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

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NON-KEYNESIAN EFFECTS OF FISCAL CONSOLIDATION: AN ANALYSIS WITH AN ESTIMATED DSGE MODEL FOR THE HUNGARIAN ECONOMY

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ABSTRACT/RESUMÉ

Non-Keynesian effects of fiscal consolidation: an analysis with an estimated DSGE Model for the Hungarian economy

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 show that fiscal consolidation policies are typically contractionary. 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 interest rate risk premium or favourable balance sheet effects through the appreciation of the currency. However, the credibility of fiscal consolidation is key in achieving positive output effects. A non-credible consolidation is unlikely to expand output, regardless of the assumptions regarding the specific features of the economy, and regardless of the composition of a consolidation package.

This Working Paper relates to the 2012 *OECD Economic Survey of Hungary* (www.oecd.org/eco/surveys/hungary).

JEL classification: E62, E27, H30, H50.

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

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Les effets non-Keynésiens de l'assainissement budgétaire : une analyse avec un modèle DSGE estimé pour l'économie hongroise

À partir d'un modèle d'équilibre général dynamique et stochastique (DSGE) estimé pour la Hongrie, ce papier identifie les canaux non-Keynésiens susceptibles de donner un caractère expansionniste à un assainissement budgétaire. Les simulations montrent que les politiques d'ajustement budgétaire se traduisent généralement par une contraction de l'activité. Toutefois, compte tenu de certaines caractéristiques propres à l'économie hongroise, il est probable que des effets expansionnistes surviennent. Ces effets peuvent prendre la forme d'une baisse de la prime de risque de taux d'intérêt ou d'effets de bilan favorables du fait d'une appréciation du taux de change. Cela étant, la crédibilité de l'assainissement budgétaire est indispensable pour obtenir des effets positifs sur la production. Un ajustement non crédible a peu de chances de produire de tels effets, quelles que soient les hypothèses retenues à propos des caractéristiques de l'économie et quelle que soit la composition du programme d'assainissement.

Ce Document de travail se rapporte à l'Étude économique de l'OCDE de la Hongrie, 2012 (www.oecd.org/eco/etudes/hongrie).

Classification JEL: E62, E27, H30, H50.

Mots-clés: assainissement budgétaire, effets non-Keynésiens, modèle DSGE, fiscalité, dépense publique.

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NON-KEYNESIAN EFFECTS OF FISCAL CONSOLIDATION: AN ANALYSIS WITH AN ESTIMATED DSGE MODEL FOR THE HUNGARIAN ECONOMY

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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-tem 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 which may contribute to faster growth even in the short term. These positive effects are commonly referred to in the literature as non-Keynesian effects.

The empirical literature confirms that the level of public debt can have a significant effect on growth. 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 find important growth-reducing effects of high debt levels (above 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 real interest rates. Kumar and Woo (2010) find that GDP growth in 38 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. Going further, Sutherland *et al.* (2012) and Merola and Sutherland (2012) argue in favor of setting an explicit debt target that could serve as a long-term anchor for fiscal policy.

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Empirical evidence based on various fiscal consolidation episodes confirms the existence of growth-enhancing fiscal consolidations. Afonso (2010) finds some evidence in favor of the existence of expansionary fiscal retrenchment episodes for 15 EU countries. Yet expansionary effects depend on the specific budgetary spending items, as well as on the specification and the time span used. Based on a panel of OECD countries Alesina and Perotti (1995) and Alesina and Ardagna (2010) conclude that fiscal consolidation may be expansionary if implemented mainly by cutting government spending. Giudice *et al.* (2007) show that a considerable number of fiscal consolidation episodes are followed by higher growth. Hauptmeier *et al.* (2007) argue that expenditure reforms are the most likely to promote growth. Using panel estimation techniques, Rzonca and Cizkowicz (2005) provide evidence that, in the EU new member states, fiscal consolidation may contribute substantially to the acceleration of output growth even in the short term.

These results, however, have recently faced a series of criticisms. IMF (2010) criticises 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 costly, 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 argues 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) summarises 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 linked 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.[2]

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 consolidation 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 past expansionary consolidation episodes in Denmark, Ireland, Finland and Sweden do not hold any more for European countries. Therefore, it is inappropriate to extrapolate from past findings the impact of fiscal consolidation in the fiscal and financial environment of the current post-crisis period.[3]

2. Expectation effects, however, can be also detrimental if fiscal policy – either expansionary or contractionary – is implemented in an inappropriate (e.g. non-credible) way.

3. 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 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 find 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 consolidation suggests. A related analysis using the same model confirms these finding, 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 contractionary (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 effects are stronger and the likelihood of a positive output reaction increases when the interest rate risk premium falls as a response to a consolidation policy that decreases the debt-to-GDP ratio.

- 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 household and public sector 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, regardless of the assumptions regarding the specific features of the economy and regardless of the composition of the consolidation measures.

- If inflation expectations are well anchored, non-Keynesian effects are more likely to arise.

The remainder of the paper is structured as follows. The second section reviews the theory of non-Keynesian effects and channels, which may arise as a result of a fiscal tightening. The third section sets up a DSGE model for the Hungarian economy, which incorporates the channels relevant for Hungary through which non-Keynesian effects may appear. The fourth section simulates the model by generating various types of fiscal consolidation (either through expenditure cuts or tax increases), discusses the results and identifies the non-Keynesian effects that may be present in the Hungarian economy. The last section concludes.

Non-Keynesian effects of fiscal consolidation

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 response of private consumption and/or private investment

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 and 1996; Alesina and Perotti, 1997; Alesina and Ardagna, 1998; Perotti, 1999; and Ardagna, 2004). On the demand side the explanations usually include the following channels: expectation, risk premium and wealth effects on consumption, also the substitution effect from pubic to private spending. On the supply side there is a labour market channel stemming from increased labour market efficiency and an increase in competitiveness through lower wage costs. Credibility aspects are important as well. In the following sections, we discuss these channels in detail.

Expectation channel

The expectation channel is key in inducing economic reactions that may already offset the negative demand effects 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 been too pessimistic in their 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 consolidation 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 consolidation and is directly linked with its credibility, hinging on the assumption that economic agents believe that fiscal adjustment efforts will be carried out – both quantitatively and qualitatively – exactly in the way they were 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) summarise the preconditions under which positive expectation effects could be particularly large: *i*) the initial fiscal 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, which increases the probability of a long-lasting structural improvement in the fiscal stance; *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.

Interest rate risk premium channel

The interest rate risk premium channel works through a decrease in real interest rates as a consequence of a reduction in the risk default premium, driven by a cut in 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.

Wealth channel

The wealth channel can be composed of various effects that could all contribute to a boost in consumption. According to a standard effect, a fall in the interest rates increases the market value of assets held by consumers. Consequently, the market value of the fraction that households normally consume out of their wealth is 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 in the risk default premium), the gap between foreign and domestic real interest rates widens (given that the central bank smoothes the interest rate and does not lower it to the same extent as the decline in the risk premium) causing a real appreciation of the currency.[4] 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)[5], the extra income would mainly be used for additional consumption.

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.

Substitution channel

Fiscal consolidation involving a cut in spending on public goods also generates substitution effects relating to the replacement of public consumption by private consumption. If consumers value services supplied by the public sector (e.g. education, health care, cultural services), they will most likely increase private spending on these items (crowding-in effects) once they are no longer provided by the public sector.

Supply-side channels

While the channels described above all work on the demand side, there are important supply-side channels as well, mainly linked to the labour market. They depend crucially on the composition of fiscal adjustment, and are more effective in the case 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 trade unions (either by increasing the probability of unemployment or by raising the costs of being unemployed), therefore reducing real wage pressure, stimulating employment, investment and output growth. While these effects finally result in an enhancement of labour market efficiency and the overall competitiveness of the economy, the structure and institutions of the labour market may play an important role as well. Nevertheless, they also highlight the importance of the composition of fiscal

4. 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.

5. The fact that they are liquidity constrained does not mean that they did not have access to the market in the past. Indeed, they could be liquidity constrained at present just because they have previously contracted large amount of FX debt (as it is often the case of Hungarian households).

adjustment, as a cut in expenditure on wages increases the price competitiveness of businesses, while the opposite effect occurs if taxes are raised.[6]

Credibility effects

A key factor for the operation of many of these channels 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 and implementation.

Non-Keynesian channels modelled in the paper

In the rest of the paper we use a DSGE model to examine the macroeconomic effects of alternative fiscal consolidation strategies, with an emphasis on identifying the channels through which non-Keynesian effects of fiscal consolidation 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 them. However, due to technical constraints the model lacks the explicit mechanism of risk-premium dependent foreign capital inflows. Further, we did not model the government sector in detail; therefore we do not have productive government investment, explicit supply of public goods, or interactions between the public and private sector linked to labor market developments.

On top of traditional Keynesian effects and credibility effects, in this paper we consider the following non-Keynesian channels: *i*) the expectation channel (linked to the Ricardian behavior of agents expecting lower taxes in the future); *ii*) the risk premium channel (which decreases the debt level of both households and the government through lower interest rates); and *iii*) the wealth channel (driven by balance sheet effects resulting from the foreign exchange exposure of households and the government). The baseline model includes the expectation channel only. Subsequently, it is supplemented with the interest rate risk premium channel. Finally, the full model assesses the impact of fiscal consolidation when all the three non-Keynesian channels are switched on. 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.

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. Besides 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 of future taxes or expenditure.

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 driving the neoclassical result.

6. Different types of taxes affect competitiveness to a different extent. Also, different sectors are affected to different extent (for instance, a hike in VAT favours the tradable sector).

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.

- Investment: 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 introduce 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. Thus 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 labour and paid by the employees, a tax levied on labour 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.

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. A fraction $\bar{\omega}$ of households choose their consumption stream in the standard rational optimising manner. These optimising households have labour and capital income and they own domestic firms. The expected utility function of household *j* is given by:

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

where $u\left(H_t^o(j)\right) = \left(\frac{c_t^o(j) - hc_{t-1}^o(j)}{1-\sigma}\right)^{1-\sigma}$ denotes the consumption utility of household *j* considered under consumption habits, $v(l_t(j)) = \frac{l_t^{1+\varphi}}{1+\varphi}$ 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 β. Households' consumption and employment valuation may vary over time, represented by preference shocks to consumption, $\eta^c{}_t$, and leisure, $\eta^l{}_t$. 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:

$$\begin{aligned} (1+\tau_t^c) P_t c_t^o(j) + P_t I_t(j) + \frac{B_t(j)}{1+i_t} \\ = B_{t-1}(j) + (1-\tau_t^l) W_t(j) l_t(j) + P_t r_t^k u_t(j) k_{t-1}(j) \\ - \Psi(u_t(j)) P_t k_{t-1}(j) + Div_t - OT_t \end{aligned} \tag{2}$$

According to this, individual households supply labour (differentiated by their skill type indexed by *j*), and 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 into physical capital or 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 a capital income r_t^k on the capital supplied earlier. As households own the shares of the firms, profits (if 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:

$$k_t = (1-\delta)k_{t-1} + \left[1 - \phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right)\right]I_t, \tag{3}$$

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

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

1. Euler equation is written as:

$$\frac{\lambda_t}{(1+\tau_t^c)P_t} = \beta(1+\breve{\imath}_t)E_t\left[\frac{\lambda_{t+1}}{(1+\tau_{t+1}^c)P_{t+1}}\right] \tag{4}$$

where λ_t denotes the marginal utility of consumption in period *t*, and the effective nominal interest rate $\breve{\imath}_t$ is given by:

$$1+\breve{\imath}_t = 1 + i_t + \nu_D\widetilde{d_t} = \breve{r}_t + E_t\pi_{t+1} \tag{5}$$

$$\breve{r}_t = \frac{1}{\beta} - 1 + \nu_D\widetilde{d_t} \tag{6}$$

This setup indicates that the net (less value added tax) real interest rate, $\breve{r}_t$, is adjusted for the interest rate premium dependent on public debt. ($\widetilde{d_t}$) is the debt-to-GDP ratio minus the debt level in the steady state ($\widetilde{d_t} = d_t - d$). In the baseline case we keep the parameter ν_D at zero and, hence, in that case forward-looking consumers just use the risk-free real interest rate (which in the steady state equals the inverse of the discount factor) and their inflation expectations for discounting future marginal utilities. When the interest rate premium channel is switched on, the real interest rate is adjusted for the interest rate premium ($\nu_D\widetilde{d_t}$), and according to (5) the nominal interest rate ($\breve{\imath}_t$) is the debt-adjusted real interest rate plus expected inflation.

Investment dynamics are determined by:

$$\begin{aligned}\frac{\lambda_t}{1+\tau_t^c}Q_t\left[1 - \phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right) - \phi_I'\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right)\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right] \\ = \frac{\lambda_t}{1+\tau_t^c} \\ - \beta E_t\frac{\lambda_{t+1}}{1+\tau_{t+1}^c}\left[Q_{t+1}\phi_I'\left(\frac{(1+\eta_{t+1}^I)I_{t+1}}{I_t}\right)\frac{(1+\eta_{t+1}^I)I_{t+1}^2}{I_t^2}\right]\end{aligned} \tag{7}$$

where Q_t is the implicit shadow price of capital. Note, that as λ_{t+1} depends on the adjusted (debt dependent) real interest rate, investment decisions are also affected by the public debt. In the baseline model, however, this channel is switched off.

2. The no-arbitrage condition determines the portfolio choice between bonds and physical capital:

$$\lambda_t Q_t = \beta E_t \lambda_{t+1}\left[Q_{t+1}(1-\delta) + u_{t+1} r_{t+1}^k - \Psi(u_{t+1}(j))\right] \quad (8)$$

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

$$r_t^k = \Psi'(u_t(j)) \quad (9)$$

4. A $(1-\overline{\omega})$ fraction of consumers are liquidity-constrained and are unable to optimise their entire lifetime utility. They spend all of their labour income and the financial transfers TR_t received in a given period on purchasing consumption goods c_t^{no}. When balance sheet effects are considered, consumers are also indebted in foreign currency. Therefore, a currency appreciation will decrease their debt service burden and, as a result, boost their consumption.

$$(1+\tau_t^c)P_t c_t^{no} = \left(1-\tau_t^l\right)W_t l_t + \frac{TR_t}{1-\bar{\omega}} + (e_t B_{t-1} - D_{t-1})(i_t^* + \frac{1}{duration}) \quad (10)$$

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 labour market, with different types of labour being supplied by households. Households act as trade unions being able to set wages with a markup. Only *1-*γ_w of the households are able to set the nominal wage in an optimising way, with the remaining part following a non-optimising rule-of-thumb indexation to past inflation. The resulting (log-linearised) wage Phillips curve has the form:

$$\widehat{\pi_t^w} = \frac{(1-\gamma^w)(1-\beta\gamma^w)}{\gamma^w(1+\theta^w\varphi)(1+\beta\vartheta^w)}\left\{\varphi l_t - w_t + \eta_t^l + \frac{\sigma}{1-h}\left(c_t^l - hc_{t-1}^l\right) + \frac{\tau^c}{1+\tau^c}\tau_t^c + \frac{\tau^l}{1+\tau^l}\tau_t^l + \xi_t^w\right\} + \frac{\beta}{1+\beta\vartheta^w}E_t\widehat{\pi_{t+1}^w} + \frac{\vartheta^w}{1+\beta\vartheta^w}\widehat{\pi_{t-1}^w}, \quad (11)$$

where ϑ^w denotes the rate of indexation, θ^wdenotes the labour market elasticity, while c_t^l is the weighted marginal utility of the two types of consumers. $\xi_t^w$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 labour l_t and imports m_t as inputs. Factor inputs are subject to quadratic adjustment costs (with parameters ϕ_1 and ϕ_2).

$$z_t = (a^{\frac{1}{\varrho_z}}[(1+\phi_1)^{-1}l_t]^{\frac{\varrho_z-1}{\varrho_z}} + (1-a)^{\frac{1}{\varrho_z}}[(1+\phi_2)^{-1}m_t]^{\frac{\varrho_z-1}{\varrho_z}})^{\frac{\varrho_z}{\varrho_z-1}}, \quad (12)$$

where α 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 relevant factor costs differ from the market prices of the inputs. The firm's cost minimisation problem yields:

1. Relevant wage $\overline{w_t}$ (the wage adjusted for adjustment costs):

$$\overline{w_t} = \frac{(1+\tau_t^s)w_t}{(1+\phi_1)^{-1} - l_t(1+\phi_1)^{-2}\phi_1'} \tag{13}$$

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

2. Relevant import price $\overline{q_t P_t^{m*}}$ (import prices adjusted for adjustment costs):

$$\overline{q_t P_t^{m*}} = \frac{q_t P_t^{m*}}{(1+\phi_2)^{-1} - m_t(1+\phi_2)^{-2}\phi_2'}, \tag{14}$$

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_t^{m*} is the import price expressed in foreign currency.

3. Marginal cost of the intermediate product:

$$w_t^z = [a\overline{w}_t^{1-\varrho_z} + (1-a)\,\overline{q_t P_t^{m*}}^{1-\varrho_z}]^{\frac{1}{1-\varrho_z}} \tag{15}$$

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

4. Labour demand:

$$l_t = a\left(\frac{w_t^z}{\overline{w_t}}\right)^{\varrho_z} z_t(1+\phi_1) \tag{16}$$

5. Import demand:

$$m_t = (1-a)\left(\frac{w_t^z}{\overline{q_t P_t^{m*}}}\right)^{\varrho_z} z_t(1+\phi_2) \tag{17}$$

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

$$y_t(i) = (1+\eta_t^A)(\alpha^{\frac{1}{\varrho}}\overline{k_t}(i)^{\frac{\varrho-1}{\varrho}} + (1-\alpha)^{\frac{1}{\varrho}} z_t(i)^{\frac{\varrho-1}{\varrho}})^{\frac{\varrho}{\varrho-1}} - y\bar{f}, \tag{18}$$

where α denotes the share of capital used 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 minimisation problem are:

1. Final goods real marginal cost *mc*:

$$mc_t = \frac{(\alpha(r_t^k)^{1-\varrho} + (1-\alpha)(w_t^z)^{1-\varrho})^{\frac{1}{1-\varrho}}}{1+\eta_t^A} \tag{19}$$

2. Capital demand function:

$$u_t k_{t-1} = \alpha \left(\frac{mc_t}{r_t^k} \right)^{\varrho} \frac{DP_t y_t + y\bar{f}}{(1+\eta_t^A)^{1-\varrho}} \tag{20}$$

3. Intermediate product demand function:

$$z_t = (1-\alpha) \left(\frac{mc_t}{w_t^z} \right)^{\varrho} \frac{DP_t y_t + y\bar{f}}{(1+\eta_t^A)^{1-\varrho}}, \tag{21}$$

where DP_t denotes dispersion (related to the cross-section variance) of the price index.

We assume that firms set their price in a Calvo-setting manner, that is, only a fraction (1-γ_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-linearised New Keynesian Phillips curve for the domestic inflation $\widehat{\pi_t}$ takes the form:

$$\widehat{\pi_t} = \frac{(1-\gamma^d)(1-\beta\gamma^d)}{\gamma^d(1+\beta\vartheta^d)} \{ mc_t + \xi_t^d \} + \frac{\beta}{1+\beta\vartheta^d} E_t \widehat{\pi_{t+1}} + \frac{\vartheta^d}{1+\beta\vartheta^d} \widehat{\pi_{t-1}}, \tag{22}$$

where ϑ^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- γ_x) of them is able to set the optimal price, while the remaining index their price to the previous price change. The new Keynesian Phillips curve for export price inflation $\widehat{\pi_t^{x*}}$ takes the form:

$$\widehat{\pi_t^{x*}} = \frac{(1-\gamma^x)(1-\beta\gamma^x)}{\gamma^x(1+\beta\vartheta^x)} \{ -P_t^{x*} - q_t + \xi_t^x \} + \frac{\beta}{1+\beta\vartheta^x} E_t \widehat{\pi_{t+1}^{x*}} + \frac{\vartheta^x}{1+\beta\vartheta^x} \widehat{\pi_{t-1}^{x*}}, \tag{23}$$

where ϑ^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:

$$(1+\overline{\pi_t}) = (1+\overline{\pi_{t-1}})^{\rho_\pi} \left(\frac{1+\pi_t}{1+\overline{\pi_t}} \right)^{g}, \tag{24}$$

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:

$$1 + \pi_t^{gross} = (1+\pi_t) \frac{1+\tau_t^c}{1+\tau_{t-1}^c} \tag{25}$$

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.

$$\frac{1+i_t}{1+r} = \left(\frac{1+i_{t-1}}{1+r}\right)^{\zeta_i} \left((1+\pi_t)^{\zeta_\pi} e_t^{\zeta_e}\right)^{1-\zeta_i} \left(1+\eta_t^i\right), \tag{26}$$

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 real (risk free) interest rate, while η^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 the output gap was found insignificant, and thus we use a reaction function without this term.[7]

Fiscal policy

Fiscal policy is implemented through a set of simple fiscal rules. 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. For simplicity, we assume that financial transfers are devoted only to non-optimiser households. During the simulations described later, we assume a reduction in deficit by a change in the five, distortionary instruments (and not in the lump sum 'other net revenues'). The government budget constraint is:

$$\begin{aligned} OT_t + \tau_t^c c_t + \tau_t^l w_t l_t + \tau_t^s w_t l_t = P_t(1+\eta_t^G)G + TR_t + D_t - \\ \left(\frac{1+\breve{\imath}_t}{1+\pi_{t+1}^{gross}} + \frac{fxshare}{duration_{gov}} * e_t\right) D_{t-1} \end{aligned} \tag{27}$$

where G is the steady-state value of the 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. 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-optimising households. τ_t^c refers to the value added tax rate, τ_t^l to the personal income tax rate[8], and τ_t^s to the employers' social security contribution rate. The last term in equation (27) is the balance sheet effect of foreign currency denominated bonds. Other net revenues (OT_t) are assumed to be of a lump sum nature. D_t denotes government debt in national currency. We assume that other net revenues follow an autoregressive process with an i.i.d. shock.

$$\widehat{OT_t} = \rho^{OT} \widehat{OT_{t-1}} + \xi_t^{OT} \tag{28}$$

T_t is total deficit/surplus (primary balance minus interest payments) and the government debt follows the law of motion:

$$D_t = D_{t-1} + T_t \tag{29}$$

7. Results with a Taylor rule where monetary policy reacts also to the output gap are available upon request.

8. Social security contributions paid by employees are categorised to personal income taxes throughout this paper.

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 reaction functions into the model. For this purpose, we define five alternative fiscal rules and estimate their parameters. It is assumed that the fiscal authority reacts to current output (deviation from steady state) in order to fulfill its stabilising role (or simply letting the automatic stabilisers work) and to past deficits. Thus, fiscal policy (though only in a lagged fashion) tries to stabilise the deficits and consequently the debt level, but does not target a specific debt level, just stabilises it. This seems to be at odds with fiscal rules in practice, but as we analyse permanent fiscal consolidations, we need to establish debt dynamics, such that in the long run the debt is lower than in the initial steady state.

The reaction function for taxes follows:

$$\widehat{\tau_t^i} = \rho^{\tau^i}\widehat{\tau_{t-1}^i} + \left(1-\rho^{\tau^i}\right)\left(\varphi_{GDP}^{\tau^i} GDP_t - \varphi_T^{\tau^i}\widehat{T_{t-1}}\right) + \xi_t^i \quad (30)$$

where *i={c, s, l}* define the three rules corresponding to the three taxes, ξ_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:

$$\widehat{x_t} = \rho^x\widehat{x_{t-1}} + (1-\rho^x)\left(-\varphi_{GDP}^x GDP_t + \varphi_T^x\widehat{T_{t-1}}\right) + \xi_t^x \quad (31)$$

where x={TR, η_t^G}.

As we analyse permanent fiscal consolidations, reaction functions are switched off for some time. In order to achieve a stationary solution of the model we switch on the reaction function with personal income taxes. That way, public debt stabilises 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:

$$x_t = (1+\eta_t^x)x^*(P_t^{x*})^{-\theta^{x*}}, \quad (32)$$

where θ^{x*} is the export price elasticity, x^* is the long-term value of exports, and $\eta^x{}_t$ is the exogenous shock to export demand. We assume that import prices evolve exogenously.

Economic agents may accumulate debts against foreign partners. Foreign agents supply capital at a rate which depends on the deviation of the net foreign asset position (b_t) 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).

$$\frac{1+i_t^*}{1+r} = e^{-\nu(b_t-b)}e^{+\nu_D(d_t-d)}\left(1+\eta_t^{pr}\right), \quad (33)$$

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

$$b_t = (1 + i^*_{t-1})b_{t-1} + \frac{P^{x*}_t x_t}{GDP^{ss}} - \frac{P^{m*}_t m_t}{GDP^{ss}}, \quad (34)$$

The nominal exchange rate is determined by the modified uncovered interest rate parity, where i^*_t depends on public debt as well (if the interest rate premium channel is switched on).

$$\frac{1 + i_t}{1 + i^*_t} = \frac{e_{t+1}}{e_t} \quad (35)$$

Equilibrium conditions

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

$$y_t = c_t + I_t + (1 + \eta^G_t)G + DP^x_t x_t + \Psi(u_t(j))k_{t-1}, \quad (36)$$

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^x_t 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:

$$GDP_t = y_t + q_t P^{x*}_t x_t - q_t P^{m*}_t m_t - x_t \quad (37)$$

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 framework[9] 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 done exactly by setting the mean of the prior distributions for the second regime to be posterior to the first regime (prior standard errors are generally higher than the posterior ones).

The model is estimated without switching on the fiscal reaction functions (Table 1). This choice of the estimation strategy was motivated by the observation that Hungarian fiscal policy stabilised the 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.

9. Hungarian monetary policy followed an exchange rate targeting (crawling band) regime until 2001. Since then an inflation targeting framework operates.

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.

Table 1. Estimation results

		Prior distribution*			Estimated posterior			
					Regime 1		Regime 2	
		Type	Mean	Standard error	Mean	90% probability interval	Mean	90% probability interval
Utility function								
Intertemporal elasticity	σ	Normal	2.0	0.4	2.01	1.60-2.44	2.24	1.67-2.77
Consumer habit	h	Beta	0.6	0.1	0.42	0.32-0.50	0.39	0.26-0.53
Parameters of pricing, waging								
Indexation of:								
Wages	ϑ^w	Beta	0.5	0.15	0.24	0.10-0.39	0.08	0.01-0.15
Domestic prices	ϑ^d	Beta	0.5	0.15	0.92	0.87-0.97	0.15	0.01-0.29
Export prices	ϑ^x	Beta	0.5	0.15	0.66	0.45-0.87	0.60	0.37-0.84
Calvo parameter of:								
Domestic prices	γ^d	Beta	0.5	0.15	0.82	0.79-0.84	0.84	0.81-0.86
Export prices	γ^x	Beta	0.5	0.15	0.68	0.63-0.72	0.76	0.73-0.79
Wages	γ^w	Beta	0.5	0.15	0.46	0.39-0.53	0.47	0.41-0.54
Other parameters								
Elasticity of exports	θ^{x*}	Beta	0.5	0.15	0.70	0.58-0.80	0.70	0.55-0.87
Inflation learning	g	Beta	0.17	0.03	0.20	0.16-0.24	0.20	0.15-0.24
Interest rate smoothing**	ζ_i	Beta	0.5	0.15	-	-	0.61	0.45-0.76
Inflation in Taylor rule**	ζ_π	Normal	1.5	0.16	-	-	1.53	1.29-1.80
Autoregressive coefficients								
Productivity	ρ_a	Beta	0.8	0.1	0.53	0.43-0.62	0.42	0.29-0.53
Export demand	ρ_x	Beta	0.8	0.1	0.86	0.79-0.95	0.69	0.55-0.85
Financial premium	ρ_{pr}	Beta	0.8	0.1	0.56	0.49-0.62	0.46	0.37-0.57
Government expenditure	ρ_g	Beta	0.8	0.1	0.80	0.62-0.92	0.75	0.62-0.89
Financial transfer	ρ_{tr}	Beta	0.8	0.1	0.86	0.79-0.95	0.81	0.67-0.96
Consumer preference	ρ_c	Beta	0.8	0.1	0.87	0.79-0.96	0.82	0.68-0.98
Labor market	ρ_w	Beta	0.8	0.1	0.93	0.86-0.98	0.90	0.78-0.99
Investment	ρ_I	Beta	0.8	0.1	0.90	0.84-0.95	0.48	0.34-0.62
Value-added tax rate	ρ_{tc}	Beta	0.8	0.1	0.88	0.81-0.97	0.76	0.57-0.99
Social security contribution rate	ρ_{ts}	Beta	0.8	0.1	0.94	0.88-0.99	0.99	0.97-1.00
Personal income tax rate	ρ_{tl}	Beta	0.8	0.1	0.85	0.77-0.93	0.91	0.84-0.98

Notes:

* 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.

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 composition 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 probability that the measures will be reversed at some point in the future. Agents expect that fiscal tightening will gradually cease, 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 impact in the first quarter account for 1% of (original) steady-state GDP (for a detailed description of the scenarios see Table 2).[10] This means that the simulated trajectory we present is equal to minus one times the multipliers. In all simulations we analyse permanent fiscal consolidation: government consumption, financial transfers are lower, taxes are higher permanently.

Table 2. Description of fiscal scenarios

Type of consolidation		Description
Reduction in	Government consumption	4.4% drop in the sum of government consumption, government investment and transfers in kind
	Transfers	7.1% lower financial transfers
Increase in	Personal income tax	2.2 percentage point higher rate of the sum of personal income and social security contribution paid by employees
	Social security contribution	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

Note: These are stylized scenarios based on the simple fiscal instruments contained by the model. However, the set of fiscal consolidation instruments available to a policymaker is much more varied. Sutherland *et al.* (2012) offers a comprehensive assessment of spending and revenue instruments in terms of their potential to improve the primary balance as well as other policy objectives such as growth and distributional impacts.

There is a difference in how these *ex post* permanent retrenchments are perceived by the economic agents. A perfectly credible simulation is 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

10. We set the shocks as having a direct impact of 1% 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% even in the very short term.

envisaged fiscal plan. Technically this could be modeled by running simulations with a series of unexpected shocks. This case is analysed 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 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 the consolidation finally becomes perfectly credible). This is similar to the simplest learning mechanism.

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 are accompanied by some tax cuts later) [see e.g. Gali and Monacelli (2008) and more recently Obstbaum (2011)]. However, in this paper we analyse fiscal consolidation resulting in a permanently lower government debt level, thus we allow debt level to change. So, fiscal reactions are switched off 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 labour 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.

The shocks we consider are expected to operate through a number of non-Keynesian channels, beside the traditional Keynesian effects, which initially include the expectation channel only (baseline model); then the expectation and risk premium channels; and finally the combined effects of expectation, risk premium and wealth (balance sheet) channels. The non-Keynesian channels will therefore either dampen the Keynesian effects, or even completely reverse their sign. All simulations are performed around the deterministic steady state by using the log-linearised version of the model.

Simulations in the baseline New Keynesian model

In 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 labour supply. Higher taxes (on labour paid by employees) decrease the supply of labour and also put downward pressure on aggregate demand and consequently on labour demand. The substitution away from labour to leisure is dominant and this leads to lower consumption and output, both in the short and in the long run. In the long run, all of these effects are associated with a positive multiplier, *i.e.* a lower economic activity.[11] 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 a reduction in government investments and public goods through their possible negative impact on production capacities. 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. underutilised resources during recessions (which generate higher multipliers in recessions).

The New Keynesian model incorporates the neoclassical wealth effect through the expectation channel, but it has some features which could modify multipliers. A significant share of households is

11. In the short run the increase in labour taxes (paid by employers) works in a different way (through labour demand first), but in principle it does not differ from labour taxes paid by employees as households own firms.

liquidity-constrained (rule-of-thumb consumers).[12] They are consuming all of their net disposable income (labour 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 falls and this generates a fall in demand for labour. This is the major reason why our New Keynesian model generates a 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.[13]

In addition, the presence of a backward-looking indexation mechanism, variable capacity utilisation, and adjustment cost for factors, are all responsible for the short-run dominance of positive multipliers. In all cases, a fiscal tightening 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 or higher taxes today also lead to lower real interest rates (helped by supportive monetary policy) and real wages, and to an increase in consumption and investment (Ricardian behavior). This is because agents expect lower taxes or less binding resource constraints due to lower government purchases in the future in exchange of higher taxes or lower income today, and they smooth consumption, thus private consumption and investment grow immediately.

The above mentioned mechanism predicts that the negative short-term effects of 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 stabilisations 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.

Table 3 and the dashed lines in the charts in the Annex show the results from simulating various fiscal scenarios in the baseline New Keynesian model. Simulations indicate that all fiscal consolidation scenarios end up with negative effects on output: non-Keynesian expectation 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 labour, but the income effects mitigate this – to keep up the same level of utility agents work a bit longer, compared to other scenarios. Even though shocks on personal income tax and social security contributions have the same long-run effects, they have somewhat different effects in the short run. The reason is that

12. The 25% share of rule-of-thumb consumers is calibrated by a separate error correction equation between consumption, disposable income, household wealth and the short term immediate effect of disposable income measures on the role of liquidity constraints.

13. When interest rates are around the zero lower bound and if monetary policy reacts to gross inflation, it might be unable to counteract the fiscal tightening through value-added tax hikes and thus the drop in output would be larger (see Coenen *et al.*, 2010 on how multipliers are affected by the zero lower bound).

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. As a result, after a personal income tax hike, inflation drops while the opposite happens with an increase in social security contributions.

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

Percentage point deviations from the steady state

Years	Reduction in		Increase in		
	Government consumption	Transfers	Personal income tax	Social security contribution	Value-added tax
Fully credible					
1	-0.44	-0.32	-0.12	-0.09	-0.27
2	-0.25	-0.14	-0.12	-0.16	-0.30
3	-0.21	-0.08	-0.14	-0.17	-0.11
4	-0.23	-0.07	-0.15	-0.16	-0.11
Partially credible					
1	-0.62	-0.48	-0.12	-0.08	-0.36
2	-0.40	-0.32	-0.11	-0.15	-0.26
3	-0.28	-0.21	-0.11	-0.17	-0.11
4	-0.27	-0.19	-0.12	-0.16	-0.12

Value-added tax hikes have the strongest negative 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 tightens in response to the hike in inflation. This behavior is not as straightforward: at a first glance, as monetary policy targets net inflation[14], one would not expect monetary reaction. However, as there is an adaptive learning scheme for "perceived inflation", trend inflation rises and monetary policy tries to counteract the rise in inflation perception, that is, it tries to maintain its credibility by increasing the nominal interest rate.

The negative effect of the VAT hike is reinforced by the behavior of demand for imports and exchange rate that should be taken into consideration, given that Hungary is a small, open economy (and that imports are mostly considered as a production input). Both work in the direction of lower multipliers, with 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 (as monetary policy targets inflation net of value added taxes), which can also explain why value-added tax hikes have stronger output effects than income tax or social security contribution hikes.

A reduction of (targeted) transfers has a quite high multiplier as rule-of-thumb households consume less in the short run. However, this effect fades away at a relatively fast pace, as the increase in consumption of Ricardian households at least partly offsets 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).

14. One can argue that monetary policy might rather respond to gross inflation. This case is considered in more detail below.

The response of investment depends on several factors. Labour tax hikes cause labour to be more expensive than capital, giving rise to a substitution effect and investment increases. On the other hand, lower future growth prospects lead to lower demand for capital. We find that in labour 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, the real interest rate also drops which gives an impetus to investments. For value-added tax hikes, the real interest rate also declines 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 for 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. Thus, a tax hike works as a "subsidy" to exports. As Hungary's exports are close to 100% 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 consolidation has 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 a lower intensity of Ricardian behaviour, making the expectation 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 shocks 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 labour taxes.

Summing up, the baseline model captures some, but not all potential non-Keynesian effects of fiscal consolidations. Namely, the expectation channel of 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. 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 a reduction in the 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.

Interest rate premium channel

As a next step we depart from the baseline model and analyse the additional 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 implies an appreciating pressure on the currency through the modified uncovered interest rate parity (UIP) condition[15]. This enables the monetary authority to lower nominal (and real) interest rates somewhat, 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 the 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, this can change our previous assessment of the magnitude of non-Keynesian effects. For this purpose, we let the equilibrium

15. A modified UIP denotes a UIP condition with a risk premium dependant on the net foreign asset position.

real interest rate be sensitive to public debt. We calibrate the semi-elasticity of the equilibrium real interest rate on the debt-to-GDP ratio to be at the lower end of what is usually found in empirical literature. A one percentage point reduction in public debt causes a cut in the annualised real interest rate by five basis points.

A prolonged fiscal adjustment lowers the budget deficit by around 1% of initial GDP over a long period for all types of instrument. 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 investment until a higher level of capital is reached 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 stabilisation becomes less likely.

Table 4 and the solid lines in the charts in the Annex show that, when inserting the interest rate premium channel into the benchmark model, the drop in output is significantly less pronounced in the longer run. Apart from the very strong direct multiplier effect due to government spending being directly accounted to GDP in the national accounts, and the dominantly Keynesian effects of cuts in transfers, the fall in output is smaller even in the short run. Interestingly, for fully credible fiscal consolidations, non-Keynesian effects may arise for labour tax hikes.[16]

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.

Foreign currency denominated debt

We further enrich our model with another element. As borrowing in foreign currency by households is a serious issue in Hungary, we develop a version of the model where some (very stylised) 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 (non-Ricardian households). We modify the budget constraint for this group (equation 10), such that their consumption equals their net labour income minus the interest rate payments out of the privately held debt (which is the total net foreign asset position minus public debt[17]) 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% depreciation of the currency leads to a half of a tenth of a per cent increase in their quarterly instalments and thus their real disposable income is lower by this amount. For simplicity, we assumed that the share of foreign exchange (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% share of government debt held in foreign currency and the duration of government FX debt is also calibrated to be five years.

16. Because government consumption adds to value-added in the system of national accounts, reduction in government consumption has a very strong direct effect statistically (this is the "gross multiplier"). However, the "net multiplier" (which is defined as the gross multiplier minus one) measures the additional effect of government action on activity. In this sense the net multiplier of government purchases in our model is negative, meaning that a reduction in demand for otherwise "useless" public goods crowds in the demand for more "useful" private goods.

17. 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 downward.

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

Percentage point deviations from the steady state

Years	Reduction in		Increase in		
	Government consumption	Transfers	Personal income tax	Social security contribution	Value-added tax
Fully credible					
1	-0.14	-0.10	0.13	0.09	-0.05
2	-0.06	0.00	0.04	-0.04	-0.17
3	-0.11	-0.01	-0.05	-0.11	-0.03
4	-0.13	-0.01	-0.07	-0.11	-0.04
Partially credible					
1	-0.56	-0.45	-0.06	0.04	-0.34
2	-0.33	-0.27	-0.03	-0.07	-0.22
3	-0.20	-0.15	-0.04	-0.11	-0.07
4	-0.18	-0.13	-0.05	-0.10	-0.08

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

Comparing Table 4 and Table 5, one can clearly observe that non-Keynesian effects become stronger in this 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 rates causes a real appreciation of the currency (if the exchange rate regime is a floating one). 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"[18], 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 behaviour of Ricardian households (they are aware of this balance-sheet effect), the increase in non-Ricardian households' consumption is slightly counterbalanced by the consumption-smoothing behaviour 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 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 has a dampening effect on investment. In the case of partially credible consolidation this does not happen, as non-Keynesian balance sheet effects resulting from appreciation are less likely.

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 consolidation.

18. The "expenditure switching effect" works as imports become cheaper and exports become less competitive, thus leading to a worsening in the trade balance.

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

Percentage point deviations from the steady state

Years	Reduction in		Increase in		
	Government consumption	Transfers	Personal income tax	Social security contribution	Value-added tax
Fully credible					
1	0.18	0.14	0.29	0.17	0.22
2	0.01	0.06	0.06	-0.04	0.03
3	-0.21	-0.08	-0.11	-0.14	-0.12
4	-0.27	-0.11	-0.16	-0.14	-0.15
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

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

Putting together the endogenous response of equilibrium real interest rate and the balance sheet effects resulting from a 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 somewhat, the presence of FX loans is not always enough to generate an expansionary fiscal consolidation.

The role of the exchange rate regime

As a third extension of the baseline model we analyse the role of the exchange rate regime. 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 a fixed exchange rate regime is found to be more effective than in a floating one, 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, the short-run boost 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 stabilisation are a bit stronger assuming that it is fully credible. The opposite holds in the case of partially credible stabilisations. A fixed exchange rate regime does not help too much in enhancing expansionary fiscal consolidation 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

Percentage point deviations from the steady state

Years	Reduction in		Increase in		
	Government consumption	Transfers	Personal income tax	Social security contribution	Value-added tax
Fully credible					
1	0.20	0.15	0.31	0.19	0.24
2	0.10	0.11	0.15	0.02	0.10
3	-0.22	-0.09	-0.13	-0.16	-0.13
4	-0.30	-0.13	-0.18	-0.16	-0.17
Partially credible					
1	-0.48	-0.39	0.00	0.11	-0.27
2	-0.27	-0.22	-0.01	-0.03	-0.18
3	-0.14	-0.09	-0.07	-0.17	-0.08
4	-0.16	-0.10	-0.10	-0.17	-0.08

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

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 are added to the benchmark model. The former effect is dependent on how the nominal exchange rate behaves. The nominal exchange rate in this model is largely determined by the monetary policy reaction function. Thus it is interesting to analyse the influence of alternative monetary policy rules.

Table 7 presents a scenario when monetary policy also takes into account the temporary rise in inflation due to value added tax hikes (contrary to the original rule, where monetary policy reacted to inflation net of value added taxes). This occurs when the central bank tries to avoid that such 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 likelihood of 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 inflation expectations are well anchored and there is no need for the monetary policy to respond to a temporary shock to inflation (such as a VAT increase).

Table 7. 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

Percentage point deviations from the steady state

Years	Reduction in		Increase in		
	Government consumption	Transfers	Personal income tax	Social security contribution	Value-added tax
Fully credible					
1	0.18	0.14	0.29	0.17	0.14
2	0.01	0.06	0.06	-0.04	-0.11
3	-0.21	-0.08	-0.11	-0.14	-0.10
4	-0.27	-0.11	-0.16	-0.14	-0.14
Partially credible					
1	-0.48	-0.39	0.00	0.10	-0.33
2	-0.29	-0.24	-0.03	-0.06	-0.22
3	-0.23	-0.16	-0.07	-0.14	-0.10
4	-0.23	-0.16	-0.09	-0.14	-0.12

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

Conclusion

This paper examines the macroeconomic effects of various fiscal consolidation policies in an estimated open-economy DSGE model of the Hungarian economy. It identifies 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 consolidation.

Simulations show that fiscal consolidation policies are typically contractionary in a 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, expansionary effects may 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 generates favorable balance-sheet effects for households and the government 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, regardless of the assumptions regarding the specific features of the economy, and regardless of the composition of a consolidation package.

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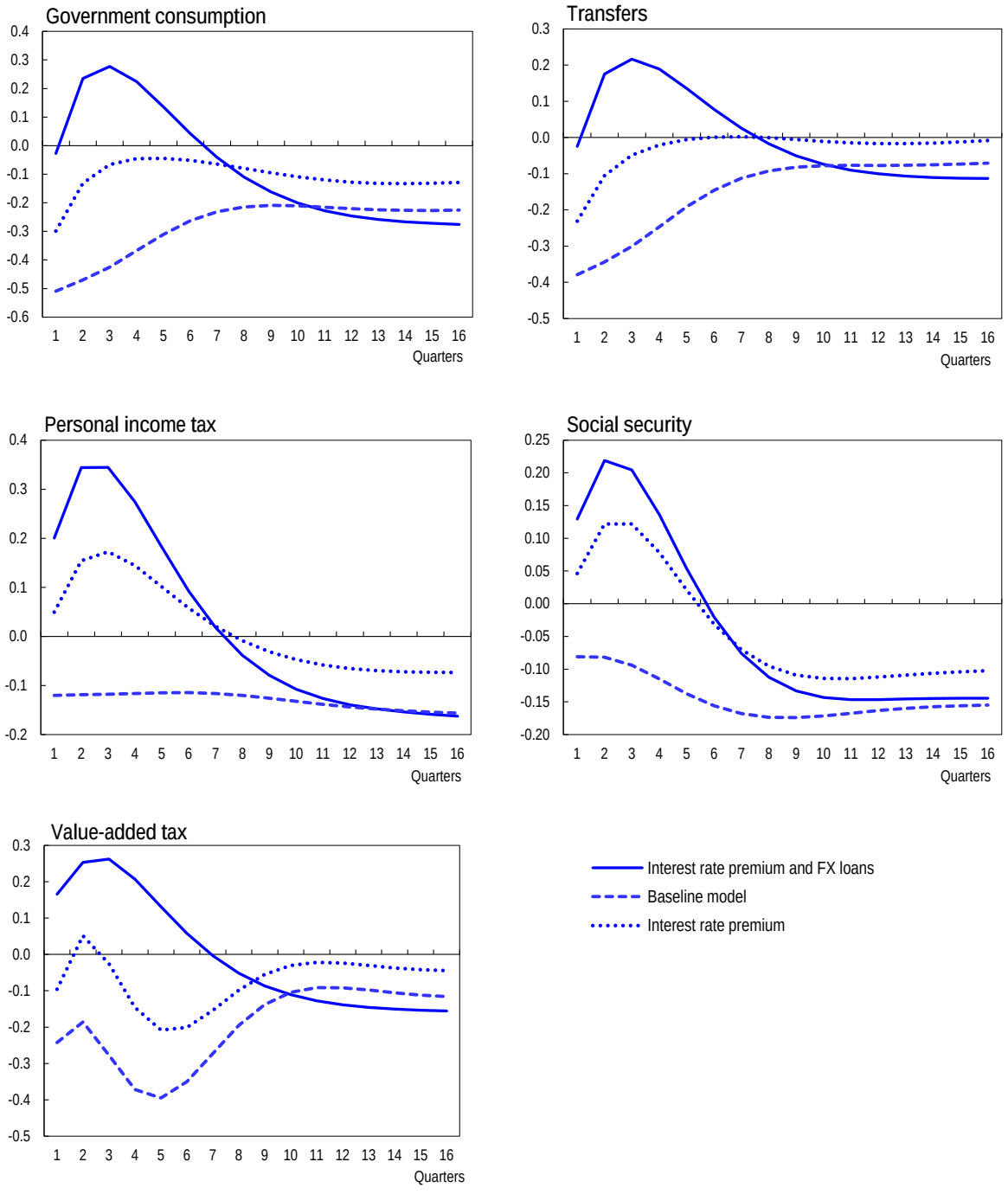
ANNEX

Perfectly credible fiscal consolidation

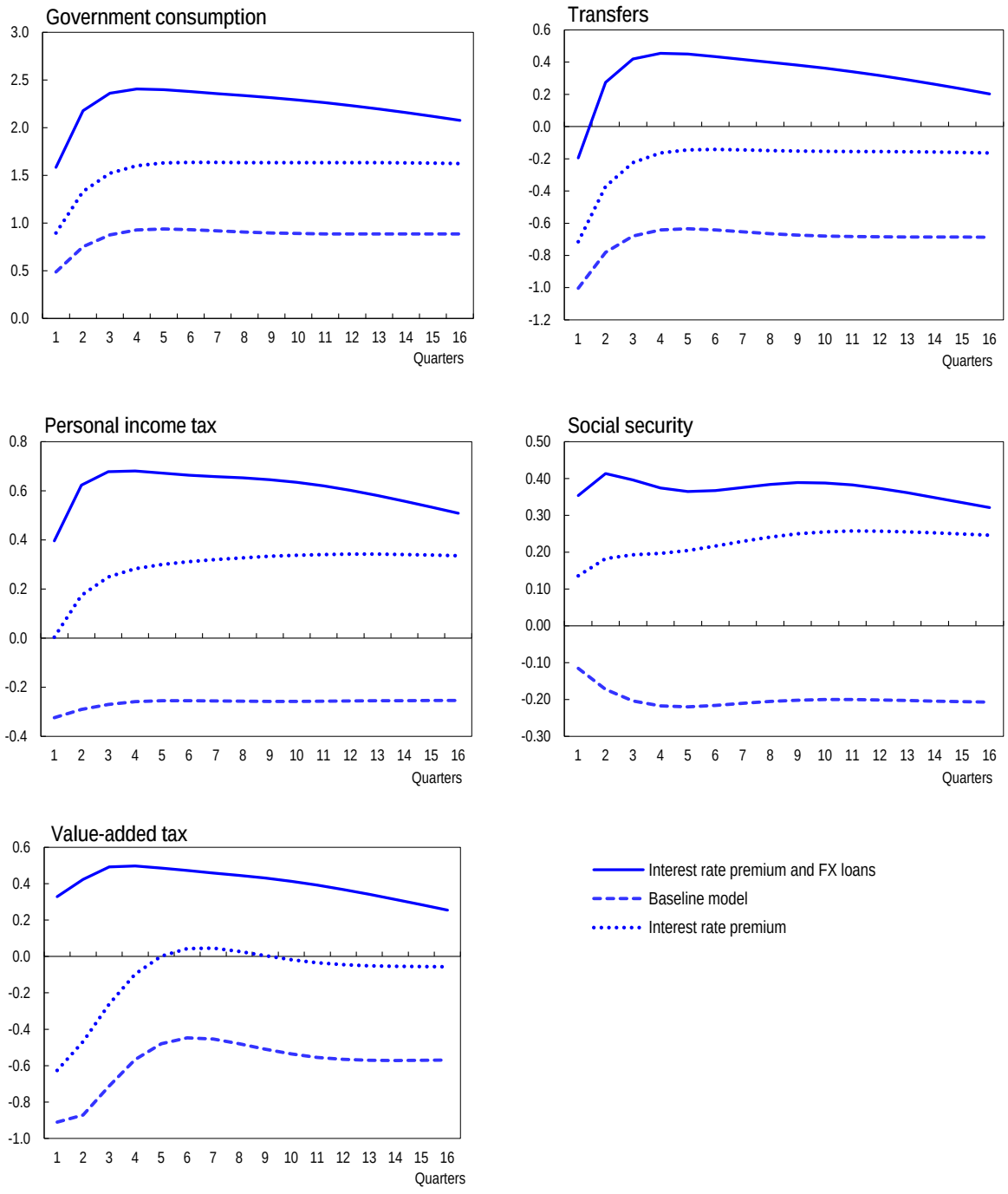
Gross Domestic Product

Percentage point deviation from the steady state



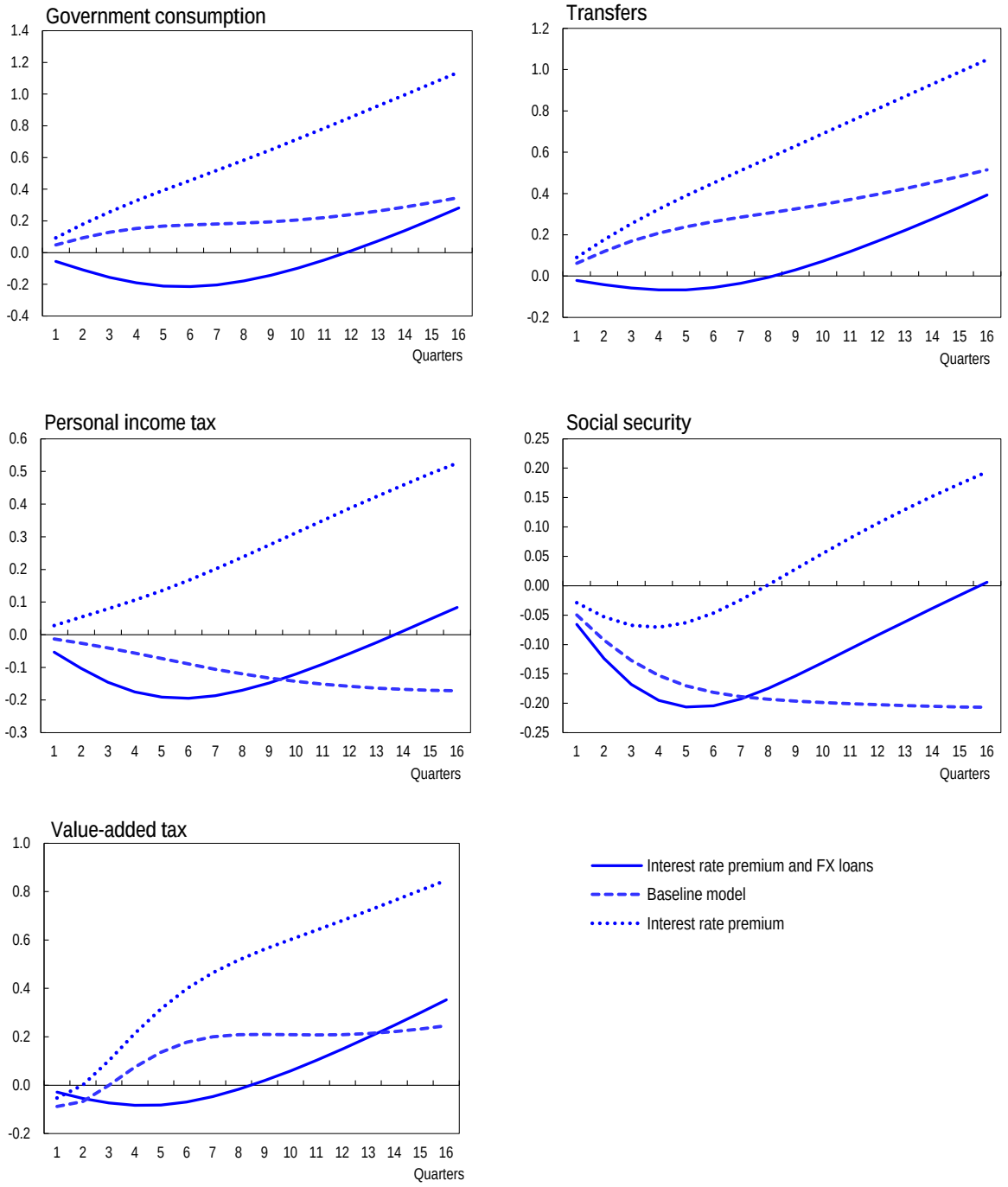
Private consumption

Percentage point deviation from the steady state



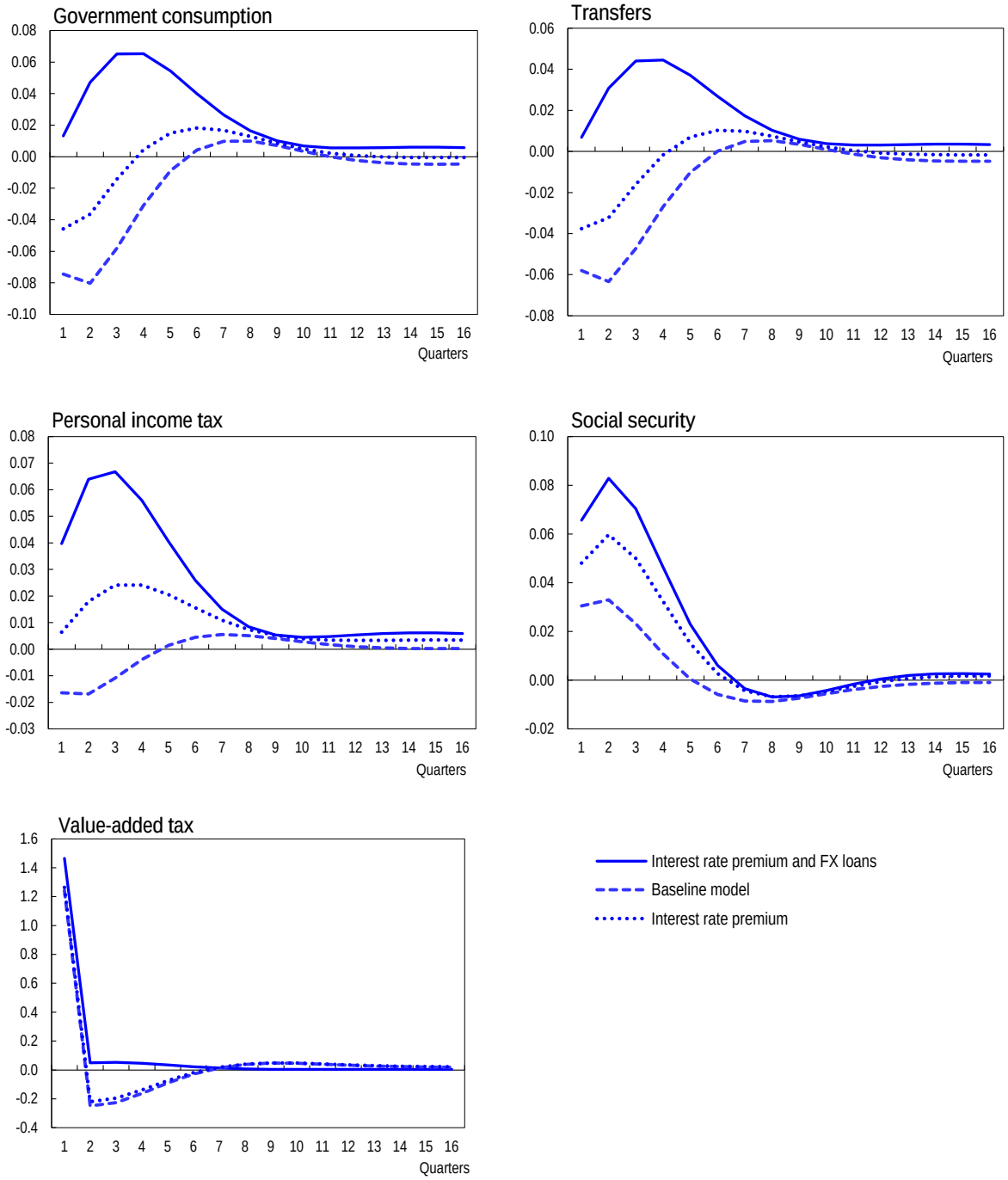
Private investment

Percentage point deviation from the steady state



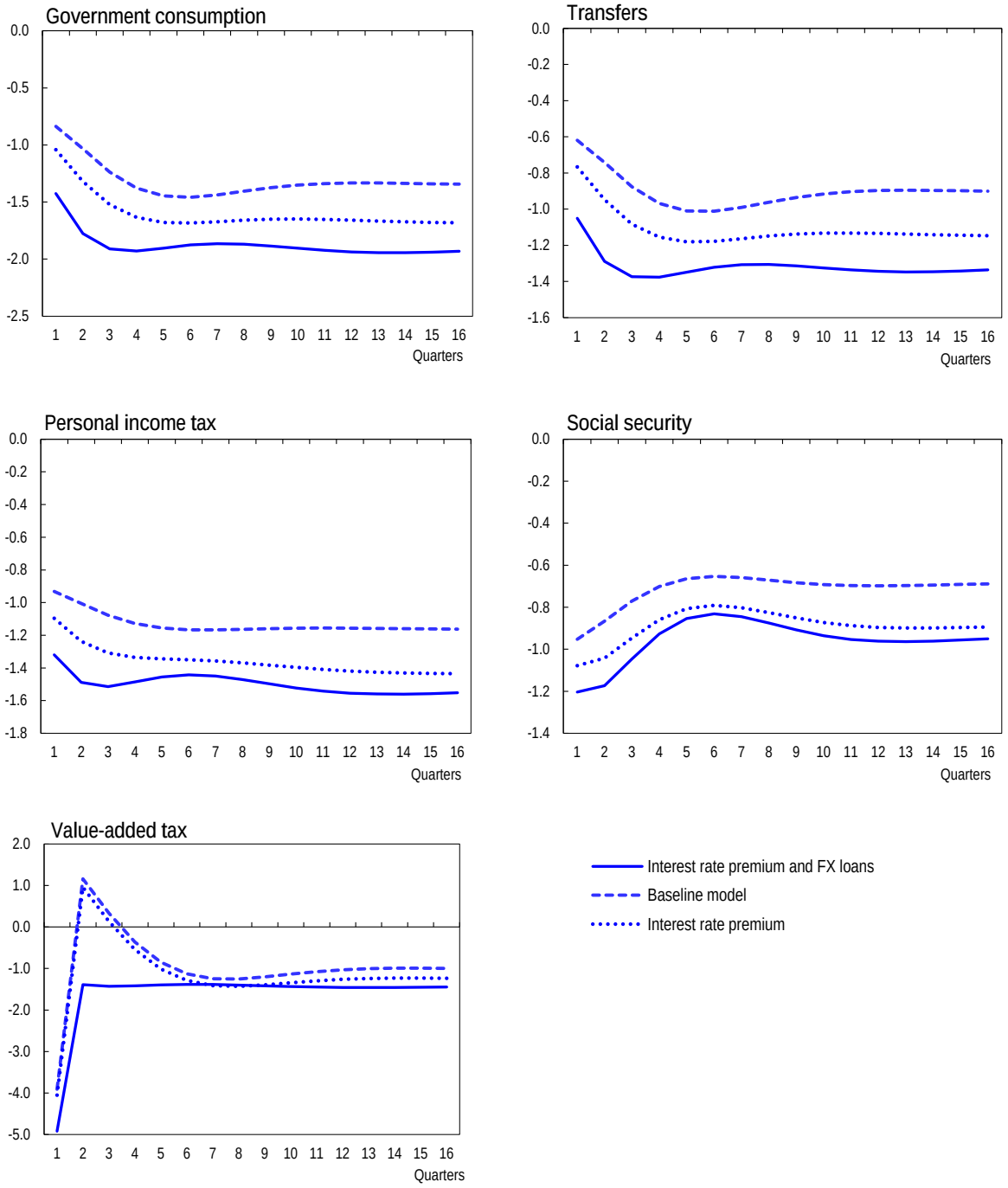
Inflation

Percentage point deviation from the steady state



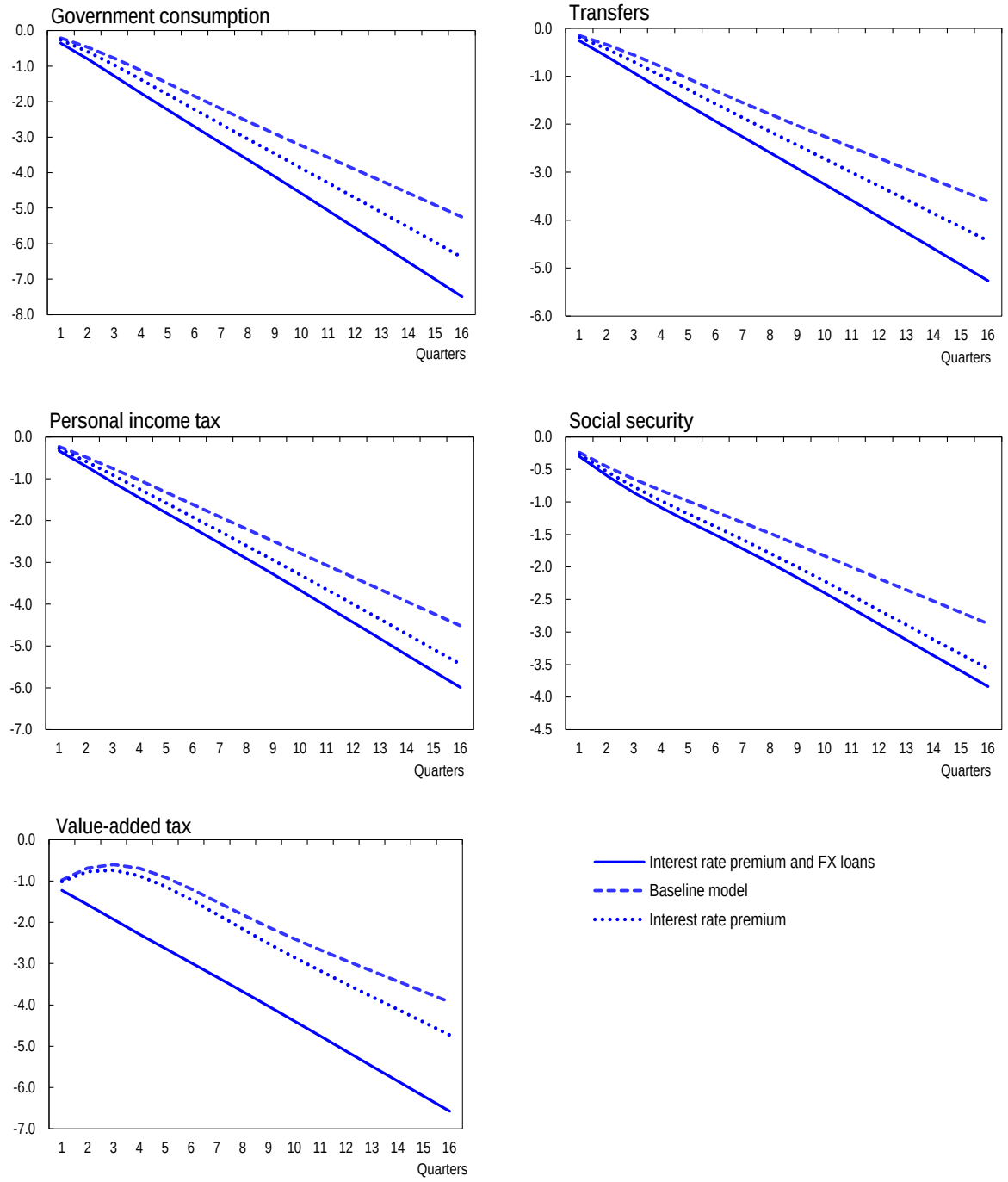
Budget balance

Percentage point deviation from steady-state GDP



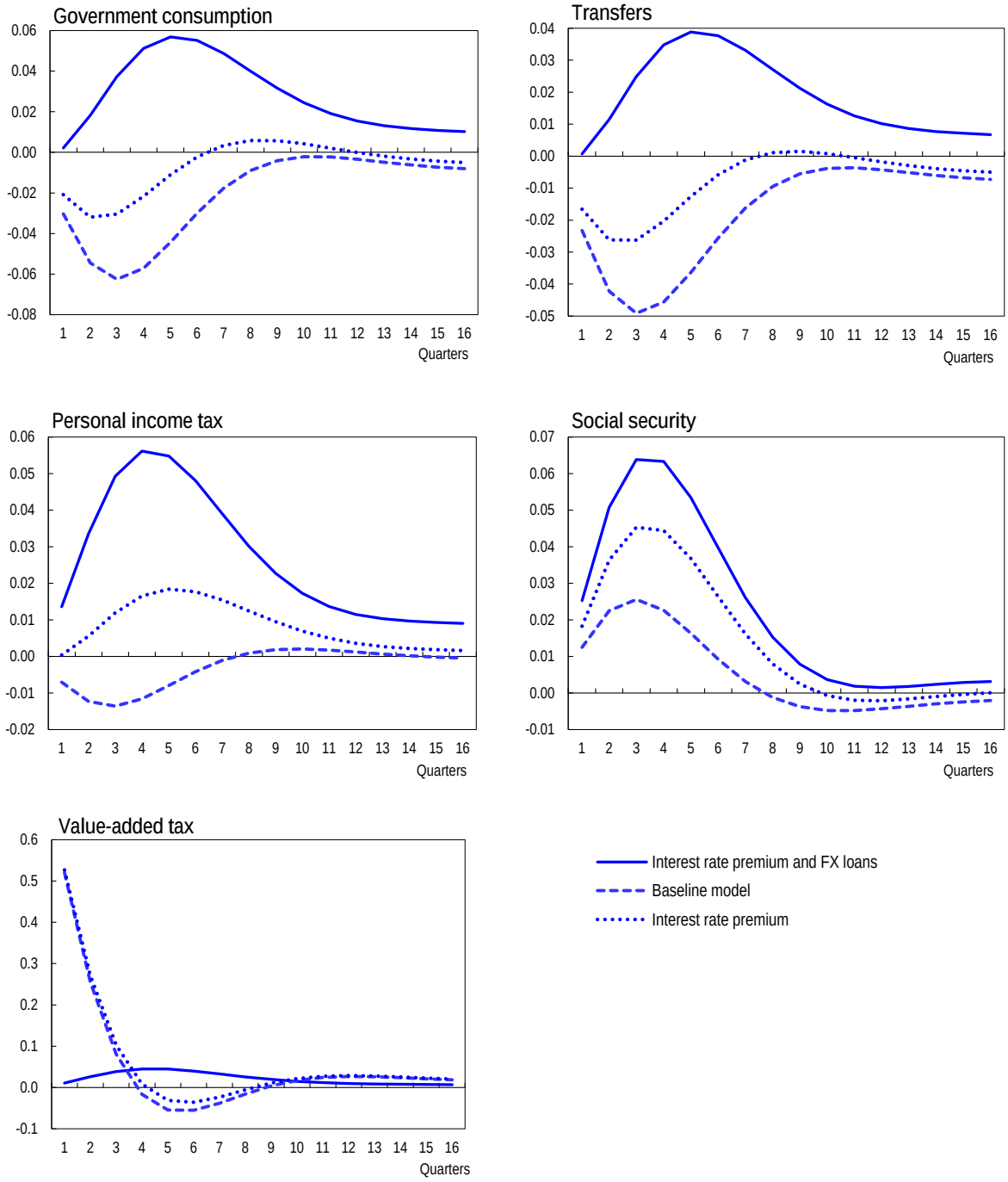
Government debt

Percentage point deviation from steady-state GDP



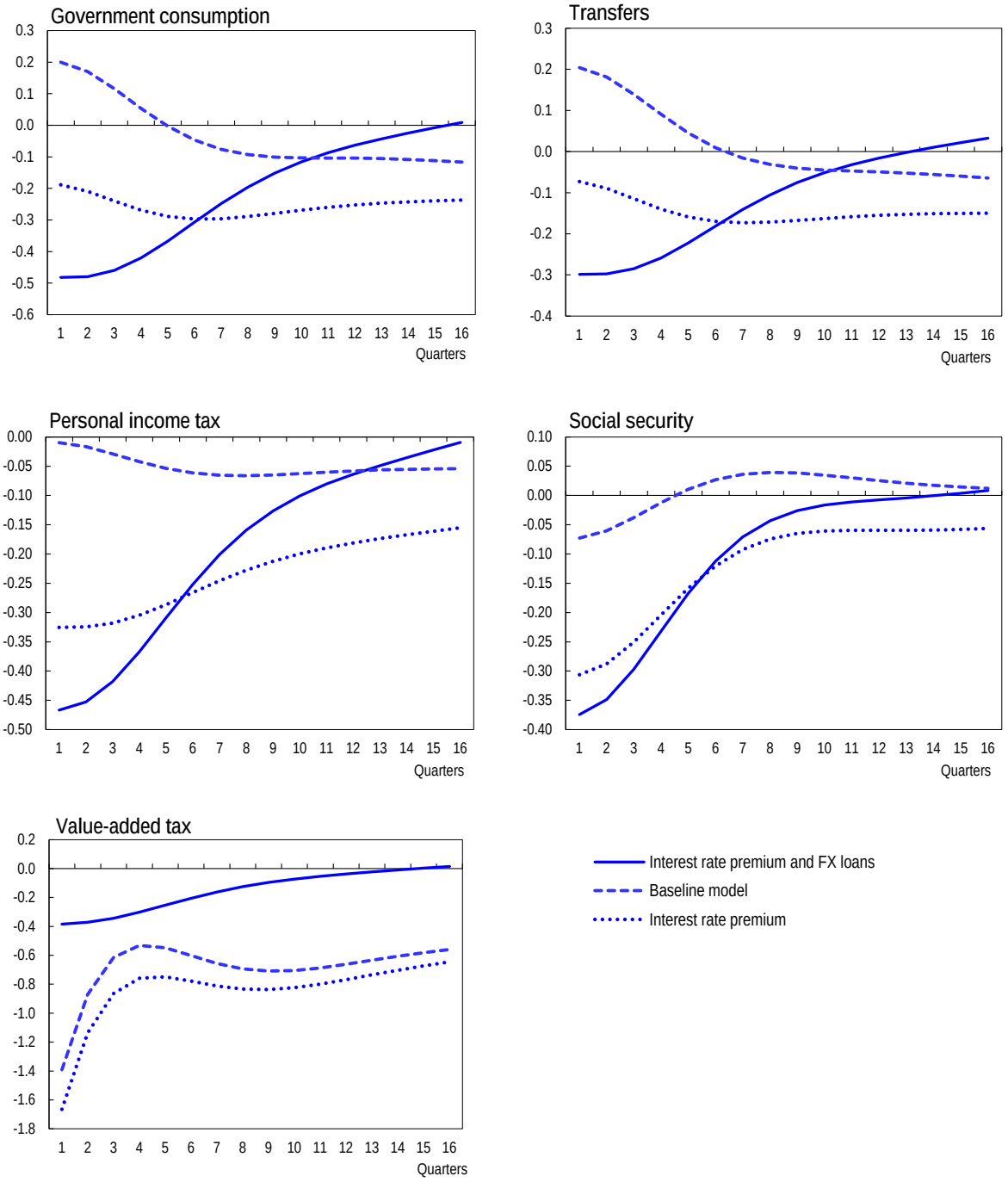
Nominal short-term interest rate

Percentage point deviation from the steady state



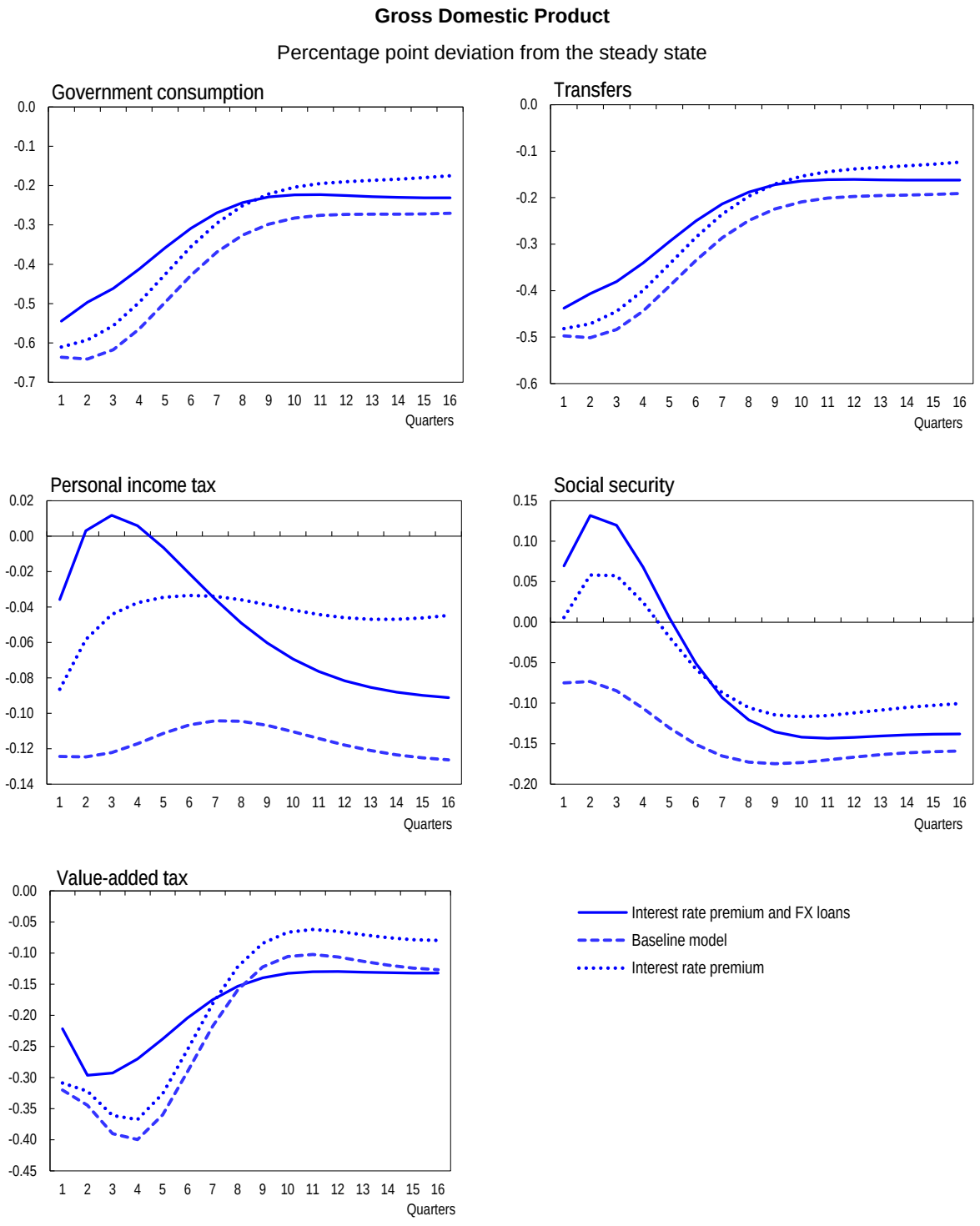
Nominal exchange rate

Percentage point deviation from the steady state*



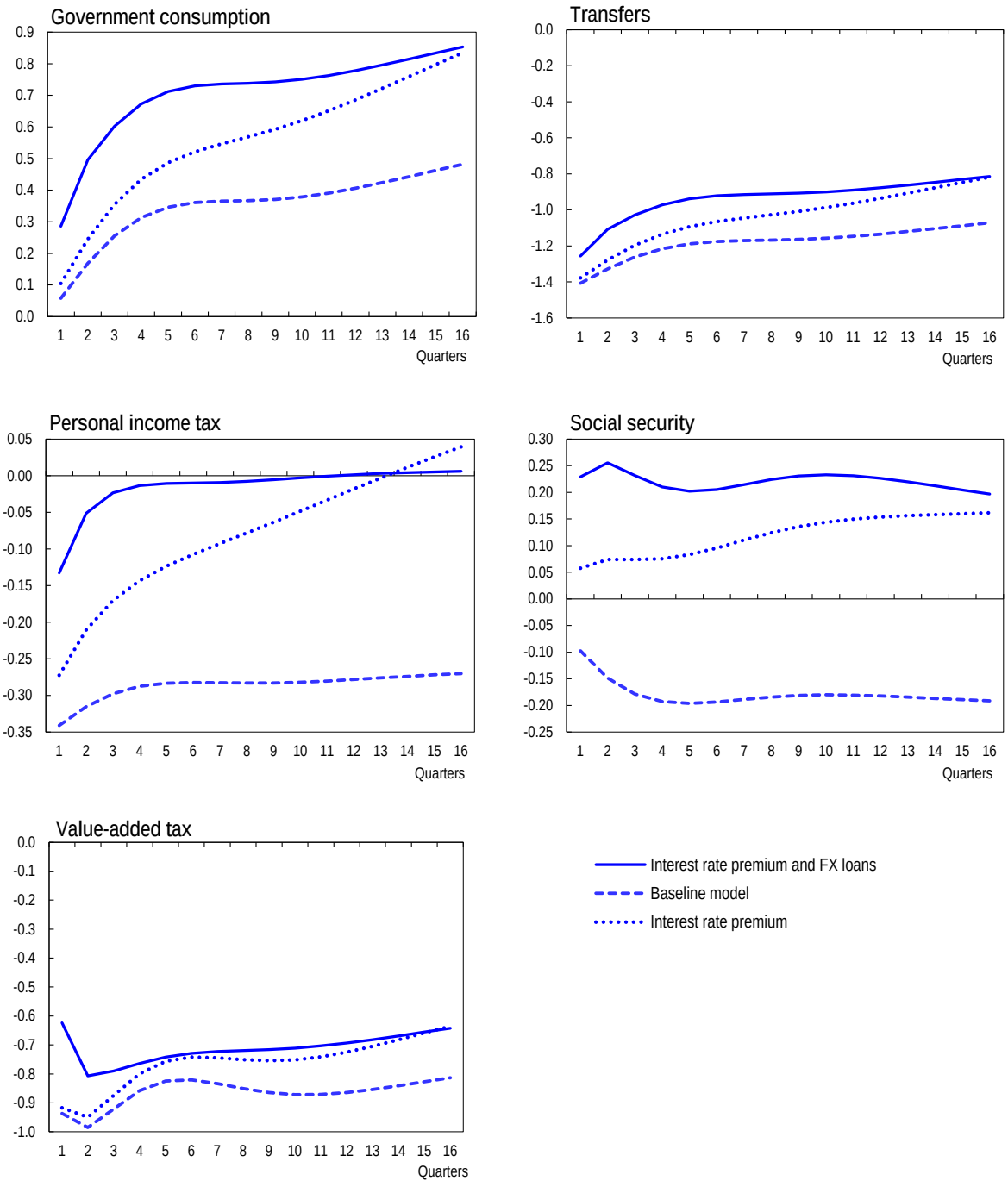
* A positive number indicates currency depreciation.

Partially credible fiscal consolidation



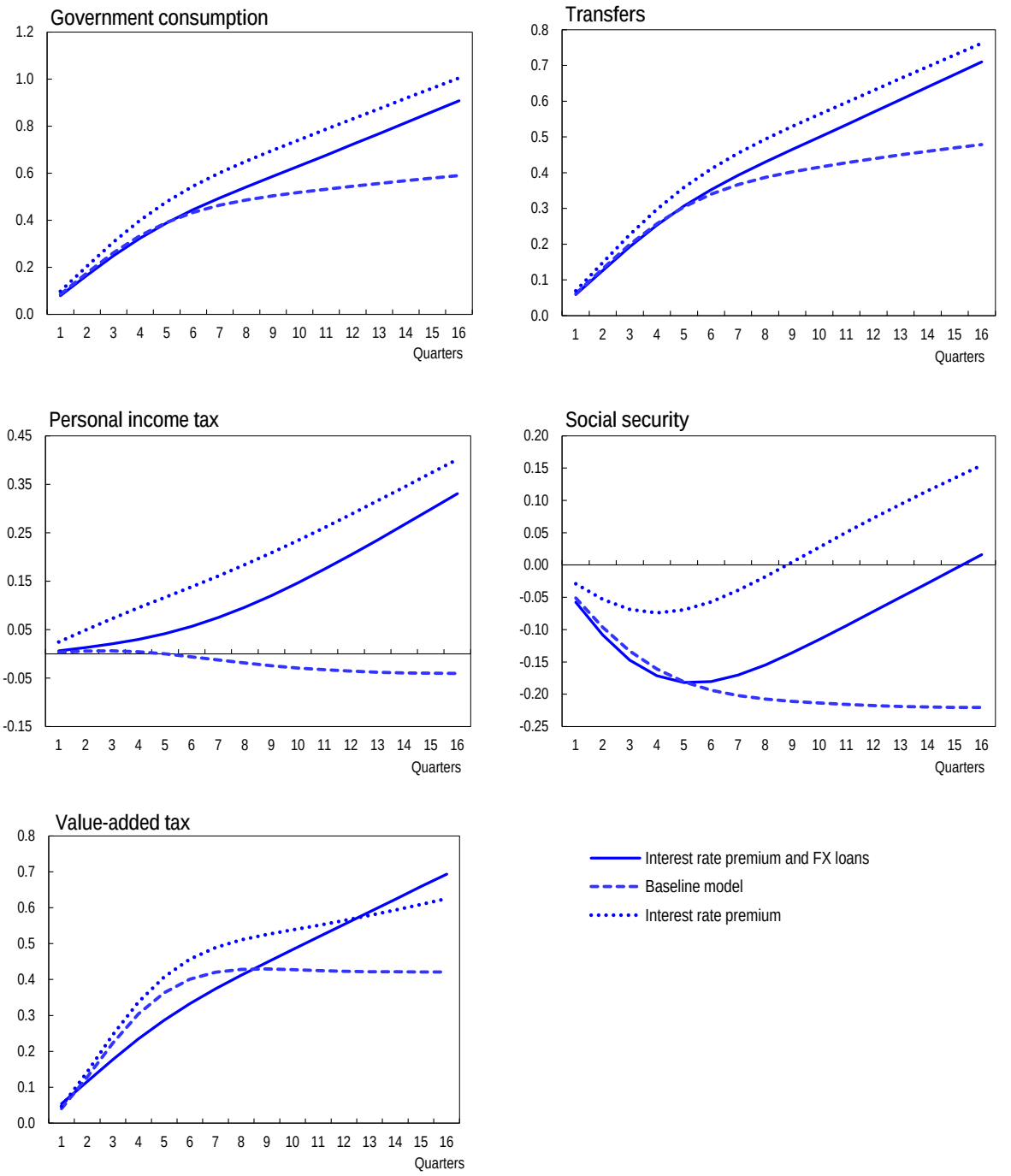
Private consumption

Percentage point deviation from the steady state



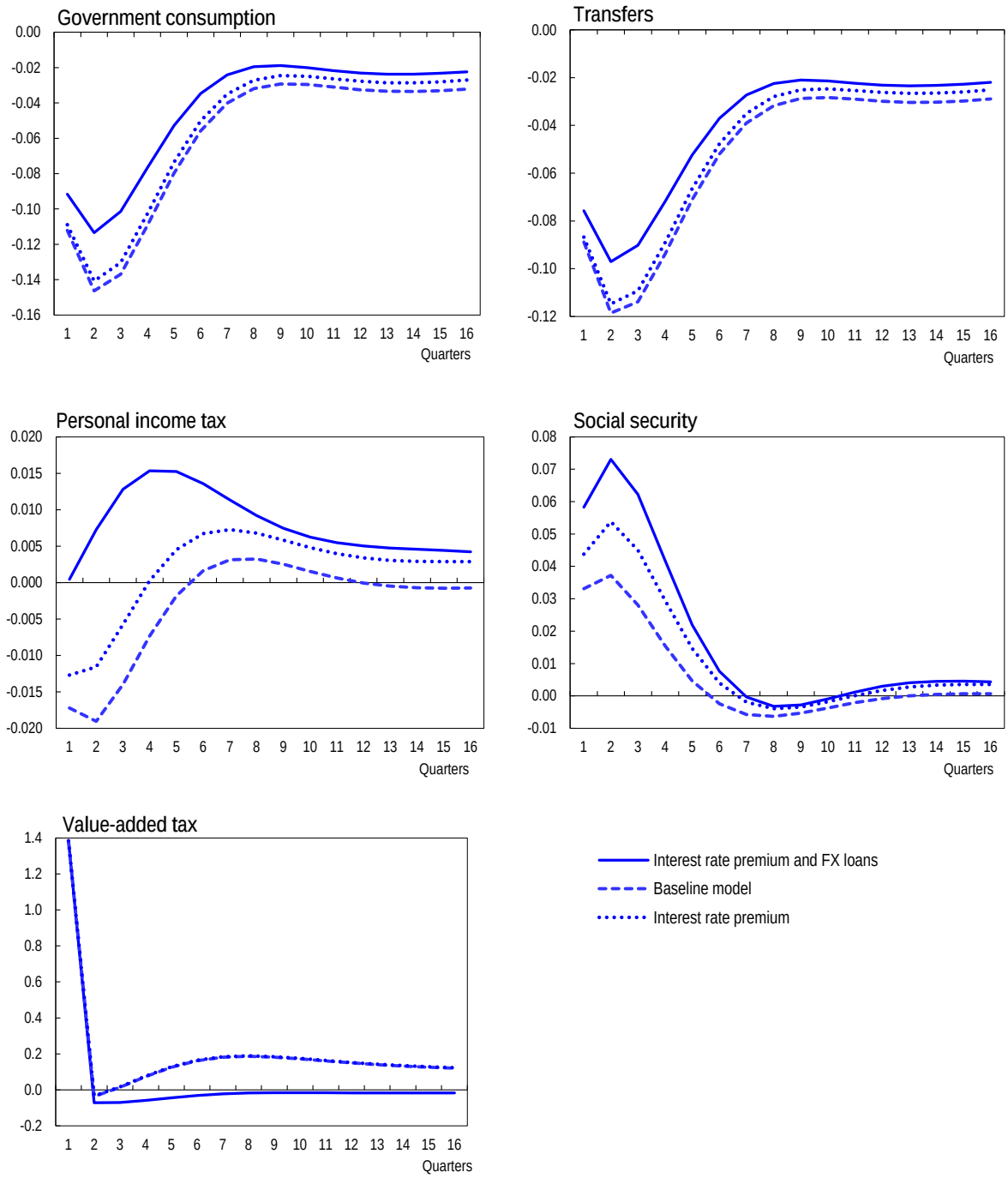
Private investment

Percentage point deviation from the steady state



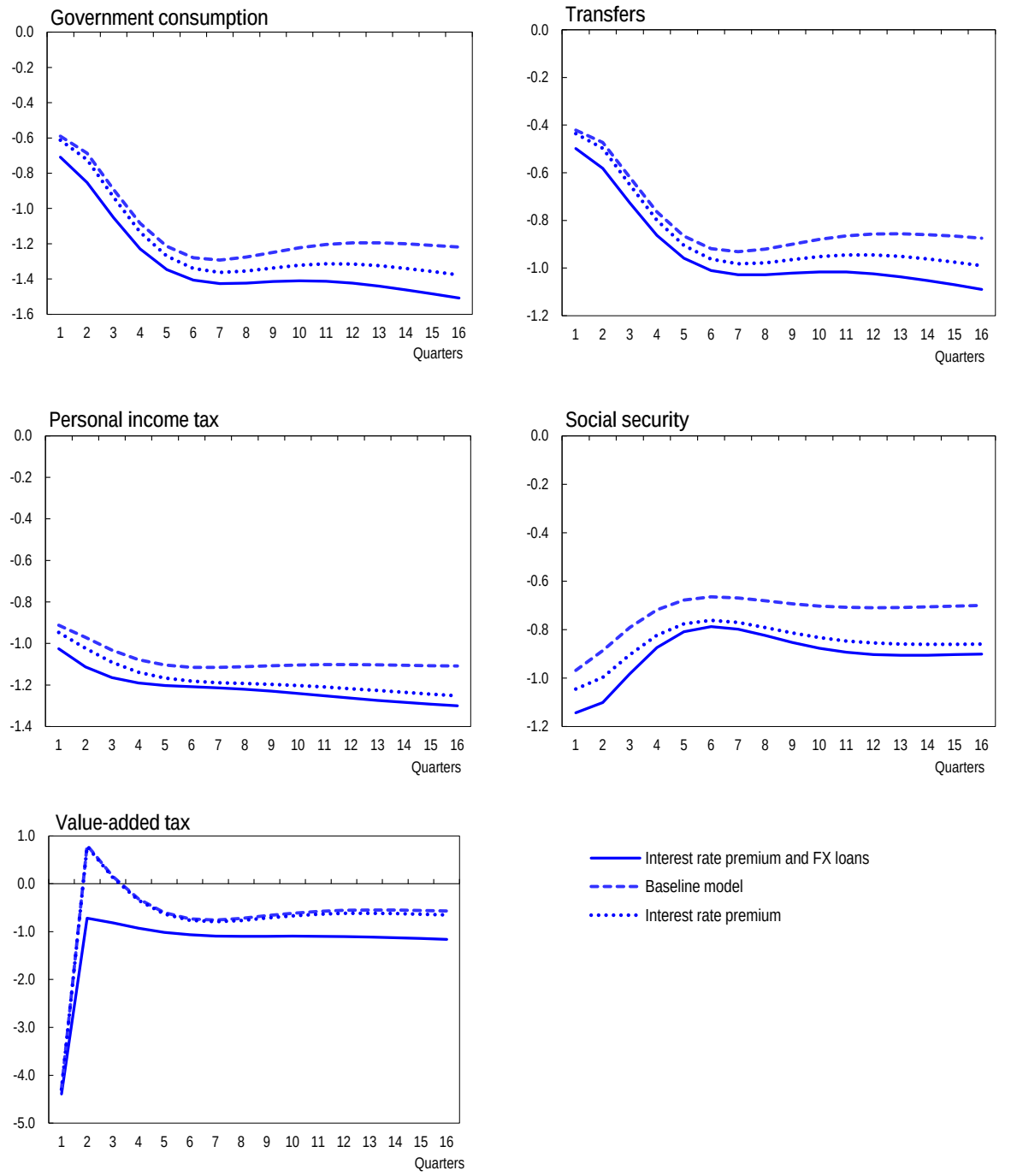
Inflation

Percentage point deviation from the steady state



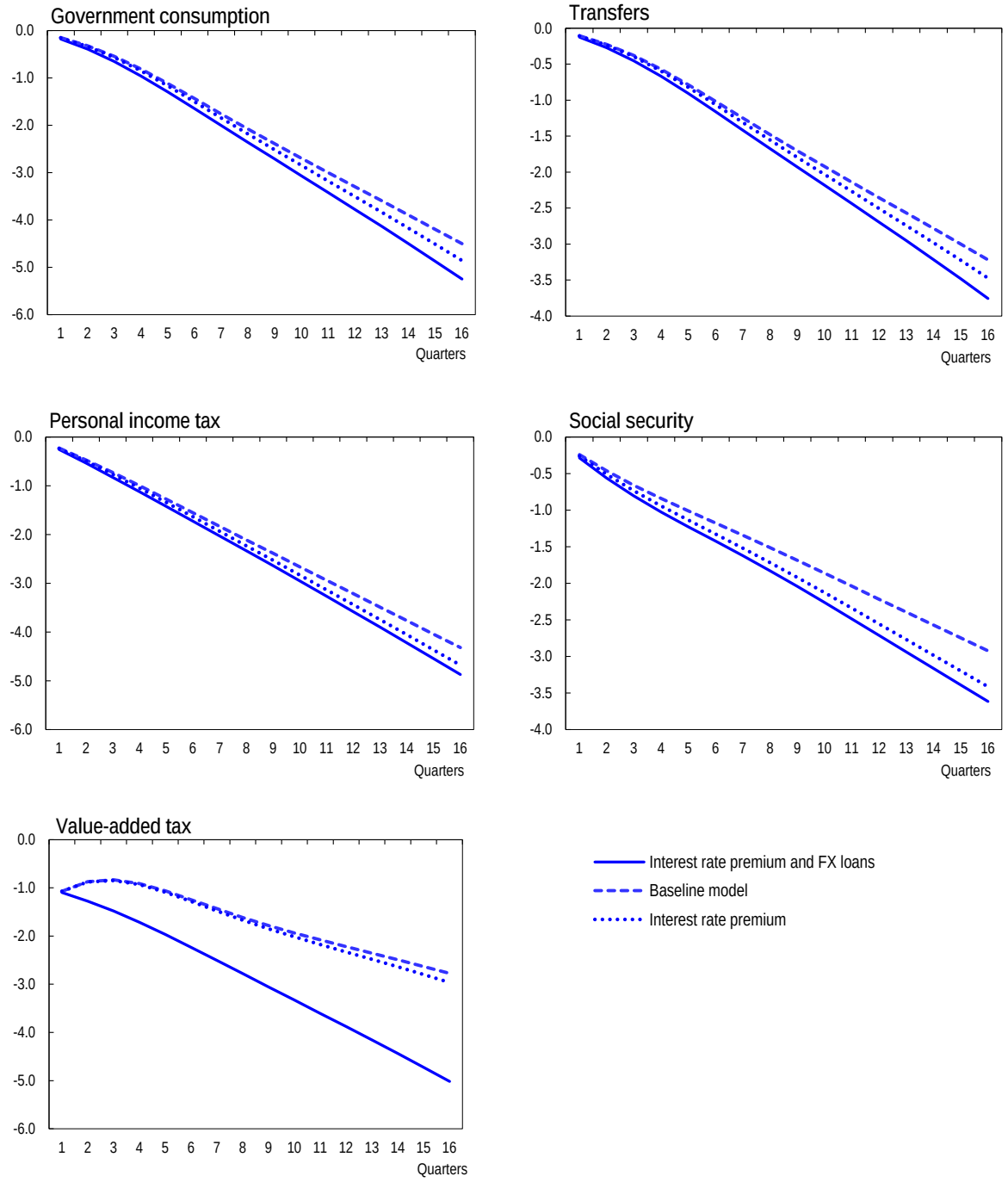
Budget balance

Percentage point deviation from steady-state GDP



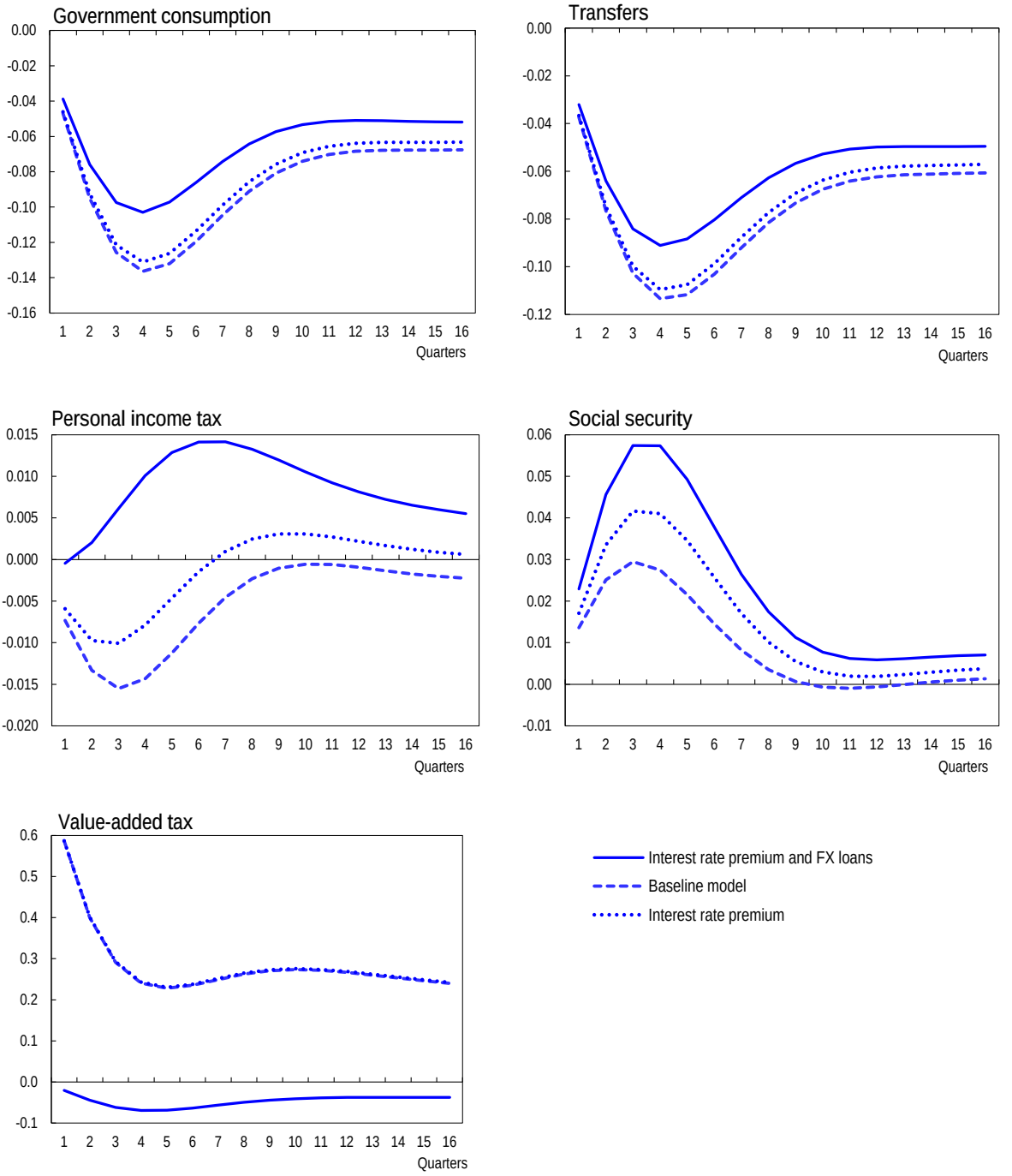
Government debt

Percentage point deviation from steady-state GDP



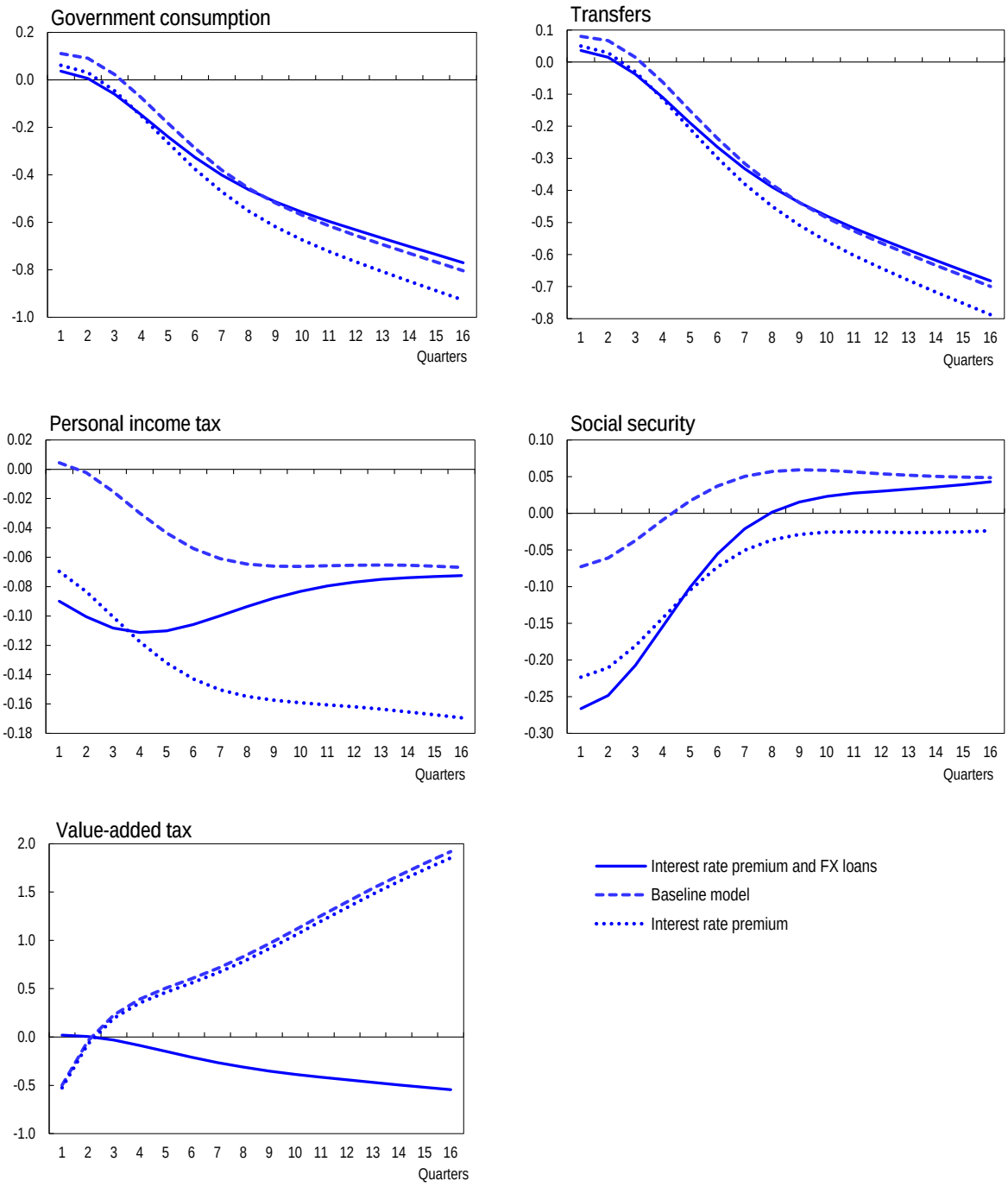
Nominal short-term interest rate

Percentage point deviation from the steady state



Nominal exchange rate

Percentage point deviation from the steady state*



* A positive number indicates currency depreciation.

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