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Inflation Targets in a Monetary Union with Endogenous Entry

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Abstract

This paper shows that in a monetary union the interest rate rule of the Central Bank should react to the inflation rate of the Harmonized Index of Consumption Price (HICP) rather than to the inflation rate of the Welfare–Based Consumption Price (WBCP). In a two–country general equilibrium model of the EMU with endogenous entry, we compare both monetary policy regimes and find that targeting the HICP inflation rate reduces the volatility of the Producer Price Index (PPI) inflation rate and the volatility of the nominal interest rate.

Keywords: monetary union, interest rate rule, harmonized index of consumption price.
JEL Classification: E51, E58, F36, F41.

1 Introduction

Many criticisms are addressed to the European Central Bank (ECB) practice that defines price stability in the European Monetary Union (EMU) in terms of a Harmonized Index of Consumer Price (HICP). Conceptually the HICP is a Laspeyres–type index that measures the prices of a fixed expenditure pattern rather than a consumer utility–based cost of living index. Although this way of defining price stability in a comparable way for the union members is statistically appealing, it may lead to shortcomings in the measurement of the real rate of inflation in the Euro zone (see Rodriguez-Palenzuela and Wynne [2004]) and by so, may imply inadequate monetary policy decisions.

For instance, HICPs ignore two important dimensions with respect to Welfare–Based Consumption Price (WBCP) indexes: the substitutability among existing varieties and the introduction of new varieties in the economy. As an example, Broda and Weinstein [2004] use official data about import prices in the US between 1972 and 2001 and construct a welfare relevant import price index that takes both aspects into account. According to their estimates, the corresponding inflation rate of import prices is 1.2% per year lower that the official rate. In the case of the EMU, ignoring these aspects may be even more costly, given both the increase in the extensive margin of trade observed since 1999 and the deeper goods market integration that has made foreign and domestic goods more substitutable.

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Our paper explores the consequences of committing to monetary policy rules that target the HICP inflation rate compared to monetary policy rules targeting the WBCP inflation rate in a two–country DSGE model with endogenous entry. Activity thus moves both at the intensive margin (the quantity of each of the existing variety) and at the extensive margin (the number of goods varieties). After Bilbiie, Ghironi and Melitz [2007], we assume that the creation of new firms in the economy requires efficient units of labor and that the adjustment of production prices proceeds according to a Rotemberg [1982] technology. Assuming that the Central Bank of the monetary union commits to an interest rate rule to stabilize the inflation rate, we contrast the consequences of an inflation target defined in terms of the HICP with an inflation target defined in terms of a WBCP. Simulating the model and computing standard deviations of important variables in the monetary union makes our results clear. Targeting the HICP inflation rate increases the standard deviation of both the intensive and extensive margin of activity and reduces the volatility of the nominal interest rate and PPI inflation rates. This result therefore suggests that targeting the HICP inflation rate is preferable since the optimal monetary policy consists in stabilizing national PPI inflation rates, just as in the closed economy set–up described by Bilbiie et al. [2007].

The paper is organized as follows. Section 2 presents a model of the EMU with trade frictions and endogenous entry. Section 3 describes the monetary policy set–up. Section 4 explores the dynamic properties of the model under alternative monetary policy targets and presents our results. Some concluding remarks are presented in Section 5.

2 The Model

2.1 Households

In each country the number of infinitely–living households is normalized to one. In the home country $j \in [0,1]$ the representative household maximizes a welfare index,[1]

$$\Omega_t(j) = E_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \log c_t(j) - \chi \frac{\ell_t(j)^{1+\psi}}{1+\psi} \right\},$$

subject to the budget constraint,

$$\frac{b_{t+1}(j)}{p_{WBCP,t}} + v_t(n_t + n_{e,t})\, x_{t+1}(j) + c_t(j) = (1+i_t)\frac{b_t(j)}{p_{WBCP,t}} + (d_t + v_t)\, n_t x_t(j) + (1-\zeta_t)\, w_t \ell_t(j) + \frac{\gamma_t(j)}{p_{WBCP,t}}.$$

In the above expressions, β is the subjective discount factor, $c_t(j)$ is the consumption bundle chosen by household j, $\ell_t(j)$ is the quantity of labor supplied and ψ^{-1} is the Frischian elasticity. The consumer price index in the domestic country in period t is $p_{WBCP,t}$, $w_t(j)$ is the real wage, ζ_t is a tax on real wages intended to correct distortions related to the presence of monopolistic competition on goods market. Household j possesses two types of assets: mutual fund shares for domestic firms ($x_{t+1}(j)$) and a nominal bond ($b_{t+1}(j)$), that pays a nominal interest rate i_t between periods $t-1$ and t. In period t, the representative household determines the optimal fraction $x_{t+1}(j)$ of the national fund to be held, given the real average value of national firms in period t, v_t, and the total real amount of dividends d_t. Finally, $\gamma_t(j)$ is a lump-sum transfer

[1] Similar conditions do hold for the foreign economy.

amount. Similar relations hold for the representative foreign household, where foreign variables are marked by a $*$.

First order conditions of the domestic representative household j with respect to $c_t(j)$, $\ell_t(j), b_{t+1}(j)$ and $x_{t+1}(j)$ imply,

$$\begin{aligned}
\beta E_t\left\{\frac{(1+i_{t+1})\,c_t(j)}{(1+\pi_{WBCP,t+1})\,c_{t+1}(j)}\right\}-1&=0,\\
v_t-(1-\delta)\,\beta E_t\left\{\frac{(d_{t+1}+v_{t+1})\,c_t(j)}{c_{t+1}(j)}\right\}&=0,\\
\chi\ell_t(j)^{\psi}\,c_t(j)-(1-\zeta_t)\,w_t&=0,
\end{aligned}$$

where $\pi_{WBCP,t}=\frac{p_{WBCP,t}}{p_{WBCP,t-1}-1}$.

In each country in period t, agents have access to a time-varying (n_t) number of type ω varieties of domestic goods and to n_t^* type ω^* varieties of foreign goods. Final consumption bundles are a combination of national and foreign varieties in which varieties are imperfectly substitutable with elasticity $\sigma>1$. The household consumption j is,

$$c_t(j)=\left[\int_0^{n_t}c_{d,t}(\omega,j)^{\frac{\sigma-1}{\sigma}}\,d\omega+\int_0^{n_t^*}c_{m,t}(\omega^*,j)^{\frac{\sigma-1}{\sigma}}\,d\omega^*\right]^{\frac{\sigma}{\sigma-1}}.$$

The corresponding domestic price indexes are,

$$p_{WBCP,t}=\left[\int_0^{n_t}p_t(\omega)^{1-\sigma}\,d\omega+\int_0^{n_t^*}p_{x,t}^*(\omega^*)^{1-\sigma}\,d\omega^*\right]^{\frac{1}{1-\sigma}}.$$

We assume that the imported goods price, denoted by $p_{x,t}^*(\omega^*)$ (resp. $p_{x,t}(\omega)$) for those goods imported by the domestic (foreign representative) agent is affected by iceberg shipping costs, so that agents must buy a quantity $(1+\tau)$ of units to consume one unit of imported goods. We also posit a unitary elasticity of exchange rate pass-through. Export prices for foreign varieties (imported by domestic consumers) are thus,

$$p_{x,t}^*(\omega^*)=(1+\tau)\,p_t^*(\omega^*).$$

Optimal variety demands from domestic households are,

$$\begin{aligned}
c_{d,t}(\omega,j)&=\rho_t(\omega)^{-\sigma}\,c_t(j),\\
c_{m,t}(\omega^*,j)&=((1+\tau)\,q_t\rho_t^*(\omega^*))^{-\sigma}\,c_t(j),
\end{aligned}$$

where $\rho_t(\omega)=\frac{p_t(\omega)}{p_{WBCP,t}}$ and $\rho_t^*(\omega^*)=\frac{p_t^*(\omega^*)}{p_{WBCP,t}^*}$ are the real prices of goods ω and ω^* and where $q_t=\frac{p_{WBCP,t}^*}{p_{WBCP,t}}$ stands for real terms-of-trade.

2.2 Firms

In a given period t, there are two types of firms in the domestic economy: n_t firms that are already on the goods market at the beginning of the period and $n_{e,t}$ firms that are newly created during this period.[2] At the end of the period a fraction $\delta\in[0,1]$ of all existing firms is hurt by

[2]similar conditions do hold for the foreign economy.

a death shock. We assume that the entry is made at least one period ahead of production, so that,

$$n_t = (1-\delta)(n_{t-1} + n_{e,t-1}).$$

Each of the n_t firms is specialized in the production of a good. In period t, the production function for the representative domestic firm specialized in variety ω goods is,

$$y_t(\omega) = z_t \ell_t^d(\omega),$$

where z_t is the aggregate labor productivity common to all domestic firms and evolves according to an $AR(1)$ process. $\ell_t^d(\omega)$ is the firm's labor demand. We assume that prices are chosen before the beginning of the production period so that firms must pay to change it according to a Rotemberg [1982] technology. The representative firm ω faces a quadratic cost,

$$\Gamma_t(\omega) = \frac{\kappa}{2}\left(\frac{p_t(\omega)}{p_{t-1}(\omega)} - 1\right)^2 \rho_t(\omega) y_t^d(\omega).$$

The adjustment cost that firms pay is a function of consumption goods. Consequently, the demand faced by the representative firm is,

$$y_t^d(\omega) = \rho_t(\omega)^{-\sigma}\left[(c_t + \Gamma_t) + \left((1+\tau) q_t^{-1}\right)^{-\sigma}(c_t^* + \Gamma_t^*)\right],$$

where $c_t = \int_0^1 c_t(j)\,dj$, $c_t^* = \int_0^1 c_t^*(j)\,dj$, $\Gamma_t = n_t \Gamma_t(\omega)$ and $\Gamma_t^* = n_t^* \Gamma_t^*(\omega^*)$.

The corresponding optimal pricing is,

$$\frac{p_t(\omega)}{p_{WBCP,t}} = \rho_t(\omega) = \frac{\sigma}{(\sigma-1)\left(1-\frac{\kappa}{2}\pi_t^2\right) + \kappa(1+\pi_t)\pi_t - \kappa\beta(1-\delta)E_t\left\{\frac{\pi_{t+1}^2(1+\pi_{t+1})^2 y_{t+1} c_t}{(1+\pi_{c,t+1}) y_t c_{t+1}}\right\}}\frac{w_t}{z_t}.$$

In period t, $n_{e,t}$ new firms enter the market. They can only begin to produce consumption goods in $t+1$. Period t is designed to build the new firm using labor. New firms enter the market as long as the current discounted expected profit value is greater than the cost of entry. Assuming that new firms pay a sunk cost representing $f_{e,t}\frac{w_t}{z_t}$ units of effective labor to be constructed, a firm's entry occurs until the firm's value v_t is equal to the entry cost,

$$v_t = f_{e,t}\frac{w_t}{z_t}. \tag{1}$$

Finally, the link between consumer price inflation and individual price inflation is given as,

$$\frac{1+\pi_t}{1+\pi_{c,t}} = \frac{\rho_t}{\rho_{t-1}} \text{ and } \frac{1+\pi_t^*}{1+\pi_{c,t}^*} = \frac{\rho_t^*}{\rho_{t-1}^*}. \tag{2}$$

2.3 Aggregation and Equilibrium

We solve the model by assuming behavioral symmetry among firms and balance trade, *i.e.* $b_{t+1} = b_{t+1}^* = 0$. In this economy we define competitive equilibrium as a sequence of quantities,

$$\{\mathcal{Q}_t\}_{t=0}^{\infty} = \{y_t, y_t^*, c_t, c_t^*, \ell_t, \ell_t^*, \ell_t^d, \ell_t^{d*}, n_t, n_t^*, n_{e,t}, n_{e,t}^*\}_{t=0}^{\infty},$$

and a sequence of real prices,

$$\{\mathcal{P}_t\}_{t=0}^{\infty} = \{\rho_t, \rho_t^*, w_t, w_t^*, v_t, v_t^*, d_t, d_t^*, q_t\}_{t=0}^{\infty},$$

such as:

(i) For a given sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty}$, the realization of shocks $\{\mathcal{S}_t\}_{t=0}^{\infty} = \{z_t, z_t^*\}_{t=0}^{\infty}$, the sequence $\{\mathcal{Q}_t\}_{t=0}^{\infty}$ respects first order conditions for domestic and foreign households and maximizes domestic and foreign firm profits.

(ii) For a given sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^{\infty}$, the realization of shocks $\{\mathcal{S}_t\}_{t=0}^{\infty} = \{z_t, z_t^*\}_{t=0}^{\infty}$, the sequence $\{\mathcal{P}_t\}_{t=0}^{\infty}$ guarantees labor markets equilibrium and goods markets equilibrium.

Finally, we use labor markets equilibrium,

$$\ell_t = n_t \ell_t^d + z_t^{-1} f_{e,t} n_{e,t},\ \ell_t^* = n_t^* \ell_t^{d*} + z_t^{*-1} f_{e,t}^* n_{e,t}^*,$$

and the aggregate production functions,

$$y_t = n_t z_t \rho_t \ell_t^d,\ y_t^* = n_t^* z_t^* \rho_t^* \ell_t^{d*}, \tag{3}$$

as well as other structural relations to simplify the labor markets equilibrium,

$$z_t \ell_t = \frac{y_t}{\rho_t} + f_{e,t} n_{e,t},\ z_t^* \ell_t^* = \frac{y_t^*}{\rho_t^*} + f_{e,t}^* n_{e,t}^*. \tag{4}$$

3 Monetary policy

3.1 Objectives

As in a closed economy with endogenous entry (see Bilbiie et al. [2007]), the Central Bank of the monetary union should try to stabilize national PPI inflation rates. Indeed with endogenous entry, inflation affects the number of operating firms on the goods market by acting as a tax on production and dividends. The following equations illustrate the negative consequences of PPI inflation,

$$y_t = \left(1 - \frac{\kappa}{2}\pi_t^2\right)^{-1} c_t, \qquad \mu_t = \frac{\sigma}{(\sigma-1)\left(1-\frac{\kappa}{2}\pi_t^2\right) + \kappa\eta_t}, \qquad d_t = \frac{y_t}{n_t}\left(1 - \frac{\kappa}{2}\pi_t^2 - \frac{1}{\mu_t}\right),$$

where $\eta_t = (1+\pi_t)\pi_t - \beta(1-\delta) E_t \left\{ \frac{\pi_{t+1}^2 (1+\pi_{t+1})^2 y_{t+1} c_t}{(1+\pi_{c,t+1}) y_t c_{t+1}} \right\}$.

These equations describe the dynamics of output, mark–ups and dividends. Obviously, producer price inflation lowers the level of output that households have access to. Inflation acts as a tax on output since firms have to pay the adjustment cost that lowers the output and thus private consumption. It also distorts the value of dividends through inefficient mark–up fluctuations, and thereby the number of entries in the economy.

However, the first–best ($\pi_t = \pi_t^*$) is out of reach in an environment where shocks may be asymmetric with only one policy instrument. Furthermore, an optimal monetary policy rule, such as described by Gali and Monacelli [2005] is clearly out of reach since the natural interest rate, that depends on underlying structural shocks, is unobservable.

3.2 Implementation

We therefore assume that the Central Bank of the monetary union sets the nominal interest rate according to the following simple rule,

$$\widehat{i}_{t+1} = \rho_i \widehat{i}_t + (1-\rho_r)\,\phi_\pi^u \widehat{\pi}_{policy,t}^u,$$

where ρ_r is a smoothing parameter and where $\widehat{\pi}^u_{policy,t}$ is the log–deviation of the inflation rate chosen by the Central Bank as the policy target.

This interest rate rule is traditionally used in the literature as a fair approximation of the monetary policy of the ECB with respect to the stabilization of aggregate inflation in the EMU. The variable $\widehat{\pi}_{policy,t}$ may either be the PPI rate ($\widehat{\pi}^u_t$), the WBCP inflation rate ($\widehat{\pi}^u_{WBCP,t}$) or the HICP inflation rate ($\widehat{\pi}^u_{HICP,t}$).

3.3 Different monetary policy targets

Log–linearizing the different price indexes helps clarifying the role of firms entry in the problem we aim at investigating.

The log–linear WBCP index is,

$$\widehat{p}^u_{WBCP,t} = \widehat{p}^u_t - \frac{1}{\sigma - 1}\widehat{n}^u_t,$$

and the corresponding inflation rate is,

$$\widehat{\pi}^u_{WBCP,t} = \widehat{\pi}^u_t - \frac{1}{\sigma - 1}\left(\widehat{n}^u_t - \widehat{n}^u_{t-1}\right).$$

The HICP index is defined as a Laspeyres index (*i.e.* $\sigma = 0$) that does not incorporate immediately the introduction of new varieties in the economy. The corresponding inflation rate is,

$$\widehat{\pi}^u_{HICP,t} = \widehat{\pi}^u_t + \varpi\left(\widehat{n}^u_t - \widehat{n}^u_{t-1}\right),$$

where ϖ is a parameter capturing the speed at which new varieties are incorporated in the price index. Based on statistical practices in the Euro area, we let ϖ vary from $\varpi = 1$ for an instantaneous correction to $\varpi = (28)^{-1} = 0.04$ that corresponds to a situation where new varieties are incorporated 28 quarters after their introduction in the economy. The difference between both inflation rate is,

$$\widehat{\pi}^u_{HICP,t} - \widehat{\pi}^u_{WBCP,t} = \frac{1 + \varpi(\sigma - 1)}{\sigma - 1}\left(\widehat{n}^u_t - \widehat{n}^u_{t-1}\right).$$

Thus, taking into account the extensive margin of activity to assess the inflation record of alternative inflation targets is affected by two important parameters: the speed of incorporation of new goods in the HICP (ϖ) and the elasticity of substitution among varieties (σ).

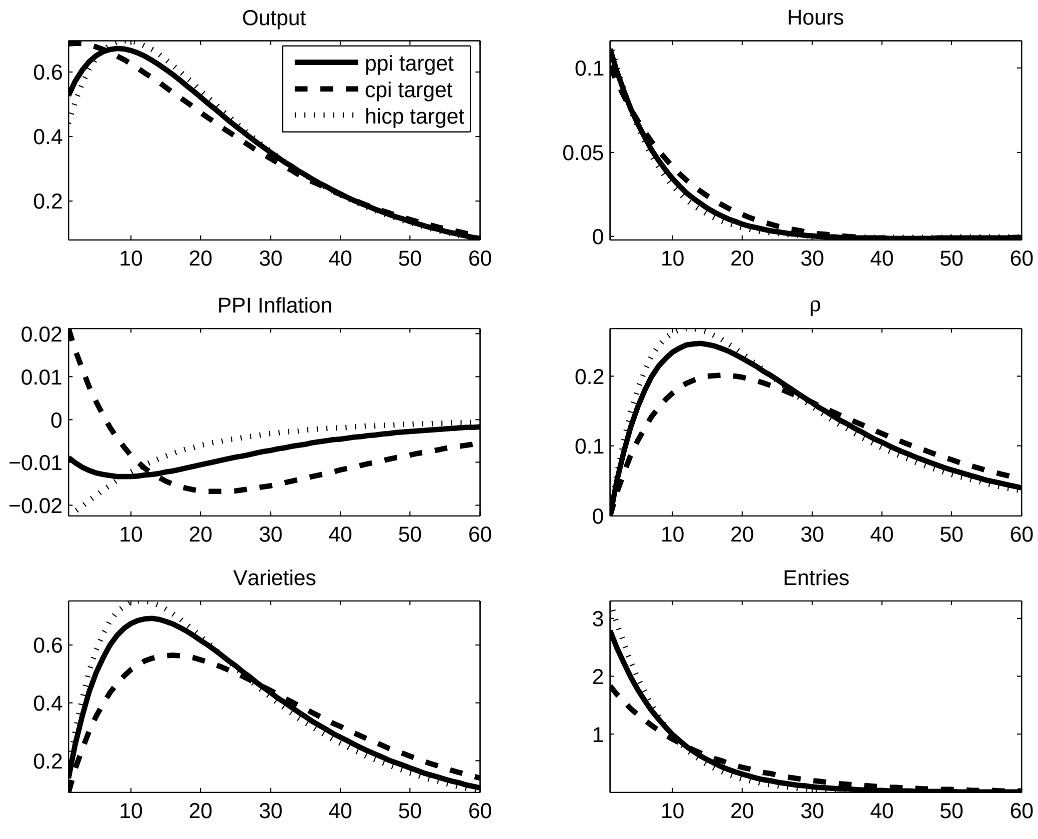
We affect numerical values to the parameters of the economy. The discount factor is set to $\beta = 0.99$, implying a steady state annual real interest rate of 4%. The proportion of firms dying each period in the economy is $\delta = 0.05$ (see Bergin and Corsetti [2005]). The friction parameter, affecting the size and persistence of inflation in the economy, is set to $\kappa = 77$, as in Bilbiie et al. [2007]. The elasticity of substitution between varieties is $\sigma = 3.8$ (see Bilbiie et al. [2007]). The transportation iceberg cost is $\tau = 0.5$, which lies in the middle of the interval suggested by Corsetti, Martin and Pesenti [2008], who let transportation costs vary from 0.2 to 0.75. The inverse of the Frischian elasticity is $\psi = 5$, lying within the interval proposed by Canzoneri, Cumby and Diba [2007]. Finally, parameters of the interest rate rules are $\rho_r = 0.75$ and $\phi^u_\pi = 2$, as pointed by several empirical studies (see for instance Clarida, Gali and Gertler [2000]). In the baseline calibration, it is assumed that new varieties enter the HICP every year, so that $\varpi = 0.25$.

4 The consequences of alternative monetary policy targets

Figure 1 plots the Impulse Response Functions (IRFs) of several key variables in the monetary union after a unit symmetric productivity shock under alternative monetary policy targets.

When the productivity of labor increases, both the intensive and extensive margin of the activity go up. Indeed, as indicated by Equation (4), the increase of efficient hours in the economy allows for a joint increase of hours devoted to both types of activities: production and the creation of new firms. The number of entries peaks immediately while the number of varieties exhibits a nice hump-shaped response. In the standard New Keynesian model, hours drop because private consumption rises and because the wealth effect dominates. In this model, the expected value of firms rises which leads households to increase their labor effort to invest in the creation of new firms. The incentive to enter the market is indeed so strong that even with an increasing stock of efficient hours, households optimally choose to reallocate towards the creation of new firms. The marginal cost of producing firms thus climbs which triggers an increase in the relative price of individual goods, ρ_t. However, this inflationary pressure is more than compensated by the positive impact of entries on the aggregate inflation rate. As the number of firms gradually increases, competition intensifies on goods markets, pushing mark–ups down. As a result, the PPI inflation rate drops (except in the case of CPI targeting).

Figure 1: IRFs to a positive unit productivity shock.



Differences across monetary policy targets relate to the latter competitive effect. As in

Bilbiie et al. [2007] and as show in the first paragraph of this section, stabilizing the PPI inflation rate is the best thing to do to offset the distortive effects of inflation on both margins of the activity. Analyzing the IRFs makes clear that targeting the PPI inflation rate maximizes the joint response of both margins. As shown by Equation (2), the stabilization of the PPI inflation rate is associated with an increased variability of the WBCP inflation rate and thereby the variability of relative prices of individual goods. Targeting the HICP inflation rate magnifies the response of entries, that could be welfare improving. However, it also implies a steadier drop of the PPI inflation rate, triggered by the increased intensity of competition. At the same, it magnifies the response of relative prices and affects negatively the response of output. HICP targeting thus results in a deeper deflation of PPI and lowers the response of aggregate output. Finally, when the Central Bank targets the WBCP inflation rate, entries are clearly dampened compared to other monetary policy targets. The increase reaches 2% whereas it peaks to more than 3% under other monetary policy targets. The mechanism behind this result is the following. Stabilizing the WBCP inflation rate results in a deeper reduction of the real interest rate that tends to lower the expected returns of shares through the no–arbitrage condition between bonds and shares. The significant reduction in the reaction of entries and varieties translates into a reduced competitive effect, that does not compensate the increase in relative prices as in other cases. A positive reaction of the PPI inflation rate is thus observed.[3]

We complete these results by computing second order moments on simulated data. Table 1 reports the average standard deviation of PPI inflation rates, outputs, hours and the standard deviation of the nominal interest rate under alternative monetary policy targets. First, it should be noticed that targeting the PPI inflation rate and targeting the HICP inflation rate yield very close standard deviations of the PPI inflation rate and of the nominal interest rate. Targeting the PPI inflation rate however leads to lower standard deviation of output and varieties. Second, comparing the volatility when the Central Bank targets either the WBCP inflation rate or the HICP inflation rate makes it clear that the Central Bank should target the HICP inflation rate, as it leads to a lower volatility of the PPI inflation rate and of the nominal interest rate. Table 1 also displays the standard deviations under alternative targets when some deep parameters of the model vary. None of these variations is able to alter our main result stating that the Central Bank of the monetary union should target the HICP inflation rate instead of the WBCP inflation rate.

5 Conclusion

Based on the evidence presented above, the major conclusion is that the Central Bank of the monetary union should not monitor the WBCP inflation rate. According to our results, its actual statistical practice has preferable implications in terms of business cycles and volatility.

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Appendix

Table 1: Standard deviations in %.

	PPI				WBCP				HICP			
	π	y	n	i	π	y	n	i	π	y	n	i
baseline	0.05	1.42	2.75	0.08	0.07	1.42	2.47	0.09	0.05	1.54	2.78	0.08
$\psi = 1$	0.05	1.69	3.05	0.09	0.07	1.61	2.98	0.11	0.05	1.76	3.29	0.09
$\psi = 3$	0.05	1.53	2.83	0.08	0.07	1.47	2.57	0.10	0.05	1.58	2.93	0.08
$\psi = 10$	0.05	1.45	2.68	0.09	0.07	1.35	2.38	0.09	0.05	1.50	2.67	0.08
$\kappa = 0.01$	0.08	1.51	2.86	0.13	0.13	1.54	2.84	0.17	0.07	1.62	2.86	0.12
$\kappa = 25$	0.06	1.45	2.65	0.09	0.10	1.53	2.62	0.12	0.06	1.59	2.93	0.10
$\kappa = 50$	0.05	1.49	2.65	0.09	0.08	1.47	2.63	0.10	0.05	1.57	2.89	0.08
$\kappa = 100$	0.05	1.51	2.70	0.08	0.06	1.43	2.47	0.09	0.05	1.53	2.85	0.08
$\sigma = 2$	0.05	2.06	1.99	0.07	0.08	1.75	1.72	0.09	0.05	2.20	2.13	0.07
$\sigma = 5$	0.05	1.46	3.13	0.08	0.06	1.34	2.92	0.09	0.05	1.48	3.12	0.08
$\sigma = 10$	0.06	1.31	3.79	0.09	0.07	1.29	3.61	0.10	0.06	1.38	3.80	0.09
$\tau = 0.25$	0.05	1.62	2.62	0.09	0.07	1.53	2.42	0.09	0.05	1.70	2.77	0.09
$\tau = 0.75$	0.05	1.44	2.81	0.08	0.07	1.31	2.54	0.09	0.05	1.46	2.82	0.08
$\varpi = 0.1$	0.05	1.50	2.69	0.08	0.07	1.43	2.61	0.10	0.05	1.51	2.79	0.08
$\varpi = 0.25$	0.05	1.50	2.77	0.08	0.07	1.38	2.43	0.09	0.05	1.55	2.81	0.08
$\varpi = 0.50$	0.05	1.52	2.70	0.08	0.07	1.45	2.59	0.09	0.05	1.63	2.88	0.09
$\rho_r = 0.00$	0.06	1.45	2.76	0.10	0.07	1.39	2.48	0.11	0.06	1.51	2.86	0.10
$\rho_r = 0.25$	0.05	1.46	2.64	0.09	0.07	1.37	2.40	0.11	0.05	1.55	2.82	0.09
$\rho_r = 0.550$	0.05	1.49	2.66	0.09	0.07	1.39	2.51	0.10	0.05	1.55	2.79	0.09

Note: baseline values: $\psi = 5$, $\kappa = 77$, $\sigma = 3.8$, $\tau = 0.5$, $\varpi = 0.25$, $\rho_r = 0.75$.