Monetary Integration under Household Heterogeneity and Bounded Rationality*

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Abstract

We examine the macroeconomic consequences of Poland's hypothetical accession to the euro area in a New Keynesian open economy model with behavioral expectations (BE). First, we find that monetary integration would have substantially amplified output volatility, while making inflation more stable. Second, we document the key role of the exchange rate at entry. An undervalued currency delivers a boom and bust cycle and inflationary pressures, while an overvalued one leads to a deep, prolonged downturn and deflation. Third, we check whether fiscal policy can stabilize the economy in absence of monetary autonomy and find that - under plausible assumptions about its activity - it is unable to restore macroeconomic stability attainable under an independent monetary regime. Fourth, we show the effects of deviating from rational expectations. BE fits the data much better and limits somewhat the estimated cost of joining the currency union.

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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. While the literature on costs and benefits of monetary integration is rich, this paper offers two important new contributions. First, in line with the growing emphasis placed on modeling the consequences of deviating from the unrealistic assumption of rational expectations, we analyze how the effects of joining a monetary union depend on the mechanism of expectation formation. Second, in contrast to most of the literature which discusses the theoretical consequences of integration, our paper offers simulations based on the experience of Poland and the euro area as observed in the data. This allows to compare the importance of various channels and offer a quantitative answer what would have happened given developments that occurred in the real world.

Speaking in more detail about the first contribution, we compare rational expectations (RE) with behavioral expectations (BE), the latter modeled to reflect myopic behavior of agents in the spirit of Gabaix (2020). 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, BE models tend to have stronger internal propagation, which leads to the estimation of smaller shock variances. This reduces the overall macroeconomic variability and, in turn, lessens the aggregate consequences of losing monetary autonomy. The net effect of these opposing forces is ultimately an empirical question. We find that, on balance, surrendering independent monetary policy increases GDP volatility less under BE than under RE. In other words, standard models overestimate the cost of monetary integration.

Our second contribution follows from conducting several counterfactual simulations, assuming that Poland had joined the euro area in the past. This offers three important findings which, while known in theory from earlier studies, gain a quantitative dimension related to real-life developments from the past. These relate to the amount of de/amplification of volatility, the role of exchange rate at entry and the limits of fiscal stabilization policy.

Speaking about macroeconomic volatility, we find that the differences between euro adoption and monetary independence would have been very limited during tranquil periods. However, during turbulent times—particularly during the COVID-19 pandemic and after Russia's unprovoked, full-scale military incursion into Ukraine, participation in the common currency area would have led to significantly greater GDP volatility. Inflation, on the other hand, becomes more stable independently of the period under consideration.

Let us move to the exchange rate at the point of entry. We simulate counterfactual scenarios in which the country adopts the euro at different historical moments (and historical levels of the exchange rate). We find that the macroeconomic effects of monetary integration depend crucially on whether the nominal exchange rate is undervalued or overvalued at the time of joining. 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 deep and persistent output contraction. These results underscore the importance of strategic timing in monetary integration and highlight the real exchange rate as a critical state variable often ignored in static cost-benefit frameworks.

Finally, we explore the capacity of fiscal authorities to stabilize the domestic economy in the absence of monetary autonomy within a monetary union. While the literature suggests that behavioral expectations amplify the effectiveness of fiscal interventions, we assess whether fiscal tools could meaningfully compensate for the inability to conduct independent monetary policy. Our findings indicate that—under empirically plausible assumptions—fiscal 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.

Together, these insights suggest that both the moment of euro adoption and the behavioral assumptions embedded in policy evaluation models play a central role in shaping macroeconomic outcomes. For countries like Poland still contemplating euro area accession, our results offer a nuanced view of the costs and benefits of monetary integration that extend beyond traditional considerations of structural symmetry or institutional readiness.

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 contributes to the growing literature on the macroeconomic consequences of losing monetary independence within a currency union. A well-established finding in this area is that relinquishing autonomous monetary policy typically leads to higher output volatility and reduced inflation volatility, as national monetary tools are no longer available to respond to country-specific shocks (Gradzewicz and Makarski, 2013; Lama and Rabanal, 2014). This trade-off reflects the structural constraints imposed by a shared currency and the need to absorb asymmetric shocks without traditional stabilization tools.

A related strand of literature investigates the role of alternative policy instruments in stabilizing economies within a monetary union. A key insight from early work such as Galí and Monacelli (2008) is that optimal policy design involves monetary policy responding to union-wide shocks, while national fiscal policies address idiosyncratic disturbances. In the absence of exchange rate flexibility and independent interest rates, the literature has explored fiscal devaluation as a substitute for nominal devaluation. de Mooij and Keen (2012) provide empirical evidence suggesting that such fiscal adjustments can improve trade balances in the short run, although the effects may dissipate over time. Kaufmann (2019) shows that value-added tax (VAT) adjustments can partially replicate the effects of monetary policy, providing a degree of stabilization in currency unions.

Building on this, more recent studies have examined whether supranational fiscal mechanisms could further mitigate the loss of national monetary autonomy. Inspired by proposals such as those in Farhi and Werning (2017), researchers have explored institutional arrangements like common unemployment insurance schemes. Kaufmann et al. (2023), for instance, evaluates whether a European unemployment insurance mechanism could serve as an effective shock absorber, helping to stabilize output and income disparities within the euro area in the absence of monetary policy independence. Additionally, Cimadomo et al. (2018) investigate the contribution of private and public channels for consumption risk sharing in the EMU, highlighting the role of financial integration and international financial assistance in smoothing consumption

While the literature discussed above typically assumes rational expectations—an approach formalized by Muth (1961)—this assumption has increasingly come under scrutiny. Rational expectations posit that agents use all available information to form statistically optimal and internally consistent forecasts about future economic conditions. This framework became central to modern macroeconomics through the influential work of Lucas (1972) and the development of time-consistent policy analysis by Kydland and Prescott (1982).

However, growing evidence from behavioral economics challenges the empirical realism of this assumption. Foundational work by Daniel Kahneman and Amos Tversky shows that individuals often rely on cognitive shortcuts and are prone to systematic biases in judgment and decision-making (Kahneman and Tversky, 1972; Tversky and Kahneman, 1974). These insights have motivated a new wave of macroeconomic models that relax the rational expectations hypothesis to better reflect how expectations are formed in practice.

To account for non-rational expectations, macroeconomic models have adopted various approaches. Early work on adaptive learning assumes agents use simple econometric rules to form expectations from past data. More recently, models have focused on cognitive limitations. Rational inattention models, for example, assume agents optimally allocate limited attention across decisions (Maćkowiak and Wiederholt, 2015).

Other approaches include k-level thinking, where agents forecast a limited number of periods ahead, and diagnostic expectations, in which agents overweight recent information and overreact to shocks (Bordalo et al., 2020). Behavioral expectations, as proposed by Gabaix (2020), assume agents form forecasts myopically due to limited attention, systematically discounting future outcomes and anchoring expectations toward the steady state. These models can better capture macroeconomic persistence and volatility than those based on rational expectations.

Our study builds on the behavioral expectations framework developed by Gabaix (2020), who integrates boundedly rational agents into a New Keynesian model. He shows that under behavioral expectations (BE), the Taylor principle is modified, allowing for more passive monetary policy; the zero lower bound (ZLB) can be a stable equilibrium; and forward guidance becomes less effective. Expanding on this, Bounader and Traficante (2022) argue that BE calls for more aggressive monetary responses to stabilize the economy, while Dobrew et al. (2023) analyze the performance of alternative policy rules under BE.

In the open economy context, Brzoza-Brzezina et al. (2025) and Kolasa et al. (2025) show that models with BE match the data better than those with rational expectations (RE). They find that monetary policy is less potent under BE because agents do not fully internalize future consequences of current policy. Consequently, a more passive stance is viable, especially in small open economies when the monetary authority abroad is more active—a result not present under RE. As expectations become more behavioral, the inflation-output trade-off worsens, increasing the sacrifice ratio. Moreover, fiscal policy becomes more effective under BE due to weaker monetary crowding out, amplifying international spillovers. Notably, BE helps resolve the uncovered interest parity (UIP) puzzle by generating persistent excess returns on domestic assets following interest rate hikes.

This paper contributes to the literature on the macroeconomic implications of monetary union by showing how these effects are modified under behavioral expectations. It highlights the importance of the real exchange rate at the time of entry, a factor often overlooked in standard analyses. In addition, it extends the literature on fiscal consolidations by examining the stabilizing role of fiscal policy in a monetary union when expectations are behavioral and households are heterogeneous.

3 Model

We analyze monetary integration in a two-country New Keynesian model with heterogeneous agents and imperfect rationality. Agents form expectations using the cognitive discounting framework of Gabaix (2020), in which agents perceive future deviations from the steady state with decreasing accuracy. Specifically, if the interest rate at time $t + k$ is given by

$r_{t+k} = \bar{r} + \hat{r}_{t+k}$, then behavioral expectations (denoted by E_t^{BE}) are defined as:

$$E_t^{BE} r_{t+k} = E_t^{BE}(\bar{r} + \hat{r}t + k) = E_t(\bar{r}) + m^k E_t(\hat{r}t + k), \tag{1}$$

where $m \in [0, 1]$ captures the degree of cognitive discounting.

The model features two countries—Home and Foreign—with populations ω and $\omega^* = 1 - \omega$, respectively. Both economies share a symmetric structural setup, including Ricardian and non-Ricardian households, firms producing for domestic and export markets, monetary authorities, and governments. However, they may differ in size and parameters. Throughout the paper, we use bars to denote steady-state values, hats for deviations from steady state, and lowercase and uppercase letters to distinguish real and nominal variables, respectively. Variables without an asterisk refer to the Home country, while asterisks denote Foreign country counterparts. Given the structural symmetry, we describe agent behavior in the Home country only.

3.1 Households

The household sector consists of two types of agents: Ricardian households (denoted by subscript R) and non-Ricardian, hand-to-mouth households (denoted by subscript H). Both types of households supply labor, but they differ in their access to financial and capital markets and in their intertemporal behavior. A constant fraction ω_R of the population consists of Ricardian households, while the remaining share, $\omega_H = 1 - \omega_R$ comprises hand-to-mouth households. Ricardian households maximizes utility under boundedly rational expectations, following the behavioral approach of Gabaix (2020), whereas non-Ricardian consume all their disposable income.

Households $j \in \{R, H\}$ derive utility from consumption $c_{j,t}$ and disutility from supplying labor $n_{j,t}$. Their preferences given by:

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

where $\beta \in (0, 1)$ is the discount factor, σ is the inverse of the intertemporal elasticity of substitution in consumption, and γ is the inverse of the Frisch elasticity of labor supply. The term $\varepsilon_{u,t}$ represents a discount factor shock, and $\varepsilon_{w,t}$ is a wage markup shock, defined—following Galí et al. (2012)—as the log deviation between the real wage and the marginal rate of substitution between labor and consumption. Both shocks follow AR(1) processes, with persistence parameters denoted by ρ_c and ρ_w, and standard deviations of innovations by σ_c and σ_w, respectively.

Ricardian households own physical capital k_t, which they rent to firms at the real rental rate $r_{k,t}$. Ricardian households do not invest in capital formation directly; instead, they purchase capital at the market price Q_t from specialized capital goods producers.

In addition to holding capital, Ricardian households participate in domestic and international bond markets.[1] Domestic bonds B_t pay a nominal risk-free return R_t, while foreign bonds B_t^* yield a nominal return of $R_t^*\kappa_t$, where R_t^* is the foreign nominal interest rate and κ_t is a risk premium. Following Schmitt-Grohe and Uribe (2003), we assume the risk premium depends on the aggregate foreign debt position of the home country:

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

where S_t denotes the nominal exchange rate, P_t the consumption price index, and $\tilde{y}_t$ the level of GDP. The parameter d is chosen such that the risk premium is zero in the deterministic steady state. The term $\varepsilon_{\kappa,t}$ represents a risk premium shock, modeled as an AR(1) process with persistence ρ_κ and innovation standard deviation σ_κ.

Furthermore, Ricardian households are the residual claimants of all domestic firms and receive lump-sum real profits denoted by 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 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:

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

where P_t is the consumption price level, $B_{R,t}$ and $B_{R,t}^*$ denote domestic and foreign bond holdings, T_t denotes lump-sum taxes, and Π_t are nominal profits rebated from firms. The nominal exchange rate is denoted by S_t, and the risk premium by κ_t.

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

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

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

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

[1] 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.

In contrast, domestic and foreign bond holdings, physical capital, and the stream of dividends from firms are exclusively held by Ricardian households:

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

3.2 Linearization

To solve the model, we log-linearize the 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-specifically, domestic and foreign bond holdings-which may be zero in steady state, we use level deviations: for example, $\hat{b}_{R,t} = b_{R,t} - \bar{b}_R$.

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

$$\begin{aligned} \hat{c}_t &= mE_t\hat{c}_{t+1} - \frac{1}{\sigma}(\hat{R}_t - mE_t\hat{\pi}_{t+1}) + \frac{1}{\sigma}(\hat{\varepsilon}_{u,t} - mE_t\hat{\varepsilon}_{u,t+1}) \\ &\quad + \frac{(1-\beta)}{\beta\bar{c}_R}(1-m)(\hat{b}_t + \hat{b}^*_t + \bar{k}(\hat{p}_{k,t} + \hat{k}_t) + \bar{b}^*_H\hat{\kappa}_t) \end{aligned} \tag{8}$$

This expression departs from the standard rational expectations version in two important ways. First, following Gabaix (2020), expectations of future deviations from steady state are discounted by a factor $m \in [0,1]$, reflecting agents' bounded rationality. Second, current-period consumption depends directly on the level of asset holdings—including domestic and foreign bonds. This breaks Ricardian equivalence and its open-economy analogue, as consumption decisions are influenced by wealth effects stemming from myopic expectations of future income.

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.

We also derive a behavioral version of the uncovered interest parity (UIP) condition:

$$\underbrace{\hat{R}_t - mE_t\hat{\pi}_{t+1}}_{\substack{\text{behaviorally expected domestic} \\ \text{real interest rate}}} = \underbrace{\hat{R}^*_t + \hat{\kappa}_t - m\hat{\pi}^*_{t+1}}_{\substack{\text{behaviorally expected foregin} \\ \text{real interest rate}}} + \underbrace{mE_t\hat{q}_{t+1} - \hat{q}_t}_{\substack{\text{behaviorally expected} \\ \text{RER depreciation rate}}} \tag{9}$$

where $q_t \equiv S_t P^*_t / P_t$ is the real exchange rate. Under behavioral expectations, agents discount deviations in expected inflation and exchange rates, leading to a slower and less complete arbitrage response than in the rational benchmark. As expected, all behavioral modifications vanish when $m = 1$, and the model collapses to the rational expectations case.

3.3 Wage setting

We assume that each household supplies a continuum of differentiated labor types indexed by $h \in [0, 1]$. For each labor type h, there is a labor union that sets the nominal wage $W_t(h)$ in a monopolistically competitive market. Each union represents a fixed share of Ricardian (ω_R) and non-Ricardian (ω_H) households, who are uniformly distributed across all 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.

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

$$n_t = \left(\int_0^1 n_t\left(h\right)^{\frac{\phi_n - 1}{\phi_n}} dh \right)^{\frac{\phi_n}{\phi_n - 1}} \tag{10}$$

where ϕ_n denotes the elasticity of substituting between differentiated labor types. The aggregated labor input n_t is then supplied to firms. Since each household supplies all types of labor, and wage-setting is symmetric across labor types, all households receive the same labor income. Labor unions only set wages; they do not retain any revenues.

Nominal wages are subject to rigidity following the Calvo (1983) mechanism. In each period, a fraction $1 - \theta_w$ of labor unions receives the opportunity to reoptimize their nominal wage, while the remaining fraction θ_w keeps the previous period's wage, adjusted for past wage inflation. Specifically, wages are indexed to the lagged wage growth rate $\pi_{w,t-1}$ according to the rule:

$$w_{h,t} = w_{h,t-1} \pi_{w,t-1}^{\zeta_w} \bar{\pi}_w^{1-\zeta_w}, \tag{11}$$

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

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

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

where $\varepsilon_{w,t}$ is a wage markup shock.

The behavioral wage Phillips curve captures how nominal wage inflation responds to economic conditions when expectations are bounded. Due to Calvo frictions and partial indexation, wage adjustments are gradual, and only a subset of labor unions can reoptimize wages in each period. In addition, expectations of future variables are discounted by the parameter m, reflecting limited attention to future developments. This results in a muted forward-looking component and places more emphasis on current labor market conditions-specifically, consumption, hours worked, and wage markup shocks. As a result, wage inflation becomes more persistent and reacts more strongly to contemporaneous fluctuations in marginal rates of substitution and real activity, while being less sensitive to anticipated future changes in inflation and wage pressure.

3.4 Producers

The economy includes several types of firms, all owned by Ricardian households. Final goods are produced by perfectly competitive firms that aggregate a variety 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.

3.4.1 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:

$$k_t = (1-\delta)k_{t-1} + \varepsilon_{i,t}\left(1 - S\left(\frac{i_t}{i_{t-1}}\right)\right) i_{k,t}, \tag{13}$$

where k_t is the aggregate capital stock, i_t is capital investment, δ is the depreciation rate, and $\varepsilon_{i,t}$ is a 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:

$$S\left(\frac{i_t}{i_{t-1}}\right) = \frac{\psi_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2, \tag{14}$$

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

3.4.2 Final Good Producers

Perfectly competitive final good producers purchase domestic and foreign varieties of differentiated intermediate goods, $y_H(i)$ and $y_F(i)$, and aggregate them into a homogeneous good using a constant elasticity of substitution (CES) technology:

$$y_t = \left[(1-\eta_H)^{\frac{1}{\phi_y}} y_{F,t}^{\frac{\phi_y-1}{\phi_y}} + \eta_H^{\frac{1}{\phi_y}} y_{H,t}^{\frac{\phi_y-1}{\phi_y}}\right]^{\frac{\phi_y}{\phi_y-1}}, \tag{15}$$

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 $i \in [0,1]$:

$$y_{H,t} = \left(\int_0^1 y_{H,t}(i)^{\frac{1}{\mu_{p,t}}}, di\right)^{\mu_{p,t}}, \qquad y_{F,t} = \left(\int_0^1 y_{F,t}(i)^{\frac{1}{\mu_{p,t}}}, di\right)^{\mu_{p,t}}, \tag{16}$$

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.

3.4.3 Intermediate Goods Producers

Intermediate goods producers indexed by i use capital and labor to produce output according to the Cobb-Douglas production function:

$$y_{H,t}(i) + \frac{1-\omega}{\omega} y^*_{H,t}(i) = z_t k_t(i)^\alpha n_t(i)^{1-\alpha}, \tag{17}$$

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

This production function gives rise to the formula determining marginal costs, which is convenient to express in terms of the relative price of respective goods:[2]

$$mc_{H,t} = (1-\alpha)^{1-\alpha}\alpha^\alpha \frac{w_t^{1-\alpha} r_{k,t}^\alpha}{z_t p_{H,t}} \tag{18}$$

where $w_t \equiv \frac{W_t}{P_t}$ is the real wage and $p_{H,t} \equiv \frac{P_{H,t}}{P_t}$ is the relative price of domestic intermediate goods.

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.

[2] 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.

Solving we obtain the following behavioral Phillips curve

$$\begin{aligned}\theta_H(\hat{\pi}_{H,t} - \zeta_H \hat{\pi}_{H,t-1}) &= \beta\theta_H m(E_t\hat{\pi}_{H,t+1} - \zeta_H\hat{\pi}_{H,t}) \\ &+ (1-\theta_H)(1-\beta\theta_H)(\hat{mc}_{H,t} + \hat{\varepsilon}_{p,t}) - (1-\theta_H)\beta\theta_H(1-m)\zeta_H\hat{\pi}_{H,t} \quad (19)\end{aligned}$$

Note that it implies that under behavioral expectations price setters are relatively more responsive to current variables (like marginal cost) and less responsive to expected inflation as compared to rational agents.

The problem of the home goods producer operating in the foreign market is analogous, except that prices are expressed and sticky in the foreign currency. Solving it results in the following behavioral Phillips curve

$$\begin{aligned}\theta_H^*(\hat{\pi}_{H,t}^* - \zeta_H^* \hat{\pi}_{t-1}^*) &= \beta\theta_H^* m E_t(\hat{\pi}_{H,t+1}^* - \zeta_H^*\hat{\pi}_{H,t}^*) \\ &+ (1-\theta_H^*)(1-\beta\theta_H^*)(\hat{mc}_{H,t}^* + \hat{\varepsilon}_{p,t}^*) - (1-\theta_H^*)\beta\theta_H^*(1-m)\zeta_H^*\hat{\pi}_{H,t}^* \quad (20)\end{aligned}$$

3.5 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:

$$g_t + R_t b_{G,t-1} = T_t + b_{G,t} \quad (21)$$

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 is conducted according to a Taylor-type rule in which the central bank adjusts the nominal interest rate in response to inflation and output deviations. The policy rule is specified as:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\gamma_\pi} \left(\frac{\tilde{y}_t}{\bar{\tilde{y}}}\right)^{\gamma_y}\right]^{1-\gamma_R} e^{\varepsilon_{R,t}} \quad (22)$$

Here, $\tilde{y}$ represents GDP, γ_π and γ_y determine the responsiveness of the policy rate to inflation and output, while γ_R governs the degree of interest rate smoothing. The term $\varepsilon_{R,t}$ represents an i.i.d. monetary policy shock with standard deviation σ_R.

3.6 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:

$$\frac{R_t^*}{R^*} = \left(\frac{R_{t-1}^*}{R^*}\right)^{\gamma_R^*} \left[\left(\frac{(1-\omega)\pi_t^* + \omega\pi_t}{\bar{\pi}}\right)^{\gamma_\pi^*} \left(\frac{(1-\omega)\tilde{y}_t^* + \omega\tilde{y}_t}{\bar{\tilde{y}}}\right)^{\gamma_y^*}\right]^{1-\gamma_R^*} e^{\varepsilon_{R,t}^*} \tag{23}$$

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

$$R_t = R_t^*. \tag{24}$$

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 (9) is replaced by an identity describing the evolution of the real exchange rate in log-deviations from the steady state:

$$\hat{q}_t - \hat{q}_{t-1} = \hat{\pi}_t^* - \hat{\pi}_t \tag{25}$$

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.

3.7 Closing the model

3.7.1 GDP and Balance of Payments

Aggregate output (GDP) is defined as the sum of domestic consumption, government spending, and net exports:

$$\tilde{y}_t \equiv c_t + g_t + nx_t \tag{26}$$

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:

$$b^*_{H,t} = nx_t + \frac{q_t}{q_{t-1}\pi^*_t} b^*_{H,t-1} R^*_{t-1} \rho_{t-1} \tag{27}$$

This equation shows that net foreign assets increase through current account surpluses (net exports) and are also affected by the return on previously held foreign assets, adjusted for inflation and exchange rate movements.

3.7.2 Market clearing

We impose standard market clearing conditions. The final goods market clears when aggregate consumption and government spending equal domestic output:

$$c_t + g_t = y_t \tag{28}$$

The labor market clears when the total supply of individual labor services equals aggregate labor demand:

$$\int_0^1 n_t(h)dh = n_t \tag{29}$$

Finally, in the domestic bond market, clearing requires that the aggregate private holdings of domestic and foreign bonds equal the government's outstanding debt, weighted by the respective consumption shares:

$$\omega B_{H,t} + (1-\omega) B_{F,t} = \omega B_{G,t} \tag{30}$$

The complete set of linearized equilibrium conditions is presented in Appendix A.1.

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 - 2024 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_H, ω_H^*	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
$\varepsilon_p, \varepsilon_p^*$	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 48.4% 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 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. (2014), 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 2024Q4, resulting in 100 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 interest rates for Poland, 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 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 inflation we first download Harmonised Index of Consumer Prices (2021=100) that we log-differentiate to obtain quarter-to-quarter inflation. The EUR/PLN 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 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 data by assuming that observed wages may also be driven by white noise.[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 400,000 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 all estimated parameters, and the posterior modes align well with those reported in the literature for both Poland and the euro area.

In addition to the behavioral expectations (BE) model, we estimate a rational expectations (RE) 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 better fits the data. 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 99, strongly favoring the behavioral model over its rational expectations counterpart.

5 Shock Transmission Inside and Outside the Monetary Union

This section explores how macroeconomic dynamics are affected by monetary union membership when expectations are either rational or boundedly rational, and households are heterogeneous. By comparing Poland inside and outside the monetary union, we assess how the loss of monetary autonomy interacts with these frictions to shape policy transmission and shock propagation. The following subsections examine the role of monetary and fiscal policy, as well as the economy's adjustment to various shocks.

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

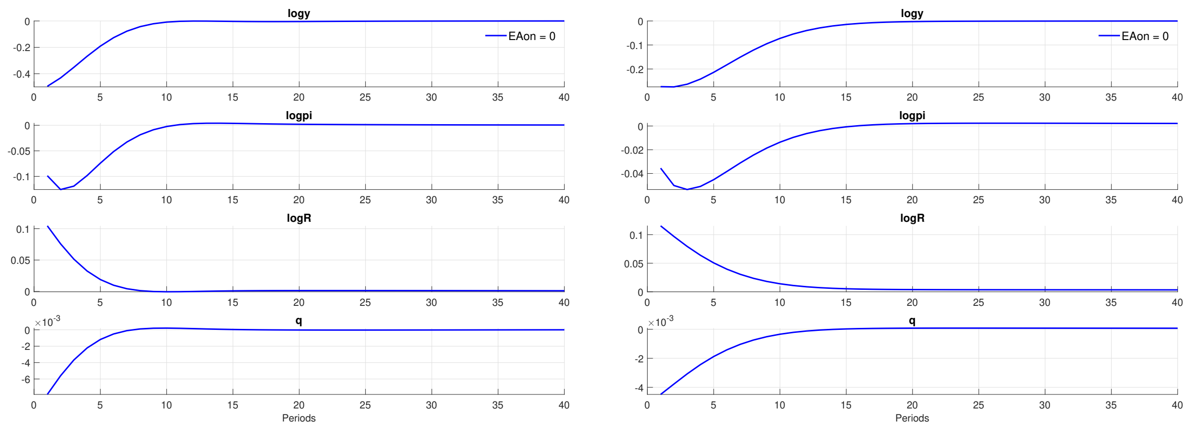
[4] The rational model estimation results are presented in Appendix (tables 7 and 8).

5.1 The working of monetary policy

Figures 1a and 1b present 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. The comparison focuses on the role of expectation formation—rational versus behavioral—in shaping the dynamics of output and inflation.

Figure 1: Impulse Response to Monetary Shock

(a) Rational Model (b) Behavioral Model



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. 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 (BE), 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[5] 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.

[5]This point is further illustrated by Brzoza-Brzezina et al. (2025), who show that in an open economy, monetary policy under BE is less potent.

Key Takeaways

- Even with monetary independence, behavioral expectations significantly reduce the short-run effectiveness of monetary policy, leading to weaker and more persistent responses in output and inflation.

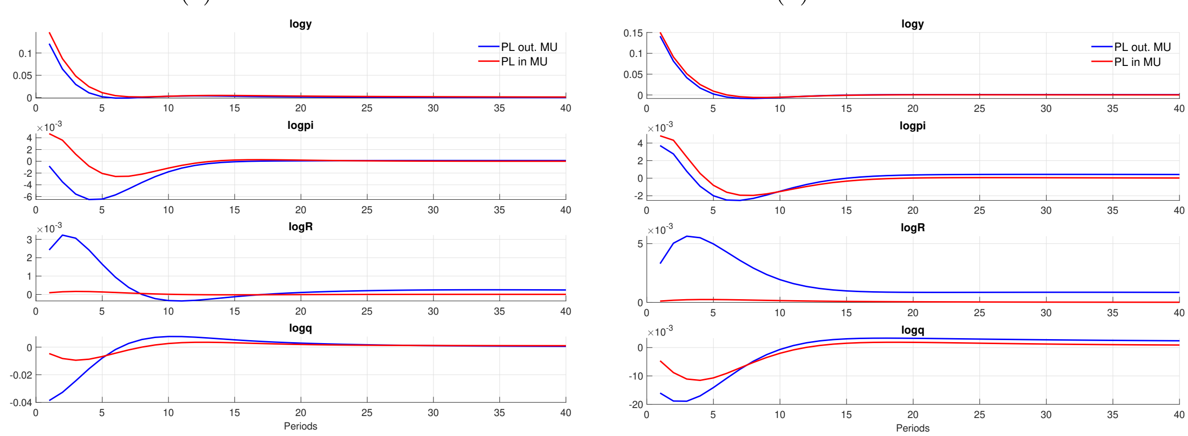
5.2 The working of fiscal policy

In a setting where behavioral expectations and household heterogeneity weaken the transmission of monetary policy, fiscal policy—particularly through government expenditure—emerges as a vital stabilization tool. This is especially relevant for countries such as Poland, which may either retain monetary independence or join a monetary union.

When Poland maintains monetary autonomy, fiscal spending complements national interest rate policy. In this setting, monetary policy remains the primary stabilization instrument, and fiscal policy plays a supportive role. By contrast, upon joining a monetary union and surrendering independent control over interest rates, fiscal policy becomes the main lever for domestic stabilization.

Figure 2: Impulse Response to Government Spending Shock

(a) Rational Model (b) Behavioral Model



Rational Expectations Under rational expectations, monetary policy is highly effective at stabilizing demand through intertemporal substitution. Consequently, outside a monetary union, fiscal expansions tend to trigger 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, fiscal multipliers are 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, the forward-looking channel of intertemporal substitution is muted. Households respond more to current income and less to expected future variables. This diminishes the role of interest rates in shaping consumption decisions, reducing the effectiveness of monetary policy regardless of whether the country is inside or outside the monetary union.

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 expectations than under rational expectations.

Key Takeaways

- Behavioral expectations amplify the impact of fiscal policy.
- Behavioral expectations reduce the increase in fiscal multipliers due to monetary integration.

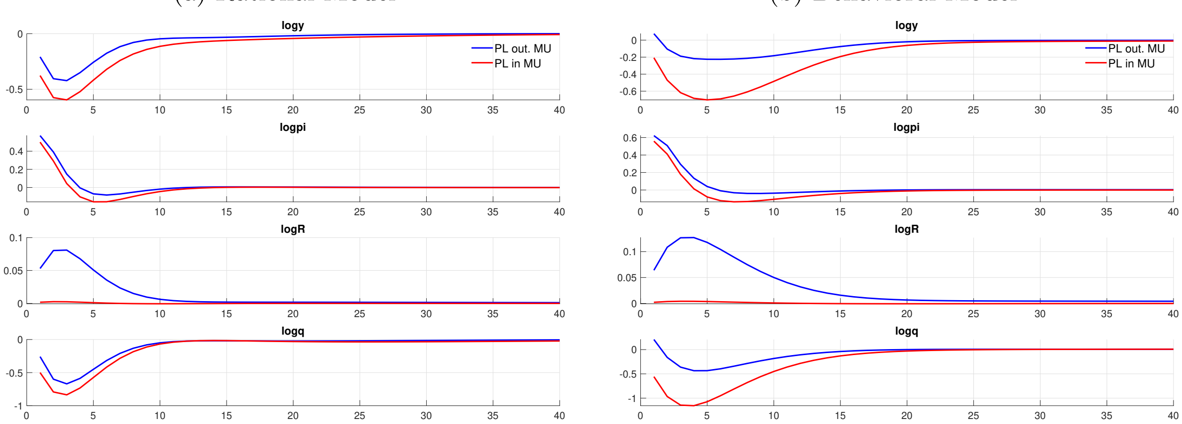
5.3 Monetary Union and Shock Transmission: The Case of Markup Shocks

Figures 3a and 3b present the impulse responses to a domestic mark-up shock for Poland in the rational and behavioral model, comparing the cases where it operates outside and inside a monetary union. The shock increases firms' desired mark-ups, raising inflation and compressing 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 real exchange rate flexibility.

Figure 3: Impulse Response to Markup Shock

(a) Rational Model

(b) Behavioral Model



Rational expectations Under rational expectations and monetary autonomy, Poland can raise interest rates in response to the shock, helping contain inflation. Although higher interest rates would typically exert upward pressure on the currency, the response of central bank is not strong enough to result in appreciation of the nominal exchange rate, instead it depreciates. This depreciation increases import prices and thus inflation, but it also improves external competitiveness and boost the increase in output.

In contrast, within a monetary union, Poland cannot adjust nominal interest rates or its exchange rate. In the absence of exchange rate flexibility the domestic price level does all the adjustment. Since prices rise in response to the markup shock, and the nominal exchange rate is fixed, the real exchange rate appreciates more strongly than in 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, real exchange rate adjustment serves as an effective buffer against domestic cost shocks—stabilizing output at the cost of greater inflation volatility.

Behavioral expectations Under behavioral expectations, agents place less weight on future policy outcomes, reducing the responsiveness of inflation and output to monetary conditions. This weakens the traditional policy transmission channels, making inflation more persistent and slowing the recovery. The dampened reaction to interest rate changes limits the capacity of monetary policy—whether national or union-level—to stabilize the economy effectively after a markup shock.

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, as domestic inflation rises against a fixed nominal exchange rate. The appreciation further depresses output, and the muted response of expectations slows the return to steady state, deepening and prolonging the adverse effects of the shock.

Key Takeaways

- Outside a monetary union, nominal exchange rate depreciation mitigates output losses from domestic cost shocks, but leads to slightly higher inflation.

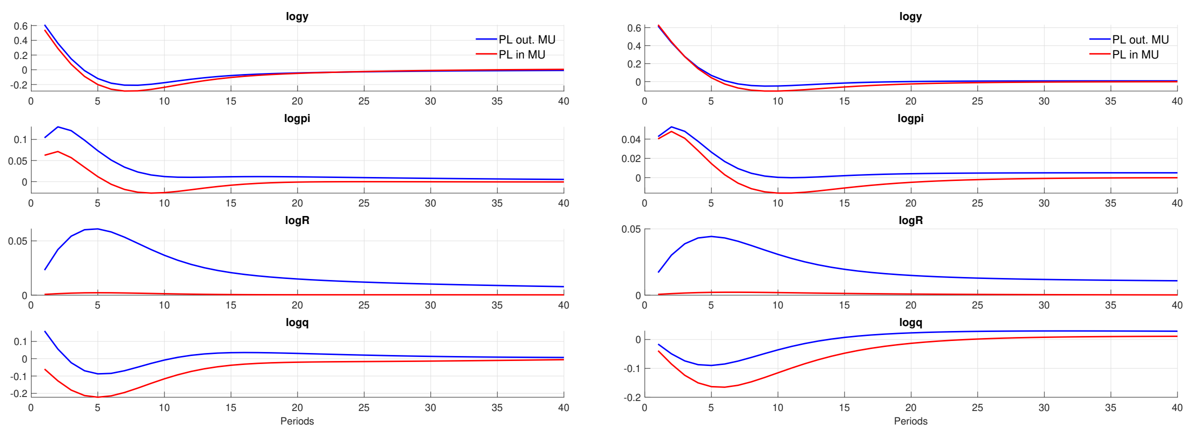
- Under behavioral expectations, the decline in output in a monetary union—relative to monetary independence—is more pronounced than under rational expectations, while the impact on inflation remains limited.

5.4 Monetary Union and Shock Transmission: The Case of Consumption Preference Shocks

Figures 4a and 4b show the impulse responses to a domestic consumption preference shock in both the rational and behavioral expectations models, comparing Poland's macroeconomic dynamics inside and outside a monetary union. 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. Unlike the previous shocks analyzed, the adjustment dynamics in this case are quite similar across monetary regimes.

Figure 4: Impulse Response Function to Consumption Preference Shocks

(a) Rational Model (b) Behavioral Model



Rational model Under rational expectations and monetary independence, Poland can raise its policy interest rate in response to the demand pressure. While higher nominal rates would normally appreciate the currency, the response in this model is not forceful enough to outweigh the inflationary pressures and increased domestic demand. As a result, the nominal exchange rate depreciates. This depreciation raises import prices, contributing to inflation, but also boosts external competitiveness, amplifying the output response.

Inside the monetary union, however, Poland forfeits both nominal interest rate autonomy and exchange rate flexibility. With the nominal exchange rate fixed and no independent monetary tightening, the domestic price level must carry the burden of adjustment. Since the nominal currency cannot depreciate as in the independent regime, the rise in prices is more contained. Nevertheless, the increase in domestic inflation relative to the union average leads to a real appreciation, albeit smaller than in the flexible exchange rate case. This reduces competitiveness and tempers the output increase—despite a smaller rise in inflation compared to the outside-union case.

Behavioral model Under behavioral expectations, inflation responds more sluggishly to the consumption preference shock. However, the overall pattern of adjustment remains similar to the rational model. The responses of output, inflation, and the real exchange rate under monetary union versus independent regimes mirror those seen in the RE case, though the magnitude of changes may be more muted due to attenuated forward-looking behavior.

Key Takeaways

- The macroeconomic response to a consumption preference shock is broadly similar in and outside the monetary union. In the independent regime, the central bank responds only moderately, leading to a slight nominal depreciation. This limits the differential effect of losing monetary autonomy under the union.

- The distinction between rational and behavioral expectations is relatively small in this case. While the propagation is slightly weaker under behavioral expectations, the qualitative dynamics remain similar across the two models.

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All in all, our investigation of how monetary integration and expectation formation affects the impact of various shocks on the economy delivers an unequivocal picture where some shocks or policies do while others do not become more powerful in a monetary union. 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: A View on Shocks and Integration

6.1 What Happened: Historical Shock Decomposition

This section examines how a range of shocks has shaped Poland's economy over the past 25 years, providing essential context for the counterfactual simulations of euro area accession presented in the following sections.

The economic relationship between Poland and the euro area offers an ideal setting to explore the potential benefits and costs of monetary integration. Since 2004, Poland and all euro area countries have been members of the European Union, allowing for the free movement of goods, capital, and labor. During this period, Poland underwent rapid structural transformation, driven by foreign direct investment, trade liberalization, and deepening integration with euro area economies. These dynamics contributed to substantial income convergence with Western Europe.

Crucially—from the point of view of our study—this era included both a relatively stable decade in the 2010s and two major global shocks—the global financial crisis of 2008-2009, and the more recent period marked by the COVID-19 pandemic and Russia's full-scale invasion of Ukraine. These episodes revealed key structural differences between Poland and the euro area, making them valuable case studies for assessing the role of independent monetary policy and a flexible exchange rate.

To better illustrate the evolution of Poland's macroeconomic environment, we present a historical decomposition of GDP and inflation into structural shocks (Figure 5), as identified by our model. Since the model incorporates fifteen distinct disturbances, we group them into five broad categories for clarity:

- **Risk premium:** risk premium shocks;
- **Monetary policy:** monetary policy shocks;
- **Foreign shocks:** all shocks originating in the euro area;
- **Demand shocks:** time preference, government spending, and investment shocks;
- **Supply shocks:** productivity, price markup, and labor markup shocks;

We keep risk premium and monetary policy shocks separate because they represent an important part of the effects of independent monetary policy, particularly through their influence on the exchange rate and domestic interest rates. While this does not capture the full impact of monetary independence, it reflects a substantial share of its effects. The remaining impact arises from the systematic component of monetary policy, shaped by the domestic Taylor rule and the modified uncovered interest parity (UIP) condition, both of which are altered upon accession to the euro area.

In the years leading up to the global financial crisis, Polish GDP growth was strongly supported by favorable external conditions, as reflected in the positive contribution of foreign shocks. However, this expansion was simultaneously constrained by elevated risk premium shocks, which contributed to the sustained appreciation of the Polish zloty. The currency reached a peak level of overvaluation at the onset of the crisis before undergoing a historically sharp depreciation. During this period, the depreciation acted as a key stabilizing force for output. According to our decomposition, this was instrumental in shielding the Polish economy from contraction.

Monetary sovereignty also played an important role during the most recent episode of global macroeconomic turbulence, triggered by the COVID-19 pandemic and Russia's full-scale invasion of Ukraine. The decomposition suggests that the strong recovery was driven by both zloty depreciation and accommodative domestic monetary policy, which helped offset the adverse effects of global supply-side shocks—including surging commodity prices. While domestic monetary policy significantly supported output stabilization, its effect on inflation was more limited. This likely reflects the fact that, as noted by Szafranek et al. (2024), price dynamics during this period were heavily influenced by global factors—captured in our model not only through foreign shocks but also via domestic price markup shocks.

Interestingly, while the magnitude of shocks in the 2000s was relatively large, their effects largely offset one another, resulting in moderate overall volatility. In contrast, during the 2010s, the size of shocks declined substantially, yet GDP fluctuations diminished only slightly. The magnitude of shocks increased again during and after the COVID-19 period, though not to the levels observed in the 2000s.

Moreover, the role of exchange rate adjustments also evolved. In the 2000s, exchange rate movements—primarily driven by risk premium shocks—were a key factor stabilizing Polish GDP. However, in the 2010s and 2020s, risk premium shocks played a much smaller role. Additionally, while monetary policy shocks did not contribute significantly to stabilization during the global financial crisis, they became an important driver of GDP dynamics during the more recent period of macroeconomic turmoil caused by the pandemic and the war in Ukraine.

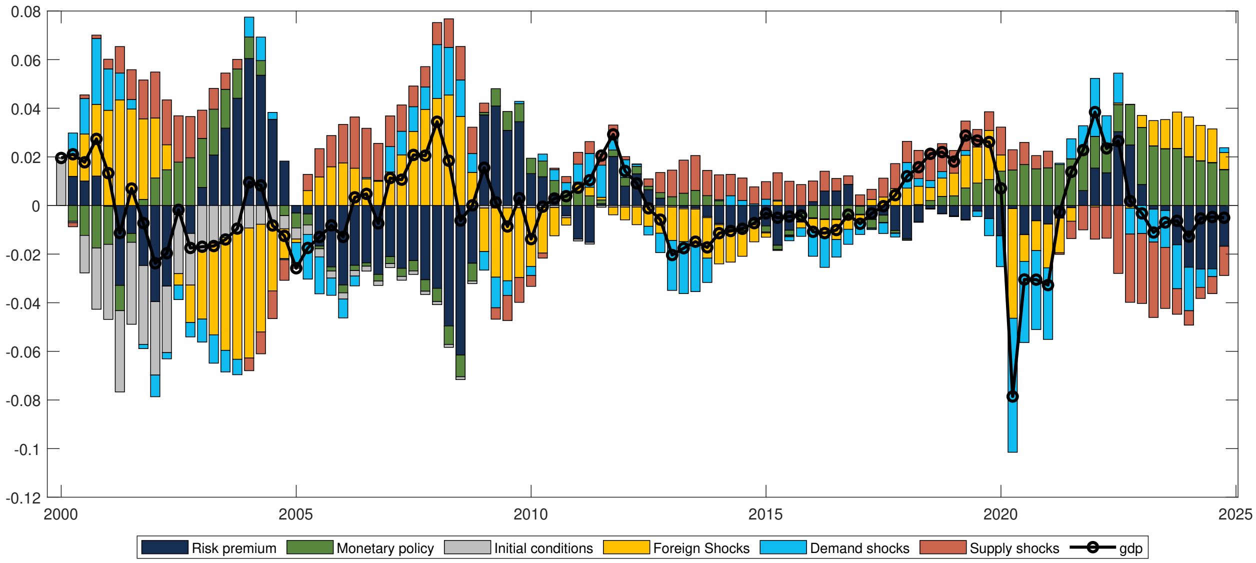
Key Takeaways

- Poland offers a compelling case study for assessing the effects of joining a monetary union. It is closely integrated with the euro area and, over the past 25 years, has experienced two major macroeconomic shocks—the global financial crisis of 2008-2009, and the more recent period marked by the COVID-19 pandemic and Russia's full-scale invasion of Ukraine—as well as a relatively calm period during the 2010s.

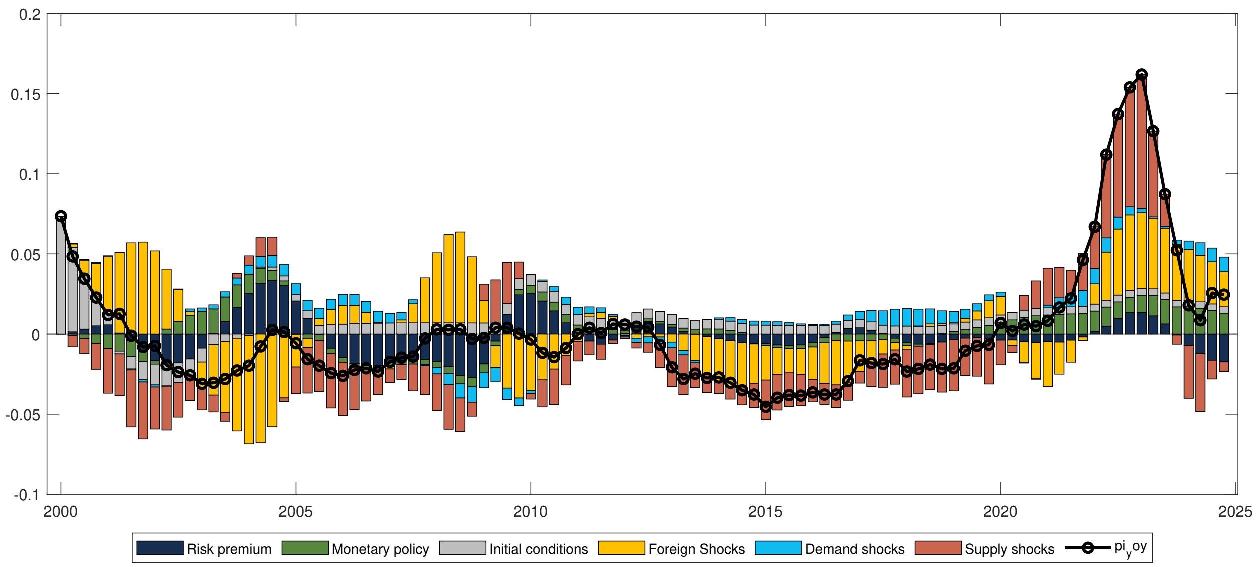
- While the exchange rate was the primary stabilizing factor for GDP in the 2010s, the role of domestic monetary policy became more pronounced during the recent period of macroeconomic turbulence triggered by the COVID-19 pandemic and Russia's full-scale invasion of Ukraine.

Figure 5: Historical decomposition: grouped shocks

(a) GDP



(b) Inflation yoy



6.2 What Could Have: Counterfactual Simulations of Monetary Union Entry

To analyze the potential macroeconomic implications of Poland's accession to the euro area, we conduct a set of counterfactual simulations. The results of such an exercise are highly sensitive to the timing of euro adoption - particularly due to variation in the initial level of the exchange rate. If a country joins a currency union while its domestic currency is undervalued, one may expect a subsequent rise in inflation (e.g., via higher import prices) alongside improved export competitiveness, potentially stimulating output growth. Conversely, if accession occurs under an overvalued currency, one might anticipate downward pressure on inflation and reduced export performance.

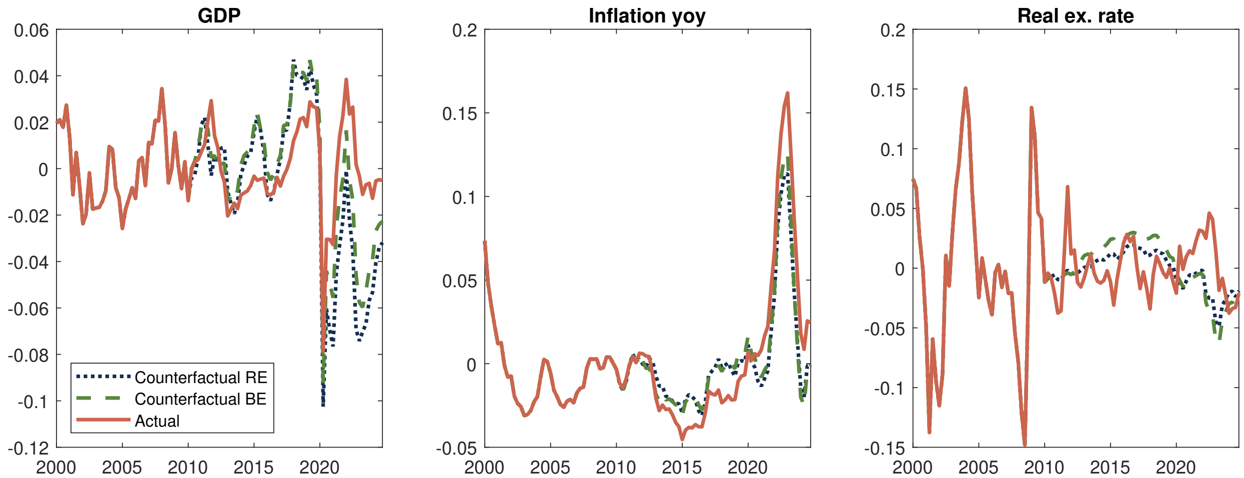
To explore these scenarios, we simulate counterfactual accession dates around the period of the global financial crisis (GFC). We choose this period because, between 2008Q3 and 2010Q1, the Polish zloty experienced episodes of being overvalued, undervalued, and near its long-run equilibrium value - all within a relatively short time frame. This temporal proximity of divergent currency valuations makes the GFC period an ideal basis for comparing the macroeconomic implications of accession under different initial exchange rate conditions.

At the onset of the GFC (2008Q3), Poland's real effective exchange rate (REER) was substantially appreciated - approximately 15% below its estimated trend level. We treat this point as a counterfactual accession under an overvalued currency. By 2009Q2, the zloty had undergone a sharp depreciation, with the REER reaching 15% above trend - representing an accession under an undervalued currency. Finally, by 2009Q4, the REER had returned close to its steady-state value; we interpret this case as a benchmark scenario in which the currency is neither over- nor undervalued at the time of accession.

6.2.1 Macroeconomic Effects of Counterfactual 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. The results highlight how the interaction between expectation formation and monetary integration shapes the transmission of shocks and the broader macroeconomic environment. Figure 6 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 6: Counterfactual Euro Adoption in 2010Q1: Actual vs. Simulated Paths



We treat the counterfactual simulations under BE as the baseline for interpretation, while the RE outcomes serve as a point of reference. Under BE, 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. These institutional changes fundamentally alter the shock transmission mechanism. Without control over its own interest rate, Poland cannot tailor monetary policy to domestic conditions. The fixed nominal exchange rate, meanwhile, removes a key channel of adjustment, especially important for a small open economy.

The real exchange rate thus 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, especially under behavioral expectations.

This shift has notable macroeconomic implications. For instance, in the counterfactual euro 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 depreciation—and associated real depreciation—would not have occurred, implying a more sluggish recovery in the aftermath of the pandemic. However, the more stable real exchange rate path under euro adoption would have contributed to improved inflation control during turbulent periods.

Table 3: Macroeconomic Volatility: Euro Adoption in 2010Q1

Variable	Historical	Counterfactual Behavioral	Counterfactual Rational
GDP	1.9	3.0	3.5
Inflation (YOY)	4.8	3.5	3.2

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.

Quantitatively, the results in Table 3 reveal that adopting the euro under BE would have increased output volatility (from 1.9 to 3.0) while reducing inflation volatility (from 4.8 to 3.5). The fixed nominal exchange rate removes a key channel for external adjustment, forcing the economy to absorb shocks through changes in domestic prices.

Compared to rational expectations (RE), the impact of euro adoption under BE is more muted. This outcome stems from two main factors. First, monetary policy is inherently less potent under BE, so the loss of domestic interest rate control alters macroeconomic dynamics to a lesser extent. Second, as documented in Section 5, the behavioral model exhibits stronger internal propagation, which results in smaller estimated structural shocks. Consequently, although the GDP response to a given shock is more amplified under BE following euro adoption, the shocks themselves are less pronounced. This combination leads to more stable counterfactual macroeconomic outcomes relative to the RE model. Specifically, Table 3 shows that output volatility rises to 3.5 under RE, compared to 3.0 under BE. This greater output stability comes at the cost of slightly less inflation smoothing, with inflation volatility falling to 3.2 under RE versus 3.5 under BE.

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. By joining the monetary union a country loses two instruments: interest rate policy and exchange rate flexibility. The former results in destabilizing both, GDP and inflation. The effects of the latter are more nuanced.

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 our case this effect outweights the destabilizing role of losing the interest rate instrument.

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. Hence, in case of GDP both interest rate and exchange rate behavior work in the same - destabilizing - direction.

Key Takeaways

- Euro adoption leads to a moderate increase in output volatility and a mild reduction in inflation volatility. The loss of monetary policy reduces domestic stabilization capacity, while the absence of exchange rate flexibility constrains external shock absorption. The latter contributes however to the stability of inflation. As a result, output fluctuations intensify even as inflation becomes more stable.

- Comparing behavioral and rational expectations reveals that the effects of monetary integration are less amplified under behavioral expectations. Stronger internal propagation leads to more persistent responses, but smaller estimated shocks in the behavioral model result in overall lower output volatility compared to the rational case.

6.2.2 What Could Have: Counterfactual decomposition

To better understand the drivers of differences between the counterfactual and actual paths of GDP and inflation, we perform a historical shock decomposition based on the counterfactual series.

A direct and mechanical consequence of euro adoption is the elimination of domestic monetary autonomy and exchange rate flexibility, which in our model translates into the disappearance of monetary policy and risk premium shocks. The effects of this loss are particularly evident during the COVID-19 pandemic. As shown in Section 6.1, under the actual data, the post-pandemic recovery in Poland was significantly supported by expansionary domestic monetary policy and declining risk premia. In the euro area counterfactual, these stabilizing forces are no longer present and cannot mitigate the adverse impact of demand and supply shocks. Moreover, monetary policy conducted at the euro area level - where Poland represents only 5% of the monetary union (according to our calibration) - does not respond adequately to shocks hitting the Polish economy.

This weakened stabilization effect is further amplified by our assumption of boundedly rational expectations: under behavioral expectations, the monetary transmission mechanism is less effective, especially in the absence of a domestic monetary policy. As shown in Section 5.3, this reduces the effectiveness of policy responses to markup shocks, making their negative impact more pronounced in the counterfactual scenario.

In the case of inflation, the relative importance of domestic monetary autonomy is lower than for output. Consequently, we observe a larger role of foreign shocks and a deeper disinflationary trend at the end of the sample. This result is linked to the behavior of the real interest rate under a fixed exchange rate regime, which—without nominal depreciation—becomes a function of relative price levels between Poland and the euro area. In the actual scenario, Poland's interest rate cut during the pandemic led to a depreciation of the zloty, which in turn stimulated GDP growth at the cost of higher import prices. In the counterfactual scenario, however, the absence of exchange rate adjustment—combined with higher inflation in Poland relative to the euro area—leads to an appreciation of the real exchange rate. This appreciation reduces Poland's international competitiveness but also helps contain domestic price growth in the post-pandemic phase.

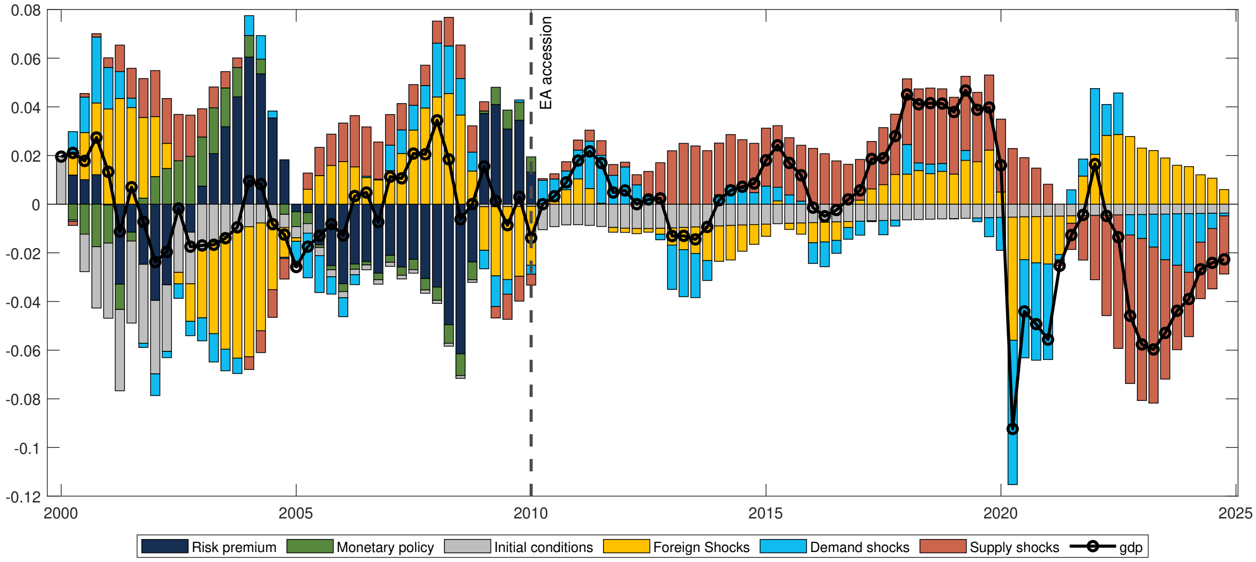
While weaker monetary policy responses may deepen recessions in periods of strong adverse demand or supply shocks, they may also amplify positive output effects when shocks act in the direction of expansion. In such periods, limited monetary tightening - combined with the absence of a nominal exchange rate - can allow for a stronger transmission of expansionary shocks into output, at the cost of higher inflation. A clear example of such dynamics emerges in the 2012-2019 period. In our counterfactual simulations, positive markup shocks -particularly wage markup shocks - would have boosted output more strongly in the euro area scenario than in reality. This is primarily due to the absence of nominal exchange rate adjustments: under fixed exchange rates, persistent inflation differentials between Poland and the euro area would have led to a depreciation of the real exchange rate, thereby supporting Poland's relative competitiveness and GDP growth, albeit at the cost of elevated price.

Key Takeaways

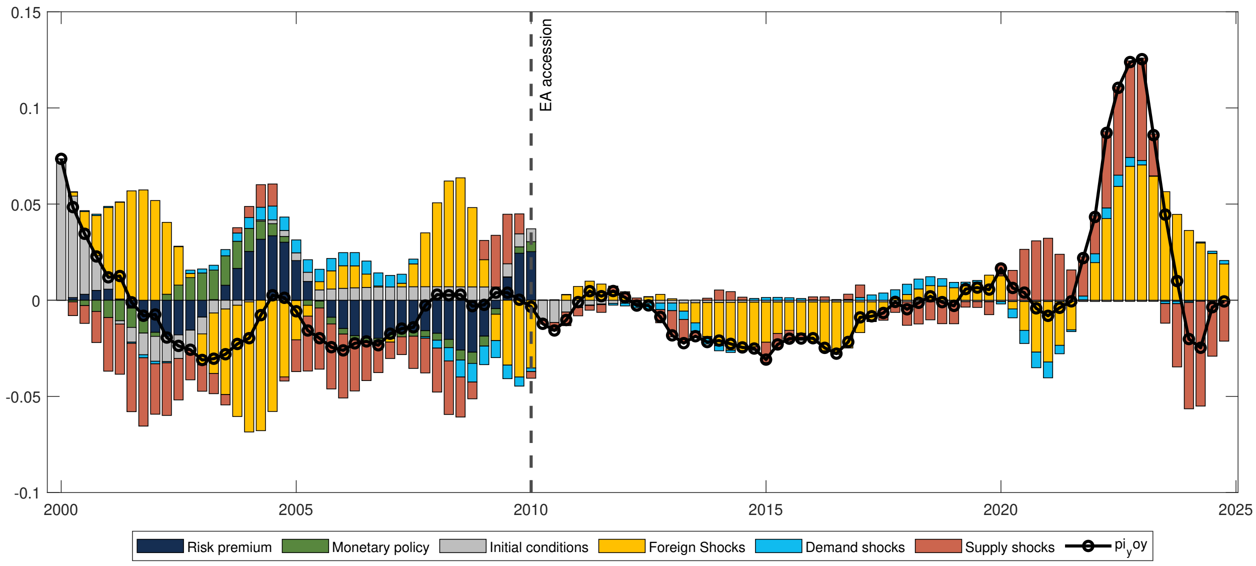
- Loss of monetary autonomy under euro adoption weakens Poland's ability to stabilize output during asymmetric shocks, especially in crises like COVID-19.
- A fixed nominal exchange rate amplifies the impact of markup shocks; between 2012 and 2019, it would have boosted Polish output through real depreciation, albeit at the cost of higher inflation.

Figure 7: Counterfactual decomposition: shocks grouped by types

(a) GDP



(b) Inflation yoy



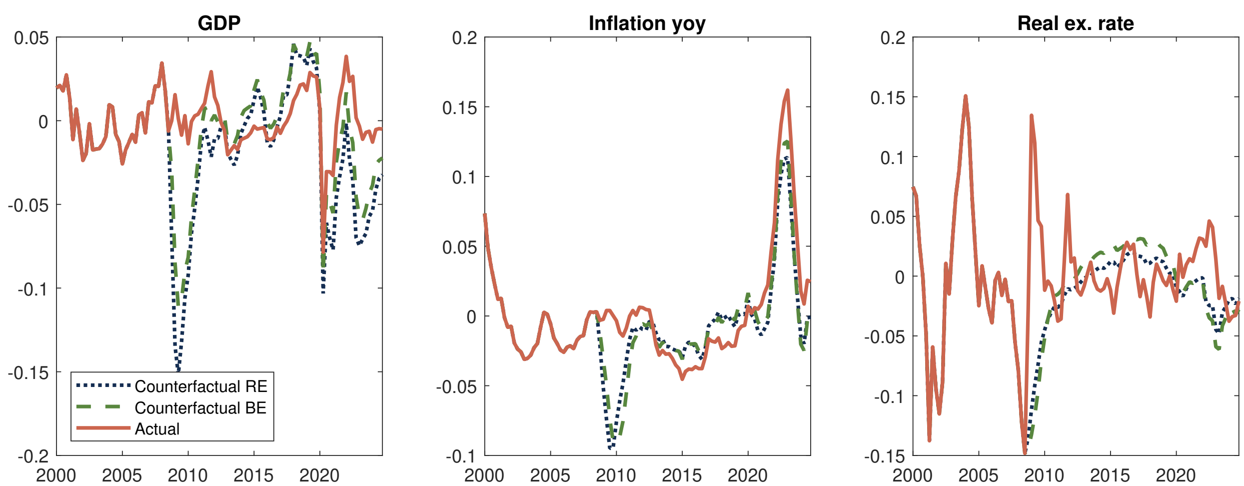
6.2.3 Macroeconomic Effects of Monetary Union Entry with an Appreciated Real Exchange Rate

Figure 8 presents both the actual macroeconomic outcomes and a simulated counterfactual scenario in which Poland adopts the euro in 2008Q3. The counterfactual is evaluated under both behavioral expectations (BE) and rational expectations (RE). The analysis below is based primarily on the behavioral model, with the rational case serving as a comparative benchmark.

In this scenario, monetary union entry occurs when the Polish currency is strongly overvalued. Fixing the nominal exchange rate at that level locks in an uncompetitive real exchange rate, undermining external competitiveness. With exchange rate adjustment off the table and prices slow to respond due to nominal rigidities, the economy enters the monetary union structurally misaligned.

Under behavioral expectations, the effects are severe. Output contracts sharply and remains depressed for several periods, as the loss of competitiveness reduces net exports and weak domestic demand offers little support. With depreciation ruled out, disinflation persists, eventually turning into deflation. Prices decline steadily, as internal devaluation becomes the only path to restoring competitiveness.

Figure 8: Counterfactual Euro Adoption in 2008Q3: Actual vs. Simulated Paths



The historical (non-euro) path tells a different story. The flexible nominal exchange rate allows the Polish currency to depreciate gradually following 2008Q3, providing a natural adjustment channel. This depreciation supports export demand and helps maintain output at a higher level than in the euro scenario. Inflation also stays higher, avoiding the deflationary spiral observed under fixed exchange rates.

The rational expectations case amplifies these dynamics. Since forward-looking agents react more strongly to future imbalances, the initial drop in output is deeper and the deflationary process more abrupt.

Key Takeaways

- Entering the monetary union with an appreciated currency results in a severe and persistent decline in output and sustained deflation. The fixed exchange rate eliminates the possibility of external adjustment, and nominal rigidities slow the internal correction. As a result, the economy experiences a costly period of contraction as it rebalances through domestic price deflation.

- Comparing behavioral and rational expectations shows that the immediate impact of euro adoption is slightly smaller under rational expectations. Although the behavioral model features stronger internal propagation and amplifies dynamic responses more, the smaller magnitude of the estimated shocks results in a less pronounced decline in GDP and a milder fall in inflation, relative to the rational expectations framework.

6.2.4 Macroeconomic Effects of Monetary Union Entry with a Depreciated Real Exchange Rate

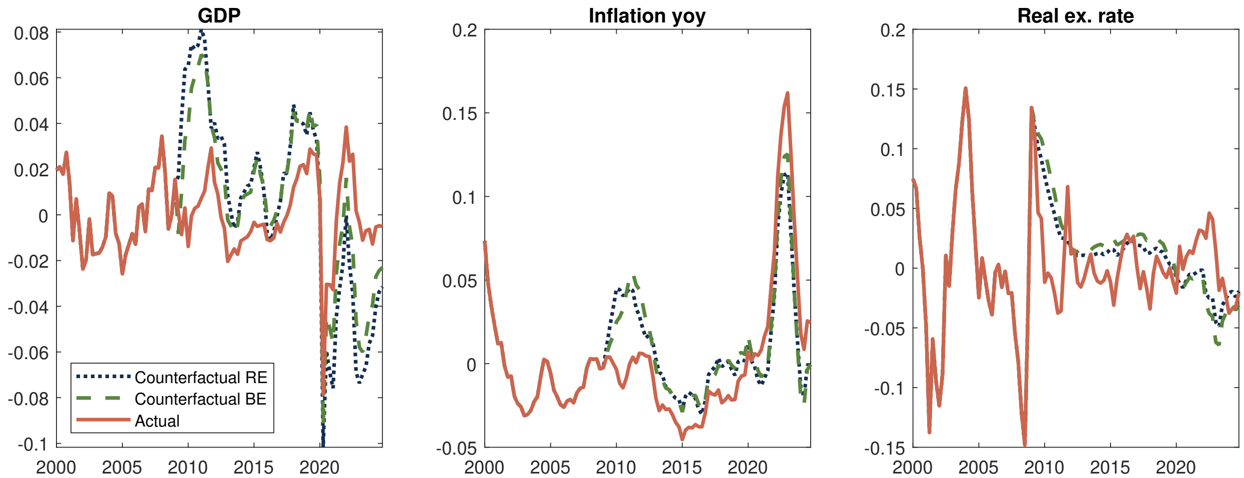
Figure 9 presents both the actual macroeconomic dynamics and a simulated counterfactual scenario in which Poland adopts the euro in 2009Q1. The counterfactual is computed under both behavioral expectations (BE) and rational expectations (RE). In the analysis that follows, we focus on the effects of euro adoption under BE, treating the RE scenario as a reference point for later comparison.

In the behavioral model, GDP initially rises above the historical baseline. This short—term expansion is not driven by monetary easing—indeed, the domestic interest rate increases slightly after accession—but rather by real exchange rate dynamics and the nominal rigidities built into the model.

At the time of euro adoption, the Polish currency is substantially depreciated. Locking in the nominal exchange rate at this depreciated level effectively secures a highly competitive real exchange rate. This provides an immediate boost to external competitiveness: Polish exports become relatively cheaper, and domestic production is stimulated. Because prices and wages adjust sluggishly, internal price levels remain temporarily low, reinforcing the competitiveness gains in the short run.

Following accession, the real exchange rate appreciates only gradually, as the fixed nominal exchange rate requires internal adjustment through domestic inflation. However, nominal rigidities slow this process. As a result, Poland retains a competitive external position for an extended period, supporting net exports and prolonging the output expansion. At the same time, the internal appreciation process contributes to a moderate but persistent elevation in inflation.

Figure 9: Counterfactual Euro Adoption in 2009Q1: Actual vs. Simulated Paths



Under historical developments, by contrast, the exchange rate remained flexible. Following 2009Q1, the domestic currency appreciated relatively quickly, eroding external competitiveness earlier and more sharply. This faster adjustment limited the short-term export boost, which helps explain why GDP initially underperforms relative to the euro adoption path.

In sum, fixing the nominal exchange rate at a time when the domestic currency is significantly undervalued generates an initial competitive boost and stimulates output in the short run. However, this temporary advantage gradually erodes and comes at the cost of elevated inflation. The combination of a fixed exchange rate, initial undervaluation, and nominal rigidities leads to a slow but persistent real appreciation. As external competitiveness diminishes, the early gains fade, and output eventually converges back toward its historical path.

The comparison between BE and RE shows that the macroeconomic effects of euro adoption are more pronounced under rational expectations. The increase in GDP following monetary integration is larger, while the rise in inflation is relatively similar—slightly smaller under rational expectations.

Under behavioral expectations, the boom is more subdued. While the internal propagation of shocks is stronger—leading to more persistent dynamics—the estimated shocks themselves are smaller. As a result, even though euro adoption amplifies responses within the BE model, the overall macroeconomic expansion is less pronounced. Output and inflation both increase more moderately, reflecting a broader pattern: when expectations are less forward-looking, the economy reacts less sharply to structural changes, despite more inertial transmission mechanisms.

Key Takeaways

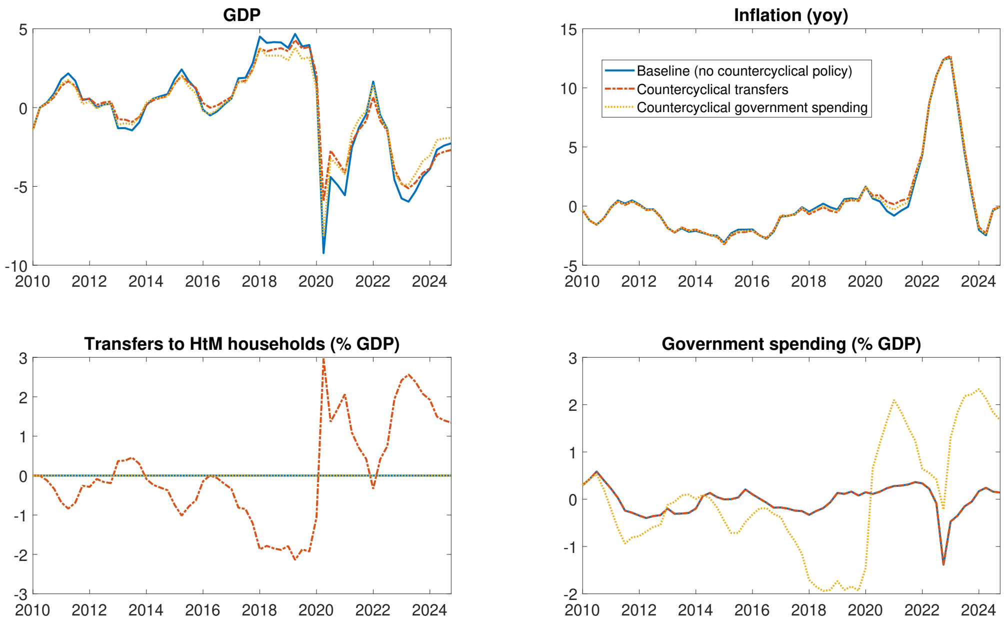
- Joining the monetary union with a depreciated exchange rate generates an initial boom in output at the expense of elevated inflation. The undervalued currency at the time of entry boosts competitiveness, driving a short-term surge in GDP and price pressures. However, since nominal exchange rates are fixed post-entry, the real exchange rate must adjust through gradual domestic price changes. This makes the adjustment process slower and the boom eventually fades.

- Comparing behavioral and rational expectations reveals that the entry-related boom is more subdued under behavioral expectations. Although the behavioral model features stronger internal propagation, which amplifies dynamic responses, the smaller magnitude of the estimated shocks results in a smaller expansion of output and inflation following monetary union accession, relative to the rational expectations framework.

6.3 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	1.9	3.0	2.5	2.5
Inflation (YOY)	4.8	3.5	3.6	3.5
HtM consumption	10.7	9.1	24.3	9.0

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 2-3 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 huge (rather unacceptable) cost for HtM consumers, volatility of their consumption increases more than twofold.

Key Takeaways

- Fiscal policy might help stabilize the economy after euro area accession.
- However, under realistic assumptions about fiscal activity it would (historically) not have been able to restore macroeconomic stability that prevailed under independent monetary policy.

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 assess how monetary integration alters shock transmission and macroeconomic volatility, depending on both the structure of expectations and the state of the real exchange rate at entry.

We document two main findings. 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.

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 short-lived 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. These dynamics emphasize the real exchange rate as a crucial state variable, often overlooked in static cost-benefit frameworks for euro adoption.

Second, we show that allowing for behavioral expectations shapes the account of the effects of monetary integration. Although such expectations amplify internal propagation mechanisms, they also yield smaller estimated structural shocks, leading to somewhat lower output volatility relative to the rational expectations benchmark. Importantly, the loss of monetary autonomy under a monetary union is less costly under behavioral expectations due to weaker policy traction and slower adjustment. However, even in this case, joining the monetary union destabilizes output.

We also 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.

Overall, our findings suggest that both the timing of euro area entry and the nature of expectations are critical in determining the real economic costs and benefits of monetary integration. These insights offer a more nuanced perspective on the euro adoption debate, particularly for countries like Poland that have yet to relinquish monetary sovereignty.

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Tables and figures

Table 5: Behavioral model estimation results: deep parameters

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
m	beta	0.850	0.0250	0.7821	0.0281
θ_H	beta	0.750	0.1000	0.7729	0.0618
θ_F^*	beta	0.750	0.1000	0.8854	0.0122
θ_H^*	beta	0.750	0.1000	0.8035	0.0350
θ_F	beta	0.750	0.1000	0.7929	0.0314
θ_w	beta	0.750	0.1000	0.6131	0.0597
θ_w^*	beta	0.750	0.1000	0.7680	0.0423
ζ_w	beta	0.500	0.1000	0.4770	0.0961
ζ_w^*	beta	0.500	0.1000	0.3945	0.0971
ζ_H	beta	0.500	0.1000	0.4256	0.0908
ζ_F^*	beta	0.500	0.1000	0.2756	0.0649
ζ_H^*	beta	0.500	0.1000	0.6606	0.0868
ζ_F	beta	0.500	0.1000	0.5899	0.0998
γ_r	beta	0.700	0.1000	0.9321	0.0061
γ_π	norm	1.500	0.0500	1.4787	0.0505
γ_y	beta	0.125	0.0500	0.3053	0.0659
γ_r^*	beta	0.700	0.1000	0.9511	0.0079
γ_π^*	norm	1.500	0.0500	1.4934	0.0502
γ_y^*	beta	0.125	0.0500	0.1432	0.0496

Table 6: Behavioral model estimation results: shock parameters

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
ρ_z	beta	0.700	0.1000	0.7525	0.0761
ρ_z^*	beta	0.700	0.1000	0.8043	0.0544

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Table 6: (continued)

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
ρ_g	beta	0.700	0.1000	0.6827	0.0649
ρ_g^*	beta	0.700	0.1000	0.7310	0.0668
ρ_p	beta	0.700	0.1000	0.4487	0.0890
ρ_p^*	beta	0.700	0.1000	0.4573	0.0849
ρ_κ	beta	0.700	0.1000	0.7608	0.0516
ρ_w	beta	0.700	0.1000	0.7508	0.0695
ρ_w^*	beta	0.700	0.1000	0.6362	0.0869
ρ_c	beta	0.700	0.1000	0.8193	0.0510
ρ_c^*	beta	0.700	0.1000	0.6842	0.0703
ρ_i	beta	0.700	0.1000	0.4151	0.0741
ρ_i^*	beta	0.700	0.1000	0.3730	0.0724
σ_z	invg	0.005	Inf	0.0205	0.0104
σ_z^*	invg	0.005	Inf	0.0465	0.0082
σ_R	invg	0.003	Inf	0.0012	0.0001
σ_R^*	invg	0.003	Inf	0.0009	0.0001
σ_g	invg	0.010	Inf	0.0104	0.0010
σ_g^*	invg	0.010	Inf	0.0040	0.0006
σ_p	invg	0.010	Inf	0.0753	0.0274
σ_p^*	invg	0.010	Inf	0.1498	0.0408
σ_κ	invg	0.010	Inf	0.0142	0.0020
σ_w	invg	0.010	Inf	0.1106	0.0635
σ_w^*	invg	0.010	Inf	0.3227	0.1406
σ_c	invg	0.010	Inf	0.0313	0.0031
σ_c^*	invg	0.010	Inf	0.0319	0.0034
σ_i	invg	0.010	Inf	0.3109	0.0256
σ_i^*	invg	0.010	Inf	0.1938	0.0167

Table 7: Rational model estimation results: deep parameters

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
θ_H	beta	0.750	0.1000	0.9125	0.0200
θ_F^*	beta	0.750	0.1000	0.8721	0.0838
θ_H^*	beta	0.750	0.1000	0.7352	0.0513
θ_F	beta	0.750	0.1000	0.7500	0.0457
θ_w	beta	0.750	0.1000	0.7212	0.0525
θ_w^*	beta	0.750	0.1000	0.8465	0.0383
ζ_w	beta	0.500	0.1000	0.4191	0.0868
ζ_w^*	beta	0.500	0.1000	0.3766	0.0962
ζ_H	beta	0.500	0.1000	0.4085	0.0909
ζ_F^*	beta	0.500	0.1000	0.2181	0.0763
ζ_H^*	beta	0.500	0.1000	0.5960	0.0952
ζ_F	beta	0.500	0.1000	0.4866	0.0932
γ_r	beta	0.700	0.1000	0.9233	0.0064
γ_π	norm	1.500	0.0500	1.4563	0.0504
γ_y	beta	0.125	0.0500	0.3841	0.0568
γ_r^*	beta	0.700	0.1000	0.9334	0.0093
γ_π^*	norm	1.500	0.0500	1.4804	0.0491
γ_y^*	beta	0.125	0.0500	0.1948	0.0510

Table 8: Rational model estimation results: shock parameters

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
ρ_z	beta	0.700	0.1000	0.8717	0.0561
ρ_z^*	beta	0.700	0.1000	0.8372	0.1168
ρ_g	beta	0.700	0.1000	0.6853	0.0662
ρ_g^*	beta	0.700	0.1000	0.7279	0.0659
ρ_p	beta	0.700	0.1000	0.5199	0.0833
ρ_p^*	beta	0.700	0.1000	0.5856	0.0850

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Table 8: (continued)

	Prior			Posterior	
	Dist.	Mean	Stdev	Mean	Stdev
ρ_κ	beta	0.700	0.1000	0.7845	0.0428
ρ_w	beta	0.700	0.1000	0.7438	0.1218
ρ_w^*	beta	0.700	0.1000	0.7222	0.1097
ρ_c	beta	0.700	0.1000	0.8134	0.0485
ρ_c^*	beta	0.700	0.1000	0.6657	0.0599
ρ_i	beta	0.700	0.1000	0.4347	0.0655
ρ_i^*	beta	0.700	0.1000	0.3712	0.0656
σ_z	invg	0.005	Inf	0.0287	0.0130
σ_z^*	invg	0.005	Inf	0.0343	0.0135
σ_R	invg	0.003	Inf	0.0013	0.0001
σ_R^*	invg	0.003	Inf	0.0009	0.0001
σ_g	invg	0.010	Inf	0.0104	0.0009
σ_g^*	invg	0.010	Inf	0.0040	0.0006
σ_p	invg	0.010	Inf	0.1367	0.0508
σ_p^*	invg	0.010	Inf	0.1267	0.0628
σ_κ	invg	0.010	Inf	0.0089	0.0016
σ_w	invg	0.010	Inf	0.0190	0.0179
σ_w^*	invg	0.010	Inf	0.1608	0.0929
σ_c	invg	0.010	Inf	0.0419	0.0038
σ_c^*	invg	0.010	Inf	0.0373	0.0033
σ_i	invg	0.010	Inf	0.2414	0.0244
σ_i^*	invg	0.010	Inf	0.1586	0.0157

Appendix A

A.1 Model equations

TBA