Does “The” Fiscal Multiplier Exist?

Fiscal and Monetary Reactions, Credibility and Fiscal Multipliers in Hungary[1]

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Abstract:

There is a lack of consensus on the effects of fiscal policy measures (the so called fiscal multipliers) both in Hungary and in developed countries. We argue that there is no such a unique fiscal multiplier. We use a stochastic, dynamic general equilibrium (DSGE) model estimated on Hungarian data, with five types of distortionary fiscal instruments. Not surprisingly, there is a significant difference between the multipliers of different types of fiscal expansions. Second, we found that agents’ perception on how permanent the shift in fiscal policy is has sizable implications on the multipliers. Third, multipliers can vary also when we take into account the future ways of financing the expansion. Our results show that the role of fiscal reaction in shaping multipliers is mostly important when the initial expansion affected taxes. On the other hand, multipliers are affected by a lesser extent in the case of increasing government expenditures or financial transfers. The extreme cases are when multipliers turn into negative after a relatively short time. These are the cases of reduction in employers’ social security contributions or personal income taxes when they are financed through expenditure items, for example. We also

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found that in a small open economy where monetary policy mostly reacts to inflation, accommodative monetary policy only hardly modifies fiscal multipliers.
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1. Introduction

Recent financial crisis and the accompanying fiscal policy measures initiated a large debate among economists on the possible effects of the large-scale fiscal packages in the US (American Reinvestment and Recovery Act). Romer and Bernstein (2009) present an estimate on how this fiscal stimulus helps in mitigating the recent crisis. However, the Romer and Bernstein (2009) Report is heavily criticized by several economists.

Worldwide fiscal stimuli gave rise to a growing number of papers on fiscal multipliers[5]. Van Brusselen (2009) summarizes and compares multipliers of traditional macroeconomic models, VAR-models and DSGE models. The multipliers estimated by VAR models (of tax cuts or public spending) have no obvious signs, the estimated public spending multipliers ranging between -3.77 and 3.68, and the tax cut multipliers varying between -4.75 and 2.64. Standard macroeconomic and econometric models produce similar results, the estimated range of fiscal multipliers for the US showing similar magnitudes. Public spending multipliers were estimated to be situated between -0.6 and 1.6, while the tax cut multiplier was between -0.4 and 1.3. In DSGE models multipliers have obvious signs e.g. in IMF's Global Fiscal Model (Bootman and Kumar (2006)) the public spending multipliers lie between 0 and 3.9, and the tax cut multipliers are situated between 0.23 and 2.63. Although in the international literature the fiscal stimulus has an increasingly important role, there are only a scarce number of papers on it, with no consensus whatsoever.

For example, Leeper et al (2009) argue that (1) „the assumption about which fiscal instruments may adjust to stabilize debt are very important for the ultimate impacts of change in fiscal policy", (2) „the speed at which debt is stabilized following a fiscal disturbance plays a critical role in determining the effects of the shock on the macroeconomy" and (3) „because debt-financed fiscal changes trigger very long-lived dynamics, even in completely conventional models, short-run impacts can differ sharply from long-run effects even being of different signs".

Cogan et al (2009) compare the Romer and Bernstein (2009) simulations with results that emerged from an estimated DSGE model (Smets and Wouters, 2007). They find that in this new-Keynesian model the GDP impact of the fiscal stimulus is only one-sixth of the results presented by Romer and Bernstein (2009).

[5] A set of new literature on fiscal multipliers emerged recently. Nice examples are Kilponen et al (2006), Batini et al (2009), Blanchard and Perotti (1999), Burriel et al (2009), Cogan et al (2009), Corsetti et al (2009), Forni et al (2009), Freedman et al (2009), Galí et al (2007), Laxton and Kumhof (2009), Leeper et al (2009), Lipinska and von Thadden (2009), Hansen and Sargent (2009), Mountford and Uhlig (2008), van Brusselen (2009).

These examples show that fiscal multipliers are often debated even for an economy like the US and the final outcome largely depends on the assumptions on what agents think of the future financing of these fiscal packages.

In small countries like Hungary the lack of research in this field is more severe. This paper is intended to contribute to this literature by discussing the effects of five distortionary fiscal instruments within an estimated DSGE model. Hungary is special in the sense that in the recent past it faced several episodes of sizeable fiscal expansions and consolidations. However, there are only a few papers focusing on the macroeconomic effects of these fiscal episodes. The very scarce literature includes Horváth et al (2006), Hornok et al (2008), a box in the August 2006 Inflation Report of the Hungarian central bank (Magyar Nemzeti Bank) and a recent paper of the newly established Fiscal Council.[6]

The lack of well-established research results in this field hinders the public debate as well. As noted by the Fiscal Council in September this year, there is a lack in transparency of the Hungarian fiscal planning procedure. This means that the methodology underlying the projections in the Budget Bill is not well reported. To assess the feasibility and the welfare costs or the benefits of fiscal measures, one would require a basic knowledge on the so called fiscal multipliers.

In this paper we focus on three aspects of the effects of fiscal policy measures for Hungary. We employ an estimated DSGE model for Hungary (the model is described in Baksa et al (2009)). The model is derived from Jakab-Kucsera-Szilágyi (2009) which is a simplified version of the model of Jakab and Világi (2008). The baseline model incorporates a fiscal block with two-types of expenditures (financial transfers and government purchases of goods), three types of distortionary taxes (value-added taxes, personal income tax and employers' social security contributions) and a lump-sum tax. The baseline model which is estimated does not contain fiscal reaction given our short data set and the highly erratic (and procyclical) nature of Hungarian fiscal policy (fiscal consolidations, though were aggressive, occurred only rarely).

Fiscal multipliers here are defined as *dynamic multipliers*: the percentage change in the particular variable (usually the GDP) for a fiscal shock amounting 1 percentage point of initial GDP. This measure is dynamic, as we calculate it for each period. The numerical results point to a set of conclusion as follows:

First, the values of the multipliers highly depend on the model structure and on the policy reactions. We use a DSGE model where agents expectations are explicitly modeled and monetary policy (and in some cases fiscal policy) follows a reaction function. Unlike in DSGE models, in more traditional macromodels (such as in Horváth et al (2006) where the Quarterly Projection Model of the Hungarian central bank is used) there is only a limited role for expectations and policy responses. Thus, in a DSGE-type framework one would expect

[6] A unique feature of this Fiscal Council report is that both the short and the long-run effects were presented.

smaller short run multipliers as both macroeconomic policies and agents' expectations react and this might reduce the multiplier effects. This is exactly the case here. Our estimated short-run multipliers are for most of the cases smaller than reported by Horváth et al (2006).

Not very surprisingly, the five types of fiscal stimuli we consider (increasing government purchases or financial transfers, reducing value-added tax, personal income tax or social security contributions) have very different implications both in the short and in the longer run.

Our second result is related to the agents' beliefs about the permanence of a shock. If the fiscal authority can credibly announce that a change in fiscal policy is permanent then the steady state allocation of the economy may change. Consequently, as long as there exist enough forward-looking agents, even the short run multiplier is markedly different from that of a fiscal shock perceived as temporary. Hence, what matters for the multiplier is how agents think of the measures; therefore credibility of fiscal announcements has important implications for the multipliers.

If the fiscal measures are permanent, the multiplier of government purchases is the largest and that of financial transfers is the smallest (both on the short-run (1-year) or the medium run (4 years ahead)). The reason is that in the model financial transfers are allocated to non-optimizer (rule-of-thumb) consumers, and even though their consumption increases, optimizers expect a future tax-rise and therefore the multiplier becomes relatively small. The multiplier of the VAT is smaller than that of other taxes and the reason might be that VAT affects domestic and export retailers differently. There is a reallocation in favor of the sellers of the domestic goods and this puts an additional effect on the top of what is observed with other distortionary taxes, the mechanism affecting the consumption-leisure choice.

On the other hand, the ordering of multipliers shows a very different picture if fiscal measures are temporary. Although the shocks are calibrated such that their effects on the deficit are the same in the first year, afterwards a stochastic process drives the future evolution of them (an estimated autoregressive process is set to be at work). Hence, what also matters is the estimated persistence of the shocks. According to our estimations a shock to social security contributions has a very long lasting path, while indirect taxes (VAT) are the least persistent. Thus, for example, when social security contributions are reduced, agents expect it to remain lower than the steady-state for a longer time and therefore its short run multiplier becomes much stronger than in the permanent-shock scenario. Government consumption has the strongest short-run multiplier, while the weakest is that of personal income taxes. In the medium run (4 years) social security contributions has by far the largest multiplier, while government purchases has almost zero multiplier.

The next question we raise is how the multipliers depend on the sources of financing of fiscal stimuli. For this sake, we inserted calibrated fiscal reaction functions where expenditures or taxes depend on the prevailing deficit. Since in Hungary fiscal policy was highly procyclical, we have not estimated reaction functions.

According to our simulation results, fiscal reactions do not largely modify the multipliers when fiscal reaction affects the expenditure side (government consumption or financial transfers). On the other hand, in the cases of initial tax-based fiscal expansions the way how the deficit is financed has a more pronounced role. If reductions of labor-related taxes (personal income tax or social security tax) are counterbalanced through cutting financial transfers or government expenditures, then the multipliers die out rapidly or become even negative. In the case of value-added tax reduction there is some change in the multiplier only when government expenditures react to it.

The last set of results deal with the role of monetary policy reactions (accommodative vs. activist) in shaping the multipliers. We found that since interest rate reacts to inflation and to a lesser extent to the nominal exchange rate, multipliers of a fiscal stimulus accompanied by a temporarily accommodative monetary policy hardly differ from the multipliers of a fiscal stimulus with activist monetary tightening. Our simulations suggest that in contrast to Freedman et al (2009) where passive monetary policy amplifies multipliers in large countries or currency areas, for a small open economy like Hungary this effect is less important.

2. The model

Our model is an estimated dynamic stochastic general equilibrium (DSGE) model, which is derived from the two-sector DSGE model of Jakab and Világi (2008), which ultimately draws on Smets and Wouters (2003).

The model economy incorporates a set of specific features, relative to Smets and Wouters (2003): Production is taking place by using – beyond labour and capital – imported inputs, while part of domestic production is exported. Part of consumers is liquidity-constrained, non-Ricardians, who spend their entire income (labour income and transfers) on consumption. Agents learn trend inflation in an adaptive way, from the previous period's trend inflation and the actual inflation.

Relative to Jakab and Világi (2008), there are a number of notable differences. While there are two production sectors (export and domestic) in the model, these two sectors are identical in terms of their production technology, in the sense that they produce intermediate output by using imports and labour, and then final output is being produced by using intermediate goods and capital. However, the price of exported goods is set in foreign currency, while goods consumed domestically are priced in domestic currency (both priced subject to nominal rigidities).

The most important contribution of this model is that here the fiscal policy is modelled explicitly. While in the Jakab-Világi (2008) model the government budget appears only implicitly so that it always achieves equilibrium by collecting lump sum per capita taxes and by transfers, here we introduce a number of different taxes (personal income tax, employers' contribution tax and consumption tax), and we implement a set of fiscal rules.

We estimated the resulting one-sector model – augmented with fiscal policy – for the sample between 1995 and 2008. It was taken into account that in 2001 there was a change in the monetary policy, which – in the case of the general equilibrium models – leads to an entirely different model. We managed the problem of the policy change by setting up two separate models and we considered this change – using Jakab-Kónya (2009) method – during the Bayesian estimation. First we estimated the model for the first period, and subsequently we used the resulting posterior averages as priors for the estimation of the second period.

DSGE models are particularly useful when exploring fiscal impact mechanisms. As they describe a general equilibrium, they are suitable for modelling the long-term welfare consequences of the measures taken by the government. This cannot be achieved by using traditional macro-econometric models. Another advantage is that as there are forward-looking agents, the model is capable of distinguishing between expected and unexpected events. The model behaves very differently, depending on whether the agents expect a future tax increase or the increase comes as a surprise. However, this feature may have disadvantages in fiscal policy simulations, since part of the fiscal measures is expected to take place for sure, while another part is uncertain and depends on political bargaining. Therefore the model user should make a decision regarding what to presume about the persistence and credibility of future measures. In the case of fiscal policy simulations these decisions may even reverse the sign of the results.

Our model has the following features: the underlying basic model is a neoclassical (RBC) model, which is then augmented by various imperfections and frictions. The resulting model has Keynesian features in the short run, and neoclassical ones in the long run.

The main frictions are the following:

- Habit formation: consumers do not only consider their instantaneous utility, but their habits (past consumption) also plays a role. This induces less volatility and more persistence in consumption, compared to RBC models.

- Production: there are fixed costs in production and the capacity utilisation of production factors varies. Production can adjust to changes in conditions only with a lag.

- Investments: the amount of capital is costly to adjust. When making investments decisions one should take also into consideration the current and expected price of capital. Thus, future profitability will have a key role in making capital-related decisions.

- Pricing: Price and wage setters face nominal stickiness and follow a Calvo-pricing mechanism, not being able to determine an optimal price and wage at all times. Exporters set their price in foreign currency (local currency pricing) while domestic good producers in domestic currency.

- There are significant indexation mechanisms in the economy; agents unable to set an optimal price may apply the rules of thumb and partially index their prices and wages with past inflation. The consequence of this is that the disinflationary efforts of the monetary policy bear real economic costs even beyond those determined by price stickiness: the realisation of a permanently lower inflation environment is accompanied by a decline in production.

- There is perceived trend inflation in the model that agents learn from past events. Thus, inflation trend reaches the central bank's target only gradually. The central bank will face credibility problems – at least temporarily – if it announces a new target for the future.

- The economy is small and open: export prices, foreign import prices and export demand are exogenous On the other hand foreign investors penalise the country's excessive indebtedness by demanding higher interest rate premium.

- The monetary authority operates an inflation targeting regime with an interest rate rule that considers deviations from the inflation target and movements in the exchange rate.

In addition to the above, we introduced several frictions in connection with fiscal policy measures.

- Some agents are fully liquidity-constrained and spend the entire amount of their current income on consumption. This entails that any fiscal policy change will have significant real impacts over the short term (with no such players, the fully rational and forward-looking agents would know that each current fiscal measure will have a tax increasing or tax reducing impact in the future. They would therefore incorporate this knowledge into their current decisions; – they would be Ricardian consumers – their behaviour would not change).

- There are three types of taxes: the tax levied on labour and paid by the employees, the tax levied on labour and paid by employers and consumption tax. We did not include capital taxes in the model, as the empirical modelling of those would have entailed rather complicated data problems. These taxes are distorting taxes, and they influence the long-term profitability of the economy. Regarding VAT rates, we assume that the net prices are the sticky ones, thus any VAT change would always entail a price change.

- The government has two types of discretionary expenditures: it provides financial transfers to the liquidity-constrained non-optimiser consumers and purchases goods and services from the private sector.

- The questions of deficit financing are rather simplified in the model; due to the existence of forward-looking consumers, the financing structure of the general government deficit predominantly depends on the structure of the tax system.

There are five categories of players in the model: households, firms, the government, the monetary policy maker and the foreign sector. In the case of households and firms we define their behavioural equations on their objective functions and budget constraints.

Households

The utility function of household j is given by:

$$\sum_{t=0}^{\infty} \beta^t [(1+\eta_t^c)\{u(H_t^o(j)) - (1+\eta_t^l)v(l_t(j))\}],$$

where $u(H_t^o(j)) = \left(\frac{c_t^o(j) - hc_{t-1}^o}{1-\sigma}\right)^{1-\sigma}$ denotes the consumption utility of household j considered under external consumption habits, $v(l_t(j)) = \frac{l_t^{1+\varphi}}{1+\varphi}$ denotes the leisure utility of the individual households, where $l_t(j)$ denotes the number of working hours spent by consumer j in the corporate sector. The households' subjective and the economy's long term discount factor is given by parameter β. Households' consumption and employment valuation may vary over time, represented by preference shocks to consumption, η_t^c, and leisure, η_t^l. The σ parameter describes the intertemporal elasticity of the individual households' utility, while the h parameter denotes the strength of habit formation.

Households maximise the above objective function subject to the budget constraint:

$$\begin{aligned}(1+\tau_t^c)P_t c_t^o(j) + P_t I_t(j) + \frac{B_t(j)}{1+i_t} \\ = B_{t-1}(j) + X_t^w(j) + (1-\tau_t^l)W_t(j)l_t(j) + P_t r_t^k u_t(j) k_{t-1}(j) \\ - \Psi(u_t(j))P_t k_{t-1}(j) + Div_t - T_t\end{aligned}$$

According to this, individual households receive labour income for their work in accordance to their negotiated wage $W_t(j)$, on which they pay (τ_t^l) income tax to the government. Income is either consumed or saved. Consumption ($c_t(j)$) is subject to a consumption tax(τ_t^c). Savings are either invested or placed into risk-free bonds (B_t) that yield an interest income (i_t). Investments $I_t(j)$ increase the stock of available capital goods *(k_t)*, with the limitation that in the period concerned not all the accumulated capital, but only a certain part of it *(u_t)* is put at the disposal of firms. Households receive capital income (r_t) on the capital supplied earlier. Households own the shares of the firms, thus if firms realise profits (Div_t) then those will further increase the income of households. If the government accumulates a deficit (T_t) then it is covered fully by lump-sum taxes levied on households. Households supply differentiated labour; however, there is a $X_t^w(j)$ state-contingent security that eliminates the risk of heterogeneous labour supply and income.

Physical capital accumulation is given by:

$$k_t = (1-\delta)k_{t-1} + \left[1 - \phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right)\right] I_t,$$

where $\phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right)$ is a convex investment adjustment cost, while η_t^I denotes the shock to the adjustment function.

Households maximise their lifetime utility, resulting the following equilibrium conditions:

1. Euler equation:

$$\frac{\lambda_t}{(1+\tau_t^c)P_t} = \beta(1+i_t)E_t\left[\frac{\lambda_{t+1}}{(1+\tau_{t+1}^c)P_{t+1}}\right]$$

where λ_t denotes the marginal utility of consumption in period *t*.

2. Dynamics of investments:

$$\frac{\lambda_t}{1+\tau_t^c}Q_t\left[1-\phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right) - \phi_I'\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right)\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right]$$
$$= \frac{\lambda_t}{1+\tau_t^c} - \beta E_t\frac{\lambda_{t+1}}{1+\tau_{t+1}^c}\left[Q_{t+1}\phi_I'\left(\frac{(1+\eta_{t+1}^I)I_{t+1}}{I_t}\right)\frac{(1+\eta_{t+1}^I)I_{t+1}^2}{I_t^2}\right]$$

where Q_t is the shadow price of capital.

3. No-arbitrage condition determines the portfolio choice between bonds and physical capital:

$$\lambda_t Q_t = \beta E_t \lambda_{t+1}[Q_{t+1}(1-\delta) + u_{t+1}r_{t+1}^k - \Psi(u_{t+1}(j))]$$

4. Capital utilisation level is determined by the condition:

$$r_t^k = \Psi'(u_t(j))$$

An ϖ fraction of the consumers are liquidity-constrained unable to optimize their entire life-time utility. They spend all of their labour income and the financial transfers (TR_t) received in the given period on purchasing consumption goods (c_t^{no}).

$$(1+\tau_t^c)P_t c_t^{no} = (1-\tau_t^l)W_t l_t + \frac{TR_t}{1-\varpi}$$

There is monopolistic competition in the labour market, different types of labour being supplied by households. Households act as unions being able to set wages with a markup.

Only $1\text{-}\gamma_w$ of the households are able to set the optimal nominal wage, the remaining follow a rule-of thumb indexation to past inflation. The resulting (log-linearized) wage Phillips curve has the form:

$$\widehat{\pi_t^w} = \frac{(1-\gamma^w)(1-\beta\gamma^w)}{\gamma^w(1+\theta^w\varphi)(1+\beta\vartheta^w)}\left\{\varphi l_t - w_t + \eta_t^l + \frac{\sigma}{1-h}\left(c_t^l - hc_{t-1}^l\right) + \frac{\tau^c}{1+\tau^c}\tau_t^c + \frac{\tau^l}{1+\tau^l}\tau_t^l + \xi_t^w\right\} + \frac{\beta}{1+\beta\vartheta^w}E_t\widehat{\pi_{t+1}^w} + \frac{\vartheta^w}{1+\beta\vartheta^w}\widehat{\pi_{t-1}^w},$$

where ϑ^w denotes the rate of indexation, θ^w denotes the labour market elasticity, while c_t^l is the weighted marginal utility of the two types of consumers in the period t. ξ_t^w is the mark-up shock.

Firms:

Production takes place in two Phases. In the first phase firms produce a homogenous intermediate product (z_t) through a CES production function by using labour (l_t) and import (m_t) as input. Factor inputs are subject to adjustment costs (ϕ_1 and ϕ_2).

$$z_t = \left(a^{\frac{1}{\varrho_z}}\left[(1+\phi_1)^{-1}l_t\right]^{\frac{\varrho_z-1}{\varrho_z}} + (1-a)^{\frac{1}{\varrho_z}}\left[(1+\phi_2)^{-1}m_t\right]^{\frac{\varrho_z-1}{\varrho_z}}\right)^{\frac{\varrho_z}{\varrho_z-1}},$$

where a denotes the share of labour used in production, while ϱ_z denotes the elasticity of substitution between the factors. Due to the adjustment costs, the effective factor costs differ from the market prices of the inputs. The firm's cost minimisation problem yields:

1. Effective wage ($\overline{w_t}$):

$$\overline{w_t} = \frac{(1+\tau_t^s)w_t}{(1+\phi_1)^{-1} - l_t(1+\phi_1)^{-2}\phi_1^{'}}$$

This indicates the link between the market real wage (w_t) and the wage costs relevant for firms.

2. Effective import price ($\overline{q_t P_t^{m*}}$):

$$\overline{q_t P_t^{m*}} = \frac{q_t P_t^{m*}}{(1+\phi_2)^{-1} - m_t(1+\phi_2)^{-2}\phi_2^{'}},$$

This indicates the relationship between the import price and the import costs relevant for companies, where q_t is the real exchange rate and P_t^{m*} is the import price expressed in foreign currency.

3. Marginal cost of the intermediate product:

$$w_t^z = \left[a\overline{w}_t^{1-\varrho_z} + (1-a)\,\overline{q_t P_t^{m*}}^{1-\varrho_z}\right]^{\frac{1}{1-\varrho_z}}$$

shows – in real terms – the production costs of the supplementary intermediate product.

4. Labour demand:

$$l_t = a\left(\frac{w_t^z}{w_t}\right)^{\varrho_z} z_t(1+\phi_1)$$

5. Import demand:

$$m_t = (1-a)\left(\frac{w_t^z}{q_t P_t^{m*}}\right)^{\varrho_z} z_t(1+\phi_2)$$

The homogenous intermediate product is purchased by monopolistically competitive firms and combined through a CES production function with the accumulated capital supplied by households, yielding the final output:

$$y_t(i) = (1+\eta_t^A)(\alpha^{\frac{1}{\varrho}}\bar{k}_t(i)^{\frac{\varrho-1}{\varrho}} + (1-\alpha)^{\frac{1}{\varrho}}z_t(i)^{\frac{\varrho-1}{\varrho}})^{\frac{\varrho}{\varrho-1}} - y\bar{f},$$

where α denotes share of the capital in the production, ϱ denotes the elasticity of substitution, while $\bar{f}$ is the fixed cost of production. The first order conditions of the cost minimization problem are::

1. Final goods real marginal cost (mc):

$$mc_t = \frac{(\alpha(r_t^k)^{1-\varrho} + (1-\alpha)(w_t^z)^{1-\varrho})^{\frac{1}{1-\varrho}}}{1+\eta_t^A}$$

2. Capital demand function:

$$u_t k_{t-1} = \alpha\left(\frac{mc_t}{r_t^k}\right)^{\varrho} \frac{DP_t y_t + y\bar{f}}{(1+\eta_t^A)^{1-\varrho}}$$

3. Intermediate product demand function:

$$z_t = (1-\alpha)\left(\frac{mc_t}{w_t^z}\right)^{\varrho} \frac{DP_t y_t + y\bar{f}}{(1+\eta_t^A)^{1-\varrho}},$$

where DP_t denotes the prices' dispersion from the price index.

We assume that firms set their price in a Calvo-setting, that is, only a fraction of $1\text{-}\gamma_d$ of them is able to set their optimal price in a given period. The remaining firms follow a rule-of-thumb by indexing their price to the perceived trend inflation. The resulting log-linearized New Keynesian Phillips curve for the domestic inflation ($\widehat{\pi_t}$) takes the form:

$$\widehat{\pi_t} = \frac{(1-\gamma^d)(1-\beta\gamma^d)}{\gamma^d(1+\beta\vartheta^d)}\{mc_t + \xi_t^d\} + \frac{\beta}{1+\beta\vartheta^d}E_t\widehat{\pi_{t+1}} + \frac{\vartheta^d}{1+\beta\vartheta^d}\widehat{\pi_{t-1}},$$

where ϑ^d denotes the rate of indexation, while ξ_t^d is the mark-up shock.

Part of final goods is exported. Exporting companies – similarly to domestic companies – also compete monopolistically and set their price in a Calvo manner. 1- γ_x of them is able to set the optimal price, while the remaining index their previous price by the previous price change. The new Keynesian Phillips curve for export price inflation ($\widetilde{\pi_t^{x*}}$) takes the form:

$$\widetilde{\pi_t^{x*}} = \frac{(1-\gamma^x)(1-\beta\gamma^x)}{\gamma^x(1+\beta\vartheta^x)}\{-P_t^{x*} - q_t + \xi_t^x\} + \frac{\beta}{1+\beta\vartheta^x}E_t\widetilde{\pi_{t+1}^{x*}} + \frac{\vartheta^x}{1+\beta\vartheta^x}\widetilde{\pi_{t-1}^{x*}},$$

where ϑ^x denotes the rate of indexation, while ξ_t^x is the mark-up shock and P_t^{x*} is the export price measured in foreign currency.

Regarding tend inflation, agents apply a special adaptive learning algorithm, where they "learn" trend inflation gradually from the previous period's trend inflation and the actual inflation of the period concerned:

$$(1+\overline{\pi_t}) = (1+\overline{\pi_{t-1}})^{\rho_\pi}\left(\frac{1+\pi_t}{1+\overline{\pi_t}}\right)^g,$$

where ρ_π is the persistence of trend inflation and g is the learning speed parameter.

We assume that the change in consumption taxes is irrelevant for firms; therefore the Phillips curves do not include any consumption tax. Consumption taxes are introduced separately – in addition to the actual inflation – by defining gross price-based inflation:

$$1+\pi_t^{gross} = (1+\pi_t)\frac{1+\tau_t^c}{1+\tau_{t-1}^c}$$

Monetary policy

The monetary authority controls interest rates based on a Taylor-type rule. The objective function includes net inflation (i.e. inflation without VAT) and (with smaller weight) changes in the nominal exchange rate:

$$\frac{1+i_t}{1+r} = \left(\frac{1+i_{t-1}}{1+r}\right)^{\zeta_i}\left((1+\pi_t)^{\zeta_\pi}e_t^{\zeta_e}\right)^{1-\zeta_i}(1+\eta_t^i),$$

where ζ_i denotes the degree of interest rate smoothing, ζ_π the weight on inflation, ζ_e the weight of the nominal exchange rate (e_t). r is the long-term interest rate, while η_t^i is an exogenous stochastic shock.

Fiscal policy

Fiscal policy is implemented through a set of simple fiscal rules, in the baseline model the fiscal policy is passive player (levies lump-sum taxes and spends on lump-sum transfers in order to achive balanced budget). The government can finance its expenditure either from raising tax revenues (value added tax, personal income tax or employers' social security contributions) or from deficit. We assume that financial transfers are devoted to non-optimiser households. The government budget constraint is:

$$OT_t + Debt_t + \tau_t^c c_t + \tau_t^l w_t l_t + \tau_t^s w_t l_t = P_t(1+\eta_t^G)G + TR_t + \frac{1+i_t}{1+\pi_{t+1}^{gross}} Debt_{t-1},$$

where G is the steady state value of volume of government purchases of goods and services, while η_t^G is the shock to government expenditures leading to temporary deviations from steady state expenditures. TR_t denotes financial transfers to non-optimizers. τ_t^c refers to the value added tax rate, τ_t^l to personal income tax rate[7], τ_t^s to the employers' social security contribution tax rate, respectively. Other net revenues (OT_t assumed to be of a lump-sum nature. $Debt_t$ denotes government debt calculated for simplicity as accumulated deficits. We assume that other revenues follow an autoregressive process with an i.i.d.shock.

$$\widehat{OT}_t = \rho^{OT}\widehat{OT}_{t-1} + \xi_t^{OT}$$

Total deficit is defined by the following equation:

$$T_t = PS_t - \left(\frac{1+i_t}{1+\pi_{t+1}^{gross}} - 1\right) Debt_{t-1},$$

where T_t is total sufficit (primary balance minus interest payments) while PS_t denotes the primary balance of the budget. Government debt follows the law of motion:

$$Debt_t = Debt_{t-1} - T_t$$

In the baseline model (which is the estimated one, as well) we treat all tax rates as exogenous processes, and thus deficit is financed by lump sum taxes. This choice of estimation strategy was motivated by the observation that Hungarian fiscal policy stabilized its deficit in a rather erratical way: hence estimating reaction functions would have been rather impossible, our short data set is not enough informative.

On the other hand, we seek to analyse the role of fiscal reactions. Conseqently, we use calibrated fiscal reaction functions through the alternative simulations. For this purpose, we define five alternative rules. According to the reaction functions fiscal authroity reacts to current output (deviation from steady state) in order to fulfil its stabilizationary role (or

[7] Social security contributions paid by employees are categorized to personal income taxes throughout this paper.

simply letting the automatic stabilizers work). Apart from it, either taxes or expenditures are set such that they react to past deficits or debts. Thus, fiscal policy (though only in a lagged fashion) tries to stabilize the deficits and consequently the debt level.

The reaction for taxes follow:

$$\widehat{\tau_t^i} = \rho^{\tau^i}\widehat{\tau_{t-1}^i} + \varphi_{GDP}^{\tau^i} GDP_t + \varphi_T^{\tau^i}\widehat{T_{t-1}} + \varphi_D^{\tau^i}\widehat{D_{t-1}} + \xi_t^i$$

where *i={c, s, l}* for each type of tax belong one tax rule, where ξ_t^i means the shocks in t periods, and hats denote log-deviations.

For the government expenditure and financial transfers the following rules are applied:

$$\widehat{x_t} = \rho^x\widehat{x_{t-1}} + \varphi_T^x\widehat{T_{t-1}} + \varphi_{GDP}^x GDP_t + \varphi_D^x\widehat{D_{t-1}} + \xi_t^x$$

where *x={TR,* η_t^G*}.*

In order to have an insight on the role of each rule, in either of the fives cases only one reaction function is switched on.

The parameters for fiscal reaction function are imported from Leeper et al (2009) estimation.

External sector

The external sector is represented in an ad hoc manner. The demand for export goods (x_t) is given by:

$$x_t = (1 + \eta_t^x)x^*(P_t^{x*})^{-\theta^{x*}},$$

where θ^{x*} is the export price elasticity, x^* is the long-term value of export, and η_t^x is the exogenous shock to export demands. We assume that import prices evolve exogenously. Economic agents may accumulate debts against foreign partners. Foreign interest rate depends on the net foreign asset position (b_t) and on the financial premium shock η_t^{pr} (Schmitt-Grohé-Uribe):

$$\frac{1 + i_t^*}{1 + r} = e^{-\nu(b_t - b)}(1 + \eta_t^{pr}),$$

The evolution of net foreign assets (expressed in foreign currency) is given by the assets in the previous period and by the net exports:

$$b_t = (1 + i_{t-1}^*)b_{t-1} + \frac{P_t^{x*}x_t}{GDP^{ss}} - \frac{P_t^{m*}m_t}{GDP^{ss}},$$

Nominal exchange rate is determined by the uncovered interest rate parity:

$$\frac{1+i_t}{1+i_t^*}=\frac{e_{t+1}}{e_t}$$

Equilibrium conditions

The goods market equilibrium condition follows from aggregating the individual budget constraints:

$$y_t=c_t+I_t+(1+\eta_t^G)G+DP_t^x x_t+\Psi(u_t(j))k_{t-1},$$

where c_t is the aggregated consumption of the two types of consumers, $\Psi(u_t(j))k_{t-1}$ is the volume of capital not utilised in production and DP_t^x is the dispersion of export prices**.** In order to determine the total GDP of the economy, it still needs to be adjusted by the export revenues, import expenses (calculated in domestic currency) and the expenses used for export production:

$$GDP_t=y_t+q_tP_t^{x*}x_t-q_tP_t^{m*}m_t-x_t$$

Estimation results

The model was estimated by Bayesian methods for two regimes describing different monetary policy strategies. The two-step estimation method is similar to that of Baksa et al (2009). Table 1 summarizes that estimation results. According to the estimation, nominal wages are relatively flexible, and domestic prices are the most rigid. Indexation mechanism in setting domestic prices were important in the first monetary regime (with preannounced depreciation of the currency) while in the second regime (in the inflation targeting period) it has lost its role. Though in a much limited extent it can also observed in the case of indexation of export prices and wages. Our estimation results show a relatively small extent to habit in consumption (in contrast to Jakab-Világi (2008) and Jakab-Kucsera-Szilágyi (2009)). Interest rate smoothing in the second monetary regime was found to be low in international comparison, while the reaction of monetary policy to (net) inflation does not differ too much from the original Taylor coefficient of 1.5.

Table 1: Estimated parameters

		Prior distribution*			Estimated posterior			
		Type	Mean	Std. Error	1. regime		2. regime	
					Mean	90% prob. int.	Mean	90% prob. int.
Utility function								
Intertemporal elasticity	σ	Normal	2.0	0,4	2.0078	1.6-2.44	2.2351	1.67 -2.77
Consumer habit	h	Beta	0,6	0,1	0.4168	0.32-0.50	0.3949	0.26 -0.53
Parameters of pricing, waging								
Indexation of wage	ϑ^{w}	Beta	0,5	0,15	0.2415	0.1-0.39	0.0795	0.01-0.15
Indexation domestic price	ϑ^{d}	Beta	0,5	0,15	0.9166	0.87-0.97	0.1482	0.01-0.29
Indexation export price	ϑ^{x}	Beta	0,5	0,15	0.6619	0.45-0.87	0.5971	0.37-0.84
Calvo parameter of domestic price	γ^{d}	Beta	0,5	0,15	0.8176	0.79-0.84	0.838	0.81-0.86
Calvo parameter of export price	γ^{x}	Beta	0,5	0,15	0.6782	0.63-0.72	0.7575	0.73-0.79
Calvo parameter of wage	γ^{w}	Beta	0,5	0,15	0.4617	0.39-0.53	0.4744	0.41-0.54
Other parameters								
Elasticity of export	ϑ^{xs}	Beta	0,5	0,15	0.7009	0.58-0.80	0.7029	0.55-0.87
Inflation learning	g	Beta	0,167	0,03	0.2014	0.16-0.24	0.2004	0.15-0.24
Interest rate smoothing**	ζ_{i}	Beta	0,5	0,15	-	-	0.6141	0.45-0.76
Inflation in Taylor rule**	ζ_{π}	Normal	1,5	0,16	-	-	1.5328	1.29-1.8
Autoregresszive coefficients								
Productivity	ρ_{a}	Beta	0,8	0,1	0.5331	0.43-0.62	0.4172	0.29-0.53
Export demand	ρ_{x}	Beta	0,8	0,1	0.8593	0.79-0.95	0.6917	0.55-0.85
Financial premium	ρ_{pr}	Beta	0,8	0,1	0.5551	0.49-0.62	0.4621	0.37-0.57
Government expenditure	ρ_{g}	Beta	0,8	0,1	0.8022	0.62-0.92	0.7528	0.62-0.89
Financial transfer	ρ_{tr}	Beta	0,8	0,1	0.857	0.79-0.95	0.8115	0.67-0.96
Consumer preference	ρ_{c}	Beta	0,8	0,1	0.8731	0.79-0.96	0.8203	0.68-0.98
Labor market	ρ_{w}	Beta	0,8	0,1	0.9265	0.86-0.98	0.902	0.78-0.99
Investment	ρ_{I}	Beta	0,8	0,1	0.895	0.84-0.95	0.4786	0.34-0.62
Value-added tax rate	ρ_{tc}	Beta	0,8	0,1	0.8849	0.81-0.97	0.7598	0.57-0.99
Social security contribution rate	ρ_{ts}	Beta	0,8	0,1	0.9359	0.88-0.99	0.99	0.97-1
Personal income tax rate	ρ_{tl}	Beta	0,8	0,1	0.853	0.77-0.93	0.9094	0.84-0.98

** The prior distribution concerns the first regime; in the second regime the prior corresponds to the posterior average estimated for the first regime. The parameters of the monetary policy reaction functions are exceptions.*

*** The parameter was only estimated in the second regime.*

3. Results

3.1. Fiscal multipliers under permanent and transitory fiscal measures

In DSGE models the expectations that the agents form regarding the various fiscal measures, are crucial. In this respect, when determining the impact of fiscal stimulus we operate with two distinct set of assumptions that form the basis of the two scenarios we consider.

In the first scenario agents consider fiscal policy changes as permanent and fully credible. Technically, this is implemented as permanent shocks that change the long-run steady state of the economy.

The second scenario considers transitory fiscal stimulus. This implies that the measures taken are not fully credible, and there is a chance that they will be abolished at some point in the future. While the timing of the reversal is uncertain, however, we impose the special assumption that the measures would be for sure in operation for at least one year. Technically, this implies that the economy would start to move back gradually to its initial steady state not earlier than one year.

We implement five simple alternative fiscal shocks, each under the two scenarios, and compare the implied fiscal multipliers. There are considerable differences between the effects of the permanent and temporary stimuli. As general rule, the effect of the permanent stimulus emerges more gradually, thus, in the first year it shows less than half of its full impact. On the other hand, transitory measures are usually most effective in the first year (when they are in operation with a 100% probability) and then they die out gradually. The remaining differences are detailed below.

Value added tax

Figure 1 shows the multiplier of a 1% fiscal stimulus (in GDP terms) through a reduction of the value added tax rate. A permanent ease of value added taxes has a long-run multiplier of around 0.45. In the first year the impact is much lower than in the transitory case. This is explained by the different behavior of the optimizer Ricardian consumers. Ricardian agents are aware that a tax easing will be followed by future tax increases. If the easing is transitory, then obviously they would expect less future tax increase and therefore they will resort to less precautionary savings and consume more in the first year.

This reaction of the optimizer agents is amplified further by the relative price of current consumption relative to future consumption. If the tax decrease is temporary, then they will expect higher consumption tax and more expensive consumption for the subsequent years, which determines them to take the advantage of cheap consumption in the first year and consume more.

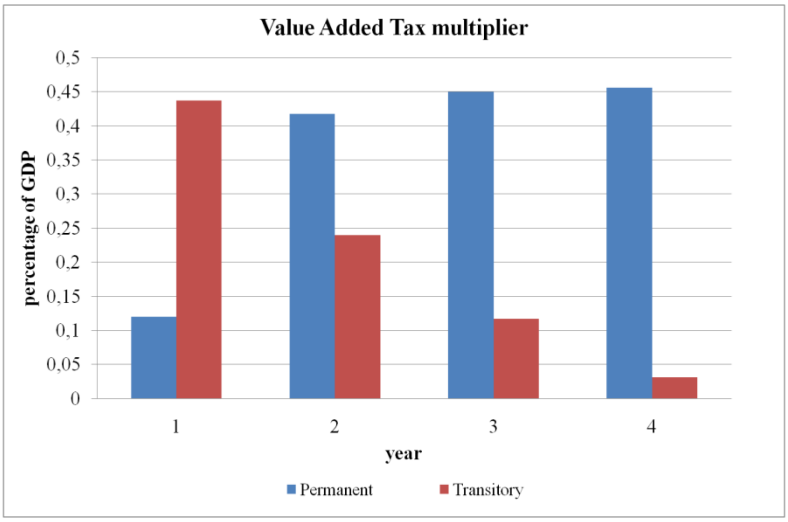

Figure 1: 1% stimulus (in GDP terms) through lowering the VAT rate

Personal income tax

The impact of a 1% fiscal stimulus (in GDP terms) through a lowering of the personal income tax rate is shown on Figure 2. The long-run multiplier of a permanent tax decrease is around 80%, much higher than for a VAT decrease. The reason for this is that VAT decrease affects domestic and export retailers differently, triggering a reallocation in favor of the sellers of the domestic goods. Further, the lower income tax boosts labor supply, and since fiscal measures are credible and permanent, the agents would permanently adjust to a higher level of employment and consumption.

A temporary change in the personal income taxes has a relatively small effect. The temporary increase in income will be partly saved to finance future tax increases, and partly consumed in a smooth way.

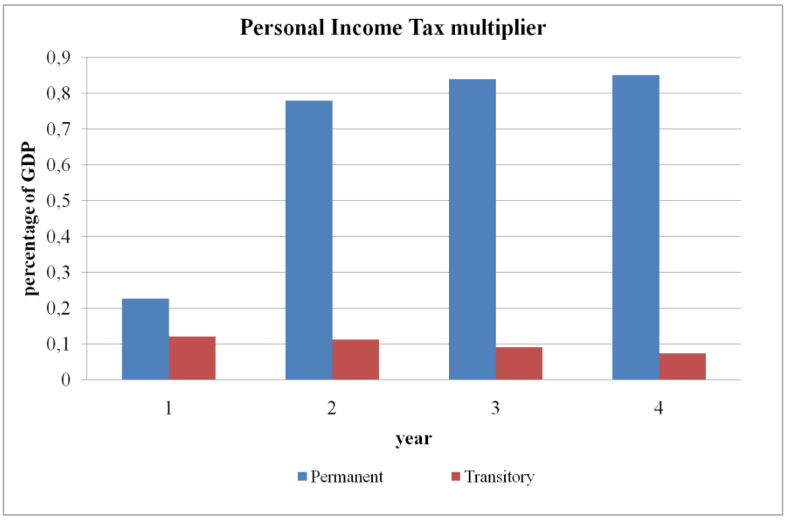

Figure 2: 1% stimulus (in GDP terms) through lowering the personal income tax rate

Employers' social security contribution

The reduction of employers' social security contributions has a long-run multiplier of around 0.5 (Figure 3). A permanent reduction in SSC lowers the costs of firms, raises labor demand, and then the disposable income of households. The amplified economic activity increases GDP permanently as well.

It is interesting that even a temporary easing of the social security contributions will have relatively long effects on GDP. This can be explained by the fact that according to our estimation, the persistence of a SSC change in Hungary is high, so even if agents consider the measures as temporary, they will expect that these measures will last for a couple of years.

It is important to note, that in the permanent case, personal income tax multiplier is the highest, while the multipliers of value added and employers' social security contribution reductions lies around 0.5. On the other hand, when measures are taken as transitory, employers' social security contribution has the largest impact on output.

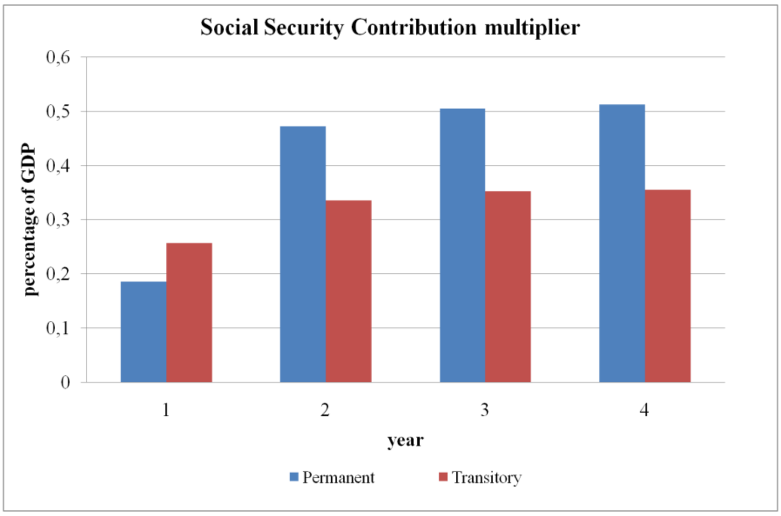

Figure 3: 1% stimulus (in GDP terms) through lowering the social security contribution rate

Financial transfers

Financial transfers to non-optimizer households have different effect on GDP, depending on whether they are regarded as being permanent or temporary. In the permanent case Ricardian consumers would reduce their own consumption because of the expected future tax increase. On overall, economic activity is expanded by about 0.3%. Since optimizers expect a future tax-rise, the multiplier becomes relatively small. In the transitory case the non-optimizing households increase their consumption expenditure by the same amount, but Ricardian households will expect less tax burden as the shock ceases out, and therefore they expand their consumption.

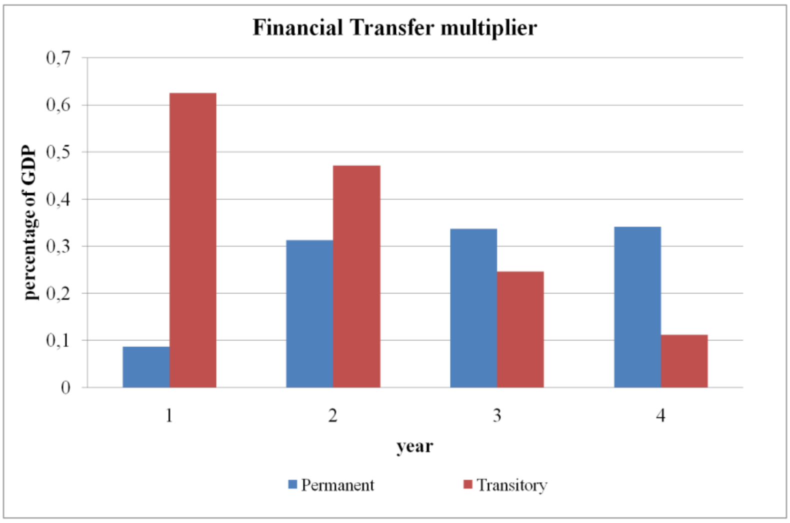

Figure 4: 1% stimulus (in GDP terms) through increasing financial transfers

Government expenditure

Permanent government expenditure (Figure 5) has a multiplier effect of about 1. Higher government expenditure raises the demand for domestic products, generating more investment and more economic activity, especially since it is considered credibly permanent. In a transitory case the multiplier is higher in the first year (due to the behavior of the optimizers), but the multiplier effect vanishes over time along with the reversion of the government expenditure to the steady state

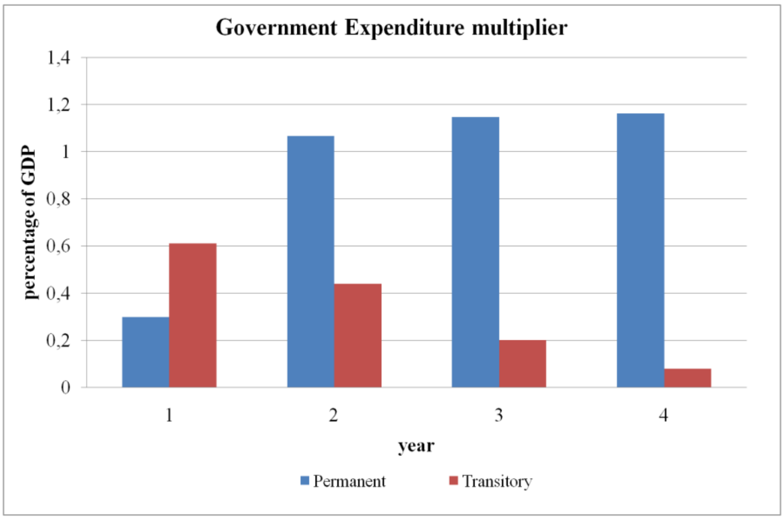

Figure 5: 1% stimulus (in GDP terms) through increasing government expenditures

3.2. Fiscal policy and fiscal rules

So far in the model fiscal instruments were defined as exogenous processes. In order to implement an endogenous fiscal policy we have to define a fiscal rule. We follow Leeper et al (2009) and define fiscal rules for value added tax, labor taxes, social security contribution, government expenditure and financial transfers, and compare the results with the exogenous fiscal policy. We analyze various type of fiscal stimulus and determine for each the fiscal rule that has the biggest multiplier. Here we assume that the various fiscal measures are transitory.

Transitory reduction in the value added tax rate

Figure 6 shows how the GDP dynamic multipliers evolve after a VAT tax decrease, when various fiscal rules operate. Obviously, if there is no fiscal rule, the GDP multiplier is the highest. In this case we supposed that the fiscal authority does not make any substitution between tax revenues and expenditures but debt is allowed to increase. When switching on the reaction functions there are only relatively minor differences. If VAT reduction is financed by cutting government expenditure then the multiplier changes the most.

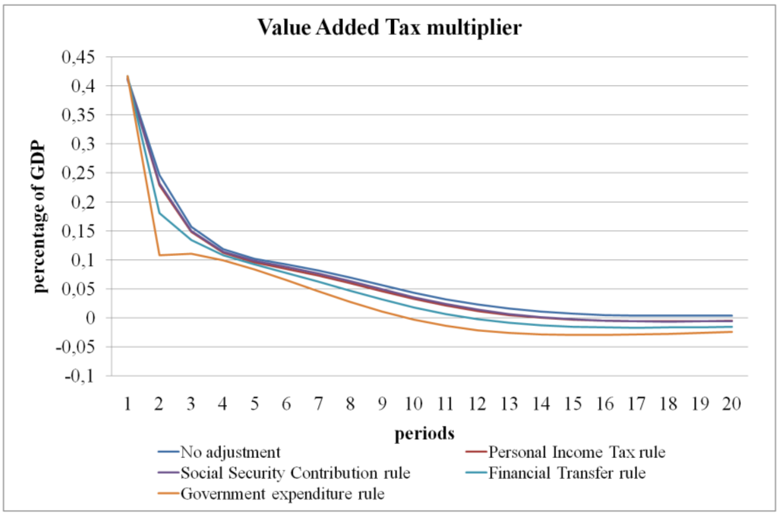

Figure 6: Stimulus through lowering value added tax rate under alternative fiscal rules

Transitory reduction in employers' social security tax rate

The impact of a decrease in employers' social security tax rate is shown in Figure 7. Since the SSC rate changes have been estimated as being very persistent, the implied multipliers are persistent as well. In contrast to the previous case, there is a significant difference between the multipliers implied by the various fiscal rules. The multiplier dies out rapidly (or even turns into negative) if the SSC cuts are financed from personal income tax increases or reductions in government expenditures.

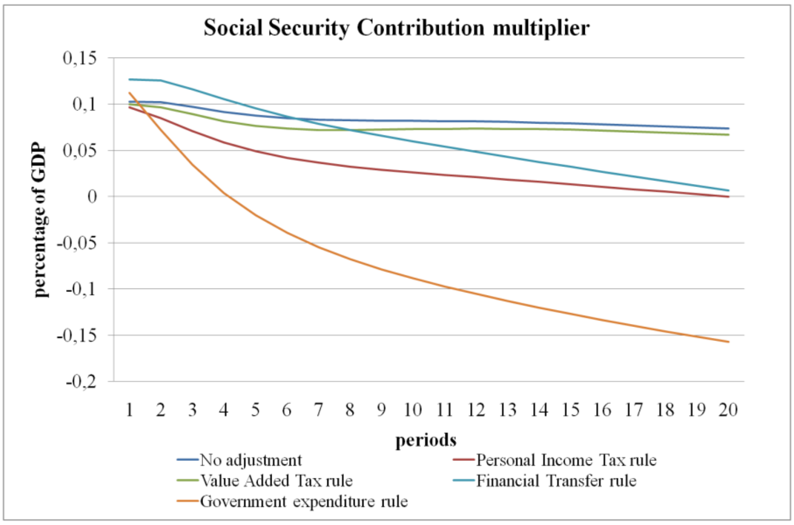

Figure 7: Stimulus through lowering social security contribution under alternative fiscal rules

Transitory reduction in personal income tax rate

Figure 8 shows the impact of a transitory personal income tax cut. The effects are similar to the previous case. The multiplier turns into negative when government expenditures or financial transfers are cut in order to finance the tax cut.

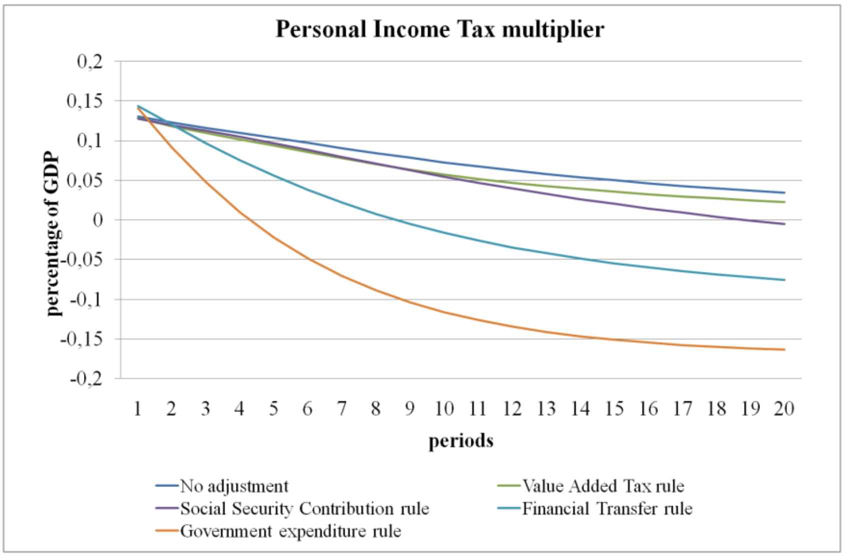

Figure 8: Stimulus through lowering personal income tax under alternative fiscal rules

Transitory increase in government expenditures or financial transfers

Figures 9 and 10 show the government expenditure and financial transfer multipliers. One can observe that multipliers are relatively independent from the fiscal reaction chosen.

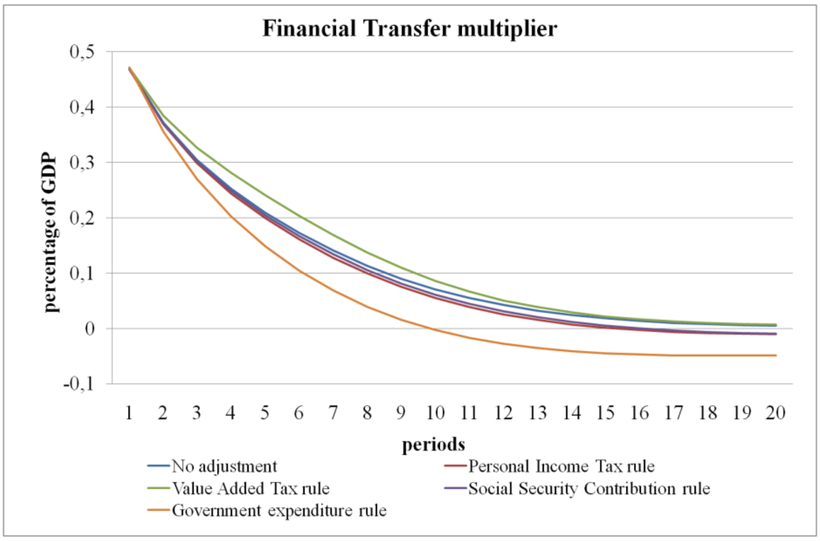

Figure 9: Stimulus through increasing financial transfers under alternative fiscal rules

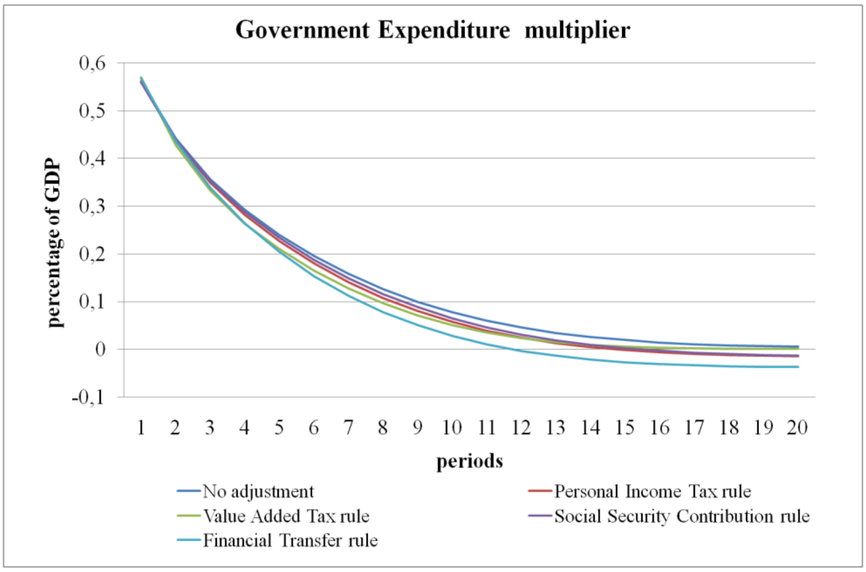

Figure 10: Stimulus through increasing government expenditure under alternative fiscal rules

3.3. The role of monetary policy

We also experimented with the role of monetary policy. Freedman et al (2009) found that for large economies and currency areas fiscal multipliers are heavily affected by the assumption whether monetary policy is activist or monetary reactions are switched-off at least temporarily (accomodative monetary policy).

When monetary policy reaction was switched on/off for one year, we could not identify large role for monetary policy. There small impact is attributable to the fact that monetary policy only reacts to inflation (and not to output) and inflation is affected by a fiscal stimulus only through increasing marginal costs.

The fact that the estimated monetary policy rule does not include output stabilization can be motivated by the small open economy nature of Hungary where exchange rate plays far the biggest role in monetary transmission. Hence, monetary policy (in normal circumstances) would not give large weight on output stabilization. This logic is reinforced by simple optimal monetary policy calculations (either based on second order welfare maximization as in Jakab-Kucsera-Szilágyi-Világi (2009) or based on an ad hoc loss function minimization as in Jakab-Tóth (2009)) showing that inserting output gap in the reaction function is far from an optimal monetary policy.

We can detect some role of monetary policy reaction in the case of increasing government expenditures (see Figure 11) where one can observe somewhat higher multipliers when monetary policy becomes accomodative. This effect, however, cannot be really judged as economically significant, in contrast to the findings of Freedman et al (2009) for larger economies.

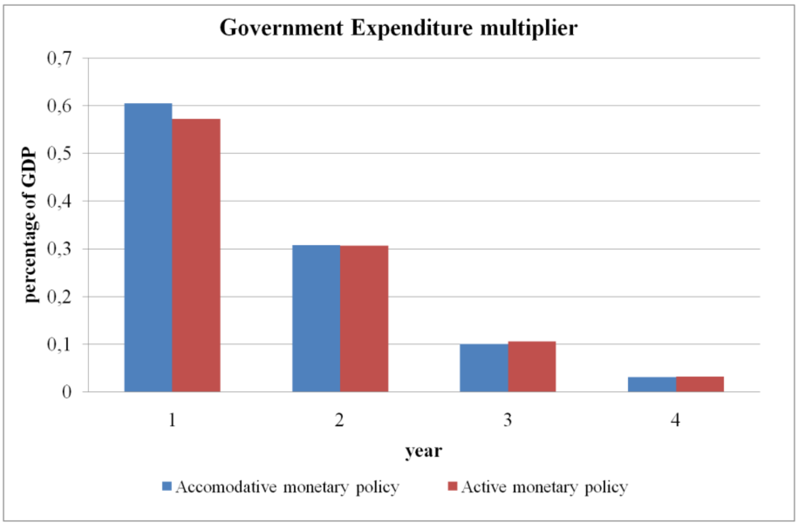

Figure 11: Stimulus through increasing government expenditure under accommodative monetary policy for 1 year

4. Conclusions

In this paper we turned our attention on the question of how large are fiscal multipliers. There is a lack of consensus on the effects of fiscal policy measures (the so called fiscal multipliers) both in Hungary and in developed countries. According to our results there is no such a unique fiscal multiplier. For this we employ a stochastic, dynamic general equilibrium (DSGE) model estimated on Hungarian data, with five types of distortionary fiscal instruments. Large differences between the multipliers of different types of fiscal expansions were found. Model simulations showed that agents' perception on how permanent the shift in fiscal policy is has sizable implications on the multipliers. Multipliers can also be largely modified when we take into account the future ways of financing the expansion. We found that the roles of fiscal reactions in shaping multipliers are mostly important when the initial expansion was implemented in form of tax cuts. Multipliers turn into negative after a relatively short time, if reduction in employers' social security contributions or in personal income taxes is financed through expenditure items. We also found that in a small open economy where monetary policy mostly reacts to inflation, accommodative monetary policy only hardly modifies fiscal multipliers.

References

to be completed

Appendix

to be completed

Comparison of estimated fiscal multipliers for Hungary
(percentage deviation of GDP from baseline)

Type of fiscal shock	Traditional model* (Horváth et al (2006))				DSGE model** (Our results)			
	Years							
	1	2	3	4	1	2	3	4
Financial transfers	0.19	0.43	0.59	0.68	0.09	0.31	0.34	0.34
Personal income tax	0.19	0.43	0.59	0.68	0.23	0.78	0.84	0.85
Gov't purchase of goods	0.68	0.59	0.59	0.62	0.30	1.07	1.15	1.16
Social security contributions	0.28	0.88	1.29	1.52	0.19	0.47	0.51	0.51
Indirect taxes	0.27	0.57	0.32	0.10	0.12	0.42	0.45	0.46

** Simulation results with endogenous monetary policy, Table 14 in Horváth et al (2006)*
*** Fiscal multipliers with permanent fiscal shocks and without fiscal reactions*