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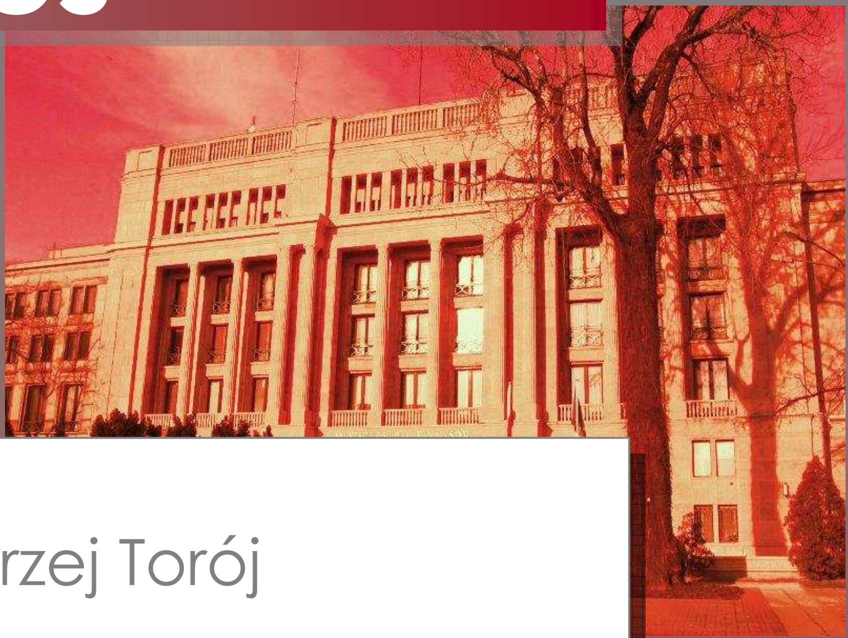

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Poland and Slovakia during the crisis: would the euro (non-)adoption matter?

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Poland and Slovakia during the crisis: would the euro (non-)adoption matter?

Andrzej Torój*

It is commonly argued that Poland avoided a massive drop in output during the 2008/2009 economic crisis in part thanks to substantial nominal zloty's depreciation against the euro. The Polish case is often contrasted with Slovakia that adopted the euro in January 2009 and, since the Ecofin Council decision in summer 2008, exhibited virtually no nominal exchange rate volatility while facing deep losses in output. In this paper we attempt to validate this contrast by reversing the roles, i.e. checking if Poland really would have faced the same drop – and Slovakia the same boost – if it had been Poland, not Slovakia, that adopted the euro at that point. Our counterfactual simulations based on a New Keynesian DSGE model indicate that, indeed, the Polish tradable output could have been 10-15 percent lower than actually observed in 2009, while the Slovak one – approximately 20 percent higher. This asymmetry results mainly from structural differences between the two economies, such as size, openness, share of nontradable sector and foreign trade elasticities. The difference of this size would have been short-lived (3-4 quarters), and the difference of the nontradable output would have been of much lower magnitude.

JEL Classification: C54, E42.

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1 Introduction

The financial and economic crisis that began to intensify in autumn 2008 (after the milestone of Lehman Brothers fall) coincided with divergent patterns in FX market in Central Europe. Amid the loss of investors' confidence and rising risk aversion, the currencies of most emerging markets were heavily depreciating. This phenomenon affected Poland (PL) with particular strength. The zloty depreciated against the euro by almost 40% between September 2008 and February 2009. Similar shocks of smaller magnitude hit i.a. the Czech, Romanian and Hungarian currencies.

This was not the case for Slovakia (SK). In July 2008, the Ecofin Council has taken the decision that SK would become the sixteenth member of the euro area (EA) while setting the irrevocable conversion

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rate. It anchored the market rate of Slovak koruna strongly against the euro for the 5 remaining months of this quoting's history. As a result, the Slovak economy has faced the entire crisis at the pre-crisis, strong level of (ex-)koruna.

In the following months, the impact of the crisis on both economies in question turned out to be highly heterogeneous. While the Slovak GDP fell by 8,4% between 2008q4 and 2009q1, PL avoided any recession at all and its annual GDP dynamics dipped at 0,9% in 2009q3, i.e. the average growth rate for SK over the 2 years to follow. It is commonly argued that PL avoided a massive drop in output during the 2008/2009 economic crisis in part thanks to substantial depreciation of zloty against the euro. The Polish case is often contrasted with SK that, at that point, had a nominal external correction already beyond the feasible set of policy options.

Is this contrast justified? Can both countries be treated as mirror images of each other, both qualitatively and quantitatively? And, if not, what is the difference in quantitative terms? In this paper, we attempt to answer the above questions by means of a New Keynesian DSGE model. Such models imply two principal channels through which external conditions can affect domestic tradable output:

- fluctuations in the level of foreign demand;
- fluctuations in the relative prices between tradable output in the domestic and foreign economy (terms of trade).

The latter source of volatility is directly affected by sizeable exchange rate fluctuations (or the lack thereof). At the same time, their impact on the real economy depends on many structural characteristics, such as size, degree of openness, share of the nontradable sector and foreign trade elasticities. Size and degree of openness are also key characteristics explaining the impact of the first source of volatility. On top of that, the tradable output in a country is also related to country-specific factors, such as domestic demand and internal terms of trade (i.e. relative prices of tradable and nontradable prices in the home economy).

Therefore, our questions regarding the impact of monetary regime change call for a model that (i) incorporates the channel of external competitiveness in a 2-country framework, (ii) identifies the common shocks in foreign demand, (iii) identifies the possibly idiosyncratic domestic real shocks in PL and SK. With all of this, we can run counterfactual simulations in an alternative policy regime (i.e. monetary union and autonomous monetary policy).

The rest of the paper is organised as follows. Having specified and estimated the DSGE model (Sections 2 and 3 respectively), and then identified the paths of real shocks for PL, SK and the EA (Section 4), we simulate the following counterfactual scenarios (and compare them to factual ones):

- What would have been the Polish tradable and nontradable output over the period 2008-2010 if PL had adopted the euro in 2009?
- What would have been the Slovak tradable and nontradable output over the period 2008-2010 if SK had not adopted the euro in 2009?

The conclusions are presented in Section 5.

2 New Keynesian DSGE model

The New Keynesian DSGE model applied has been developed by Torój (2011).

The whole economy of the monetary union is represented by the interval $\langle 0; 1\rangle$, whereby the first region (say, home economy) is indexed over $\langle 0; w\rangle$ (relative size of the region: w), and the second (foreign economy) is indexed over $\langle w; 1\rangle$. Both economies consist of two sectors. Each of them is characterized by price rigidities, modelled with Calvo (1983) mechanism. There are also labour market rigidities. Conventionally, consumers in each region maximize their utility and producers in each sector – their present and discounted future profits. International exchange of goods implies that external adjustment via competitiveness take place.

We consider 2 versions of the model: a monetary union (i.e. fixed exchange rates and single monetary policy) and independent monetary policies (i.e. variable exchange rates, two interest rates and UIP condition).

Henceforth, parameters of the foreign economy are denoted analogously to home economy and marked with an asterisk, e.g. σ and σ^*. For the purpose of estimation and simulations, the model has been log-linearised. Lowercase letters denote the log-deviations of their uppercase counterparts from the steady-state values.

2.1 Consumers

Households get utility from consumption and disutility from hours worked. In addition, utility from consumption depends on consumption habits formed in the previous period (see Smets and Wouters, 2003; Kolasa, 2009). The constant relative returns to scale utility function takes the following form (compare Galí, 2008):

$$U_t\left(C_t, N_t, H_t\right) = \varepsilon_{d,t}\frac{\left(C_t - H_t\right)^{1-\sigma}}{1-\sigma} - \varepsilon_{l,t}\frac{N_t^{1+\phi}}{1+\phi} \tag{1}$$

where C_t – consumption at t, H_t – stock of consumption habits at t, N_t – hours worked at t, $\sigma > 0$ and $\phi > 0$. Consumption habits are assumed to be proportional to consumption at $t-1$ (see Fuhrer, 2000; Smets and Wouters, 2003):

$$H_t = hC_{t-1} \tag{2}$$

with $h \in [0; 1)$ The overall consumption index aggregates the tradable and nontradable consumption bundles:

$$C_t \equiv \left[\left(1-\kappa\right)^{\frac{1}{\delta}} C_{T,t}^{\frac{\delta-1}{\delta}} + \kappa^{\frac{1}{\delta}} C_{N,t}^{\frac{\delta-1}{\delta}}\right]^{\frac{\delta}{\delta-1}} \tag{3}$$

where $\kappa \in (0;1)$ characterizes the share of nontradables in the home economy and $\delta > 0$ is the elasticity of substitution between the goods produced in both sectors.

The domestic consumption of tradables at t consists of goods produced at home, $C_{H,t}$, and abroad, $C_{F,t}$:

$$C_{T,t} \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{4}$$

An analogous relationship holds for the foreign economy. Given this, α is an intuitive measure of degree of openness and $1-\alpha$ – home bias in consumption. $\eta > 0$ is the elasticity of substitution between home and foreign tradables.

The consumption of domestic tradable goods in the home economy ($C_{H,t}$) and in the foreign one ($C^*_{H,t}$) is defined as:

$$C_{H,t} \equiv \left[\left(\frac{1}{w}\right)^{\frac{1}{\varepsilon_T}} \int_0^1 \left(\int_0^w C^j_{H,t,k} dj \right)^{\frac{\varepsilon_T - 1}{\varepsilon_T}} dk \right]^{\frac{\varepsilon_T}{\varepsilon_T - 1}} \quad C^*_{H,t} \equiv \left[\left(\frac{1}{w}\right)^{\frac{1}{\varepsilon_T}} \int_0^1 \left(\int_0^w C^{j*}_{H,t,k} dj \right)^{\frac{\varepsilon_T - 1}{\varepsilon_T}} dk \right]^{\frac{\varepsilon_T}{\varepsilon_T - 1}} \tag{5}$$

The parameter $\varepsilon_T > 1$ measures the elasticity of substitution between various types of goods in international trade, k indexes the variety of goods, and j – the households (integral over j reflects the difference in both economies' size).

The nontradable consumption bundles, domestic ($C_{N,t}$) and foreign ($C_{N*,t}$), are characterized in a similar fashion as:

$$C_{N,t} \equiv \left[\left(\frac{1}{w}\right)^{\frac{1}{\varepsilon_N}} \int_0^1 \left(\int_0^w C^j_{N,t,k} dj \right)^{\frac{\varepsilon_N - 1}{\varepsilon_N}} dk \right]^{\frac{\varepsilon_N}{\varepsilon_N - 1}} \qquad C_{N*,t} \equiv \left[\left(\frac{1}{1-w}\right)^{\frac{1}{\varepsilon_{N*}}} \int_0^1 \left(\int_w^1 C^{j*}_{N*,t,k} dj \right)^{\frac{\varepsilon_{N*} - 1}{\varepsilon_{N*}}} dk \right]^{\frac{\varepsilon_{N*}}{\varepsilon_{N*} - 1}}$$

Consequently, ε^N and ε^{N*} is defined as elasticity of substitution between various types of nontradable goods.

Households maximize at t the discounted flow of future utilities:

$$E_t \sum_t^{\infty} \beta^t U(C_t, N_t, H_t) \to \max_{C,N} \tag{6}$$

where $\beta \in (0,1)$ is households' discount factor. Maximization of (6) is subject to a sequence of standard period budget constraints faced by a representative household. It leads to the standard first order conditions that define the demand for various types of goods as a declining function of their relative prices and the demand for the bundle to which this good belongs.

The standard condition of intertemporal optimality, i.e. equality between marginal loss in utility due to buying a security at t instead of allocating this money to consumption and the discounted payoff at $t+1$, also expressed in terms of marginal growth of future utility, lead to the following log-linearized dependence (Euler equation for consumption):

$$c_t = \frac{h}{1+h}c_{t-1} + \frac{1}{1+h}E_t c_{t+1} - \frac{1-h}{(1+h)\,\sigma}\left(i_t - E_t\pi_{t+1} - \rho\right) + \frac{1-h}{(1+h)\,\sigma}\left(\varepsilon_{d,t} - E_t\varepsilon_{d,t+1}\right) \tag{7}$$

where i_t denotes short-term nominal interest rate at t, $E_t\pi_{t+1}$ – expected domestic consumer price growth, $\rho = -ln\beta$ – natural interest rate corresponding to the households' discount factor β.

We apply a simplified version of a labour market rigidity mechanism described by Erzeg et al. (2000). It allows the marginal rate of substitution between consumption and leisure, mrs_t, to equal the real wage, $w_t - p_t$, but only in the long run. In the short run, we let nominal wages be sticky and behave according to the Calvo scheme. Only a fraction of households, $1-\theta^w \in (0;1)$, can renegotiate their wages in every period. This fraction remains constant and households allowed to reoptimize are selected at random. In particular, the probability of being allowed to renegotiate the wage does not depend on the amount of time elapsed since the last change. Other households partly index their their wages to past consumer inflation. Their fraction is represented by the parameter $\omega^w \in (0;1)$. Under monopolistic competition in the labour market, individual domestic and foreign households supply differentated types of labour services with the elasticity of substitution ε_w.

Solving households' optimization problem leads to the following (home) wage dynamics equation (an analogous solution holds for the foreign economy):

$$\pi_t^w = \beta E_t\pi_{t+1}^w + \frac{(1-\theta^w)\,(1-\beta\theta^w)}{\theta^w\,[1+\phi\varepsilon_w]}\left[mrs_t - (w_t - p_t)\right] - \omega^w\left(\beta\pi_t - \pi_{t-1}\right) \tag{8}$$

Household can smooth their consumption not only in time, but also in international financial markets. Under complete markets, equation (7) holds for both home and foreign economy. This allows to derive the following log-linearized relation between home and foreign consumption and the real exchange rate q_t (being a price ratio of the home and foreign consumption basket, seesee also Chari et al., 2002):

$$\frac{\sigma}{1-h}\left(c_t - hc_{t-1}\right) - \varepsilon_{d,t} = \frac{\sigma^*}{1-h^*}\left(c_t^* - h^*c_{t-1}^*\right) - \varepsilon_{d,t}^* - q_t \tag{9}$$

Define bilateral terms of trade between the home and foreign economy as:

$$S_t \equiv \frac{P_{H,t}}{P_{F,t}} \tag{10}$$

Also, define internal terms of trade as price ratio between tradables and nontradables:

$$X_t \equiv \frac{P_{T,t}}{P_{N,t}} \tag{11}$$

2.2 Producers

The producers of variety k in the tradable or nontradable bundle face a single-factor production function with constant returns to scale. Following Clarida et al. (1999), we assume away the price deviations of individual varieties within a sector as of second-order importance in the proximity of the steady state.

The real marginal cost (as log-deviation from the steady-state) is calculated as the difference between the wage level in a region (w_t) and the sectoral producer price log-level plus the log of marginal labour product (mpn), which can be expressed in both sectors as:

$$mc_t^H = (w_t - p_t) - \alpha s_t - \kappa x_t - \left(a_t^H + \varepsilon_t^H\right) \tag{12}$$

$$mc_t^N = (w_t - p_t) + (1-\kappa) x_t - \left(a_t^N + \varepsilon_t^N\right) \tag{13}$$

with supply shocks in both sectors denoted as ε_t^H and ε_t^N respectively. a_t^H and a_t^N are log labour productivities.

There are nominal price rigidities in the economy. Following the usual approach in the New Keynesian literature, we model them by means of the Calvo (1983) scheme. In a given period, a fraction θ of producers are not allowed to reoptimise their prices in reaction to economic innovations and must sell at the price from the previous period. The probability of being allowed to reoptimise the price is equal across producers: $1-\theta$ in each period, independently of the amount of time elapsed since the last price change.

Some of the producers (fraction ω of reoptimisers) allowed to change their price do not really reoptimize. Following Galí and Gertler (1999) we assume that the change in price is partly implemented as an indexation to past inflation. This mechanism leads to a hybrid Phillips curve. Inflation is modelled separately in the tradable and nontradable sector.

The abovementioned assumptions lead to the following hybrid Phillips curve in the H sector:

$$\begin{aligned} \pi_t^H = & \tfrac{\omega^H}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}\pi_{t-1}^H + \tfrac{\beta\theta^H}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}E_t\pi_{t+1}^H + \\ & + \tfrac{(1-\omega^H)(1-\theta^H)(1-\beta\theta^H)}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}mc_t^H \end{aligned} \tag{14}$$

and analogously for N.

2.3 Market clearing conditions

Equilibrium in the world markets of individual goods requires equality of overall production and consumption of every variety k in the basket of domestically produced tradables. This implies the following log-linearized relationships:

$$y_t^H = \tilde{w} c_t + (1-\tilde{w}) c_t^* - [\tilde{w}\alpha\eta + (1-\tilde{w})(1-\alpha^*)\eta^*] s_t - \tilde{w}\kappa\delta x_t - (1-\tilde{w})\kappa^*\delta^* x_t^* \tag{15}$$

$$y_t^{F*} \quad = \quad \tilde{w}^* c_t + (1-\tilde{w}^*)\, c_t^* + [\tilde{w}^*\,(1-\alpha)\,\eta + (1-\tilde{w}^*)\,\alpha^*\eta^*]\, s_t - \tilde{w}^*\kappa\delta x_t - (1-\tilde{w}^*)\,\kappa^*\delta^* x_t^* \tag{16}$$

whereby:

$$\tilde{w} = \frac{w\,(1-\alpha)\,(1-\kappa)}{w\,(1-\alpha)\,(1-\kappa) + (1-w)\,\alpha^*\,(1-\kappa^*)} \qquad \tilde{w}^* = \frac{w\alpha\,(1-\kappa)}{w\alpha\,(1-\kappa) + (1-w)\,(1-\alpha^*)\,(1-\kappa^*)} \tag{17}$$

Market clearing conditions for the nontradable sector can be written as:

$$y_t^N = (1-\kappa)\,\delta x_t + c_t \quad y_t^{N*} = (1-\kappa^*)\,\delta^* x_t^* + c_t^* \tag{18}$$

2.4 Policy frameworks

In this paper, we consider 2 policy frameworks:

(a) two countries form a **monetary union**;

(b) both regions represent **autonomous monetary regimes**.

To accommodate the latter case in the model, one needs to adjust the above setup it in three ways (cf. Torój, 2011):

- there are separate home and foreign interest rates in home and foreign Euler equations for consumption (7);
- terms of trade dynamics (10) is additionally affected by the nominal exchange rate dynamics;
- nominal exchange rate evolves according to a standard UIP equation, depending on the interest rate disparity and an UIP shock.

The central bank's monetary policy is described with a Taylor (1993) rule with smoothing. The common nominal interest rate is set according to the equation:

$$i_t = \rho + (1-\gamma_\rho)\,(\gamma_\pi \tilde{\pi}_t + \gamma_y \tilde{y}_t) + \gamma_\rho i_{t-1} + \varepsilon_t^i \tag{19}$$

where i_t – central bank policy rate at t, $\tilde{y}_t$ – the output gap, $\tilde{\pi}_t$ – inflation rate, $\gamma_\rho \in (0;1)$ – smoothing parameter, $\gamma_\pi > 1$, $\gamma_y > 0$ – parameters of central bank's response to deviations of inflation and output from the equilibrium levels. The condition $\gamma_\pi > 1$ is necessary to satisfy the Taylor principle (Taylor, 1993), leading to a unique equilibrium. In the case of two separate monetary regimes, $\tilde{y}_t$ and $\tilde{\pi}_t$ are simply the respective values for the foreign economy. For the monetary union, both variables aggregate the values for individual regions, according to their size:

Table 1: Calibrated parameters

Parameter \ Region	PL	SK	EA
size of the economy (w)	0.007	0.004	$1-w$
openness of domestic economy (α)	0.175	0.496	–
openness of EA economy vs... (α^*)	0.023	0.009	–
share of NT sector (κ)	0.702	0.615	0.76
households' impatience (β)	0.9851	0.9909	0.9959

Source: author.

$$\begin{aligned} \tilde{\pi}_t &= w\pi_t + (1-w)\,\pi_t^* \\ \tilde{y}_t &= wy_t + (1-w)\,y_t^* \end{aligned} \tag{20}$$

Consequently, if the home economy is small, "foreign" and "unionwide" monetary policy is conducted in almost the same way.

3 Model estimation

The parameters of the model are partly calibrated and partly estimated with Bayesian methods. The estimation is performed 2 country pairs, in which the home economy represents PL or SK and the foreign economy – the EA (as a whole) consisting of 12 states that have belonged there since 1999-2001.

Country weight, as well as α, β and κ, were calibrated (see Table 1) in a standard way (see Torój, 2010, 2011). We set α (α^*) as a corresponding measure of economies' openness, i.e. the share of imports (exports) in a country's (the euro area) GDP. κ was calibrated to reflect the share of NACE branches F-P in the value added of every economy in question, in accordance with the construction of proxy variables. The calibration of β was implied by *ex post* real interest rates, calculated using the consumption deflator and averaged over the sample period. Also, the unidentified parameter ϕ^W is calibrated at 3.0 in line with Smets and Wouters (2003).

It should be emphasized that SK is characterised by a smaller size of economy, much higher openness and lower share of the nontradable sector. This all determines higher vulnerability to external demand and exchange rate fluctuations (cf. equation (15)).

The rest of the parameters were estimated with Bayesian methods (see Tables 2-4). The choice of prior probability functions was based i.a. on the work by Kolasa (2009). The parameters interpretable as shares ranging between 0 and 1 are distributed as beta, elasticities (and others ranging from zero upwards) as gamma, standard errors – as inverse gamma, while correlations – as uniform between -0.99 and 0.99. Parametrisation of the priors roughly corresponds with the full information maximum likelihood estimates obtained by Torój (2011). The same prior distributions were assigned to analogous parameters for PL, SK and the EA.

The following observable time series are used in the estimation:

- y^T – real value added in sectors A-E (NACE), i.e. agriculture and industry; percentage deviations from Christiano-Fitzgerald filter for nonstationary series;
- y^{NT} – real value added in sectors F-P (NACE), i.e. construction and services; percentage deviations from Christiano-Fitzgerald filter for nonstationary series;
- c – real consumption; percentage deviations from Christiano-Fitzgerald filter for nonstationary series;
- π^T – dynamics (q/q) of real value added in sectors A-E (NACE);
- π^{NT} – dynamics (q/q) of real value added in sectors F-P (NACE);
- i – 3-month money market interest rates (detrended for PL and SK). In the case of Poland, the interest rate series were detrended using the National Bank of Poland's data on inflation target. This data is not continuous in quarterly terms, and it was smoothed using the Hodrick-Prescott filter. No such data was available for Slovakia, as there was no explicit inflation targeting strategy until early 2005 (Slovenska, 2004). Instead, the main monetary policy objective was defined as a low inflation rate that would allow the fulfilment of the Maastricht criterion. This is why the Slovak disinflation was interpreted as an element of euro adoption strategy. In consequence, the nominal interest rate on the Slovak money market was disentangled into an element due to convergence to the euro area and an the residual component of regular monetary policy and policy shocks. Using the values of $\hat{\triangle i_t}$ from the equation of Slovak interest rate convergence to the euro area, $\triangle i_t = \rho^{\hat{SK}} (i_t - i_t^*) + \hat{\triangle i_t}$ ($\rho^{\hat{SK}} = -0.031$ with a standard error 0.02) and the terminal value of i_{2009Q1}, the detrended "net of convergence" component of the nominal interest rate was constructed. For details, see Torój (2011);
- Δw – dynamics of wages and salaries in the entire economy;
- Δe – log-increments of PLN/EUR and PLN/SKK (growth means appreciation).

The source of the data is Eurostat. The estimation sample ranges from 1995q1 to 2011q2 (EA-PL) and 2010q4 (EA-SK). Both parameter sets are estimated from the sample covering a period when the two economies did not (or mostly did not) belong to the EA. Therefore the estimated parameters can be applied directly, while changing the model structure to the EA or non-EA framework.

Macroeconomic time series (y^T, y^{NT}, c, π^T, π^{NT}, Δw) are allowed to exhibit measurement errors. Their prior standard deviation was not strongly restricted, i.e. as it was set to be distributed rather non-informatively as inverse gamma with infinite variance.

Among the parameters that mainly account for the output sensitivity to the exchange rate fluctuations and macroeconomic adjustment dynamics (see Figures 1-2), some do not differ meaningfully between PL and SK (e.g. habit persistence h, intertemporal elasticity of substitution σ, domestic elasticity of H/F substitution η and – to an extent – elasticity of T/NT substitution δ, as well as nominal rigidity of the tradable sector θ^T).

Table 2: Estimated parameters (1)

parameter	prior	prior mean	prior SD	region	posterior mean	posterior 95% CI	
η	gamma	1	0.4	PL	0.98	0.94	1.01
				EA vs PL	0.68	0.61	0.77
				SK	0.88	0.80	0.93
				EA vs SK	1.00	0.95	1.04
δ	gamma	1	0.4	PL	0.63	0.59	0.68
				SK	0.76	0.70	0.82
				EA vs PL	0.55	0.52	0.57
				EA vs SK	1.53	1.44	1.60
ϕ	gamma	2	0.5	PL	1.92	1.89	1.97
				SK	2.36	2.28	2.43
				EA vs PL	1.96	1.91	2.00
				EA vs SK	2.09	1.99	2.19
σ	gamma	1.5	0.4	PL	1.63	1.60	1.67
				SK	1.82	1.74	1.89
				EA vs PL	1.68	1.64	1.73
				EA vs SK	2.01	1.94	2.10
θ^T	beta	0.5	0.2	PL	0.58	0.56	0.59
				SK	0.67	0.64	0.70
				EA vs PL	0.78	0.77	0.80
				EA vs SK	0.64	0.58	0.68
θ^N	beta	0.5	0.2	PL	0.45	0.44	0.47
				SK	0.48	0.46	0.50
				EA vs PL	0.78	0.77	0.81
				EA vs SK	0.38	0.35	0.41
θ^W	beta	0.5	0.2	PL	0.37	0.36	0.39
				SK	0.59	0.56	0.63
				EA vs PL	0.58	0.57	0.60
				EA vs SK	0.59	0.56	0.62
ω^T	beta	0.5	0.2	PL	0.70	0.69	0.72
				SK	0.25	0.19	0.29
				EA vs PL	0.62	0.59	0.65
				EA vs SK	0.52	0.48	0.55
ω^N	beta	0.5	0.2	PL	0.45	0.43	0.47
				SK	0.20	0.17	0.23
				EA vs PL	0.23	0.20	0.26
				EA vs SK	0.83	0.81	0.85
ω^W	beta	0.5	0.2	PL	0.28	0.26	0.29
				SK	0.48	0.45	0.50
				EA vs PL	0.48	0.46	0.50
				EA vs SK	0.51	0.46	0.54
h	beta	0.7	0.1	PL	0.69	0.68	0.70
				SK	0.69	0.67	0.71
				EA vs PL	0.83	0.81	0.84
				EA vs SK	0.62	0.60	0.63

Source: author.

Table 3: Estimated parameters (2)

parameter	prior	prior mean	prior SD	region	posterior mean	posterior 95% CI	
γ_π	gamma	2	0.4	PL	2.21	2.17	2.25
				SK	1.89	1.83	1.95
				EA vs PL	2.06	2.04	2.09
				EA vs SK	1.78	1.74	1.82
γ_y	gamma	0.7	0.2	PL	0.78	0.77	0.80
				SK	0.76	0.73	0.78
				EA vs PL	0.51	0.49	0.53
				EA vs SK	0.68	0.65	0.70
γ_φ	beta	0.7	0.1	PL	0.62	0.61	0.63
				SK	0.78	0.76	0.80
				EA vs PL	0.73	0.72	0.74
				EA vs SK	0.77	0.75	0.78
ρ^D	uniform	0	0.5716	PL	0.05	0.03	0.06
				SK	0.27	0.19	0.32
ρ^T	uniform	0	0.5716	PL	-0.15	-0.21	-0.10
				SK	-0.03	-0.11	0.07
ρ^N	uniform	0	0.5716	PL	0.47	0.42	0.52
				SK	-0.09	-0.21	0.02
ρ^W	uniform	0	0.5716	PL	-0.11	-0.23	-0.02
				SK	0.18	0.07	0.26
ρ^I	uniform	0	0.5716	PL	0.00	-0.01	0.01
				SK	0.18	0.10	0.25
φ^D	beta	0.7	0.15	PL	0.72	0.71	0.74
				SK	0.81	0.79	0.82
				EA vs PL	0.77	0.75	0.78
				EA vs SK	0.82	0.80	0.85
φ^T	beta	0.7	0.15	PL	0.64	0.63	0.66
				SK	0.70	0.67	0.72
				EA vs PL	0.76	0.75	0.79
				EA vs SK	0.60	0.59	0.62
φ^N	beta	0.7	0.15	PL	0.57	0.56	0.58
				SK	0.47	0.44	0.51
				EA vs PL	0.58	0.56	0.59
				EA vs SK	0.66	0.64	0.68
φ^W	beta	0.7	0.15	PL	0.95	0.94	0.96
				SK	0.91	0.89	0.93
				EA vs PL	0.76	0.75	0.76
				EA vs SK	0.66	0.64	0.67
φ^I	beta	0.7	0.15	PL	0.42	0.40	0.44
				SK	0.63	0.61	0.65
				EA vs PL	0.68	0.67	0.70
				EA vs SK	0.70	0.68	0.72
φ^E	beta	0.7	0.15	PL	0.24	0.24	0.24
				SK	0.56	0.56	0.57

Source: author.

Table 4: Estimated parameters (3)

parameter	prior	prior mean	prior SD	region	posterior mean	posterior 95% CI	
σ^D	inv. gamma	4	Inf	PL	1.34	1.06	1.64
				SK	4.76	4.50	5.02
				EA vs PL	6.22	5.89	6.49
				EA vs SK	2.72	2.07	3.23
σ^T	inv. gamma	4	Inf	PL	3.62	3.17	4.14
				SK	1.50	1.14	1.90
				EA vs PL	4.27	4.10	4.48
				EA vs SK	4.17	3.75	4.67
σ^N	inv. gamma	3	Inf	PL	3.67	3.45	3.92
				SK	2.30	1.88	2.71
				EA vs PL	4.74	4.11	5.20
				EA vs SK	1.17	0.84	1.51
σ^W	inv. gamma	6	Inf	PL	6.08	5.70	6.61
				SK	6.08	5.64	6.55
				EA vs PL	4.31	3.87	4.81
				EA vs SK	6.24	5.76	6.78
σ^I	inv. gamma	0.2	Inf	PL	0.17	0.06	0.29
				SK	0.23	0.06	0.47
				EA vs PL	1.49	1.27	1.78
				EA vs SK	0.13	0.05	0.22
σ^E	inv. gamma	0.01	Inf	PL	0.01	0.00	0.01
				SK	0.01	0.00	0.01
ME c	inv. gamma	0.1	Inf	PL	0.31	0.11	0.50
				SK	0.34	0.19	0.46
	inv. gamma	0.1	Inf	EA vs PL	0.16	0.12	0.20
				EA vs SK	0.10	0.06	0.14
ME Δw	inv. gamma	0.1	Inf	PL	6.55	6.34	6.76
				SK	2.21	1.97	2.53
				EA vs PL	0.18	0.13	0.23
				EA vs SK	0.06	0.04	0.09
ME π^T	inv. gamma	0.1	Inf	PL	5.11	4.86	5.29
				SK	4.07	3.74	4.44
				EA vs PL	0.54	0.44	0.63
				EA vs SK	0.63	0.52	0.71
ME π^N	inv. gamma	0.1	Inf	PL	5.42	5.06	5.87
				SK	3.65	3.33	3.98
				EA vs PL	0.23	0.19	0.27
				EA vs SK	0.21	0.20	0.23
ME y^T	inv. gamma	0.1	Inf	PL	4.43	4.03	4.86
				SK	5.72	5.13	6.34
				EA vs PL	5.14	4.78	5.39
				EA vs SK	4.27	3.87	4.62
ME y^N	inv. gamma	0.1	Inf	PL	3.14	2.93	3.40
				SK	1.75	1.51	1.97
				EA vs PL	0.41	0.32	0.51
				EA vs SK	0.15	0.11	0.19

Source: author.

Higher Slovak sensitivity to appreciations and depreciations – apart from the calibrated values – results from a higher foreign elasticity of H/F substitution (η^*). It amounts – as measured by posterior mean – to only 0.68 in PL (with 95% confidence interval from 0.61 to 0.77) and 1.00 in SK (confidence interval from 0.95 to 1.04). One should also emphasise the higher rigidity of the Slovak labour market (θ^W, 0.59 in SK and 0.37 in PL with narrow confidence intervals) and the higher persistence of inflation in the tradable sector in PL (ω^T, 0.70 in PL and 0.25 in SK, with relatively high precision as well).

4 Switching roles: the counterfactual exercise

With the DSGE model developed and estimated in Sections 2-(3) in hand, we attempt to simulate two hypothetical scenarios:

- output in PL in 2008-2011, provided that it was a member of the EA at that time (and compare with the actual performance outside the EA);
- output in SK in 2008-2011, provided that it remained outside the EA at that time (and compare with the actual performance inside the EA).

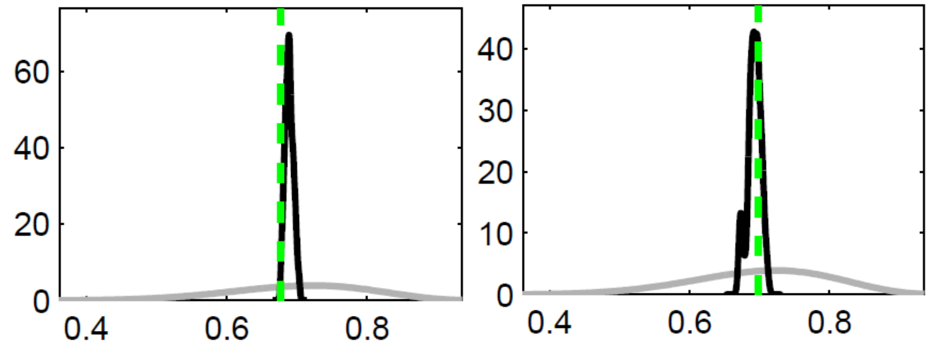
In the counterfactual analysis, we assume that both PL and SK faced the same set of real shocks as in the actual case during the crisis, i.e. demand, T supply, NT supply and labour supply shocks. In this way, we leave aside any considerations of the fact that the euro adoption in SK has caused *per se* some real shocks (or that the euro adoption in PL might have caused ones). Acknowledging the fact that (at least) some parameters of simple DSGE models may not be fully resistant to the Lucas critique, we could also expect some changes in structural parameters. For example, the euro adoption could increase the openness of the economy or enforce reforms that improve economic flexibility. However, in this work, we use the same parameter set in both the factual and counterfactual scenario, which – in our view – can be justified in the short term.

The counterfactual simulation in PL requires no additional assumptions. The volatility of the nominal interest rate (UIP) shocks is set to 0 and – since there is no autonomous monetary policy – the interest rate is directly provided by the ECB (also taking into account the developments in PL, but to a very limited extent).

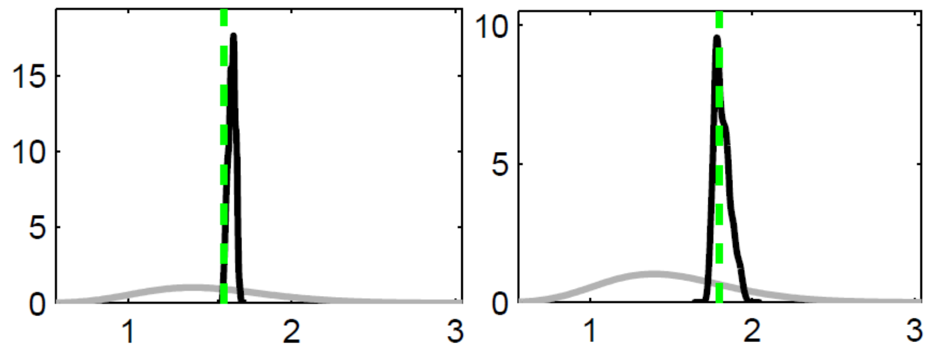
The simulation of the Slovak economy outside the EA is more challenging. We must "switch on" both nominal shocks, i.e. interest rate (to be plugged into the re-activated Taylor rule for SK) and UIP shocks. The values are unknown and we assume here the same series of shocks as empirically identified for PL. The motivation is twofold. Firstly, we treat SK as an emerging market similar to PL and assume that investors in the FX market would have behaved in the same way. Secondly, this ensures highest possible comparability of the counterfactual scenario in Solvakia with the empirical values for PL, i.e. the two "no-euro" simulations. We must emphasize that it is the UIP series of shocks that matters far more in this case than the interest rate shocks (that seem to be purely technical for the model mechanics and have very low volatility).

Figure 1: Priors and posteriors (1)

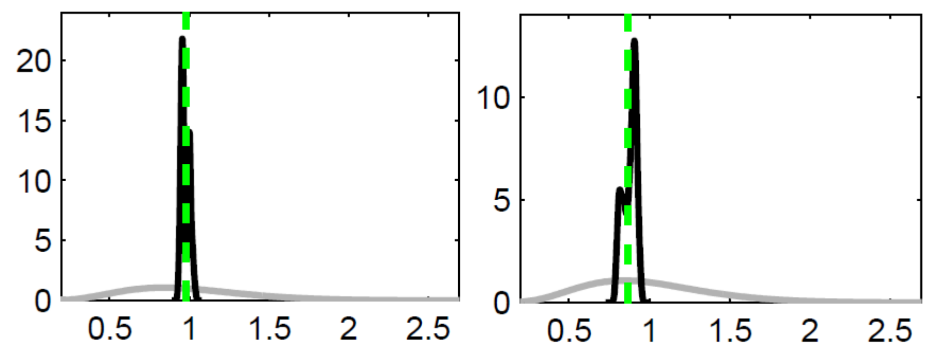
(a) h (PL, SK)



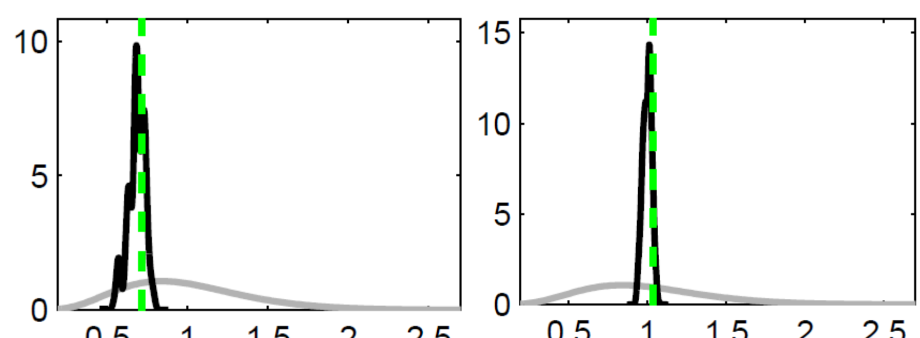
(b) σ (PL, SK)



(c) η (PL, SK)



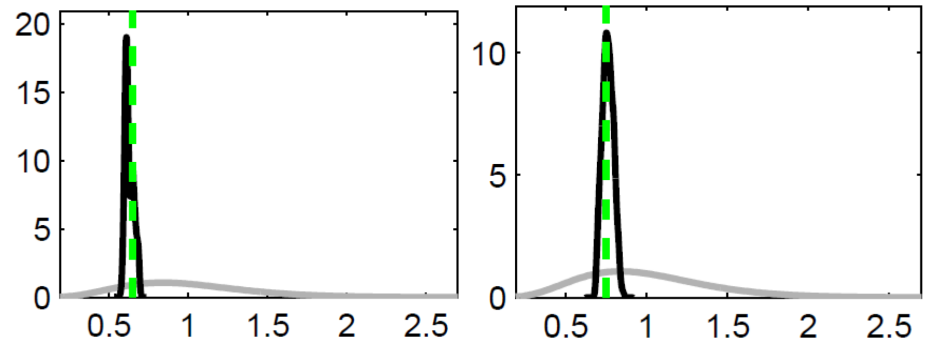
(d) $\eta*$ (PL, SK)



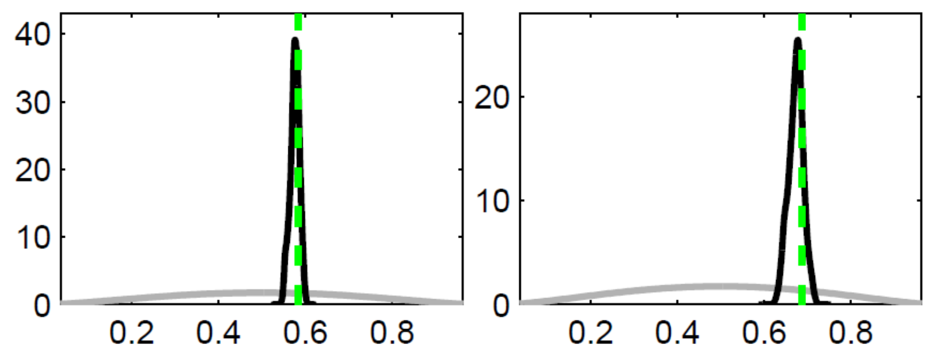
Source: author.

Figure 2: Priors and posteriors (2)

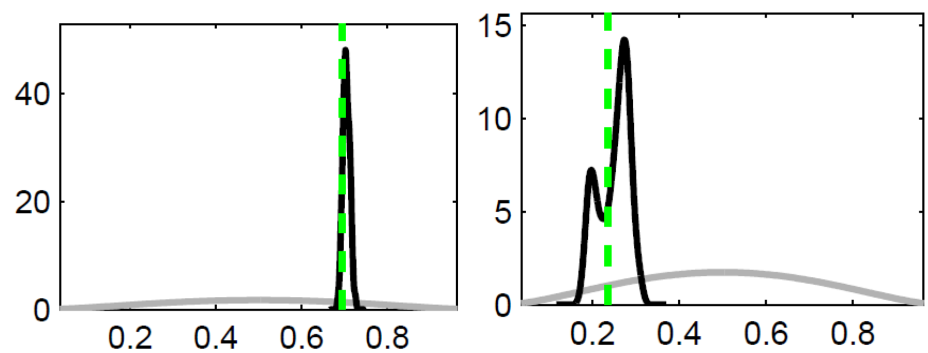
(a) δ (PL, SK)



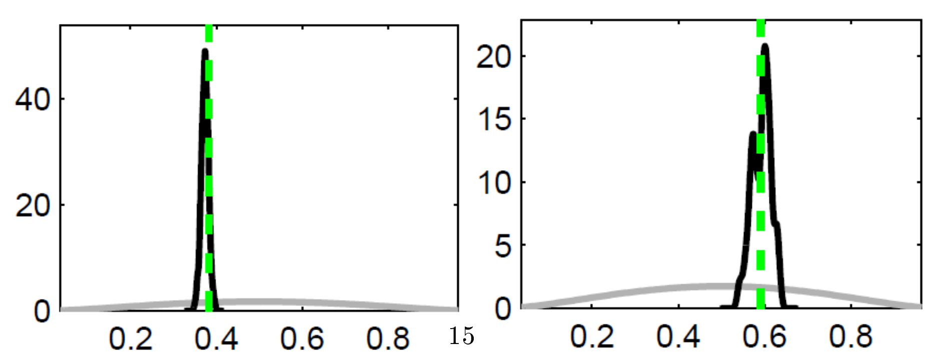
(b) θ^T (PL, SK)



(c) ω^T (PL, SK)

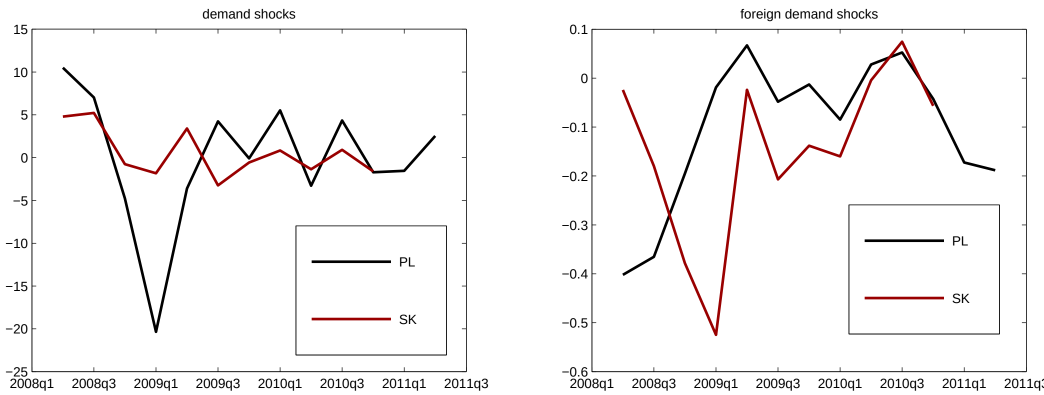


(d) θ^W (PL, SK)



Source: author.

Figure 3: Identified series of demand shocks in PL and SK



Source: author.

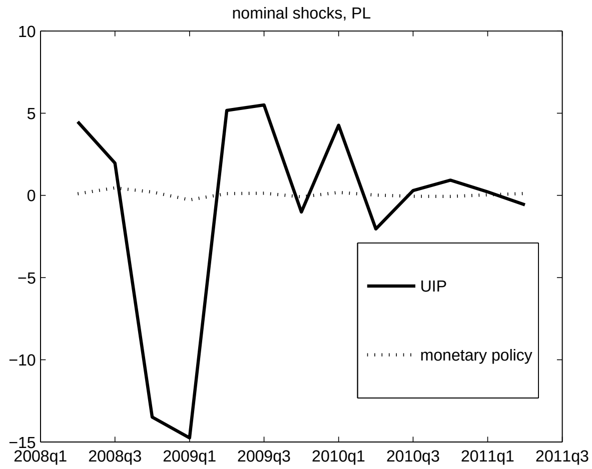
As regards the paths of real shocks, the key source of the variables' volatility over the period in question seems to be the demand shock in the foreign (i.e. EA) economy (see Figure 3). While PL faced the strongest external demand drop in late 2008, it was the first quarter of 2009 in SK that brought about the most accentuated negative foreign demand shock. Theoretically, this is a euro-area series and should not depend on the country pair, but this dependency on the "lense" through which we analyse the EA stems from country-specific differences between PL and SK, model simplicity and short samples. In PL, in turn, much of the 2009q1 shock can be attributed to a domestic demand slowdown, not experienced by SK in the same period.

The path of UIP shocks identified for PL over the period 2008-2011 contains two strong, consecutive depreciation shocks in 2008q4 and 2009q1 (see Figure 4). As these shocks are – empirically – the main explanation of the short-term nominal PLN/EUR volatility, this finding is in line with the heavy depreciation that the Polish zloty faced during that periods. Also note low volatility of monetary policy shocks, suggesting that monetary policy actions were highly predictable with the Taylor rule.

The above-mentioned shocks, along with the supply shocks identified in the sample, served as an input for the simulations. These simulations generally confirm that PL would have faced a higher drop in output (and SK would have avoided it) if it had been PL, not SK, that had adopted the euro at the start of the economic crisis. These key findings of this paper are contained in Figure 5 and Table 5.

If we assume the measurement errors away (upper panels), we can see that the tradable output in PL would have been 10-15% lower under the euro in early 2009, while the Slovak tradable output would have been by approximately 20% higher (see Subfigure 5a). This is due to the fact that SK is more sensitive to external demand developments, as a smaller, more open economy with higher estimated external substitution elasticity. This finding confirms the widespread opinion that massive depreciation in 2008-2009 helped the Polish export sector face the external (and internal) demand slowdown as compared to the hypothetical case of EA-membership. On top of that, it suggests that demonstrating SK as an opposite case is justified – on the qualitative level and as a rough approximation. However,

Figure 4: Identified series of nominal shocks

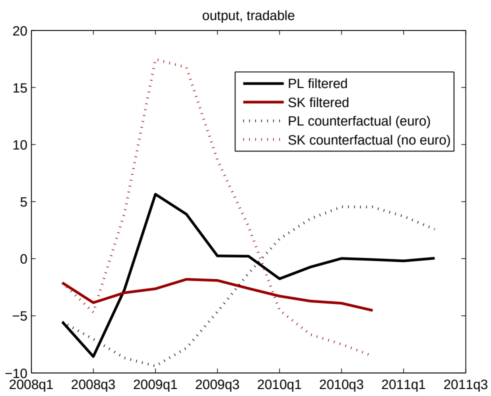


Source: author.

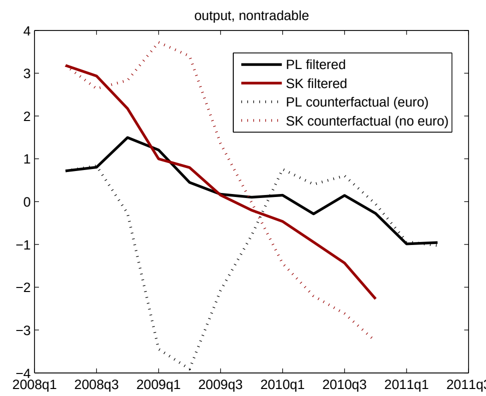
this opposition is not justified qualitatively, as – due to structural differences – the loss in the Slovak tradable output was heavier than it would have been for PL.

Figure 5: Output in PL and SK – empirical and counterfactual values

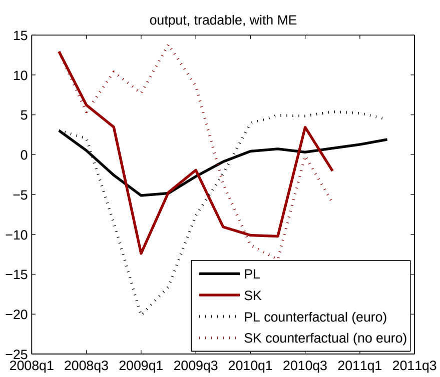
(a) tradable output, without ME



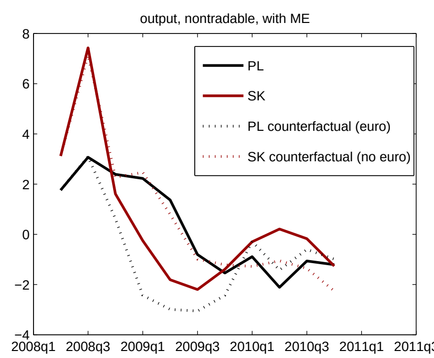
(b) Nontradable output, without ME



(c) tradable output, with ME



(d) nontradable output, with ME



Source: author.

Table 5: Output in PL and SK – empirical and counterfactual values

Sector	Tradable output								Nontradable output							
Country	PL				SK				PL				SK			
Measurement errors	no ME		with ME		no ME		with ME		no ME		with ME		no ME		with ME	
Regime	€	no €	€	no €	€	no €	€	no €	€	no €	€	no €	€	no €	€	no €
2008q2	-5,5	-5,5	3,0	**3,0**	-2,1	-2,1	**12,9**	12,9	0,7	0,7	1,8	**1,8**	3,2	3,2	**3,1**	3,1
2008q3	-7,0	-8,6	2,1	**0,5**	-3,9	-4,7	**6,2**	5,4	0,8	0,8	3,1	**3,1**	2,9	2,6	**7,4**	7,1
2008q4	-8,7	-2,7	-8,5	**-2,6**	-3,0	3,9	**3,5**	10,4	-0,3	1,5	0,6	**2,4**	2,2	2,8	**1,6**	2,3
2009q1	-9,4	5,6	-20,2	**-5,1**	-2,6	17,5	**-12,4**	7,7	-3,4	1,2	-2,4	**2,2**	1,0	3,7	**-0,3**	2,5
2009q2	-7,8	3,9	-16,6	**-4,8**	-1,8	16,8	**-4,7**	13,8	-3,9	0,4	-3,0	**1,4**	0,8	3,4	**-1,8**	0,8
2009q3	-4,6	0,2	-7,6	**-2,7**	-1,9	8,6	**-1,9**	8,6	-2,1	0,2	-3,1	**-0,8**	0,2	1,4	**-2,2**	-1,0
2009q4	-1,3	0,2	-2,4	**-0,9**	-2,6	2,8	**-9,1**	-3,6	-0,8	0,1	-2,4	**-1,5**	-0,2	0,0	**-1,4**	-1,2
2010q1	1,7	-1,8	3,9	**0,4**	-3,3	-4,5	**-10,1**	-11,3	0,8	0,1	-0,3	**-0,9**	-0,5	-1,4	**-0,3**	-1,3
2010q2	3,5	-0,7	4,9	**0,7**	-3,7	-6,6	**-10,2**	-13,2	0,4	-0,3	-1,4	**-2,1**	-0,9	-2,2	**0,2**	-1,1
2010q3	4,5	0,0	4,8	**0,3**	-3,9	-7,5	**3,4**	-0,2	0,6	0,1	-0,6	**-1,1**	-1,4	-2,6	**-0,2**	-1,4
2010q4	4,5	-0,1	5,4	**0,8**	-4,5	-8,5	**-2,0**	-6,0	-0,1	-0,3	-1,0	**-1,2**	-2,3	-3,3	**-1,3**	-2,3

Numbers in bold are CF-filtered, empirical values of respective real value added series, expressed in percentage deviations from the filter.
Source: author.

Interestingly, not only would the tradable sector have been affected by the regime change. Also the nontradable output would have shrunk in PL under the euro and would have expanded in SK under autonomous monetary policy and nominal depreciation (see Subfigure 5b). The recession in the tradable sector in PL (as compared to the case without the euro) would have spilled over into the nontradable sector in the short term. In this case, the difference would have been lower than for the tradable sector (approximately -4 p.p. in PL and +3 p.p. in SK). Note that, this time, the size of this effect in PL outsizes the Slovak impact in absolute terms. As an explanation, one needs to stress that the Polish nontradable sector more closely follows country-specific consumption as the economy is more closed, and hence the nontradable sector reacts possibly more procyclically.

It is noteworthy that the above-mentioned effects exhibit rather short-run nature. The difference between the factual and counterfactual scenario vanishes in early 2010. Moreover, in late 2010, the recovery dynamics is higher in both euro-based scenarios, i.e. the factual scenario in SK and the counterfactual one in PL. This can be attributed to the lack of positive UIP shocks inducing appreciation, as well as to more procyclical economic dynamics in the monetary union framework.

Last but not least, the factual variable paths in Subfigures 5a-5b do not replicate the observed series of output data. This directly results from the statistical structure of the model, as we allowed for measurement errors in all macroeconomic variables. The use of measurement errors is common and well justified in empirical DSGE analyses. In this model, additionally, we cannot force their variance down to zero as this would render the model estimation impossible (the number of structural shocks themselves would be lower than of observable variables). In this context, it is of crucial importance what portion of observable variables' variance is pushed into measurement errors.

Unfortunately, in our case, measurement errors account for a non-negligible proportion of CF-filtered output in both sectors. This may be due to e.g. the oversimplified specification of the model (no confidence effects, financial markets, investment or government), residual skewness during the crisis (extreme negative values) or nonlinear effects that are absent from the model in the log-linearised version. One possible solution would be to impose a strongly informative prior distribution on the variance of the measurement errors, i.e. reduce the prior standard deviation of this parameter (which was infinite). This, however, could be seen as a numerical trick rather than fully fledged solution to the problem. As a result, we prefer to discuss the reservations and leave this question for future research.

Adding the measurement errors to the filtered variables in the factual scenario allows to replicate the empirical variables. In the counterfactual scenarios, one can also add the same identified measurement errors to the generated paths of filtered variables (Subfigures 5c-5d) and arguably treat them as the impact of other factors, not included in the model, that would remain unchanged between the factual and counterfactual case. This assumption can be treated as valid insofar as all the relevant factors, i.e. monetary policy regime change and nominal exchange rate volatility are explicitly included in the model, up to linear relationships. This does not affect the previous conclusions, but – to some extent – modifies the paths of both variables in question, as well in PL as in SK.

5 Conclusions

It is commonly argued that Poland avoided a massive drop in output during the 2008/2009 economic crisis in part thanks to substantial nominal depreciation against the euro. The Polish case is often contrasted with Slovakia that adopted the euro in January 2009 and, since the Ecofin Council decision in summer 2008, exhibited virtually no nominal exchange rate volatility while facing deep losses in output. In this paper we attempt to validate this contrast by reversing the roles, i.e. checking if Poland really would have faced the same drop – and Slovakia the same boost – if it had been Poland, not Slovakia, that adopted the euro at that point.

To this aim, we develop, estimate and then simulate a New Keynesian DSGE model of 2-region, 2-sector economy. It incorporates shifts in international competitiveness, nominal rigidities in the product and labour market, as well as 2 possible policy regimes: monetary union (with a single nominal interest rate and without nominal exchange rate fluctuations) and autonomous monetary policies (with region-specific nominal interest rates aawarend nominal exchange rate fluctuations). We calibrate and estimate the model in 2 region pairs: Poland-euro area and Slovakia-euro area. For the estimation, we use Bayesian techniques.

Using the model, we identified a strong negative foreign demand shock as the main source of the real developments in the Slovak economy in late 2008 and early 2009. In Poland, the same shock coincided with a moderate negative internal demand shock and, above all, strong shock inducing nominal exchange rate depreciation. In our counterfactual exercise, we run both economies – Poland and Slovakia – using the same path of real shocks, but under "switched" policy regimes. Moreover, we assume that Slovakia would have faced the same path of UIP shocks as Poland did at that time.

In our simulations we find that, indeed, Polish tradable output could have been 10-15 percent lower than actually observed, while the Slovak one – approximately 20 percent higher. This asymmetry results mainly from the structural differences between the two economies that result in higher exposure of the Slovak economy to both external demand and exchange rate developments, such as: size, openness, share of nontradable sector and foreign trade elasticities. The difference of this size would have been short-lived (3-4 quarters), and the difference of the nontradable output would have been of much lower magnitude.

This result should be interpreted with prudence, mainly due to high simplicity of the model, i.e. the absence of explicitly modelled financial markets and the credit crunch. This might be one of the reasons for relatively high variance of measurement errors in output. They could also result from skewness of the shocks and nonlinear effects in the untypical, crisis period. One should also be aware of the fact that the euro adoption itself could have caused some real shocks in Slovakia (and – hypothetically – could have some short-term impact in Poland), and hence the assumption of maintaining the same path of domestic real shocks in both economies in the counterfactual scenario might be partly inappropriate. A similar reservation might be associated with the parameter values that the euro adoption might affect in the long term.

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