Monetary Integration under Bounded Rationality*

Michał Brzoza-Brzezina† Paweł R. Galiński‡ Krzysztof Makarski§

Abstract

We examine the macroeconomic consequences of Poland's hypothetical accession to the euro area in a New Keynesian open-economy model with bounded rationality. Our paper offers two main contributions. First, we analyze how the effects of joining a monetary union depend on the mechanism of expectation formation. The bounded rationality assumption fits the data much better and strongly affects model dynamics, but given historical shocks and policies it changes the cost of accession only marginally as compared to rational expectations. Second, we separate the consequences of fixing the exchange rate from those of adopting the common interest rate. We show that the consequences of accession are mainly due to fixing the exchange rate, while adopting the common interest rate is of minor importance. Beyond these two contributions, we find that monetary integration would have substantially amplified output volatility while making inflation more stable. We also document the key role of the exchange rate at entry and show that fiscal policy is unable to restore the degree of macroeconomic stability attainable under an independent monetary regime.

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†Narodowy Bank Polski; Email: michal.brzoza-brzezina@nbp.pl.

‡Narodowy Bank Polski; Email: pawel.galinski@nbp.pl.

§Narodowy Bank Polski; Email: krzysztof.makarski@nbp.pl.

1 Introduction

The question of whether, when and how to join a monetary union remains central for countries navigating the trade-offs between monetary sovereignty and integration. In this paper we use an estimated two-country model to investigate the consequences o a hypothetical accession of Poland to the euro area. We conduct counterfactual, historical simulations that allow to check how monetary integration would have affected output and inflation, how the consequences depend on the exchange rate at entry and what role fiscal policy could play in the absence of independent monetary policy.

Beyond covering these topics, which closely correspond to earlier conclusions from both the theoretical and empirical studies, our paper offers two important new contributions to the literature. First, in line with the growing emphasis placed on modeling the consequences of deviating from the assumption of rational expectations, we analyze how the effects of joining a monetary union depend on the mechanism of expectation formation. Second, we overcome the consequences of the impossible trinity of monetary policy for inference about the role of flexible exchange rates. In particular, we separate the consequences of fixing the exchange rate from those of adopting a common interest rate. As a consequence, we are not only able to show (giving up) which of these instruments is more important, but also to answer the question of whether a flexible exchange rate is a shock absorber or a shock generator.

Let us briefly discuss the main findings. The most general one is that joining the euro area would have substantially increased the volatility of output and somewhat lowered the volatility of inflation. The intuition behind this result is as follows. Joining a monetary union eliminates nominal exchange-rate flexibility. This has different effects for GDP and inflation. Stabilizing the nominal exchange rate, stabilizes import prices and inflation. For GDP, however, the relevant driver is the real exchange rate, which remains flexible but becomes more persistent because adjustment relies on sluggish relative-price changes. Thus, the loss of exchange-rate flexibility contributes to greater GDP volatility.

Next we checked how counterfactual paths depend on the exchange rate at entry. We simulated counterfactual scenarios in which the country adopts the euro at different historical moments (and historical levels of the exchange rate). An entry with an undervalued currency delivers an initial boom through improved competitiveness, followed by a bust. It also leads to strong inflationary pressures. An appreciated exchange rate at entry leads to a deep and persistent output contraction. It takes even seven years until the consequences of over- or undervalued exchange rate fade away. These results underscore the importance of strategic timing in monetary integration and highlight the exchange rate as a critical state variable often ignored in static cost-benefit frameworks.

Then, we explored the capacity of fiscal authorities to stabilize the domestic economy in

the absence of monetary autonomy within a monetary union. Our findings indicate that—under empirically plausible assumptions about fiscal activity—this policy alone would not have been sufficient to replicate the level of macroeconomic stability afforded by an autonomous monetary regime. This underscores the limitations of relying solely on national fiscal instruments in the face of asymmetric shocks and highlights the importance of monetary flexibility in maintaining economic resilience.

Let us now move to the two aforementioned main contributions to the literature. First, we compare the consequences of assuming rational expectations (RE) and behavioral expectations (BE), the latter modeled to reflect myopic behavior of agents in the spirit of Gabaix (2020). This assumption has been shown to affect features critical from the perspective of monetary integration, including the effectiveness of monetary and fiscal policy or the behavior of the exchange rate. We show that the behavioral model better captures observed macroeconomic dynamics—particularly the persistence and amplification of shocks.

To understand how the impact of euro area accession changes under BE relative to RE, we identify three interacting mechanisms. First, monetary policy is less powerful under BE—because households and firms respond less to future policy changes—reducing the marginal cost of giving up national control over interest rates. Second, the effect of some shocks—particularly markup shocks—on output becomes more pronounced in a monetary union under BE than under RE, suggesting that the absence of stabilization tools may be more consequential. Third, since BE models tend to exhibit stronger internal propagation, they generally require smaller shock innovations to account for observed fluctuations, although this need not hold for every individual shock. This should, *ceteris paribus*, lower the cost of losing monetary autonomy. The net effect of these opposing forces is ultimately an empirical question. We find that, on balance these effects netted out, so that surrendering independent monetary policy increases GDP volatility and lowers inflation volatility under RE and BE assumptions to a similar extent.

Moving to our second contribution, we design counterfactual scenarios that allow to single-out the role of fixing the exchange rate and the interest rate in driving the dynamics. This is done by applying monetary policy and risk premium innovations such that (i) the nominal exchange rate is fixed, while the domestic interest rate follows its historical path or (ii) the domestic interest rate equals the euro area rate, while the exchange rate follows the historical path. As the model is linear, these two scenarios sum-up to the full monetary union accession scenario with a fixed exchange rate and interest rate at the euro area level. The findings are striking: most of the difference between being and not-being a member of the euro area comes from fixing the exchange rate. The role of interest rate adjustment is of secondary importance. This can be explained by relatively similar historical interest rate developments amid significant swings of the exchange rate. At the same, however, this finding has an interesting flip-side. Since giving up exchange rate flexibility is the main factor behind

destabilizing the real economy, the exercise provides an answer to the question whether the flexible exchange rate is a stabilizing or destabilizing instrument. It is a stabilizing device for GDP fluctuations (destabilizing for inflation).

Before proceeding, one important point should be made clear. Our paper deals with the consequences of cyclical fluctuations and adjustments, leaving aside the issue of interest rates being on average higher in Poland than in the euro area. This feature is related to a higher equilibrium interest rate in Poland, has been documented in the literature (e.g. Eichengreen and Steiner (2008), Brzoza-Brzezina et al. (2014b)) and can lead to boom-bust developments upon euro area accession that can potentially be even more volatile than the fluctuations we deal with in this paper. We treat them as a separate phenomenon deserving special treatment and hence, leave them aside.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 outlines the model, and Section 4 describes its calibration and estimation. Section 5 examines shock transmission across monetary regimes and expectation frameworks. Section 6 presents the main results, and Section 7 concludes.

2 Literature review

Our paper relates to two main streams of the literature: the one on the economic consequences of monetary integration and the one on bounded rationality and its consequences for monetary policy.

The intellectual starting point of the former is the theory of optimum currency areas developed by Mundell (1961). Its central insight is that joining a monetary union deprives a country of two important stabilization instruments: an independent interest rate and adjustment through the nominal exchange rate. Consequently, country-specific shocks may generate larger fluctuations in output and employment unless other adjustment mechanisms, such as factor mobility, are sufficiently strong. The cost of relinquishing monetary autonomy should therefore be smaller when shocks are more symmetric and factors of production are more mobile. Later contributions extended this argument in two important directions. First, the criteria for forming an optimum currency area may themselves be endogenous: monetary integration can intensify trade and increase business-cycle synchronization, allowing a country to satisfy these criteria ex post even if it does not satisfy them ex ante (Frankel and Rose, 1998). Second, the stabilization costs of monetary unification must be weighed against its credibility and transaction-cost benefits (Alesina and Barro, 2002).

A particularly relevant strand of the monetary integration literature, to which our paper is related, uses model simulations to assess how an economy would perform under alternative monetary regimes. Lama and Rabanal (2014) compute welfare effects of a hypothetical UK accession to the euro area and show that they are positive when the risk premium is low,

but may turn into welfare losses when risk-premium volatility is high during financial crises. Negative effects on GDP and unemployment in the case of a hypothetical UK entry into the euro area are also documented by Mazumder and Pahl (2012). Bruha and Tonner (2018) show that Czech accession to the euro area would increase consumption and GDP due to the elimination of exchange-rate risk vis-à-vis the euro area, which is the Czech Republic's dominant trading partner, but at the cost of more economic volatility. For Poland, Gradzewicz and Makarski (2013) quantify the business-cycle implications of euro adoption and identify a trade-off that is also present in our results: relinquishing an independent monetary policy increases output volatility and stabilizes inflation. Similar results are obtained by Brzoza-Brzezina et al. (2014a) in a model with financial frictions in the context of participating in the common currency area during the global financial crisis. [1]

Against this background, our paper provides a novel perspective on the consequences of monetary integration in two dimensions. First, we examine how the assessment of euro adoption changes when agents form expectations under bounded rather than full rationality. Second, we use the model to distinguish the consequences of fixing the nominal exchange rate from those of losing an independent national interest rate. Existing counterfactual studies generally consider these two changes jointly, as inseparable elements of accession to a monetary union.

Regarding the first contribution, to the best of our knowledge, existing quantitative studies of monetary integration based on structural micro-founded models assume rational expectations. This assumption is increasingly difficult to reconcile with survey evidence showing that households and firms process information imperfectly (Coibion and Gorodnichenko, 2015; Bordalo et al., 2018; Goldstein, 2023). We build on the behavioral New Keynesian framework of Gabaix (2020), in which agents are partly myopic to future economic outcomes. The implications of these features for monetary-policy design have been explored i.a. by Bounader and Traficante (2022), Benchimol and Bounader (2023), and Dobrew et al. (2023). Monetary transmission is weaker, forward guidance is less powerful and the Taylor principle is relaxed, compared to the rational expectations benchmark. In open-economy settings, behavioral expectations can also help account for the uncovered interest parity puzzle and weaken international monetary transmission (Kolasa et al., 2022). These mechanisms are particularly relevant for evaluating monetary integration, as its costs depend crucially on the effectiveness of monetary policy, propagation of domestic and foreign shocks through the

[1] A broader literature examines mechanisms that may compensate for the loss of national monetary autonomy. These include national fiscal stabilization (Galí and Monacelli, 2008), fiscal devaluations and tax-based substitutes for monetary policy (de Mooij and Keen, 2012; Kaufmann, 2019), supranational fiscal insurance (Farhi and Werning, 2017; Kaufmann et al., 2023), and private and public risk-sharing channels (Cimadomo et al., 2018). More recent work studies how household heterogeneity and incomplete insurance affect the distributional consequences of monetary integration and the optimal stabilization of output and the exchange rate (Bayer et al., 2024; Acharya and Challe, 2025).

economy and the behavior of the exchange rate. Importantly, behavioral expectations have also been shown to outperform rational expectations is terms of data fit (Brzoza-Brzezina et al., 2025).

Our second contribution is to disentangle two policy restrictions that are bundled together during monetary-union accession: eliminating nominal exchange-rate adjustment and replacing the national policy rate with the common monetary-policy rate. Standard accession counterfactuals compare a regime combining a floating exchange rate with an independent interest rate against monetary-union membership, where the bilateral exchange rate is irrevocably fixed and the interest rate is set at the union level. This joint treatment reflects the well-known impossible trinity of monetary policy: under unrestricted capital mobility, a country cannot maintain a fixed exchange rate and simultaneously conduct an independent monetary policy. The empirical evidence broadly confirms this constraint. Under free capital mobility, stabilizing the exchange rate limits a central bank's ability to set interest rates independently. Accordingly, countries that peg their currency tend to follow the interest rate of the anchor country, especially when the peg is credible and capital controls are absent (Shambaugh, 2004; Obstfeld et al., 2005).

To the best of our knowledge, we are the first to document the impact of loosing the two instruments separately and we come up with a strong finding, that the consequences both for output and inflation are almost entirely related to exchange rate flexibility.

As a byproduct our decomposition provides a novel contribution to the literature that asks whether flexible exchange rates are net shock absorbers or shock generators. The traditional view, embedded in the OCA theory by Mundell (1961) is that losing the exchange rate is a cost, as a flexible exchange rate insulates the country against shocks. However, exchange rates can also generate shocks (e.g. due to financial transactions), so that *ex ante* it is not obvious whether fixing them is indeed costly (Gabaix and Maggiori (2015)). Several papers, tried to approach this problem from the empirical perspective. For instance Edwards and Levy Yeyati (2005) compare the economic performance of countries with fixed and flexible exchange rates in reaction to terms-of-trade shocks and show that flexible exchange rate arrangements play an insulating role. Farrant and Peersman (2006) use a VAR with sign restrictions and show that exchange rate fluctuations are mainly shock-generators. Artis and Ehrmann (2006) estimate SVAR models for four advanced economies and find that in most cases the shock-absorbing role of the exchange rate is small. De and Sun (2020) estimate a VAR model for the US and show that the exchange rate acted mainly as a shock generator. Dąbrowski and Wróblewska (2016) provide evidence for Poland and Slovakia which suggests that Poland's greater exchange-rate flexibility contributed to the absorption of macroeconomic shocks. The closest approach to ours is Beckmann et al. (2024) , who provide counterfactual simulations based on a SVAR model. However, their simulation neutralizes only the exchange rate reaction, leaving the interest rate to adjust to the counterfactual scenario. To the best of

our knowledge, the existing approaches do not explicitly separate the impact of the exchange rate from the reaction of interest rate policy, as these, as already explained, are inextricably intertwined. Our findings confirm that exchange-rate flexibility acts as a shock absorber for output fluctuations, although it increases inflation volatility.

3 Model

We study monetary integration in a two-country New Keynesian model with heterogeneous households and behavioral expectations. The model consists of a Home economy, representing Poland, with population share ω, and a Foreign economy, representing the euro area, with population share $1-\omega$. Each economy includes heterogeneous households, monopolistically competitive firms, and fiscal and monetary authorities.

The two economies are structurally symmetric but may differ in size and parameter values. Variables without an asterisk refer to the Home economy, whereas starred variables denote Foreign counterparts. Bars denote steady-state values and hats deviations from steady state. Given symmetry, we focus on the Home economy.

Agents form expectations according to the cognitive discounting framework of Gabaix (2020). Consider the nominal interest rate at time $t+k$, decomposed into its steady state value and its deviation as $R_{t+k} = \bar{R} + \hat{R}_{t+k}$. Behavioral expectations, denoted by E_t^{BE}, are defined by:

$$E_t^{BE} R_{t+k} = E_t(\bar{R}) + m^k E_t(\hat{R}_{t+k}), \tag{1}$$

where $m \in [0,1]$ measures the degree of cognitive discounting. Agents correctly perceive steady-state values, but discount future deviations from steady state. Lower values of m imply weaker forward-looking responses, while $m = 1$ corresponds to rational expectations.

3.1 Households

The household sector features Ricardian households, indexed by R and weighted by ω_R, and non-Ricardian hand-to-mouth households, indexed by N and weighted by ω_N. Both types supply labor, but only Ricardian households participate in financial and capital markets and make intertemporal decisions under behavioral expectations. Non-Ricardian households consume their current disposable income each period.

Preferences of household $j \in \{R, N\}$ over consumption $c_{j,t}$ and labor $n_{j,t}$ are given by:

$$E_0^{BE} \left\{ \sum_{t=0}^{\infty} \exp(\varepsilon_{u,t}) \beta^t \Big(\frac{c_{j,t}^{1-\sigma}}{1-\sigma} - \frac{n_{j,t}^{1+\gamma}}{1+\gamma} \Big) \right\}, \tag{2}$$

where $\beta \in (0,1)$ is the discount factor, σ is the inverse intertemporal elasticity of substitution,

and γ is the inverse Frisch elasticity. The term $\varepsilon_{u,t}$ denotes a discount factor shock following an AR(1) process with persistence ρ_c and standard deviations of innovations σ_c.

Ricardian households own physical capital $k_{R,t}$, rent it to firms at the real rental rate $r_{k,t}$, and purchase new capital at price Q_t. They also hold equity claims on domestic firms and receive the firms' profits in lump-sum form, denoted $\Pi_{R,t}$.

Since only Ricardian households participate in asset markets, bond positions are indexed by the residence of the holder. Thus, $B_{H,t}$ and $B_{F,t}$ denote home-bond holdings of home and foreign households, while $B^*_{H,t}$ and $B^*_{F,t}$ denote their holdings of foreign bonds. Home Ricardian households therefore trade home and foreign bonds, which yield gross nominal returns R_t and $R^*_t\kappa_t$, respectively, where κ_t is the risk premium.[2]. Following Schmitt-Grohe and Uribe (2003), the premium depends on the aggregate foreign debt position of the home country:

$$\kappa_t = \exp\left(-\chi\left(\frac{-S_t B^*_{H,t}}{P_t \tilde{y}_t} - d\right)\right)\varepsilon_{\kappa,t}, \tag{3}$$

where S_t denotes the nominal exchange rate, P_t the consumption price index, and $\tilde{y}_t$ GDP. The parameter d ensures a zero premium in steady state. The risk premium shock $\varepsilon_{\kappa,t}$ follows an AR(1) process with persistence ρ_κ and standard deviation of innovations σ_κ. Ricardian households receive firm profits Π_t.

To ensure that both Ricardian and non-Ricardian households supply the same amount of labor and receive the same nominal wage, we assume that each household supplies a continuum of differentiated labor types indexed by $h \in [0,1]$. Each labor type h receives a wage $W_t(h)$. The details of wage setting are described in the following subsection. Their nominal budget constraint is:

$$\begin{aligned} P_t c_{R,t} + Q_t k_{R,t} + \frac{B_{H,t}}{\omega_R} + S_t\frac{B^*_{H,t}}{\omega_R} + P_t T_t \leq \int_0^1 W_t(h) n_{R,t}(h)dh + R_{t-1}\frac{B_{H,t-1}}{\omega_R} \\ + S_t\kappa_{t-1}R^*_{t-1}\frac{B^*_{H,t-1}}{\omega_R} + r_{k,t}k_{R,t-1} + Q_t(1-\delta)k_{R,t-1} + P_t\Pi_{R,t}, \end{aligned} \tag{4}$$

where T_t denotes lump-sum taxes.

Non-Ricardian households do not own assets and consume their entire labor income net of taxes in each period:

$$P_t c_{N,t} = \int_0^1 W_t(h) n_{N,t}(h)dh - P_t T_t. \tag{5}$$

Aggregate consumption and labor supply for each labor type h are defined as population-

[2]The model is calibrated such that, around the steady state, the home economy is a net borrower and the foreign economy is a net lender.

weighted averages:

$$c_t = \omega_R c_{R,t} + \omega_N c_{N,t}, \qquad n_t(h) = \omega_R n_{R,t}(h) + \omega_N n_{N,t}(h). \tag{6}$$

In contrast, aggregate home-household holdings of domestic and foreign bonds, as well as aggregate physical capital and the stream of dividends from firms, are held exclusively by Ricardian households. Hence, each Ricardian household holds $B_{H,t}/\omega_R$ units of home bonds and $B^*_{H,t}/\omega_R$ units of foreign bonds, while aggregate capital and dividends satisfy

$$k_t = \omega_R k_{R,t}, \qquad \Pi_t = \omega_R \Pi_{R,t}. \tag{7}$$

3.2 Wage setting

We assume that households supply a continuum of differentiated labor types indexed by $h \in [0, 1]$, with the elasticity of substitution across labor types denoted by ϕ_n. For each labor type h, a labor union sets the nominal wage $W_t(h)$ in a monopolistically competitive labor market. Each union represents fixed shares of Ricardian (ω_R) and non-Ricardian (ω_N) households, which are uniformly distributed across labor types. Since all households are affiliated with every union, they receive the same effective wage and supply the same amount of labor in equilibrium.

Nominal wages are subject to rigidity following the Calvo (1983) mechanism. In each period, a fraction $1 - \theta_w$ of labor unions can reoptimize their nominal wage, while the remaining fraction θ_w keeps its previous wage, indexed to past wage inflation. Specifically, wages are indexed to a geometrically weighted average of past wage inflation and the steady-state wage inflation rate, with the weight on past wage inflation given by ζ_w.

The labor market is also subject to wage markup shocks. The process $\varepsilon_{w,t}$ follows an AR(1) process with persistence parameter ρ_w and standard deviation of innovations σ_w.

3.3 Producers

The economy includes several types of firms, all owned by Ricardian households. Final goods are produced by perfectly competitive firms that aggregate a continuum of intermediate goods. These intermediate goods are supplied by monopolistically competitive producers using capital and labor as inputs. Final goods are either consumed or used to produce new capital, subject to investment adjustment costs.

3.3.1 Capital Good Producers

Each period, perfectly competitive capital-good producers combine undepreciated capital from the previous period with new investment to produce the aggregate capital stock. Capital

evolves according to:

$$k_t = (1-\delta)k_{t-1} + \varepsilon_{i,t}\left(1 - S\left(\frac{i_t}{i_{t-1}}\right)\right) i_t, \tag{8}$$

where k_t is the aggregate capital stock, i_t denotes gross investment, δ is the depreciation rate, and $\varepsilon_{i,t}$ is an investment-specific technology shock following an AR(1) process with persistence ρ_i and standard deviation σ_i.

The adjustment cost function takes the standard quadratic form:

$$S\left(\frac{i_t}{i_{t-1}}\right) = \frac{\psi_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2, \tag{9}$$

where $\psi_I > 0$ governs the intensity of investment adjustment costs.

3.3.2 Final Good Producers

Perfectly competitive final good producers purchase domestic and foreign varieties of differentiated intermediate goods, $y_{H,t}$ and $y_{F,t}$, and aggregate them into a homogeneous good using a constant elasticity of substitution (CES) technology:

$$y_t = \left[(1-\eta_H)^{\frac{1}{\phi_y}} y_{F,t}^{\frac{\phi_y - 1}{\phi_y}} + \eta_H^{\frac{1}{\phi_y}} y_{H,t}^{\frac{\phi_y - 1}{\phi_y}}\right]^{\frac{\phi_y}{\phi_y - 1}}, \tag{10}$$

where $\eta_H \in (0,1)$ denotes the degree of home bias in demand and $\phi_y > 1$ is the elasticity of substitution between domestic and foreign goods.

The domestic and foreign aggregates are themselves CES combinations of differentiated intermediate goods produced by firms indexed by $i \in [0,1]$:

$$y_{H,t} = \left(\int_0^1 y_{H,t}(i)^{\frac{1}{\mu_{p,t}}}, di\right)^{\mu_{p,t}}, \qquad y_{F,t} = \left(\int_0^1 y_{F,t}(i)^{\frac{1}{\mu_{p,t}}}, di\right)^{\mu_{p,t}}, \tag{11}$$

where $\mu_{p,t}$ captures time-varying markup shocks, which follow an AR(1) process characterized by persistence parameter ρ_p and innovation standard deviation σ_p.

3.3.3 Intermediate Goods Producers

Intermediate goods producers indexed by $i \in [0,1]$ use capital and labor to produce output according to the Cobb-Douglas production function:

$$y_{H,t}(i) + \frac{1-\omega}{\omega} y_{H,t}^*(i) = z_t k_t(i)^{\alpha} n_t(i)^{1-\alpha}, \tag{12}$$

where z_t is a total factor productivity shock following an AR(1) process with persistence ρ_z and standard deviation σ_z.

Producers operate in a monopolistically competitive market and set prices following the Calvo (1983) mechanism. Each period, a firm has a probability $1-\theta_H$ of resetting its price. Otherwise, prices are updated according to an indexation rule $\pi_t^{\zeta,H} = \pi_{t-1}^{\zeta_H}\bar{\pi}^{(1-\zeta_H)}$, where $\zeta_H \in [0,1]$ controls the degree of indexation to past inflation, and $\bar{\pi}$ denotes the steady-state inflation rate.

3.4 Government and the central bank

The government finances its spending using lump-sum taxes and issues debt to cover any shortfalls. Its intertemporal budget constraint is given by:

$$g_t + R_t b_{G,t-1} = T_t + b_{G,t} \tag{13}$$

where $b_{G,t} = B_{G,t}/P_t$ denotes the real value of government debt. Taxes follow a simple feedback rule aimed at stabilizing debt around its steady-state level:

$$\frac{T_t - \bar{T}}{\bar{T}} = \nu \frac{b_{G,t} - \bar{b}_G}{\bar{b}_G}$$

This ensures that taxes adjust gradually in response to deviations of debt from its long-run target. Government spending follows a standard AR(1) process with persistence ρ_g and standard deviation of innovations σ_g.

Monetary policy follows a Taylor-type rule in which the central bank adjusts the nominal interest rate in response to inflation and output deviations from the steady state:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\gamma_\pi} \left(\frac{\tilde{y}_t}{\bar{\tilde{y}}}\right)^{\gamma_y}\right]^{1-\gamma_R} e^{\varepsilon_{R,t}} \tag{14}$$

Here, γ_π and γ_y govern the response to inflation and output, while γ_R captures interest-rate smoothing. The term $\varepsilon_{R,t}$ is an i.i.d. monetary policy shock with standard deviation σ_R.

3.5 Monetary Union accession

This section describes how the model adjusts when the home country joins a monetary union. In this regime, national monetary policy is replaced by a union-wide policy, with the central bank setting a single nominal interest rate based on aggregate conditions across member states.

Specifically, the monetary policy rule now responds to a weighted average of inflation and output in the union. The modified Taylor rule that determines the union-wide nominal

interest rate R_t^* is given by:

$$\frac{R_t^*}{R^*} = \left(\frac{R_{t-1}^*}{R^*}\right)^{\gamma_R^*} \left[\left(\frac{(1-\omega)\pi_t^* + \omega\pi_t}{\bar{\pi}}\right)^{\gamma_\pi^*} \left(\frac{(1-\omega)\tilde{y}_t^* + \omega\tilde{y}_t}{\bar{\tilde{y}}}\right)^{\gamma_y^*}\right]^{1-\gamma_R^*} e^{\varepsilon_{R,t}^*} \tag{15}$$

and the domestic nominal interest rate is set equal to the union-wide rate:

$$R_t = R_t^*. \tag{16}$$

Moreover, joining a monetary union with a fixed nominal exchange rate implies that the domestic currency can no longer adjust independently. As a result, the uncovered interest parity (UIP) condition (A.4) is replaced by an identity describing the evolution of the real exchange rate in log-deviations from the steady state:

$$\hat{q}_t - \hat{q}_{t-1} = \hat{\pi}_t^* - \hat{\pi}_t \tag{17}$$

This equation indicates that, in the absence of nominal exchange rate flexibility, the real exchange rate adjusts entirely through inflation differentials between the domestic economy and the rest of the monetary union.

Importantly, the fixed exchange rate and shared monetary policy imply that shocks to domestic interest rate setting ($\varepsilon_{R,t}$) and the risk premium ($\varepsilon_{\kappa,t}$) become irrelevant in the context of a monetary union. This structural change plays a notable role in shaping our results on the macroeconomic effects of euro area accession.

4 Calibration and estimation

4.1 Calibrated parameters

Following standard practice in the literature, we calibrate the majority of parameters that determine the model's steady state equilibrium. The calibration targets are set to match average values of key macroeconomic ratios observed over the 2000 - 2025 period. The full set of calibrated parameters is shown in Table 1, while Table 2 reports the corresponding steady state targets.

Table 1: Calibrated Parameters

Parameter	Value	Description
ω	0.05	Agents residing in home country (Poland)
ω_R, ω_R^*	0.8	Share of Ricardian households
ω_N, ω_N^*	0.2	Share of Hand-to-mouth households
α, α^*	0.3	Capital share in production function
β, β^*	0.995	Discount factors
γ, γ^*	1	Inverse of Frisch elasticities of labor supply
ϕ_y, ϕ_y^*	2.5	Elasticity of substitution between home and foreign goods
ϕ_n, ϕ_n^*	6	Elasticity of substitution across labor types
μ_p, μ_p^*	1.2	Gross markups
η_H	0.7	Home bias in consumption (Poland)
η_H^*	0.98	Home bias in consumption (EA)
ν, ν^*	0.1	Semi-elasticity of taxes

Table 2: Steady state ratios

Steady state ratio	Value
Export to GDP ratio (Poland)	0.30
Export to GDP ratio (EA)	0.016
Government spending to GDP ratio	0.2
Gov. debt to GDP ratio (Poland)	1.27
Gov. debt to GDP ratio (EA)	1.74
Foreign debt to GDP ratio (Poland)	0.60

The model distinguishes between two economies: Poland and the euro area (EA). We calibrate Poland's economic size to 5%, which approximately reflects Poland's GDP to euro area GDP ratio. The domestic content of Poland's consumption is set at 0.7, aligning with the estimates in Bussière et al. (2013). When adjusted for relative country sizes, this implies a corresponding home bias in the euro area consumption of 0.98.

To determine steady state government debt ratios, we take the average shares of government debt held by residents in GDP for both regions. These average annual ratios amount to 31.7% for Poland and 43.5% for the euro area. Poland's steady state external debt-to-GDP ratio is set in line with the net holdings of debt securities (liabilities minus assets) by domestic agents, based on international investment position data, and is calibrated at 15% of GDP.

As there is little empirical evidence of substantial or persistent differences between Poland and the euro area in the remaining steady state ratios—and since such asymmetries are not central to our analysis—we assume symmetry in the rest of the calibration. Government spending is fixed at 20% of GDP in both regions. Following Brzoza-Brzezina et al. (2014b), we set the elasticity of substitution between home and foreign goods to 2.5 and the average

gross markup to 1.2. The discount factor is calibrated to 0.995, which implies an annual real interest rate of approximately 2%. We also set the inverse of the Frisch elasticity of labor supply to 1.

Regarding household composition, we assume that Ricardian households represent 80% of the population in both Poland and the euro area. Finally, for the production function, the capital share is calibrated to 0.3.

4.2 Estimation procedure

We estimate the remaining parameters using a dataset spanning the period from 2000Q1 to 2026Q2, resulting in 106 quarterly observations. The initial period is set one year after two key structural changes: the launch of the euro in the euro area and the adoption of inflation targeting in Poland. The estimation is based on seven macroeconomic series for both Poland and the euro area: gross domestic product, real private consumption, real government expenditure, HICP inflation, the short-term nominal interest rate, real investment, and real wages. In addition, we include the real exchange rate between the two regions as an observable variable.

All data, except the Polish interest rate and Polish wages, are sourced from the Eurostat database. For GDP and its expenditure components, i.e. consumption, investment, and government spending, we use seasonally adjusted national accounts indexes (2021=100) expressed in constant prices. Wage series for the euro area are constructed using total compensation from national accounts, expressed in current prices, divided by the number of employed persons, and deflated by the CPI. For Poland, seasonally adjusted nominal wage data are obtained from Statistics Poland and deflated using the CPI. For inflation we use the Harmonised Index of Consumer Prices (2025=100) which we log-differentiate to obtain quarter-to-quarter inflation. The EUR/PLN real effective exchange rate series is also drawn from Eurostat, while data on short-term interest rates comes from Eurostat for the euro area and from the financial market platform `stooq.com` for Poland. Next, series on inflation and interest rates are demeaned, while all the remaining variables are detrended using the HP filter.

We estimate the model using Bayesian techniques. Prior distributions for most parameters are chosen based on values commonly found in the literature. For the behavioral parameter m, we assume a beta prior with a mean of 0.85, following the suggestion of Gabaix (2020).

The model includes fifteen structural shocks: productivity, time preference, price markup, monetary policy, government spending, wage markup, and investment shocks for each of the two regions, along with an international risk premium shock. All shocks are modeled as AR(1) processes, except for the monetary policy shock, which is assumed to follow a white

noise process. The prior mean of the autoregressive coefficients is set to 0.7, with relatively wide standard deviations to reflect parameter uncertainty. Shock standard deviations are assigned priors centered at 0.01, with the exception of the monetary policy and productivity shocks, for which the prior means are set to 0.0025 and 0.005, respectively. Furthermore, we account for potential measurement errors in wage and national account data.[3]

Model estimation is carried out in `Dynare` version 5.5. We begin by obtaining the posterior mode using the optimization routine developed by Christopher Sims. Subsequently, we employ the Metropolis-Hastings algorithm, running two independent chains with 200,000 draws each. Convergence is confirmed through diagnostic statistics proposed by Brooks and Gelman (1998). Posterior distributions are based on the second half of the draws. Tables 5 and 6 summarize the resulting posterior means and standard deviations. The dataset proves informative for most of the estimated parameters, and the posterior modes align well with those reported in the literature for both Poland and the euro area. The posterior mean of parameter m is 0.8.

In addition to the behavioral expectations model, we estimate a rational expectations variant[4]. The same prior distributions are applied, except for the behavioral parameter, which is set to unity. This comparative exercise allows us to evaluate which framework fits the data better. Using standard Bayesian model comparison, we compute the Bayes factor $F = p(D|M_{BE})/p(D|M_{RE})$, i.e., the ratio of marginal likelihoods of the two models. Following Cuba-Borda and Singh (2024), we consider the statistic $2 \cdot \log(F)$, where a value greater than 10 is interpreted as "very strong" evidence in favor of the model with higher marginal likelihood, as per the classification of Kass and Raftery (1995). In our case, the value of this statistic is 46, strongly favoring the behavioral model over its rational expectations counterpart. Hence, in what follows, we treat the BE model as our baseline.

5 Economic Dynamics Inside and Outside of the Monetary Union

Before presenting the overall effects of Poland's hypothetical participation in the monetary union, we examine how membership changes the transmission of monetary and fiscal policy and selected structural shocks. We compare behavioral expectations which, given the estimation results, constitute our baseline specification and rational expectations, which provide the standard benchmark.

To isolate the role of expectation formation, the RE variant used in this section is constructed by setting $m = 1$ in the model estimated under BE ($m = 0.80$), while holding the

[3]We calibrate their standard deviation to 0.5 percent, so that they do not have a significant impact on the results.

[4]The rational model estimation results are presented in the Appendix (tables 7 and 8).

remaining structural parameters and the size of each shock constant.

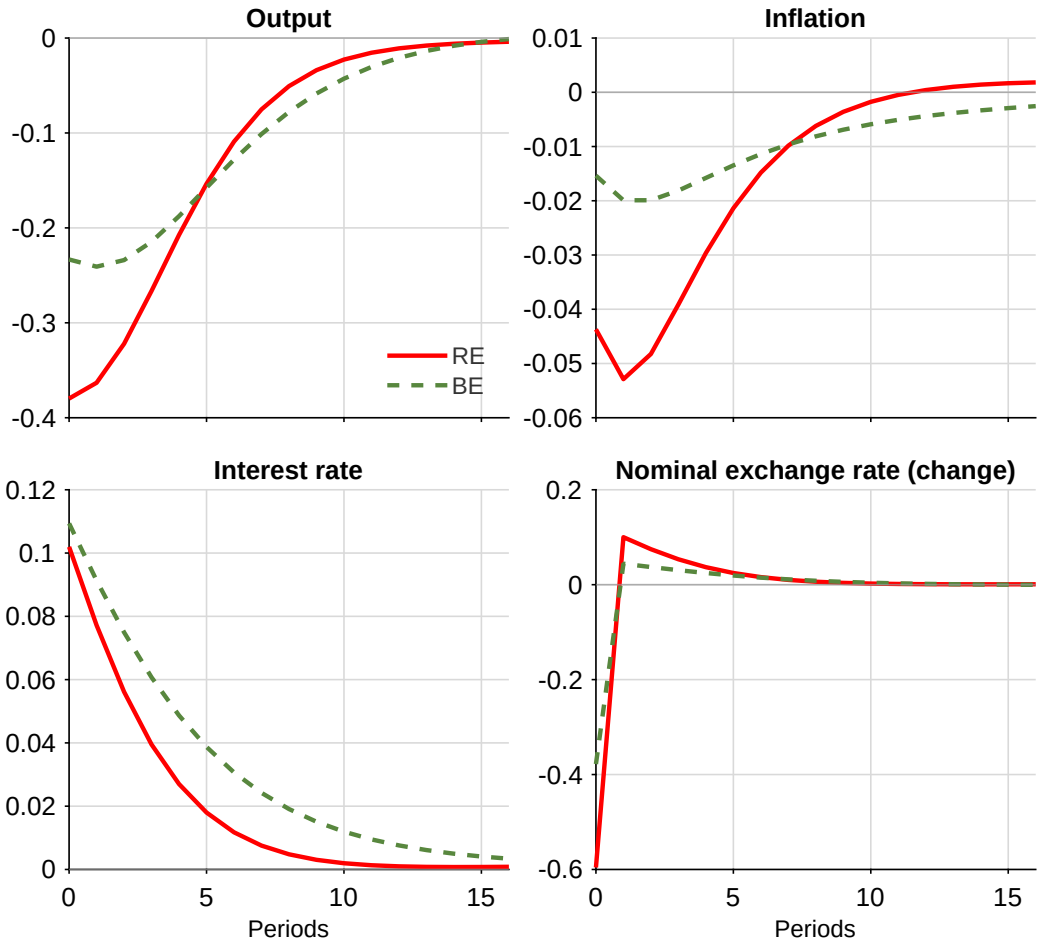
5.1 The working of monetary policy

We begin with comparing the working of monetary policy under BE and RE (for obvious reasons domestic monetary policy is nonexistent after joining the monetary union, so this dimension of comparison is absent). This helps to understand whether the loss of monetary autonomy is more or less costly when accounting for bounded rationality. Figure 1 presents the impulse responses to a contractionary monetary policy shock in the case where Poland operates outside the monetary union and retains full control over its interest rate.

Rational Expectations Under rational expectations (RE), agents fully internalize the future path of the policy interest rate. A monetary tightening immediately affects consumption and investment decisions, primarily through the intertemporal substitution channel. Forward-looking households reduce consumption in anticipation of lower future income and higher real interest rates, while firms adjust prices and wages accordingly. The resulting decline in current labor income also reduces the consumption of hand-to-mouth households, reinforcing the contraction in aggregate demand. As a result, output contracts sharply and inflation falls. The transmission is front-loaded and relatively short-lived, reflecting the efficient anchoring of expectations around the new policy path.

Behavioral Expectations Under behavioral expectations, agents exhibit cognitive discounting and respond less strongly to future policy changes. As in Gabaix (2020), expectations about future interest rates are attenuated, which weakens forward-looking behavior. Optimizing households react less to changes in the anticipated real interest rate path, while hand-to-mouth households—who base consumption purely on current income—remain largely insensitive to interest rates. This behavioral inertia leads to a more muted and delayed contraction in output and inflation. Although the initial effects are smaller compared to the RE case, the shock propagates internally, resulting in a more persistent deviation from the steady state.

Figure 1: Impulse Response to Monetary Shock

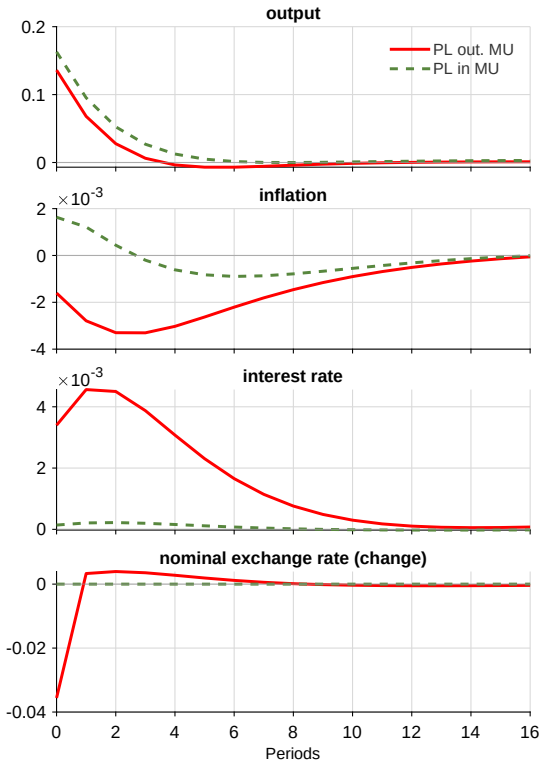


5.2 The working of fiscal policy

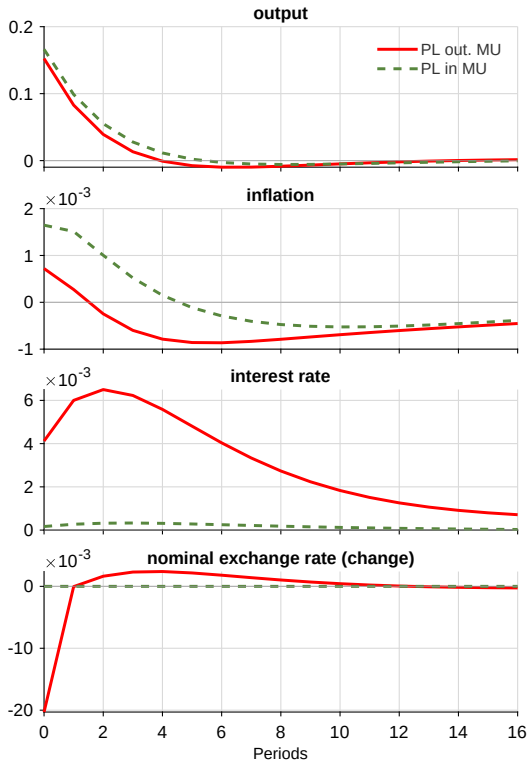
Under monetary autonomy monetary policy remains the primary stabilization instrument, and fiscal policy plays a supportive role. Upon entering the monetary union, with loss of the monetary instrument, fiscal policy becomes the key economic policy for stabilizing the economy. In what follows we compare the consequences of an exogenous increase in domestic government spending.

Figure 2: Impulse Response to Government Spending Shock

(a) Rational Model



(b) Behavioral Model



Rational Expectations Under rational expectations (Figure 2a), monetary policy is highly effective at stabilizing demand through intertemporal substitution. Consequently, outside a monetary union, fiscal expansions tend to trigger an offsetting monetary tightening by the central bank, limiting their short-run effect on output. However, once monetary autonomy is surrendered, this offset is removed. As a result, the impact on output (and the fiscal multiplier) is considerably larger inside the monetary union than outside, reflecting the stronger role of fiscal policy when interest rates are fixed.

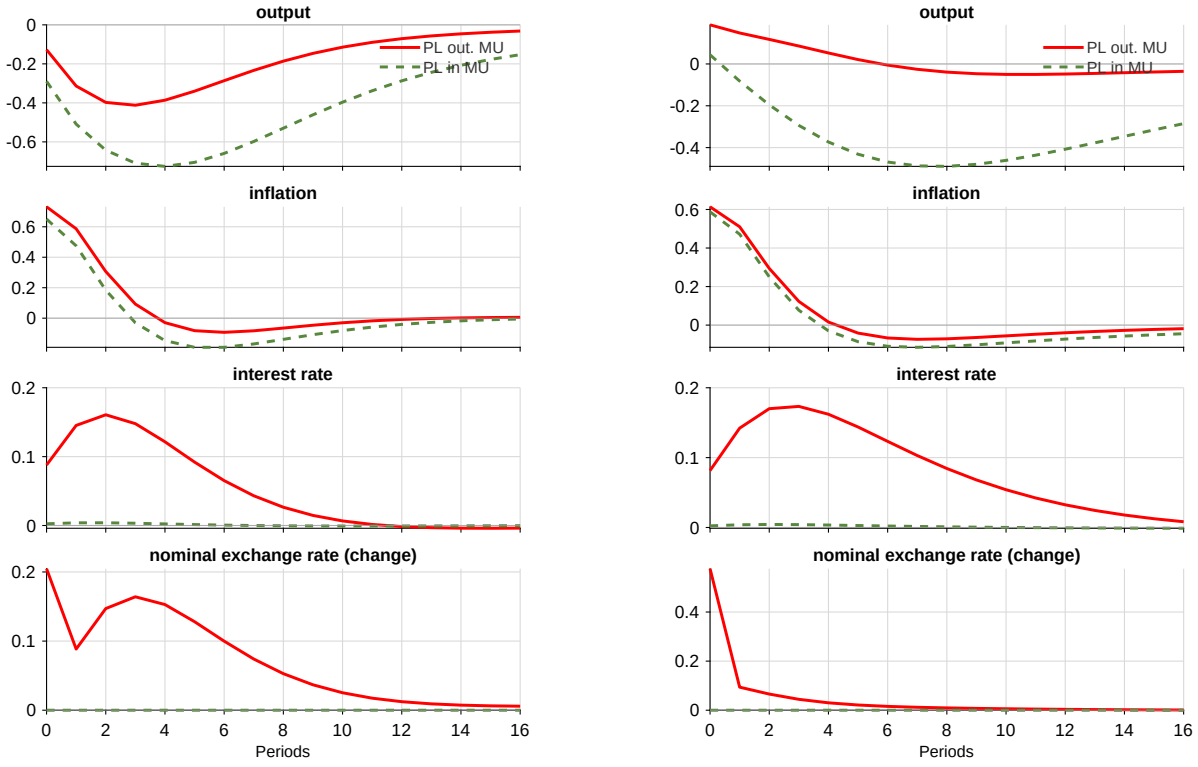
Behavioral Expectations Under behavioral expectations (Figure 2b), the forward-looking channel of intertemporal substitution is muted and, as explained above monetary policy is less powerful. This diminishes the role of interest rates in crowding-out the effects of fiscal expansions. As a result, fiscal policy becomes a more effective stabilization tool in absolute terms. However, because the interest rate channel is weaker to begin with, the change in fiscal effectiveness from entering a monetary union is smaller. That is, the increase in fiscal multipliers due to monetary integration is less pronounced under behavioral than under rational expectations.

5.3 The transmission of price markup shocks

Figures 3a and 3b present the impulse responses to a domestic mark-up shock for Poland. The shock increases firms' desired mark-ups, raising inflation and exerting downward pressure on output—a standard cost-push mechanism. However, the adjustment dynamics diverge sharply depending on Poland's monetary regime, particularly due to differences in monetary policy autonomy and exchange rate flexibility.

Figure 3: Impulse Response to Markup Shock

(a) Rational Model (b) Behavioral Model



Rational expectations Under monetary autonomy the central bank raises interest rates in response to the shock, helping contain inflation. However, at the same time the exchange rate depreciates, as consumers turn from more expensive domestic goods to foreign alternatives, thus increasing imports and demand for foreign exchange. This depreciation increases import prices and thus inflation, but it also improves external competitiveness and boost output. As a consequence under independent monetary policy and flexible exchange rate output contraction is reduced.

In contrast, within a monetary union, the exchange rate remains fixed and thus does not cushion the shock. Since prices rise in response to the markup shock, and the nominal

exchange rate is fixed, the real exchange rate appreciates more strongly than under the independent regime. This real appreciation, driven entirely by domestic inflation, reduces competitiveness and deepens the fall in output—even though inflation increases by less than outside the union.

Thus, outside a monetary union, exchange rate adjustment serves as a buffer against domestic cost shocks—stabilizing output at the cost of greater inflation volatility.

Behavioral expectations Under behavioral expectations, the mechanism is similar. However, as the exchange rate depreciates more than under RE, the stabilizing effect of maintaining independent monetary and exchange rate policy is stronger.

As a flip-side, within a monetary union, where Poland cannot adjust interest rates or the nominal exchange rate, domestic prices carry the full burden of adjustment. This results in a stronger real appreciation than under monetary independence which depresses output.

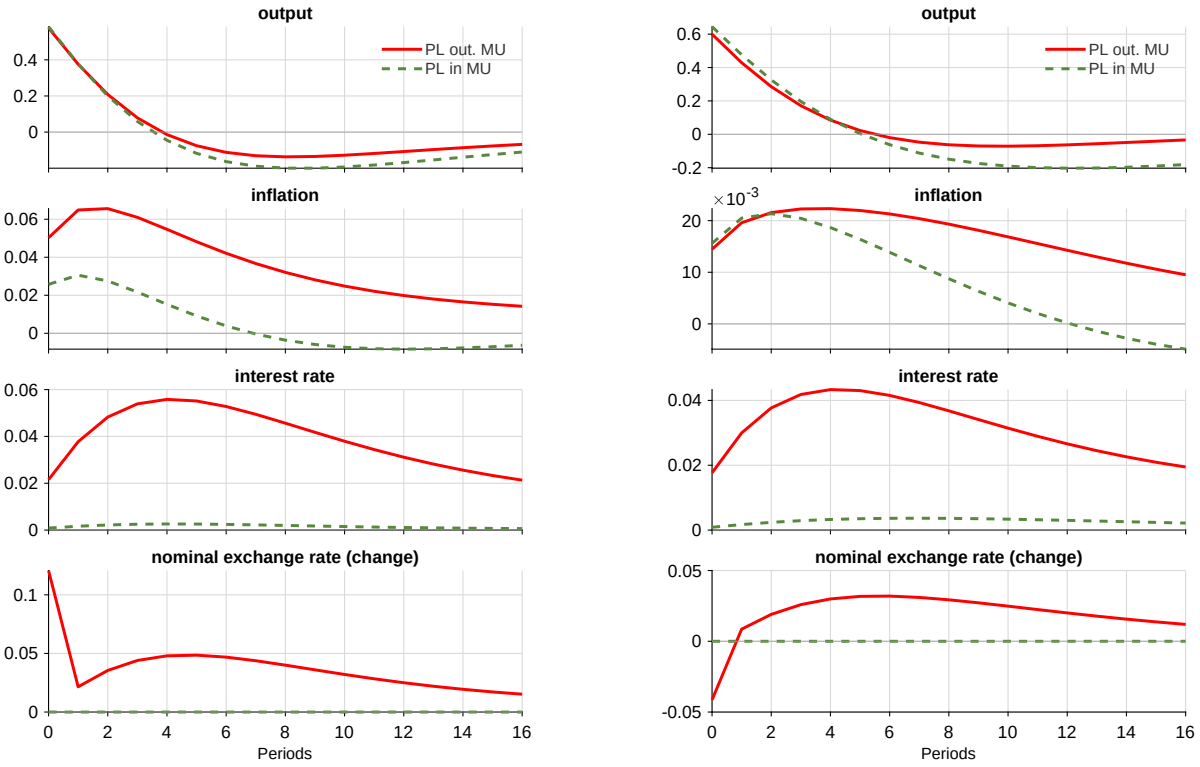
5.4 The transmission of Consumption Preference Shocks

Figures 4a and 4b show the impulse responses to a domestic consumption preference shock. The shock increases households' preference for current consumption, raising aggregate demand and triggering a simultaneous rise in output and inflation—consistent with a standard demand-driven mechanism.

Figure 4: Impulse Response Function to Consumption Preference Shocks

(a) Rational Model

(b) Behavioral Model



Rational expectations Under rational expectations and monetary independence, Poland can raise its policy interest rate in response to the demand pressure. However, increased domestic demand raises imports, demand for foreign exchange and thus leads to a depreciation of the nominal exchange rate. This depreciation, in turn, raises import prices, contributing to inflation, but also boosts external competitiveness, amplifying (i.e. further destabilizing) the output response.

Inside the monetary union neither the interest rate nor the exchange rate can adjust. The latter effect proves more important for inflation whose reaction is muted. The impact of accession for output is, on the other hand, negligible.

Behavioral expectations Under behavioral expectations the overall pattern of adjustment remains similar to the rational model. However, as the exchange rate depreciation is much smaller (in fact it even appreciates on impact), so are the consequences of joining the monetary union. As a consequence the inflation stabilizing effect of being part of the euro area is also less pronounced.

All in all, our investigation of how monetary integration and expectation formation affect the economy delivers a mixed picture: some shocks and policies become more powerful in a monetary union, while others do not. Hence, the ultimate question about the effects of accession becomes empirical and quantitative. The next section offers several counterfactual simulations which offer a view how these forces would have worked out given historical developments.

6 What Happened and What Could Have

To analyze the macroeconomic implications of Poland's accession to the euro area, we show the counterfactual consequences of euro adoption in a historical context. The exercise compares the counterfactual paths of key macroeconomic variables with the historical path observed under monetary independence.

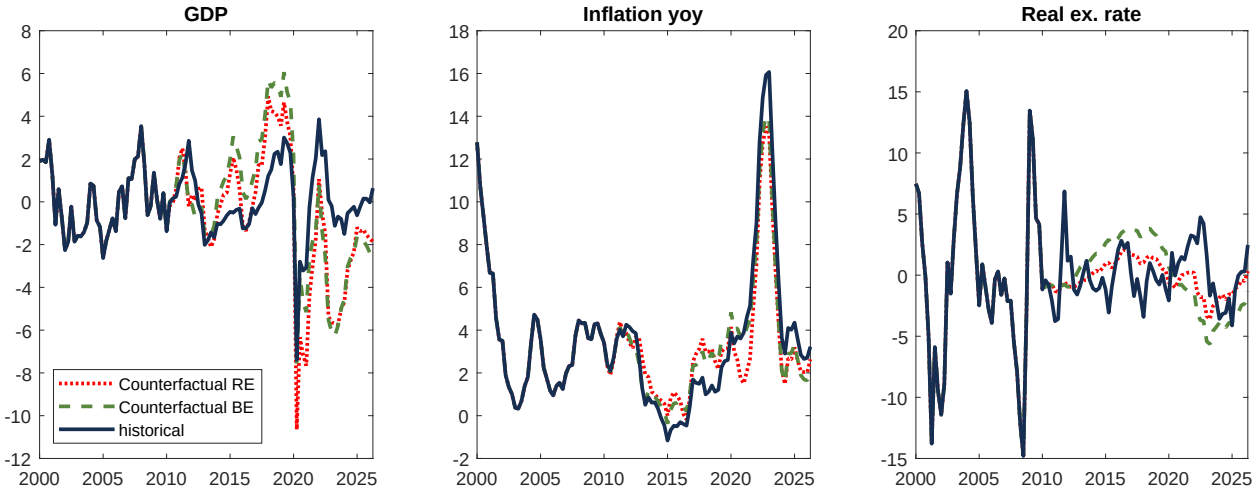
Our main scenario considers euro adoption with the real exchange rate being close to its long-run equilibrium value. This case provides a natural benchmark because it isolates the effects of monetary integration from the effects of an initial exchange-rate misalignment. We then find two additional accession dates to assess how the results change when the currency is initially overvalued or undervalued.

The period around the global financial crisis provides a useful setting for this comparison. At the onset of the GFC, in 2008Q3, Poland's real effective exchange rate (REER) was substantially appreciated, standing approximately 15% below its estimated trend level. We treat this point as counterfactual accession under an overvalued currency. By 2009Q1, the zloty had undergone a sharp depreciation, with the REER reaching 15% above trend, representing accession under an undervalued currency. Finally, by 2010Q1, the REER had returned close to its steady-state value; we interpret this case as the benchmark scenario in which the currency is neither overvalued nor undervalued at the time of accession.

6.1 Macroeconomic Effects of Monetary Union Entry in Q1 2010

This subsection examines a counterfactual scenario in which Poland adopts the euro in the first quarter of 2010. The simulation compares macroeconomic outcomes under rational expectations (RE) and behavioral expectations (BE), focusing on output, inflation, interest rates, and the real exchange rate (RER). The results highlight how the interaction between expectation formation and monetary integration shapes the transmission of shocks and the broader macroeconomic environment. Figure 5 plots the actual paths of key macroeconomic variables alongside their counterfactual trajectories under both BE and RE, offering a visual comparison of how euro adoption would have altered Poland's economic landscape.

Figure 5: Counterfactual Euro Adoption in 2010Q1: Actual vs. Simulated Paths



Note: GDP and real exchange ate in percent deviations from trend.

Let us begin with the counterfactual simulations under our baseline assumption of behavioral expectations, while treating the rational-expectations outcomes as a point of reference. Joining the monetary union imposes two critical constraints: interest rates are determined externally by the union-level authority, and the nominal exchange rate becomes fixed. As documented in the preceding section these institutional changes fundamentally alter the shock transmission mechanism.

The real exchange rate becomes a central adjustment variable. In the historical (non-euro) scenario, shocks that depress output are partially cushioned by nominal depreciation, which enhances external competitiveness and supports domestic demand. In contrast, under euro adoption, this mechanism is disabled. Any necessary real exchange rate adjustment must occur via domestic price changes, which are slower and more rigid.

This shift has notable macroeconomic implications. In the counterfactual euro adoption scenario, the real appreciation episodes observed historically in 2014 and 2016 would have been mitigated, potentially resulting in stronger GDP performance during those periods. Conversely, the post-COVID nominal —and associated real— depreciation would not have occurred, implying a more sluggish recovery in the aftermath of the pandemic.

Table 3: Macroeconomic Volatility: Euro Adoption in 2010Q1

Variable	Historical	Counterfactual	
		Behavioral	Rational
GDP	1.7	3.3	3.2
Inflation (YOY)	3.6	2.9	2.7

Note: Entries report standard deviations (in percent) of GDP and year-on-year inflation under historical conditions and in a counterfactual scenario where Poland adopts the euro in 2010Q1. The comparison is made under behavioral and rational expectations.

Table 3 confirms that adopting the euro under BE would have increased output volatility (from 1.7% to 3.3%) while reducing inflation volatility (from 3.6% to 2.9%).

Having said this, it becomes essential to explain why amplification of GDP is matched with stabilization of inflation. Our line of reasoning is as follows. Inflation is primarily shaped by nominal exchange rate fluctuations, which (subject to price stickiness) translate one-to-one to import prices. Joining the monetary union perfectly stabilizes the nominal exchange rate and, hence, contributes to inflation stability.

In contrast, GDP is primarily driven by the volatility of the real exchange rate, which determines the competitiveness of imports and exports. The real exchange rate is not fixed in a monetary union and its deviations from steady state can become more persistent, as they can be corrected only via sluggish adjustment of relative prices.

Let us compare these findings with what an RE model would have predicted. As Section 5 showed this comparison is an empirical question, since differences between the RE and BE frameworks go in either direction. Table 3 shows that the RE model would predict an increase in output volatility to 3.2%, compared with a slightly higer volatility of 3.3% under BE. This difference in output volatility is accompanied by slightly stronger inflation smoothing under RE, with inflation volatility falling to 2.7% under RE versus 2.9% under BE.

Since the BE model provides a better fit to the data, the estimated RE model should be viewed as misspecified for the purpose of this counterfactual exercise. The comparison therefore measures the error one would make by imposing rational expectations, rather than describing how monetary integration would have unfolded in an economy where agents truly formed rational expectations. Our main conclusion is, that given the important differences in transmission documented earlier, this error is (at least in the historical context of Poland) surprisingly small.

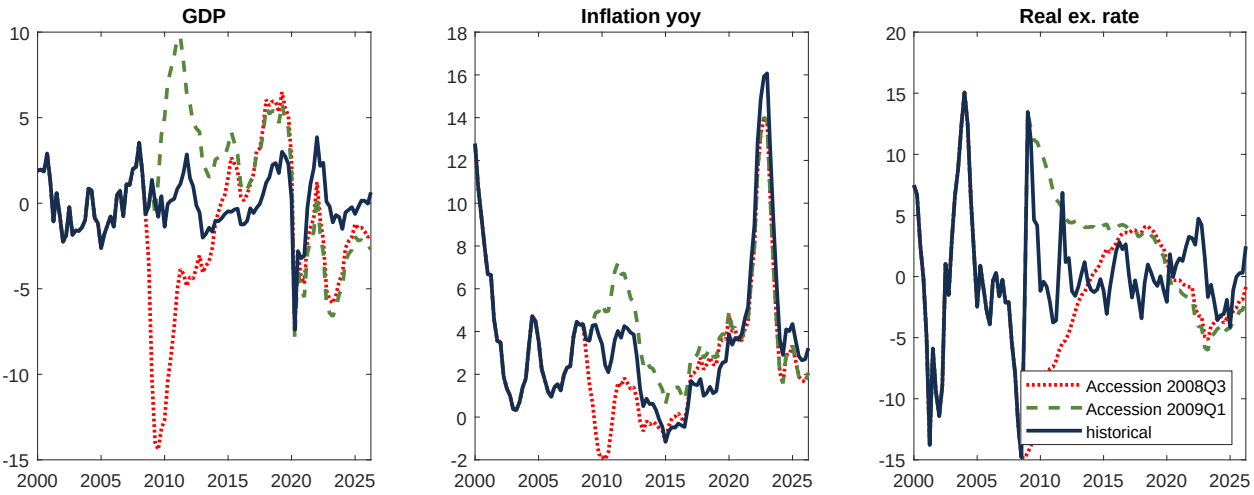
6.2 Monetary Union Entry under Initial Real Exchange Rate Misalignment

The macroeconomic effects of euro adoption depend critically on the level of the real exchange rate at the moment of entry. In both episodes, joining the monetary union eliminates nominal exchange rate adjustment and replaces independent monetary policy with a common interest rate. Because prices and wages adjust only gradually, any initial real exchange rate misalignment is not corrected immediately, but remains embedded in the economy for some time.

When entry occurs with an appreciated real exchange rate, as in 2008Q3, monetary integration locks the economy into a position of weak external competitiveness. As shown by the red dotted line on Figure 6, with depreciation no longer available, adjustment must proceed through lower domestic inflation and, eventually, deflation. This produces a prolonged contraction in output, as exports weaken and domestic demand remains subdued. In this case, euro adoption amplifies the costs of prior overvaluation by turning a temporary misalignment into a persistent drag on activity.

When entry occurs with a depreciated real exchange rate, as in 2009Q1, the same mechanism operates in the opposite direction. As shown by the green dashed line in Figure 6, fixing the exchange rate at an initially undervalued level preserves external competitiveness and generates a temporary expansion in output. Since real appreciation can occur only through gradually rising domestic prices, the improvement in competitiveness fades slowly, making the boom persistent over several years ahead. These gains are therefore accompanied by higher inflation and are gradually eroded as internal adjustment proceeds.

Figure 6: Real Exchange Rate Misalignment at Euro Adoption



Note: The figure compares the historical path, shown by the solid dark-blue line, with simulated paths under two counterfactual euro adoption scenarios. The red dotted line refers to adoption in 2008Q3, when the real exchange rate was appreciated, while the green dashed line refers to adoption in 2009Q1, when the real exchange rate was depreciated.

Taken together, the two episodes highlight a central implication of monetary union entry under real exchange rate misalignment: the macroeconomic effects of euro adoption are highly state-dependent. The same institutional change can be sharply contractionary or temporarily expansionary depending on whether the economy enters the monetary union with an overvalued or undervalued real exchange rate. More broadly, the macroeconomic consequences of euro adoption depend not only on the structure of the economy, but also on the state of external competitiveness at the time of entry. Importantly, the effects of exchange rate misalignment are highly persistent, the two scenarios align approximately in 2016, over seven years after hypothetical accession.

6.3 Role of the Flexible Exchange Rate and Independent Interest Rate Policy

In the previous subsections we analyzed the effects of loosing monetary autonomy, i.e. fixing the exchange rate and handing over interest rate setting to the ECB. It is tempting to ask what role these two instruments play separately. This is not an easy task - as is well known, monetary and exchange rate regimes are intrinsically intertwined: independent interest rate policy requires a flexible exchange rate, while irreversibly fixing the exchange rate requires setting interest rates in tandem with the second central bank. As a result separating the two seems hard, if not impossible, and to the best of our knowledge, so far, the literature has not provided a solution to this dilemma.

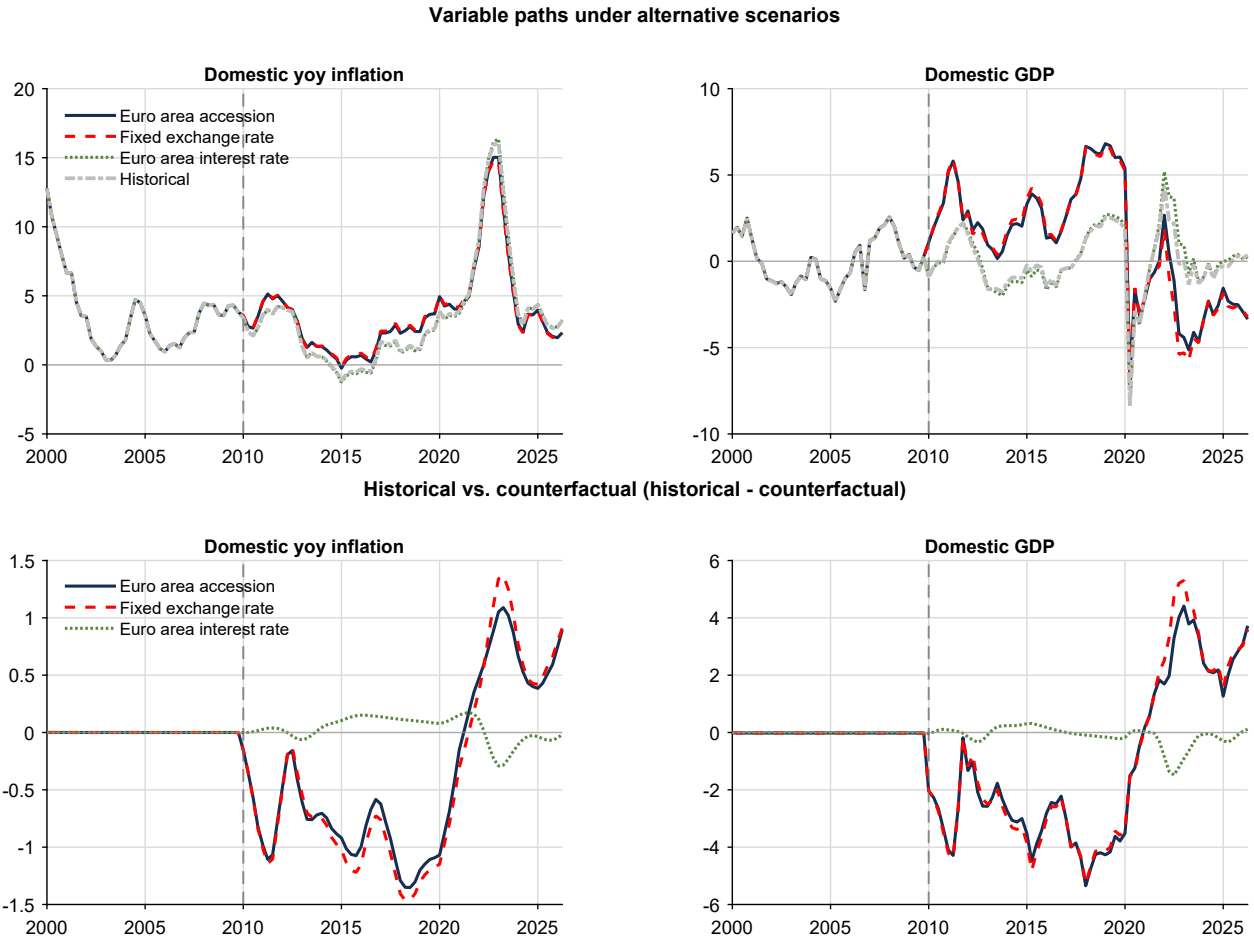
In what follows we present a novel approach that separates the impact of fixing the exchange rate from the impact of adopting the monetary union's interest rate. How can this be done? Recall that interest rates and exchange rates in our model are driven both by systematic components (Taylor rule and UIP conditions) and exogenous shocks (in particular monetary policy $\varepsilon_{R,t}$ and risk-premium $\varepsilon_{\kappa,t}$). We use these shocks to generate two counterfactual scenarios. Both begin in 2010q1 and assume behavioral expectations. The first assumes that the nominal exchange rate is fixed, while the domestic interest rate follows its historical path. The second sets the domestic interest rate to the euro-area level, while the exchange rate assumes historical values. This is done with counterfactual combinations of monetary policy and risk premium shocks that reproduce the desired paths of the two variables (conditional on historical values of the remaining shocks).[5] Since the model is linear, there is a unique mapping between two shocks and two variables and the scenarios are additive, meaning that the effects of the two simulations add up to the effects of joining the euro area.[6]

[5]The same is assumed for an extensive period after the end of our sample in order to pin down expectations. In these periods we choose shocks to match model-based forecasts of interest rates and the exchange rate.

[6]In fact the sum differs slightly from the euro-area adoption scenario presented earlier, as we assume the historical interest rate in the euro area, while earlier we assumed counterfactually that the ECB reacts

The upper panel of Figure 7 shows the simulated paths of inflation and GDP in four cases: the historical one and the euro-area accession scenario known from Section 6.1 together with the two new counterfactuals. The lower panel documents the difference between each counterfactual and the historical path. A finding that stands out very sharply is that almost all effects of euro adoption are due to fixing the exchange rate. The role of independently setting the interest rate is marginal.

Figure 7: Counterfactuals of fixing the exchange rate and adopting euro area interest rate



Note: The upper panel shows the counterfactuals of fixing the exchange rate, adopting euro area interest rate and adopting the euro together with historical data. The lower panel shows the difference between the counterfactuals and the historical path.

Let us try to understand why fixing the exchange rate is so much more important than adopting the common interest rate. Two things matter. First, due to strong correlation of business cycles between Poland and the euro area, monetary policy decisions of both central banks were relatively similar. As a result, substituting the Polish interest rate path with the one from the euro area does not make a big difference to economic performance. The same cannot be said of the exchange rate, which varied substantially over our period

to area-wide inflation including Poland. The difference is negligible given the 5% weight of Poland in the aggregate.

of interest. Second, the finding also reflects the character of monetary transmission in a small open economy, which - to a large extent - happens via the exchange rate channel. By artificially holding the exchange rate constant we effectively close this channel, lowering the power of domestic monetary policy (and hence the loss from giving up setting the interest rate). Something opposite holds true for the effects of exchange rate movements. These are normally (partly) offset by the monetary policy reaction. However, with interest rates bound to those in the euro area, the monetary policy reaction channel is closed, so that effects of exchange rate movements become stronger. As a consequence the effect of fixing the exchange rate is large.

An important and related question refers to the stabilizing and destabilizing role of the two instruments. We have seen in Section 6.1 that euro area accession on average stabilizes inflation at the cost of destabilizing output. The experiment described above allows to ask what role fixing the exchange rate and adopting euro-area interest rates play in this context. To answer this question we present the above simulations in the following way. For each period of our counterfactual presented in Figure 5 we check whether the historical or the counterfactual absolute deviation of GDP from steady state (or deviation of inflation from target) was smaller. If the historical deviation is smaller, we talk of destabilization due to euro adoption. In the opposite case, when the counterfactual deviation is smaller than the historical one, we talk of stabilizing role of euro accession. Next we plot these deviations as the lines on figures 8 (output) and 9 (inflation). Positive values denote periods when euro adoption would have destabilized output or inflation, negative values denote periods of stabilization.

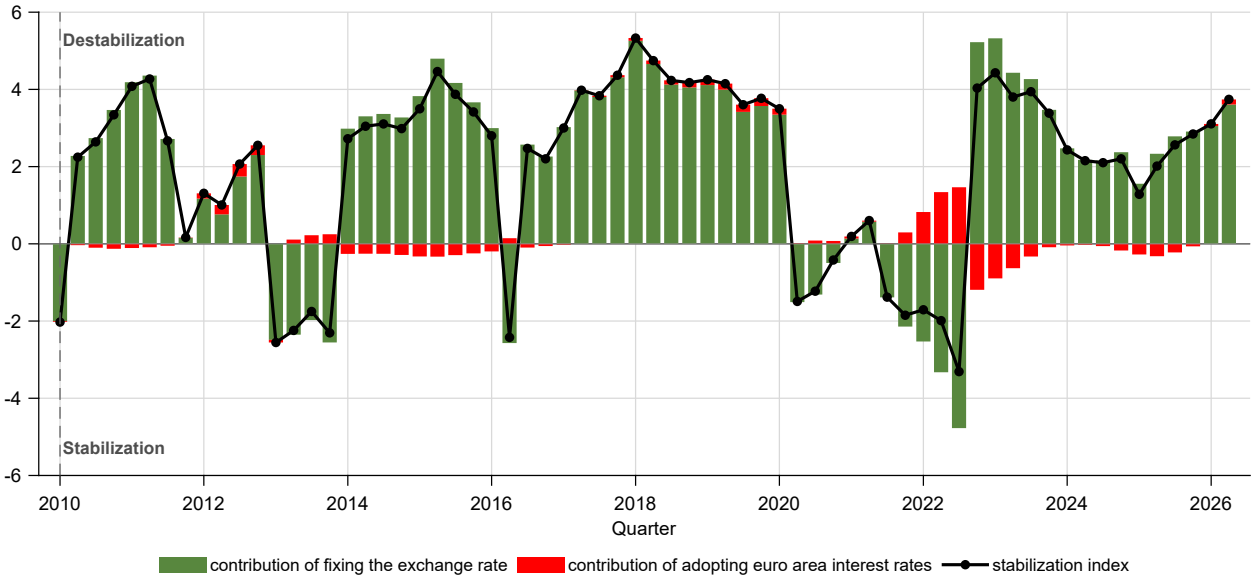
In line with previous findings, under the accession scenario, Poland would have mainly faced destabilization of real GDP (i.e. positive values of our metric). For instance at the peak in 2023Q1, GDP would have been destabilized by almost 4,4 percent compared to the historical case, reflecting the 4.6 percent deviation from steady state of the counterfactual and 0.2 percent deviation recorded historically (see Figure 5). In contrast, periods when euro adoption would have played a stabilizing role for GDP are relatively rare. The findings for inflation are of opposite nature - euro adoption would have had a stabilizing impact in most periods (negative values of our metric).

The stabilization metric can be decomposed into the contribution of fixing the exchange rate and adopting the common interest rate (green and red bars respectively). Not surprisingly the effect of stabilizing the exchange rate dominates the picture: green bars are the main force behind inflation stabilization and GDP destabilization. Flipping this finding provides an answer to an important question in open-economy macro, whether a flexible exchange rate stabilizes or destabilizes the economy. Clearly, in the Polish historical context, exchange-rate flexibility stabilized output while destabilizing inflation.

As can be expected, the role of adopting the currency union interest rate is much smaller.

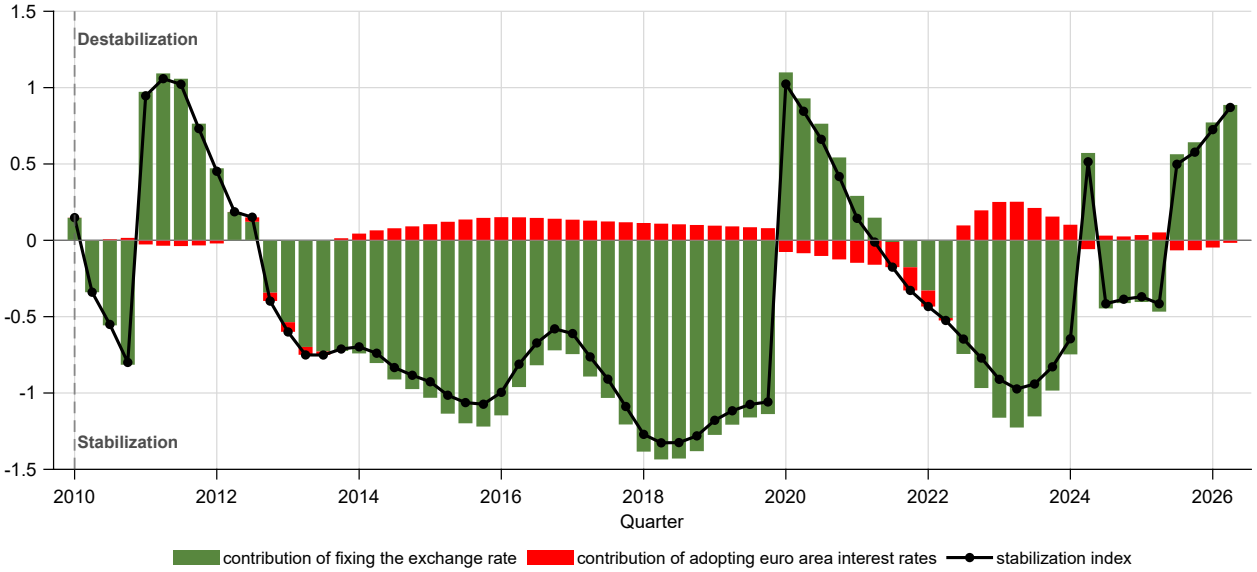
When it comes to its sign, red bars can be seen both on the positive and negative sides of both figures, meaning that adopting the euro area interest rate would have sometimes stabilized and sometimes destabilized output and inflation. However, as already mentioned, the quantitative difference is very small.

Figure 8: The impact of monetary integration on GDP stability



Note: The line shows whether in a given period GDP would have been stabilized (negative values) or destabilized (positive values) due to euro area accession. The bars denote the contribution of fixing the exchange rate (green) and of adopting the euro-area interest rate (red)

Figure 9: The impact of monetary integration on inflation stability

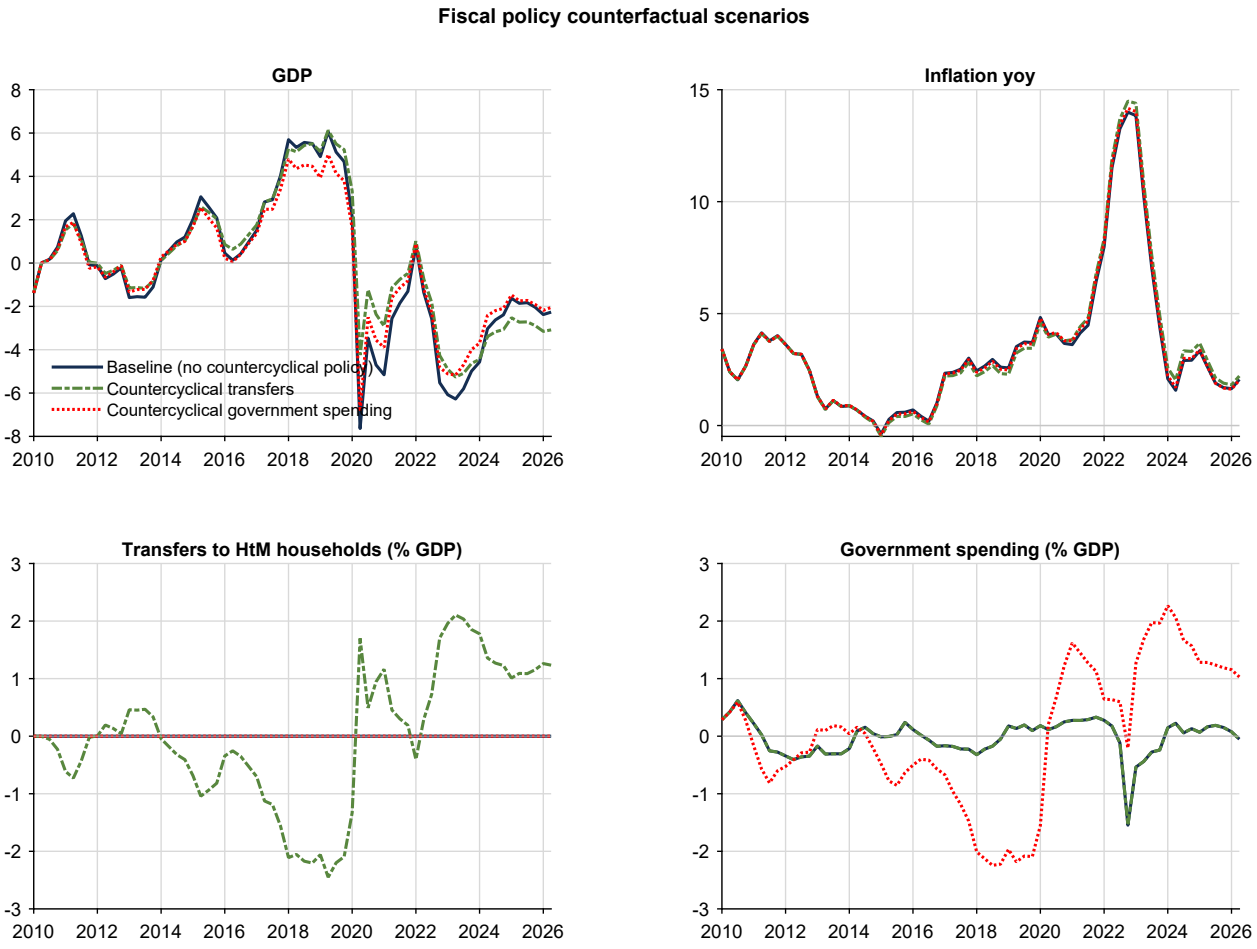


Note: The line shows whether in a given period inflation would have been stabilized (negative values) or destabilized (positive values) due to euro area accession. The bars denote the contribution of fixing the exchange rate (green) and of adopting the euro-area interest rate (red)

6.4 The role of fiscal policy

As is well known, in the absence of monetary autonomy, fiscal policy can potentially take the lead in stabilizing business cycle fluctuations. This is facilitated by the fact that fiscal policy is more effective in a monetary union, as its working is not being crowded out due to the monetary policy reaction. Our model offers two potentially attractive instruments - government purchases and transfers. The latter can be an effective tool of macroeconomic policy if targeted at hand-to-mouth households, who are assumed to spend their whole income. In contrast, optimizing households are Ricardian and, hence do not increase spending after a debt-financed package of transfers.

Figure 10: Simulations with countercyclical fiscal policy



In what follows we describe two counterfactual experiments. For both we assume that a countercyclical fiscal rule is in place, which either lowers (increases) government spending or transfers to HtM consumers in response to positive (negative) GDP deviations from steady state. While there is obviously no clear benchmark how such rule should be parametrized, we assume relatively strong responses so as to check the limits of stabilization using fiscal

policy.

Table 4: Volatilities of selected variables with and without countercyclical fiscal policy

	Historical	Baseline	Countercyclical transfers	Countercyclical gov. spending
GDP	1.7	3.3	3.0	2.7
Inflation (YOY)	3.6	2.9	3.1	3.0
HtM consumption	11.3	10.3	14.8	10.7

Note: Volatilities are expressed as standard deviations in percent.

Figure 10 shows our counterfactual simulation of euro area accession in three variants: baseline (no countercyclical fiscal policy), countercyclical government spending and countercyclical transfers. While under both scenarios with active fiscal policy the volatility of output is being reduced the consequences are quite small. This comes at a relatively high fiscal cost, which reaches around 2 percent of GDP during selected economic episodes. Such volatility of government expenditures would have required substantial fiscal space.

Table 4 shows the standard deviations of GDP, inflation and consumption of HtM households on the analyzed scenarios. The numbers confirm our general observations formed above. The implemented countercyclical fiscal policy would have been able to reduce somewhat the volatility of GDP, though not to levels observed under monetary independence. Inflation volatility, on the other hand, remains almost unaffected. This is in line with the relatively small impact of transfers and spending on this variable. Moreover, macroeconomic stabilization via transfers comes at a substantial cost for HtM consumers, as the volatility of their consumption increases by approximately 44 percent.

7 Conclusions

This paper analyzes the macroeconomic consequences of euro area accession in a New Keynesian open economy model with behavioral expectations and household heterogeneity. We provide answers to the following questions:

- how would accession to the monetary union have affected the Polish economy?
- how does the assumption of bounded rationality affect the consequences?
- how do the consequences of joining the euro area depend on the exchange rate at which the common currency is adopted?

- what drives the findings to a larger extent: fixing the currency or adopting the common interest rate?
- can fiscal policy restore the pre-accession volatility of output and inflation?

Our findings are as follows. First, given the historical developments, euro adoption would have substantially increased the volatility of output and somewhat reduced the volatility of inflation. This is the consequence of a fixed nominal exchange rate which stabilizes inflation, while making the deviations of the real exchange rate (and hence of GDP) more persistent.

Second, the effects of joining the euro area are also highly sensitive to the exchange rate at the moment of entry. Fixing the nominal exchange rate when the domestic currency is undervalued produces a temporary boom followed by a bust. It is also costly in terms of higher inflation. Conversely, entering with an appreciated currency results in a prolonged contraction and deflation.

Third, bounded rationality is strongly preferred by the data and hence constitutes our main assumption. In comparison to the rational expectations benchmark it affects transmission of shocks and policies in various directions, so that its ultimate impact on the accession scenario is an empirical issue. Overall, given historical shocks and policy, the assumption of bounded rationality affects the cost of joining the euro area only marginally.

Fourth, we overcome an important limitation of the existing literature in that we manage to discern the role of fixing the exchange rate from the role of setting interest rates at the euro area level. As is well known, these processes are linked by the impossible trinity of monetary economics - one cannot exist without the other. Our counterfactual simulations show, that the bulk of adjustment is in fact due to fixing the exchange rate, while the role of adopting the common interest rate is much smaller.

Last but not least, we explore the role of fiscal policy as a potential stabilizing force in a monetary union. While behavioral expectations enhance the effectiveness of fiscal instruments, we find that—under empirically plausible assumptions—fiscal policy alone cannot replicate the degree of macroeconomic stabilization achievable under an independent monetary regime.

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Tables and figures

Table 5: Behavioral model estimation results: deep parameters

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
m	beta	0.850	0.0250	0.799	0.0257	0.7576	0.8419
θ_H	beta	0.750	0.1000	0.871	0.0225	0.8356	0.9080
θ_F^*	beta	0.750	0.1000	0.651	0.0506	0.5644	0.7335
θ_H^*	beta	0.750	0.1000	0.688	0.0394	0.6246	0.7530
θ_F	beta	0.750	0.1000	0.789	0.0336	0.7358	0.8453
θ_w	beta	0.750	0.1000	0.721	0.0344	0.6643	0.7780
θ_w^*	beta	0.750	0.1000	0.792	0.0406	0.7253	0.8629
ζ_w	beta	0.500	0.1000	0.511	0.0987	0.3459	0.6699
ζ_w^*	beta	0.500	0.1000	0.396	0.1021	0.2259	0.5611
ζ_H	beta	0.500	0.1000	0.368	0.0951	0.2118	0.5204
ζ_F^*	beta	0.500	0.1000	0.419	0.0943	0.2622	0.5728
ζ_H^*	beta	0.500	0.1000	0.634	0.0877	0.4893	0.7776
ζ_F	beta	0.500	0.1000	0.553	0.1106	0.3781	0.7420
γ_r	beta	0.700	0.1000	0.916	0.0072	0.9041	0.9276
γ_π	norm	1.500	0.0500	1.482	0.0494	1.4018	1.5644
γ_y	beta	0.125	0.0500	0.314	0.0603	0.2156	0.4126
γ_r^*	beta	0.700	0.1000	0.941	0.0084	0.9271	0.9550
γ_π^*	norm	1.500	0.0500	1.495	0.0494	1.4136	1.5759
γ_y^*	beta	0.125	0.0500	0.147	0.0480	0.0697	0.2251

Table 6: Behavioral model estimation results: shock parameters

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
ρ_z	beta	0.700	0.1000	0.814	0.0466	0.7377	0.8908
ρ_z^*	beta	0.700	0.1000	0.696	0.0967	0.5446	0.8551

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Table 6: (continued)

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
ρ_g	beta	0.700	0.1000	0.661	0.0655	0.5540	0.7683
ρ_g^*	beta	0.700	0.1000	0.734	0.0676	0.6276	0.8456
ρ_p	beta	0.700	0.1000	0.512	0.0838	0.3748	0.6503
ρ_p^*	beta	0.700	0.1000	0.489	0.0903	0.3414	0.6386
$\rho_{a,\kappa}$	beta	0.700	0.1000	0.772	0.0529	0.6864	0.8580
$\rho_{a,l}$	beta	0.700	0.1000	0.799	0.0687	0.6901	0.9084
$\rho_{a,l}^*$	beta	0.700	0.1000	0.795	0.0758	0.6760	0.9134
ρ_c	beta	0.700	0.1000	0.834	0.0473	0.7600	0.9123
ρ_c^*	beta	0.700	0.1000	0.707	0.0602	0.6075	0.8039
ρ_x	beta	0.700	0.1000	0.408	0.0746	0.2868	0.5302
ρ_x^*	beta	0.700	0.1000	0.421	0.0714	0.3028	0.5362
σ_z	invg	0.005	Inf	0.043	0.0050	0.0345	0.0508
σ_z^*	invg	0.005	Inf	0.005	0.0038	0.0011	0.0101
σ_R	invg	0.003	Inf	0.001	0.0001	0.0010	0.0013
σ_R^*	invg	0.003	Inf	0.001	0.0001	0.0008	0.0010
σ_g	invg	0.010	Inf	0.011	0.0009	0.0095	0.0126
σ_g^*	invg	0.010	Inf	0.004	0.0005	0.0030	0.0047
σ_p	invg	0.010	Inf	0.161	0.0444	0.0897	0.2297
σ_p^*	invg	0.010	Inf	0.021	0.0067	0.0119	0.0309
σ_κ	invg	0.010	Inf	0.014	0.0019	0.0104	0.0166
σ_w	invg	0.010	Inf	0.086	0.0251	0.0470	0.1255
σ_w^*	invg	0.010	Inf	0.093	0.0647	0.0231	0.1638
σ_c	invg	0.010	Inf	0.033	0.0034	0.0270	0.0380
σ_c^*	invg	0.010	Inf	0.030	0.0025	0.0263	0.0343
σ_i	invg	0.010	Inf	0.306	0.0255	0.2646	0.3474
σ_i^*	invg	0.010	Inf	0.167	0.0149	0.1417	0.1904

Table 7: Rational model estimation results: deep parameters

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
θ_H	beta	0.750	0.1000	0.932	0.0139	0.9136	0.9526
θ_F^*	beta	0.750	0.1000	0.907	0.0115	0.8894	0.9258
θ_H^*	beta	0.750	0.1000	0.716	0.0422	0.6489	0.7865
θ_F	beta	0.750	0.1000	0.688	0.0431	0.6192	0.7619
θ_w	beta	0.750	0.1000	0.751	0.0263	0.7087	0.7950
θ_w^*	beta	0.750	0.1000	0.884	0.0207	0.8511	0.9180
ζ_w	beta	0.500	0.1000	0.421	0.0811	0.2883	0.5550
ζ_w^*	beta	0.500	0.1000	0.411	0.0983	0.2517	0.5736
ζ_H	beta	0.500	0.1000	0.436	0.0950	0.2777	0.5912
ζ_F^*	beta	0.500	0.1000	0.188	0.0468	0.1108	0.2627
ζ_H^*	beta	0.500	0.1000	0.569	0.0927	0.4177	0.7220
ζ_F	beta	0.500	0.1000	0.447	0.0931	0.2924	0.5995
γ_r	beta	0.700	0.1000	0.912	0.0068	0.9007	0.9228
γ_π	norm	1.500	0.0500	1.458	0.0504	1.3767	1.5428
γ_y	beta	0.125	0.0500	0.369	0.0533	0.2799	0.4554
γ_r^*	beta	0.700	0.1000	0.928	0.0083	0.9139	0.9410
γ_π^*	norm	1.500	0.0500	1.482	0.0495	1.3995	1.5625
γ_y^*	beta	0.125	0.0500	0.197	0.0473	0.1209	0.2746

Table 8: Rational model estimation results: shock parameters

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
ρ_z	beta	0.700	0.1000	0.918	0.0281	0.8765	0.9623
ρ_z^*	beta	0.700	0.1000	0.932	0.0272	0.8921	0.9736
ρ_g	beta	0.700	0.1000	0.668	0.0659	0.5611	0.7768
ρ_g^*	beta	0.700	0.1000	0.736	0.0652	0.6322	0.8442
ρ_p	beta	0.700	0.1000	0.554	0.0864	0.4103	0.6954
ρ_p^*	beta	0.700	0.1000	0.623	0.0746	0.5056	0.7474

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Table 8: (continued)

	Prior			Posterior			
	Dist.	Mean	Stdev.	Mean	Stdev.	HPD inf	HPD sup
$\rho_{a,\kappa}$	beta	0.700	0.1000	0.764	0.0421	0.6938	0.8312
$\rho_{a,l}$	beta	0.700	0.1000	0.722	0.0976	0.5676	0.8816
$\rho^*_{a,l}$	beta	0.700	0.1000	0.734	0.0925	0.5878	0.8849
ρ_c	beta	0.700	0.1000	0.789	0.0425	0.7206	0.8592
ρ^*_c	beta	0.700	0.1000	0.662	0.0607	0.5661	0.7645
ρ_x	beta	0.700	0.1000	0.412	0.0671	0.2998	0.5210
ρ^*_x	beta	0.700	0.1000	0.405	0.0682	0.2927	0.5182
σ_z	invg	0.005	Inf	0.021	0.0046	0.0131	0.0281
σ^*_z	invg	0.005	Inf	0.029	0.0045	0.0218	0.0363
σ_R	invg	0.003	Inf	0.001	0.0001	0.0010	0.0013
σ^*_R	invg	0.003	Inf	0.001	0.0001	0.0008	0.0010
σ_g	invg	0.010	Inf	0.011	0.0010	0.0094	0.0126
σ^*_g	invg	0.010	Inf	0.004	0.0005	0.0029	0.0047
σ_p	invg	0.010	Inf	0.094	0.0259	0.0551	0.1345
σ^*_p	invg	0.010	Inf	0.132	0.0351	0.0764	0.1846
σ_κ	invg	0.010	Inf	0.009	0.0015	0.0063	0.0110
σ_w	invg	0.010	Inf	0.014	0.0122	0.0022	0.0332
σ^*_w	invg	0.010	Inf	0.161	0.0827	0.0373	0.2855
σ_c	invg	0.010	Inf	0.036	0.0031	0.0306	0.0406
σ^*_c	invg	0.010	Inf	0.034	0.0030	0.0294	0.0390
σ_i	invg	0.010	Inf	0.240	0.0230	0.2017	0.2764
σ^*_i	invg	0.010	Inf	0.130	0.0137	0.1078	0.1528

Appendix A

A.1 Derivation of the Euler and UIP equations

Households maximize their utility (2) subject to the budget constraint (4). While choosing consumption in period t, $c_{R,t}$, they also choose future consumption for all future periods and all possible states of the world, denoted by $c_{R,t,t+k}$.

To derive the key behavioral equilibrium conditions, we start from the household's first-order conditions. In what follows, we work with the log-linearized equilibrium conditions around the deterministic steady state. Most variables are expressed as log-deviations from their steady-state values: for any variable X_t, we define $\hat{X}_t = \log X_t - \log \bar{X}$. For asset positions, in particular home households' holdings of home and foreign bonds, which may be zero in steady state, we use level deviations; for example, $\hat{b}_{H,t} = b_{H,t} - \bar{b}_H$ and $\hat{b}^*_{H,t} = b^*_{H,t} - \bar{b}^*_H$.

The first-order conditionsfor home bonds, foreign bonds, and phisical capital are:

$$\hat{c}_{R,t} = E_t^{BR}\hat{c}_{R,t,t+1} - \frac{1}{\sigma}E_t^{BR}(\hat{R}_t - \hat{\pi}_{t+1}) + \frac{1}{\sigma}(\hat{\varepsilon}_{u,t} - E_t^{BR}\hat{\varepsilon}_{u,t+1}) \tag{A.1}$$

$$\begin{aligned}\hat{c}_{R,t} = {} & E_t^{BR}\hat{c}_{R,t,t+1} - \frac{1}{\sigma}E_t^{BR}(\hat{R}^*_t + \hat{\kappa}_t - \hat{\pi}^*_{t+1}) \\ & - \frac{1}{\sigma}(E_t^{BR}\hat{q}_{t+1} - \hat{q}_t) + \frac{1}{\sigma}(\hat{\varepsilon}_{u,t} - E_t^{BR}\hat{\varepsilon}_{u,t+1})\end{aligned} \tag{A.2}$$

$$\begin{aligned}\hat{c}_{R,t} = {} & E_t^{BR}\hat{c}_{R,t,t+1} - \frac{1}{\sigma}\Big[(1-\beta(1-\delta))E_t^{BR}\hat{r}_{k,t+1} + \beta(1-\delta)E_t^{BR}\hat{p}_{k,t+1} - \hat{p}_{k,t}\Big] \\ & + \frac{1}{\sigma}(\hat{\varepsilon}_{u,t} - E_t^{BR}\hat{\varepsilon}_{u,t+1})\end{aligned} \tag{A.3}$$

Here, $E_t^{BR}\hat{c}_{R,t,t+1}$ denotes expected consumption in period $t+1$ as chosen in period t under behavioral expectations. Actual consumption in period $t+1$ may differ because decisions are then based on expectations formed in period $t+1$. The first two conditions refer to bond holdings, while the third concerns capital accumulation. For one-step-ahead variables, behavioral expectations satisfy $E_t^{BR}\hat{x}_{t+1} = mE_t\hat{x}_{t+1}$, where $m \in [0,1]$ captures cognitive discounting. Moreover, $p_{k,t} \equiv Q_t/P_t$ denotes the real price of installed capital.

UIP. Combining (A.1) and (A.2) yields the modified uncovered interest parity (UIP) condition:

$$\underbrace{\hat{R}_t - mE_t\hat{\pi}_{t+1}}_{\substack{\text{behaviorally expected domestic} \\ \text{real interest rate}}} = \underbrace{\hat{R}^*_t + \hat{\kappa}_t - mE_t\hat{\pi}^*_{t+1}}_{\substack{\text{behaviorally expected foreign} \\ \text{real interest rate}}} + \underbrace{mE_t\hat{q}_{t+1} - \hat{q}_t}_{\substack{\text{behaviorally expected} \\ \text{RER depreciation rate}}} \tag{A.4}$$

where $q_t \equiv S_t P_t^*/P_t$ is the real exchange rate. Under behavioral expectations, expected inflation and exchange-rate deviations from their steady-state values are discounted, implying a weaker arbitrage response than under rational expectations. When $m = 1$, the condition collapses to its rational-expectations counterpart.

Non-arbitrage between domestic bonds and capital. Similarly, combining (A.1) and (A.3) implies the following no-arbitrage condition between domestic bonds and capital:

$$\underbrace{\hat{R}_t - mE_t\hat{\pi}_{t+1}}_{\substack{\text{behaviorally expected domestic} \\ \text{real interest rate}}} = \underbrace{(1-\beta(1-\delta))mE_t\hat{r}_{k,t+1}}_{\substack{\text{behaviorally expected} \\ \text{rental return on capital}}} + \underbrace{\beta(1-\delta)mE_t\hat{p}_{k,t+1} - \hat{p}_{k,t}}_{\substack{\text{behaviorally expected resale value} \\ \text{minus current purchase price}}} . \quad \text{(A.5)}$$

The first term on the right-hand side captures the expected rental return on capital, while the second captures its expected resale value net of current purchase price. Under behavioral expectations, both components are discounted by m.

Euler. The solution to the Ricardian household's intertemporal optimization problem yields the following behavioral Euler equation:

$$\begin{aligned}\hat{c}_{R,t} = mE_t\hat{c}_{R,t+1} - \frac{1}{\sigma}(\hat{R}_t - mE_t\hat{\pi}_{t+1}) + \frac{1}{\sigma}(\hat{\varepsilon}_{u,t} - mE_t\hat{\varepsilon}_{u,t+1}) \\ + \frac{(1-\beta)}{\beta\bar{c}_R}(1-m)(\hat{b}_{H,t} + \hat{b}^*_{H,t} + \bar{k}(\hat{p}_{k,t} + \hat{k}_t) + \bar{b}^*_H\hat{\kappa}_t) \quad \text{(A.6)}\end{aligned}$$

Relative to the rational-expectations benchmark, this equation differs in two respects. First, future deviations from steady state are discounted by $m \in [0, 1]$. Second, current consumption depends directly on asset positions, implying wealth effects and breaking Ricardian equivalence.

For example, if income is expected to increase in the future, a behavioral agent anticipates only a muted version of that increase due to cognitive discounting. As a result, the agent raises consumption by less than a rational agent would. In equilibrium, this leads to a higher accumulation of financial assets relative to the rational expectations benchmark, as myopic households underconsume in anticipation of future income gains they undervalue.

A.2 Wage setting

Households supply differentiated labor services $n_t(h)$ indexed by $h \in [0, 1]$. The nominal wage for each labor type is set by a corresponding labor union in a monopolistically competitive

labor market. Each union represents fixed shares of Ricardian (ω_R) and non-Ricardian (ω_N) households, which are uniformly distributed across labor types. Because households are affiliated with all unions, they earn the same effective wage and supply identical amounts of labor in equilibrium.

Labor services are sold to perfectly competitive aggregators, which combine differentiated labor types into a homogeneous composite input used in production according to the following technology:

$$n_t = \left(\int_0^1 n_t \left(h\right)^{\frac{1}{\mu_{w,t}}} dh \right)^{\mu_{w,t}} \tag{A.7}$$

where $\mu_{w,t}$ denotes the time-varying wage markup given by:

$$\mu_{w,t} = \frac{\phi_n}{\phi_n - 1} e^{\varepsilon_{w,t}}. \tag{A.8}$$

Here, ϕ_n governs the steady-state elasticity of substitution between differentiated labor types, and $\varepsilon_{w,t}$ is a wage markup shock following an AR(1) process with persistence parameter ρ_w and innovation standard deviation σ_w. The aggregated labor input n_t is supplied to firms.

Cost minimization by the labor aggregator then implies the following demand for a differentiated labor type:

$$n_t(h) = \left(\frac{W_t(h)}{W_t} \right)^{-\frac{\mu_{w,t}}{\mu_{w,t}-1}} n_t. \tag{A.9}$$

Nominal wages are subject to Calvo-type rigidity. In each period, a fraction $1 - \theta_w$ of labor unions can reoptimize their nominal wage, while the remaining fraction θ_w updates its wage according to an indexation rule based on past wage inflation $\pi_{w,t-1}$. This implies that the nominal wage for a given labor type h evolves according to:

$$w_{h,t} = w_{h,t-1} \pi_{w,t-1}^{\zeta_w} \bar{\pi}_w^{1-\zeta_w}, \tag{A.10}$$

where $\zeta_w \in [0, 1]$ measures the degree of indexation to past wage growth and $\bar{\pi}_w$ denotes the steady-state wage inflation rate.

Accordingly, the wage markup shock drives a wedge between the real wage and the marginal rate of substitution between consumption and labor. In the flexible-wage benchmark, the desired real wage is therefore a time-varying markup over the marginal rate of substitution:

$$\hat{w}_t^{des} = \sigma \hat{c}_t + \gamma \hat{n}_t + \varepsilon_{w,t}. \tag{A.11}$$

Solving the wage-setting problem yields the behavioral New Keynesian wage Phillips

curve:

$$\hat{w}_t - \hat{w}_{t-1} + \hat{\pi}_t - \zeta_w \hat{\pi}_{w,t} = \beta \left(m E_t \left(\hat{w}_{t+1} + \hat{\pi}_{t+1} - \hat{w}_t \right) - \zeta_w \hat{\pi}_{w,t-1} \right) + \frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w (1+\gamma\phi_n)} \left(\sigma \hat{c}_t + \gamma \hat{n}_t + \varepsilon_{w,t} - \hat{w}_t \right). \quad \text{(A.12)}$$

The behavioral wage Phillips curve describes how nominal wage inflation responds to economic conditions under bounded expectations. Calvo frictions and partial indexation imply gradual wage adjustment, as only a subset of unions can reoptimize in each period. Moreover, expectations of future variables are discounted by the parameter m, reflecting limited attention to future developments. This reduces the forward-looking component and places greater weight on current labor market conditions—namely consumption, hours worked, and wage markup shocks. As a result, wage inflation becomes more persistent and responds more strongly to contemporaneous fluctuations in real activity, while being less sensitive to anticipated future changes in inflation and wage pressure.

A.3 Derivation of the Phillips curve

We derive the Phillips curve for home goods sold in the domestic market. Using the implied marginal-cost expression,[7]

$$mc_{H,t} = (1-\alpha)^{1-\alpha} \alpha^{\alpha} \frac{w_t^{1-\alpha} r_{k,t}^{\alpha}}{z_t p_{H,t}} \quad \text{(A.13)}$$

Here, $w_t \equiv \frac{W_t}{P_t}$ is the real wage, while $p_{H,t} \equiv \frac{P_{H,t}}{P_t}$ is the relative price of domestic intermediate goods. With Calvo pricing and partial indexation, the reset relative price $\tilde{p}_{H,t} = P_{H,t}(j)/P_{H,t}$ satisfies

$$\hat{\tilde{p}}_{H,t} = (1-\beta\theta_H) E_t \sum_{s=0}^{\infty} (\beta\theta_H)^s [m^s (\hat{mc}_{H,t+s} + \hat{\varepsilon}_{p,t+s}) + \sum_{\nu=1}^{s} (m^{\nu} \hat{\pi}_{H,t+\nu} - m^{\nu-1} \zeta_h \hat{\pi}_{H,t-1+\nu})] \quad \text{(A.14)}$$

Following Benchimol and Bounader (2023), this expression can be written recursively as

$$\hat{\tilde{p}}_{H,t} = (1-\beta\theta_H)(\hat{mc}_{H,t} + \hat{\varepsilon}_{p,t}) + \beta\theta_H \left[m E_t \hat{\tilde{p}}_{H,t+1} + m E_t \hat{\pi}_{H,t+1} - \zeta_h \hat{\pi}_{H,t} \right] \quad \text{(A.15)}$$

From the zero-profit condition of the final-good producer,

$$P_{H,t} = \left[\int_0^1 P_{H,t}(i)^{\frac{\varepsilon_{p,t}}{\varepsilon_{p,t-1}}} di \right]^{\frac{\varepsilon_{p,t-1}}{\varepsilon_{p,t}}} \quad \text{(A.16)}$$

[7] Analogously, $mc^*_{H,t} = (1-\alpha)^{1-\alpha} \alpha^{\alpha} \frac{w_t^{1-\alpha} r_{k,t}^{\alpha}}{z_t p^*_{H,t} q_t}$, where q_t denotes the real exchange rate.

which implies, after linearization,

$$\hat{\tilde{p}}_{H,t} = \frac{\theta_H}{1-\theta_H}(\hat{\pi}_{H,t} - \zeta_h \hat{\pi}_{H,t-1}) \tag{A.17}$$

Substituting (A.17) into (A.15) yields the domestic behavioral Phillips curve:

$$\theta_H(\hat{\pi}_{H,t} - \zeta_H \hat{\pi}_{H,t-1}) = \beta\theta_H(mE_t\hat{\pi}_{H,t+1} - \zeta_H\hat{\pi}_{H,t}) + (1-\theta_H)(1-\beta\theta_H)(\hat{mc}_{H,t} + \hat{\varepsilon}_{p,t}) \tag{A.18}$$

Under behavioral expectations, the forward-looking component is weaker than under rational expectations. The corresponding Phillips curve for home goods sold abroad, with prices sticky in foreign currency, is:

$$\theta^*_H(\hat{\pi}^*_{H,t} - \zeta^*_H \hat{\pi}^*_{t-1}) = \beta\theta^*_H(mE_t\hat{\pi}^*_{H,t+1} - \zeta^*_H\hat{\pi}^*_{H,t}) + (1-\theta^*_H)(1-\beta\theta^*_H)(\hat{mc}^*_{H,t} + \hat{\varepsilon}^*_{p,t}) \tag{A.19}$$

A.4 Closing the model

A.4.1 GDP and Balance of Payments

GDP is the sum of domestic consumption, government spending, and net exports:

$$\tilde{y}_t \equiv c_t + g_t + nx_t \tag{A.20}$$

Net exports, nx_t, are given by the difference between the value of exports and imports:

$$nx_t = q_t p^*_{H,t} \frac{1-\omega}{\omega} y^*_{H,t} - p_{F,t} y_{F,t}$$

The balance of payments condition reflects changes in the stock of net foreign assets $b^*_{H,t}$ and is given by:

$$b^*_{H,t} = nx_t + \frac{q_t}{q_{t-1}\pi^*_t} b^*_{H,t-1} R^*_{t-1} \kappa_{t-1} \tag{A.21}$$

Thus, net foreign assets evolve with net exports and with the return on previously accumulated foreign assets, adjusted for inflation and exchange-rate movements.

A.4.2 Market clearing

We impose standard market-clearing conditions. The final-goods market clears when:

$$c_t + g_t = y_t \tag{A.22}$$

The labor market clears when:

$$\int_0^1 n_t(h)dh = n_t \tag{A.23}$$

Finally, in the home-bond market, clearing requires that aggregate holdings of home bonds by home and foreign households equal the government's outstanding debt:

$$\omega B_{H,t} + (1-\omega)B_{F,t} = \omega B_{G,t} \tag{A.24}$$

Appendix A.5 reports the complete set of linearized equilibrium conditions.

A.5 Model equations

This subsection reports the linearized equilibrium conditions used in the Dynare implementation. To keep notation consistent with the main text, we denote the real price of installed capital by $p_{k,t}$, use N for non-Ricardian households, and express steady-state objects through explicit ratios such as $\bar{c}/\bar{y}$ or $\bar{T}/\bar{\tilde{y}}$. Since capacity utilization is fixed at one, this margin is omitted from the reported system. Unless noted otherwise, hatted variables denote log-deviations from steady state, whereas bond positions and government debt are level deviations.

A.5.1 Households

$$\begin{aligned}\hat{c}_{R,t} - mE_t\hat{c}_{R,t+1} = &-\frac{1}{\sigma}\left(\hat{R}_t - mE_t\hat{\pi}_{t+1}\right) + \frac{1-m\rho_c}{\sigma}\varepsilon_{u,t} \\ &+ \frac{1-\beta}{\beta}\frac{1-m}{\bar{c}}\left(\hat{b}^*_{H,t} + \hat{b}_{G,t} + \frac{\bar{c}_R}{\bar{c}}\bar{x}\left(\hat{p}_{k,t} + \hat{k}_t\right) - \bar{b}^*_H\hat{\kappa}_t\right)\end{aligned} \tag{A.25}$$

$$\begin{aligned}\hat{c}^*_{R,t} - mE_t\hat{c}^*_{R,t+1} = &-\frac{1}{\sigma^*}\left(\hat{R}^*_t - mE_t\hat{\pi}^*_{t+1}\right) + \frac{1-m\rho^*_c}{\sigma^*}\varepsilon^*_{u,t} \\ &+ \frac{1-\beta^*}{\beta^*}\frac{1-m}{\bar{c}^*}\left(-\frac{\omega}{1-\omega}\hat{b}^*_{H,t} + \hat{b}^*_{G,t} + \frac{\bar{c}^*_R}{\bar{c}^*}\bar{x}^*\left(\hat{p}^*_{k,t} + \hat{k}^*_t\right)\right)\end{aligned} \tag{A.26}$$

$$\hat{R}_t - mE_t\hat{\pi}_{t+1} = (1-\beta(1-\delta))\, mE_t\hat{r}_{k,t+1} + \beta(1-\delta)mE_t\hat{p}_{k,t+1} - \hat{p}_{k,t}, \tag{A.27}$$

$$\hat{R}^*_t - mE_t\hat{\pi}^*_{t+1} = (1-\beta^*(1-\delta^*))\, mE_t\hat{r}^*_{k,t+1} + \beta^*(1-\delta^*)mE_t\hat{p}^*_{k,t+1} - \hat{p}^*_{k,t} \tag{A.28}$$

$$\frac{\bar{c}_N}{\bar{y}}\hat{c}_{N,t} = \left(\frac{\bar{c}_N}{\bar{y}} + \frac{\bar{T}}{\bar{y}}\right)\left(\hat{w}_t + \hat{l}_t\right) - \frac{\bar{T}}{\bar{y}}\hat{T}_t + \frac{\widehat{TR}_t}{\bar{y}}, \tag{A.29}$$

$$\frac{\bar{c}^*_N}{\bar{y}^*}\hat{c}^*_{N,t} = \left(\frac{\bar{c}^*_N}{\bar{y}^*} + \frac{\bar{T}^*}{\bar{y}^*}\right)\left(\hat{w}^*_t + \hat{l}^*_t\right) - \frac{\bar{T}^*}{\bar{y}^*}\hat{T}^*_t \tag{A.30}$$

$$\hat{c}_t = \omega_R\frac{\bar{c}_R}{\bar{c}}\hat{c}_{R,t} + \omega_N\frac{\bar{c}_N}{\bar{c}}\hat{c}_{N,t}, \tag{A.31}$$

$$\hat{c}^*_t = \omega^*_R\frac{\bar{c}^*_R}{\bar{c}^*}\hat{c}^*_{R,t} + \omega^*_N\frac{\bar{c}^*_N}{\bar{c}^*}\hat{c}^*_{N,t} \tag{A.32}$$

A.5.2 Wage setting

$$\begin{aligned}\theta_w\left(\hat{w}_t - \hat{w}_{t-1} + \hat{\pi}_t - \zeta_w\hat{\pi}_{w,t-1}\right) = \theta_w\beta\left(mE_t\hat{w}_{t+1} + mE_t\hat{\pi}_{t+1} - \hat{w}_t - \zeta_w\hat{\pi}_{w,t}\right)\\ + \frac{(1-\theta_w)(1-\beta\theta_w)}{1+\gamma\phi_n}\left(\sigma\hat{c}_t + \gamma\hat{l}_t + \varepsilon_{w,t} - \hat{w}_t\right)\end{aligned} \tag{A.33}$$

$$\begin{aligned}\theta^*_w\left(\hat{w}^*_t - \hat{w}^*_{t-1} + \hat{\pi}^*_t - \zeta^*_w\hat{\pi}^*_{w,t-1}\right) = \theta^*_w\beta^*\left(mE_t\hat{w}^*_{t+1} + mE_t\hat{\pi}^*_{t+1} - \hat{w}^*_t - \zeta^*_w\hat{\pi}^*_{w,t}\right)\\ + \frac{(1-\theta^*_w)(1-\beta^*\theta^*_w)}{1+\gamma^*\phi^*_n}\left(\sigma^*\hat{c}^*_t + \gamma^*\hat{l}^*_t + \varepsilon^*_{w,t} - \hat{w}^*_t\right)\end{aligned} \tag{A.34}$$

$$\hat{\pi}_{w,t} = \hat{w}_t - \hat{w}_{t-1} + \hat{\pi}_t, \tag{A.35}$$

$$\hat{\pi}^*_{w,t} = \hat{w}^*_t - \hat{w}^*_{t-1} + \hat{\pi}^*_t \tag{A.36}$$

A.5.3 Capital Good Producers

$$\hat{k}_t = (1-\delta)\hat{k}_{t-1} + \delta(\hat{x}_{t-1} + \varepsilon_{i,t-1}), \tag{A.37}$$

$$\hat{k}^*_t = (1-\delta^*)\hat{k}^*_{t-1} + \delta^*(\hat{x}^*_{t-1} + \varepsilon^*_{i,t-1}) \tag{A.38}$$

$$\hat{x}_t = \frac{\iota}{1+\beta}\left(\hat{p}_{k,t} + \varepsilon_{i,t}\right) + \frac{\beta m}{1+\beta}E_t\hat{x}_{t+1} + \frac{1}{1+\beta}\hat{x}_{t-1}, \tag{A.39}$$

$$\hat{x}^*_t = \frac{\iota^*}{1+\beta^*}\left(\hat{p}^*_{k,t} + \varepsilon^*_{i,t}\right) + \frac{\beta^* m}{1+\beta^*}E_t\hat{x}^*_{t+1} + \frac{1}{1+\beta^*}\hat{x}^*_{t-1} \tag{A.40}$$

A.5.4 Final Good Producers

$$\hat{\pi}_{H,t} = \hat{\pi}_t + \hat{p}_{H,t} - \hat{p}_{H,t-1}, \qquad \hat{\pi}^*_{F,t} = \hat{\pi}^*_t + \hat{p}^*_{F,t} - \hat{p}^*_{F,t-1}, \tag{A.41}$$

$$\hat{\pi}_{F,t} = \hat{\pi}_t + \hat{p}_{F,t} - \hat{p}_{F,t-1}, \qquad \hat{\pi}^*_{H,t} = \hat{\pi}^*_t + \hat{p}^*_{H,t} - \hat{p}^*_{H,t-1} \tag{A.42}$$

$$\hat{\pi}_t = (1-\eta_H)\left(\hat{\pi}_{F,t} + \hat{p}_{F,t-1}\right) + \eta_H\left(\hat{\pi}_{H,t} + \hat{p}_{H,t-1}\right), \tag{A.43}$$

$$\hat{\pi}^*_t = (1-\eta^*_H)\left(\hat{\pi}^*_{H,t} + \hat{p}^*_{H,t-1}\right) + \eta^*_H\left(\hat{\pi}^*_{F,t} + \hat{p}^*_{F,t-1}\right) \tag{A.44}$$

$$\hat{y}_{H,t} = -\phi_y \hat{p}_{H,t} + \hat{y}_t, \qquad \hat{y}_{F,t} = -\phi_y \hat{p}_{F,t} + \hat{y}_t, \tag{A.45}$$

$$\hat{y}^*_{H,t} = -\phi^*_y \hat{p}^*_{H,t} + \hat{y}^*_t, \qquad \hat{y}^*_{F,t} = -\phi^*_y \hat{p}^*_{F,t} + \hat{y}^*_t \tag{A.46}$$

A.5.5 Intermediate Goods Producers

$$\hat{r}_{k,t} - \hat{w}_t = \hat{l}_t - \hat{k}_t, \tag{A.47}$$

$$\hat{r}^*_{k,t} - \hat{w}^*_t = \hat{l}^*_t - \hat{k}^*_t \tag{A.48}$$

$$\hat{mc}_{H,t} = \alpha \hat{r}_{k,t} + (1-\alpha)\hat{w}_t - \hat{p}_{H,t} - \hat{z}_t, \tag{A.49}$$

$$\hat{mc}^*_{F,t} = \alpha^* \hat{r}^*_{k,t} + (1-\alpha^*)\hat{w}^*_t - \hat{p}^*_{F,t} - \hat{z}^*_t, \tag{A.50}$$

$$\hat{mc}_{F,t} = \alpha^* \hat{r}^*_{k,t} + (1-\alpha^*)\hat{w}^*_t - \hat{p}_{F,t} - \hat{z}^*_t + \hat{q}_t, \tag{A.51}$$

$$\hat{mc}^*_{H,t} = \alpha \hat{r}_{k,t} + (1-\alpha)\hat{w}_t - \hat{p}^*_{H,t} - \hat{z}_t - \hat{q}_t \tag{A.52}$$

$$\hat{\pi}_{H,t} - \zeta_H \hat{\pi}_{H,t-1} = \beta\left(mE_t\hat{\pi}_{H,t+1} - \zeta_H \hat{\pi}_{H,t}\right) + \frac{(1-\theta_H)(1-\beta\theta_H)}{\theta_H}\left(\hat{mc}_{H,t} + \varepsilon_{p,t}\right) \tag{A.53}$$

$$\hat{\pi}^*_{F,t} - \zeta^*_F \hat{\pi}^*_{F,t-1} = \beta^*\theta^*_F\left(mE_t\hat{\pi}^*_{F,t+1} - \zeta^*_F \hat{\pi}^*_{F,t}\right) + \frac{(1-\theta^*_F)(1-\beta^*\theta^*_F)}{\theta^*_F}\left(\hat{mc}^*_{F,t} + \varepsilon^*_{p,t}\right) \tag{A.54}$$

$$\theta_F\left(\hat{\pi}_{F,t} - \zeta_F \hat{\pi}_{F,t-1}\right) = \beta^*\theta_F\left(mE_t\hat{\pi}_{F,t+1} - \zeta_F\hat{\pi}_{F,t}\right) + (1-\theta_F)(1-\beta^*\theta_F)\left(\hat{mc}_{F,t} + \varepsilon_{p,t}\right) \tag{A.55}$$

$$\theta_H^*\left(\hat{\pi}_{H,t}^* - \zeta_H^*\hat{\pi}_{H,t-1}^*\right) = \beta\theta_H^*\left(mE_t\hat{\pi}_{H,t+1}^* - \zeta_H^*\hat{\pi}_{H,t}^*\right) + (1-\theta_H^*)(1-\beta\theta_H^*)\left(\hat{mc}_{H,t}^* + \varepsilon_{p,t}^*\right) \tag{A.56}$$

Define the steady-state sales weights

$$\bar{\omega}_{H,y} \equiv \frac{\bar{y}_H}{\bar{y}_H + \frac{1-\omega}{\omega}\bar{y}_H^*}, \qquad \bar{\omega}_{F,y}^* \equiv \frac{\bar{y}_F^*}{\frac{\omega}{1-\omega}\bar{y}_F + \bar{y}_F^*}.$$

$$\bar{\omega}_{H,y}\hat{y}_{H,t} + (1-\bar{\omega}_{H,y})\,\hat{y}_{H,t}^* = \hat{z}_t + \alpha\hat{k}_t + (1-\alpha)\hat{l}_t, \tag{A.57}$$

$$\left(1-\bar{\omega}_{F,y}^*\right)\hat{y}_{F,t} + \bar{\omega}_{F,y}^*\hat{y}_{F,t}^* = \hat{z}_t^* + \alpha^*\hat{k}_t^* + (1-\alpha^*)\hat{l}_t^* \tag{A.58}$$

A.5.6 Government and the central bank

$$\frac{\omega_R}{\bar{\tilde{y}}}\hat{b}_{G,t} + \frac{\bar{T}}{\bar{\tilde{y}}}\hat{T}_t - \frac{\omega_N}{\bar{\tilde{y}}}\widehat{TR}_t = \frac{\bar{b}_G}{\beta\bar{\tilde{y}}}\left(\hat{R}_{t-1} - \hat{\pi}_t\right) + \frac{\omega_R}{\beta\bar{\tilde{y}}}\hat{b}_{G,t-1} + \frac{\bar{g}}{\bar{\tilde{y}}}\hat{g}_t, \tag{A.59}$$

$$\frac{\omega_R^*}{\bar{\tilde{y}}^*}\hat{b}_{G,t}^* + \frac{\bar{T}^*}{\bar{\tilde{y}}^*}\hat{T}_t^* = \frac{\bar{b}_G^*}{\beta^*\bar{\tilde{y}}^*}\left(\hat{R}_{t-1}^* - \hat{\pi}_t^*\right) + \frac{\omega_R^*}{\beta^*\bar{\tilde{y}}^*}\hat{b}_{G,t-1}^* + \frac{\bar{g}^*}{\bar{\tilde{y}}^*}\hat{g}_t^* \tag{A.60}$$

$$\frac{\bar{T}}{\bar{\tilde{y}}}\hat{T}_t = \nu\frac{\hat{b}_{G,t}}{\bar{\tilde{y}}}, \tag{A.61}$$

$$\frac{\bar{T}^*}{\bar{\tilde{y}}^*}\hat{T}_t^* = \nu^*\frac{\hat{b}_{G,t}^*}{\bar{\tilde{y}}^*} \tag{A.62}$$

$$\frac{\omega_N}{\bar{\tilde{y}}}\widehat{TR}_t = -\nu_{y,T}\hat{\tilde{y}}_t \tag{A.63}$$

$$\hat{R}_t = \gamma_r\hat{R}_{t-1} + (1-\gamma_r)\Big[\gamma_\pi\hat{\pi}_t + \gamma_y\hat{\tilde{y}}_t + \gamma_{\Delta\pi}\left(\hat{\pi}_t - \hat{\pi}_{t-1}\right) + \gamma_{\Delta y}\left(\hat{\tilde{y}}_t - \hat{\tilde{y}}_{t-1}\right)\Big] + \varepsilon_{R,t}, \tag{A.64}$$

$$\hat{R}_t^* = \gamma_r^*\hat{R}_{t-1}^* + (1-\gamma_r^*)\Big[\gamma_\pi^*\hat{\pi}_t^* + \gamma_y^*\hat{\tilde{y}}_t^* + \gamma_{\Delta\pi}^*\left(\hat{\pi}_t^* - \hat{\pi}_{t-1}^*\right) + \gamma_{\Delta y}^*\left(\hat{\tilde{y}}_t^* - \hat{\tilde{y}}_{t-1}^*\right)\Big] + \varepsilon_{R,t}^* \tag{A.65}$$

A.5.7 Monetary Union accession

Outside the monetary union, the domestic economy is characterized by the UIP condition

$$\hat{R}_t - \hat{R}_t^* = mE_t\hat{q}_{t+1} - \hat{q}_t + mE_t\hat{\pi}_{t+1} - mE_t\hat{\pi}_{t+1}^* + \hat{\kappa}_t. \tag{A.66}$$

After monetary-union entry, UIP is replaced by

$$\hat{q}_t - \hat{q}_{t-1} = \hat{\pi}^*_t - \hat{\pi}_t, \tag{A.67}$$

the domestic nominal interest rate satisfies

$$\hat{R}_t = \hat{R}^*_t, \tag{A.68}$$

and the common monetary policy rule becomes

$$\begin{aligned}\hat{R}^*_t = \gamma^*_r \hat{R}^*_{t-1} + (1-\gamma^*_r)\big(\gamma^*_\pi\left((1-\omega)\hat{\pi}^*_t + \omega\hat{\pi}_t\right) + \gamma^*_y\left((1-\omega)\hat{\tilde{y}}^*_t + \omega\hat{\tilde{y}}_t\right) \\ + \gamma^*_{\Delta y}\left((1-\omega)(\hat{\tilde{y}}^*_t - \hat{\tilde{y}}^*_{t-1}) + \omega(\hat{\tilde{y}}_t - \hat{\tilde{y}}_{t-1})\right)\big) + \varepsilon^*_{R,t}.\end{aligned} \tag{A.69}$$

A.5.8 Closing the model

$$\hat{y}_t = \frac{\bar{c}}{\bar{y}}\hat{c}_t + \frac{\bar{x}}{\bar{y}}\hat{x}_t + \frac{\bar{g}}{\bar{y}}\hat{g}_t, \tag{A.70}$$

$$\hat{y}^*_t = \frac{\bar{c}^*}{\bar{y}^*}\hat{c}^*_t + \frac{\bar{x}^*}{\bar{y}^*}\hat{x}^*_t + \frac{\bar{g}^*}{\bar{y}^*}\hat{g}^*_t \tag{A.71}$$

$$\hat{\tilde{y}}_t = \frac{\bar{y}}{\tilde{\bar{y}}}\hat{y}_t + \frac{\bar{q}\bar{p}^*_H\bar{y}^*_H}{\tilde{\bar{y}}}\frac{1-\omega}{\omega}\left(\hat{y}^*_{H,t} + \hat{q}_t + \hat{p}^*_{H,t}\right) - \frac{\bar{p}_F\bar{y}_F}{\tilde{\bar{y}}}\left(\hat{p}_{F,t} + \hat{y}_{F,t}\right), \tag{A.72}$$

$$\hat{\tilde{y}}^*_t = \frac{\bar{y}^*}{\tilde{\bar{y}}^*}\hat{y}^*_t + \frac{\bar{p}_F\bar{y}_F}{\tilde{\bar{y}}^*}\left(\hat{y}_{F,t} - \hat{q}_t + \hat{p}_{F,t}\right) - \frac{\bar{p}^*_H\bar{y}^*_H}{\tilde{\bar{y}}^*}\left(\hat{p}^*_{H,t} + \hat{y}^*_{H,t}\right) \tag{A.73}$$

$$\hat{\kappa}_t = \chi\left(-\frac{\omega_R}{\tilde{\bar{y}}}\hat{b}^*_{H,t} - \frac{\bar{b}^*_H}{\tilde{\bar{y}}}\hat{\tilde{y}}_t\right) + \varepsilon_{\kappa,t} \tag{A.74}$$

$$\begin{aligned}\frac{\bar{q}\bar{p}^*_H\bar{y}^*_H}{\tilde{\bar{y}}}\frac{1-\omega}{\omega}\left(\hat{q}_t + \hat{p}^*_{H,t} + \hat{y}^*_{H,t}\right) - \frac{\omega_R}{\tilde{\bar{y}}}\hat{b}^*_{H,t} = \frac{\bar{p}_F\bar{y}_F}{\tilde{\bar{y}}}\left(\hat{p}_{F,t} + \hat{y}_{F,t}\right) \\ + \frac{\bar{b}^*_H}{\beta^*\tilde{\bar{y}}}\left(\hat{R}^*_{t-1} + \hat{\kappa}_{t-1}\right) - \frac{\omega_R}{\beta^*\tilde{\bar{y}}}\hat{b}^*_{H,t-1}\end{aligned} \tag{A.75}$$

A.5.9 Shock processes

$$\hat{z}_t = \rho_z \hat{z}_{t-1} + e_{z,t}, \qquad \hat{z}^*_t = \rho^*_z \hat{z}^*_{t-1} + e^*_{z,t}, \tag{A.76}$$

$$\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + e_{i,t}, \qquad \varepsilon^*_{i,t} = \rho^*_i \varepsilon^*_{i,t-1} + e^*_{i,t}, \tag{A.77}$$

$$\varepsilon_{R,t} = e_{R,t}, \qquad \varepsilon^*_{R,t} = e^*_{R,t}, \tag{A.78}$$

$$\varepsilon_{p,t} = \rho_p \varepsilon_{p,t-1} + e_{p,t}, \qquad \varepsilon^*_{p,t} = \rho^*_p \varepsilon^*_{p,t-1} + e^*_{p,t}, \tag{A.79}$$

$$\hat{g}_t = \rho_g \hat{g}_{t-1} - \nu_{y,g} \hat{\tilde{y}}_t + e_{g,t}, \qquad \hat{g}^*_t = \rho^*_g \hat{g}^*_{t-1} + e^*_{g,t}, \tag{A.80}$$

$$\varepsilon_{\kappa,t} = \rho_\kappa \varepsilon_{\kappa,t-1} + e_{\kappa,t}, \tag{A.81}$$

$$\varepsilon_{w,t} = \rho_w \varepsilon_{w,t-1} + e_{w,t}, \qquad \varepsilon^*_{w,t} = \rho^*_w \varepsilon^*_{w,t-1} + e^*_{w,t}, \tag{A.82}$$

$$\varepsilon_{u,t} = \rho_c \varepsilon_{u,t-1} + e_{u,t}, \qquad \varepsilon^*_{u,t} = \rho^*_c \varepsilon^*_{u,t-1} + e^*_{u,t} \tag{A.83}$$