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The Extensive Margin of Trade under Alternative Monetary Policy Regimes ⋆

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Abstract

This paper investigates the impact of alternative monetary policy regimes on the creation of new varieties in open economies. Using a dynamic two-country model incorporating nominal rigidities, international trade and firm entries we compare an independent monetary policy regime to a monetary union regime. We find that a common monetary policy defined by a nominal interest rate rule reactive to inflation increases extensive margin of trade volatility. Simulations based on business cycle frequencies indicate that on average this increase reaches 3%. Although monetary policy interdependence is found to be a key ingredient in generating this effect, we stress that those parameters affecting international trade structures are crucial in determining its magnitude.

Keywords: Extensive Margin, Variety Effect, Monetary Union, Monetary Policy.
JEL Class.: E51, E58, F36, F41.

1 Introduction

This paper contributes to a growing amount of literature investigating the link between monetary policy and the creation of new goods varieties through extending the problem

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to an open economy.[1] In a closed economy set-up, Bilbiie, Ghironi and Melitz [2007] show that real interest rate dynamics are crucial to the intertemporal arbitrage faced by firms when they invest in the creation of new varieties, thereby increasing the future value of their shares, or produce more of each existing variety, thus paying a higher dividend at present in order to increase the current value of their shares. Using SVAR estimations, Bergin and Corsetti [2005] confirm that monetary policy has a non-negligible effect on net business creation or a firm's entry into this particular channel. They also show how simple macroeconomic endogenous entry models are able to replicate some of these features.

In this paper we build a two-country model incorporating nominal rigidities and international trade in order to compare the variety effects of alternative monetary policy arrangements. Our results serve as a theoretical assessment of certain recently documented stylized facts about monetary unification. Flam and Nordstrom [2006] show that the creation of the Euro has led to an increase in trade, driven by the extensive margin and vertical specialization. Berthou and Fontagné [2008] confirm these results using firm-level data estimates. They stress the fact that monetary unification leads to an increase in the extensive margin of trade.

We lay out a two-country version of the model developed by Bilbiie et al. [2007] wherein households consume domestic and foreign goods. Since the model explicitly takes firm entries into account, with new varieties being entered in both consumption bundles at each period and trade occurring through both intensive and extensive margins. Financial markets are closed since financial assets (nominal bonds and equities) are only accessible to national households and the model is closed, assuming balanced trade. Consequently the nominal exchange rate is left undetermined by the model. As for nominal exchange rate flexibility issues, they are beyond the scope of this paper. Monetary policies are determined by central banks, with the monetary policy instrument being the nominal interest rate, thus intended to stabilize producer price index (PPI) inflation rates. We compare the variety effects of two alternative monetary policy regimes: a regime independent of monetary policies and a monetary union regime. The first can be thought of as a flexible exchange rate regime or fixed exchange rate regime with imperfect capital mobility (in this case, both are equivalent because capital is perfectly immobile). Under the first system, each central bank sets the nominal interest rate through a simplified Taylor-type rule that reacts positively to inflation. Under the second regime, the common central bank sets the nominal interest rate using the same kind of rule, reacting to aggregate PPI within the monetary union.

This paper shows that participation in a monetary union increases extensive margin of trade volatility. Under independent monetary policies, the transmission of productivity shocks from one country to another occurs through trade linkages. In the economy

[1] Other extensive margin models applied to international macroeconomics include Broda and Weinstein [2004], Broda and Weinstein [2006], Corsetti, Martin and Pesenti [2007], Corsetti, Martin and Pesenti [2008] and Hummels and Klenow [2005].

experiencing the shock, say the domestic economy, most variables react, including the number of entries and the varieties that trigger trade flows between both countries. Trade flows are caused by movement in both intensive and extensive margins, and also by movements in the relative price of domestic goods included in final household consumption within the other or foreign economy. Foreign entries and varieties do not however react to the shock. In the model used, entries are triggered by variations in expected returns on shares and these must be equated with the expected return on bonds in equilibrium. Since the foreign nominal interest rate remains totally flat in response to the domestic productivity shock, entries and varieties do not respond either. As for monetary union, in both economies a monetary policy reaction induces the nominal interest rate to drop. Response of entries in the economy undergoing the positive productivity shock are magnified, while in the other economy the number of varieties decreases, since in equilibrium the expected returns on shares drop. As a consequence, the overall volatility of the extensive margin is increased.

The increased macroeconomic interdependence resulting from the participation to a currency area is thus found to increase the volume of trade and the volatility of the extensive margin of trade. Our result thus provide a theoretical assessment of stylized facts showing that monetary unification has led to an increase in trade flows trough the extensive margin in the case of the EMU.

This paper is organized as follows. Section 2 describes the economy. Section 3 compares the variety effect following productivity and monetary shocks within the alternative regimes, based on impulse response functions (IRF, hereafter). This section also investigates the variety effect's robustness when confronted with changes in the foremost parameters. Section 4 makes some concluding remarks.

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, [2]

$$\Omega_t(j) = E_t\left\{\sum_{s=t}^{\infty} \beta^{s-t} u\left(c_s(j), \ell_s(j)\right)\right\},$$

where,

$$u\left(c_s(j), \ell_s(j)\right) = \log c_t(j) - \chi \frac{\ell_t(j)^{1+\psi}}{1+\psi},$$

[2] We do not detail relations for the foreign economy, but similar conditions do hold.

subject to the budget constraint,

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

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, ψ^{-1} is the Frischian elasticity. The consumer price index in the domestic country in period t is $p_{c,t}$, $w_t(j)$, the real wage, ζ_t is a tax on real wages intended to correct distortions related to the economy's monopolistic competition. 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 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,

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

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

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,

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

Similar expressions are used for the foreign country. 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,

$$p^*_{x,t}(\omega^*) = (1+\tau)\, e_t p^*_t(\omega^*) \,.$$

Optimal variety demands from domestic households are,

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

where $\rho_t(\omega) = \frac{p_t(\omega)}{p_{c,t}}$ and $\rho^*_t(\omega^*) = \frac{p^*_t(\omega^*)}{p^*_{c,t}}$ are the real prices of goods ω and ω^* and where $q_t = \frac{e_t p^*_{c,t}}{p_{c,t}}$ 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.[3] At the end of the period a fraction $\delta \in [0,1]$ of all existing firms is hurt by 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 that can be imperfectly substituted in the agent's consumption. In period t, the production function for the representative domestic firm specialized in variety ω goods is,

$$y_t(\omega) = z_t \ell^d_t(\omega)\,,$$

where z_t is the aggregate labor productivity common to all domestic firms and $\ell^d_t(\omega)$ is the firm's labor demand. The aggregate productivity thus evolves according to the following autoregressive structure,

$$z_{t+1} = (1-\rho_z)\, z + \rho_z z_t + \xi_{z,t},$$

where $\xi_{z,t}$ represents an *i.i.d* innovation with zero mean and constant variance.

[3] For the foreign economy we do not detail relations but assume that similar conditions hold.

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 [1996] 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 those goods having the exact same features as the 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 $\Gamma_t^* = n_t^* \Gamma_t^*(\omega^*)$.

In period t, the representative firm ω chooses $p_t(\omega)$, to maximize $d_t(\omega) + v_t(\omega)$, where

$$v_t(\omega) = c_t E_t\left\{\sum_{s=1}^{\infty}(\beta(1-\delta))^s\left(\frac{d_{t+s}(\omega)}{c_{t+s}}\right)\right\},$$

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

The optimal pricing is,

$$\frac{p_t(\omega)}{p_{c,t}} = \rho_t(\omega) = \mu_t \frac{w_t}{z_t},$$

where,

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

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,

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

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

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

2.3 Aggregation and Equilibrium

We solve the model by applying the behavioral symmetry equation to the firms,

$$\rho_t(\omega) = \rho_t,\ y_t^d(\omega) = y_t^d,\ y_t(\omega) = y_t(\omega),\ \ d_t(\omega) = d_t,\ v_t(\omega) = v_t,$$

and by assuming that a balance of trade exists between the two parts of the world, *i.e.* $b_{t+1} = b_{t+1}^* = 0$, which implies that,

$$n_t^* \rho_t^{*1-\sigma}\left[c_t + \frac{\kappa}{2}\pi_t^2 y_t\right] = q_t^{2(\sigma-1)} n_t \rho_t^{1-\sigma}\left[c_t^* + \frac{\kappa}{2}\pi_t^2 y_t^*\right],$$

where,

$$y_t = \int_0^{n_t} \rho_t(\omega)\, y_t(\omega)\, d\omega, \text{ and } y_t^* = \int_0^{n_t^*} \rho_t^*(\omega^*)\, y_t^*(\omega^*)\, d\omega^*.$$

In this open economy, the real price index structure implies the following variety effect since,

$$n_t \rho_t^{1-\sigma} + \phi q_t^{1-\sigma} n_t^* \rho_t^{*1-\sigma} = 1, \quad (1)$$
$$n_t^* \rho_t^{*1-\sigma} + \phi q_t^{\sigma-1} n_t \rho_t^{1-\sigma} = 1, \quad (2)$$

where $\phi = (1+\tau)^{1-\sigma}$ is the inverse of home bias.

Moreover, upon aggregating consumer budget constraints, assuming symmetry in asset holdings (so that, $x_{t+1} = x_t = x_{t+1}^* = x_t^* = 1$), and using the government's budget constraint,

$$\int_0^1 \gamma(j)dj = -\zeta_t p_{c,t} w_t \int_0^1 \ell_t(j),$$

we get the following aggregate relations,

$$v_t n_{e,t} + c_t = d_t n_t + w_t \ell_t,$$
$$v_t^* n_{e,t}^* + c_t^* = d_t^* n_t^* + w_t^* \ell_t^*.$$

Finally, in the 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,

$$\ell_t = \int_0^1 \ell_t(j)\, dj = \int_0^{n_t} \ell_t^d(\omega)\, d\omega + z_t^{-1} f_{e,t} n_{e,t},$$
$$\ell_t^* = \int_0^1 \ell_t^*(j^*)\, dj^* = \int_0^{n_t^*} \ell_t^{*d}(\omega^*)\, d\omega^* + z_t^{*^{-1}} f_{e,t} n_{e,t}^*,$$

· goods markets equilibrium,

$$y_t = n_t \rho_t^{1-\sigma}\left[c_t + \frac{\kappa}{2}\pi_t^2 y_t + \phi q_t^{\sigma-1}\left(c_t^* + \frac{\kappa}{2}\pi_t^2 y_t^*\right)\right],$$
$$y_t^* = n_t^* \rho_t^{*1-\sigma}\left[c_t^* + \frac{\kappa}{2}\pi_t^2 y_t^* + \phi q_t^{1-\sigma}\left(c_t + \frac{\kappa}{2}\pi_t^2 y_t\right)\right].$$

Using the trade balance condition and the variety effect (1)-(2), goods market equilibrium collapses to the closed economy version of the goods market equilibrium,

$$y_t\left(1 - \frac{\kappa}{2}\pi_t^2\right) = c_t,$$
$$y_t^*\left(1 - \frac{\kappa}{2}\pi_t^{*2}\right) = c_t^*.$$

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 definition,

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

as well as other structural relations to simplify aggregate accounting relations,

$$d_t = \frac{y_t}{n_t}\left(1 - \frac{\kappa}{2}\pi_t^2 - \frac{1}{\mu_t}\right),\ \ d_t^* = \frac{y_t^*}{n_t^*}\left(1 - \frac{\kappa}{2}\pi_t^{*2} - \frac{1}{\mu_t^*}\right),$$

and the labor markets equilibrium,

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

3 Monetary Policy Regimes and Variety Effect

We compare the effects of independent and common monetary policies on the extensive margin of trade between the two countries. In particular we show that the interdependence generated by a common interest rate reaction to inflation leads to significant consequences on the volume and volatility for the extensive margin component of trade flows.

3.1 The Interest Rate Rule

As shown in Bilbiie et al. [2007], targeting domestic producer inflation is the optimal policy in a model having an endogenous entry. The following equations exemplify the negative impact that inflation exerts in this economy,

$$
\begin{aligned}
y_t &= \left(1 - \frac{\kappa}{2}\pi_t^2\right)^{-1} c_t, \\
\mu_t &= \frac{\sigma}{(\sigma - 1)\left(1 - \frac{\kappa}{2}\pi_t^2\right) + \kappa\eta\left(\pi_t\right)}, \\
d_t &= \frac{y_t}{n_t}\left(1 - \frac{\kappa}{2}\pi_t^2 - \frac{1}{\mu_t}\right),
\end{aligned}
$$

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

These equations describe the dynamics of output, mark-ups and dividends. Obviously, inflation acts as a tax on both output consumption and dividends. It directly lowers the level of output to which households have access. It also distorts the value of dividends through inefficient mark-up fluctuations, and thereby the number of entries in the economy. Inflation also acts as a direct tax on output since firms have to pay the adjustment cost, which in turn lowers the output and thus private consumption. An optimal policy thus stabilizes producer price inflation while an optimal rate of consumer price inflation can move freely and thus accommodate changes in the number of varieties in this situation where ($\pi_t = 0$, $\pi_{c,t} = \frac{\rho_t}{\rho_{t-1}} - 1$).

For these reasons, we assume that monetary authorities strictly target the inflation rate and use simple monetary policy interest rate rules to stabilize the PPI inflation rate within the economy. Since the model has no closed-form solution, we loglinearize the model around the deterministic steady state, according to the procedure described in the Appendix.

Under independent monetary policies, the domestic central bank sets the interest rate according to the following linearized rule,

$$
\widehat{i}_{t+1} = \rho_r\widehat{i}_t + \phi_\pi E_t\widehat{\pi}_{t+1} + \xi_{i,t}, \tag{3}
$$

where $\widehat{i}$ and $\widehat{\pi}$ are deviation and logdeviation respectively of the nominal interest and the PPI inflation rate from their steady state values and where $\xi_{i,t}$ is an $i.i.d$ innovation with constant variance. The foreign central bank adopts a similar behavior,

$$\widehat{i}^*_{t+1} = \rho_r \widehat{i}^*_t + \phi^*_\pi E_t \widehat{\pi}^*_{t+1} + \xi_{i^*,t}, \tag{4}$$

where ξ_{i^*} is an $i.i.d$ innovation with constant variance.

In a monetary union, both countries share the same currency and interest rates that households face in the Euler equation, common to both countries. The common central bank follows a simple interest rate rule targeting the aggregate PPI inflation rate,

$$\widehat{i}_{t+1} = \widehat{i}^*_{t+1} = \widehat{i}^u_{t+1} = \rho_r \widehat{i}^u_t + \phi^u_\pi E_t \left(\frac{1}{2} \widehat{\pi}_{t+1} + \frac{1}{2} \widehat{\pi}^*_{t+1} \right) + \xi_{i^u,t}, \tag{5}$$

where $\xi_{i^u,t}$ is an $i.i.d$ innovation with constant variance.

This policy has different implications in terms of macroeconomic dynamics since the national PPI inflation rates and thus the real exchange rate are not determined by the same equations. Given that both the real exchange rate and the real interest rate impact directly on the variety effect, the macroeconomic dynamics of both economies will be greatly affected by the monetary policy regime.

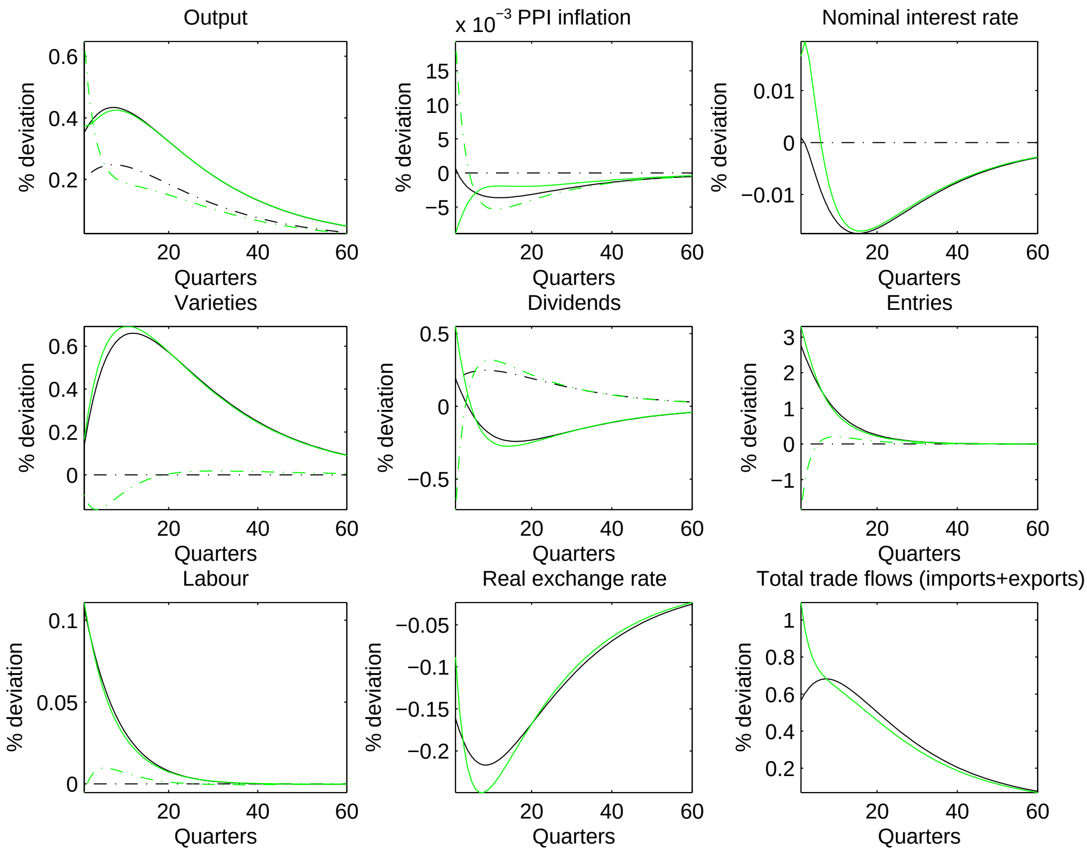
3.2 Dynamic Properties of Monetary Policy Regimes

A closer look at the IRFs to a standard unit productivity shock helps identify differences between alternative monetary policy regimes, in terms of macroeconomic adjustment. The independent monetary policy (IMP) regime implies that the economy evolves according to the model described in the Appendix along with the equations (3)–(4), while in a monetary union case (MU), the economy evolves according to the model described in the Appendix along with the equations (5).

We assign numerical values to the economy's parameters. The discount factor is set to $\beta = 0.99$, implying a steady state annual real interest rate of 4%. The proportion of failing firms during each period in the economy is $\delta = 0.05$ (see Bergin and Corsetti [2005]). The friction parameters which affect 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 the varieties is $\sigma = 4$ (Bilbiie et al. [2007]). The transportation iceberg cost is τ =0.5, which lies in the middle of the interval suggested by Corsetti et al. [2008], which allows transportation costs to vary from 0.2 to 0.75. The inverse of the Frischian elasticity is $\psi = 5$, which lies within the interval proposed by Canzoneri, Cumby and Diba [2006]. Finally, parameters for interest rate rules are $\rho_r = 0.7$ and $\phi_\pi = \phi^*_\pi = \phi^u_\pi = 1.5$, as pointed out by several empirical studies (see for instance Taylor [1999] and Clarida, Gali and Gertler [2000]).

Figure 1 plots the IRFs to a unit positive productivity shock in both economies under independent monetary policies and in a monetary union.

Fig. 1. IRFs to a positive unit productivity shock in the domestic economy (black line: independent monetary policies, green line: monetary union, solid: home, dashed: foreign).



The general mechanism behind changes in productivity transmission is triggered by changes in labor markets equilibrium. As labor becomes more productive, entry costs drop and households work harder to produce larger quantities of existing varieties. Thus, both the extensive and the intensive margins for aggregate production increase. As entry costs are reduced, expected dividends improve, thereby inducing entries, and this in turn leads to an increasing number of goods varieties over time. This latter effect is known as the variety effect. According to this effect, the number of firms in the economy increases and this positively affects competition and forces producers to lower their selling prices. As a consequence mark-ups drop and this in turn produces a sharp decrease in the PPI inflation rate.

The monetary authorities reduce the nominal interest rate in reaction to the PPI inflation rate decrease. The output boom is thus magnified through a standard liquidity effect. On the other hand, the variety effect is cooled down by the reaction caused by the monetary policy rule, since the equalization of returns on bonds and shares implied by the non-arbitrage condition involves a slight moderation of entries. This phenomenon marginally affects the activity's extensive margin since it is too small to change the variety effect's sign, which remains clearly positive.

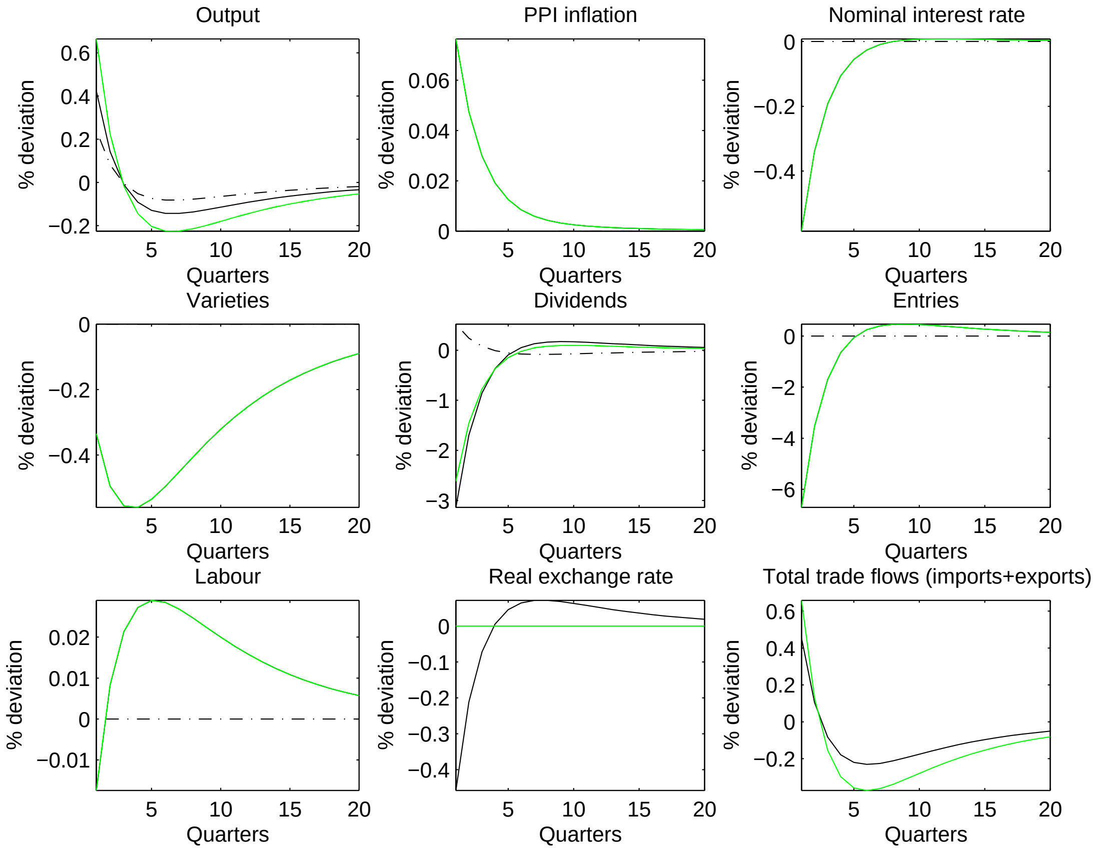
Under independent monetary policies, the domestic economy reacts according to the generic pattern described in the previous paragraphs. The transmission of shock to the foreign economy relies entirely on international trade. Foreign consumers benefit from the relative price drop for goods produced in the domestic economy, and their aggregate consumption increases. Nominal variables such as the interest rate, the PPI inflation rate and real variables such as entries and number of varieties are unaffected by the domestic productivity shock. Finally, since the domestic economy tends to become a net exporter, the trade balance condition requires a drop in the real exchange rate, and thus the relative competitiveness of domestically produced goods. [4] When both countries form a currency union, the adjustment pattern is globally unaffected for the domestic economy. However, transmission to the foreign economy is different. The foreign economy faces the same nominal interest rate decrease as that observed in the domestic economy, because the nominal interest rate is common and because the central banks react positively to the aggregate rate of PPI inflation. This situation implies a drop in the real interest rate, producing standard effects: both output and inflation increase, expected return on shares drops, implying a decrease in the number of entries and a decrease in the number of foreign varieties. The major difference is that both real and nominal variables are more strongly affected in the case of a monetary union than when both countries form a currency union.

It should be noted that differences in extensive margin dynamics last for twenty quarters before converging. As such, in the short run, in terms of volatility, monetary policy impacts variety creation more substantially. In order to document the pure effect of monetary regime during these twenty quarters, we also study the effects that monetary policy changes have on the economy, as depicted in Figure 2.

Following a monetary policy shock, the nominal interest rate drops, as does the real interest rate, thus boosting output through a standard liquidity effect. As a consequence, both quantities and prices increase and the PPI inflation rate also increases. The drop in the real interest rate has a major effect on the number of entries, given that the expected return on drop in shares due to the non-arbitrage condition. This mechanism conflicts with the evidence put forth by Bergin and Corsetti [2005], but, as underlined by Bilbiie et al. [2007], it is related to the nature of entry costs. In a model with entry costs paid in terms of consumption goods, such as developed by Bergin and Corsetti [2005], the number of varieties increases following a monetary policy shock. However, modeling entry costs according to the amount of hours worked also constitutes a realistic concept regarding how varieties are introduced in the economy.

[4] Releasing the balanced-trade condition would allow another real exchange rate pattern to take effect. The latter would clearly improve and the domestic economy would enjoy commercial surpluses, translating into positive current account balances for a few periods. The current account however is clearly shut-off by the balanced-trade condition, and thus when a positive domestic productivity shock occurs it forces the domestic real exchange rate to drop.

Fig. 2. IRFs to a negative unit interest rate shock in the domestic economy(black line: independent monetary policies, green line: monetary union, solid: home, dashed: foreign).



Under independent monetary policies, transmission to the foreign economy occurs through trade linkages. Since the domestic economy experiences an increase in its output and a decrease in the number of available varieties, the foreign economy tends to become a net exporter and its output increases. In the very short run, the domestic real exchange rate drops, driven by an increase in the relative price of domestic goods, but by an increase in the medium run (7 to 8 periods after the shock) to balance trade flows. In the case where those countries form a currency union, the effects of a monetary shock are perfectly symmetric, and the real exchange rate remains perfectly flat. The shock tends to boost trade flows between both countries however to a level higher than trade flows under independent monetary policies.

In others words and to sum up, sharing the same interest rate enhances macroeconomic interdependence, leads to higher trade flows and increases the volatility of the extensive margin of trade compared to a situation of independent monetary policies. These effects can be observed in both the productivity shock and monetary policy shock cases. The next section aims at disentangling the sources of this increased extensive margin volatility in a monetary union.

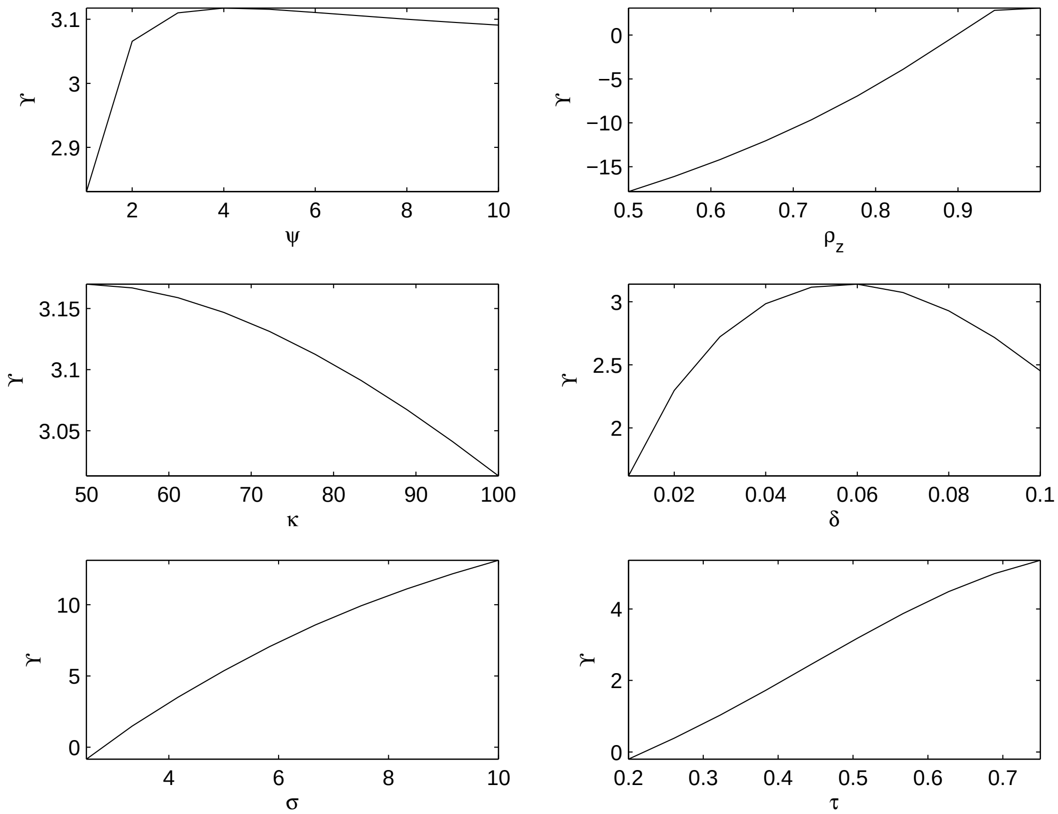
3.3 *Variety Effect Robustness*

In this section, we run simulations in order to provide a quantitative assessment of the variety effect of the alternative monetary policy regime. We thus simulate the model 1,000 times under the alternative monetary policy regime. Each simulation feeds the model with random productivity and monetary policy shocks with standard deviation $std(\xi_{i,t}) = std(\xi_{i^*,t}) = std(\xi_{i^u,t}) = 0.5\%$ and $std(\xi_{z,t}) = 1\%$ and computes the following indicator,

$$\Upsilon = 100 \cdot \left[\frac{std\left(\widehat{n}_t^{MU}\right) + std\left(\widehat{n}_t^{*MU}\right)}{std\left(\widehat{n}_t^{IMP}\right) + std\left(\widehat{n}_t^{*IMP}\right)} - 1 \right].$$

Averaging Υ across the simulations yields the average volatility surplus in the economy's extensive margin associated with the monetary union regime, compared to that with the independent monetary policy regime. The Υ value used for the model's baseline calibration is 3.1154%. For a monetary union situation we thus find that extensive margin volatility increases by about 3%, compared to that of the independent monetary policy. Figure 3 plots the value of Υ for various departures from the baseline calibration.

Fig. 3. Robustness of the variety effect.



As shown in Figure 3 we find that the extensive margin's extra volatility under a common monetary policy is a robust phenomenon across a wide range of parameter values. It is easy to see that when inflation rates increase and remain persistent, extensive margin volatility decreases in the monetary union. In addition, there is an increase in the proportion of firms failing in each period, thus implying the opposite effect. Furthermore the extensive margin's volatility moves in the opposite direction with respect to productivity shock persistence. This happens because the monetary policy's reaction under monetary union has less effect on the original creation of new varieties in the domestic economy.

More importantly, it is worth noting that the extensive margin's extra volatility under the monetary union regime is sensitive to two parameters related to international trade. First, for substitution elasticity among consumer goods, we find that a higher value for this parameter magnifies the phenomenon. As goods substitution increases, it lowers the value of PPI inflation thus leading to a reduction in interest rate adjustments. As a consequence, monetary policy reactions have less impact on the dampening of variety creation, which in turn reinforces the relative volatility of the monetary union's extensive margin. Second, an increase in trade costs affects the quantity of goods demanded for exportation, thus leaving the quantity of these goods consumed in the importing country unchanged. As a consequence, an increase in these costs has a positive affect on the value of dividends and thus on the value of exporting firms.

These additional results confirm our intuition and lead us to conclude that being in a monetary union increases the extensive margin's volatility when compared to situations involving independent monetary policies.

4 Conclusion

This paper studies the effects of alternative monetary policy regimes on intensive and extensive margins. We build a two-country version of the model of Bilbiie et al. [2007] in which households consume domestic and foreign goods. Since the model explicitly takes firm entries into account, new varieties enter into both consumption bundles at each period and trade occurs through both the intensive and the extensive margin. We compare the variety effect of two monetary policy regimes: independent monetary policies and monetary union. We show that monetary unification increases macroeconomic interdependence by means of a nominal interest rate policy. This channel is found to increase the extensive margin of trade volatility. This results in first theoretical foundation for empirical studies showing that the Euro has led to an increase in the trade of new varieties.

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Appendix

Linearization

We solve the model by deviating from Pareto-optimal symmetric steady state equilibrium with balanced trade, *i.e.*, $b = b^* = 0$, $c = c^*$, $y = y^*$, $\ell = \ell^*$, $n = n^*$, $n_e = n_e^*$. Pareto-optimality requires that $\zeta = (1-\sigma)^{-1}$. Assuming $z = 1$, the steady state of the economy is,

$$
\begin{gathered}
\rho = 1 => \frac{w}{z} = w = \mu^{-1} = \frac{\sigma - 1}{\sigma},\ c = \left(\chi\left(1+\varphi\right)^{-\psi}\right)^{\frac{1}{1+\psi}},\ y = c, \\
d = \frac{c\left(1+\phi\right)}{\sigma},\ v = \frac{\left(1-\delta\right)\beta}{\left(1-\left(1-\delta\right)\beta\right)} d,\ n = \left(1+\phi\right)^{-1},\ n_e = \frac{\delta}{1-\delta}\left(1+\phi\right)^{-1} \\
\ell = c\left(1+\varphi\right),\ f_e = v\frac{\sigma}{\sigma-1} = \frac{\left(1-\delta\right)\beta}{\left(1-\left(1-\delta\right)\beta\right)} \frac{c\left(1+\phi\right)}{\sigma - 1} \geq 0,
\end{gathered}
$$

where $\varphi = \frac{\beta\delta}{(\sigma-1)(1-(1-\delta)\beta)}$. Reminding that the linearized resource constraint implies,

$$
\begin{aligned}
\widehat{y}_t - \widehat{c}_t &= 0, \\
\widehat{y}_t^* - \widehat{c}_t^* &= 0,
\end{aligned}
$$

the linear conditions for households are,

$$
\begin{aligned}
E_t\left\{\widehat{y}_{t+1}\right\} - \widehat{y}_t - E_t\left\{\widehat{i}_{t+1} - \widehat{\pi}_{c,t+1}\right\} &= 0, \\
E_t\left\{\widehat{y}_{t+1}^*\right\} - \widehat{y}_t^* - E_t\left\{\widehat{i}_{t+1}^* - \widehat{\pi}_{c,t+1}^*\right\} &= 0, \\
E_t\left\{\widehat{y}_{t+1}\right\} - \widehat{y}_t + \widehat{v}_t - E_t\left\{\frac{r+\delta}{1+r}\widehat{d}_{t+1} + \frac{1-\delta}{1+r}\widehat{v}_{t+1}\right\} &= 0, \\
E_t\left\{\widehat{y}_{t+1}^*\right\} - \widehat{y}_t^* + \widehat{v}_t^* - E_t\left\{\frac{r+\delta}{1+r}\widehat{d}_{t+1}^* + \frac{1-\delta}{1+r}\widehat{v}_{t+1}^*\right\} &= 0, \\
\psi\widehat{\ell}_t + \widehat{y}_t - \widehat{w}_t &= 0, \\
\psi\widehat{\ell}_t^* + \widehat{y}_t^* - \widehat{w}_t^* &= 0,
\end{aligned}
$$

where $r = \beta^{-1} - 1$ is the steady state real rate of interest. Linear conditions for firms are,

$$
\begin{aligned}
\widehat{n}_t - (1-\delta)\,\widehat{n}_{t-1} - \delta \widehat{n}_{e,t-1} &= 0, \\
\widehat{n}_t^* - (1-\delta)\,\widehat{n}_{t-1}^* - \delta \widehat{n}_{e,t-1}^* &= 0, \\
\widehat{\rho}_t - \widehat{\mu}_t - (\widehat{w}_t - \widehat{z}_t) &= 0, \\
\widehat{\rho}_t^* - \widehat{\mu}_t^* - (\widehat{w}_t^* - \widehat{z}_t^*) &= 0, \\
\widehat{v}_t - \widehat{f}_{e,t} - (\widehat{w}_t - \widehat{z}_t) &= 0, \\
\widehat{v}_t^* - \widehat{f}_{e,t}^* - (\widehat{w}_t^* - \widehat{z}_t^*) &= 0, \\
\widehat{\pi}_t - \beta\,(1-\delta)\, E_t \widehat{\pi}_{t+1} + \frac{\sigma - 1}{\kappa} \widehat{\mu}_t &= 0, \\
\widehat{\pi}_t^* - \beta\,(1-\delta)\, E_t \widehat{\pi}_{t+1}^* + \frac{\sigma - 1}{\kappa} \widehat{\mu}_t^* &= 0.
\end{aligned}
$$

Other linear equilibrium conditions are,

$$
\begin{aligned}
\widehat{n}_t + \phi \widehat{n}_t^* - (\sigma - 1)\left(\widehat{\rho}_t + \phi\left(\widehat{\rho}_t^* + \widehat{q}_t\right)\right) &= 0, \\
\widehat{n}_t^* + \phi \widehat{n}_t - (\sigma - 1)\left(\widehat{\rho}_t^* + \phi\left(\widehat{\rho}_t - \widehat{q}_t\right)\right) &= 0, \\
\widehat{z}_t + \widehat{\ell}_t + \widehat{\rho}_t - \widehat{y}_t - \frac{\varphi}{1+\varphi}\left(\widehat{f}_{e,t} + \widehat{n}_{e,t}\right) &= 0, \\
\widehat{z}_t^* + \widehat{\ell}_t^* + \widehat{\rho}_t^* - \widehat{y}_t^* - \frac{\varphi}{1+\varphi}\left(\widehat{f}_{e,t}^* + \widehat{n}_{e,t}^*\right) &= 0, \\
\widehat{n}_t + \widehat{d}_t - \widehat{y}_t - (\sigma - 1)\,\widehat{\mu}_t &= 0, \\
\widehat{n}_t^* + \widehat{d}_t^* - \widehat{y}_t^* - (\sigma - 1)\,\widehat{\mu}_t^* &= 0, \\
\widehat{\pi}_t - \widehat{\pi}_{c,t} - \widehat{\rho}_t + \widehat{\rho}_{t-1} &= 0, \\
\widehat{\pi}_t^* - \widehat{\pi}_{c,t}^* - \widehat{\rho}_t^* + \widehat{\rho}_{t-1}^* &= 0, \\
\widehat{n}_t^* - \widehat{n}_t + (1-\sigma)\left(\widehat{\rho}_t^* - \widehat{\rho}_t\right) - \left(\widehat{y}_t^* - \widehat{y}_t\right) - 2\,(\sigma - 1)\,\widehat{q}_t &= 0,
\end{aligned}
$$

where $\varphi = \frac{\beta\delta}{(\sigma-1)(1-(1-\delta)\beta)}$.