Non-Keynesian Effects of Fiscal Consolidation: an Analysis with an Estimated DSGE Model for the Hungarian Economy*

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Abstract

Using an estimated DSGE model for Hungary, the paper identifies the possible non-Keynesian channels through which a fiscal consolidation may manifest as expansionary. Simulations showed that fiscal consolidation policies are typically restrictionary. Nevertheless, taking into account some specific features of the Hungarian economy, there is a possibility that expansionary effects arise. These effects may take the form of a drop in risk premium or favourable balance sheet effects through the appreciation of the currency. However, the credibility of the consolidation policy is key in achieving positive output effects. A non-credible consolidation is unlikely to expand output, no matter the assumptions regarding the specific features of the economy, and no matter of the composition of a consolidation package.

Keywords: fiscal consolidation, non-Keynesian effects, DSGE model, taxation, government expenditure

JEL: E62, E27, H30, H50,

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1. Introduction

Economists generally agree that fiscal consolidation is beneficial for the economy in the long term. Nevertheless, it is also common to consider that fiscal consolidation causes temporary slow-downs, that is, there are short-term costs before long-term benefits can be reaped. However, the short-term cost of a unit of long-term benefit can be highly variable, and depends heavily both on the economic circumstances and the proper composition and execution of the consolidation measures. In extreme cases, the short-term costs could be completely avoided, thus reducing fiscal imbalances may contribute to faster growth even in the short term. These positive effects are commonly referred in the literature as non-Keynesian effects.

The empirical literature confirms that fiscal consolidations have significant growth-enhancing effects. Reinhart and Rogoff (2010) show that countries with debt-to-GDP ratios above 90% record significantly lower average growth rates. Checherita and Rother (2010) also found important growth-reducing effects of high debt levels (above around 90% of GDP) for a number of euro area countries. The channels they identify through which government debt can have an impact on the economic growth rate are private saving, public investment, total factor productivity, and sovereign long-term nominal and long term real interest rates. Kumar and Woo (2010) find that GDP growth in advanced and emerging countries is more adversely affected when debt levels exceed 90% of GDP.

The empirical evidence cited above clearly supports the view that fiscal consolidation policies aiming to reduce high debt levels can contribute to a faster growth rate. Although the empirical literature has found a relatively robust debt threshold (around 90% of GDP) above which a debt-reducing policy may be especially effective, Rother et al. (2010) argue that this threshold is most likely not invariant to changes in the economic environment. For example, in times of high actual levels of risk exposure and increased risk aversion, economic agents will be more cautious in their decisions, therefore the growth-reducing effects of fiscal imbalances are likely to occur at lower levels of fiscal deficit and debt. At the same time, the long-term benefits of fiscal consolidation will also be larger in such an environment.

Empirical evidence based on various fiscal consolidation episodes confirms the existence of growth-enhancing fiscal consolidations. Afonso (2010) found some evidence in favor of the existence of expansionary fiscal retrenchment episodes for 15 EU countries. Expansionary effects depended on the specific budgetary spending items, as well as on the specification and the time span used. Alesina and Perotti (1995) and Alesina and Ardagna (2010) concluded on a panel of OECD countries, that fiscal consolidations may be expansionary if implemented mainly by cutting government spending. Giudice et al. (2007) show that a considerable part of fiscal consolidation episodes has been followed by higher growth. Hauptmeier et al. (2007) argue that in the episodes they studied the expenditure reforms were the most likely to promote growth. Rzonca and Czakon-Michalowska (2005), by using panel estimation techniques, provide evidence that in EU new member
states fiscal consolidation contributed substantially to the acceleration of output growth even in the short term.

The results above, however, have recently faced a series of criticism. IMF (2010) criticizes the data used by Alesina and Perotti (1995) and Alesina and Ardagna (2010), and shows that fiscal consolidation typically reduces output and raises unemployment in the short term (being less painful, though, if it relies on cutting government spending). A similar result is found by Hernández de Cos and Moral-Benito (2011) and by Guajardo, Leigh and Pescatori (2011) on new datasets of OECD countries. Perotti (2011) presents four detailed expansionary fiscal episodes and argue, that the underlying economic conditions (depreciation in an EMU country, or a further decline in interest rates) do not hold any more.

Beside the consolidation episodes, there is a rich literature on positive fiscal multipliers, where expansionary fiscal policies have growth-enhancing effects (see for example, Cogan et al. 2009; Bernstein and Romer, 2009; Coenen et al., 2010). These findings, nevertheless, should not necessarily be interpreted as evidence of the growth-reducing effects of fiscal consolidation, as expansionary policies are not always growth-enhancing. Van Riet (2010) summarizes the conditions under which a fiscal stimulus can have beneficial effects: it needs to be discretionary, implemented in a timely manner (no long implementation lags to ensure counter-cyclicality), targeted (to liquidity- or credit-constrained agents), and temporary. On the other hand, as Rother et al. (2010) argue, a permanent improvement in fiscal sustainability is needed in the case of fiscal consolidation. They further point out that the economic conditions underlying fiscal expansions are likely to be different from those prevailing for fiscal consolidation. Expectation effects liked to the credibility of the announced policy (concerning the expected future tax burden), for instance, are likely to work in a growth-supporting direction in both cases, i.e. supporting the impact on growth of fiscal loosening, but offsetting the negative demand effect of fiscal tightening.¹

Nevertheless, extrapolating findings based on past fiscal consolidation episodes into the future needs to be done with considerable caution. There is no reason to believe that fiscal consolidations would work in the same way when implemented procyclically or countercyclically. The conditions under which a consolidation would be executed in the future would typically be different from the pre-conditions of the past episodes. Rother et al. (2010) warn that the conditions underlying earlier studies of i) a generally modest public debt; ii) only isolated incidences of large public debts; iii) little uncertainty over public liabilities; and iv) calm financial markets – are currently not met. Perotti (2011) also argues that the underlying economic conditions of some expansionary consolidation episodes of Denmark, Ireland, Finland, Sweden experienced in the past do not hold any more for European countries. Therefore, it is inappropriate to extrapolate from past

¹ Expectation effects, however, can be also detrimental if fiscal policy – either expansionary or contractionary – is implemented in an inappropriate (e.g. non-credible) way.
findings the impact of fiscal consolidation in the fiscal and financial environment of the current post-crisis period.²

The different channels through which fiscal consolidation affects the economy can be modeled in a dynamic stochastic general equilibrium (DSGE) framework. A prominent example in this direction is Coenen et al. (2008), who examine the macroeconomic effects of alternative fiscal consolidation policies in the New Area-Wide Model (NAWM), a two-country open-economy model of the euro area. They found that fiscal consolidation has positive long-run effects on key macroeconomic aggregates when the resulting improvement in the budgetary position is used to lower distortionary taxes. At the same time, fiscal consolidation gives rise to noticeable short-run adjustment costs in contrast to what the literature on expansionary fiscal consolidations suggests. A related analysis using the same model confirms these findings, and points out that, if there is confidence in fiscal consolidation (meaning a permanent reduction in the long-term interest rate and hence the financing costs of government debt), then the long-run benefits are considerably higher, while the short-run costs are moderately lower (ECB, 2010).

This paper examines the macroeconomic effects of various fiscal consolidation policies in an estimated open-economy DSGE model of the Hungarian economy and attempts to identify the possible non-Keynesian effects that fiscal consolidation may generate. The main findings and policy implications are the following:

- In a standard DSGE model estimated for the Hungarian economy, fiscal consolidation policies are restrictionary (have positive multipliers), regardless of the fiscal instrument chosen. Although non-Keynesian channels are present, the Keynesian channels dominate. The dominance of the Keynesian effects is weaker, however, if a consolidation is performed in a credible manner.
- Non-Keynesian effect is stronger where the real interest rate (the risk premium) reacts (falls) more as a response to a consolidation policy. If the risk premium reacts to the reduction of the debt level, then the chance of a positive output reaction increases.
- Taking into account the high level of indebtedness in foreign currency (a specific feature of the Hungarian economy), a fiscal consolidation policy is able to generate positive output responses through the exchange rate effect on balance sheets.
- The credibility of the consolidation policy is key in achieving positive output effects. A non-credible consolidation is unlikely to generate positive effects, no matter the assumptions regarding the specific features of the economy.
- The choice of the exchange rate regime has little impact on the effects of a fiscal measure.
- If inflation expectations are well anchored, non-Keynesian effects are more likely to arise.

² Consequently, care should be taken when estimating non-structural parameters on pre-crisis data. Estimating structural models (e.g. DSGE), however, can mitigate this problem.
The remaining of the paper is structured as follow: Section 2 reviews the theory of non-Keynesian effects and channels, which may arise as a result of a fiscal tightening. Section 3 sets up a DSGE model for the Hungarian economy, which incorporates the channels relevant for Hungary through which non-Keynesian effects may appear. Section 4 simulates the model by generating various types of fiscal consolidations (either through expenditure cuts or tax increases), discusses the results and identifies the non-Keynesian effects that may be present in the Hungarian economy. Section 5 concludes.

2. Non-Keynesian effects of fiscal consolidations

In the Keynesian approach, fiscal consolidation has, by definition, a direct negative effect on domestic demand in the short run. Indirect effects, however, are likely to mitigate this contractionary impact on aggregate demand. Whether or not the final effect of a consolidation becomes expansionary (non-Keynesian effect), depends on whether the private consumption’s and/or private investment’s responses to the consolidation are able to offset its direct negative effect over aggregate demand and, hence, output. It is important therefore to identify the effects and channels through which consumption and investment may react in a favourable way.

The economic literature has proposed a number of theoretical explanations on why a fiscal tightening can stimulate the economy, or at least, the overall effect is less negative than the direct effect (see for example, Giavazzi and Pagano, 1990, 1996; Alesina and Perotti, 1997; Alesina and Ardagna, 1998; Perotti, 1999; and Ardagna, 2004). The explanations usually include on the demand side the expectation channel, the risk premium channel, the wealth effect on consumption, the substitution effect from public to private spending, while on the supply side the labor market effects (increased labor market efficiency and an increase in competitiveness through lower wage costs). In what follows, we discuss these effects in detail.

The expectation channel is key in inducing economic reactions that may offset the negative demand effects already in the short run. This channel works through the improvement in consumers’ expectations (a reduction in the uncertainty) regarding future tax liabilities. In the aftermath of fiscal contraction, households may conclude that they have had too pessimistic expectations regarding future public expenditure and cumulated tax burdens, factors that determine their decision regarding the distribution of their income between consumption and savings. The reduction in uncertainty itself allows consumers to decrease their precautionary savings. By reducing the probability of a fiscal tightening in the future, the present fiscal contraction raises the present discounted value of disposable income, thus leading to a further increase in private consumption. This expectation effect is obviously dependent on the size and persistence of fiscal contraction and is directly linked with its credibility, with the belief of the economic agent that the consolidation will be carried out – both quantitatively and qualitatively – exactly in the way as it was announced.
The emergence of a positive impact on GDP growth of the expectation channel is therefore uncertain, and its probability and magnitude is linked to a set of factors. ECB (2010) and Rother et al. (2010) summarize the preconditions under which positive expectation effects could be particularly large: i) the fiscal starting position is weak, so the consolidation is expected to lead to a significant improvement in fiscal sustainability; ii) the fiscal consolidation plan is ambitious and credible, possibly part of an overall structural reform agenda, so that the probability of a long-lasting structural improvement in the fiscal stance increases; iii) the composition of the adjustment focuses on reducing disincentives to work and save, enhancing expenditure efficiency and protecting growth-friendly expenditure so that the supply conditions in the economy improve quickly; iv) the share of households that can adjust their saving in response to the fiscal consolidation (i.e. Ricardian households) is high; and v) part of the negative impact of consolidation is offset via the exchange rate or low interest rates.

The risk premium channel works through the decrease in real interest rates as a consequence of the reduction in the risk default premium driven by the reduction of government borrowing requirements associated with fiscal consolidation. The decline in interest rates would then stimulate aggregate demand by stimulating private investment. Moreover, lower interest rates would also increase the opportunity cost of saving, leading households to increase their current consumption. This risk premium effect obviously depends on the initial state of public finances, being more probable when the level of the debt-to-GDP ratio before the consolidation exceeds some relatively high thresholds.

Various wealth effects could arise that all contribute to a consumption boost. An increase in wealth is generated by a fall in the interest rates, which in turn increases the market value of assets held by consumers. Consequently, the market value of the fraction that households normally consume out of their wealth will be also higher.

Another wealth effect operates through the exchange rate channel and impacts households whose portfolio liabilities (loans) are denominated in foreign currency (balance sheet effect). Such portfolio holdings are typical in countries like Hungary, where households were tempted to contract foreign currency denominated loans due to the interest rate advantage of such loans against loans denominated in domestic currency. The market value of the net wealth of such households is highly influenced by exchange rate fluctuations. If the real equilibrium interest rate falls (through the reduction of the risk default premium), the gap between foreign and domestic real interest rate widens (given that the central bank smooths interest rate and does not lower interest rates to the same extent as the decline in the risk premium) causing a real appreciation of the currency. This reduces the loan repayment burden of households indebted in foreign currencies, meaning that they are left with higher disposable income that can be used for consumption. As these indebted households are typically liquidity constrained (they are non-Ricardians), the extra income would mainly be used for additional consumption.

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3 Exchange rate movements can be triggered not only by the reduction of the risk default premium per se, but also by extra capital inflows generated by the consolidation and the reduction in country risk.
The exchange rate movements influence not only the behaviour of households indebted in foreign currencies, but also affect that of the government if a high share of the public debt is foreign-denominated (as is the case in Hungary). The decline in the costs of servicing foreign-denominated public debt frees up resources and provides more room for budgetary manoeuvre.

Fiscal consolidations, that involve a cut in spending on public goods, also generate substitution effects, which relates to the replacement of public consumption by private consumption. If consumers value services supplied by the public sector (e.g. educational, health care, cultural services), they will most likely increase private spending on these items (crowding-in) once they are no longer provided by the public sector.

While the effects described above all work on the demand side, there are important supply-side effects as well, mainly linked to the labor market. This depends crucially on the composition of the fiscal adjustment, and is more effective if it consists of public spending cuts, especially government wage bills and welfare payments, rather than tax increases. Wage cuts in the public sector may induce a moderation in the wage claims by unions (either by increasing the probability of unemployment or by increasing the costs of being unemployed), therefore reducing real wage pressure, stimulating employment, investment and output growth. While this effect finally results in an enhancement of the labor market efficiency and overall competitiveness of the economy, the structure and institutions of the labor market may play an important role in the development of this effect. Nevertheless, this effect points out the importance of the composition of a fiscal adjustment, as a cut in expenditures on wages increases the price competitiveness of businesses, while the opposite effect happens if taxes are raised.4

The key ingredient of many of these effects to operate is the credibility of the consolidation process. Agents need to believe that the government is able to generate a persistent decrease in the public debt. The expectation channel will work only if economic agents believe that the future tax burden will indeed be lower. Similarly, since agents participating in financial markets tend to take their decisions with a forward-looking perspective, the risk premium and interest rates would fall only if improvements in the long-term fiscal position and financing needs are credibly announced. Consequently, an appreciation of the exchange rate and an improvement in the net wealth position are possible only if the risk premium falls after a credible announcement.

In the rest of the paper we use a DSGE model to examine the macroeconomic effects of alternative fiscal consolidation strategies, with emphasis on identifying the channels through which non-Keynesian effects of fiscal consolidations arise. Theoretically, most of the channels and effects examined above may be relevant for Hungary, therefore there is a rationale for incorporating all the possible mechanisms into the model that may generate these effects. However, due to technical constraints the model lacks the explicit mechanism

4 Different types of taxes affect competitiveness to different extent. Also, different sectors are affected to different extent (for instance, a hike in VATfavours the tradable sector).
of risk-premium dependent foreign capital inflows. Further, we did not model the government sector in detail; therefore we do not have a productive government investment, explicit supply of public goods, or interactions between the public and private sector concerning labor market developments. The next section provides a description of the model, with a particular emphasis on those features that give rise to a meaningful role for fiscal policy.

3. A DSGE model of the Hungarian economy

The model is an estimated DSGE built for the Hungarian economy. The model is built upon the model of Baksa, Benk and Jakab (2010), which ultimately draws on Smets and Wouters (2003). DSGE models are particularly useful when exploring fiscal impact mechanisms. Beside the standard short-run Keynesian channels through liquidity-constrained rule-of-thumb consumers, in the longer run the model presents non-Keynesian effects through forward-looking agents, whose behaviour is driven by their expectations on future taxes or expenditures.

The underlying basic model is a neoclassical model, which is then augmented by various imperfections and frictions. This results in a model that has Keynesian features in the short run, while the long run is dominated by Ricardian agents, which drives the neoclassical result.

3.1 Main assumptions

The main frictions and related assumptions are the following:

- Habit formation: consumers not only consider their instantaneous utility, but also their habit (past consumption) 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 investment decisions one should also take 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, being unable to set an optimal price and wage at every period. Exporters set their price in foreign currency (local currency pricing), while domestic good producers set theirs in domestic currency.

- There are significant indexation mechanisms in the economy: agents unable to set an optimal price may apply a rule 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 a perceived trend inflation in the model that agents learn from past events in an adaptive way. 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.

- 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 agents, the fully rational and forward-looking Ricardian consumers would know that each current fiscal measure will have a tax increasing or tax reducing impact in the future and would therefore incorporate this knowledge into their current decisions, inducing offsetting effects in the short term).

- Foreign investors penalise the country’s excessive indebtedness by demanding a higher interest rate premium. Risk premium therefore depends on the prevailing debt-to-GDP ratio.

- Part of loans held by households is denominated in foreign currency. Therefore a change in the exchange rate will affect the current value of the periodical repayments and hence their disposable income.

- There are three types of taxes: a tax levied on labor and paid by the employees, a tax levied on labor and paid by employers, and a consumption tax. 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 a VAT change would always entail a price change. We did not include capital taxes in the model as their empirical modelling would have entailed rather complicated data problems.

- 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.

- We define several alternative fiscal reaction functions. Fiscal authority may react to current output (deviation from steady state) and to past deficits. These rules allow fiscal policy to stabilise the debt level.
3.2 Agents

There are five categories of agents in the model: households, firms, the government, the monetary policy maker and the foreign sector.

Households

The domestic economy is populated by a continuum of infinitely-lived households. Fraction $\bar{\omega}$ of household choose their consumption stream in the standard rational optimizing manner. These optimizing households have labor and capital income and they own domestic firms. The expected utility function of household $j$ is given by:

$$\sum_{t=0}^{\infty} \beta^t [(1 + \eta^c_t)\{u(H_t^c(j)) - (1 + \eta^l_t)\nu(l_t(j))\}], \quad (1)$$

where $u(H_t^c(j)) = \left(\frac{c_t^c(j)-h_{t-1}^c(j)}{1-\sigma}\right)^{1-\sigma}$ denotes the consumption utility of household $j$ considered under consumption habits, $\nu(l_t(j)) = \frac{l_t(j)}{1+\varphi}$ denotes the leisure utility of 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 $\beta$. Households’ consumption and employment valuation may vary over time, represented by preference shocks to consumption, $\eta^c_t$, and leisure, $\eta^l_t$. The $\sigma$ 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:

$$(1 + \tau^c_t)P_t c_t^c(j) + P_t l_t(j) + \frac{B_t(j)}{1+i_t} = B_{t-1}(j) + (1 - \tau^l_t)W_t(j)l_t(j) + P_t r^k_t u_t(j)k_{t-1}(j) \quad (2)$$

According to this, individual households supply differentiated labor, and receive labor income for their work in accordance to their negotiated wage $w_t(j)$, on which they pay $\tau^l_t$ income tax to the government. Income is either consumed or saved. Consumption $c_t(j)$ is subject to a consumption tax $\tau^c_t$. Savings are either invested into physical capital or into risk-free bonds $B_t$ that yield an interest income $i_t$. Investments $l_t(j)$ 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 a capital income $r^k_t$ on the capital supplied earlier. As households own the shares of the firms, profits (if there is any) are redistributed to them in the form of dividends $Div_t$. $OT_t$ represents any other lump-sum government taxes levied on households.

Physical capital accumulation is given by:
\[ k_t = (1 - \delta)k_{t-1} + \left[ 1 - \phi_f \left( \frac{(1 + \eta_t')}{l_{t-1}} \right) \right] I_t, \]  

(3)

where \( \phi_f \left( \frac{(1 + \eta_t')}{l_{t-1}} \right) \) is a convex investment adjustment cost, while \( \eta_t' \) denotes the shock to the adjustment function.

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

1. Euler equation:
   \[
   \frac{\lambda_t}{(1 + \tau^c_t)P_t} = \beta (1 + \bar{\tau}_t) E_t \left[ \frac{\lambda_{t+1}}{(1 + \tau^c_{t+1})P_{t+1}} \right]
   \]
   (4)

   where \( \lambda_t \) denotes the marginal utility of consumption in period \( t \), and the effective nominal interest rate \( \bar{\tau}_t \) is given by:
   \[
   1 + \bar{\tau}_t = 1 + i_t + \nu_D \bar{d}_t = \bar{\eta}_t + E_t \pi_{t+1}
   \]
   (5)

   \[
   \bar{\eta}_t = \frac{1}{\bar{\beta}} - 1 + \nu_D \bar{d}_t
   \]
   (6)

   This setup indicates that the net (less of value added tax) real interest rate is adjusted for the interest rate premium dependent on public debt \( \bar{d}_t \) (debt-to-gdp ratio) minus steady state debt level \( \bar{d}_t = d_t - d \). In the baseline case we keep \( \nu_D \) at zero, and hence, in that case forward-looking consumers just use the risk free real interest rate (which in steady state equals the inverse of the discount factor) and their inflation expectations for discounting future marginal utilities. When interest rate premium channel is switched on, the effective real interest rate \( \bar{\eta}_t \) is adjusted for the interest rate premium \( \nu_D \bar{d}_t \), and the effective nominal interest rate \( \bar{\tau}_t \) becomes its inflation adjusted counterpart.

2. Dynamics of investments:
   \[
   \lambda_t Q_t \left[ 1 - \phi_f \left( \frac{(1 + \eta_t')}{I_{t-1}} \right) \right] - \phi_f' \left( \frac{(1 + \eta_t')}{I_{t-1}} \right) \left( \frac{1 + \eta_t'}{I_{t-1}} \right) I_t \\
   = \frac{\lambda_t}{1 + \tau^c_t} - \beta E_t \frac{\lambda_{t+1}}{1 + \tau^c_{t+1}} \left[ Q_{t+1} \phi_f \left( \frac{(1 + \eta_{t+1})}{I_t} \right) \left( \frac{1 + \eta_{t+1}'}{I_{t+1}} \right) I_{t+1}^2 \right]
   \]
   (7)

   where \( Q_t \) is the implicit shadow price of capital. Note, that as \( \lambda_{t+1} \) depends on the adjusted (debt dependent) real interest rate, investment decisions are also affected by public debt. In the baseline model, however, this channel is switched off.
3. The no-arbitrage condition determines the portfolio choice between bonds and physical capital:

$$\lambda_t Q_t = \beta E_t \lambda_{t+1}[Q_{t+1}(1 - \delta) + u_{t+1} r^k_{t+1} - \Psi(u_{t+1}(j))]$$  \hspace{1cm} (8)

4. Capacity utilisation of capital is given by the following condition:

$$r^k_t = \Psi'(u_t(j))$$  \hspace{1cm} (9)

5. A $1 - \bar{\omega}$ fraction of consumers are liquidity-constrained and are unable to optimize their entire life-time utility. They spend all of their labor income and the financial transfers $TR_t$ received in a given period on purchasing consumption goods $c^{no}_t$. In the case of FX loan scenario they are also indebted in foreign currency. Therefore, a currency appreciation will decrease their debt service burden and, as a result, boost their consumption.

$$ (1 + \tau^e_t) P_t c^{no}_t = \left(1 - \tau^e_t\right) W_t l_t + \frac{TR_t}{1 - \bar{\omega}} + (e_t B_{t-1} - D_{t-1})(i^e_t + \frac{1}{\text{duration}}) $$  \hspace{1cm} (10)

The last term in equation (10) is only present when we allow for foreign currency indebtedness. In the baseline model and in the model version with interest rate premium only this channel is switched off.

There is monopolistic competition in the labor market, with different types of labor being supplied by households. Households act as unions being able to set wages with a markup. Only $1 - \gamma_w$ of the households are able to set the nominal wage in an optimizing way, with the remaining part following a non-optimizing rule-of-thumb indexation to past inflation. The resulting (log-linearized) wage Phillips curve has the form:

$$\pi^w_t = \frac{1 - \gamma^w_t(1 - \beta \gamma^w)}{\gamma^w_t(1 + \theta^w \phi)(1 + \beta \theta^w)} \left( \varphi l_t - w_t + \eta^l_t + \frac{\sigma}{1 - \beta}(c^l_t - h c^l_{t-1}) \right) 
+ \frac{\tau^e_t}{1 + \tau^e_t} \pi^e_t + \frac{\tau^l_t}{1 + \tau^l_t} i^l_t + \xi^w_t
+ \frac{\beta}{1 + \beta \theta^w} E_t \pi^w_{t+1} + \frac{\theta^w}{1 + \beta \theta^w} \pi^w_{t-1} \right) $$  \hspace{1cm} (11)

where $\theta^w$ denotes the rate of indexation, $\theta^w$ denotes the labor market elasticity, while $c^l_t$ is the weighted marginal utility of the two types of consumers. $\xi^w_t$ is the wage mark-up shock.

**Firms**

Production takes place in two stages. In the first stage firms produce a homogenous intermediate product $z_t$ through a CES production function by using labor $l_t$ and import $m_t$ as inputs. Factor inputs are subject to quadratic adjustment costs ($\phi_1$ and $\phi_2$).
where $\alpha$ denotes the share of labor used in production, while $\varphi_z$ 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** $\overline{w}_t$:

$$\overline{w}_t = \frac{(1 + \tau^*_t)w_t}{(1 + \phi_1)^{-1} - l_t(1 + \phi_1)^{-2}\phi_1} \tag{13}$$

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

2. **Effective import price** $q_tP^{m*}_t$:

$$\overline{q_tP^{m*}_t} = \frac{q_tP^{m*}_t}{(1 + \phi_2)^{-1} - m_t(1 + \phi_2)^{-2}\phi_2} \tag{14}$$

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

3. **Marginal cost of the intermediate product**:

$$w^*_t = \left[aw_t^{1-\varphi_z} + \left(1 - a\frac{q_tP^{m*}_t}{(1 + \phi_2)^{-1} - m_t(1 + \phi_2)^{-2}\phi_2}\right)\right]^{\frac{1}{1-\varphi_z}} \tag{15}$$

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

4. **Labor demand**:

$$l_t = a\left(\frac{w^*_t}{\overline{w}_t}\right)^{\varphi_z} z_t(1 + \phi_1) \tag{16}$$

5. **Import demand**:

$$m_t = (1 - a)\left(\frac{w^*_t}{\overline{q_tP^{m*}_t}}\right)^{\varphi_z} z_t(1 + \phi_2) \tag{17}$$

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

$$y_t(i) = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$

$$y_t = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$}

$$y_t(i) = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$

$$y_t = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$

$$y_t(i) = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$

$$y_t = \left(1 + \eta^{A}_t\right)\left(\frac{1}{a\overline{\varphi^*_t}(i)}\right)^{\frac{\varphi^*_t - 1}{\varphi^*_t}} z_t(i)^{\frac{1}{\varphi^*_t - 1}} - y$$
where \( \alpha \) denotes the share of capital used in the production, \( \varphi \) denotes the elasticity of substitution, while \( \ddot{f} \) is the fixed cost of production. The first order conditions of the cost minimization problem are:

1. Final goods real marginal cost \( mc \):

\[
mc_t = \frac{\alpha(r^k_t)^{1-\varphi} + (1 - \alpha)(w^z_t)^{1-\varphi} \frac{1}{1 + \eta^A_t}}{1 + \eta^A_t}
\]

2. Capital demand function:

\[
u_t k_{t-1} = \alpha \left( \frac{mc_t}{\eta^k_t} \right)^{\varphi} DP_t y_t + y \ddot{f}
\]

3. Intermediate product demand function:

\[
z_t = (1 - \alpha) \left( \frac{mc_t}{w^z_t} \right)^{\varphi} DP_t y_t + y \ddot{f}
\]

where \( DP \) 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 \( 1 - \gamma_d \) 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 \( \ddot{p}_t \) takes the form:

\[
\ddot{p}_t = \frac{(1 - \gamma^d)(1 - \beta \gamma^d)}{\gamma^d(1 + \beta \delta^d)} \{ mc_t + \xi^d_t \} + \frac{\beta}{1 + \beta \delta^d} E_t \ddot{p}_{t+1}^d \delta^d
\]

\[+ \frac{1 + \beta \delta^d \ddot{p}_{t-1}^d}{1 + \beta \delta^d \ddot{p}_{t-1}^d},
\]

where \( \delta^d \) denotes the rate of indexation, while \( \xi^d_t \) is the domestic price 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. \( 1 - \gamma_x \) of them is able to set the optimal price, while the remaining index their price by the previous price change. The new Keynesian Phillips curve for export price inflation \( \ddot{p}_t^x \) takes the form:

\[
\ddot{p}_t^x = \frac{(1 - \gamma^x)(1 - \beta \gamma^x)}{\gamma^x(1 + \beta \delta^x)} \{ -P^x - q_t + \xi^x_t \} + \frac{\beta}{1 + \beta \delta^x} E_t \ddot{p}_{t+1}^x \delta^x
\]

\[+ \frac{1 + \beta \delta^x \ddot{p}_{t-1}^x}{1 + \beta \delta^x \ddot{p}_{t-1}^x},
\]

where \( \delta^x \) denotes the rate of indexation, while \( \xi^x_t \) is the mark-up shock and \( P^x_t \) is the export price measured in foreign currency.
Regarding trend inflation, agents apply a special adaptive learning algorithm, where they “learn” trend inflation gradually from the previous period’s trend inflation and the inflation of the current period:

\[
(1 + \bar{\pi}_t) = (1 + \bar{\pi}_{t-1})^{\rho \pi} \left(\frac{1 + \pi_t}{1 + \bar{\pi}_t}\right)^g,
\]

where \(\rho\) 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:

\[
1 + \pi_t^{\text{gross}} = (1 + \pi_t) \frac{1 + \pi^e_t}{1 + \pi^e_{t-1}}
\]

**Monetary policy**

The central bank follows an inflation targeting regime, and sets the nominal interest rates based on a Taylor-type rule. The objective function includes net inflation (i.e. inflation without VAT) and (with a smaller weight) the nominal exchange rate.

\[
\frac{1 + i_t}{1 + r} = \left(\frac{1 + i_{t-1}}{1 + r}\right)^{\zeta_i} \left((1 + \pi_t)^{\zeta_{\pi}} G D P^0_t \pi^e_t\right)^{1-\zeta_i} (1 + \eta^i_t),
\]

where \(\zeta_i\) denotes the degree of interest rate smoothing, \(\zeta_{\pi}\) the weight on inflation, \(\zeta_e\) the weight of the nominal exchange rate \(e_t\), \(r\) is the long-term real (risk free) interest rate, while \(\eta^i_t\) is an exogenous stochastic shock. The choice of this particular form of the monetary policy rule is justified by Hidi (2006), who showed, that for Hungary (as a small open economy) the fit of the standard Taylor rule can be significantly improved by including the exchange rate, while the impact of the output gap is negligible. Central bank’s reaction to output gap was found insignificant, and thus in most of the scenarios analyzed we use a reaction function without this term.

In Section 4.5 we experiment with alternative policy rules. First, we use rule (26a) which is a Taylor type rule (with interest rate smoothing) with output gap. As a second exercise we introduce rule (26b) which reacts to gross inflation instead of net inflation.

\[
\frac{1 + i_t}{1 + r} = \left(\frac{1 + i_{t-1}}{1 + r}\right)^{\zeta_i} \left((1 + \pi_t^{\text{gross}})^{\zeta_{\pi}} G D P^0_t \pi^e_t\right)^{1-\zeta_i} (1 + \eta^i_t),
\]
Government: Fiscal policy

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

\[ OT_t + \tau^c_t c_t + \tau^f_t w_t l_t + \tau^g_t l_t = P_t (1 + \eta^g_t) G + TR_t + D_t - \]

\[ \left( \frac{1 + \bar{r}_t}{1 + \pi_{t+1}^{\text{gross}}} + \frac{fx\text{share}}{duration_{\text{gov}}} * e_t \right) D_{t-1} \]

where \( G \) is the steady-state value of the volume of government purchases of goods and services, while \( \eta^g_t \) is the shock to government expenditures leading to temporary deviations from steady-state expenditures. \( G \) is unproductive, that is, while it raises aggregate demand, it is consumed rather than invested and does not generate any positive externality. \( TR_t \) denotes financial transfers to non-optimizing households. \( \tau^c_t \) refers to the value added tax rate, \( \tau^f_t \) to personal income tax rate\(^5\), \( \tau^g_t \) to the employers’ social security contribution tax rate, respectively. The last term in equation (27) is the balance sheet effect on foreign currency denominated bonds. Other net revenues \((OT_t)\) are assumed to be of a lump-sum nature. \( D_t \) denotes government debt calculated for simplicity as accumulated deficits. We assume that other revenues follow an autoregressive process with an i.i.d. shock.

\[ \hat{OT}_t = \rho_{\hat{OT}} \hat{OT}_{t-1} + \xi_{\hat{OT}} \]

\( T_t \) is total deficit/surplus (primary balance minus interest payments) while \( PS_t \) denotes the primary balance of the budget. The government debt follows the law of motion:

\[ D_t = D_{t-1} + T_t \]

In the baseline estimated model we treat all tax rates as exogenous processes, and thus the deficit is financed by lump sum taxes.

As opposed to the baseline model, one may introduce fiscal reactions into the model. For this purpose, we define five alternative fiscal rules and estimate their parameters. According to the reaction functions fiscal authority reacts to current output (deviation from steady state) in order to fulfill its stabilizing role (or simply letting the automatic stabilizers work) and to past deficits. Thus, fiscal policy (though only in a lagged fashion) tries to stabilize the deficits and consequently the debt level, but does not target a specific debt level, just stabilizes it. This seems to be at odds with fiscal rules in practice, but as we

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\(^5\) Social security contributions paid by employees are categorized to personal income taxes throughout this paper.
analyze permanent fiscal consolidations, we need to have debt dynamics, such that in the long run debt is lower than in the initial steady state.

The reaction function for taxes follows:

$$\tilde{t}_t^{i} = \rho^{i} t_{t-1}^{-i} + (1 - \rho^{i}) \left( \phi_{GDP}^{i} GDP_t - \phi_{T}^{i} T_{t-1}^{-i} \right) + \xi_t^{i}$$

where \( i=\{c, s, l\} \) define the three rules corresponding to the three taxes, \( \xi_t^{i} \) indicates the shocks in \( t \) periods, and hats denote log-deviations.

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

$$\tilde{x}_t = \rho^{x} x_{t-1}^{-x} + (1 - \rho^{x}) (-\phi_{GDP}^{x} GDP_t + \phi_{T}^{x} T_{t-1}^{-x}) + \xi_t^{x}$$

where \( x=\{TR, \eta_{\xi}^{x}\} \).

As we analyze permanent fiscal consolidations, reaction functions are switched off for some time. In order to achieve stationary solution of the model we switch on the reaction function with personal income taxes. That way, public debt stabilizes at a lower level than the initial steady state.

**External sector**

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

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

where \( \theta^{x^{\ast}} \) is the export price elasticity, \( x^{\ast} \) is the long-term value of export, and \( \eta_t^{x} \) is the exogenous shock to export demand. We assume that import prices evolve exogenously.

Economic agents may accumulate debts against foreign partners. The foreign interest rate depends on the net foreign asset position’s \( b_t \) deviation from its steady state \( (b) \), the financial premium shock \( \eta^{pr}_t \) (Schmitt-Grohé-Uribe, 2002) and on the country’s debt level (foreign investors penalise the country’s excessive indebtedness by demanding a higher interest rate premium).

$$\frac{1 + i_t^{x}}{1 + r} = e^{-(b_t-b)} e^{\nu_d (d_t-d)} \left( 1 + \eta_t^{pr} \right),$$

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

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

The nominal exchange rate is determined by the modified uncovered interest rate parity, where \( i_t^{x} \) depends on public debt, as well (if interest rate premium channel is switched)
\[
\frac{1 + i_t}{1 + i_t} = \frac{e_{t+1}}{e_t} \quad (35)
\]

### 3.2 Equilibrium conditions

The goods market equilibrium condition is derived by aggregating the individual budget constraints:

\[
y_t = c_t + I_t + (1 + \eta_t^c)G + DP_t^x x_t + \Psi(u_t(j))k_{t-1}, \quad (36)
\]

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, domestic demand needs to be adjusted by the export revenues, import expenses (calculated in domestic currency) and the expenses used for export production:

\[
GDP_t = y_t + q_t P_t^{*} x_t - q_t P_t^{m*} m_t - x_t \quad (37)
\]

### 3.3 Estimation

The model is estimated on a quarterly data sample between 1995 and 2010 by using Bayesian techniques. It is taken into account that there was a change in the monetary policy in 2001, which – in the case of general equilibrium models – may lead to a different model. The problem of the policy change is handled by setting up two separate models, which is then taken into consideration in the Bayesian estimation by using the method of Jakab-Kónya (2009). We estimated the model for the first subsample and, subsequently, used the resulting posterior averages as priors for the estimation of the second subsample.

This method is based on the presumption that the regime change did not affect the whole structure of the model economy, so that we do not expect too much change for some of the key parameters (e.g. elasticity of intertemporal substitution, consumer habit) of the model. Certainly, some other parameters (the extent of indexation, the frequency of price changes etc.) could have changed in the wake of the regime change. The use of Bayesian estimation is therefore a flexible solution: we let the data “speak” whether the parameters have changed or not and this is exactly done by setting the mean of the prior distributions for the second regime to be the posterior from the first regime (prior standard errors are generally higher than the posterior ones).

The model is estimated without switching on the fiscal reaction functions. This choice of estimation strategy was motivated by the observation that Hungarian fiscal policy stabilized its deficit in a rather erratic way: hence estimating the model jointly with reaction functions would have been rather impossible. Throughout this paper we use the coefficients estimated for the second regime.

According to our estimates domestic prices are relatively sticky, while export prices and nominal wages are less so. Interest rate smoothing is lower than usually found for advanced economies and monetary policy reacts to inflation with a coefficient close to 1.5.
4. Results

This section simulates the effects of various fiscal consolidation scenarios, under various assumptions. The assumptions of the scenarios differ, first, in terms of the expectations (credibility), and second, in terms of the compositions of various consolidation measures.

Expectations that the agents form regarding the various fiscal measures, are crucial. In this respect, when determining the impact of fiscal tightening we operate with two distinct sets of assumptions regarding the extent to which a fiscal measure is credible (fully anticipated) or not.

In the first case agents consider fiscal policy changes as permanent and fully credible. All Ricardian agents expect a permanent tightening, and this tightening indeed takes place as expected. This is simulated with fully anticipated permanent shocks. The second case considers measures which are not fully credible, despite the fact that the measures are designed to be permanent. This means that agents think that there is a chance that the
measures will be reversed at some point in the future. Agents expect that the fiscal tightening will gradually cease down, according to a pace (autoregressive process) observed in the past. In this respect, in every subsequent period a part of the shock will be interpreted as a “surprise” (i.e. agents are surprised by the fact that the measure still fully persists).

The fiscal shocks throughout this analysis are always set to be such that their direct fiscal impacts in the first quarter account for one per cent of (original) steady-state GDP (for detailed description of the scenarios see Table 2)\(^6\). This means that the simulated trajectory we present is equal to minus one times the multipliers. In all simulations we analyze permanent fiscal consolidations: government consumption, financial transfers are lower, taxes are higher permanently.

**Table 2: Description of fiscal scenarios**

<table>
<thead>
<tr>
<th>Type of consolidation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduction in</strong></td>
<td></td>
</tr>
<tr>
<td>Gov't consumption</td>
<td>4.4 percent drop in the sum of government consumption, government investment and transfers in kind</td>
</tr>
<tr>
<td>Transfers</td>
<td>7.1 percent lower financial transfers</td>
</tr>
</tbody>
</table>

| **Increase in**       |             |
| Personal income tax   | 2.2 percentage point higher rate of the sum of personal income and social security contribution paid by employees |
| Soc. sec. contrib.    | 2.2 percentage point higher rate of social security contribution paid by employers |
| Value-added tax       | 1.83 percentage point higher rate of value added tax |

There is a difference on how these ex post permanent retrenchments are perceived by the agents of the economy. We call perfectly credible simulations when the whole fiscal path is fully anticipated and in this case the model is solved with perfect-foresight. This treatment of credibility is, in our view, quite straightforward. However, modeling incredibility is a slightly more complicated issue. One can think of perfect incredibility when agents are always surprised that in the next period the government ties its hands and sticks to the envisaged fiscal plan. Technically this could be modeled by running simulations with a series of unexpected shocks. This case is analyzed in depth by Baksa-Benk-Jakab (2010). However, it is quite difficult to imagine this case for the long run. One can think of imperfect credibility as a gradual learning of the shocks: agents continuously learn that the government really achieves the permanent fiscal tightening. In this case the learning mechanism of agents should also be explicitly modeled.

The approach we follow captures this mechanism with a proxy solution. All fiscal variables are governed by an autoregressive process. Letting these autoregressive equations work means that in each period a part of the fiscal tightening is anticipated by the agents

\(^6\) Note, that we set the shocks as having a direct impact of 1 per cent of steady state GDP, and since indirect effects are in place starting from the first quarter, the immediate effects on budget deficit are slightly different from 1 per cent even in the very short term.
and a constant fraction of the fiscal shocks comes as a surprise (partially credible scenarios are hard to interpret in the long run, as in the long run finally the consolidation becomes perfectly credible). This is similar to the simplest learning mechanism.

The shocks we consider are expected to operate through a number of non-Keynesian channels, beside the traditional Keynesian effects. The non-Keynesian channels will therefore either dampen the Keynesian effects, or even completely reverse their sign. In this paper we consider only the specific non-Keynesian channels which are through the expectation effect of households (the Ricardian behavior that agents expect lower taxes in the future), the wealth effect through the lower real interest rate coming from the endogenous risk premium (which decreases with the debt level of both households and government), and through the balance sheet effects (liquidity effects) resulting from the foreign exchange exposure of households. We do not consider non-Keynesian effects arising from wage-moderation in private labor market, as we lack a systematic link between public and private labor market (the model does not contain public labor markets).

One should be aware, that fiscal multipliers are highly affected by how the original fiscal stimulus or contraction is financed (in the latter case whether they accompany by some tax cuts later) (see e.g. Gali and Monacelli (2008) and more recently Obstbaum (2011)). However, in this paper we analyze fiscal consolidations resulting in a permanently lower government debt level, thus we allow debt level to change. So, fiscal reactions are switched out for the first five years and only switched on afterwards. The fiscal rules only contain deficit and output (equations 30 and 31). Hence in this way, the level of debt is permanently lower in all scenarios. The role of fiscal reaction is crucial (see e.g. Ramey, 2011 where an expansion of government purchases financed by distortionary labor taxes in the future has higher multipliers than those financed by lump-sum taxes, or in other words by deficit), but throughout these exercises we abstract from the issue of financing.

Simulations were performed around the deterministic steady state by using the log-linearized version of the model.

4.1 Simulations in the baseline New Keynesian model

The simplest case, the baseline model is a New Keynesian model, which captures both the neoclassical and the Keynesian channels. The neoclassical elements work mainly on their effect on labor supply. Higher taxes (on labor paid by employees) decrease the supply of labor and they also put a downward pressure on aggregate demand and consequently on labor demand. The substitution away from labor to leisure is dominant and this leads to lower consumption and output. Labor tax hikes also make leisure cheaper (by affecting the marginal product wage) and consumption drops in the long run. In the long run, all of these
effects are associated with a positive multiplier, i.e. a lower economic activity. In both the basic neoclassical and New Keynesian models reductions in government spending are like the construction of less “white elephants”, which means that in the long run less resources are vested. In this paper we do not consider the contradictory effects of reduction in government investments and public goods. Naturally, a reduced demand for productive public goods might have a very negative effect on output, e.g. if it induces a significant reduction in uniform services. In addition, we do not model potential asymmetries in multipliers stemming from e.g. underutilized resources during recessions (which generate higher multipliers in recessions).

The New Keynesian model incorporates the neoclassical wealth effect, but it has some features which could modify multipliers. A significant share of households is liquidity-constrained and indebted in foreign currencies (rule-of-thumb consumers). They are consuming all of their net disposable income (labor income in the baseline case). Price and wage rigidities generate an aggregate demand effect of fiscal shocks. Because prices and wages are not flexible, aggregate demand rises and this generates a rise in demand for labor. This is the major source why our New Keynesian model generates positive multiplier (so output drops after a fiscal drag).

On the other hand, monetary policy in the New Keynesian model is mitigating the above effects, leading to smaller multipliers (and we show this is the case in Hungary in Section 4.5). However, when interest rates are around the zero lower bound the opposite happens, monetary policy is not able to counteract the fiscal drag and thus the drop in output is larger (see Coenen et al, 2010).

In addition, the presence of backward-looking indexation mechanism, variable capacity utilization, and adjustment cost for factors, are all responsible for the short-run dominance of positive multipliers. In all cases, a fiscal drag is accompanied by a drop in output and private consumption and may strengthen the neoclassical channels.

In the short run, a fall in government consumption should be accompanied by higher private consumption and investment. Lower government consumption today or higher taxes today leads to lower real interest rates and real wages, and thus to increase in consumption and investment (Ricardian behavior). This is because agents expect lower taxes or less binding resource constraint due to lower government purchases in the future in exchange of higher taxes or lower income today, and they smooth consumption and thus private consumption and investment grow immediately.

---

7 In the short run the increase in labor taxes (paid by employers) work in a different way (through labor demand first), but in principle they do not differ from labor taxes paid by employees as households own firms.

8 The 25 per cent value is calibrated by a separate error correction equation between consumption, disposable income, household wealth and the short term immediate effect of disposable income measures the role of liquidity constraints.
These channels predict the following: the negative short-term effects of a fiscal tightening is mitigated when private agents fully perceive the fiscal consolidation efforts to be permanent and credible, that is, the government is able to commit itself to preserve the newly gained fiscal space. We would then expect a stronger chance of observing non-Keynesian effects when stabilizations are credible, compared to the partially credible consolidations.

The effect of a reduction in transfers (which are negative taxes) would have similar effects. Transfers are targeted towards rule-of-thumb consumers. Consequently, they create an immediate decrease in consumption demand from this group and, thus, the output loss is larger than that of tax hikes.

As Hungary is a small, open economy, we also need to take into account the behavior of the demand for imports (as they are mostly considered as a production input) and the role of the exchange rate. Both work in the direction of lower multipliers, with a lower short-run output consequences of a fiscal tightening: import demand drops (mitigating the response of GDP) and the accompanying easing of monetary policy depreciates the domestic currency which pushes up the volume of exports and lowers the volume of imports. This latter effect is not present in the case of value-added tax hikes, which can explain why they have stronger output effects than income tax or social security contribution hikes.

Table 3 and the dashed lines in the charts of Appendix show the results from simulating various fiscal scenarios on the baseline New Keynesian model. Simulations indicate that all fiscal consolidation scenarios end up with negative effects on output: non-Keynesian wealth effects are outweighed by Keynesian ones.

A reduction in government purchases of goods and services has by far the strongest effect on output; however, since Hungary is a small open economy, the effect is weaker than usually found for larger economies (e.g Coenen et al, 2010). Personal income tax and social security contribution hikes have very similar effects: they have the smallest multipliers. The reason is that they both lead to more expensive labor, but the income effects mitigates this – to keep up the same level of utility agents work a bit more, compared to other scenarios. Even though personal income tax and social security contribution have the same long-run effects, they have somewhat different effects in the short run. The reason is that social security contributions are paid by the employers and thus directly enter into the price setting mechanism (to the Phillips curve), while personal income tax changes have only indirect effects, through the fall in income and through wage bargaining.

After a personal income tax hike, inflation drops while the opposite happens with an increase in social security contributions. Value-added tax hikes have the strongest output effects among taxes. The reason is that while in all other scenarios fiscal tightening enables monetary policy to somewhat offset the negative effects, this does not hold here as the monetary authority reacts only moderately to the hike in inflation. This behavior is not as
straightforward: at the first glance, as monetary policy targets net inflation\textsuperscript{9}, one would not expect monetary reaction. However, as there is an adaptive learning scheme for 'perceived inflation', the trend inflation rises and monetary policy tries to counteract the rise in inflation perception, that is, tries to maintain its credibility by increasing the nominal interest rate.

A reduction of (targeted) transfers has quite high multiplier as rule-of-thumb households consume less in the short run. However, this effect fades away relatively at a fast pace, as the increase in consumption of Ricardian households at least partly offset the drop in the other group’s consumption. Except for the reduction in government purchases of goods, private consumption drops (even in the long run).

The response of investments depends on several factors. Labor tax hikes cause labor to be more expensive than capital, giving rise to a substitution effect and investments increase. On the other hand, lower future growth prospects lead to lower demand for capital. We find that in labor tax based consolidations the latter effect dominates and investments drop. While for the case of expenditure based consolidations (cuts in government purchases or financial transfers) monetary policy reacts by lowering the interest rate and since prices are sticky, real interest rate also drops which gives an impetus to investments. For value-added tax hikes, real interest rate also drops as monetary policy targets net inflation, and thus investments increase.

Exports also benefit from the corresponding monetary easing which causes a real depreciation of the currency. Monetary easing is not present during value-added tax hikes, but in this case another mechanism is in place. As the value-added tax on exports is paid abroad, higher taxes on domestic good purchases implies a shift from the domestic sector to the export-oriented one. Tax-hike works as a 'subsidy' to exports. As Hungary’s exports are close to one hundred per cent of GDP, this sectoral effect is very strong and investments in this sector are enhanced after a rise in value-added taxes.

One can observe that partially credible fiscal consolidations have more pronounced negative consequences for output, especially in the case of a reduction in transfers, government purchases and value-added tax rises. A less credible permanent fiscal retrenchment implies lower intensity of Ricardian behavior, making the wealth channel weaker. However, in the case of income tax and social security contribution hikes, these channels do not affect the numerical results significantly. The reason is that the estimated persistence of these types of taxes is relatively high. Thus, once there is a tax hike agents anticipate that the bulk of it will persist in the next period, so the 'surprise effect' under a partially credible scenario has less importance. Fully anticipated and partially anticipated scenarios will not differ too much as the partially credible scenario is associated with relatively persistent rises in labor taxes.

\textsuperscript{9} One can argue that monetary policy might respond to gross inflation. This case is explained in more details in Section 4.5.
Summing up, the baseline model captures some, but not all potential non-Keynesian effects of fiscal consolidations. Namely, the wealth channel from agents’ expectation on lower taxes is captured. The baseline scenario shows however, that credible fiscal consolidations have less detrimental effect on output in the short to medium run. This scenario also shows that credibility (when fiscal consolidation is fully anticipated) increases the likelihood of observing non-Keynesian effects. The crowding in effects from lower supply of public goods (as a result of reduction in government purchases) and the potential gains in efficiency from wage cuts in the public sector are not present in this scenario. The effects from reduction in real interest rate premium and the balance sheet effects from currency appreciation are also missing, but we are able to model them and the next two sections elaborate on these topics.

**Table 3: Effects of fiscal consolidations on output in the baseline New Keynesian model**

<table>
<thead>
<tr>
<th>Years</th>
<th>Gov’t consumption</th>
<th>Transfers</th>
<th>Personal income tax</th>
<th>Increase in Soc. sec. contrib.</th>
<th>Value-added tax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fully credible</td>
<td>Partially credible</td>
</tr>
<tr>
<td>1</td>
<td>-0.44</td>
<td>-0.32</td>
<td>-0.12</td>
<td>-0.09</td>
<td>-0.27</td>
</tr>
<tr>
<td>2</td>
<td>-0.25</td>
<td>-0.14</td>
<td>-0.12</td>
<td>-0.16</td>
<td>-0.30</td>
</tr>
<tr>
<td>3</td>
<td>-0.21</td>
<td>-0.08</td>
<td>-0.14</td>
<td>-0.17</td>
<td>-0.11</td>
</tr>
<tr>
<td>4</td>
<td>-0.23</td>
<td>-0.07</td>
<td>-0.15</td>
<td>-0.16</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

4.2 Real interest rate and public debt

As a next step we depart from the baseline model and analyze the role of changes in the interest rate premium in generating non-Keynesian effects. Although there is a link between indebtedness and interest rates even in the baseline model, it works only through the supply of capital from abroad. All else equal, lower indebtedness of the country imply an appreciating pressure on the currency through the modified uncovered interest rate parity (UIP) condition. This enables the monetary authority to lower somewhat nominal (and real) interest rates, which gives some minor impetus to growth. However, this effect might be very non-linear and thus can be hardly detected in short time-series data, and thus the elasticity of indebtedness on interest rate is calibrated at a small value. In our view, however, this effect can be strong in certain circumstances. The next simulations show that when inserting a relatively modest effect of public indebtedness term in the equilibrium real interest rate determination, it can change our previous assessment on the magnitude of non-Keynesian effects. For this purpose, we let the equilibrium real interest rate to be sensitive to public debt. We calibrated the semi-elasticity of equilibrium real interest rate on the debt-to-GDP ratio to be at the lower end of what was usually found in the empirical

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10 By modified UIP denotes a UIP condition with risk premium dependant on net foreign asset position.
literature. A 1 percentage point reduction in public debt causes a cut in the annualized real interest rate by 5 basis points.

A prolonged fiscal austerity lowers the budget deficit by around one per cent of initial GDP over a long period. This means that the debt is lowered by a significant amount during these exercises. Lower equilibrium real interest rates make future consumption in exchange of current consumption more expensive (the slope of the curve derived from the Euler-equation is less steep), current savings drop and consumption rises. A lower equilibrium real interest rate enables to invest until reaching a higher level of capital which has a lower marginal product. As investment is costly to adjust, a higher future capital leads to higher investment over a prolonged period. All these factors make the fiscal multipliers lower, i.e. the shrinking of GDP following a fiscal stabilization becomes less likely.

Table 4 and the solid lines in the charts in Appendix show that, when inserting the interest rate premium channel into the model, the drop in output is significantly less pronounced in the longer run. Apart from the very strong direct multiplier effect from national accounting of decreases in government spending and the dominantly Keynesian effects of cuts in transfers, the fall in output effects is smaller even in the short run. Interestingly, for fully credible fiscal consolidations, non-Keynesian effects may arise for labor tax hikes.11

To conclude from this exercise, when fiscal consolidations in Hungary lead to lower equilibrium real interest rates, fiscal policy may become non-Keynesian, and this holds especially when the government can credibly announce that fiscal austerity is permanent.

Table 4: Effects of fiscal consolidations on output in the model with interest rate premium channel

<table>
<thead>
<tr>
<th>Years</th>
<th>Gov’t consumption</th>
<th>Transfers</th>
<th>Personal income tax</th>
<th>Soc. sec. contrib.</th>
<th>Value-added tax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.14</td>
<td>-0.10</td>
<td>-0.13</td>
<td>0.09</td>
<td>-0.05</td>
</tr>
<tr>
<td>2</td>
<td>-0.06</td>
<td>0.00</td>
<td>0.04</td>
<td>-0.04</td>
<td>-0.17</td>
</tr>
<tr>
<td>3</td>
<td>-0.11</td>
<td>-0.01</td>
<td>-0.05</td>
<td>-0.11</td>
<td>-0.03</td>
</tr>
<tr>
<td>4</td>
<td>-0.13</td>
<td>-0.01</td>
<td>-0.07</td>
<td>-0.11</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

Shaded area: non-Keynesian (expansionary) effects of fiscal tightening

11 Because government consumption adds to value-added in national accounts, they have very strong direct effect statistically (this is the ‘gross multiplier’. However, the ‘net multiplier’ which is defined as the gross multiplier minus 1 measures the additional effect of government actions on activity. In that sense the net multiplier of government purchases in our model is negative, meaning that reduction in demand for otherwise ‘useless’ public goods crowds in the demand for more ‘useful’ private goods.
4.3 Foreign currency denominated debt

We further enrich our model with another element. As borrowing in foreign exchange by households is a serious issue in Hungary, we develop a model version where some (very stylized) balance-sheet effects are captured. Since in this model Ricardian households can smooth their consumption and have access to capital markets, balance-sheet effects are limited to the rule-of-thumb agents. We modify the budget constraint for this group (equation 10), such that their consumption equals their net labor income minus the interest rate payments out of the privately held debt (which is total net foreign asset position minus public debt\textsuperscript{12}) and they also need to partly pay the effects of nominal exchange rate changes on their debt. We assume an average loan of 20 quarters (5 years), so a 1 per cent depreciation of the currency leads to a half of a tenth of a per cent increase in their quarterly installments and thus their real disposable income is lower by this amount. For simplicity, we assumed that the share of FX loans held by rule-of-thumb consumers is the same as their share in total aggregate consumption. The government also benefits from the exchange rate appreciation as it also borrows in foreign currencies; we took the 2010 value of 30 per cent share of government debt held in foreign currency and the duration of government FX debt is also calibrated to be 5 years.

Comparing Table 4 and Table 5, one can clearly observe that non-Keynesian effects become stronger in this latter case. The major channel is that as public debt shrinks, real equilibrium interest rate drops, and given the interest rate smoothing of the central bank the growing difference between foreign and domestic real interest rate causes a real appreciation of the currency (if the exchange rate regime is a floating one, see later). This effect is also present in the previous scenario and through lower net exports it worked against non-Keynesian effects. On the other hand, in this scenario real appreciation not only has an ‘expenditure switching effect’, but also causes a strong gain in real disposable income for rule-of-thumb agents. As rule-of-thumb agents’ response is taken into account in the behavior of Ricardian households (they are aware of this balance-sheet effect), the hike in non-Ricardian households’ consumption is slightly counterbalanced by the consumption-smoothing behavior of the Ricardians.

An interesting feature is that while consumption is higher compared to the scenario with the interest rate premium channel, investments are generally lower. In the case of credible fiscal consolidation private investments drop in most of cases. As non-Keynesian effects are more likely in the case of FX channels, inflation pressures emerge due to the increase in aggregate demand. Monetary policy then tightens and this makes a dampening effect on investments. In the case of partially credible consolidation this does not happen, as non-Keynesian balance sheet effects resulting from appreciation are less likely.

\textsuperscript{12} One natural drawback of our model is that firms are owned by domestic Ricardian households. In a more realistic setup with foreign ownership and a separate corporate sector with balance sheet (cash-flow) effects non-Keynesian effects can even become stronger and our results might be biased.
The relatively large balance-sheet effects on the consumption of non-Ricardians outweigh the modest increase or even a drop in investment and finally economic activity is higher, most notably in the case of credible consolidations.

Putting together the endogenous response of equilibrium real interest rate and the balance sheet effects resulting from high level of indebtedness in foreign currency, these together make credible fiscal consolidation expansionary at least in the short run. In the case of partial credibility the exchange rate strengthening is less pronounced and even though short term multipliers decrease, meaning that the presence of FX loans is not always enough to generate an expansionary fiscal consolidation.

Table 5: Effects of fiscal consolidations on output in the model with interest rate premium and FX loan channels

<table>
<thead>
<tr>
<th>Years</th>
<th>Reduction in Gov’t consumption</th>
<th>Reduction in Transfers</th>
<th>Reduction in Personal income tax</th>
<th>Increase in Soc. sec. contrib.</th>
<th>Increase in Value-added tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully credible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.18</td>
<td>0.06</td>
<td>0.29</td>
<td>0.17</td>
<td>0.22</td>
</tr>
<tr>
<td>2</td>
<td>0.01</td>
<td>0.06</td>
<td>0.06</td>
<td>-0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>-0.21</td>
<td>-0.08</td>
<td>-0.11</td>
<td>-0.14</td>
<td>-0.12</td>
</tr>
<tr>
<td>4</td>
<td>-0.27</td>
<td>-0.11</td>
<td>-0.16</td>
<td>-0.14</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

| Partially credible | | | | | |
| 1 | -0.48 | -0.39 | 0.00 | 0.10 | -0.27 |
| 2 | -0.29 | -0.24 | -0.03 | -0.06 | -0.19 |
| 3 | -0.23 | -0.16 | -0.07 | -0.14 | -0.13 |
| 4 | -0.23 | -0.16 | -0.09 | -0.14 | -0.13 |

*Shaded area: non-Keynesian (expansionary) effects of fiscal tightening*

4.4 The role of the exchange rate regime

As a third extension of the baseline model we analyze what the role of the exchange rate regime is. So far, the central bank followed an inflation targeting framework, but now we depart from this assumption and fix the nominal exchange rate. Usually, fiscal policy in fixed exchange rate regime is found to be more effective than in floating ones, also in DSGE models. In other words, without having the necessary tools monetary policy cannot counteract the effects of fiscal policies making multipliers larger (as in Corsetti et al., 2009).

The same applies in our model as shown on Table 6. When we allow for an endogenous real interest rate premium and balance-sheet effects stemming from FX loans, the short-run impetus to consumption is less pronounced. The reason is that as the nominal exchange rate is fixed and prices are sticky, the increase in the real disposable income is more gradual. On the other hand, a slower real appreciation generates a somewhat bigger contribution of net exports to growth. Altogether, the expansionary effects of fiscal stabilization are a bit stronger assuming that it is fully credible. The opposite holds in the
case of partially credible stabilizations. A fixed exchange rate regime does not help too much in enhancing expansionary fiscal consolidations in this case.

Table 6: Effects of fiscal consolidations on output in the model with interest rate premium and FX loan channels under fixed exchange rate regime

<table>
<thead>
<tr>
<th>Years</th>
<th>Reduction in</th>
<th>Increase in</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gov’t consumption</td>
<td>Transfers</td>
</tr>
<tr>
<td></td>
<td>Fully credible</td>
<td>Partially credible</td>
</tr>
<tr>
<td>1</td>
<td>0.20</td>
<td>-0.15</td>
</tr>
<tr>
<td>2</td>
<td>0.10</td>
<td>-0.11</td>
</tr>
<tr>
<td>3</td>
<td>-0.22</td>
<td>-0.09</td>
</tr>
<tr>
<td>4</td>
<td>-0.30</td>
<td>-0.13</td>
</tr>
</tbody>
</table>

Shaded area: non-Keynesian (expansionary) effects of fiscal tightening

4.5 Alternative monetary policy rules

We observed that in the short run non-Keynesian effects might dominate when the FX loan balance sheet channel and the interest rate premium channel is present. The former effect is dependent on how nominal exchange rate behaves. Nominal exchange rate in this model is largely determined by the behavior of the monetary policy. So it is interesting to analyze the role of monetary policy. A comparison of Table 7 with Table 5 reveals that when inserting output gap into the monetary reaction function (with a coefficient equal to 0.5 as in the original Taylor-rule) non-Keynesian effects are less pronounced. The reason is that monetary policy tries to counteract the expansionary effects of fiscal consolidation by some tightening and consequently output grows by a smaller amount. This is quite standard in New Keynesian models when interest rate is far from the zero lower bound (ZLB). In our simulations interest rates were not around the ZLB\(^{13}\). One should also note, however, that our finding that the FX loan channel creates non-Keynesian effects is quite robust when using a monetary rule with more output smoothing.

\(^{13}\) Otherwise, if they are close to ZLB, monetary policy cannot help and thus multipliers are larger than those when the rate is farther away from ZLB.
Table 7: Effects of fiscal consolidations on output in the model with interest rate premium and FX loan channels with output stabilization in the monetary policy reaction

<table>
<thead>
<tr>
<th>Years</th>
<th>Reduction in Gov't consumption</th>
<th>Transfers</th>
<th>Personal income tax</th>
<th>Increase in Soc. sec. contrib.</th>
<th>Value-added tax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fully credible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.16</td>
<td>0.13</td>
<td>0.27</td>
<td>0.15</td>
<td>0.21</td>
</tr>
<tr>
<td>2</td>
<td>-0.02</td>
<td>0.03</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>-0.20</td>
<td>-0.08</td>
<td>-0.11</td>
<td>-0.13</td>
<td>-0.11</td>
</tr>
<tr>
<td>4</td>
<td>-0.25</td>
<td>-0.10</td>
<td>-0.14</td>
<td>-0.13</td>
<td>-0.14</td>
</tr>
<tr>
<td></td>
<td>Partially credible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.46</td>
<td>-0.38</td>
<td>0.00</td>
<td>0.09</td>
<td>-0.26</td>
</tr>
<tr>
<td>2</td>
<td>-0.21</td>
<td>-0.17</td>
<td>-0.02</td>
<td>-0.07</td>
<td>-0.14</td>
</tr>
<tr>
<td>3</td>
<td>-0.18</td>
<td>-0.13</td>
<td>-0.06</td>
<td>-0.13</td>
<td>-0.10</td>
</tr>
<tr>
<td>4</td>
<td>-0.19</td>
<td>-0.13</td>
<td>-0.08</td>
<td>-0.13</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

Shaded area: non-Keynesian (expansionary) effects of fiscal tightening

As noted earlier, monetary policy in the models considered so far, always reacted to ‘net’ inflation (inflation net of value added taxes). Table 8 presents a scenario when monetary policy also takes into account the temporary rise in inflation due to value added tax hikes. This occurs when the central bank tries to avoid that value added tax hikes feed into inflationary expectations and tries to prevent a situation when a one-off price increase leads to more persistent inflation dynamics. According to our results, this possibility also dampens the possible non-Keynesian effects; the rise in output is smaller for value added tax hikes when gross inflation is targeted. This suggests that non-Keynesian effects of fiscal consolidation in Hungary are more likely when inflationary expectations are well anchored.

Table 8: Effects of fiscal consolidations on output in the model with interest rate premium and FX loan channels with gross inflation in the monetary policy reaction

<table>
<thead>
<tr>
<th>Years</th>
<th>Reduction in Gov't consumption</th>
<th>Transfers</th>
<th>Personal income tax</th>
<th>Increase in Soc. sec. contrib.</th>
<th>Value-added tax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fully credible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.18</td>
<td>0.14</td>
<td>0.29</td>
<td>0.17</td>
<td>0.14</td>
</tr>
<tr>
<td>2</td>
<td>0.01</td>
<td>0.06</td>
<td>0.06</td>
<td>-0.04</td>
<td>-0.11</td>
</tr>
<tr>
<td>3</td>
<td>-0.21</td>
<td>-0.08</td>
<td>-0.11</td>
<td>-0.14</td>
<td>-0.10</td>
</tr>
<tr>
<td>4</td>
<td>-0.27</td>
<td>-0.11</td>
<td>-0.16</td>
<td>-0.14</td>
<td>-0.14</td>
</tr>
<tr>
<td></td>
<td>Partially credible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.48</td>
<td>-0.39</td>
<td>0.00</td>
<td>0.10</td>
<td>-0.33</td>
</tr>
<tr>
<td>2</td>
<td>-0.29</td>
<td>-0.24</td>
<td>-0.03</td>
<td>-0.06</td>
<td>-0.22</td>
</tr>
<tr>
<td>3</td>
<td>-0.23</td>
<td>-0.16</td>
<td>-0.07</td>
<td>-0.14</td>
<td>-0.10</td>
</tr>
<tr>
<td>4</td>
<td>-0.23</td>
<td>-0.16</td>
<td>-0.09</td>
<td>-0.14</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Shaded area: non-Keynesian (expansionary) effects of fiscal tightening
5. Conclusion

The paper examined the macroeconomic effects of various fiscal consolidation policies in an estimated open-economy DSGE model of the Hungarian economy. It identified the possible non-Keynesian channels through which a fiscal consolidation may manifest, along with the specific features of the Hungarian economy that can facilitate the appearance of growth-enhancing effects of consolidations.

Simulations showed that fiscal consolidation policies are typically recessionary in the standard New Keynesian DSGE model. Although non-Keynesian channels are present, the Keynesian channels dominate. However, taking into account the specific features of the Hungarian economy, there is a chance that expansionary effects arise. These effects may be present if the interest risk premium reacts to the reduction of the debt level, and if the high level of indebtedness in foreign currency generate favorable balance sheet effects through the appreciation of the currency.

The credibility of the consolidation policy is key to achieving positive output effects. A non-credible consolidation is unlikely to generate positive effects, no matter the assumptions regarding the specific features of the economy, and no matter the composition of a consolidation package.
APPENDIX

Perfectly credible fiscal consolidation

GDP

[Graphs showing government consumption, transfers, personal income tax, social security, and value-added tax over quarters]
Private consumption

- Government consumption
- Interest rate premium and FX loans
- Transfers
- Personal income tax
- Social security
- Value-added tax

Graphs showing changes over time in various economic indicators.
Private investment

Government consumption

Interest rate premium and FX loans

Baseline model

Transfers

Government consumption

Transfers

Government consumption
Inflation

Graphs showing the impact of various factors on Inflation over a period of 16 quarters. The factors include:

- Government consumption
- Interest rate premium and FX loans
- Transfers
- Personal income tax
- Social security
- Value-added tax
Budget balance*

* percentage point change from steady state GDP
Government debt*

* percentage point change from steady state GDP
Nominal short-term interest rate*

* percentage point deviation from steady state
Nominal exchange rate*

* higher number indicates depreciation
Partially credible fiscal consolidation

GDP
Private consumption

- Government consumption
- Transfers
- Personal income tax
- Social security
- Value-added tax

Legend:
- Interest rate premium and FX loans
- Baseline model
- Interest rate premium
Private investment

![Graphs showing various economic indicators such as government consumption, transfers, personal income tax, social security, and value-added tax over time.](image-url)
Inflation

- Government consumption
- Interest rate premium and FX loans
- Transfers
- Personal income tax
- Social security
- Value-added tax
Budget deficit*

*percentage point change from steady state GDP
Government debt*

* percentage point change from steady state GDP
Nominal short-term interest rate*

* percentage point deviation from steady state
Nominal exchange rate*

* higher number indicates depreciation
References


Checherita, Cristina and Philipp Rother (2010): “The impact of high and growing government debt on economic growth: an empirical investigation for the euro area” ECB Working Paper No 1237


