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Missing inflation in the euro area

Model-based analysis of the euro area inflation development

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The core inflation in the euro area grows well below 2% for an extended period of time. Cross-country analysis suggests that after the euro area debt crisis the core inflation in the periphery countries contributes to the overall inflation in the euro area significantly less than before. We built a simple two-country model to investigate whether asymmetric shocks to the periphery and core countries may generate different inflation, output and policy responses compared to symmetric shocks. Results show that an asymmetric demand shock to the periphery has larger effect on the euro area inflation rate and output gap over a symmetric shock, thus suggesting stronger policy reaction.

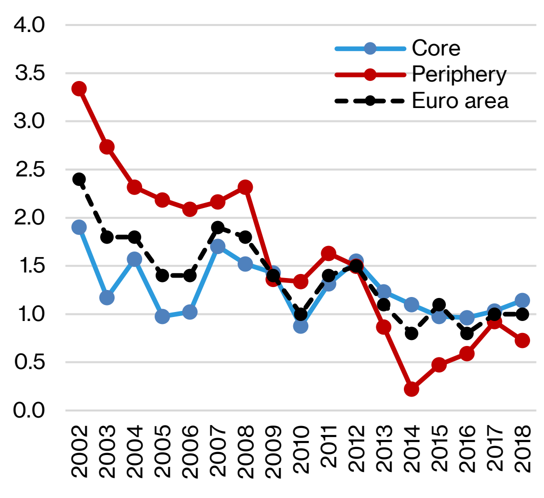
Low levels of inflation rate are supressing the economic performance

The core inflation in the euro area, further just the inflation rate, grows well below 2% targeted by the European central bank for an extended period of time (Fig.1)[1]. The average inflation rate during the pre-crisis period (2002 – 2008) was close to 1.8%, afterwards (2009-2017) it dropped to just 1.1%. Low levels of the inflation rate are further supressing the economic performance in the euro area according to the expectation theory. In addition, there is no sign of recovery as the 2018 inflation rate is just slightly above 1%.

Economies within the monetary union are converging via inflation

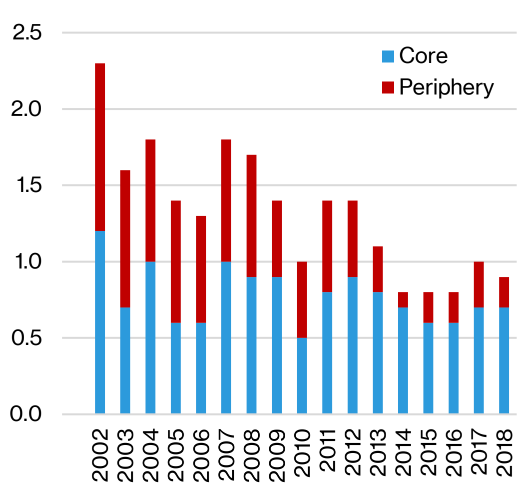
Yet, the missing inflation is not a case in all euro area countries. After the euro area debt crisis from 2013 onwards the inflation rate in the euro area periphery grows below that in the euro area core (Fig.1)[2]. This low performance is unusual from both historical and theoretical perspective. Historically, the average inflation rate in the pre-crisis period reached 2.5% in the periphery while the average in the core was around 1.4%. On the other hand, as implied by the Balassa-Samuelson theorem, converging countries without their own monetary policy shall exhibit faster inflation rate than the rest countries in a monetary union.

Fig.1: Inflation rates (%)



Source: Eurostat

Fig.2: Inflation contributions (p.p.)



Source: Eurostat

[1] We extract the core inflation from the harmonized index of consumer prices taking the overall index excluding energy, food, alcohol and tobacco.
[2] We define the euro area periphery as the economy of Italy, Spain, Portugal and Greece and the euro area core as the economy of Germany, Austria, France, Finland, Belgium, Netherlands and Luxembourg.

Contribution from the periphery is just 1/5 after the euro area debt crisis

Consequently, the inflation pressure in the periphery contributed to the overall inflation in the euro area significantly less after the financial and debt crises. In the pre-crisis period, the contributions from the periphery and the core were roughly equal, even though the economies of the periphery are just around 1/3 of the entire euro area. After 2009, the contribution from the periphery started to decline and it became almost negligible after 2013, while the contribution from the core is much more stable (Fig.2).

In fact, almost half of the euro area inflation might be generated in the periphery. To illustrate this, we assume that the inflation differential between the periphery and the core is equal to the long-term real rate differential between the two economies, thus capturing a real convergence by the uncovered interest parity. Simple calculation shows that when the real convergence is sufficiently large, approximately 1.5 p.b, then in the equilibrium half of the inflation may be actually generated in the periphery. The contribution of the periphery to the 2% inflation target is equal to the 1 p.b, even though this economy may be relatively smaller, approximately 1/3 of the entire monetary union. If assuming half of this convergence consistently with the data, the contribution of the periphery exceeds 0.8 p.b.

We simulate the euro area debt crisis by a negative demand shock

Thus, we hypothesize that when the monetary union is divided into two economies with different size and different long-term output and inflation growth rates, then an asymmetric shock to the smaller but converging economy may generate larger impact on union's average inflation rate and output gap compared to a symmetric shock. Not surprisingly, the policy response to the asymmetric shock in the periphery must be also stronger compared to the symmetric shock. The opposite should hold for the asymmetric shock in the core. To validate the hypothesis, we built a small two-country gap model to investigate the interactions between two different economies within the monetary union after being hit by a negative demand shock (see Box for details).

Box: Two-country gap model

The model belongs to the popular family of multi-country projection models, see for example Carabenciov et al. (2013), based on a system of linear equations capturing core macroeconomic variables and mutual relationships between a number of economies. The model distinguishes between potential variables captured by simple dynamic processes and cyclical variables described by behavioural equations, thus taking the form of so-called gap model.

Although structural parameters in this family of macroeconomic models are not properly derived from micro-foundations as in the dynamic stochastic general equilibrium (DSGE) models, they allow for important structural components as model-consistent expectations and are thus suitable for a policy analysis. This is in contrast to the standard vector autoregression (VAR) models unable to capture, for example, forward-looking nature of policy rules.

The model distinguishes between two open economies, the core and the periphery, represented by aggregate demand and aggregate supply equations with a common policy rule of the European central bank (ECB). Equations of the model are based on the related literature with the dynamic IS curve (Eq.1) capturing the output gap and thus the demand side of the economies and the hybrid Phillips curve (Eq.2) capturing the core inflation and thus the supply side of the economies. In future, the model could be extended by the external demand and the effective exchange rate of the euro area economy.

The output gap is explained by lagged and lead terms, capturing the persistence of demand shocks as well as the rational expectations, interest rate and exchange rate gaps, evaluating the monetary policy pass-through to the real economy, and output gap of the trading partner, representing the external demand of an open economy.

On the other hand, the core inflation is explained by hybrid expectations, i.e. backward-looking and forward-looking terms, and real marginal costs represented by output and exchange rate gaps. We exclude from the standard specification of the core inflation as the headline inflation excluding energy, food, alcohol and tobacco and estimate the core inflation within the model by incorporating measurement errors to the headline inflation.

$$\hat{y}_{i,t} = \beta_{i1}\hat{y}_{i,t-1} + \beta_{i2}\hat{y}_{i,t+1} - \beta_{i3}\hat{r}_{i,t-1} + \beta_{i4}\hat{z}_{i,t-1} + \beta_{i5}\hat{y}^{*}_{i,t-1} + \varepsilon^{y}_{i,t} \qquad \textbf{Eq.1}$$

$$\pi_{i,t} = \lambda_{i1}\pi_{i,t+1} + (1-\lambda_{i1})\pi_{i,t-1} + \lambda_{i2}\hat{y}_{i,t-1} + \lambda_{i3}\hat{z}_{i,t-1} + \varepsilon^{\pi}_{i,t} \qquad \textbf{Eq.2}$$

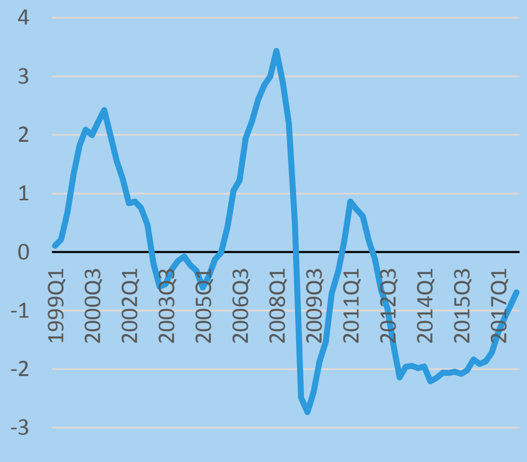
Monetary policy is described by a standard Taylor policy rule (Eq.3) with the smoothing parameter, policy-neutral interest rate and policy reaction to the cyclical deviations of annual headline inflation and real output from their target values. Central bank reacts to the inflation rate three quarters ahead, according to Orphanides (2003), thus capturing the forward-looking nature of the policy rule. Weights put on the core and the periphery are based on the relative size of the economies thus responding to the overall inflation and output of the euro area.

$$i_t = \gamma_1 i_{t-1} + (1-\gamma_1)\left(\bar{r}_t + \pi^{4}_{t+3} + \gamma_2\left(\pi^{4}_{t+3} - \pi^{t}_{t+3}\right) + \gamma_3\hat{y}_t\right) + \varepsilon^{i}_t \qquad \textbf{Eq.3}$$

Real interest rate is then obtained from the Fisher equation and real exchange rate corresponds to the inflation differential according to the absence of the nominal exchange rate. Potential output is defined by a local linear model and integrated of second order, thus allowing for the shocks to the output level as well as the output growth. The same structure is applied for the potential appreciation within the euro area. Potential rates are then defined by simple stochastic processes, thus implying the potential premium by the uncovered interest parity.

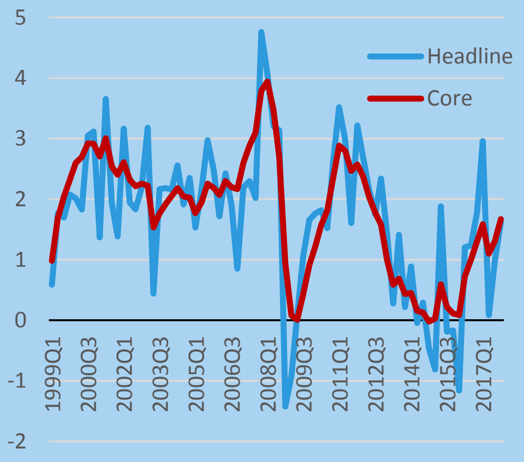
Parametrization of the model is based on a combination of calibration and Bayesian estimation. While calibrating the potential and stochastic variables, according to the historical perspective and related literature, we prefer the estimation approach for the structural variables crucial for the impulse response analysis. The only exception are the Taylor-rule parameters, due to a plausible empirical evidence, thus setting the persistence parameter $\gamma_1 = 0.75$, inflation reactiveness $\gamma_2 = 1.50$ and output reactiveness $\gamma_3 = 0.20$. Further, we set the ratio between the domestic and external variables in Eq.1 and Eq.2 according to the relative trade openness of the economies and capture the asymmetric trade channel within the euro area thus capturing the capital flows from the core to the periphery[3].

Fig.3: Output gap (% of potential output)



Source: Authors

Fig.4: Inflation rates (% qoq)



Source: Authors

[3] Historical data are obtained from the Eurostat. All computations are performed in the Matlab.

Total output gap of the periphery shows higher degree of persistence

Estimation of the structural parameters is then based on a two-step procedure with the Bayesian interface. In the first step, we set the priors to the parameters and estimate their modes by the penalized maximum likelihood approach. In the second step we apply the Monte Carlo Markov Chain procedure with the Metropolis-Hastings algorithm to sample from the posterior distributions, thus estimating the means and the standard deviations of the parameters. Evaluation of the model is performed by the method of Kalman filtering and smoothing on the estimation range from the first quarter of 1999 to the last quarter of 2017. Estimated parameters produce reasonable historical projection for the output gap (Fig.3) as well as the core inflation (Fig.4).

The most significant difference between the core and the periphery is observed in the output gap persistence, with better stabilization mechanism of the core countries. According to the zero trade balance within the euro area and thus zero aggregate effect on the output gap, exports from one country to another projected in the output gap of the exporting partner need to be compensated by imports in the output gap of the importing partner. Therefore, the true difference in the output gap persistence could be even higher between the core and the periphery.

Output gap expectations are slightly higher in the periphery, while the opposite holds for the inflation expectations. Monetary policy pass-through to the output gap, defined as an aggregate effect of the interest rate and exchange rate gaps in Eq.1, is estimated higher than the marginal costs pass-through to the inflation rate, defined as an aggregate effect of the output and exchange rate gaps in Eq.2, with the first one slightly higher for the periphery countries and the latter one for the core countries.

Demand shocks in the periphery have larger impact on the economy of the euro area

Impulse response analysis confirms that a negative demand shock to the periphery depresses the euro area output gap (Fig.5) and inflation rate (Fig.6) more compared to a same-sized symmetric shock. Specifically, the output gap of the periphery stabilizes more slowly than in the core countries due to a higher degree of persistence. This also implies higher cumulative output loss. Decline in the inflation rate follows the decline in the output gap and is enhanced by future expectations. The opposite holds for an asymmetric shock to the core with more moderate inflation and output loss. We simulate the euro area debt crisis as a highly persistent demand shock with relatively small initial magnitude to capture the gradual impact of the crisis[4].

Fig.5: Output gap response to regional demand shocks (% of potential output)

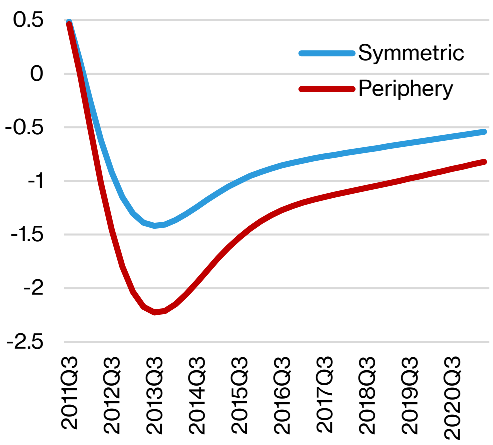


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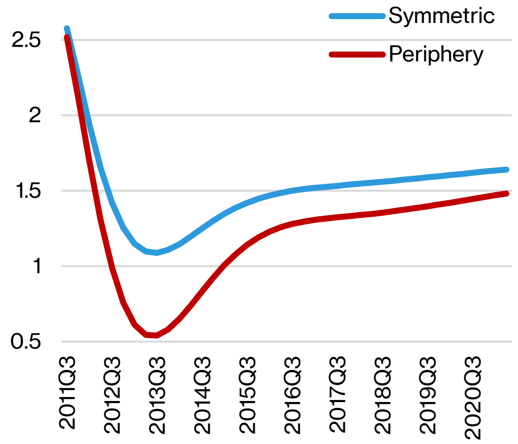
Fig.6: Inflation rate response to regional demand shocks (% qoq)



Source: Authors

[4] Negative demand shock corresponds to an unexpected negative shock to the euro area output gap with the initial magnitude of 0.33% and the persistence parameter set to 0.975, distributed either symmetrically between the core and the periphery, hitting only the core or hitting only the periphery, considering relative size of the economies.

Negative interest rates may lead to unorthodox monetary polices

Interest rate of the central bank follows the development of the euro area economy, implying stronger policy reaction to the periphery shock (Fig.7). Furthermore, demand crisis oriented in the periphery implies negative interest rates for a significant time period. This simulation is in line with the phenomenon of the zero-lower bound, observed during the debt crisis of the euro area, evaluating the economy-implied interest rates below zero and thus leading to the unorthodox monetary policies of the central bank. Subsequently, loss function that evaluates the total economy loss is significantly higher for the periphery shock (Fig.8).

Fig.7: Interest rate response to regional demand shocks (%)

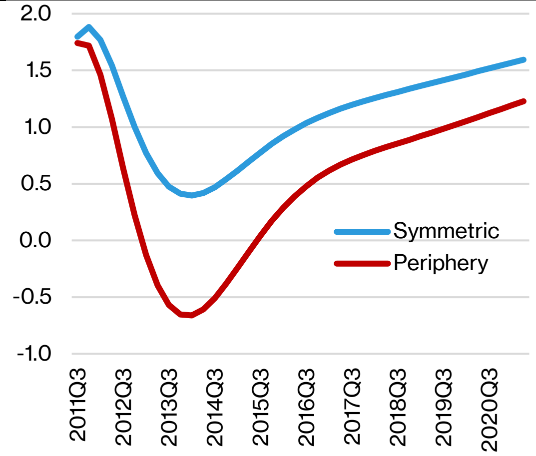


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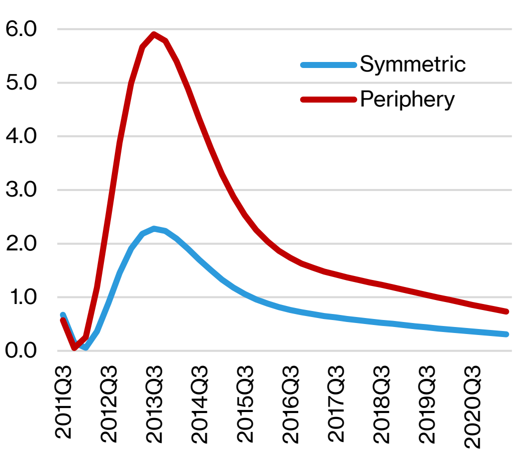
Fig.8: Loss function response to regional demand shocks (%)



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Asymmetric demand shocks imply also asymmetric monetary policy reaction

According to the simulation results, one can question whether the symmetric policy rule based on the overall inflation and output of the euro area is optimal for asymmetric demand shocks. We thus optimize the core and periphery response weight (i.e. share)[5] in the policy rule separately for both asymmetric shocks, while leaving other policy parameters unchanged, to analyse the optimal monetary policy[6]. Optimization procedure for a symmetric demand shock is not reasonable, since there is in fact no trade-off between the core and the periphery. Since both economies evolve and stabilize in a similar pace, less significant policy loss is obtained under more aggressive monetary policy and thus stabilization of the economy with higher degree of persistence.

$$L_t = (\pi_t - \bar{\pi}_t)^2 + 0.75(y_t - \bar{y}_t)^2 + 0.25(i_t - i_{t-1})^2 + 0.05(i_t - \bar{i}_t)^2 \quad \textbf{Eq.4}$$

Loss function is taken from the work of Evjen and Kloster (2012). This approach is extending the standard loss function based on the inflation and output deviations from their target values by additional interest rate terms, thus penalizing volatile interest rates and improving the predictability of the financial markets together with the robustness of the monetary policy. Furthermore, extended loss function reacts to the financial imbalances in more complex way, since penalizing also deviation of the interest rate from the nominal target.

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[5] The original weight (share) of each region is based on the share of the regional output on the total output of the euro area, i.e. the core economy 2/3 and the periphery economy 1/3.
[6] Optimization is based on the one-period demand shock in the steady-state to eliminate the issues with the starting values as well as the expectations of future shocks.

Optimization results show that when the euro area economy is hit by an asymmetric demand shock, monetary authority should increase the response weight of the affected region[7]. Although this result holds for the core as well as the periphery, the potential reduction in the total economic loss is negligible in case of the negative shock to the core economy. On the other hand, when the negative shock hits the periphery, stronger policy reaction implied by the asymmetric policy rule significantly reduces the total economic loss as could be seen in the output gap (Fig.9) as well as the inflation rate (Fig.10).

Fig.9: Output gap response under different policy rules (%)

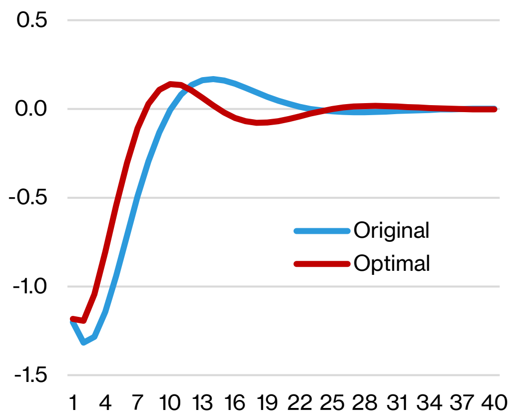

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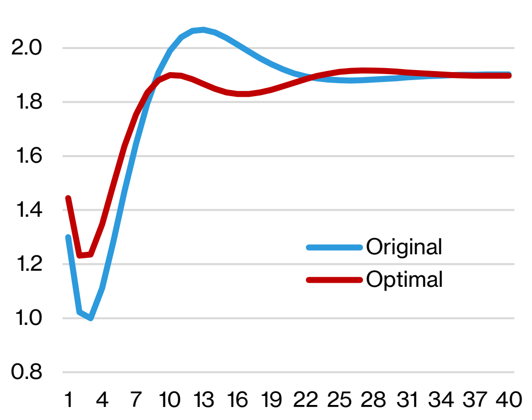
Fig.10: Inflation rate response under different policy rules (%)



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Finally, we investigate the impact of the monetary policy on the inflation development in each region. Specifically, we examine whether the stronger response to the affected region leads not only to the improvement of the entire euro area, but to the improvement in the other region as well. After the periphery is hit by a demand shock under the asymmetric policy rule, the inflation rate in the core region shows better stabilization properties during first two years. Yet, the stabilization worsens afterwards, due to the region-specific development not captured by the monetary policy (Fig.11). Inflation rate in the periphery improves over the entire horizon (Fig.12).

Fig.11: Core-region inflation rate under different policy rules (%)

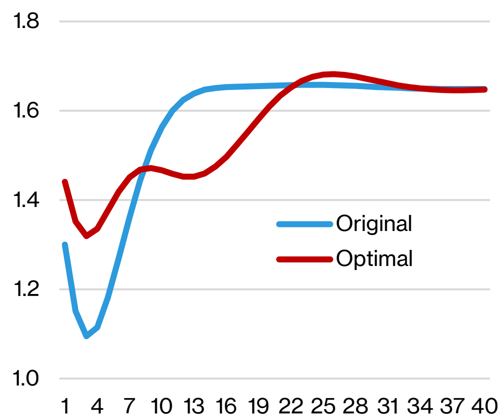

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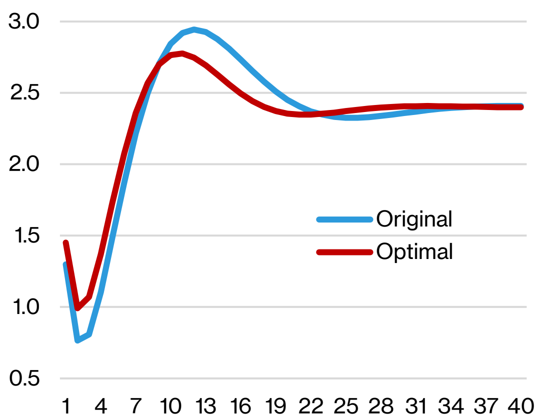
Fig.12: Periphery-region inflation rate under different policy rules (%)



Source: Authors

[7] The estimated optimum weight (share) is close to 100% of the affected region. This result is quite intuitive, due to the similar development and stabilization mechanism of both regions.

Considering that the euro area debt crisis was triggered by a negative demand shock to the euro area periphery, our paper helps to explain the nature of the significant inflation and output loss in the euro area in the years following the crisis. One could also question whether the reaction of the monetary authority should be biased towards the periphery and thus stronger during the debt crisis. However, this is difficult to answer according to the low levels of interest rates implied by the financial crisis and arising issues with the zero-lower bound. Potential recovery of the inflation rate then depends on the intensity of the realized shocks, future shocks in the euro area and potential structural changes in the parameters of both economies.

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