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MACROECONOMIC IMPLICATIONS OF FISCAL POLICY MEASURES IN DSGE

ZBYNĚK ŠTORK
JANA ZÁVACKÁ

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Zbyněk Štork
Ministry of Finance
Letenská 15
Prague 1, 118 10
Czech Republic
e-mail: zbynek.stork@mfcr.cz

Jana Závacká
Ministry of Finance
Letenská 15
Prague 1, 118 10
Czech Republic
e-mail: jana.zavacka@centrum.cz

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Abstract

In the paper we extend a simple DSGE model of the Czech economy called HUBERT in order to allow for analysis of various fiscal policy measures. Model describes behaviour of four agents in the economy: households, firms, government and world. Here we focus mainly on extensions of blocks of households and government, which includes distinction of Ricardian and Rule-of-Thumb households and endogenous tax rates. We prefer to have a simple model, so we work with aggregated variables: taxes on consumption, taxes on wages, government consumption and benefits to households. Shocks are introduced into the model using implicit tax rates. We also provide a discussion of results in the paper. Sensitivity analysis asses (i) stability of the model regarding the share of non-Ricardian households and (ii) effects of non-accommodating policy of Central Bank on fiscal measures. We add a discussion of economic impacts of different fiscal measures that aim at additional gain of certain funds for the state budget.

Abstrakt

Ve studii prezentujeme rozšíření základního DSGE modelu české ekonomiky nazvaného HUBERT, které umožňuje analyzovat opatření fiskální politiky. Model popisuje chování čtyř základních subjektů v ekonomice: domácností, firem, vlády a vnějšího prostředí. Zde se zaměřujeme především na rozšíření bloku domácností a vlády, které zahrnují rozlišení Ricardiánských a Nericardiánských domácností a endogenní daňové sazby. Preferujeme spíše jednoduchý model, proto pracujeme s agregovanými proměnnými: daněmi uvalenými na spotřebu, daněmi ze mzdy, vládní spotřebou a vyplácenými benefity domácnostem. Šoky jsou do modelu prováděny prostřednictvím implicitních sazeb. V článku poskytujeme také diskuzi výsledků modelu. Citlivostní scénáře pak hodnotí (i) stabilitu modelu s ohledem na podíl Nericardiánských domácností a (ii) efekty neakomodativní politiky centrální banky při fiskálních opatřeních. Uvádíme i diskusi ekonomických dopadů fiskálních opatření, která mají za cíl přinést určitou část prostředků do státního rozpočtu.

Keywords: Dynamic stochastic general equilibrium model, fiscal policy, taxes, impulse response functions.

JEL classification: E62, H30.

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The views expressed in the paper do not necessarily reflect those of the Ministry of Finance of the Czech Republic. And of course, all mistakes are our own.

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1 Non-technical summary

The Economic Modelling Unit at the Ministry of Finance has developed macroeconomic model "HUBERT", using a simple dynamic stochastic general equilibrium (DSGE) approach. The model provides support for macroeconomic forecasts carried out by the Ministry. Beside this, simulations of various macroeconomic scenarios are provided. However, there has been a lack of analysis of fiscal policy measures, which is of crucial importance for the Ministry. In this paper, we stem from the original model and supply it with additional attributes in order to allow for such fiscal simulations.

The model is of New Keynesian type and describes the behaviour of four basic agents in the economy. First, we assume infinitely lived households maximizing their intertemporal utility function subject to budget constraint. There are two types of households in the economy. Liquidity unconstrained Ricardians with a free access to the financial market in order to smooth their consumption and non-Ricardians[1] spending the whole income in each period of time. We incorporate habit formation according to Abel (1989) and Fuhrer (2000). Households also have a power in wage negotiation. Following Erceg, Henderson and Levin (1999) we incorporate a wage rigidity to the labour market, by assuming households to negotiate their wage only after receiving some random signal.

Second, we distinguish three types of firms: importers, intermediate-goods producers and final-good producers (retailers). Since the Czech economy is small and open one, importers are assumed to buy imports at given prices. They maximize their profit function with respect to a demand function. We assume monopolistic competition in case of producers, that maximize production function with respect to costs of inputs (imports and wages). The production function is of Cobb-Douglas type and following Hamermesh and Pfann (1996) adjustment costs for input factor are incorporated. This type of firm is also the only one which is able to handle the price on the market. Following Calvo (1983) and Gali and Gertler (1999) we consider price rigidity on the market. Finally, retailers are assumed to behave in perfect competitive environment. They aggregate intermediate goods from producers and sell them to consumers in domestic and foreign economy. In this competitive environment, the price is given by producers and retailers could optimize the quantity.

Third, the Central Bank, operating under the inflation targeting regime, determines a short term policy rate. This is set with respect to an extended Taylor rule (considering Taylor (1993) and Svensson (1998)) and interest rate smoothing (according to Srour (2001)). On the side of the government a simple expenditure fiscal rule focused on primary deficit is introduced.

Finally, because of the openness of the Czech economy, foreign trade is of crucial im-

[1] Also called "Rule-of-Thumb households".

portance. The "rest-of-the-world" is approximated using a simplified version of Smets and Wouters (2002), capturing behaviour of three European agents: households, firms and government.

In this article, we do not provide the derivation of the full model, but we rather focus on modifications of its certain parts. The rest of the model remains the same with characteristics mentioned above. An interested reader is kindly referred to Štork et al. (2009) for details.

The purpose of the model is to provide background analysis for the Macroeconomic Forecast on quarterly basis and to carry out various simulation tasks. Since the Ministry of Finance is in charge concerning the fiscal policy, analysis of various policy measures should be one of aims of the model. So we modified the model in order to allow for simulating various policy measures both, on the revenue and on the expenditure side. On the other hand, we try to keep the model as simple as possible and thus we work with aggregated variables: taxes on consumption and taxes on wages on the revenue side; government consumption and benefits to households on the expenditure side. Anyway, it would be hardly possible to analyze e.g. an increase of VAT on different commodities, so we work rather with the aggregate: taxes on consumption. Specific changes in VAT and others, such as excise taxes, are part of an aggregate of taxes on consumption and are translated into the model through respective implicit tax rates.

The paper is organized as follows. Chapter 2 introduces changes in the model in order to allow for the fiscal analysis. This part focus only on some of the model's blocks, namely households and government. However, general overview of other parts is briefly mentioned at the end. Chapter 3 discusses main simulation results and illustrates an analysis of shocks into government consumption, tax rate on consumption, tax rate on wages and rate of benefits to households. Chapter 4 then shows a sensitivity and other analysis and Chapter 5 concludes.

2 Features of the model

The original model was extended for simulation purposes. In following section we concentrate mainly on a new concept of concerned building blocks, i.e. the sector of households and the fiscal block that witnessed most substantial changes. Other parts of the model keeps the initial form.

2.1 Households

We assume that domestic economy consists of infinitely lived consumers, maximizing their intertemporal utility function subject to a lifetime budget constrain. We distinguish between Ricardian and non-Ricardian types of households, which is important for capturing proper dynamics in the model. The latter agents do not have an access to a capital market and they consume all resources in each period of time. Ricardians, on the other hand, smooth their consumption by accumulation and decumulation of assets. Thus these are expressed in net terms in equation (2). In this case, we also employ habit formation according to Abel (1989) and Fuhrer (2000) on both, consumption and labour supply.[2] For the sake of simplicity we do not discriminate households according their wages and taxes imposed.

The optimization problem of Ricardian households concentrates in following utility function:

$$\max_{\{C_t^R, A_t, A_t^*, N_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^R - H_t^c)^{1-\psi_c}}{1-\psi_c} - \frac{(N_t^R - H_t^n)^{1+\psi_n}}{1+\psi_n} \right] \tag{1}$$

with respect to their budget constraint

$$\begin{aligned} A_t + S_t A_t^* + (1+\tau_t^c) P_t C_t^R = (1+i_{t-1}) A_{t-1} + (1+i_{t-1}^* + \zeta_{t-1}^*) S_t A_{t-1}^* + \\ + (1-\tau_t^w + \tau_t^b) W_t N_t^R + (1-\tau^f) \Pi_t, \end{aligned} \tag{2}$$

where:

A_{it}, A_{it}^*	bunch of net domestic and net foreign assets held by a household,
C_t^R	individual real consumption of Ricardian household,
H_t^c	habit level of consumption,
N_t^R	individual labour supply of Ricardian household,
H_t^n	habit level of labour supply,
β	discount factor,
ψ_c	inverse of substitution of consumption,
ψ_n	inverse of substitution of labour supply,

[2] For further discussion see also Lettau and Uhlig (2000).

S_t	nominal exchange rate,
P_t	consumer price index,
W_t	nominal wage,
i_t, i_t^*	nominal rate of returns on domestic and foreign assets,
Π_{it}	aggregated profit of firms,
ζ_t^*	risk premium,
τ_t^b	rate of benefits to households,
τ_t^w	personal income tax rate,
τ_t^c	implicit tax rate on consumption (value added tax and excise tax),
τ^f	corporate income tax rate.

Non-Ricardian households maximize slightly different utility function lacking habit formation elements, i.e.

$$\max_{\{C_t^{NR}, N_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^{NR})^{1-\psi_c}}{1-\psi_c} - \frac{(N_t^{NR})^{1+\psi_n}}{1+\psi_n} \right] \tag{3}$$

subject to a simple budget constraint

$$(1+\tau_t^c) P_t C_t^{NR} = (1-\tau_t^w+\tau_t^b) W_t N_t^{NR}, \tag{4}$$

where:

C_t^{NR}	individual real consumption of non-Ricardian household,
N_t^{NR}	individual labour supply of non-Ricardian household.

Their initial consumption demands and labour supplies are then aggregated according to the formulas

$$C_t = C_t^R + C_t^{NR}, \qquad N_t = N_t^R + N_t^{NR}. \tag{5}$$

The distinction between two types of households requires defining their respective shares. According to a partial analysis and Forni et al. (2007), we assume the ratio of non-Ricardian households on consumption and labour supply would be identical. However, setting the value is not straightforward. In this sense, the literature provides a variety of proposals from 25% (Coenen and Straub (2005)) to 34–37% (Forni et al. (2007)) for Euro-area. Higher shares of non-Ricardians are used for the US as in Gali et al. (2007), often reaching level of 50%.

We stem from the EU-SILC database[3] providing quite detailed characteristics of households in our analysis of households' share. Despite using quality data, setting the share of non-Ricardians requires expert judgements taking on board country specificities (e.g. larger share of retirees in eastern Europe should be considered as non-Ricardians comparing to "old" EU member countries). We divided population into several categories.

[3]European Union - Statistics on Income and Living Conditions.

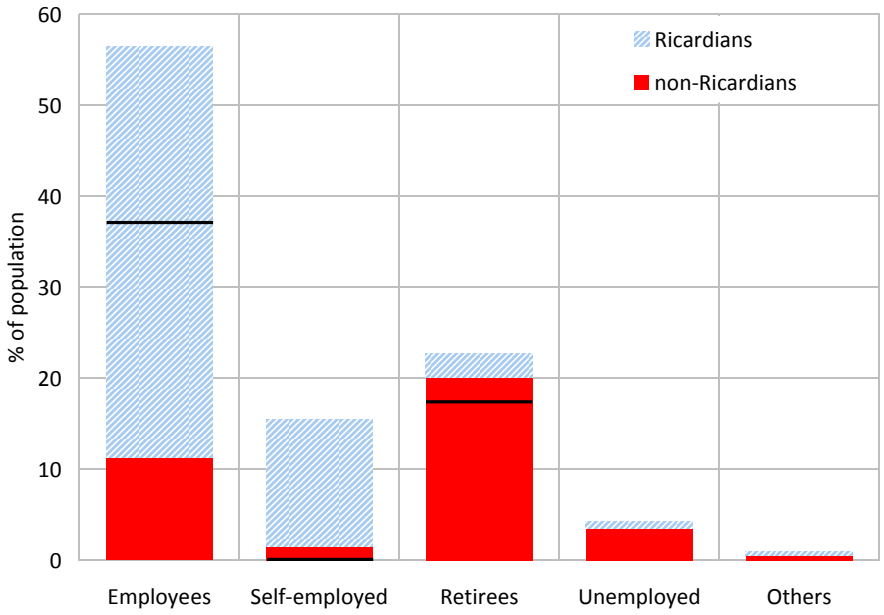

Figure 1: Share of Ricardians and non-Ricardians

In the baseline scenario we assume non-Ricardians those, who are non-working retirees and long-term unemployed. Beside these, using an expert opinion, certain parts of other groups are considered in this share: 20% of employees, 10% of self-employed, 50% of working retirees, 70% of those unemployed for less than a year, and half of others. Thus, our baseline assumption of the non-Ricardians share is equal to 37% which is illustrated by columns in Figure 1. We use this assumption in the analysis in the rest of the paper.

However, we also employ other opinion and set the non-Ricardian share on 50%, by three changes in previous assumptions: (i) half of employees are rather non-Ricardians, since they are well below an average wage[4]; (ii) those self-employed and (iii) working retirees are all Ricardians. These alternative thresholds between the two groups are displayed by lines in the Figure 1. We use this alternative scenario to analyze the sensitivity of the model in Chapter 4.1.

[4]They have approximately 80% and less of average wage.

2.2 Fiscal policy

An important part of the model is how to handle with government fiscal policy. Naturally, this field has quite strong theoretical background but it is also data driven to some extent. We try to use the most of the available data provided in national accounts (NA).

We stick to relatively simple and aggregated equations for revenues and expenditures as in the previous version of the model. However, we pay an additional attention to taxes that are endogenized to allow for simulations of government fiscal measures.

2.2.1 Government budget and deficit

Government revenues GR_t are defined as follows

$$GR_t = PIT_t + CIT_t + VAT_t + EXCISE_t = \tau_t^w W_t L_t + \tau^f \Pi_t + \tau_t^c P_t C_t, \tag{6}$$

where:

GR_t	total government revenues,
PIT_t	revenues from personal income tax,
CIT_t	revenues from corporate income tax,
VAT_t	revenues from value added tax,
$EXCISE_t$	revenues from excise tax.

Income from taxes is the essential revenue of the state budget. Personal income tax revenues are dependent on wages and employment ($W_t L_t$) and tax rate imposed – here represented by implicit personal income tax rate (τ_t^w).[5] CIT revenues are determined by corporate income tax rate (τ^f) and profits (Π_t).[6] VAT and excise taxes are modelled together and are represented by one implicit tax rate on consumption (τ_t^c), which is imposed on nominal consumption ($P_t C_t$).[7]

Government expenditures GE_t are represented by two groups

$$GE_t = G_t + G_t^s = G_t + \tau_t^b W_t N_t, \tag{7}$$

where:

GE_t	total government expenditures,
G_t	government consumption,
G_t^s	paid out social benefits,

where social expenditures are determined by implicit rate (τ_t^b) and wage development.

[5] For further explanation of implicit tax rate concept see Section 2.2.2.

[6] Currently we do not work with endogenous corporate income taxes since the sector of firms (namely capital and investments) is not developed enough to ensure meaningful analysis of corporate income tax measures.

[7] We are aware of simplification in using this notation since VAT is calculated in current prices, while excise taxes have the assessment base in constant prices.

By subtracting revenues from expenditures we easily derive a primary government deficit

$$D_t = GE_t - GR_t, \tag{8}$$

that is cumulated into debt

$$B_t = D_t + (1 + i_{t-1})B_{t-1}, \tag{9}$$

where:

B_t	government debt,
D_t	primary government deficit.

We consider that fiscal policy rule is expenditure oriented[8] and based on an assumption of a balanced primary government budget (zero primary deficit) in equilibrium.[9] The rule is given by equation

$$\frac{G_t}{P_t} = (1 - \phi_g)\frac{\bar{G}_{t-1}}{P_{t-1}} + \phi_g \frac{G_{t-1}}{P_{t-1}} \tag{10}$$

where $\bar{G}_t$ stands for equilibrium government consumption. The rule is derived from equation (8) under the following condition: $D_t = GE_t - GR_t = 0$. The parameter ϕ_g reflects a speed of convergence of public finances.[10]

2.2.2 Implicit tax rates

We endogenized implicit tax rate on consumption (value added tax and excise tax) τ_t^c, rate of benefits to households τ_t^b and personal income tax rate τ_t^w. Because of insufficient specification of investment and capital in the model, we keep corporate income tax rate τ^f as a constant and do not allow for simulations at this stage.

All variable tax rates are decomposed for modelling purposes as

$$\tau_t^x = \bar{\tau}^x + \hat{\tau}_t^x, \tag{11}$$

where:

τ_t^x	respective tax rate,
$\hat{\tau}_t^x$	deviation from the steady state value,
$\bar{\tau}^x$	steady state value of tax rate.

[8]The expenditure based rule is less complicated. We do not need to arbitrarily decide which tax rate should be adjusted. Moreover, changes in tax rates require a change in legislation which can be very inflexible. Contrary, government expenditures may be adjusted quite promptly. Finally, changes in taxation has an impact on relative prices.

[9]We use primary deficit to avoid possible fiscal restriction implied by monetary restriction through interest rate payments, and vice versa. For the same reason, to avoid an unwanted fiscal restriction forced by higher inflation pressures, we focus on real consumption.

[10]We show a sensitivity of the model on this parameter in Chapter 4.2.

The description of tax behaviour in the model is described in the fashion of Forni et al. (2007). We simply assume that deviation of each tax rate from its steady state follows AR(1) process, i.e.

$$\hat{\tau}_t^x = (1 - \lambda^x)\hat{\tau}_{t-1}^x + \varepsilon_t, \tag{12}$$

where λ^x is estimated tax parameter.[11] Steady state values of implicit taxes $\bar{\tau}^x$ are derived based on data from National Accounts. For this purpose we define tax rates as an implicit share of tax yield (T_t^x) on respective tax base.

Tax rate on consumption $\bar{\tau}^c$
This rate contains value added tax (VAT_t) and excise tax ($EXCISE_t$) altogether and is defined as

$$\bar{\tau}^c = \frac{T_t^c}{P_t C_t} = \frac{VAT_t + EXCISE_t}{P_t C_t}. \tag{13}$$

where:

T_t^c budgetary income from taxes on consumption.

Tax rate on wages $\bar{\tau}^w$
This implicit tax rate consists of personal income tax and social contributions. We defined it as

$$\bar{\tau}^w = \frac{T_t^w}{W_t L_t}. \tag{14}$$

where:

T_t^w budgetary income from taxes on wages.

Rate of benefits to households $\bar{\tau}^b$
The implicit rate is defined as a share of social benefits (G_t^s) on the base, e.g.

$$\bar{\tau}^b = \frac{G_t^s}{W_t N_t}. \tag{15}$$

It is obvious from the definitions, that we do not cover the whole government revenues and expenditures. We exclude several items that are of minor importance and that are hard to consistently implement into the model. Revenue side is thus covered by 86% and expenditures by 75%. Specific items included in implicit tax rates can be found in Appendix A.

[11] After a tax shock, we assume a gradual (exponential) convergence to steady state, which is mathematically approximated by AR process.

3 Simulation results

Performance of the model is presented in illustrative simulation results, graphically interpreted as impulse response functions (IRF). In following graphs we present impact of fiscal policy measures on main macroeconomic variables. All simulations represent a positive unit shock into respective variables.

When interpreting the IRF's, we have to bear in mind that we shock tax rates (and government consumption respectively) that are deflected from their steady state values. A specific position within business cycle is not considered. In reality, effects of the tax rate change in periods of economic boom could (and they do) differ from effects in times of economic slowdown.

3.1 Government consumption

An unit shock into the government consumption has a positive impact on real GDP. The higher government consumption elevate a demand for production, which afterwards results in higher firms' labour demand, decrease of unemployment and increase in real wages. The lower consumption is a result of Ricardian households behaviour, which defer their consumption to the future due to higher real interest rate.

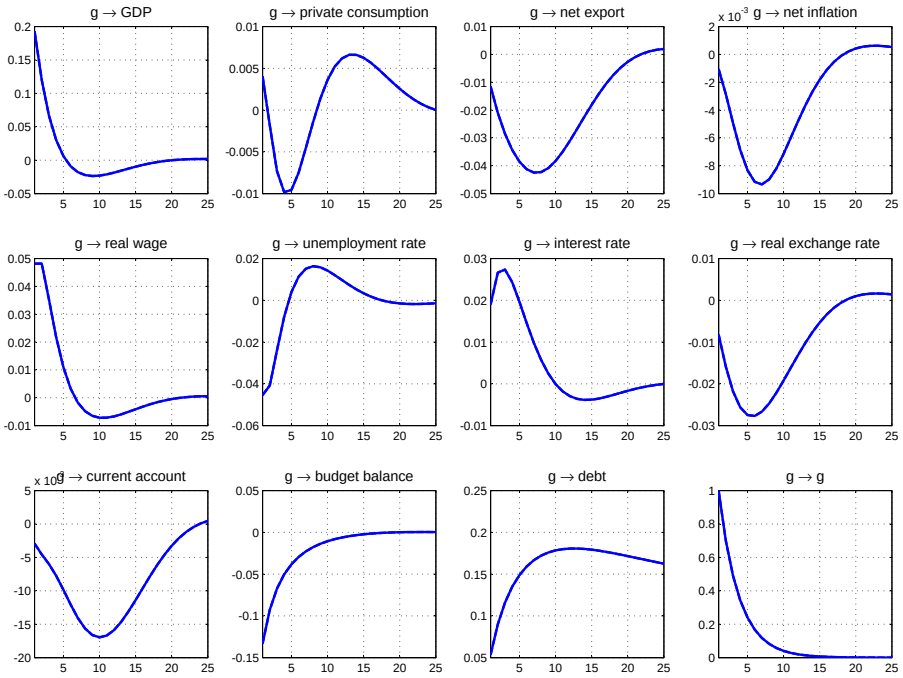

Figure 2: Government consumption shock

The higher demand in line with appreciation of real exchange rate worsen a current account. On the other hand, thanks to openness of the Czech economy, strong exchange rate causes a reduction of firms marginal costs. This helps to limit inflation tensions from higher domestic demand.

Higher government spending results in higher primary government deficit that is consequently cumulated in higher debt.

3.2 Tax rate on consumption

Higher tax rate on consumption reduces consumption demand. This means lower demand for imported goods and consequently also lower demand for imported goods as inputs of production. The difference between export and import increases and therefore net export is growing. GDP is also falling, dragged down by the lower consumption. Net export has a positive influence on GDP, but the increase is only the effect of lower demand for imported consumption goods and therefore it does not offset the negative effect of consumption on GDP.

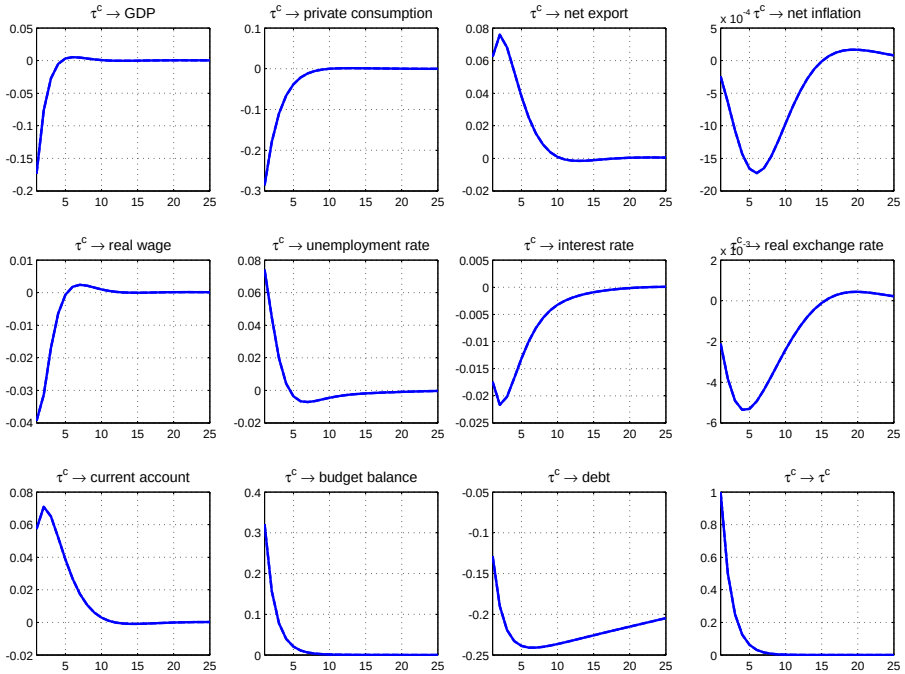

Figure 3: Tax rate on consumption shock

Lower demand for production forces firms to reduce labour demand and pushes down wages (with respect to their negotiation position). Lower wage and higher taxation of consumption demotivate households from work. On the other hand, cut-down in

consumption has a stronger influence and the final labour supply is therefore rising. Lower labour demand and higher labour supply leads to unemployment rate increase. This is in line with wage reduction.

As the lower demand for import increases net export, also a current account run surpluses. Firms, which cash their profits in foreign currency create an additional demand for czech currency and push the exchange rate to appreciate.

Wages and exchange rate are the main factors of firms' marginal costs (import prices are given). Reduction in wages and exchange rate appreciation lower marginal costs, consequently. This limits inflation pressures and together with lower GDP push down interest rates. This effect, however marginal, limits the exchange rate appreciation.

Higher government revenues from increase of tax rate on consumption itself leads to a positive primary government deficit and decrease of debt.

3.3 Tax rate on wages

The primary effect of higher tax rate on wages is reflected in households' budget through lower disposable income and thus lower consumption demand. The reaction is therefore analogical to the increase in the tax rate on consumption.

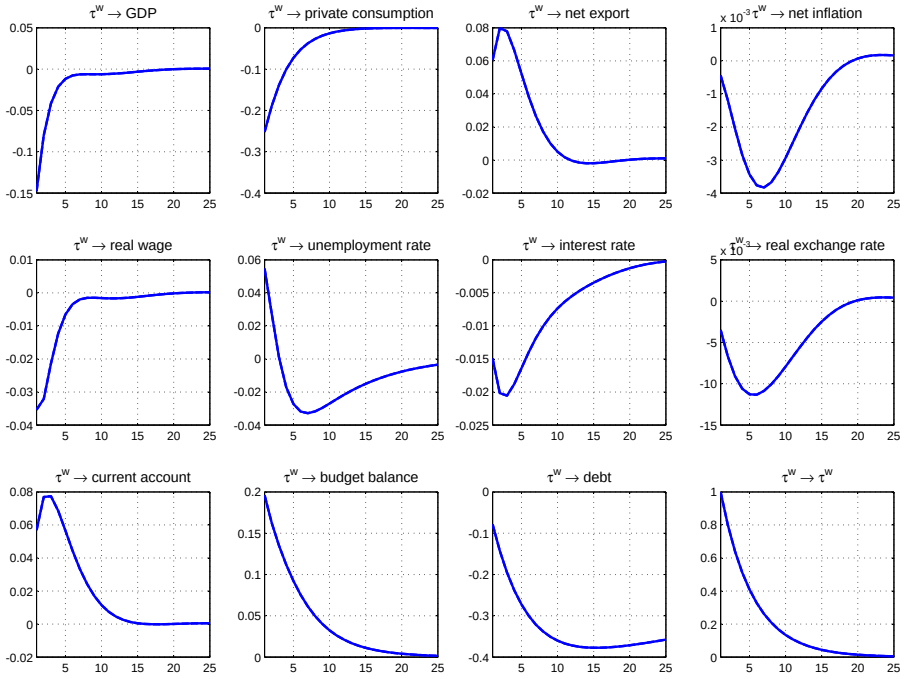

Figure 4: Personal income tax rate shock

The increase of the tax rate therefore reduces consumption, GDP and increases net export. Lower demand for production mutes wages as well as labour demand. Together with increasing labour supply unemployment rate grows. Wages, net inflation and interest rates are falling and exchange rate appreciates. Higher tax rate brings additional revenues, lower primary government deficit and consequently lower debt.

3.4 Rate of benefits to households

A positive shock into households' benefits has a primary impact on consumption, which starts to grow. The higher demand means also a higher demand for consumption of imported goods, imports are rising and net export is declining. The later pushes GDP growth down, but this is more than offset by higher consumption and as a result GDP is increasing.

Both, higher GDP and demand for production enable firms to increase wages and labour demand. This motivates households to offer their labour supply in larger extent. On the other side, higher level of consumption has a stronger effect and pushes working incentives down and labour supply is falling in the end. Thus the higher GDP growth, higher labour demand and lower labour supply cause the unemployment decrease and raises the wage growth.

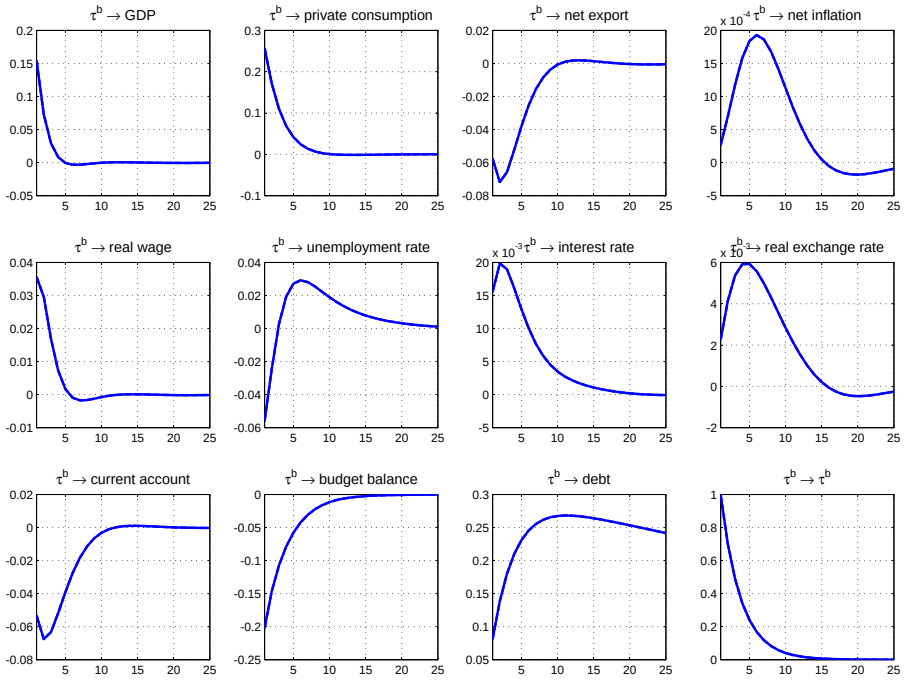

Figure 5: Rate of benefits shock

The higher demand for consumption of imported goods increases imports and induces

net export and current balance decrease. The fall of net export causes the exchange rate depreciation.

With regard to wage increase and exchange rate depreciation, marginal costs are increasing. As a result the inflation pressures intensify. In addition, interest rates are pushed to increase too. Higher interest rates, on the contrary, has a negative impact on exchange rate, but this is rather marginal effect.

As benefits grow, government expenditures are higher and higher is also a primary deficit, which translates into the debt.

4 Additional analysis

4.1 Sensitivity: the share of non-Ricardians

The share of non-Ricarian households (NR) in the population has been set with a non-negligible degree of arbitrariness (see Chapter 2.1). This has an implication on the composition of households – namely their consumption and labour supply. For the time being, we suppose that the share of non-Ricardian consumption on total consumption bundle would be equal to the non-Ricardian share on labour supply. According to the analysis we set the ratio equal to 37% in the baseline. For the fact that this number contains non-negligible portion of arbitrariness and that the value has been rather set at a lower level, we provide a sensitivity test on different value of 50%. Following analysis compares the two different settings with the same positive unit shocks as in the previous section.[12]

Government consumption
As apparent from the Figure (6) the increase in government consumption has nearly the same impact on GDP growth in both cases. As described before, higher demand for production consequently increases labour demand and wages and limits the unemployment. Higher inflation, higher interest rates and appreciation of the Czech currency are other implications.

The difference between scenarios occurs in the case of consumption. The lower the share of NR the greater decrease in consumption. Larger share of Ricardians postpones a part of their consumption into the future as a result of real interest rate increase.

Tax rate on consumption
There are not large differences also in the case of taxes on consumption. Diverse reactions occur when the higher share of NR is chosen especially in the first several quarters after shock. It then leads to a higher attenuation of consumption causing higher decrease of GDP, wages and a higher rate of unemployment.

Tax rate on wages
Although reactions on personal income tax rate increase are quite similar to those on consumptions' tax increase (both shocks have primary impact on households and then on production), they differ in intensity and persistence.

The tax increase lowers households' disposable income and thus consumption too. The higher the NR share, the greater drop in consumption, since NR have no chance to smooth their consumption. The same applies in case of imported goods leading to lower demand for imports, which raises net exports and improves a current account

[12]It is worth noting, that effects of higher and lower shares of non-Ricardian households are symmetric.

balance. The impact of more diminishing consumption is reflected in a lower GDP growth comparing to the baseline, higher unemployment, lower real wages, interest rates and inflation. Slower debt amortization is an effect on the fiscal policy side.

Rate of benefits to households
The rate of benefits is related to households' income in the same way as the tax on wages. The effects showed in graphs (8) and (9) are analogically opposite.

Thus the higher NR share on total consumption has a stronger positive effect on disposable income, which supports the consumption demand and higher GDP growth.

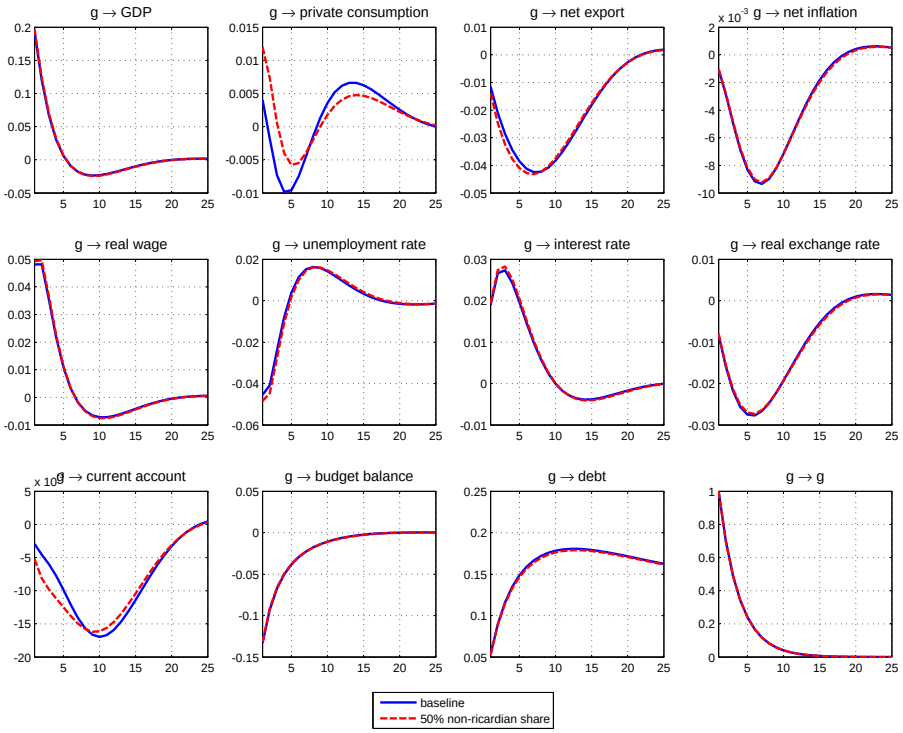

Figure 6: Government consumption shock

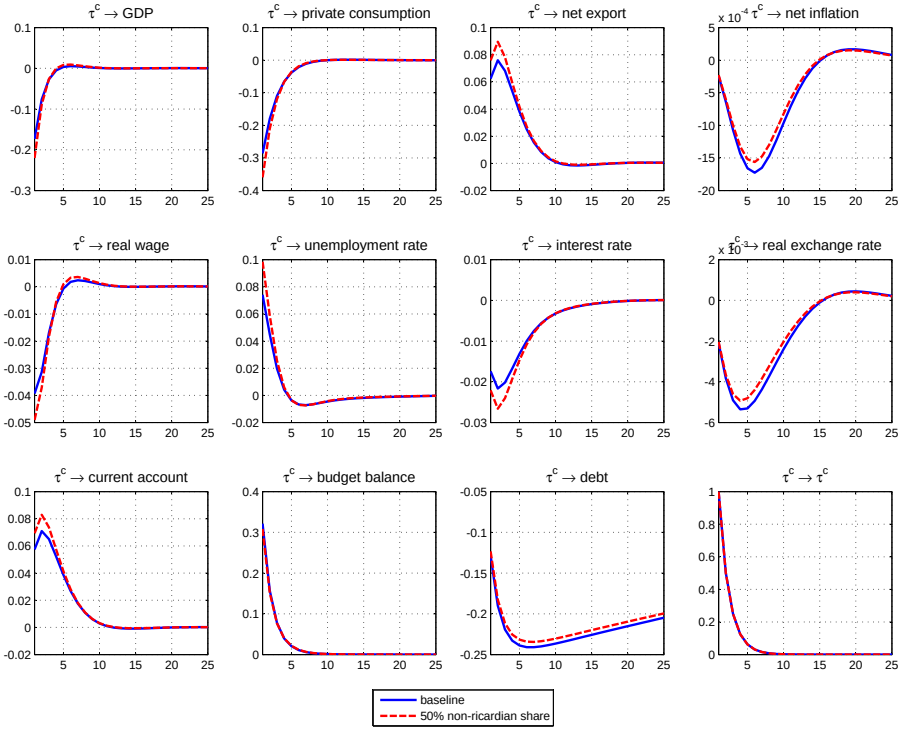

Figure 7: Tax rate on consumption shock

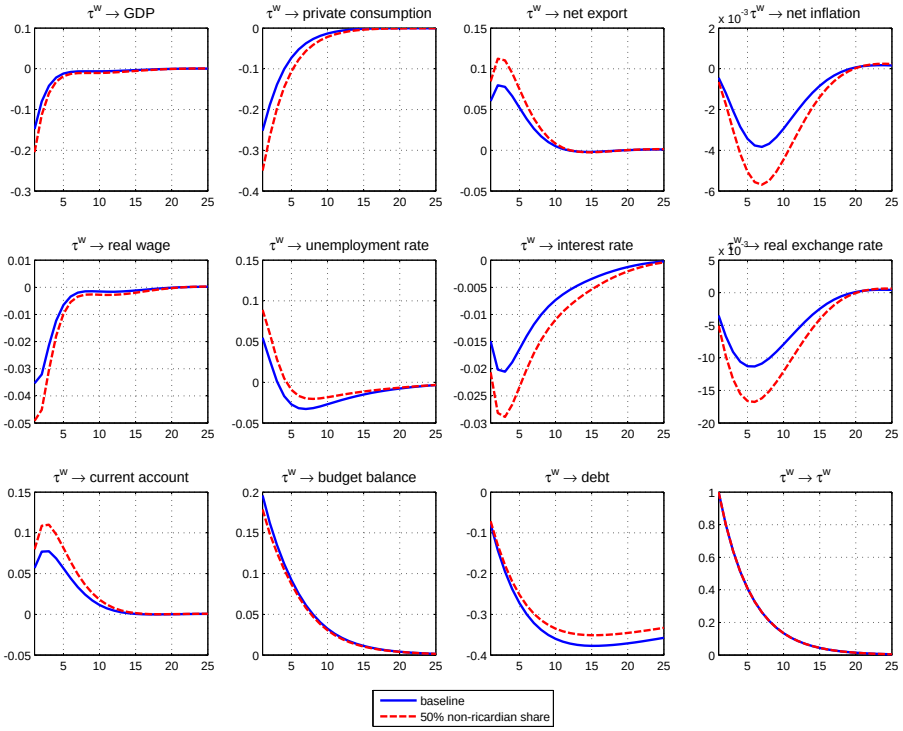

Figure 8: Tax rate on wages shock

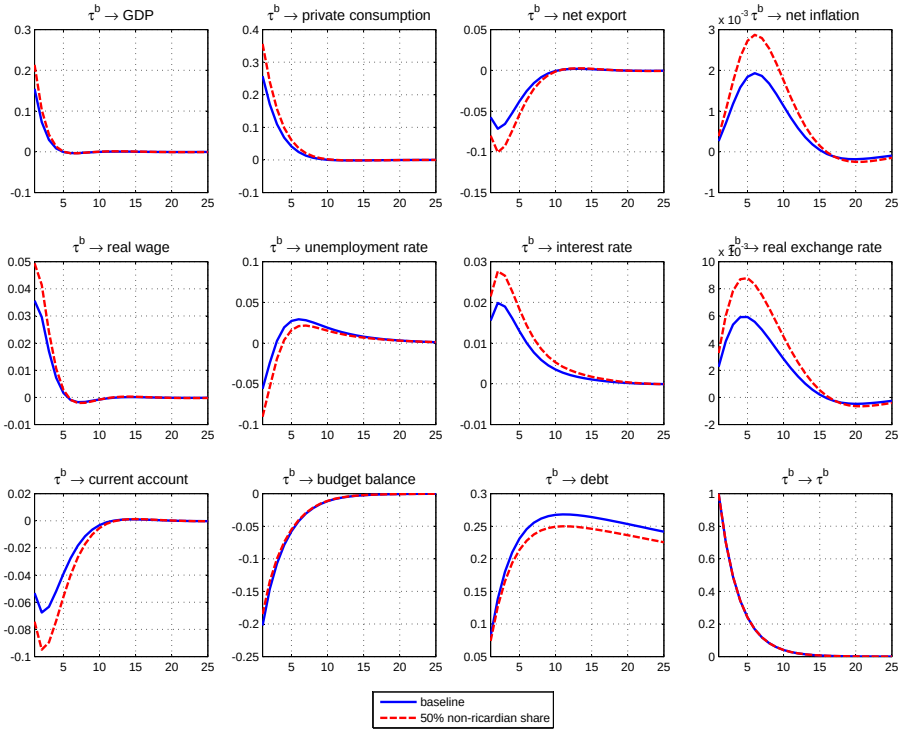

Figure 9: Rate of benefits shock

4.2 Sensitivity: fiscal rule parameter

The fiscal rule that closes the model is driven by estimated parameter of ϕ_g, which is set to 0.7 in the baseline. Let us assume alternative values of 0.6 and 0.8 respectively. Results of these alternatives are illustrated in Figures (10) to (13).

We do not see large distinctions between scenarios, which shows the stability of the model. The differences are hardly visible on Figures illustrating shocks into taxes on wages, consumption and rate of benefits. The minor exception is the government consumption shock since it directly affects the reference variable from the fiscal rule. The slower pace of consolidation (due to higher ϕ_g) maintains slightly higher demand for production with all consequences: lower unemployment, higher wages, higher increase of interest rates following by somewhat lower inflation pressures.

A budgetary effect of maintaining relatively higher government consumption shows somewhat slower consolidation of budget balance with consequently higher debt cumulation.

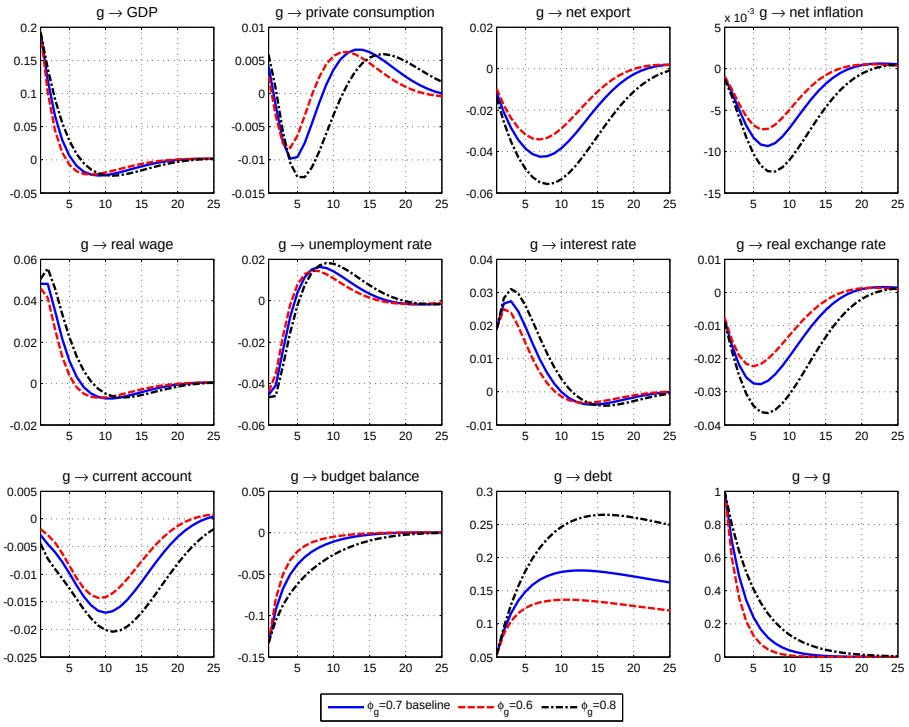

Figure 10: Government consumption shock

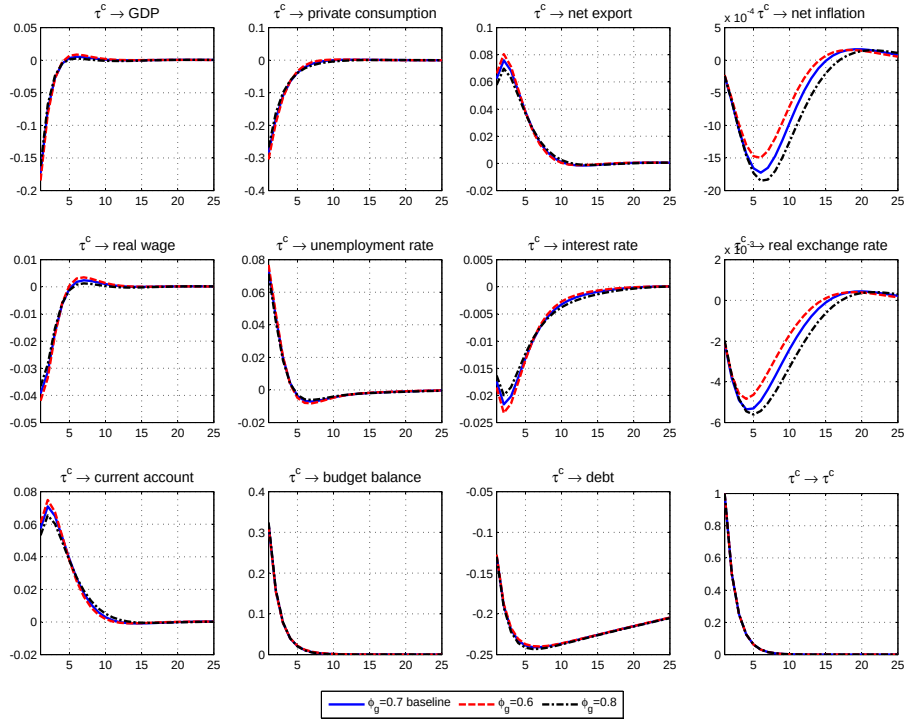

Figure 11: Tax rate on consumption shock

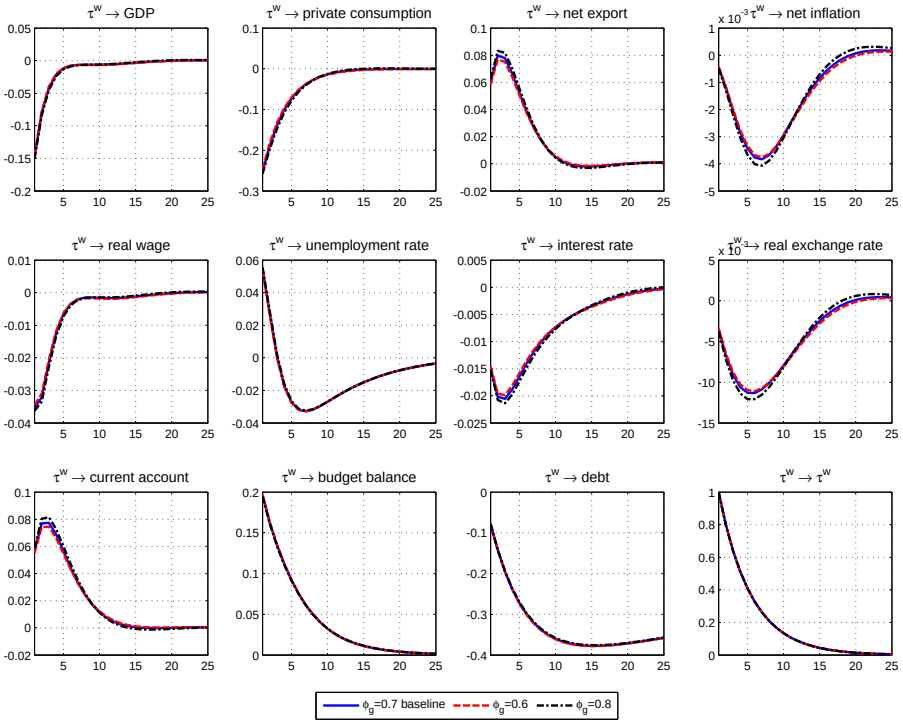

Figure 12: Tax rate on wages shock

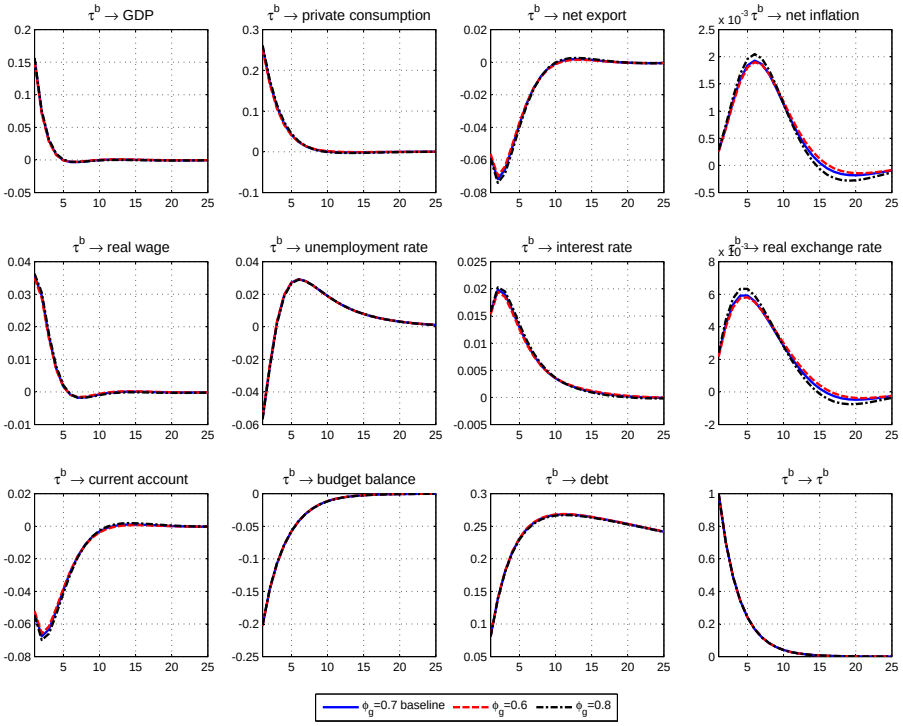

Figure 13: Rate of benefits shock

4.3 Fiscal shocks without Central Bank accommodation

In all other sections of the paper, we apply both, fiscal and monetary policy rules. So, we implicitly do not assume that government would coordinate its fiscal policy changes with the Central Bank. Short term interest rates thus react on economic development with all consequences. But what would happen if there is a cooperation between these institutions and the Central Bank does not accommodate the changes in taxation and/or government spending? Results are shown in Figures (14) to (17).

The non-accommodating policy of the Central Bank preserves the interest rate at an initial level. In comparison to the baseline, it means that if the tax on consumption increases (Figure (15)), relatively higher interest rate mutes production together with lower demand. The latter is affected more due to a greater decrease in real wages and higher interest rate. Somewhat lower production increases unemployment and pushes down wages. An effect on net export is a result of predominant effect of lower export production over the lower consumption of imported goods. Higher interest rate differential strengthen exchange rate, which has on the other hand a positive impact on production through lower marginal costs. Due to the lower production, also the primary budget balance is slightly less positive, which is reflected in lower debt decumulation.

We may find a similar reasoning behind scenarios of increase in taxes on wages and in increase of benefits (in an opposite direction). There are more visible changes in case of higher government consumption. The changeless interest rate does not mute inflation pressures stemming from higher wages. Real interest rates are thus declining comparing to the baseline and private consumption increases. This further supports higher production and GDP.

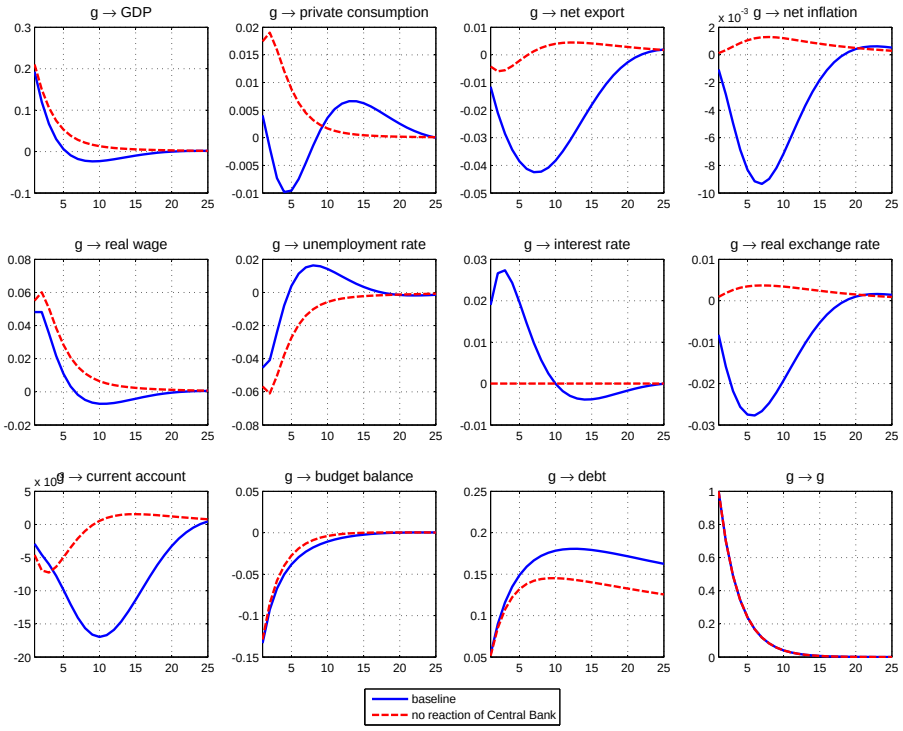

Figure 14: Government consumption shock

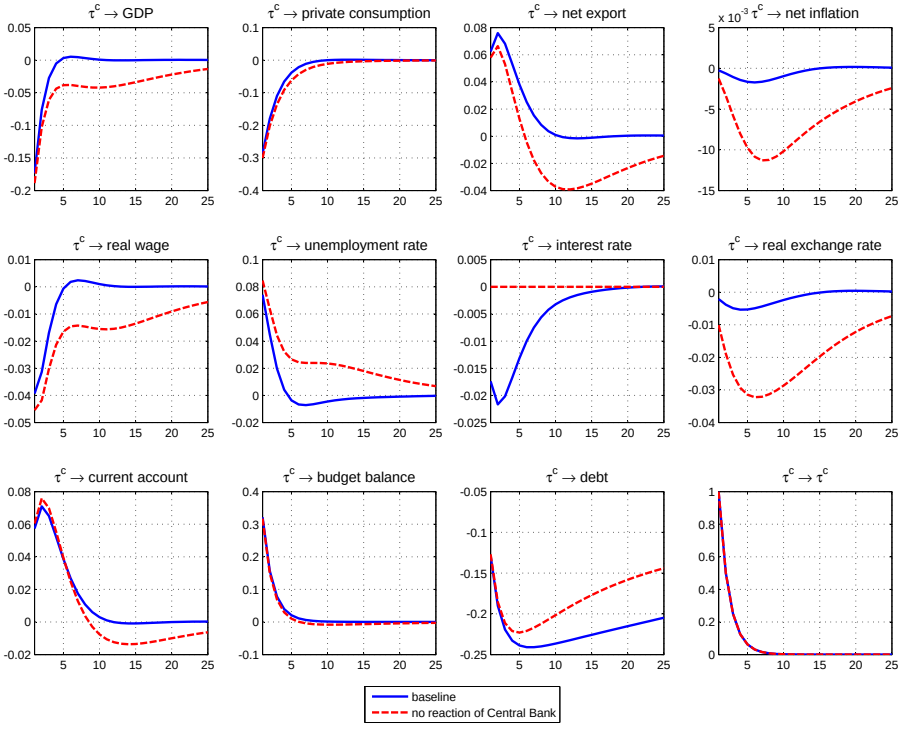

Figure 15: Tax rate on consumption shock

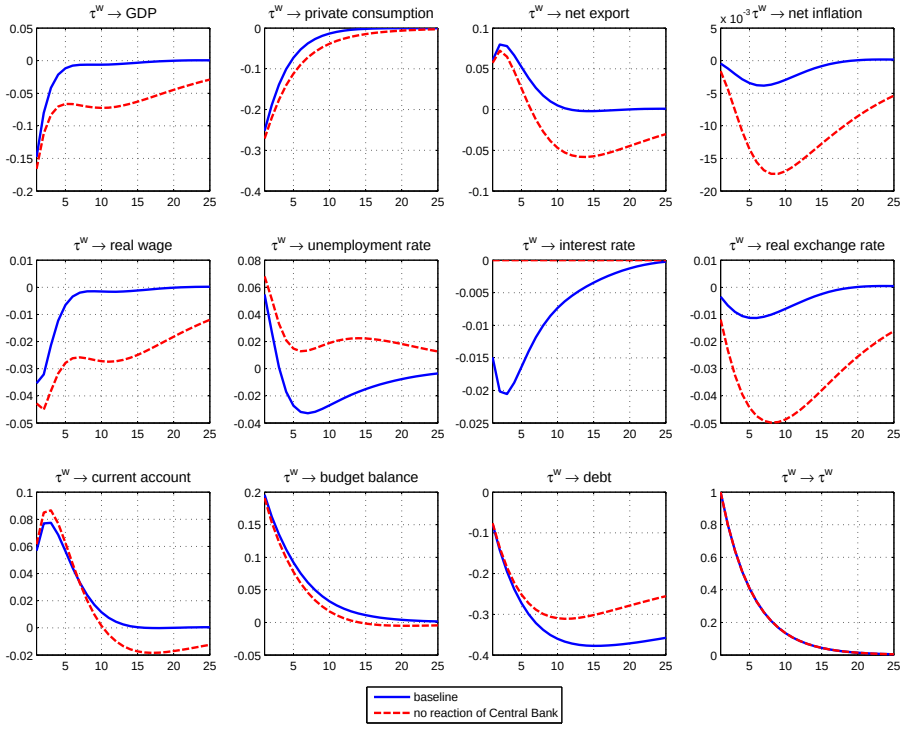

Figure 16: Tax rate on wages shock

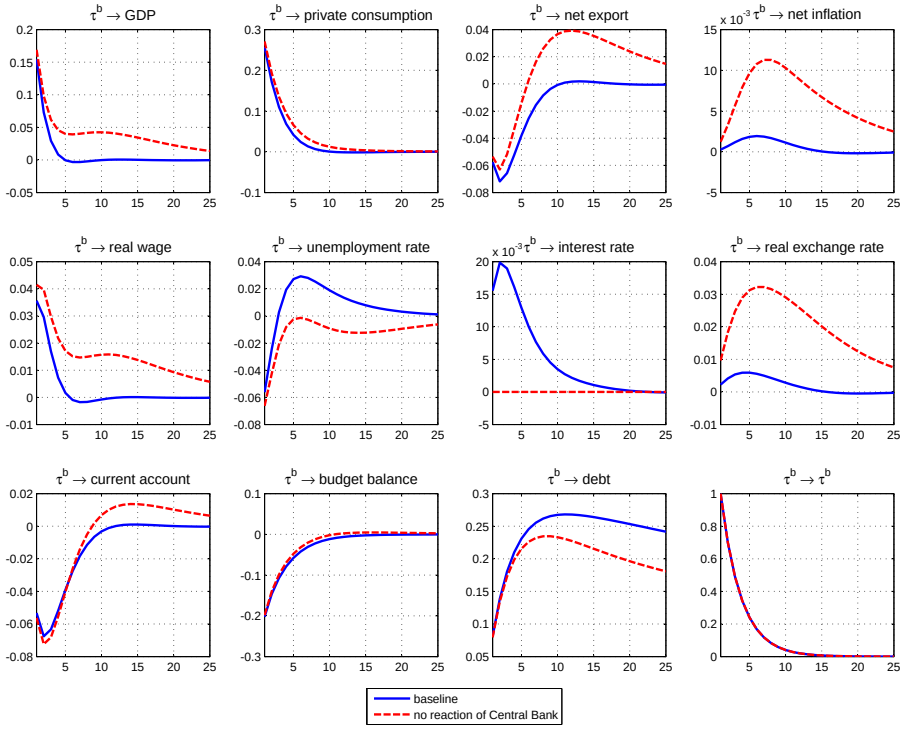

Figure 17: Rate of benefits shock

4.4 Additional funds for the state budget

Looking at the results of implications that are caused by various measures, an interesting question may come to our minds. What is the best way, how to get (or save) additional e.g. 20 bn CZK?[13] This may be inferred from the Figure (18) comparing different ways of achieving the goal through changes of implicit tax rates.

An extent of shocks varies due to differences in implicit tax rate shares. In other words, a lower increase of implicit tax rate on consumption is needed, since the tax base is larger (nominal consumption) than in case of other two taxes (wage bill). Also the speed of convergence differs depending on estimated tax specific parameters (λ^x).

Two ways of increasing direct taxation and lowering benefits to households may be said as equivalent in terms of initial impact to the economy. However, they differ in dynamics. The increase of direct taxation is more persistent and it takes longer time before negative effects on the economy pass away. Higher taxes on consumption has lower initial impacts and the persistence of effects on real economy (GDP, consumption, wages etc.) is comparable to reduction in benefits.

However we define shocks in order to get/save an equal amount of funds, resulting impacts on the budget are not identical. This is again due to dissimilarities in persistence of shocks and due to different effects that various taxation measures has on the economy and consequently on government revenues and expenditures. The debt reduction corresponds to duration of positive effects on the budget balance.

[13] This sum represents approximately 0.6% of GDP in 2009.

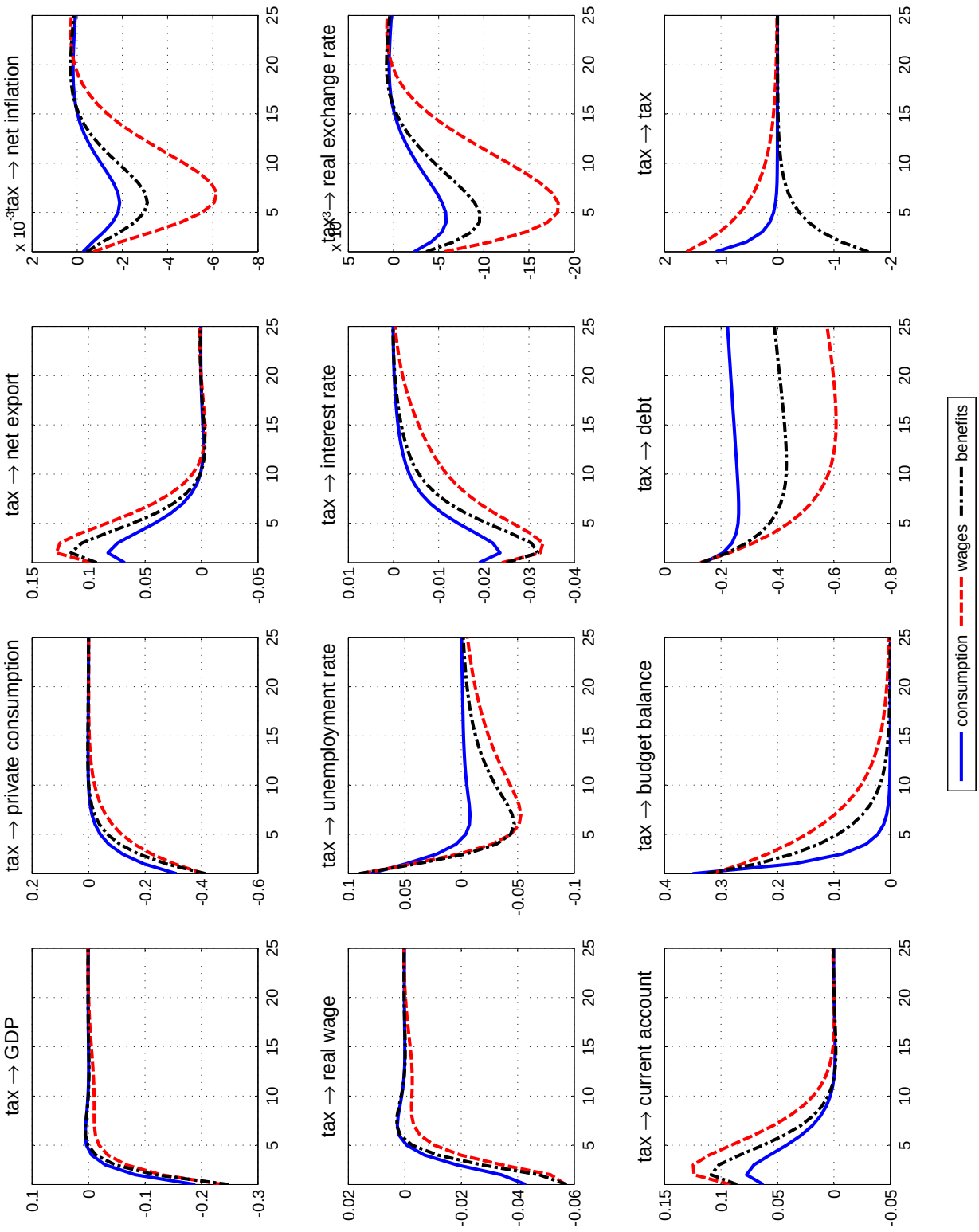

Figure 18: Different taxes/benefits measures

5 Conclusion

In this paper, we introduce an extension of the DSGE model "HUBERT" in order to be able to provide a basic analysis of fiscal policy measures. To do this, it was necessary to redefine certain parts of the current model. Two main features was introduced. First, to capture the model dynamics properly, two type of households need to be distinguished. Besides so called Ricardian households, smoothing their consumption via capital market, non-Ricardians (Rule-of-Thumb households), spending all income on consumption in each period of time, has been included. A share between them is usually a subject to an expert judgment. We stem from data of the European Union, namely Statistics on Income and Living Conditions (EU-SILC), from which we derive the assumption. To show a sensitivity of our model on this parameter we include an analysis showing not very substantial vulnerability.

Fiscal policy block witnessed mostly some refinements mainly concerning definitions of tax rates. These have been previously assumed as constants in the model and in this version became variables. We simply assume taxes to follow AR(1) process. To derive taxes as implicit shares we use National Accounts in the structure also mentioned in the paper. Variables of implicit taxes are always calculated as a share of income from the tax and its respective base. Trying to keep the model medium scaled and easily manageable, we include two tax groups on revenue side - tax on consumption and tax on wages - and two types of expenditure items - paid out benefits and government consumption.[14] Through these implicit rates, we are able to translate certain policy measures into the model. We do not modify our fiscal rule, which is still expenditure oriented and stems from the condition of balanced primary government balance.

In the analytical part of the paper we try to illustrate results using impulse response analysis. We present how unit shocks into government consumption, taxes on consumption, taxes on wages and paid out benefits affect real economy. A story behind those results is attached. Dealing with testing the model and preparing some analysis, some questions came to our mind. Some of them are demonstrated in the last Chapter. Besides the sensitivity for the share of non-Ricardian households, we show how the results are dependent on the estimated parameter of fiscal rule reflecting a speed of convergence of public finances. Also in this case there are not significant distinctions between scenarios.

Another issue, when analyzing impacts of fiscal policy measures, is a role of the Central Bank. We try to compare two situations. First, Central Bank normally react on economic situation according its rule and adjust short term rates based on output and inflation gaps. Second possibility is a cooperation of fiscal and monetary policy which lead to a non-accommodation on the side of Central Bank. In the result, interest rate

[14]The latter of course differs from the others since it is not defined as an implicit tax rate.

does not change. The differences are more pronounced here than in case of previous scenarios. Interest rate and its dynamics is thus important and deserves an attention. We namely leave the discussion of the role of short-term and long-term interest rates in the model for future research.

These policy analysis should also answer the question about differences between various policy measures and their economic impacts. That is why we compare some ways how to save or get an additional fund for the state budget. We arbitrarily choose e.g. 20 bn CZK and study impacts. They differ in both, level (due to differences in implicit shares) and dynamics. The increase in direct taxes seems more persistent and significant for the real economy compering to others.

The paper does not include an analysis of corporate income taxes, since the block of firms is not established in a proper manner to get reasonable results. This issue remains among our plans for the next period. Besides a proper definition of investments and capital in the model (see Woodford (2004), Woodford (2005) and Altig et al. (2005)), we would like to introduce some additional labour market imperfections by incorporating a matching function that can capture a limited matching between vacancies and unemployment in the economy, see Moyen and Sahuc (2004), Trigari (2004) and Stevens (2007). And finally some important parameters that are rather difficult to calibrated will be estimated via to different estimation techniques: Bayesian MLE and SMM, see Ruge-Murcia (2007) for details.

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Appendix A: Data used for construction of implicit tax rates

Data from National Accounts that are used to define incomes of the state budget from respective taxes and social expenditures are defined as follows.

ESA95 code	**Item**
Taxes on consumption T_t^c	
D211	Value-added type taxes (VAT)
D2122C	Excise taxes
D214A	Excise taxes
Taxes on wages T_t^w	
D51A	Taxes on individual or household income
D51C1	Taxes on holding gains
Benefits G_t^s	
D62	Social benefits other than social transfers in kind