paid by households, TAX_APW the earned income tax parameter, $EARN$ the earned income tax base, TAX_K the capital tax parameter, and $PROP$ the property income. The estimation results give the parameter b a value of 1.19 because of the progressive income tax system.

4. THE EFFECTS OF THE TAX CUTS[16]

4.1. Debt-financed fiscal policy changes

We begin by analyzing the effects of various fiscal policy shocks with no policy rules. First, we simulate one percentage point permanent decrease in the income taxes of an average production worker. The shock affects the economy through the following path. First, it decreases the wage pressures in the wage negotiations because the trade unions notice the cut in the income tax. The labour supply also increases, which raises the potential output in the economy and reduces the wage claims of the trade unions. As a consequence, the domestic price level declines, which improves the competitiveness of the export sector. The tax reduction also has a pure consumer demand effect while it increases the real disposable income of households and in that way boosts private consumption. The demand effect has an opposite, namely inflationary, effect on prices, but this effect is dominated by the supply side effects. Hence, in the long run, employment is 0.25 and GDP 0.58 per cent higher when compared with the baseline solution. On the other hand, the tax reduction increases the government deficit and raises the government 10-year bond to some extent.

We also simulate a five per cent shock to government purchases.[17] The shock has a standard demand effect on the economy: it increases employment and GDP sharply in the short run. However, this leads to inflationary pressures which make the prices rise in the long run. As a result, the shock's positive effect decreases in the long run. The government deficit also grows and the government ten-year bond rises as a result of the shock.

Then, we simulate a five per cent shock to the public sector working hours.[18] It tightens the labour markets, and then puts pressures on wages in the wage negotiations and leads to inflation. This weakens the competitiveness of the export sector and crowds out activity in the private sector.

[16] We make a *permanent* change to an exogenous variable in all the simulations.

[17] Five per cent permanent increase in the level of the public purchases.

[18] Five per cent permanent increase in the level of the public sector working hours.

Nevertheless, even if private employment decreases, the shock's effect on total employment stays positive. Also, the public sector deficit is not so adversely affected in response to the shock in the short run. However, the shock has quite harmful effects on GDP (and also the budget deficit) in the long run.

Table 1. Long-run effects of fiscal policy shocks.

	Income tax cut	Increase in public purchases	Increase in public hours
Employment	+0.25 %	+0.03 %	+1.06 %
GDP	+0.58 %	+0.04 %	-1.13 %
Prices	-0.48 %	+0.29 %	+3.90 %
Government deficit	-0.79 % (unit)	-0.92 % (unit)	-1.06 % (unit)

Fiscal policy shocks

Figure 6. GDP effects.

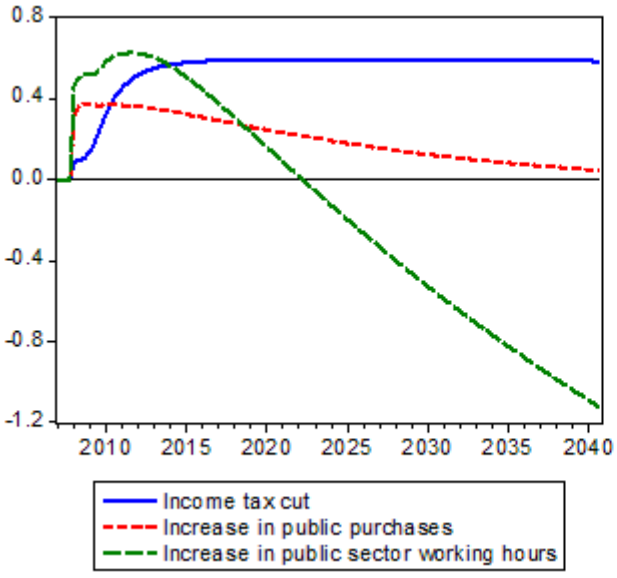


Figure 7. Employment effects.

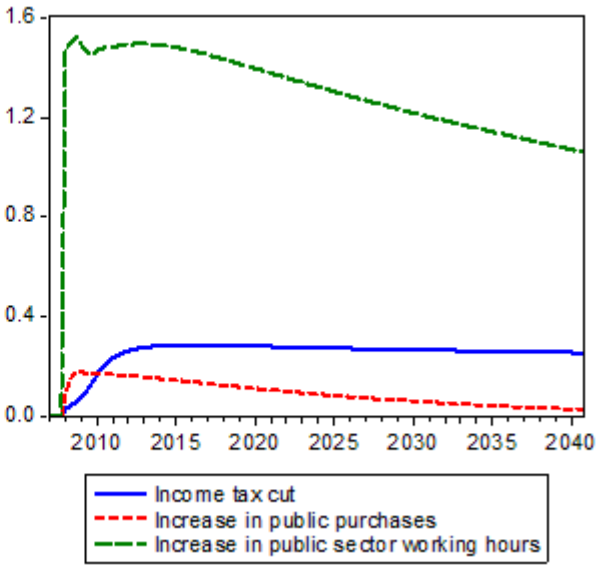


Figure 8. Price effects.

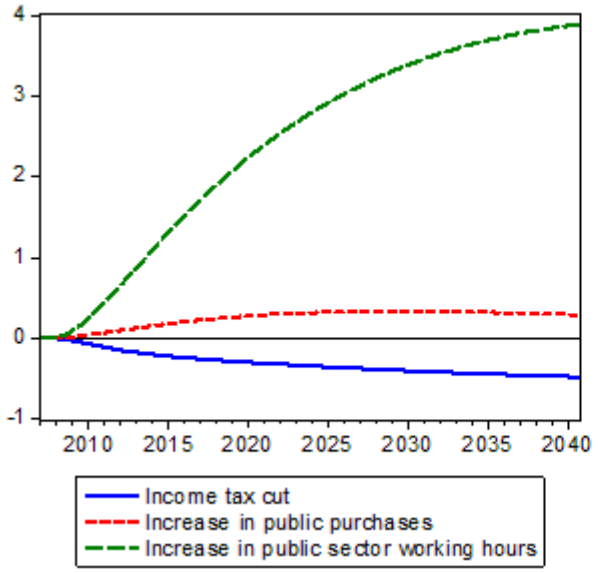
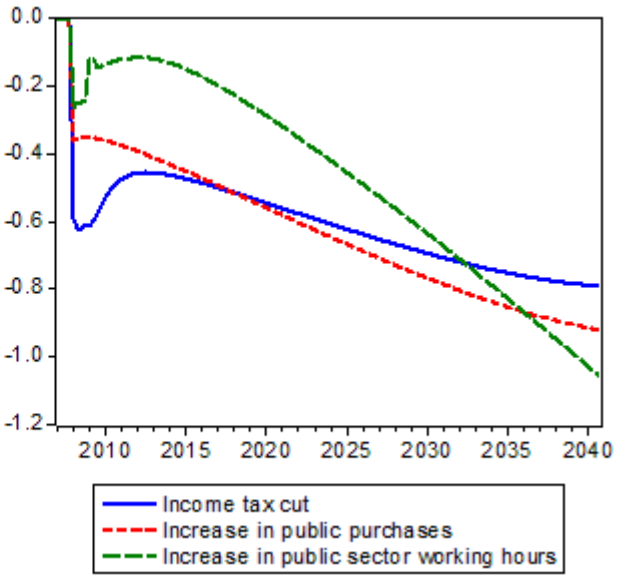


Figure 9. Government deficit effects.



4.2. Budget-neutral changes

4.2.1. Fiscal policy shocks with policy rules

In the previous simulations we did not consider how to finance the fiscal policy changes. Thus we had no policy rule; the government deficit was allowed to alter freely. Next, we scrutinize the effect of an income tax cut when the government deficit has been bound to a simple public spending rule which makes the changes in taxation budget neutral. Thus the fiscal rule is the following:

$$GQP * PG = GQP(-1) * PG(-1) + T14(-1), \tag{15}$$

where GQP denotes the real public purchases, PG is the public consumption prices, and T14 is the public sector budget deficit (a positive value means a surplus) in current terms.

Now, a one per cent permanent reduction in the income tax rate which is neutral for the government budget due to the reduction in public spending has both the effects just described above. The effect of the decrease in public purchases is sharper in the short run and thus employment and GDP first decrease as a result of the shock. However, as seen above, the demand effect decreases in the long run and the effect of the tax reduction that improves the potential output of the economy starts to dominate. As a result, both employment and GDP increase, 0.24% and 0.57% each in the long run, in response to the cut in income tax (compensated by a reduction in public purchases). Both the income tax cut and the reduction in public purchases affect prices and wages negatively; this is first due to the

looser labour markets and, later on, when employment is improved, due to the fact that the trade unions are interested in employees' post-tax wages.

Budget-neutral income tax cut

Figure 10. GDP effect.

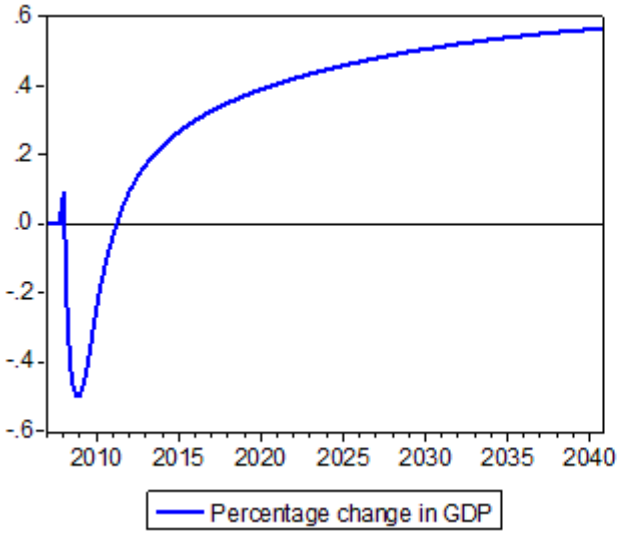


Figure 11. Employment effect.

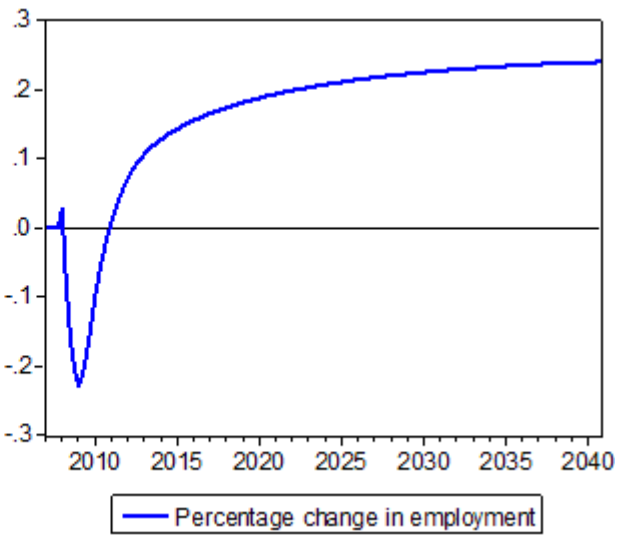


Figure 12. Price effect.

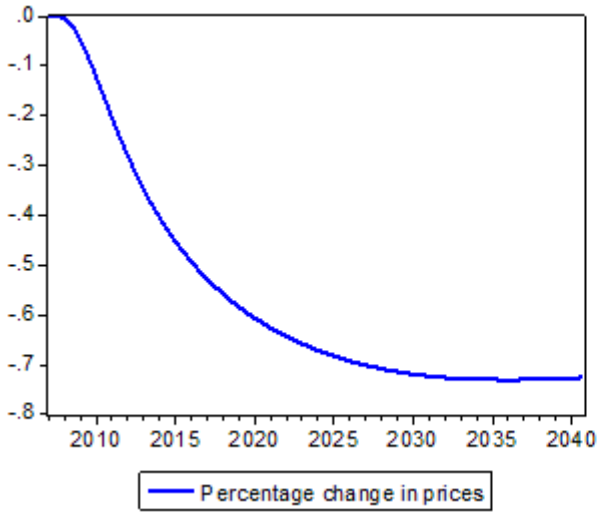
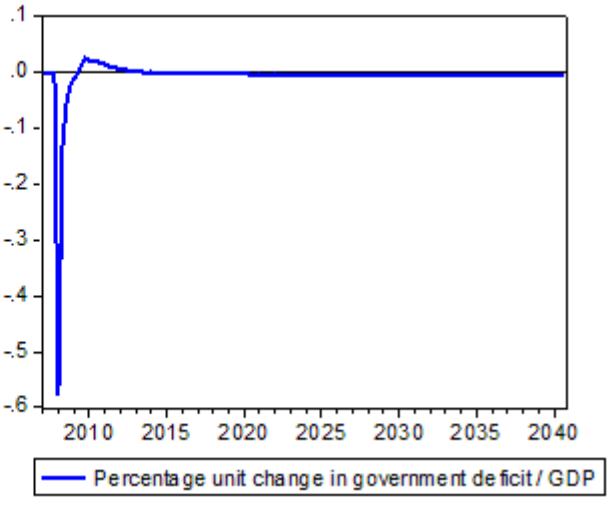


Figure 13. Government deficit effect.



Alternatively, fiscal policy rule may be bound to a tax rule, in contrast to the public spending rule above. Thus, we formulate a simple tax rule which looks like the following:

$$TAX\_APW = TAX\_APW(-1) - \left(T14/GDPV\right)*100 \qquad (16)$$

where TAX_APW denotes the income tax rate of an average production worker, T14 is the public sector budget deficit (a positive value means a surplus), and GDPV is gross domestic product in current terms. Now we simulate a 5 per cent[19]decrease in public purchases. A decrease in public purchases allows the government to lower income taxes. Although we have a different fiscal policy rule, the effect of the shock looks similar to that seen above. Again, a reduction in public spending affects the economy more sharply in the short run. But in the long run, the income tax cuts lower the wage pressure in the wage negotiations and increase the labour supply, which produces a long-lasting supply side effect. Thus, the effects are similar regardless of the type of fiscal policy rule, i.e. whether it is bound to public spending or taxes.

We also introduce a 5 per cent[20] decrease in public sector working hours, which is compensated by lowering income taxes. This slows inflation as the pressures on wages in the wage negotiations decrease. The competitiveness of the export sector is improved, and the effect of the shock on GDP is beneficial in the long run. However, the decrease in the public sector working hours is not totally compensated by the positive effects in the private sector labour hours. This is why employment (also) decreases in the long run in response to the shock.

Table 2. Long-run effects of fiscal policy shocks (with fiscal policy rules).

	Income tax cut (p. spending rule)	Decrease in public purchases (tax rule)	Decrease in public hours (tax rule)
Employment	+0.24 %	+0.27 %	-0.66 %
GDP	+0.57 %	+0.63 %	+1.9 %
Prices	-0.73 %	-0.88 %	-4.38 %

[19] of total public purchases .

[20] of the total public sector working hours.

Fiscal policy shocks (with fiscal policy rules)

Figure 14. GDP effects.

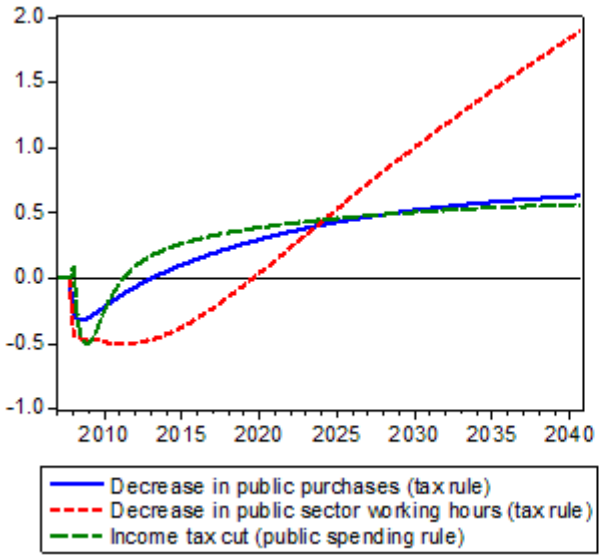


Figure 15. Employment effects.

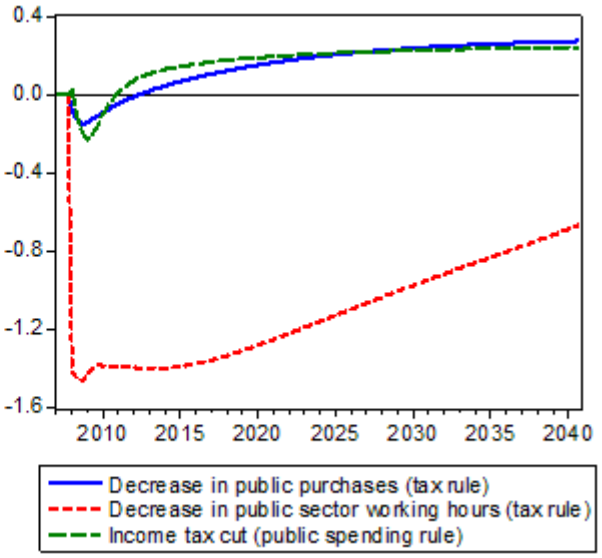


Figure 16. Price effects.

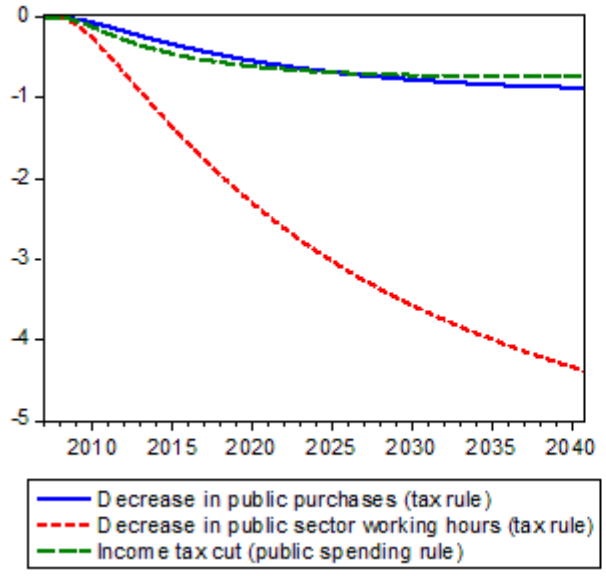
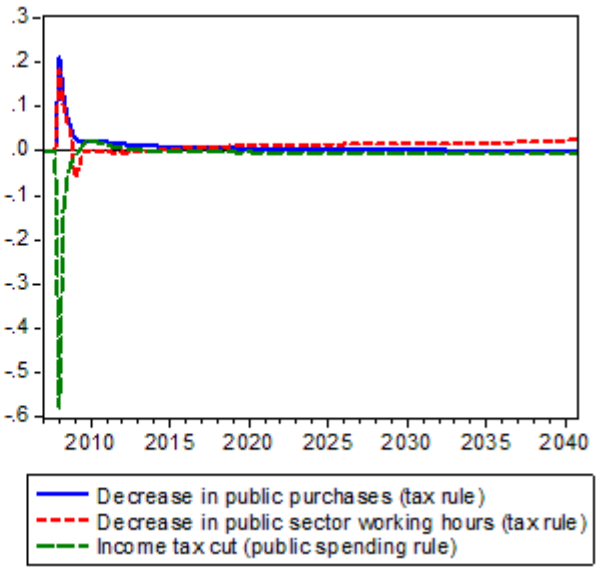


Figure 17. Government deficit effects.



On the basis of these results, income tax cuts that are neutral for the government budget due to the reductions in public purchases or public sector working hours improve GDP, at least in the long run. However, when income tax cuts are compensated by reductions in public sector working hours, employment of the economy decreases, but this is naturally due to the fact that the shock is directly directed at public employment. Finally, we have to keep in mind that we only operated with public purchases and working hours and not, for instance, public investments that may have technology-augmenting effects in the long run.

4.2.2. The structure of taxation

We also experiment with the impact of a change in the structure of the tax system, namely we shock the value added tax rate.[21] When compared internationally, the value added tax rate is relatively high in Finland, approx. 20 per cent when measured as an effective rate.[22] Notwithstanding, we simulate one percentage point increase in the (effective) value added tax rate, which is again compensated by reducing income taxes. In this simulation, we again use the tax rule (16) to make the tax changes neutral for the government budget. The effects of the value added tax change crucially depend on how the consumer prices react in response to the shock.

Table 3. Long-run effects of increasing the value -added tax rate (with tax rule).

	Value added tax rise (tax rule)
Employment	+0.02 %
GDP	+0.01 %
Prices	+1.33 %

Even though the rise in the value added tax rate pushes consumption prices up, the income tax cut's impact dominates in the short run. However, the dominance weakens in the long run, and hence the effect of the tax structure change converges to zero. As a result, the long-run values of GDP and employment are not affected by the shock. In Kilponen & Vilmunen's study (2007) for the Finnish economy, the effects of a similar shock are 0.53 for GDP and 0.25 for employment, and thus our zero result does not support the policy implications presented there.

4.3. Sensitivity analysis

How robust is our analysis? To do a sensitivity analysis for the results gained, we first alter the elasticity of the real wage in the labour demand equation. The estimations gave us the elasticity of real wages -0.21 (see section 3.2.2.); we calibrate it to a value of -0.5, which is closer to the results gained from the previous Finnish studies (Kiander, Vilmunen, Virén (2005) , Honkapohja et al. (1999)). One percentage point reduction in the income tax rate is now compared with the previous results. The reductions are financed by increasing government debt, and hence the budget deficit is allowed to alter freely.

[21]Of course, another relevant issue is the legitimate tax rates for labour and capital. Our model also allows us to study this issue, but when we are simulating capital tax changes some problems may arise.

[22] See, for instance, Coenen, McAdam, and Straub (2008).

The sensitivity of results to the wage elasticity of labour demand

Figure 18. The sensitivity of employment.

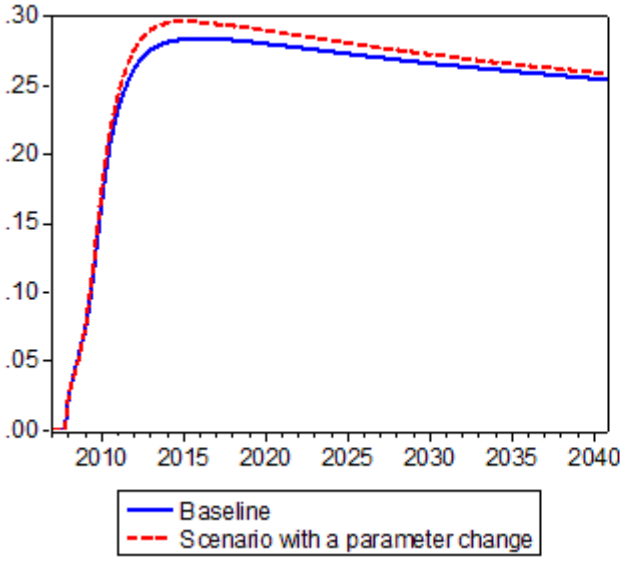


Figure 19. The sensitivity of GDP.

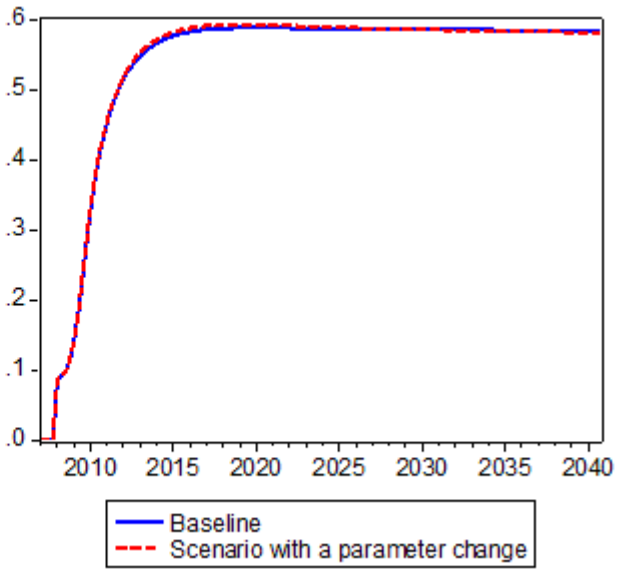
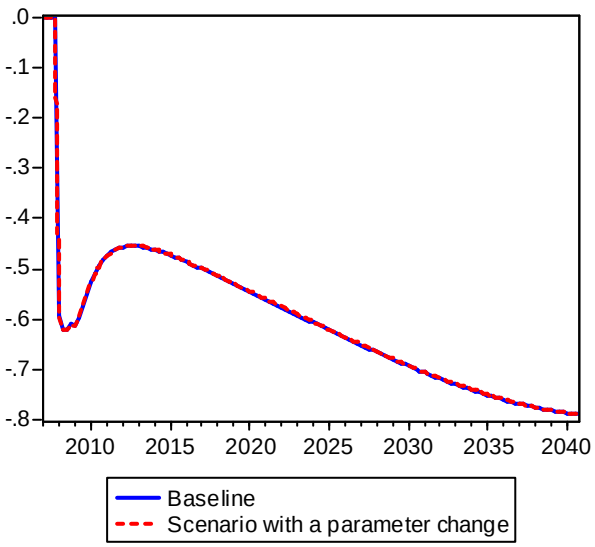


Figure 20. The sensitivity of the budget deficit.



The figures show that the government deficit and GDP are not sensitive to the wage elasticity of labour demand. One can notice some sensitivity in employment; however, this does not seem significant. One may assume that the results are sensitive to the changes of the wedge parameter in the wage formation equation. Hence, we calibrate the elasticity parameter in the standard private wage rate equation to the value of 0.028, which is, to some degree, smaller than the estimated elasticity (0.036). When we again use the formula $m/(1-0.95)$, calibration means that the long-run estimate for the wedge is now 0.56. Thus, we use the elasticity gained in Honkapohja et al. (1999).

The sensitivity of results to the wedge parameter of wage formation.

Figure 21. The sensitivity of employment.

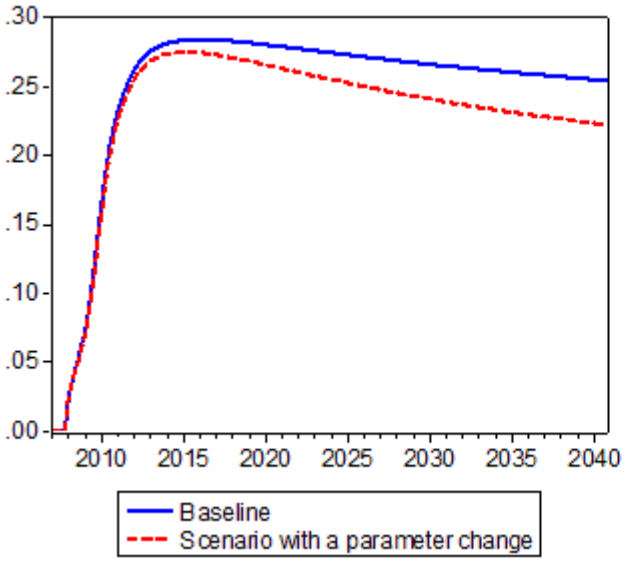


Figure 22. The sensitivity of GDP.

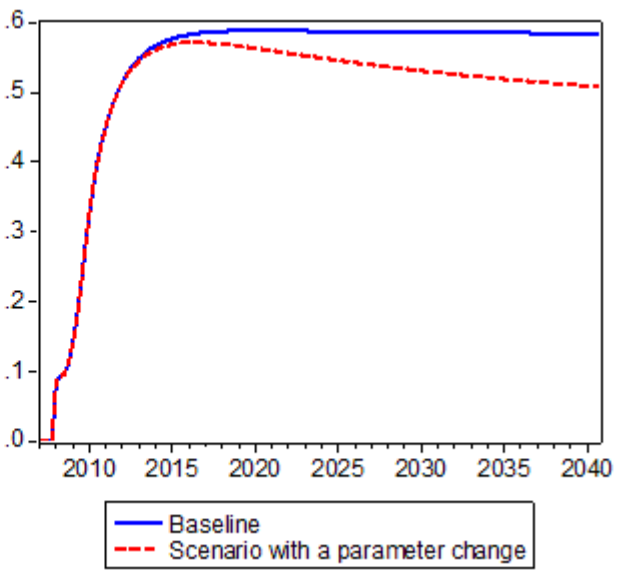
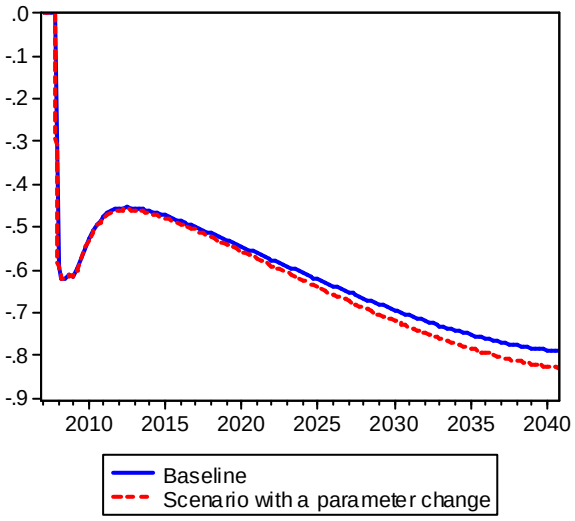


Figure 23. The sensitivity of budget deficit.



From the results it can be seen that employment is affected so that the effect of a one percentage point income tax cut on employment is now close to the average result of international studies, 0.2 per cent.[23] GDP is also, to some degree, sensitive to the wedge parameter change. As regards the budget deficit, the sensitivity is slightly smaller. However, one must notice that the long-run multiplier for the wedge was changed by just 0.16 points, which is a relatively small change. To summarize our

[23] See Nickell (2004). However, these and our results are not fully comparable because of different model frameworks.

sensitivity analysis, we can say that employment, GDP, and the government budget deficit are, to some degree, sensitive to the changes in the wedge parameter of the wage formation equation, a conlusion which is by no means surprising. However, the sensitivity of the results for the wage elasticity of labour demand is minor.

5. CONCLUDING REMARKS

We found that a one percentage point decrease in the income tax rate which is financed by increasing government debt improves GDP by approx. 0.58 and employment approx. 0.25 per cent in the long run. We also found that a one percentage point decrease in the income tax rate which is compensated by reducing public purchases produces a long-run increase of GDP and employment of similar magnitude. In the short run, the negative effects of cutting public expenditures are stronger, and GDP even decreases, but in the long run the positive effects of income tax cuts start to dominate. This is due to the smaller pressures on wages negotiated by the trade unions and increased labour supply. The result is also due to the fact that the effects of a reduction in public purchases weaken in the long run when the economy converges to its steady-state path.

We also simulated policy shocks with an alternative fiscal policy rule which is bound to the income tax rates – not to public purchases as analyzed above. This modification of the fiscal policy rule produces consistent results for the effects of lowering the income tax rate and reducing public purchases at the same time. A decrease in public sector working hours also has a clearly positive effect on GDP in the long run. However, in this case the positive effects in private sector employment due to income tax cuts do not cover all the reductions in public sector employment, and this is why employment of the economy decreases in response to this shock.

One observes some sensitivity in our results to the changes of a wedge parameter in the wage formation equation. Decreasing the coefficient for the wedge brings our simulation results close to the (average) estimates gained from international studies. The results are only slightly sensitive to the changes in the wage elasticity of labour demand. An expirement with the structure of taxation gives us a (long-run) zero result for the effects of changing taxation towards higher taxes on consumption but lower on labour. Hence in this case the results gained using a macroeconometric model seem somewhat different to those gained using a theory-based DSGE model (see Kilponen & Vilmunen (2007)).

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