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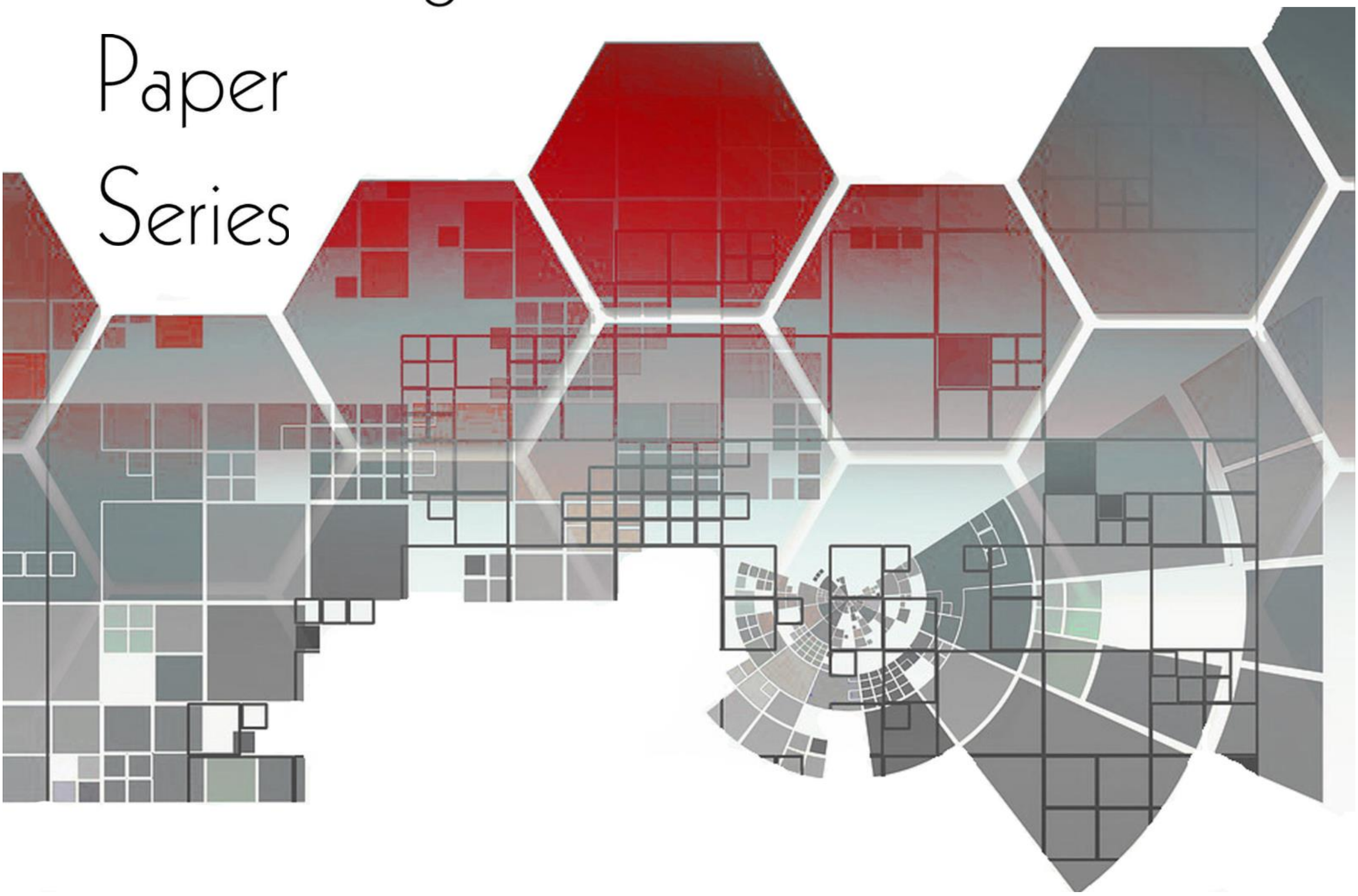

Andrzej Torój

Macroeconomic Imbalance Procedure in the EU: a Welfare Evaluation

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Andrzej Torój*

Abstract

We develop a framework for assessing the welfare implications of the new European Union's (EU) Macroeconomic Imbalance Procedure (MIP) implemented in 2012, with a special focus on the current account (CA) constraint, real effective exchange rate (REER) constraint and nominal unit labour cost (ULC) constraint. For this purpose, we apply a New Keynesian 2-region, 2-sector DSGE model, using the second order Taylor approximation of the households' utility around the steady state as a measure of welfare. The compliance with the CA criterion is ensured by modifying the policymakers' loss function in line with Woodford's (2003) treatment of the zero lower bound of nominal interest rates. The introduction of MIP threshold on CA balance results in a welfare loss equivalent to steady-state decrease in consumption of 0.0274% after the euro adoption or 0.0152% before that. If we consider the 4% threshold on current plus capital account (rather than current account alone), this cost decreases to equivalent to 0.0117% steady-state consumption under the euro and approximately a half of that without the euro. The welfare cost for the converging economies is higher due to persistent, but equilibrium-consistent CA deficits, as well as REER appreciation. MIP can also be seen as a factor augmenting the cost of euro adoption.

JEL Classification: C54, D60, E42, F32.

Keywords: Macroeconomic Imbalance Procedure, EMU, DSGE, welfare, constrained optimum policy.

1 Introduction

One of the underlying reasons for the escalation of the euro area crisis was the extent to which internal and external imbalances have built up since the euro area creation. After this experience, the European Union faced critique for concentrating on fiscal imbalances (operationalised in *Excessive Deficit Procedure* in late 1990s) and ignoring macroeconomic imbalances. The EU's response to this critique was first proposed in September 2010 by the European Commission and entered into force in late 2011 in the form of *Macroeconomic Imbalance Procedure* (EIP, European Parliament and Council Of The European Union, 23.11.2011b,1).

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The application of MIP comprises several stages and originates from the analysis of a scoreboard of macroeconomic indicators with their respective thresholds that should not be exceeded. Although the European Commission emphasises that the reading of the scoreboard would not run mechanically and the essential role in the assessment of a country's imbalances would be played by an in-depth economic analyses, the significance of the scoreboard is twofold. Firstly, its reading takes place before the in-depth analysis and hence may impact on the market's perceptions and expectations. Secondly, and even more importantly, the scoreboard is a non-discretionary component of the procedure (as opposed to in-depth analysis) and the ongoing euro-crisis seems to already have shown that discretion in such procedures should be minimised.

From this point of view, one could expect that the MIP scoreboard should be prepared carefully and have solid analytical underpinnings. These are, as yet, largely missing and this paper aims to contribute to filling this gap. In particular, we concentrate here on the thresholds for the current account balance set at -4% and +6% of GDP. We treat them as a constraint imposed on the macroeconomic policy and calculate the welfare consequences of this constraint, as well as the modifications in policies necessary to attain the new requirement. Understandably, there are substantial differences between states that do and do not belong to the euro area in terms of feasible policy instruments and we treat the two cases separately, asking also for the difference in welfare cost of MIP for EA and non-EA countries (or, inversely, whether it is more costly to adopt the euro with or without MIP). It should perhaps be mentioned that we focus here on the cost side of MIP, while acknowledging the benefits from the tools that keep track of macroeconomic stability in the EU in general.

We also focus on the -4% threshold (rather than +6% of GDP) as it seems to be binding for a number of converging economies. The intertemporal approach to the current account determination treats deficits as equilibrium phenomena in such economies, but the scoreboard treats all EU Member States homogeneously in this respect. This may imply running into another "one-size-fits-all" problem in Europe and this is why we reconsider here the choice of indicator against a possible alternative: current account plus capital account. This would not affect the big, advanced, surplus economies but could significantly relax the constraint for small, catching-up economies in a fundamentally justified way.

Our welfare analysis is rooted in the strand of literature originated by the seminal contribution of Lucas (1987) on the welfare cost of the business cycle. In the context of the European integration, a similar approach has been adopted i.a. by Gradzewicz and Makarski (2013) to evaluate the welfare consequences of the euro adoption in Poland due to abandoning the autonomous monetary policy and the resulting increase in business cycle's amplitude. As the MIP thresholds imply explicit numerical constraints on macroeconomic variables, we apply here the methodology of Woodford (2003, ch. 6) developed for the treatment of the optimum monetary problem under the problem of zero lower bound for the interest rates. Lipińska (2014) applied Woodford's framework to evaluate the welfare cost of compliance with monetary Maastricht criteria in the Czech and Polish economy.

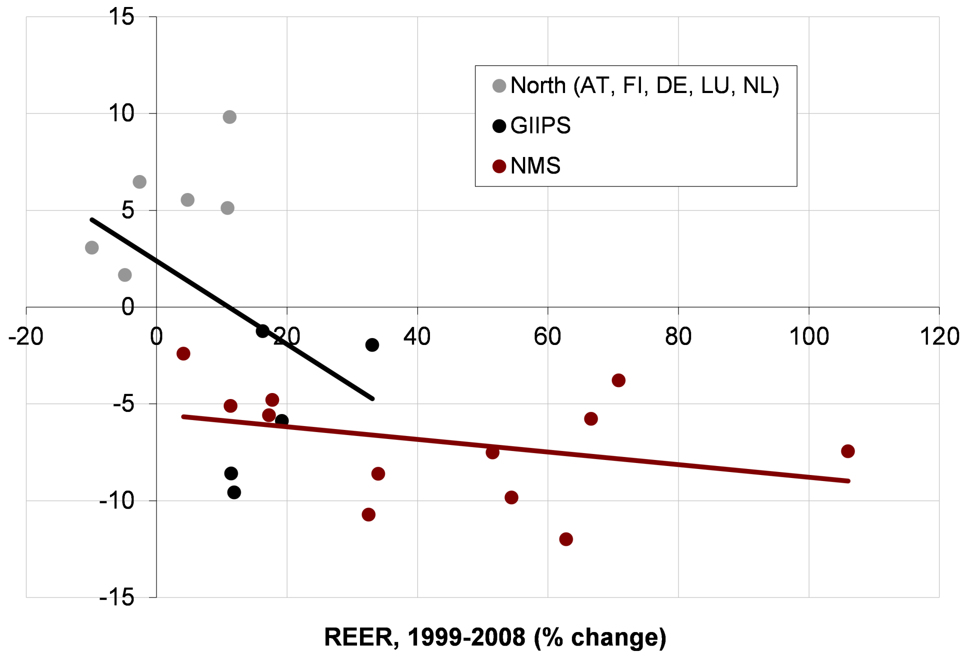
The rest of the paper is organised as follows. Section 2 summarises the stylised facts about external imbalances in the European Union and the problems that the MIP attempts to tackle. Section 3 presents the New Keynesian DSGE model that serves the purpose of our welfare evaluation. Section 4 demonstrates how we apply Woodford's framework to implement the MIP-related CA constraint into the model and analyses the resulting welfare loss and compares how the fiscal (and possibly monetary) policy responses differ when MIP-compliant policies are taken into account. Section 5 expands the previous analysis to REER and ULC indicators. Section 6 concludes.

2 External imbalances in the EU and the euro area: stylized facts

Before the outbreak of the recent crisis, external adjustment within the euro area was expected to take place via realignments in competitiveness. Once an asymmetric positive demand shock, say, pushed one country's output gap and inflation rate on the upper side of the equilibrium, the automatic real appreciation should have first deteriorated its competitiveness, which would produce a recession, which in turn would lead to real depreciation (see European Commission, 2006, for a literature survey). Obviously, this reasoning also applies to non-EA countries of EU, but they additionally have autonomous monetary and exchange rate policy as adjustment instruments.

These expectations have turned out to be overly optimistic. "Internal" real devaluation by means of price and wage decreases, once it was necessary in the Southern Europe (Greece, Italy, Spain, Portugal), hit massive social and consequently political resistance. Agents were not rational enough (cf. Torój, 2010b) to smooth out boom-bust cycles by not allowing competitiveness-detrimental real appreciation to materialize. Also, the governments afforded a decade of low reform intensity (Bednarek-Sekunda et al., 2010) that resulted in relatively high rigidities – an environment highly supportive of imbalances. As Barnes (2010) points out, it was all the matter of inertia and persistence that inhibited the competitiveness channel.

Figure 1: Current account balance and REER developments in EA countries, 1999-2008



Source: author, Eurostat data.

The external imbalances themselves emerged along the border between Northern and Southern Europe. Existing research (i.a. Zemanek et al., 2009; Barnes, 2010; Jaumotte and Sodsriwiboon, 2010; Waysand et al., 2010) unanimously confirms that (i) the euro area's current account was almost balanced, so the individual countries' imbalances are an internal phenomenon of the EA, (ii) it was the "core" or "North" of the euro area (Germany, Netherlands, Austria, Luxembourg, Finland) that were depreciating and lending and the "GIIPS" (Southern countries plus Ireland) that were appreciating and borrowing (see Figure 1).

The Macroeconomic Imbalance Procedure, introduced in late 2011 as part of the "six-pack" of EU regulations (i.e. in two EU Council and European Parliament regulations, see European Parliament and Council Of The European Union, 23.11.2011b,1) is intended to provide incentives for governments to avoid such developments. In this paper, we pay here particular attention to the external aspect of the regulations, i.e. the constraint on the current account balance.

The preventive arm of MIP comprises at first an alert mechanism. A scoreboard of indicators (see Table 1), along with their economic reading, is evaluated by the European Commission in an annual report (called Alert Mechanism Report). There are thresholds set for every indicator (in some cases differentiated between euro area and other countries), also certain combinations of indicators should be regarded as particularly risky (e.g. remarkable appreciation of REER, deterioration of the current account balance, falling export market share, growing labour cost dynamics, as well as negative and sizable net international investment position). The set of indicators was constructed with the

Table 1: Excessive Imbalance Procedure – scoreboard for alert mechanism

Imbalance	Indicator	Thresholds	Additional indicators
external	**current account balance (3 year average, as a % of GDP)**	**-4% to 6%**	**net lending/borrowing vis-à-vis rest of the world (CA+KA)**
	net international investment position (as a % of GDP)	>-35%	net external debt
	real effective exchange rate (% change over 3 years, HICP-deflated, relative to 41 industrial countries)	**+/-5% for €, +/-11% for non-€**	**REER vis-à-vis rest of the euro area**
	export market shares (% change over 5 years)	>-6%	export market shares based on volumes of goods, labour productivity, trend TFP growth
	nominal unit labour cost (% change over 3 years)	**<9% for €, <12% for non-€**	**nominal ULCs (changes over 1, 5, 10 years), effective ULC relative to rest of euro-area**
internal	deflated house prices (y-o-y % change)	<+6%	real house price, nominal house price, residential construction
	private sector credit flow (as % of GDP)	<+15%	financial liabilities of the non-consolidated financial sector, debt/equity ratio
	private sector debt (as % of GDP)	<13%	private sector debt based on consolidated data
	general government debt (as % of GDP)	<60%	–
	unemployment rate (3 year average)	<10%	–
	total financial sector liabilities (y-o-y % change)	<+16.5%	

Source: European Commission (8.11.2011, 14.11.2012).

intention to reflect i.a. the principles of simplicity, parsimony and forward-looking orientation. The Eurogroup and Ecofin Council discuss this report, and – as a conclusion – Member States with potential macroeconomic risks are identified.

If risks of imbalances are identified, an in-depth review is prepared. As the European Commission states, "the countries identified [by means of the "flashes" in scoreboard] are investigated in detail, by means of a wide set of indicators and analytical tools". A few outcomes are possible: (i) no imbalance problems are identified, (ii) some (moderate) imbalance is identified and EC/Council recommendations are released (formally, EC differentiates between impalances that require "monitoring and policy action", "monitoring and decisive policy action" and "specific monitoring and decisive policy action"), (iii) excessive imbalance is identified. The last possibility comes in two variants – excessive imbalances either require "specific monitoring and decisive policy action" or may activate the Excessive Imbalance Procesure, which is the corrective arm of MIP.

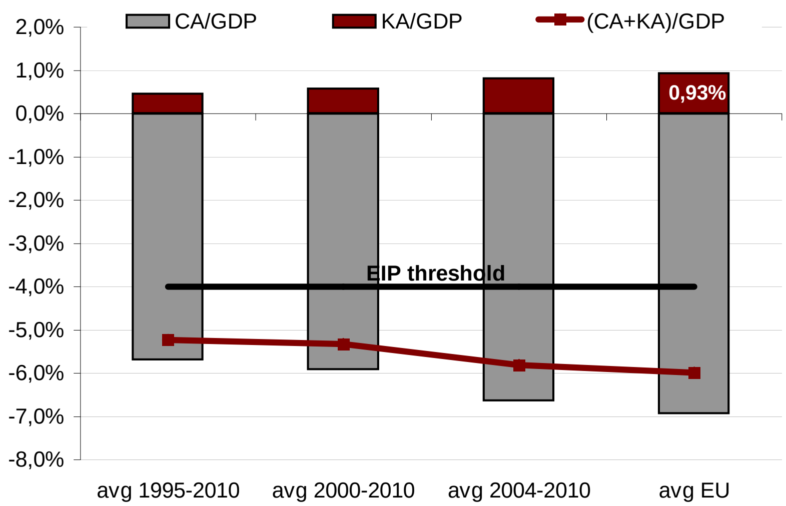
In the corrective arm, the Member States are obliged to submit to EC corrective action plans. The EC and EU Council can either assess this plan as sufficient and endorse it, listing the adequate corrective actions and their respective deadlines, or as insufficient, asking for a resubmission. If two successive corrective action plans are evaluated as insufficient, a fine is imposed on the Member State under procedure. Countries have to update the plans every 6 months. The monitoring of an agreed corrective action plan's implementation requires regular reports by the Member State. Based on these reports, the EC/Council repeatedly assesses the undertaken corrective actions and the plan itself. If a Member State fails to implement the plan within envisaged deadlines, the EC/Council adopts the decision on non-compliance, sets new deadlines and imposes an interest-bearing deposit of 0.1% GDP. In case of two successive decisions on non-compliance, this deposit becomes a (yearly) fine.

In this paper, we focus our attention on the first stage (scoreboard) and on three indicators in particular, i.e. CA balance, ULC and REER dynamics. In our view, solid analytical underpinnings for the scoreboard are essential for the credibility of the entire MIP. The reading of the scoreboard focuses some of the markets' attention and may adversely affect the sovereign's financing conditions once the indicators are flashing even though the (later) economic analysis may play down the previous reading. Also, the experience with the application of EDP suggests that non-discretionary components are essential for efficient procedures, whereby the in-depth analysis – as formulated before – contains more discretion, by nature and by intention (for the sake of flexibility). However, in its documents, the European Commission emphasises the lack of comprehensive analytical frameworks underlying the design of the scoreboard, e.g. the thresholds were set as order statistics from panel historical distributions.

In this context, another essential problem is related to the fact that all EU countries face a homogeneous treatment in the MIP, regardless of their level of development. Although the in-depth analysis may take account of the catching-up process, for the abovementioned reasons it would also be comfortable to consider it in the design of the scoreboard. Under the intertemporal approach, current account balance exhibits deficits for fundamental reasons and therefore the MIP scoreboard may be more restrictive for the New Member States of the EU. Figure 1 shows that their performance in terms of CA deficit does not fit into the previously discussed North-South dichotomy of the EA-12 group. NMS were all experiencing CA deficit, in spite of highly varying scale of real appreciation (cf. flatter regression line in Figure 1).

In the years preceding the introduction of MIP, current account deficits in the catching-up Europe ranged approximately between 6% and 7% of GDP, depending on the period and group of countries in consideration (see Figure 2). This would definitely violate the threshold of minimum -4% GDP. However, one could think of a measure that takes into account – at least partly – the catching-up effects and leaves aside the part of current account deficit that can be financed in a relatively safe way. Even though the reading as of 2013 was more favourable in on average (e.g. -3.3% GDP for Poland, -1.7% for the Czech Republic and even +0.2% for Slovakia), the Central and Eastern Europe countries are still at higher risk of non-compliance with scoreboard indicators, given the business cycle volatility. If, however, we focus on the joint balance of current and capital account (see Figure 2), we could partly relax the NMS' constraint by almost one percentage point without significantly changing the scoreboard's mechanics for the EA-12 group.

Figure 2: Current account and capital account balance in the EU NMS



avg EU = average of NMS-12 over the period of their EU membership; **avg** = average of NMS-12 plus Croatia and Turkey calculated with all available data over a given period.
Source: author, Eurostat data.

Our further analysis aims at calculating the welfare consequences of imposing the binding constraint, illustrated in Figure 2, along with illustrating the changes in policy necessary to comply with this constraint.

3 New Keynesian DSGE model

We analyse the welfare impact of MIP introduction by means of a New Keynesian DSGE model of a 2-region economy. The model builds strongly upon multi-region currency union models with possible heterogeneity, such as e.g. ones considered in the works by Benigno (2004), Lombardo (2006), Brissimis and Skotida (2008), Blessing (2008), Kolasa (2009) or Torój (2010b,a).

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. 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 and allows us to define the current account balance (simplified here to trade balance).

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

3.1 Household decisions

3.1.1 Intratemporal allocation of consumption

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:

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

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:

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

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.

3.1.2 Intertemporal allocation of consumption

The standard condition of intertemporal optimality, i.e. equality between marginal loss in utility due to purchasing 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.

3.1.3 Labour market rigidity

We apply a simplified version of a labour market rigidity mechanism described by Erzeg et al. (2000) and used i.a. by Kolasa (2009). 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):

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

3.2 International prices

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

$$S_t \equiv \frac{P_{H,t}}{P_{F,t}} \tag{9}$$

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

$$X_t \equiv \frac{P_{T,t}}{P_{N,t}} \tag{10}$$

3.3 International risk sharing

Household can smooth their consumption not only in time, but also in international financial markets (Blessing, 2008; Galí, 2008; Kolasa, 2009; Lipińska, 2008). 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 (see also Chari et al., 2002):

$$\frac{\sigma}{1-h}(c_t - hc_{t-1}) - \varepsilon_{d,t} = \frac{\sigma^*}{1-h^*}\left(c_t^* - h^* c_{t-1}^*\right) - \varepsilon_{d,t}^* - q_t \tag{11}$$

whereby

$$q_t = (1 - \alpha - \alpha^*) s_t - \kappa x_t - \kappa^* x_t^* \tag{12}$$

3.4 Producers

3.4.1 Real marginal costs

The producers of variety k in the tradable or nontradable bundle face a single-factor production function with constant returns to scale (see Galí, 2008). 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 a difference between the wage level in the region (w_t) and the sectoral producer price log-level plus the log of marginal labour product (mpn) (see Galí and Monacelli, 2005), which can be expressed in both sectors as:

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

$$mc_t^N = (w_t - p_t) + (1-\kappa)\, x_t - \left(a_t^N + \varepsilon_t^N\right) \tag{14}$$

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.

3.4.2 Pricing decisions

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 (see Galí and Gertler, 1999; Galí et al., 2001), commonly considered to outperform the purely forward-looking specifications in terms of empirical goodness-of-fit. Inflation is modelled separately in the tradable and nontradable sector.

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

$$\begin{aligned} \pi_t^H = {} & \tfrac{\omega^H}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}\pi_{t-1}^H + \tfrac{\beta\theta^H}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}E_t\pi_{t+1}^H + \\ & + \tfrac{\left(1-\omega^H\right)\left(1-\theta^H\right)\left(1-\beta\theta^H\right)}{\theta^H+\omega^H[1-\theta^H(1-\beta)]}mc_t^H \end{aligned} \tag{15}$$

and analogously for N.

3.5 Market clearing conditions

Equilibrium on 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:

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

$$y_t^{F*} = \tilde{w}^*c_t + (1-\tilde{w}^*)\, c_t^* + [\tilde{w}^*(1-\alpha)\,\eta + (1-\tilde{w}^*)\,\alpha^*\eta^*]\, s_t - \tilde{w}^*\kappa\delta x_t - (1-\tilde{w}^*)\,\kappa^*\delta^* x_t^* \tag{17}$$

whereby:

$$\tilde{w} = \frac{w(1-\alpha)(1-\kappa)}{w(1-\alpha)(1-\kappa) + (1-w)\,\alpha^*(1-\kappa^*)} \qquad \tilde{w}^* = \frac{w\alpha(1-\kappa)}{w\alpha(1-\kappa) + (1-w)(1-\alpha^*)(1-\kappa^*)} \tag{18}$$

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

$$y_t^N = (1-\kappa)\,\delta x_t + c_t + g_t \quad y_t^{N*} = (1-\kappa^*)\,\delta^* x_t^* + c_t^* \tag{19}$$

whereby g_t denotes the demand resulting from the domestic government's purchases.

3.6 Stochastic properties of the shocks

For every sort of shock in the model ε_t^j with $j \in \{D, D^*, H, F, N, N^*, W, W^*\}$, we assume an autoregressive process:

$$\varepsilon_t^j = \rho_j \varepsilon_{t-1}^j + u_t^j$$

with $u_t^j \sim N\left(0, \sigma_j^2\right)$.

3.7 Policy frameworks

In this paper, we consider 2 monetary 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 (9) is additionally affected by the nominal exchange rate dynamics:

$$S_t \equiv \frac{P_{H,t}}{P_{F,t}} \cdot E_t \tag{20}$$

- nominal exchange rate evolves according to a standard UIP equation, depending on the interest rate disparity and an UIP shock.

$$E_t \equiv i_t - i_t^* + \varepsilon_t^e \tag{21}$$

Regardless of the regime, the domestic government pursues Ramsey optimum macroeconomic policy under commitment in a timeless perspective, maximising a measure of domestic agents' welfare. It performs this optimisation task with respect to either one instrument (g_t – government expenditures, in a monetary union) or two instruments (g_t and i_t – domestic nominal interest rate, in an autonomous monetary regime).

3.7.1 Foreign economy

The foreign economy's (or monetary union's) central bank's monetary policy is described with a Taylor (1993) rule with smoothing, which is commonly applied in the literature and empirically tested as an adequate tool for the euro area (see e.g. Sauer and Sturm, 2003). The common nominal interest rate is set according to the equation:

$$i_t = \rho + (1 - \gamma_\rho)\left(\gamma_\pi \tilde{\pi}_t + \gamma_y \tilde{y}_t\right) + \gamma_\rho i_{t-1} + \varepsilon_t^i \tag{22}$$

where i_t – central bank policy rate at t, $\tilde{y}_t$ – the output gap in a currency union, $\tilde{\pi}_t$ – inflation rate in a currency union, $\gamma_\rho \in (0;1)$ – 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. Consequently, if the home economy is small, "foreign" and "unionwide" monetary policy is conducted in almost the same way.

As we do not focus on the foreign economy, we assume a neutral foreign fiscal policy with balanced budget at all times.

3.7.2 Home economy

Domestic fiscal (or monetary and fiscal) policy maximises the measure of welfare developed as second order Taylor expansion of the utility function around the steady state $\bar{C}$:

$$W_0 = \bar{C}^{1-\sigma} E_0 \sum_{t=0}^{\infty} \beta^t \left(\mathbf{A_v} \hat{\mathbf{v}}_t + \tfrac{1}{2} \hat{\mathbf{v}}_t' \mathbf{A_{vv}} \hat{\mathbf{v}}_t + \hat{\mathbf{v}}_t' \mathbf{A_{v\epsilon}} \boldsymbol{\epsilon}_t \right) + tip\left(\boldsymbol{\epsilon}_t\right) + O\left(\left\| \boldsymbol{\epsilon} \right\|^3 \right) \tag{23}$$

where $\hat{\mathbf{v}}_t$ denotes the vector of log-linearised model's variables, $\boldsymbol{\epsilon}_t$ – vector of structural shocks, $\mathbf{A_v}, \mathbf{A_{vv}}, \mathbf{A_{v\epsilon}}$ – coefficient matrices (see Appendix 1), $tip\left(\boldsymbol{\epsilon}_t\right)$ – terms independent of policy (but only on the state of nature $\boldsymbol{\epsilon}_t$ and hence irrelevant for the ranking of alternative policies) and $O\left(\left\| \boldsymbol{\epsilon} \right\|^3 \right)$ – terms of order 3 or higher.

The maximisation task is performed with respect to g_t (or g_t and i_t), subject to constraints given by log-linearised structural equations of the model.

3.7.3 Macroeconomic Imbalance Procedure – constrained current account balance

In order to incorporate the constraint on the current account balance resulting from the MIP scoreboard into the model, we define the one-period current account balance as:

$$pca_t = (1-\kappa) \left[y_t^H - (1-\kappa) c_t \right] \tag{24}$$

i.e. the difference between home tradable output and the (average) share of consumption of tradable goods. The aim of the factor $(1-\kappa)$ is to express pca_t as a share of GDP in the proximity of the steady state, not just as a share of the tradable output. As these log-linearised variables are expressed as log-deviations (i.e. percentage differences) from the steady state level, one can think of this difference as an approximate relation of current account to (steady-state) output ratio. Before we impose the constraint, note that MIP places limits not on one-period current account, but on 3-year (12-quarter) average:

$$ca_t = \frac{1}{12} \sum_{i=0}^{11} pca_{t-i} \tag{25}$$

The MIP constraint reads as follows:

$$-0.04 \leq ca_t \leq 0.06 \tag{26}$$

Alternatively, if we constrain the joint current-capital account balance $(ca_t + ka_t)$ instead:

$$-0.04 \leq ca_t + ka_t \leq 0.06$$

and bearing in mind that for the NMS-12 sample $ka_t \approx 0.01$ on average (see Section 2):

$$-0.04 \leq ca_t + 0.01 \leq 0.06$$

we obtain another (counterfactual) constraint for the NMS to be considered as an alternative:

$$-0.05 \leq ca_t \leq 0.05 \quad (27)$$

3.8 Model parameters

Tables 2-4 present the parameters of the model used in the simulation analysis. The parameters are intended to illustrate the economies of Poland (home economy) and the euro area (foreign economy). They are based on two sources.

Firstly, we calibrate the group of parameters that are easily available from the descriptive statistics and that usually cause identification problems (Table 2). This is the country weight w, as well as α, β and κ. w is chosen so as to represent the relative weight of GDP between Poland and the euro area in terms of 2000q1-2014q2 average. κ approximates the share of nontradable sector in the economy and is computed as the ratio of value added in all sectors except agriculture and industry (but including construction) to total value added. α is the share of imports from the respective trade partner in the GDP of the recipient, i.e. the share of imports from the euro area in Poland's GDP and *vice versa* in the case of α^*. Finally, β was calibrated to reflect the average interest rate level, in quarterly terms.

Table 2: Calibrated parameters

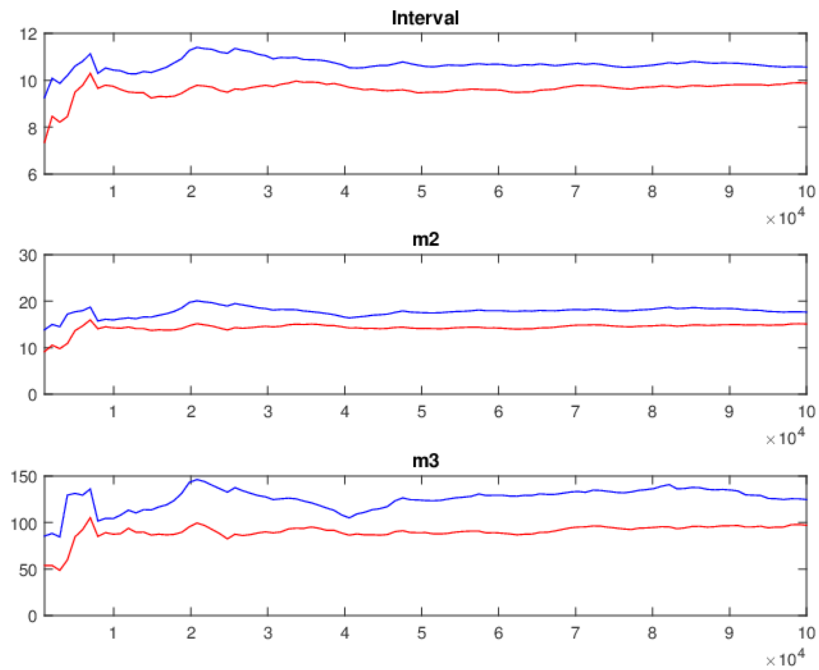
parameter	value
β	0.990
β^*	0.995
α	0.4023
α^*	0.3835
κ	0.7167
κ^*	0.7822
w	0.0325

Source: author.

Secondly, we perform Bayesian estimation of the other structural and stochastic parameters. To fit the model, we use the following quarterly time series observed over the period 2000q1-2014q2: real value added in agruculture and industry except construction (as $y^{H/F}$), real value added in the rest of the economy (as y^N), the respective price deflators (as $\pi^{H/F}$ and π^N), real consumption (as c), 3-M interbank interest rates (as i and i^*), labour cost dynamics (as dw) and nominal EUR/PLN exchange rate (as e). Our data source is the Eurostat database. Data on interest rates are not transformed, price and wage deflators as well as the nominal exchange rate appear in the form of q/q changes, while the quantity indices are HP-filtered.

Our prior distributions are largely based upon the proposals by Kolasa (2009) in a similar framework. However, they were partly adjusted after initial estimation periods to ensure the convergence and more appropriate behaviour (though not fully satisfactory) of the posterior distributions. The marginal

Figure 3: Multivariate M-H convergence diagnostics



Source: author, based on Dynare output.

posterior distributions and posterior modes were assessed using random-walk type Metropolis-Hastings altorithm with 10 chains of 100 000 replications for every chain. Aggregate convergence diagnostics, based on Brooks and Gelman (1998) and available in Dynare, is presented in Figure 3. One can note relatively good performance of *m1* and *m2* statistics in terms of line stability (though some distance between both lines remains), while *m3* remains more volatile along the chains.

Tables 3 and 4 provide the information on prior distributions, posterior modes and 90% highest posterior density intervals. For the sake of completeness, estimation details on measurement error standard deviations are also provided in Table 5.

Table 3: Estimated structural parameters

parameter	prior	prior mean	prior S.D.	posterior mode	90% HPD	
h	beta	0.33	0.1	0.3417	0.3505	0.3865
h^*	beta	0.33	0.1	0.3627	0.3307	0.3968
σ	gamma	0.7	0.2	0.9654	0.8944	1.0310
σ^*	gamma	0.7	0.2	1.0321	1.0172	1.1100
η	gamma	0.6	0.2	0.5336	0.5071	0.5933
η^*	gamma	0.6	0.2	0.4009	0.4061	0.5349
δ	gamma	0.5	0.2	0.5244	0.4485	0.6453
δ^*	gamma	0.5	0.2	0.8754	0.8317	0.9360
ϕ	gamma	2.5	0.4	2.8196	2.8526	3.0374
ϕ^*	gamma	2.5	0.4	2.2064	2.0925	2.3571
θ_H	beta	0.5	0.15	0.4805	0.4344	0.5140
θ_F	beta	0.5	0.15	0.3519	0.2688	0.3999
θ_N	beta	0.6	0.15	0.6160	0.5890	0.6638
θ_N^*	beta	0.6	0.15	0.7512	0.7116	0.7774
θ_W	beta	0.6	0.15	0.8074	0.7928	0.8737
θ_W^*	beta	0.6	0.15	0.6136	0.6213	0.6989
ω_H	beta	0.4	0.15	0.4064	0.3708	0.4956
ω_F	beta	0.4	0.15	0.2106	0.2003	0.3047
ω_N	beta	0.6	0.15	0.6968	0.6661	0.7260
ω_N^*	beta	0.6	0.15	0.7224	0.6692	0.7511
ω_W	beta	0.4	0.15	0.3499	0.3135	0.3770
ω_W^*	beta	0.4	0.15	0.3350	0.2977	0.4163
γ_ρ^*	beta	0.85	0.1	0.6990	0.6737	0.7332
γ_π^*	gamma	1.5	0.1	1.5699	1.5389	1.5895
γ_y^*	gamma	0.8	0.1	0.8670	0.8310	0.8900

Source: author.

Table 4: Estimated stochastic parameters

parameter	prior	prior mean	prior S.D.	posterior mode	90% HPD	
ρ_d	beta	0.6	0.04	0.6517	0.6420	0.6629
ρ_H	beta	0.4	0.04	0.4061	0.402	0.4325
ρ_N	beta	0.4	0.04	0.3483	0.339	0.3598
ρ_W	beta	0.5	0.04	0.4444	0.428	0.4512
ρ_d^*	beta	0.6	0.04	0.5881	0.585	0.5987
ρ_F	beta	0.4	0.04	0.3028	0.279	0.3207
ρ_N^*	beta	0.4	0.04	0.3768	0.359	0.3805
ρ_i^*	beta	0.45	0.04	0.5326	0.510	0.5435
ρ_W^*	beta	0.5	0.04	0.5417	0.534	0.5524
ρ_e	beta	0.2	0.04	0.2214	0.207	0.2387
correlation d	beta	0.3	0.05	0.3422	0.330	0.3542
correlation $H-F$	beta	0.3	0.05	0.2634	0.246	0.2820
correlation $N-N^*$	beta	0.3	0.05	0.2034	0.187	0.2252
correlation W	beta	0.2	0.05	0.1713	0.167	0.2047
σ_d	inv gamma	0.03	∞	0.0613	0.054	0.0730
σ_H	inv gamma	0.03	∞	0.0513	0.034	0.0679
σ_N	inv gamma	0.02	∞	0.0086	0.004	0.0222
σ_W	inv gamma	0.035	∞	0.6827	0.476	1.2427
σ_d^*	inv gamma	0.03	∞	0.0257	0.022	0.0302
σ_F	inv gamma	0.02	∞	0.0158	0.011	0.0209
σ_N^*	inv gamma	0.01	∞	0.0195	0.002	0.0253
σ_i^*	inv gamma	0.01	∞	0.0030	0.002	0.0035
σ_W^*	inv gamma	0.035	∞	0.0880	0.076	0.1339
σ_e	inv gamma	0.04	∞	0.0426	0.036	0.0500

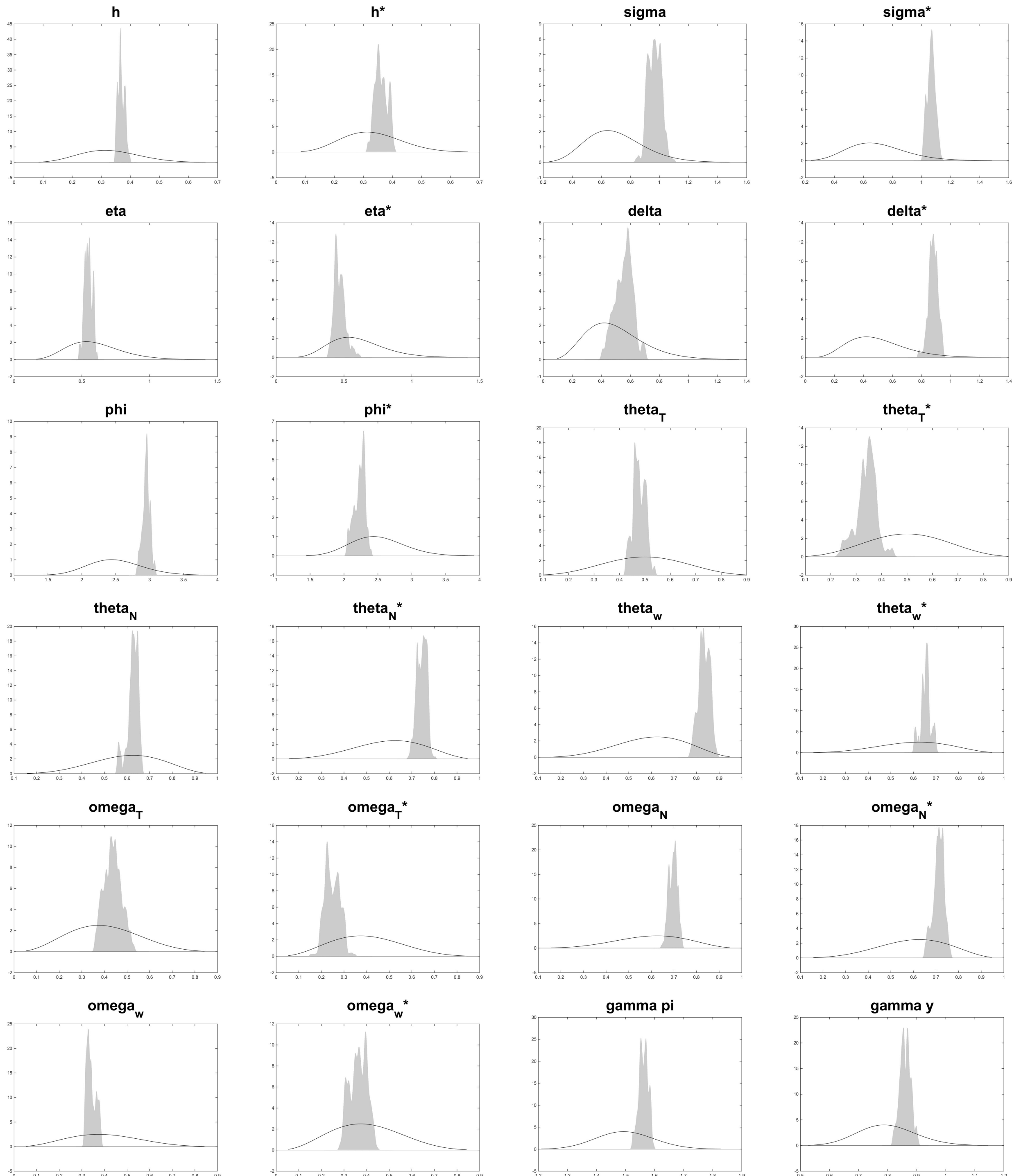
Source: author.

Table 5: Estimated S.D. of measurement errors

parameter	prior	prior mean	prior S.D.	posterior mode	90% HPD	
measurement error y^H	beta	0.6	0.04	4.6161	2.1936	0.0068
measurement error y^F	beta	0.4	0.04	0.0031	0.0021	0.0048
measurement error y^N	beta	0.4	0.04	0.0109	2.6064	0.0153
measurement error y^{N*}	beta	0.5	0.04	4.6311	2.3854	0.0013
measurement error π^H	beta	0.6	0.04	0.0305	0.0260	0.0361
measurement error π^F	beta	0.4	0.04	0.0042	0.0035	0.0052
measurement error π^N	beta	0.4	0.04	0.0069	0.0059	0.0086
measurement error π^{N*}	beta	0.45	0.04	0.0020	0.0016	0.0023
measurement error c	beta	0.5	0.04	0.0234	0.0189	0.0291
measurement error c^*	beta	0.2	0.04	0.0079	0.0068	0.0093
measurement error dw	beta	0.3	0.05	0.0122	0.0103	0.0146
measurement error dw^*	beta	0.3	0.05	5.0738	2.7353	0.0023

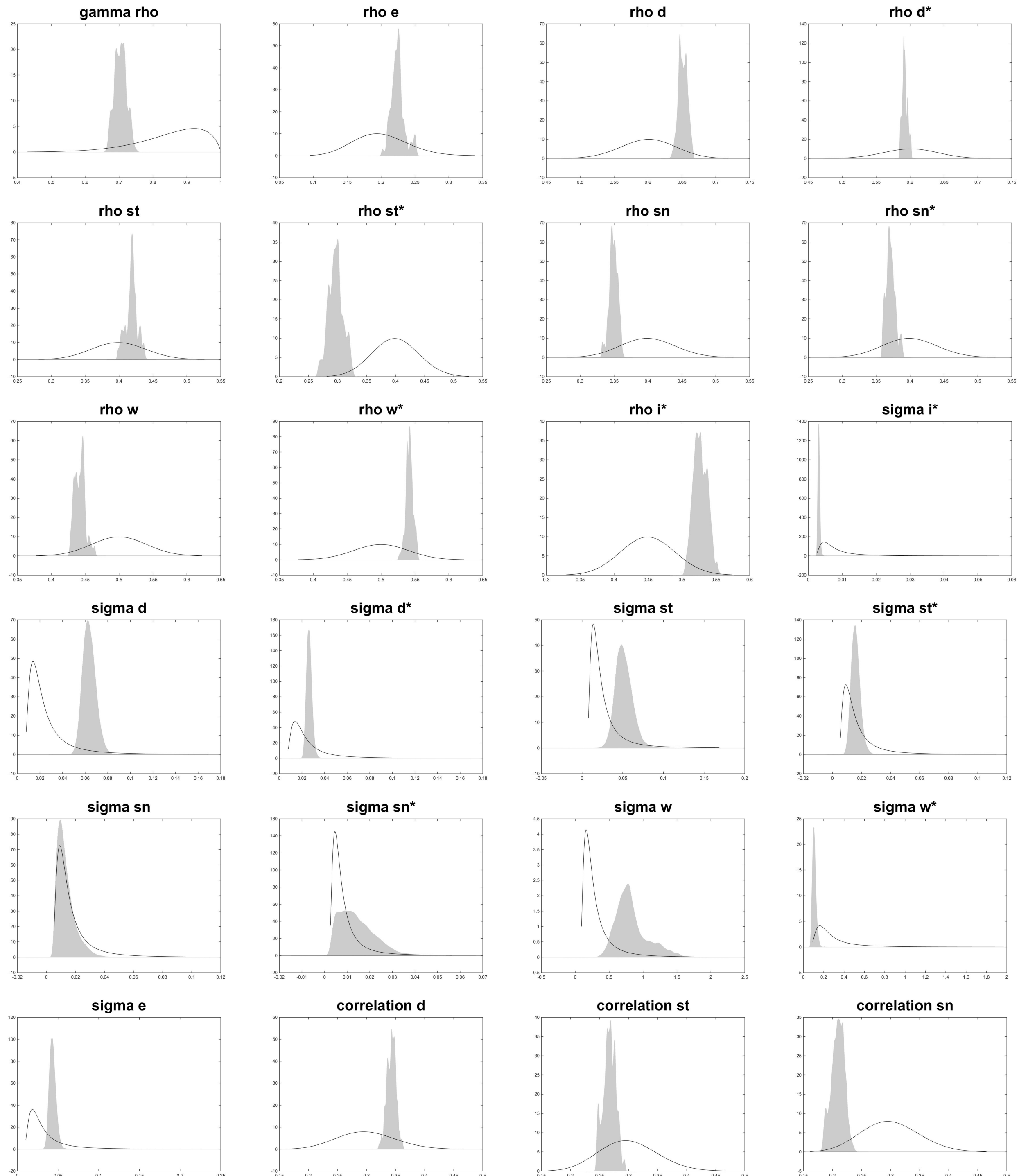
Source: author.

Figure 4: Prior and posterior distributions (1)



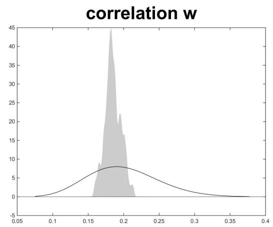
Black line represents the prior distribution, gray area – the posterior distribution.
Source: author.

Figure 5: Prior and posterior distributions (2)



Black line represents the prior distribution, gray area – the posterior distribution.
Source: author.

Figure 6: Prior and posterior distributions (3)



Black line represents the prior distribution, gray area – the posterior distribution.
Source: author.

4 Compliance with current account deficit threshold under MIP

4.1 Constrained macroeconomic policy

Given the model's parametrisation described in Subsection 3.8, theoretical standard deviation of 3-year average current account balance equals 0.0079 with the euro and 0.0114 without it (due to higher terms of trade volatility under nonzero variance of UIP premium). Whether volatility of this magnitude may challenge the MIP threshold depends on the long-term level of fluctuations. Clearly, given zero steady state values (under balanced foreign trade and the law of one price) that normally appear in New Keynesian models, this volatility is rather tiny. However, the catching-up economies normally exhibit persistent current account deficits (see Figure 2), in line with the predictions by intertepmoral current account theory.

For this reason, we decided not to evaluate the compliance with the constraints around the zero steady state, but around long-term values consistent with the catching-up process. To ensure the alignment with our model, we run first a deterministic simulation that replicates the widespread evidence of CA deficits when substantial growth in labour productivity is anticipated. We assume that over a 120-period horizon (30 years), the labour productivity should double in Poland and fully converge to the euro area level on a linear basis. This roughly corresponds to the speed of potential GDP growth anticipated in European Commission's Ageing Working Group report of 2012, where annual potential GDP growth rates between 2010 and 2040 imply a growth of 85% (European Commission, 2011, p. 130). The simulation yields the average value of current account deficit of 5.5% GDP, culumated 3-year growth of REER at 0.38% and cumulative 3-year growth in nominal ULC by 6.78%.

Note that this value alone clearly exceeds the -4 bound on ca_t and – by a narrower margin – also the hypothetical -5 bound (resulting from the same constraint imposed on $ca_t + ka_t$). When we take into account the normal business cycle fluctuations, i.e. additionally consider 1.96 times the calculated standard deviation, the non-compliance with MIP condition on CA deficit becomes even more evident. This is why we can regard the unconstrained optimum policy as violating the MIP thresholds.

Our goal is to derive a policy that leads to fulfilling the MIP requirement regarding CA deficit. In operationalising the constraint, we refer to Woodford's (2003, ch. 6) treatment of the problem with

Table 6: Current account constraint in MIP scoreboard versus theoretical standard deviation of ca_t

policy regime	standard deviation (sd) of ca_t	lower bound on ca_t	lower bound on $ca_t + ka_t$	long-term level minus $1.96 \cdot sd$	result
€	0.0079	-0.04	-0.05	-0.0706	violated
no €	0.0114	-0.04	-0.05	-0.0774	violated

Source: author.

zero lower bound on the interest rates. The idea behind this is to ensure that a variable does not hit the constraint by keeping its average at least k standard deviations away from the bound. Let $k = 1.96$ (implying the fulfilment of the MIP condition approximately 95% of the time). Also let $K = 1 + k^{-2}$ and denote the lower bound on ca_t as LB. The condition (26) or (27) reformulated in this way can be written as:

$$(1-\beta) E_0 \sum_{t=0}^{\infty} \beta^t (LB + ca_t)^2 \leqslant K \left[(1-\beta) E_0 \sum_{t=0}^{\infty} \beta^t (LB + ca_t) \right]^2 \tag{28}$$

Consider (23) as $W_0 = \bar{C}^{1-\sigma} E_0 \sum_{t=0}^{\infty} \beta^t W_t + tip(\boldsymbol{\epsilon}_t) + O\left(\|\boldsymbol{\epsilon}\|^3\right)$, i.e. the welfare measure W_0 as a discounted stream of one-period welfare W_t. Denote one-period loss as its opposite, i.e. $L_t \equiv -W_t$. In line with Proposition 6.9 by Woodford (2003, p. 428) and Proposition 1 by Lipińska (2014), one can show that the optimum policy constrained by (28) is characterised by the following loss function:

$$\tilde{L}_t \equiv L_t + \Phi_C \left(ca_t - ca^T\right)^2 \tag{29}$$

whereby:

- the target value for ca_t can be expressed as $ca^T = -LB + K \cdot (1-\beta) \sum_{t=0}^{\infty} \beta^t (ca_t + LB) > 0$;
- policy coefficient $\Phi_C \geqslant 0$ and $\Phi_C > 0$ iff the additional constraint is binding (see Table 6).

Strictly positive values of the additional loss function coefficients under MIP, Φ_C and ca^T, can be found iteratively. Note that, to some extent, there is a trade-off between shifting away the average level from the constraint by increasing ca^T or squeezing the variance of ca_t by increasing Φ_C. In practice, one

Table 7: Additional loss function coefficient Φ_C – value under different policy regimes

Φ_C	$CA \geq -4\%$	$CA + KA \geq -4\%$
euro	550	360
non-euro	2032	567

Source: author.

Table 8: Welfare ranking of different policy regimes

Welfare estimate	without MIP	$CA \geq -4\%$	$CA + KA \geq -4\%$
euro	7.0406	4.2997	5.8685
non-euro	7.7135	6.1875	7.0658

Timeless perspective, in [$\%^2$], up to a constant. Higher number implies higher welfare ranking (absolute or relative differences not directly interpretable).

Source: author.

should consider different combinations of Φ_C and ca^T that fulfil the constraint (28) as equality, and select the one that allows to attain maximum feasible welfare. Note that fulfilling (28) as equality is required to achieve the optimum solution (see Lipińska, 2014 for a discussion). Given both monetary policy regimes and both versions of MIP indicator in question, Φ_C ranges from 360 to 2032. The loss function is the most aggressively corrected in response to MIP when the more restrictive (factual) version of the indicator is in force, i.e. $CA \geq -4\%$, as well as after the euro adoption, when less policy tools are available. Also, the policy response to current account deviations is more aggressive under the euro with less restrictive (counterfactual) version of the indicator (i.e. $CA + KA \geq -4\%$) than without the euro and with more restrictive indicator. That is, the euro-dimension notably matters more for the welfare ranking than the variant of MIP implementation.

It is also worth mentioning that the inclusion of the lower bound threshold is resulting in a slight bias towards targeting a CA surplus ($0.1 - 0.3\%$ GDP). It is higher under the more restrictive MIP version, as well as under flexible exchange rate (to keep a buffer for nominal rate fluctuations).

4.2 Welfare and policy responses under MIP

As expected, the introduction of policy targeting to comply with the MIP thresholds for the CA balance has turned out to be welfare-decreasing, although to a lesser extent if the alternative formulation of the indicator ($CA + KA \geq -4\%$) is taken into account (see Table 8). This is true for both policy regimes in question, i.e. in the euro area and in an autonomous monetary policy regime. At the same time, and in line with previous research, the welfare measures in the economy that participates in the monetary union are lower than the analogous values for a non-euro economy.[1]

The values of welfare (in Table 8) are approximated up to a constant and not directly interpretable, either in absolute or relative terms. It is therefore a common practice to focus on their differences expressed in an alternative metric, i.e. as an equivalent shift in steady state consumption (cf. Lucas, 1987; Gradzewicz and Makarski, 2013; Lipińska, 2014):

$$\Delta = (1-\beta)\,\frac{W_U - W_C}{\bar{C}^{1-\sigma}} \tag{30}$$

[1] Like Gradzewicz and Makarski (2013), we do not take into account possible benefits from the euro adoption in Poland and focus exclusively on the cost of different business cycle properties.

Table 9: Shift to constrained policy: equivalent decline in steady-state consumption

Unconstrained policy		Constrained policy*		% change in $\bar{C}$	(no €→€=100)
€	MIP	€	MIP		
€	no MIP	€	$\mathbf{CA \geq -4\%}$	-0.0274	407
no €		no €		-0.0152	227
€	no MIP	€	$\mathbf{CA + KA \geq -4\%}$	-0.0117	174
no €		no €		-0.0065	96
no €	no MIP	**€**	$\mathbf{CA \geq -4\%}$	-0.0341	507
			$\mathbf{CA + KA \geq -4\%}$	-0.1845	274
no €	no MIP	**€**	no MIP	-0.0067	100
	$CA \geq -4\%$		$CA \geq -4\%$	-0.0189	281
	$CA + KA \geq -4\%$		$CA + KA \geq -4\%$	-0.0120	178

* – imposed policy constraint marked in bold. Source: author.

where W_U, W_C – welfare under unconstrained and constrained policy (respectively) under comparison. The value of Δ in (30) can be interpreted as the fraction of consumption that consumers would give up on a permanent basis, which would make them equally unhappy as the transition from unconstrained to constrained policy regime (or, in other words, the maximum fraction of their consumption that they would give up to avoid this transition).

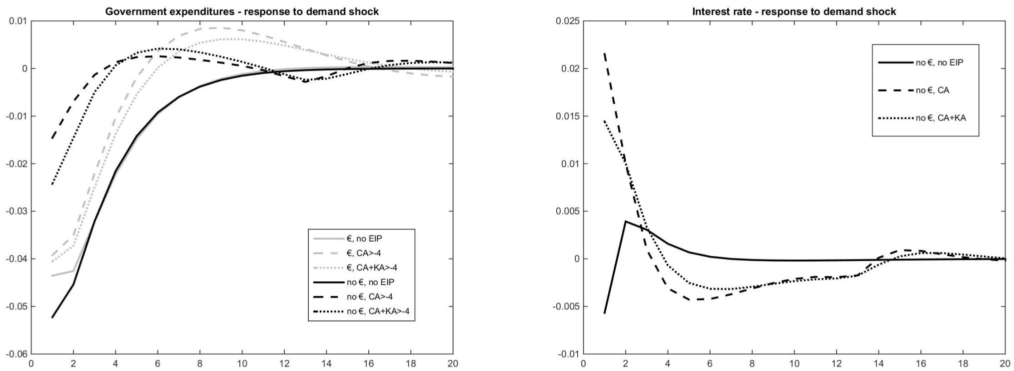
In this setup, the introduction of MIP threshold on CA balance results *ceteris paribus* (i.e. taking into account this threshold only) in a welfare loss equivalent to steady-state decrease in consumption of 0.0274% after the euro adoption or 0.0152% before that. These numbers are generally comparable with their counterparts from the previous literature on the welfare cost of business cycles: Lucas (1987) estimated the cost of business cycle itself at approximately 0.05%, Lipińska (2009) – the cost of Poland's fulfilment of the Maastricht criteria at 0.016%, and Gradzewicz and Makarski (2009) – the cost of euro adoption in Poland at 0.124%. If we consider the 4% threshold on current plus capital account (rather than current account alone), this cost decreases to 0.0117 under the euro and 0.0065 without the euro.

Interestingly, the estimated cost of the MIP threshold is substantially lower than the cost of euro adoption. From a different perspective, however, one can see the introduction of CA threshold under MIP as a factor augmenting the cost of euro adoption. Under the less restrictive version of the indicator, this rise is lower (by a factor of 1.78), but if we take into consideration the factual threshold of -4% for the CA alone, the cost of euro adoption rises by a factor of 2.81.

The analysis of impulse-response functions of the government's policy variables gives more insight into the nature of constrained policy. After a positive demand shock in the home economy (Figure 7), the fiscal policy steps in with an offsetting decrease in spending for nontradable output. This policy response is the most aggressive without MIP (black line). If the -4% threshold is introduced on CA balance, the fiscal policy cannot afford such an active intervention and the response remains limited (dark red line). Imposing the limit on CA+KA balance constitutes the intermediate scenario between these two. Note that under the 12-quarter CA average scanned on the MIP scoreboard, there is a

Figure 7: Home policy response to positive demand shock

(a) fiscal policy (b) monetary policy



characteristic dip 12 quarters after the shock, after which the return to steady state is fluent.

Without the euro adoption, the profile of government expenditures is more homogenous across different MIP-related situations. Again, the fiscal policy is also the most aggressive without MIP and the least aggressive with its more restrictive version, i.e. with a limit on CA alone. Note that in this case, the main burden of adjustment is thrust upon the monetary policy tightening (right panel of 7) and that all the paths of fiscal response remain moderate as compared to the case of monetary union membership, where g is the only available instrument.

Inversely, in the case of a positive supply shock in the tradable sector, the fiscal (and possibly monetary) policy remains the most aggressive under MIP in its most restrictive version. The current account balance quickly improves, boosting the output. The monetary policy steps in with some tightening to contain it, and the fiscal policy – with some expansion to increase consumption. They are both more aggressive under MIP as they target to keep these two variables possibly close to each other in order to avoid a high surplus in CA (or a high deficit, in a symmetric case of adverse supply shock in the tradable sector). In this case, however, an aggressive policy is producing more volatility rather than offseting it and the welfare decreases. Supply shocks in the nontradable sector do not translate into immediate shifts in international competitiveness, and hence the CA (or CA+KA) constraint does not matter for the adjustment policy. This is why the policy reactions to shocks without MIP and with MIP do not differ substantially.

After an adverse labour supply shock, fiscal policy response is slightly more persistent under MIP. Monetary policy, however, remains initially more moderate and prefers not to step in as far as in the unconstrained case. Note that the interest rate remains elevated as long as the MIP indicator "remembers" the initial shock, just to dive after that. These effects, however, are of second order in terms of economic significance.

Figure 8: Policy response to positive supply shock in T sector

(a) fiscal policy (b) monetary policy

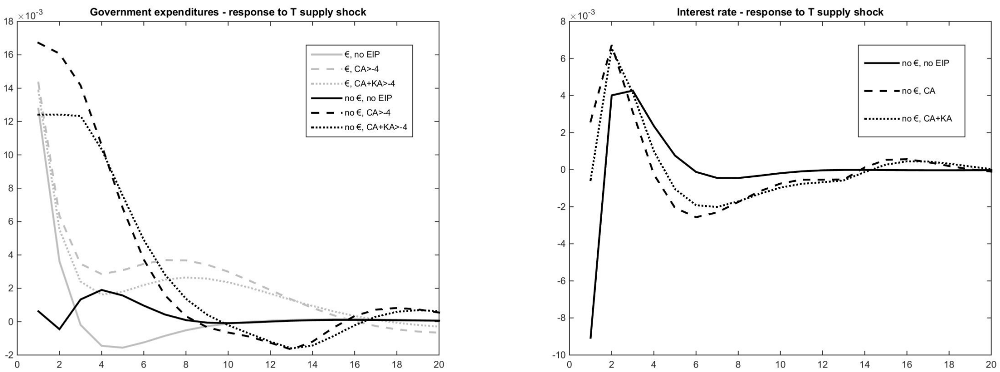


Figure 9: Policy response to positive supply shock in NT sector

(a) fiscal policy (b) monetary policy

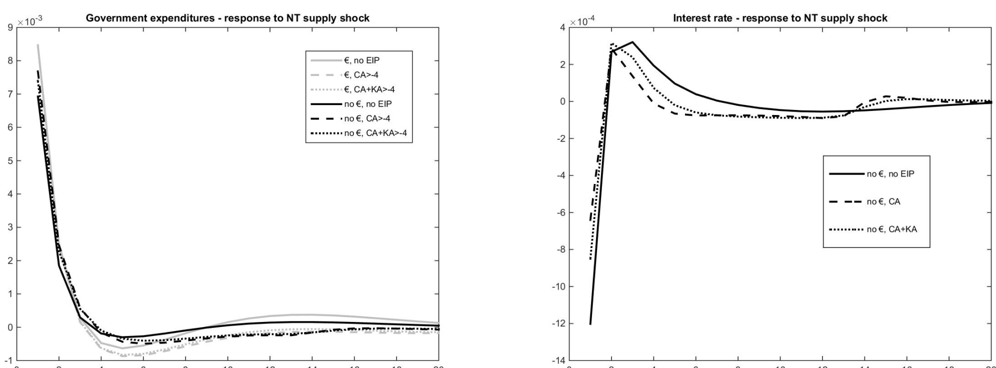
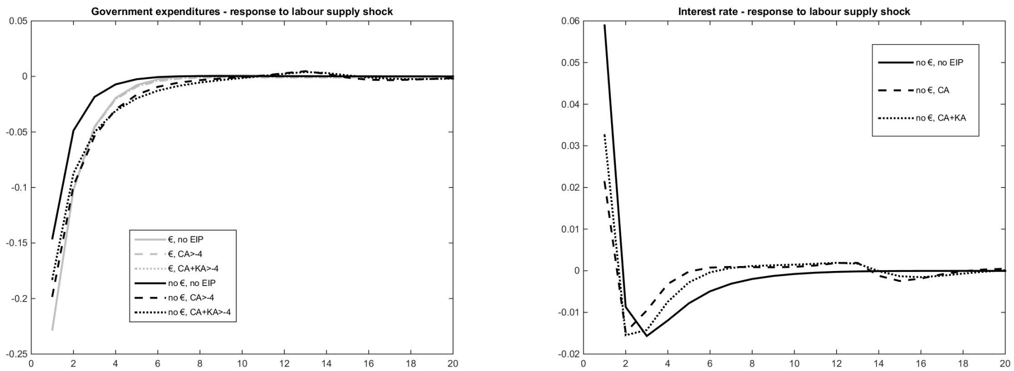


Figure 10: Policy response to adverse labour supply shock

(a) fiscal policy (b) monetary policy



5 Thresholds on nominal ULC dynamics and REER dynamics

For the purpose of analysing a wider range of indicators, we define in terms of our model's varibles:

- one-period increment in nominal unit labour cost (ULC), as a difference between the wage inflation and marginal product of labour (weighted by sectors):

$$\Delta \tilde{ulc}_t = dw_t - \left[(1-\kappa)\left(\varepsilon_t^{ST} - \varepsilon_{t-1}^{ST}\right) + \kappa\left(\varepsilon_t^{SN} - \varepsilon_{t-1}^{SN}\right)\right] \tag{31}$$

- 3-year cumulative growth in nominal ULC, to cast in the form constrained by MIP:

$$\Delta ulc_t = \sum_{i=0}^{11} \Delta \tilde{ulc}_{t-i} \tag{32}$$

- real (effective) exchange rate (REER) – see equation (12);
- 3-year cumulative growth in REER, to cast in the form constrained by MIP:

$$\Delta reer_t = q_t - q_{t-12} \tag{33}$$

Table 10 summarizes the behaviour of Δulc_t and $\Delta reer_t$ in all 3 policy variants, both under the euro and under autonomous monetary policy. Note that without MIP, the set of fulfilled constraints differs between the monetary regimes. In the monetary union, the unconstrained policy violates the CA constraint and the ULC constraint, while in the autonomous monetary policy, the CA constraint and the REER constraint are violated. The reason for this is higher volatility of REER outside the monetary union, induced both by the existence of nominal exchange rate volatility and by the higher variance of inflation, especially in the small home economy. In the monetary union, however, there

Table 10: Current account, REER and nominal ULC constraints in MIP scoreboard versus theoretical standard deviations

monetary policy regime	MIP regime	variable	standard deviation (sd)	long-term level +/-* $1.96 \cdot sd$	threshold	result	result as compared to no MIP
€	no MIP	ca_t	0.0079	-0.0706	-0.04/-0.05	violated	–
		$\Delta reer_t$	0.0198	0.0426	+0.05	fulfilled	–
		Δulc_t	0.0417	0.1496	+0.09	violated	–
	LB on ca_t	ca_t	0.0068	-0.04	-0.04	fulfilled	brought to compliance
		$\Delta reer_t$	0.0226	0.0481	+0.05	fulfilled	aggravated
		Δulc_t	0.0457	0.1850	+0.09	violated	aggravated
	LB on $ca_t + ka_t$	ca_t	0.0070	-0.05	-0.05	fulfilled	brought to compliance
		$\Delta reer_t$	0.0211	0.0452	+0.05	fulfilled	aggravated
		Δulc_t	0.0447	0.1737	+0.09	violated (worse than without MIP)	aggravated
no €	no MIP	ca_t	0.0114	-0.0774	-0.04/-0.05	violated	–
		$\Delta reer_t$	0.1176	0.2342	+0.11	violated	–
		Δulc_t	0.0250	0.1170	+0.12	fulfilled	–
	LB on ca_t	ca_t	0.0011	-0.04	-0.04	fulfilled	brought to compliance
		$\Delta reer_t$	0.0945	0.1890	+0.11	violated	improved
		Δulc_t	0.0299	0.1245	+0.12	violated	aggravated
	LB on $ca_t + ka_t$	ca_t	0.0024	-0.05	-0.05	fulfilled	brought to compliance
		$\Delta reer_t$	0.0955	0.1910	+0.11	violated	improved
		Δulc_t	0.0299	0.1253	+0.12	violated	aggravated

* – minus in the case of CA, plus in the case of REER and ULC.
Source: author.

is higher wage volatility required to adjust for shocks (via labour market rather than via interest or exchange rate fluctuations), and hence the nominal unit labour cost tend to be more volatile.

The implemented constrained policy with respect to the CA threshold does not lead, however, to the compliance with the other criteria. In the case of NULC, the situation is even aggravated. The optimum policy produces more volatility in wage dynamics to stabilise output and eventually contain the CA deficit fluctuations. This pattern occurs irrelevant of the policy regime, although under the autonomous monetary policy the increase in Δulc_t is not substantial. However, it is sufficient to produce a minor violation of the constraint. One should note, however, that it is easier for non-euro countries to comply with ULC criterion as the threshold is less restrictive (+0.12 rather than +0.09).

As regards REER, a more nuanced picture emerges. In the monetary union, the constrained policy exploits the REER as an intermediate goal in stabilising CA balance. This is why policymakers intentionally lead the policy so as to squeeze the volatility of REER. It is not sufficient for the compliance with the threshold, but one could additionally include $\Delta reer_t$ as another variable in the loss function to improve the situation and further constrain the policy. In the case of monetary union, however, the situation is aggravated again once the policy becomes constrained. Both prices and wages become more volatile as the single policy tool (g) strives more aggressively to keep CA deficit under control. As a result, the fulfilment of one criterion (CA) has led to more volatility in another criterion (REER), while not to an extent that would cause a violation.

6 Conclusions

In this paper, we consider welfare consequences of imposing the threshold on current account balance in the Macroeconomic Imbalance Procedure currently introduced in the European Union. To operationalise this idea, we apply Woodford's (2003) framework of constrained optimum policy, designed for the treatment of zero lower bound on interest rates.

The introduction of MIP threshold on CA balance results in a welfare loss equivalent to steady-state decrease in consumption of 0.0274% after the euro adoption or 0.0152% before that. These numbers are generally comparable with their counterparts from the previous literature on the welfare cost of business cycles: Lucas (1987) estimated the cost of business cycle itself at approximately 0.05%, Lipińska (2009) – the cost of Poland's fulfilment of the Maastricht criteria at 0.016%, and Gradzewicz and Makarski (2009) – the cost of euro adoption in Poland at 0.124%). If we consider the 4% threshold on current plus capital account (rather than current account alone), this cost decreases to 0.0117 under the euro and approximately a half of that without the euro.

The abovementioned differences seem to stem mainly from (i) less aggressive (and hence less volatility-containing) fiscal policy responses to demand shocks under MIP and (ii) more aggressive (but sub-optimum, and hence volatility-increasing) responses of fiscal (and – if available – monetary) policy to tradable supply shocks. One can also look at this constraint imposed on the fiscal policy in a broader context, i.e. taking into account the EDP procedure existing since late 1990s. Under EDP and MIP requirements jointly, more aggressive fiscal policy may not be a feasible option.

The estimated cost of the MIP threshold seems to be substantially lower than the cost of euro adoption. From a different perspective, however, one can see the introduction of CA threshold under MIP as a factor augmenting *ceteris paribus* the cost of euro adoption by a factor of approximately 2.81. It should perhaps be stressed that all of the abovementioned welfare losses are computed under the assumption that the CA constraint would be strictly monitored and enforced on an anticipatory basis by Member State's economic policy, without e.g. favourable interpretations of exceeded threshold in the economic reading of the scoreboard.

Importantly, some inconsistency between MIP indicators has been detected, especially for the euro area countries. Containing the CA volatility is accompanied by increasing the volatility of ULC that prevents the policy from fulfilling both criteria at once.

This analysis should be supplemented with a number of aspects in further research. More insight should be taken into the model's calibration, including also testing the sensitivity to parameter values. Going beyond the CA, ULC and REER threshold, further indicators of the MIP scoreboard should be included in the analysis, though after substantial expansion of the model. This should also be analysed jointly with the EDP requirements, as MIP-constrained fiscal policy might face more difficulties to comply with EDP (or inversely). Finally, further research should attempt to confront the welfare cost of CA threshold in MIP with possible benefits from increased macroeconomic stability.

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Appendix 1: Welfare measure

The measure of welfare, defined as 2^{nd} order Taylor expansion of the utility function around the steady state (23), takes the following form:

$$W_0 \approx \bar{C}^{1-\sigma} E_0 \sum_{t=0}^{\infty} \beta^t \left(\begin{bmatrix} (1-h)^{-\sigma} \\ -h(1-h)^{-\sigma} \\ -s_C \kappa \\ -s_C(1-\kappa) \\ 0 \\ 0 \end{bmatrix}^T \begin{bmatrix} c_t \\ c_{t-1} \\ y_t^N \\ y_t^H \\ \pi_t^H \\ \pi_t^N \end{bmatrix} + \begin{bmatrix} c_t \\ c_{t-1} \\ y_t^N \\ y_t^H \\ \pi_t^H \\ \pi_t^N \end{bmatrix}^T \begin{bmatrix} (1-h)^{-\sigma} & 0 & 0 & 0 \\ -h(1-h)^{-\sigma} & 0 & 0 & 0 \\ 0 & s_C \phi\kappa(1-\kappa) & s_C \kappa(1+\phi\kappa) & -s_C\kappa \\ 0 & s_C(1-\kappa)(1+\phi(1-\kappa)) & s_C\phi\kappa(1-\kappa) & -s_C(1-\kappa) \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \varepsilon_t^D \\ \varepsilon_t^H \\ \varepsilon_t^N \\ \varepsilon_t^W \end{bmatrix} + \right.$$

$$+\frac{1}{2} \begin{bmatrix} c_t \\ c_{t-1} \\ y_t^N \\ y_t^H \\ \pi_t^H \\ \pi_t^N \end{bmatrix}^T \cdot$$

$$\cdot \begin{bmatrix} (1-h)^{-\sigma} - \sigma(1-h)^{-1-\sigma} & h\sigma(1-h)^{-1-\sigma} & 0 & 0 & 0 & 0 \\ h\sigma(1-h)^{-1-\sigma} & -h(1-h)^{-\sigma} - h^2\sigma(1-h)^{-1-\sigma} & 0 & 0 & 0 & 0 \\ 0 & 0 & -s_C\kappa(1+\kappa\phi) & -s_C\phi\kappa(1-\kappa) & 0 & 0 \\ 0 & 0 & -s_C\phi\kappa(1-\kappa) & -s_C(1-\kappa)(1+(1-\kappa)\phi) & 0 & 0 \\ 0 & 0 & 0 & 0 & s_C\kappa\varepsilon_T \frac{\theta^H + \omega^H\left[1-\theta^H(1-\beta)\right]}{\left(1-\omega^H\right)\left(1-\theta^H\right)\left(1-\beta\theta^H\right)} & 0 \\ 0 & 0 & 0 & 0 & 0 & s_C(1-\kappa)\varepsilon_N \frac{\theta^H + \omega^H\left[1-\theta^H(1-\beta)\right]}{\left(1-\omega^H\right)\left(1-\theta^H\right)\left(1-\beta\theta^H\right)} \end{bmatrix} \cdot$$

$$\left. \cdot \begin{bmatrix} c_t \\ c_{t-1} \\ y_t^N \\ y_t^H \\ \pi_t^H \\ \pi_t^N \end{bmatrix} \right)$$

s_C denotes the steady-state ratio of domestic labour income to consumption and is assumed to equal 1.