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Independent Monetary Policy Versus a Common Currency: A Macroeconomic Analysis for the Czech Republic Through the Lens of an Applied DSGE Model

Jan Brůha and Jaromír Tonner *

Abstract

The goal of this paper is to contribute to the understanding of the macroeconomic costs and benefits of euro adoption by the Czech economy through the lens of the CNB's official structural macroeconomic model – called g3. To do so, we perform simulations using the g3 model and a modification thereof with a fixed nominal exchange rate and with the policy rate given by the ECB. First, we compare the unconditional volatilities of selected macro variables implied by the two models. Second, we use the g3 model to filter the historical data to identify the structural shocks that affected the Czech economy in the past ten years, and we then use the modified model to simulate the counterfactual outcome of what would have happened to the Czech economy if the euro had been adopted in the past. Our results indicate that euro adoption would have had positive effects on the levels of macroeconomic variables at the cost of an increase in nominal volatility.

Abstrakt

Cílem článku je přispět k porozumění přínosům a nákladům přijetí eura prostřednictvím oficiálního strukturálního makroekonomického modelu ČNB s názvem g3. Pro tento účel používáme simulace s modelem g3 a s jeho modifikací s fixním nominálním kurzem a měnověpolitickými sazbami ECB. Nejprve porovnáváme nepodmíněné volatility vybraných makroekonomických proměnných implikované oběma modely. Poté používáme model g3 k filtraci historických dat, abychom identifikovali strukturální šoky, které zasáhly českou ekonomiku v uplynulých deseti letech. Dále s využitím modifikovaného modelu simulujeme, co by se bývalo stalo v české ekonomice, kdyby bylo euro v minulosti přijato. Naše výsledky indikují, že přijetí eura by bývalo mělo kladný vliv na úrovně makroekonomických veličin za cenu růstu nominální volatility.

JEL Codes: E47, E52, F45, F47.
Keywords: DSGE model, euro, monetary policy.

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Nontechnical Summary

The Czech Republic joined the EU in 2004, i.e. after 1993, and it is therefore obliged to adopt the euro sometime in the future. Obviously, euro adoption would have its benefits and costs. This paper aims to contribute to the macroeconomic analysis of the costs and benefits. By "macroeconomic", we mean those costs and benefits which are related to business cycle fluctuations, to positive trade effects and to the nominal convergence of the Czech economy. We therefore do not investigate other costs and benefits, such as the change of legal tender, the change in the country's credibility after adopting the euro and the costs of potential fiscal free riding by other member countries. This is not to say that these other aspects are not important, but this paper concentrates on the above-mentioned well-defined aspects of euro adoption.

The main macroeconomic benefit of adopting the euro is the elimination of exchange rate risk, which should be beneficial to trade, as the euro area countries are dominant trading partners for the Czech Republic. The macroeconomic costs include a reduction in the effectiveness of domestic macroeconomic policies and the risk of greater volatility in economic activity and consumption due to the loss of independent interest rate and exchange rate policy. This is because the common monetary policy of the ECB cannot respond sufficiently to shocks which affect only a small part of the euro area economy. The relative importance of the costs and benefits of adopting the common currency is ex ante unclear and the literature offers conflicting results. Therefore, it is worth investigating the macroeconomic costs of joining the euro area.

To contribute to this research agenda, we use simulations performed using the CNB's official "g3" macroeconomic forecasting model, which is a typical small open economy new Keynesian model. As a counterfactual, we build a modified version of the g3 model with a fixed nominal exchange rate and with the monetary policy rate equal to the ECB rate.

To evaluate the effects of euro adoption on the Czech economy, we employ two approaches. We compare the unconditional volatilities of important macro variables implied by the two macroeconomic models. The volatility of nominal variables increases after joining the common currency, as the common monetary policy does not react to purely domestic shocks.

We also simulate the counterfactual outcomes of macroeconomic variables that would have happened if the euro had been adopted in the past. We find that euro adoption would have meant an increase in the volatility of macroeconomic variables, while the effects on the levels of real output and consumption would have been positive. These positive effects on the real economy are due mainly to the trade effect, but temporarily lower real interest rates would also have contributed. Nominal exchange rate appreciation during the ERM II phase could partly alleviate the nominal volatility caused by euro adoption.

1. Introduction

As the Czech Republic joined the EU in 2004, i.e. after 1993, it is obliged to adopt the euro sometime in the future. Obviously, euro adoption would have its benefits and costs. This paper aims to contribute to the macroeconomic analysis of the costs and benefits. In this paper, by "macroeconomic", we mean those costs and benefits which are related to business cycle fluctuations, to positive trade effects and to the nominal convergence of the Czech economy. We will therefore not investigate other costs and benefits, such as the change of legal tender, the change in the country's credibility after adopting the euro and the costs of potential fiscal free riding by other member countries. This is not to say that these other aspects are not important, but this paper concentrates on the above-mentioned well-defined aspects of euro adoption.

The theory of optimum currency areas is the natural starting point for assessing the macroeconomic costs and benefits of adopting the euro. The main macroeconomic benefit of adopting the euro is the elimination of exchange rate risk, which should be beneficial to trade, as the euro area countries are dominant trading partners for the Czech Republic. Exchange rate stability also creates a more favourable investment environment. The macroeconomic costs include a reduction in the effectiveness of domestic macroeconomic policies and the risk of greater volatility in economic activity and consumption due to the loss of independent interest rate and exchange rate policy. This is because the common monetary policy of the ECB cannot respond sufficiently to shocks which affect only a small part of the euro area economy. The relative importance of the costs and benefits of adopting the common currency is ex ante unclear. This is why it is worth investigating the macroeconomic costs of joining the euro area.

The previous empirical research on the costs and benefits of euro adoption tends to find positive effects of the common currency. In a seminal paper, Farrant and Peersman (2006) find evidence on a panel of data for advanced countries that the *nominal* exchange rate is a source rather than an absorber of real shocks. This would mean that the macroeconomic benefits of the common currency would probably outweigh its costs. Audzei and Brazdik (2018) inquire about the role of the *real* exchange rate using structural VARs applied to a panel of CEE countries. They conclude that the real exchange rate can absorb shocks even when the nominal exchange rate is fixed (as in the case of a currency board or euro adoption). This means that macroeconomic adjustment mechanisms function even for countries with a fixed nominal exchange rate. Moreover, Audzei and Brazdik (2018) find that most shocks between the Czech economy and the euro area are symmetric, which implies that the macroeconomic costs of euro adoption would not be prohibitive.

There are previous studies that also use simulations with structural models. These studies tend to stress the cost side of adopting the common currency. Ferreira-Lopes (2010) explores the costs of euro adoption for Sweden and the UK, concluding that they would outweigh the benefits in these countries. Moreover, Ferreira-Lopes (2014) simulates the costs of euro adoption in Central European countries using a DSGE model and concludes that the costs of the loss of independent monetary policy are high for the Czech Republic and Poland relative to Hungary because of the large significance of domestic demand shocks (e.g. government consumption). Similarly, Hurník et al. (2010) find that the costs of losing independent monetary policy would be higher than the benefits of avoiding non-fundamental exchange rate fluctuations and euro adoption would therefore not benefit the Czech economy.

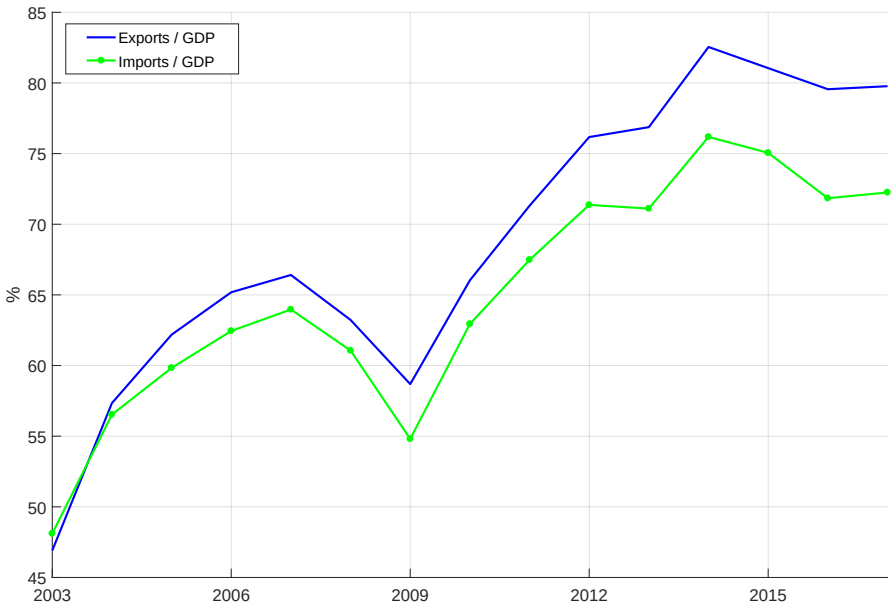
Given these conflicting results, more research is needed. This paper tries to contribute to these discussions. The rest of the text is organised as follows. The next section 2 describes some important

stylised facts. Section 3 describes the methodology employed and the results obtained. The last section 4 concludes. An appendix contains additional materials.

2. Stylised Facts

The Czech economy is open and its openness is steadily increasing, as can be seen from Figure 1. The ratio of nominal exports to nominal GDP has increased from less than 50% before EU entry in 2004 to almost 80% currently. This means that external demand has become an important driver of the business cycle in the Czech economy.[1] A very similar pattern holds for the imports-to-GDP ratio.[2] The main trading partner of the Czech economy is the euro area (EA); the share of exports to the euro area in total exports is roughly 65%, while the share of imports from the euro area in total imports is about 50% (the difference is explained mainly by imports of primary commodities from countries outside the EU or EA).

Figure 1: Openness of the Czech Economy



Given the strong trade links of the Czech economy with the euro area, it is not surprising that there are strong comovements between real variables. The upper left chart of Figure 2 shows the correlations of Czech and EA real GDP for various lags and leads. Apparently, the correlation between the two GDPs is high both on yearly growth rates and on cyclical frequencies.[3] The correlation of Czech exports with euro area GDP is also high, as can be seen in the upper right chart of Figure 2.

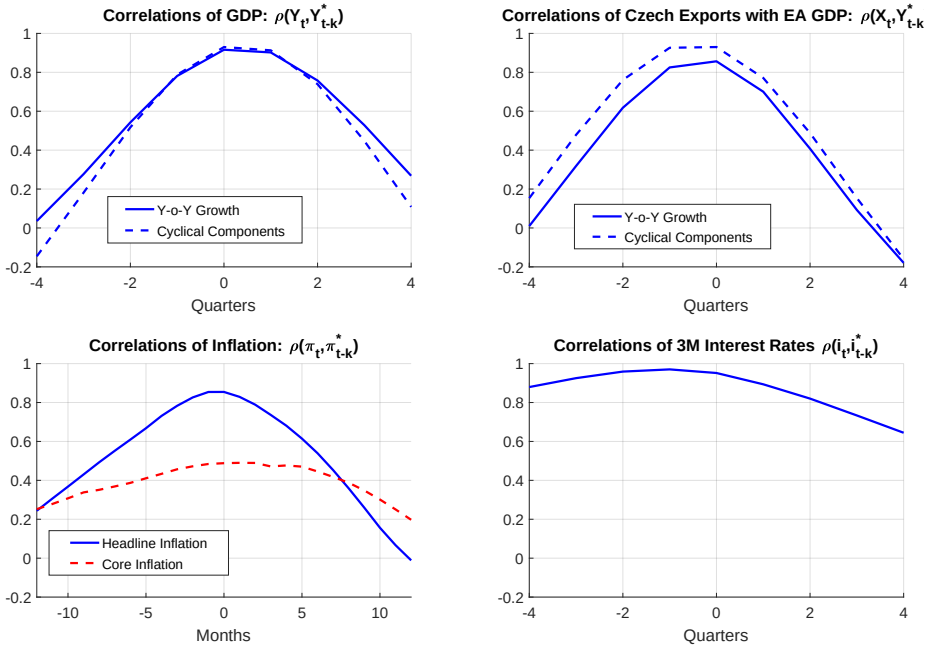
Turning to the comovements of nominal variables, the correlation of headline inflation rates in the two regions is high, as the lower left chart reveals. This high correlation is caused partly by food and

[1] Most exports (almost 90%) are concentrated in SITC categories 6, 7 and 8, i.e. in industrial goods sectors.

[2] See Babecká Kucharčuková and Brůha (2018) for a discussion of the drivers of the increase in intra- and extra-EU trade. Moreover, Babecká Kucharčuková and Brůha (2018) argue that the temporary drop in openness during the Great Recession can be explained by a high income sensitivity of trade. Therefore, the drop in trade around 2009 was just a temporary cyclical phenomenon.

[3] The cyclical components were obtained using the Christiano and Fitzgerald (1999) band pass filter.

Figure 2: Business Cycle Comovements



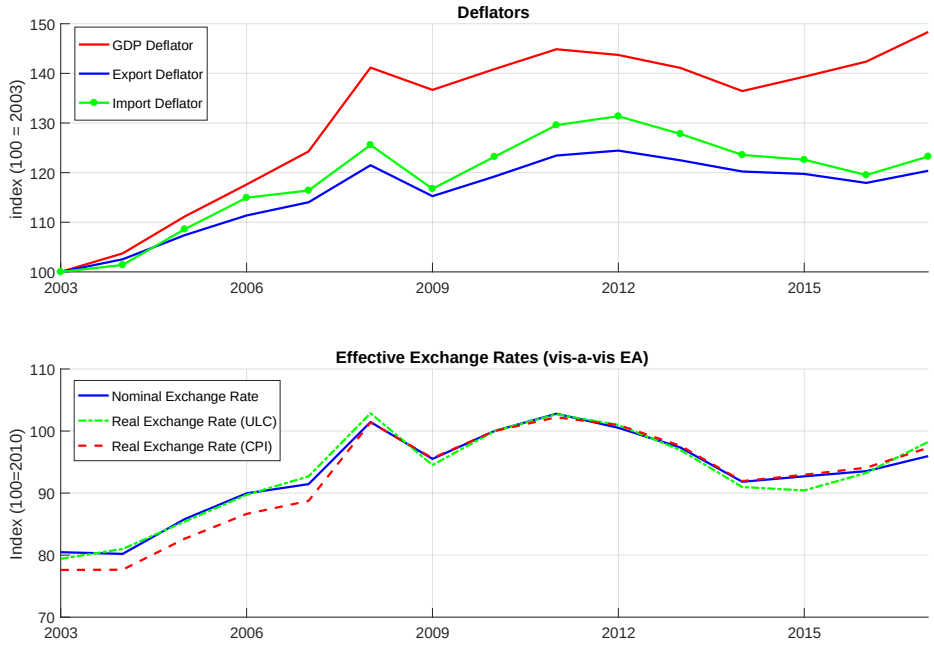
energy prices, which are determined on global markets. The correlation of core inflation (i.e. the ex-food and ex-energy inflation rates) is less strong, but still positive and significant. Finally, the correlation of the short-term money market interest rate is also high, as the lower right chart of Figure 2 reveals.

All in all, there are strong comovements on the real side of both economies and some non-negligible comovement on the nominal side. Therefore, one should not expect prohibitive macroeconomic costs. Moreover, the forecast error variance decomposition of the fluctuations in the nominal exchange rate and the policy rate suggest that a non-trivial portion of the variance in these two variables is caused by UIP and monetary policy shocks.[4]

Despite the business cycle comovements, there are trends in the price data that are specific to converging economies, including the Czech economy. These trends change relative prices both within the Czech economy and vis-á-vis the euro area. The upper subfigure of Figure 3 demonstrates that the GDP deflator has been rising much faster than the export and import deflators, which means that prices of domestic products have been going up (domestic goods have been getting more expensive than foreign goods). This is a manifestation of the nominal convergence of the Czech economy towards the euro area price level. The real and nominal exchange rates vis-á-vis the euro area have been appreciating (see the lower subfigure), yet despite this the volume exports has been increasing and the trade balance has turned positive. The explanation of these seemingly contradictory trends lies in an improvement in the perceived quality of domestic products, which can be sold on foreign markets in increasingly large quantities (Brůha and Podpiera (2010)).

[4] The core forecasting DSGE model g3 suggests that about a third of the fluctuation in the exchange rate can be explained by the combination of UIP and monetary policy shocks. These two shocks account for about 20% of the overall variance of policy rates. See Figure 4.

Figure 3: Relative Prices in the Czech Economy



These stylised facts signal that to simulate the counterfactual impact of euro adoption on the Czech economy, one needs a model that captures both the long-run trends specific to converging countries (increasing openness, trend real exchange rate appreciation) and the close comovement in real variables between the Czech economy and the euro area.

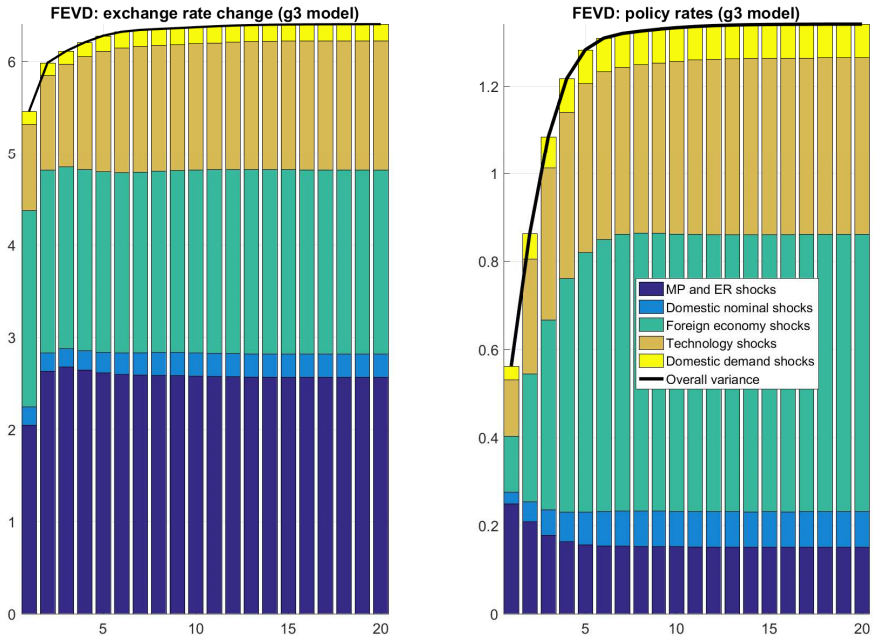
3. Simulations

For the purposes of this project, we use simulations performed using the CNB's official macroeconomic forecasting model – a DSGE model called g3. The g3 model is a typical small open economy new Keynesian model and is described in detail in Andrle et al. (2009). It is currently used by CNB staff for forecasting and performing other monetary policy analyses. As such, it contains important features that reflect the stylised facts outlined in the preceding section 2, such as the increase in openness, trend real exchange rate appreciation and the trend in the price of domestic intermediate goods relative to external trade.[5] Moreover, the usefulness and realistic calibration of g3 have been constantly checked since its introduction in 2008, see Brůha et al. (2013), and hence we can conclude that the model is suitable for the task of evaluating euro adoption.

To be able to evaluate the effects of hypothetical euro adoption in the past, we need not only a realistic model of the Czech economy – in our case the g3 model, but also a counterfactual counterpart. We therefore modify g3 with a fixed nominal exchange rate and with the monetary policy rate equal to the ECB rate – let us call it g3c (*c* for *counterfactual*). This model obviously does not contain domestic monetary policy shocks and non-fundamental exchange rate shocks (UIP shocks). The differences in the key equations and in the impulse responses are described in Appendix A.

[5] These features are incorporated into the g3 model by means of "technologies", i.e. exogenous processes that fill the wedges between various relative prices. The technologies are then filtered in a model-consistent way. Without taking into account these trends, the filtration of shocks would not be credible and the results of the quantitative exercise described below would not be reliable.

Figure 4: FEVD of the Exchange Rate and Interest Rates



To evaluate the effects of euro adoption on the Czech economy, we employ two approaches. First, we compare the unconditional volatilities of important macro variables implied by the two models, g3 and g3c. This is done in subsection 3.1. Second, in section 3.2 we compute the counterfactual outcomes of macroeconomic variables that would have happened if the euro had been adopted in the past.

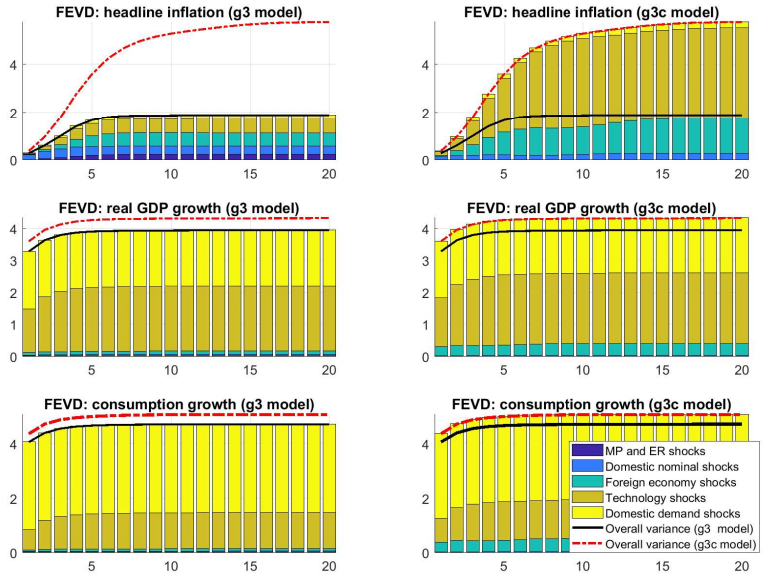
3.1 Unconditional Volatilities

The effect of euro adoption on the volatilities of the main macroeconomic variables is ex ante unclear. On the benefit side, euro adoption would mean the elimination of non-fundamental exchange rate risk (technically, UIP and risk-premium shocks are not present in the g3c model) and the elimination of domestic policy mistakes (i.e. the elimination of monetary policy shocks). On the cost side, the loss of domestic monetary policy means that purely domestic shocks are not stabilised.

The results are visible in Figure 5, which compares the forecast error variance decompositions of real consumption growth, real GDP growth and CPI inflation for the g3 and g3c models. It is clear that through lens of the DSGE models, euro adoption would have very little effect on the volatility of real variables but would imply a significant increase in the volatility of inflation. This is because shocks would cease to be mitigated by autonomous monetary policy, as the common policy can react only partially to domestic shocks.

These results are also reflected in the differences between the impulse responses of the two models. As Figures A1 and A2 in Appendix A show, the impulse responses of output are very similar across the models. This means that one cannot expect large effects on output by fixing the nominal exchange rate and adopting foreign policy rates. On the other hand, the impulse responses of inflation differ significantly, so inflation could become more volatile after adoption of the common currency.

Figure 5: FEVD: A Comparison Across Models



3.2 Counterfactual Analysis

In this part of the paper, we ask what would have happened if the euro had been adopted in 2007. To do so, we use the g3 model to filter the shocks that have affected the Czech economy since 2005. The filtered shocks (excluding MP, risk-premium and UIP shocks) and the ECB's policy rates are then plugged into the modified model g3c. This gives us a counterfactual trajectory that can be compared with the actual outcome and the likely costs and benefits assessed. Furthermore, there are two additional methodological issues that should be considered – trade effects and nominal convergence.

First, New Keynesian DSGE models are not suitable for simulating the favourable effects of the common currency on trade. The reason is that these models feature a constant number of exporters that operate without sunk costs: there is no decision on whether to enter the exporting business. Hence, the elimination of exchange rate risk does not matter in such an environment and the main trade-boosting channel cannot be present. This means that the trade effects should be imposed semi-exogenously. We do that based on the recent literature[6] and use the results of Felbermayr et al. (2018). Felbermayr et al. (2018) show that the euro area trade effect amounts to about 8.6%, and in our simulations we boost exports by the corresponding amount. Technically, we do this via a permanent-level foreign demand shock that would cause a corresponding increase in exports.[7]

Second, the Czech currency exhibits a real appreciation trend and domestic prices grow faster than foreign ones (see section 2). Under the float, the appreciation took place through nominal appreci-

[6] The original literature was fairly optimistic as regards the effects of the single currency on trade. Rose (2000), for example, found effects amounting to hundreds of per cent. However, later studies – such as Baldwin (2006) – are far more sceptical, and Havránek (2010) even finds in a meta-analysis that the effect of euro adoption on trade between euro area countries is not statistically significant and with high probability is less than 5%. By contrast, the latest studies return to positive but somewhat lower estimates – see, for example, Glick and Rose (2015) and Rose (2016).

[7] In fact, such a shock spills over to other real variables: it boosts investment, labour demand and hence private consumption and finally also imports, because they are used as inputs for all components of GDP.

ation. This implies that under the fixed exchange rate regime, the real convergence would translate to a temporarily higher inflation rate and hence lower real interest rates. This would represent an additional macroeconomic cost, since the lower real rates would affect the inter-temporal decisions of households: consumption would be temporarily higher and then fall so that the intertemporal household budget constraint was satisfied, i.e. there would be an additional cycle in consumption. As in the case of trade effects, business cycle models are not suitable for endogenously generating the higher inflation stemming from the nominal convergence. Therefore, we technically solve this challenge by adding export technology shocks – these are shocks intended to capture the permanent drift between domestic and foreign prices, i.e. the Balassa–Samuelson effect.[8]

In our simulations, we assume that during the first quarter of 2007 it is announced that the Czech economy will adopt the euro in two years and that during those two years the nominal exchange rate converges linearly to the fixed level of 25.94 CZK/EUR and then stays there forever. We assume that this announcement is credible and the future path of the exchange rate is fully expected by all economic agents from that period on. The results of the counterfactual simulations of hypothetical euro adoption in 2008 are displayed in Figures 6 and 7.

The linear convergence towards the fixed nominal exchange rate is intended to model the stay of the economy in ERM II. During the stay in this regime, the exchange rate should be stable, although the currency of the candidate country is allowed to appreciate. The Slovak experience shows us that nominal appreciation is likely to take place in practice – it is a way of temporarily mitigating the convergence process.[9]

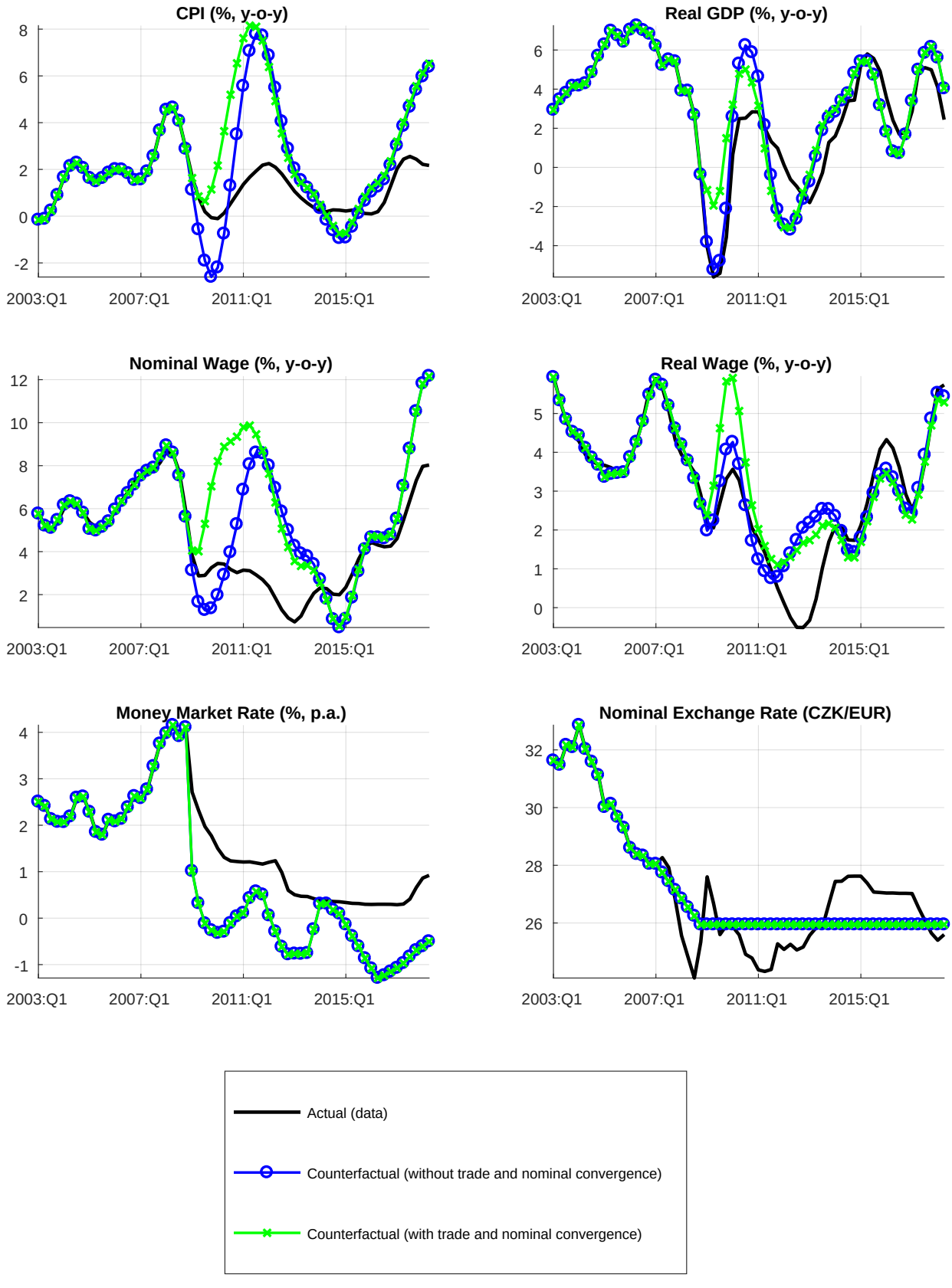
In our simulations, we compare three time series: the actual data, the counterfactual simulations without the trade and nominal convergence effects and the counterfactual simulations with these two effects. These simulations yield a clear message. First, the volatility of all variables, and especially of nominal variables, would have increased. This is especially true for inflation and nominal wages. This is in line with the results presented in section 3.1. The increase in counterfactual inflation in 2008 is to be compared with the more moderate actual increase. In fact, this was a time when domestic monetary policy helped cool down inflation.[10]

[8] This shock (denoted as $\dot{a}_t^X$) creates a permanent wedge between the GDP deflator and the export deflator as follows: $\dot{a}_t^X = \dot{p}_t^Y / \dot{p}_t^X$, where $\dot{p}_t^Y$ is growth in the GDP deflator and $\dot{p}_t^X$ is growth in the observed deflator. As export prices are determined in the long run on foreign markets and are therefore exogenous, the shock $\dot{a}_t^X$ determines the long-run price level in the domestic economy. It is therefore an appropriate tool for generating nominal convergence in the counterfactual simulations.

[9] In a previous version of our paper, we assumed that the nominal exchange rate is fixed right after the announcement of euro adoption. This resulted in incredibly high inflation volatility. A slow and steady appreciation during the stay in ERM II may help mitigate these implausible effects.

[10] Our simulations are done in a model with rational perfect foresight agents and perfectly credible monetary policy. Such models imply a strong stabilising effect of monetary policy working solely through agents' expectations. In a model containing agents with less foresight, the stabilising function of policy would probably be weaker, so our results on the size of the nominal fluctuations in the counterfactual simulations probably only represent the upper bound of what might have happened in reality.

Figure 6: Counterfactual Simulations of Hypothetical Euro Adoption



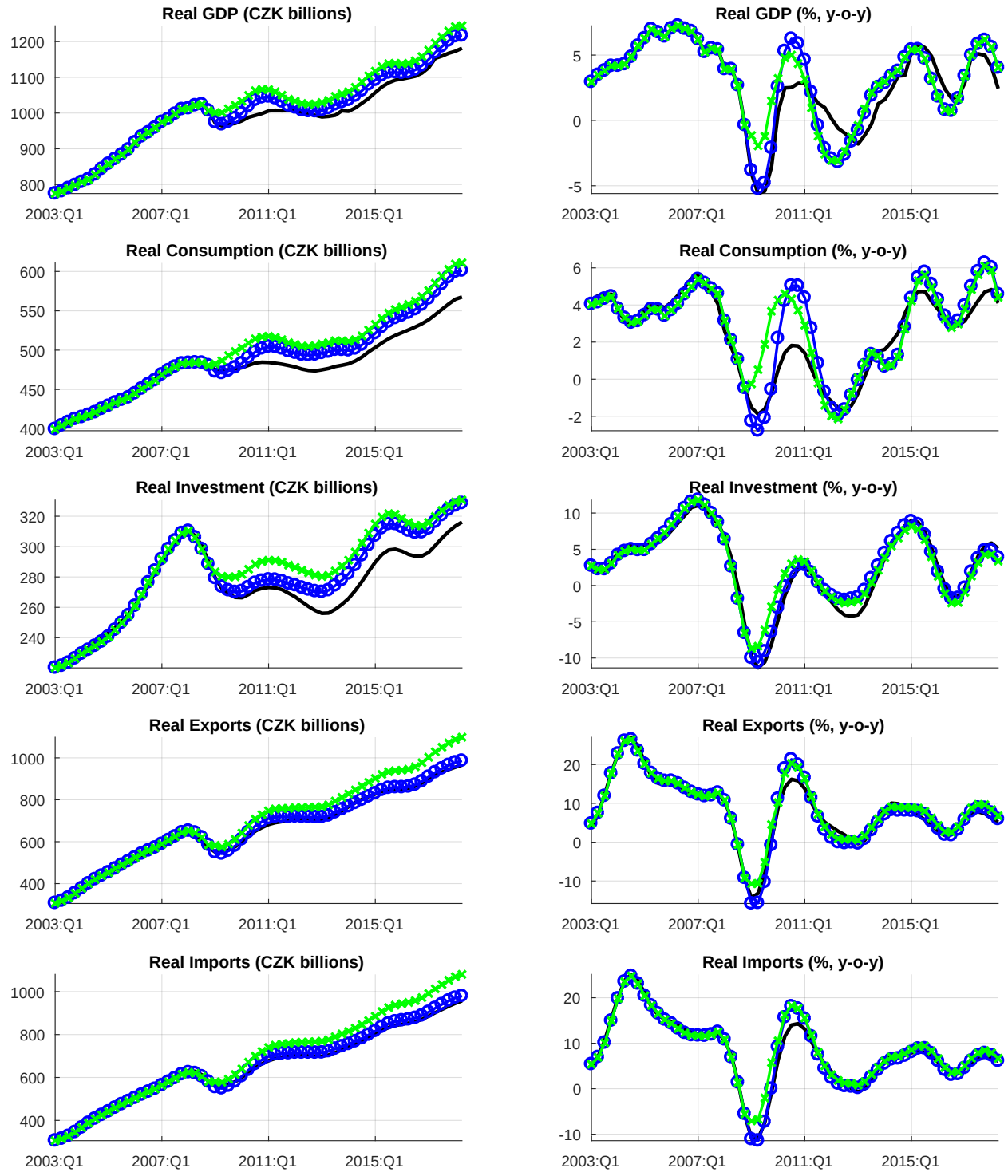

Real GDP (CZK billions)
Real GDP (%, y-o-y)
Real Consumption (CZK billions)
Real Consumption (%, y-o-y)
Real Investment (CZK billions)
Real Investment (%, y-o-y)
Real Exports (CZK billions)
Real Exports (%, y-o-y)
Real Imports (CZK billions)
Real Imports (%, y-o-y)
2003:Q1
2007:Q1
2011:Q1
2015:Q1
Actual (data)
Counterfactual (without trade and nominal convergence)
Counterfactual (with trade and nominal convergence)

Figure 8: Counterfactual Simulations of Hypothetical Euro Adoption: Sensitivity to the Final Exchange Rate

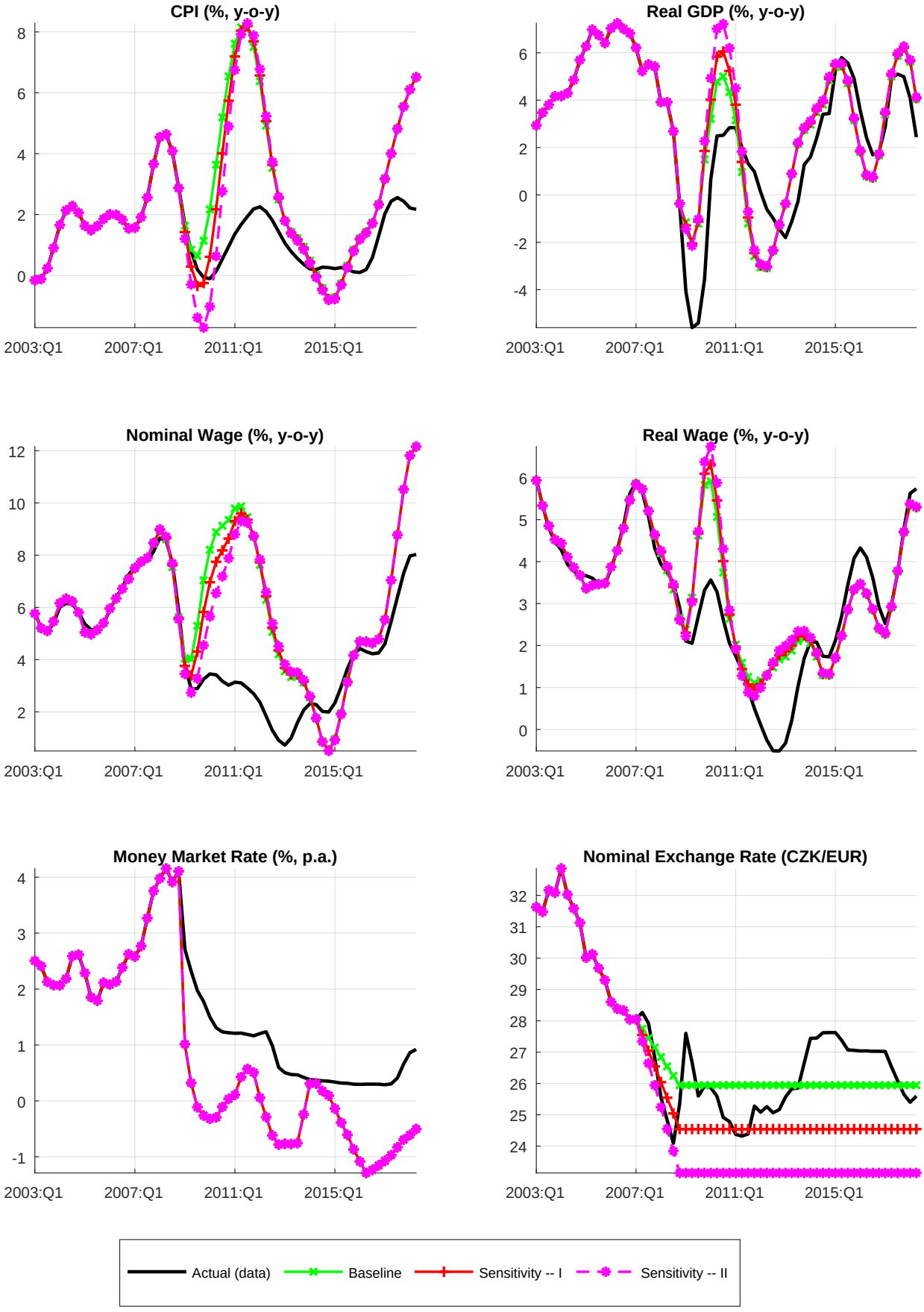
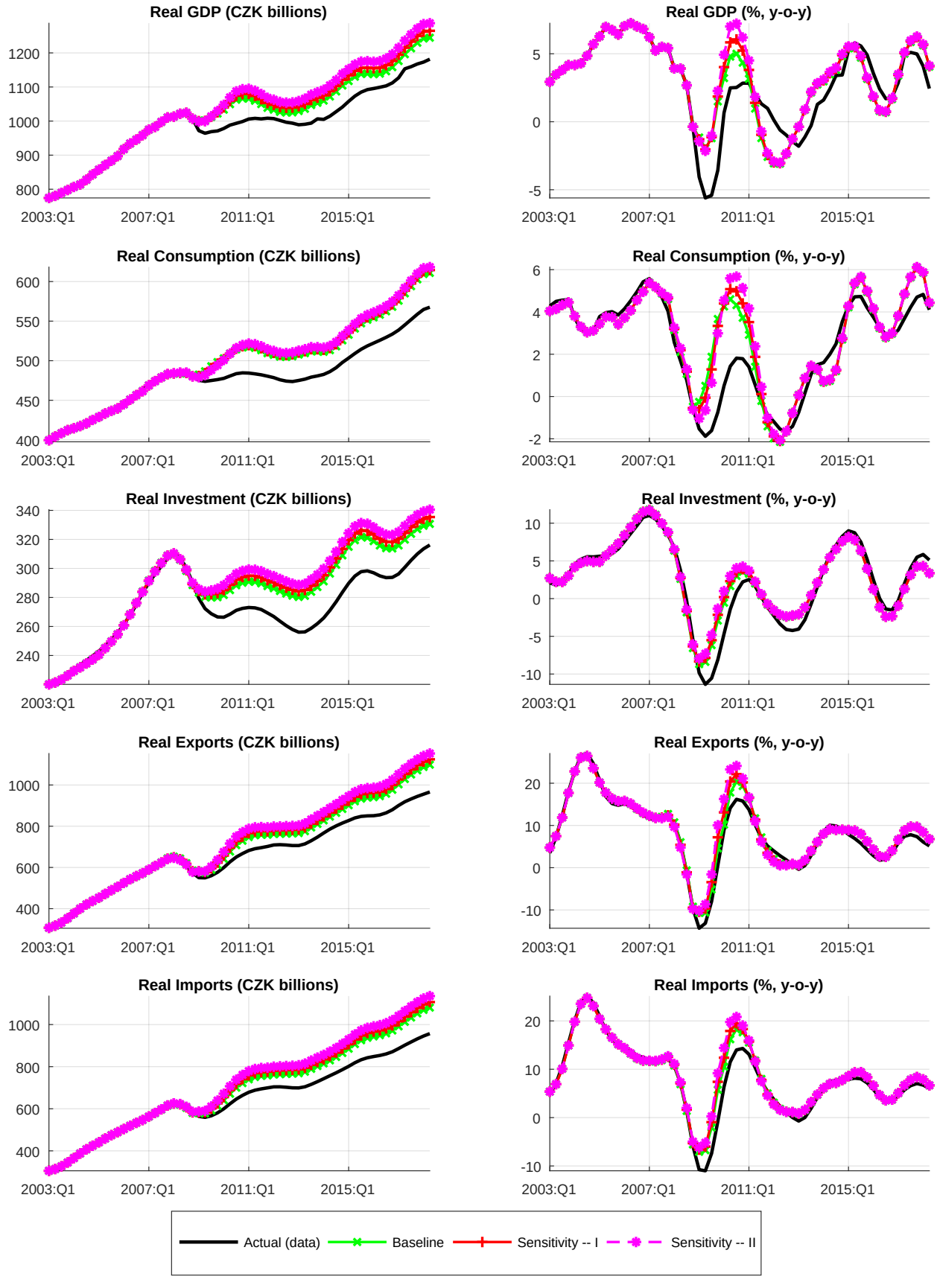


Figure 9: Counterfactual Simulations of Hypothetical Euro Adoption: Sensitivity to the Final Exchange Rate



Second, euro area entry would have had a positive impact on real variables, especially if the trade effect is assumed. The trade effect would generate a positive temporary increase in the growth rates of exports and a positive permanent level effect. This increase in exports then spills over to the rest of the macroeconomic variables. Another positive effect on the real economy stems from lower real interest rates: for a significant part of the simulations, the counterfactual real rates are lower than the actual ones (because of both higher inflation and lower nominal rates), which – by the force of the Euler equation – boosts counterfactual consumption.[11][12]

We also provide a sensitivity analysis with respect to the final level of the nominal exchange rate achieved after the ERM II stage. The results can be seen Figures 8 and 9. The two final levels considered in the sensitivity scenarios are 25.55 and 25.95 CZK/EUR. Apparently, the strongest effect is on inflation and nominal wage growth: the higher appreciation during the ERM II period means a temporarily lower inflation rate with little effect on real variables. We can conclude that nominal appreciation during the ERM II period may partly mitigate the increase in nominal volatility. On the other hand, the pace of the desired appreciation is unclear and depends on the nominal shocks that hit the economy in that phase.

4. Conclusion

In this paper we contribute to the literature on what the macroeconomic consequences would be if the Czech economy adopted the euro. To do so, we perform simulations using the CNB's core forecasting model – called g3 – and a counterpart with a fixed nominal exchange rate regime and with policy rates equal to euro area policy rates. We argue that the g3 model is suitable for this task, as it contains features important for the Czech economy, features such as increasing openness and nominal convergence. In our simulations, we try to include trade benefits stemming from the elimination of exchange rate risk and the change of the nominal convergence channel from exchange rate appreciation to a positive inflation differential.

We find that euro adoption would mean an increase in the volatility of macroeconomic variables, while the effects on real output and consumption would be positive. These positive effects on the real economy are due mainly to the trade effect, but temporarily lower real interest rates would also contribute.

To conclude this paper, we note that there is evidence; see, for example Žúdel and Melioris (2016)) of positive effects of euro adoption for Slovakia using ex-post data. Given that the Czech and Slovak economies are similar in many macroeconomic aspects (real and nominal convergence, high and increasing trade openness, a similar industrial structure), our findings on the positive effects of the common currency on the real economy are not unreasonable.

[11] This effect is not permanent, but it is long lasting. In fact, the now low real rates cause consumption to shift from the future to the present. However, this happens beyond the horizon of the simulations.

[12] In addition to these two systematic effects, there are various idiosyncratic effects. For example, real GDP growth is lower in the counterfactual simulations than in reality. In that year, the CNB adopted the exchange rate floor as an additional instrument for easing monetary conditions and there is evidence that this policy step helped the economy; see Brůha and Tonner (2017). Nevertheless, we prefer to comment on the more systematic features.

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Appendix A: Key Differences Between the g3 and g3c Models

The key difference between the original g3 model and the modified g3c model lies in the equations that determine the exchange rate and the domestic interest rate. In the g3 model, the exchange rate is determined by the modified UIP equation:

$$i_t = i_t^* \dot{s}_{t+1}^{\rho_s} \dot{s}_t^{1-\rho_s} \ddot{s}^{2(1-\rho_s)} \wp_t \varepsilon_t, \tag{A1}$$

where i_t is the domestic nominal interest rate, i_t^* is the foreign policy rate, $\dot{s}_t$ is the exchange rate change, $\ddot{s}$ is the steady state exchange rate appreciation, $\wp_t$ is the UIP premium and ε_t is the pure UIP shock. Equation (A1) differs from the standard UIP equation by a smoothing term governed by the parameter ρ_s, which smooths the response of the exchange rate to the interest rate differential, i.e. the exchange rate does not behave as a pure jump variable. The logarithm of the UIP premium follows an ARX process:

$$\log \wp_t = \rho_\wp \log \wp_{t-1} + \zeta b_t + e_t, \tag{A2}$$

where $0 < \rho_\wp < 1$ is the autoregressive parameter, b_t are net foreign assets, ζ is the positive parameter and e_t is the premium shock. The presence of net foreign assets in (A2) reflects the observed empirical regularity that an increase in net exports puts additional appreciation pressure on the Czech koruna, and it ensures that the model is stationary.

The domestic policy rate is determined by the forward-looking inflation-targeting rule:

$$i_t = \alpha_i i_{t-1}^{\rho_i} \left(\frac{\pi_{t+4}^{cpi}}{\bar{\pi}^{cpi}} \right)^{\kappa_i(1-\rho_i)} \varepsilon_t^i, \tag{A3}$$

where π_{t+4}^{cpi} is CPI inflation expected in the four quarters ahead, $\bar{\pi}^{cpi}$ is the inflation target, κ_i determines the aggressiveness of monetary policy to a deviation of expected inflation from the target, ρ_i governs the degree of smoothing in the policy rate, α_i is a constant and ε_t^i is the monetary policy shock. The foreign policy rate i_t^* (as well as the paths of foreign output and foreign inflation) are put to the model as an exogenous stationary AR process that is expected by all economic agents in the model.

In the g3c modification, we simply put $i_t = i_t^*$ and set s_t to a pre-specified trajectory. The stationarity of processes of foreign variables ensures that the modified model g3c is also stationary. To be as consistent as possible, we use the same approach in the simulations using the g3c model, i.e. foreign variables are fully expected.

Figure (A1) compares the impulse responses of output between the two models. The figure displays the deviation of real GDP growth from the steady state real GDP growth in response to the main shocks that influence output. Apparently, the impulse responses are very similar and the differences are negligible.

Figure (A2) compares the impulse responses of inflation. The figure displays the deviation of yearly CPI inflation from the target in response to the main inflation shocks. Contrary to the case of output, inflation is more volatile in the g3c model. This is a result of the loss of autonomous monetary policy.

Figure A1: Comparison of the Impulse Responses of Output for the g3 and g3c Models

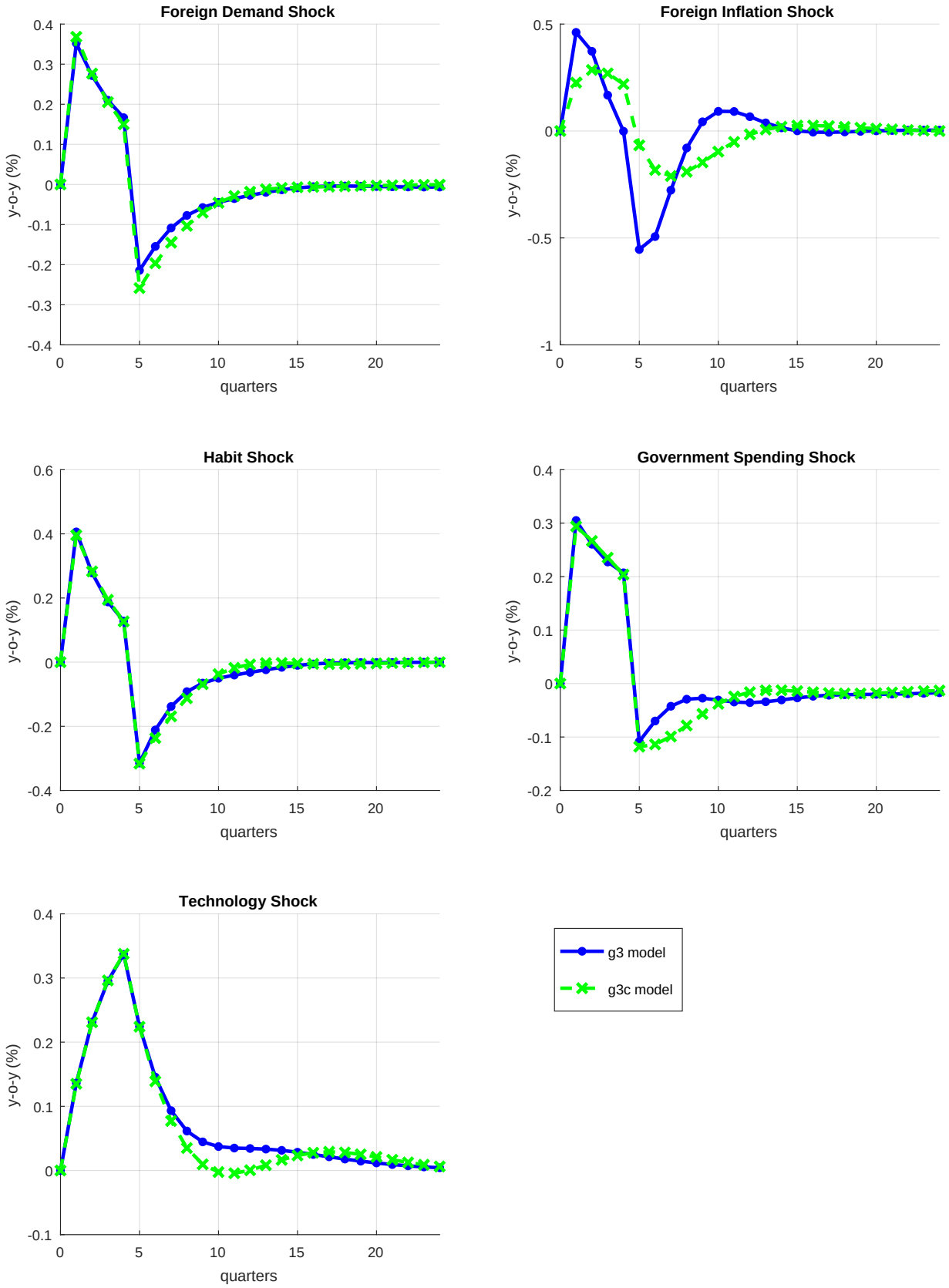
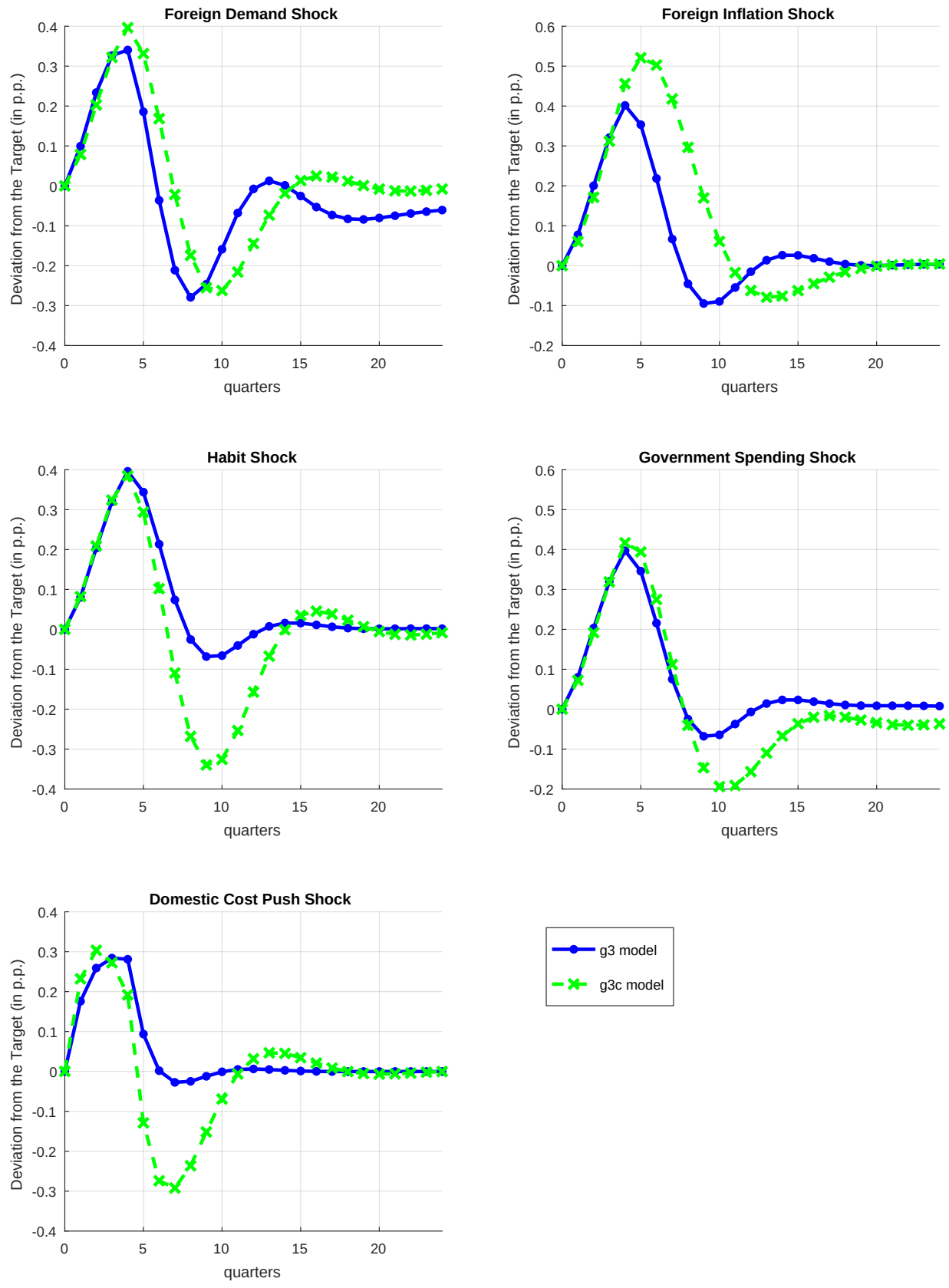


Figure A2: Comparison of the Impulse Responses of Inflation for the g3 and g3c Models



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