Monetary Policy in the Open Economy Revisited: The Case for Exchange-Rate Flexibility Restored

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Abstract

This note revisits the sticky-price pricing-to-market model of Devereux and Engel (2003), in which fixed exchange rates are optimal even in the face of country-specific nonmonetary shocks. We show that this result hinges critically on the Devereux-Engel model's prediction that international consumption levels are perfectly synchronized under flexible prices. Realistic modifications of the model that produce nonsynchronous consumption movements—for example, the presence of nontraded goods—upset the fixed exchange rate prescription even in the absence of an expenditure-switching role for the exchange rate.

1 Introduction

In a pioneering paper published in this *Review*, Devereux and Engel (2003)—DE hereafter—extend sticky-price models in the "new open economy macroeconomics" vein to incorporate price-setting in buyers' currencies by price-discriminating exporters. The motivation for this important extension is empirical: consumer prices, even of imported goods, appear very sluggish compared to exchange rates, so that nominal exchange rate movements have virtually commensurate effects on both real exchange rates and the relative international prices of very similar traded goods.

In more conventional sticky-price open macromodels, going back to the seminal works of Fleming and Mundell in the 1960s, imports are priced in the producer's, not consumer's, currency and the law of one price holds for all tradable goods. Those assumptions imply that the pass-through of an exchange rate change to import prices is full and immediate: when a currency depreciates, for example, the nominal prices of all imports rise immediately in proportion to the depreciation. Given the sticky prices of locally produced goods (in local currency), models with unitary pass-through to import prices imply that an exchange rate change moves the relative price of imports and domestic substitutes in proportion. That relative price change generates an *expenditure-switching* effect between home and foreign goods and promotes a stabilization role for flexible exchange rates in the face of country-specific real shocks. Empirical evidence suggests, however, that the assumptions of costless international trade and rapid, unitary pass-through are in general oversimplifications, lending further interest to the study of macromodels featuring market segmentation and pricing-to-market in international trade.[1]

A key feature of the DE model is that exchange rate changes are not associated in the short-run with changes in the relative import prices that confront consumers. Thus, flexible exchange rates do not generate an expenditure-switching effect between locally and imported goods. One might infer from this difference that in models such as DE's, featuring pricing to market and local-currency pricing, exchange rate variation cannot stabilize the economy as it does in the Mundell-Fleming model, by switching aggregate demand between home and foreign goods. And indeed, on the basis of a formal welfare analysis within their model, DE conclude that, absent foreign monetary instability, fixed exchange rates are optimal even in the presence of idiosyncratic national productivity shocks. Their inference would seem to overturn the conventional wisdom that country-specific real shocks make exchange-rate flexibility desirable. See Engel (2002) for an elaboration of this theme.

In this note, we demonstrate that the DE result on the optimality of fixed exchange rates is primarily due, not to the absence of expenditure-switching effects of exchange rate changes, but to knife-edge and unrealistic symmetry restrictions embedded in their model. It is important to stress that we are not simply making the point that an absence of expenditure-

[1] See Goldberg and Knetter (1997) for a survey of international pricing. On trade costs in general, see Anderson and van Wincoop (2004).

switching exchange rate effects on *consumer* spending leaves room for exchange-rate flexibility.[2] Instead, we show that even a *complete* absence of expenditure-switching effects need not nullify the case for flexible exchange rates in more realistic variants of the DE model. The specific minor modification we make to the DE model is to add nontradable goods, although our analysis suggests that a number of alternative plausible modifications would have a similar effect on the model's predictions about optimal monetary policy.[3] Our conclusion is that while more detailed theorizing about open-economy price rigidities is extremely valuable, the channels of monetary policy transmission can be subtle and researchers should accordingly be cautious about leaping to radical policy conclusions.

2 Intuition for the Basic Result

A central building block of DE's model is an assumption of complete international asset markets. With segmentation across national goods markets, but free trade in international asset markets, prices of state-contingent claims to future *money* payments are equalized internationally. That equality leads to the condition for international risk sharing tested by Backus and Smith (1993). Let C denote a consumption index, P the overall money price level, S the exchange rate (domestic price of foreign currency), and let asterisks denote the corresponding foreign variables. Furthermore, for simplicity assume a constant coefficient of relative risk aversion, ρ. Then the Backus-Smith risk-sharing condition takes the form:

$$\frac{C_{t+1}^{-\rho}/P_{t+1}}{C_t^{-\rho}/P_t} = \frac{\left(C_{t+1}^*\right)^{-\rho}/S_{t+1}P_{t+1}^*}{\left(C_t^*\right)^{-\rho}/S_tP_t^*}.$$

That is, the growth rate of the marginal consumption value of a currency unit is equal across countries in all states of nature.

[2] Thus, Obstfeld and Rogoff (2000) argue that the pass-through of exchange rates to producer prices is relevant. Following up on this point, Obstfeld (2001) presents a formal analysis in which producers respond to the implied relative-price changes, even though relative consumer prices are all predetermined.

[3] Duarte (2004) and Obstfeld (2004) demonstrate the case for flexible exchange rates in models with pricing-to-market in local currency and nontraded goods. Duarte works with a variant of the model of Corsetti and Pesenti (2001). Obstfeld uses a variant of the DE model in which the nominal interest rate is the monetary policy instrument and shocks can be temporary.

In the DE model, C and C^*always move together under flexible prices. Importantly, they move together, thanks to risk sharing, even when one country alone experiences a change in its technological productivity. In a number of models, for example, Obstfeld and Rogoff (2000), optimal monetary policy simply replicates the flexible-price equilibrium. In general that is impossible with local-currency pricing, because monetary policy lacks any capacity to alter the relative prices that consumers face, notwithstanding technological or other shocks that might render those prices obsolete. As DE prove, however, the *responses* of consumptions to real shocks are the same under optimal monetary policies as under flexible prices. That is, in response to country-specific real shocks, both countries experience proportionally equal changes in consumption.

That finding immediately leads to the prescription that fixed exchange rates should remain fixed in the face of idiosyncratic real shocks. Consider the preceding risk sharing condition. Suppose that an unanticipated increase in home productivity occurs, that the exchange rate is fixed, and that price levels do not respond to the shock in the short run. Under optimal monetary policies C and C^* rise in proportion. Because price levels cannot move, the risk sharing condition continues to hold without an exchange rate change.

Conversely, however, suppose that home and foreign consumptions do not move in proportion under flexible prices. This is the case with nontraded goods, which cause the overall consumption indexes C and C^* to respond disproportionately strongly to national productivity shocks.[4]. As we show below, even with nontradables, it is still feasible and optimal for monetary policies to mimic the flex-price responses of consumption to real shocks. In that case, however, the rigidity of price levels implies that the exchange rate *must* move under optimal policies. The risk-sharing condition above shows why: if consumptions move asymmetrically, only an exchange rate change can preserve the marginal equality above. In general, countries that experience idiosyncratic productivity increases will also experience currency depreciation under optimal monetary policies.

[4]Other preference assumptions—for example a domestic preference for domestic tradables—would have the same effect.

3 The Model with Nontradable Goods

We extend the model specification proposed by DE to include nontradable consumption goods. Even though there is debate on the role of nontradables in explaining real exchange-rate variation, there is little doubt that they can play a major role in explaining the significant inflation differentials between countries linked by fixed exchange rates, for example, the countries in the euro zone.[5]

3.1 Basic Assumptions

Each country in a two-country world economy is inhabited by a unit mass of identical consumers. A country's firms produce a continuum of tradable goods and a continuum of nontradable goods, with each producer a monopolistic supplier of a variety. Varieties of goods (tradable and nontradable) are indexed by $i \in [0,1]$ in the home country and by $i^* \in [0,1]$ in the foreign country.[6]

Markets for tradable goods are internationally segmented, such that consumers face infinite costs in purchasing tradables abroad. A producer of tradable goods may, however, sell domestically or abroad, and the assumed market segmentation allows the producer to price-discriminate on the basis of consumer nationality. A key assumption of the DE model, which we follow here, is that producers set prices *in the customers' currency* a period in advance of sales, delivering all the supply demanded at that preset local-currency price.

A representative consumer maximizes

$$U_0 = \mathrm{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\rho}}{1-\rho} + \frac{\chi}{1-\varepsilon} \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} V_t - \eta L_t \right] \right\},$$

where M stands for domestic money holdings, V is a shock to money demand, L is labor supply, $\eta, \rho > 0$, and $\beta \in (0,1)$. Consumers have access to complete markets for sate-contingent money payoffs; consumption, labor supply, and production take place after the start of the period when shocks, nominal wages, and the nominal exchange rate, S, are realized; and firms set prices in advance of production so as to maximize expected discounted profits.

[5] Duarte (2003) documents inflation differentials in the euro zone.

[6] To make our points most simply, we assume symmetric countries. In particular we assume equally sized countries, or, in the DE notation, $n = 1/2$.

In our generalization of the DE model, the overall consumption index C depends on consumption of nontradables (subscript N) as well as tradables (subscript T),

$$C = \frac{C_T^{\gamma} C_N^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}},$$

with the special case $\gamma = 1$ delivering the DE model. As in DE, the tradables subindex, C_T, depends on consumption levels for tradables originating in the home and foreign countries,

$$C_T = \frac{C_H^{\varphi} C_F^{1-\varphi}}{\varphi^{\varphi}(1-\varphi)^{1-\varphi}}.$$

The corresponding tradables subindex for the representative foreign agent is

$$C_T^* = \frac{(C_H^*)^{\varphi^*}(C_F^*)^{1-\varphi^*}}{\varphi^{*\varphi^*}(1-\varphi^*)^{1-\varphi^*}},$$

so when $\varphi = \varphi^*$, as assumed by DE, preferences for tradable goods are identical across countries. The parameter restriction $\varphi = \varphi^*$ does not allow for the empirical consumption bias toward tradable goods produced locally (which would be consistent with the alternative parameter restrictions $\varphi > 0.5$ and $1 - \varphi^* > 0.5$). Hereafter, however, we follow DE in assuming that $\varphi = \varphi^*$, and we specialize further to the case in which $\varphi = \varphi^* = 1/2$. This choice does not reduce in any essential way the generality of our results.[7]

The aggregate price index and the price index for tradable goods are now given by

$$P = P_T^{\gamma} P_N^{1-\gamma}$$

and

$$P_T = P_H^{\frac{1}{2}} P_F^{\frac{1}{2}}$$

respectively, where the price indices for home and foreign tradable goods and nontradable goods are

$$P_j = \begin{cases} \left[\int_0^1 P_j(i)^{1-\lambda} di\right]^{\frac{1}{1-\lambda}}, & j = H, N, \\ \left[\int_0^1 P_j(i^*)^{1-\lambda} di^*\right]^{\frac{1}{1-\lambda}}, & j = F. \end{cases}$$

There are two sectors of production in each country. As we have noted, firms in each sector are monopolistic competitors. The production function for firms in the home country is given by

$$Y_j(i) = \theta L_j(i), \quad j = H, N,$$

[7] Generalizing the DE setup by allowing $\varphi \neq \varphi^*$, instead of considering nontraded goods, would likewise generate a stabilization role for exchange rate changes.

and that for firms in the foreign country by

$$Y_j^*(i^*) = \theta^* L_j^*(i^*), \quad j = F, N^*.$$

The random variables θ and θ^* represent economy-wide country-specific productivity levels. For simplicity, we abstract from sector-specific productivity shocks. Although sector-specific shocks would complicate the model's implied optimal monetary rules, welfare-maximizing monetary policies would still respond to the economy-wide average of sector-specific shocks as we describe below.

Apart from the changes set out above (which reflect the introduction of nontradable goods), the model we consider is as close as possible to the one described in DE. In particular, the model is driven by shocks to money demand (velocity) and productivity in each country. The monetary policy rules we will analyze are log-linear functions of innovations to velocity and productivity levels in both countries.

3.2 The Flexible-Price Consumption Equilibrium

When prices are flexible, all firms set prices as a constant markup, $\lambda/(1-\lambda)$, over nominal marginal cost (W/θ for firms located in the home country and W^*/θ^* for firms located in the foreign country). Using the first-order optimality conditions for individual consumption, one can show that aggregate consumption levels are given by

$$C_t = \left[\left(\frac{\lambda - 1}{\lambda\eta}\right)(\theta_t\theta_t^*)^{\frac{\gamma}{2}}\,\theta_t^{1-\gamma}\right]^{\frac{1}{\rho}} \tag{1}$$

in the home country and

$$C_t^* = \left[\left(\frac{\lambda - 1}{\lambda\eta}\right)(\theta_t\theta_t^*)^{\frac{\gamma}{2}}\,(\theta_t^*)^{1-\gamma}\right]^{\frac{1}{\rho}} \tag{2}$$

in the foreign country.

When all goods are tradable ($\gamma = 1$), consumption is equalized across countries, as it depends on the same combination of home and foreign productivity levels. In contrast, when some goods are nontradable (i.e., $\gamma < 1$), a country's consumption level depends disproportionately on its own aggregate productivity level—domestic nontraded goods, by definition, cannot be shipped abroad to augment foreigners' consumption. Therefore, consumption levels need not be equalized across countries, or move in a synchronized fashion, with flexible prices.

The possibility of an equilibrium asymmetric consumption response under *flexible* prices suggests that under *sticky* prices, the optimal response of monetary policies to country-specific shocks may differ across countries. If so, the nominal exchange rate would have to vary under optimal monetary policies. We will now see that this intuition is correct. Just as in the DE model, optimal monetary policy, while not able to replicate flexible-price *levels* of consumption, does replicate flexible-price consumption *responses* to shocks. Because these may differ internationally when $\gamma < 1$, countries' best monetary rules monetary policy rules must accommodate country-specific interest rates by allowing exchange rates to move.[8]

3.3 The Equilibrium with Preset Nominal Prices

Firms choose the nominal prices for their goods one period in advance—a home-currency price for domestic sales, and a foreign-currency price for exports. This is the assumption of pricing-to-market in local rather than producer currency. As DE emphasize this local-currency pricing specification is broadly consistent with empirical evidence documenting a small short-run response of consumer prices, even for imported goods, to changes in the nominal exchange rate. Let W_t be the (flexible) nominal wage. As in DE, the optimal prices for the home producer i of tradable and nontradable goods sold in the home market are

$$P_{j,t}(i) = \frac{\lambda}{\lambda - 1} \frac{\mathrm{E}_{t-1}\left\{C_t^{1-\rho} \frac{W_t}{\theta_t}\right\}}{\mathrm{E}_{t-1}\left\{C_t^{1-\rho}\right\}}, \quad j = h, N,$$

while the foreign-currency price used for export sales of the home good is

$$P_{H,t}^*(i) = \frac{\lambda}{\lambda - 1} \frac{\mathrm{E}_{t-1}\left\{C_t^{*1-\rho} \frac{W_t}{S_t \theta_t}\right\}}{\mathrm{E}_{t-1}\left\{C_t^{*1-\rho}\right\}}.$$

The nominal exchange rate, S_t, is the home-currency price of foreign currency. There are corresponding formulas for foreign-based producers, dependent on foreign nominal marginal cost, W_t^*/θ_t^*.

[8] With transitory rather than permanent productivity shocks, asymmetric consumption responses would lead to international real and nominal interest differentials; see Obstfeld (2004).

As in DE, we assume that the log technology and velocity shocks follow random walks, with u_t and u_t^* denoting the innovations in log technology and v_t and v_t^* those in log velocity. Lower-case letters are the logs of variables denoted by upper-case letters, and the gross growth rates of the home and foreign money supplies are denoted by μ_t and μ_t^*.

It can be shown that in our extended model, consumption innovations are given by straight generalizations of the DE formulas,

$$c_t - \mathrm{E}_{t-1}c_t = \phi\left(\mu_t - \frac{\nu_t}{\varepsilon}\right) + \psi\left[\frac{\gamma}{2}(u_t + u_t^*) + (1-\gamma)u_t\right], \tag{3}$$

and

$$c_t^* - \mathrm{E}_{t-1}c_t^* = \phi\left(\mu_t^* - \frac{\nu_t^*}{\varepsilon}\right) + \psi\left[\frac{\gamma}{2}(u_t + u_t^*) + (1-\gamma)u_t^*\right], \tag{4}$$

where ϕ and ψ are functions of the steady-state nominal interest rate and parameters of the model, exactly as defined by DE (p. 774).

Because there are nontradable goods, consumption innovations depend on numerically different combinations of home and foreign productivity shocks. As one would expect, innovations to consumption depend disproportionately on the local productivity shock. In contrast, when all goods are tradable (so that $\gamma = 1$), innovations to consumption in each country depend on the same combination of productivity shocks, $(u_t + u_t^*)/2$. This feature of the model follows from the extreme symmetry of the model when $\gamma = 1$, including the assumption of complete markets. In the absence of nontradables, preferences are identical across countries and are defined over the same basket of goods.

Since the presence of nontradable goods implies that productivity shocks have distinct effects on consumption across countries, it follows that, in equilibrium, the nominal exchange rate can also depend on productivity shocks. Let i be the (level of the) steady-state nominal interest rate. In our modified model, changes in the exchange rate are given by

$$s_t - s_{t-1} = \rho\psi(1-\gamma)(u_t - u_t^*) + \rho\phi\left[\mu_t - \mu_t^* - \frac{1}{\varepsilon}(\nu_t - \nu_t^*)\right] - \frac{i(\varepsilon-1)}{1+i}[p_t - p_{t-1} - (p_t^* - p_{t-1}^*)]. \tag{5}$$

Note that this equation reduces to eq. (4.3) in DE when $\gamma = 1$. When all goods are tradable, changes in the nominal exchange rate do not depend on country-specific real shocks (in the absence of monetary rules that target these shocks). With nontradables, the exchange rate does respond to country-specific real shocks if $\psi \neq 0$ (which is true if and only if $\varepsilon \neq 1$).

4 Optimal Monetary Policies

We now turn to the implications of nontradable goods for optimal monetary policies. As in DE, we assume that the monetary authority in each country commits to preannounced state-contingent monetary policy feedback rules. These are chosen to maximize the (nonmonetary) expected utility of the country's representative consumer, taking the other country's monetary rule as given.[9] We consider monetary rules that are loglinear functions of productivity and velocity innovations: $\mu_t = a_1 u_t + a_2 u_t^* + a_3 \nu_t + a_4 \nu_t^*$ in the home country and $\mu_t^* = b_1 u_t^* + b_2 u_t + b_3 \nu_t^* + b_4 \nu_t$ in the foreign country.

The Nash equilibrium in monetary policies is defined as the set $\{a^N, b^N\}$, where $a = \{a_1, a_2, a_3, a_4\}$ and $b = \{b_1, b_2, b_3, b_4\}$, which solve

$$\max_a \mathrm{E}_0 U(a, b^N) \tag{6}$$

and

$$\max_b \mathrm{E}_0 U^*(a^N, b), \tag{7}$$

subject to the model's structural equations for consumption and labor effort in the two countries.

The solution to problems (6) and (7) is given by

$$a_1^N = \frac{\gamma}{2\varepsilon} + \frac{1-\gamma}{\varepsilon}, a_2^N = \frac{\gamma}{2\varepsilon}, a_3^N = \frac{1}{\varepsilon}, a_4^N = 0, \tag{8}$$

and

$$b_1^N = \frac{\gamma}{2\varepsilon} + \frac{1-\gamma}{\varepsilon}, b_2^N = \frac{\gamma}{2\varepsilon}, b_3^N = \frac{1}{\varepsilon}, b_4^N = 0. \tag{9}$$

Equations (8) and (9) may be compared with Proposition 2 of DE (p. 778). Note that under the preceding solution, monetary authorities place a bigger weight on the local productivity shock than on the productivity shock originating abroad when some goods are nontradable. It follows from eq. (5) that the nominal exchange rate is not constant in general. That is, optimal monetary policies need not support a fixed exchange rate regime when some goods are nontradable.[10]

[9] Formally, we look at policies optimal as $\chi \to 0$ in the utility function U_0 described above.

[10] It turns out that the Nash equilibrium actually is efficient—each country's equilibrium rule is a dominant strategy. This is also true in DE, but it is perhaps more surprising that the same result emerges when exchange rates vary.

The reader can now verify that, as claimed earlier, the responses of total consumption levels to technology shocks under optimal monetary policies are the same as in the flexible-price equilibrium. For example, eq. (1) implies that under in the flex-price allocation,

$$\frac{\mathrm{d}c}{\mathrm{d}u} = \frac{1}{\rho}\left(1 - \frac{\gamma}{2}\right).$$

Under optimal monetary policy, however, we have the same result, for eq. (3) implies that:

$$\begin{aligned}
\frac{\mathrm{d}c}{\mathrm{d}u} &= \phi\left(\frac{\mathrm{d}\mu}{\mathrm{d}u}\right) + \psi\left(1 - \frac{\gamma}{2}\right) \\
&= \frac{(1+i\varepsilon)}{\rho(1+i)}a_1^N + \left[\frac{\varepsilon - 1}{\rho\varepsilon(1+i)}\right]\left(1 - \frac{\gamma}{2}\right) \\
&= \frac{(1+i\varepsilon)}{\rho(1+i)}\left(\frac{\gamma}{2\varepsilon} + \frac{1-\gamma}{\varepsilon}\right) + \left[\frac{\varepsilon - 1}{\rho\varepsilon(1+i)}\right]\left(1 - \frac{\gamma}{2}\right) \\
&= \frac{1}{\rho}\left(1 - \frac{\gamma}{2}\right).
\end{aligned}$$

Thus, as we argued earlier, asynchronous international consumption movements under flexible prices underlie the case for exchange-rate flexibility in this model.

5 Conclusion

Taken together, DE and this note suggest caution in analyzing the transmission mechanisms for monetary policy in open economies with complex price rigidities. The DE paper makes an important advance in demonstrating how alternative price-setting arrangements in open economies can alter the transmission mechanism. A distinct advantage of the new open economy macroeconomics approach is its accommodation of the detailed modeling of price-setting regimes, coupled with an exact analysis of the general-equilibrium welfare implications. In reality, national consumption movements are asymmetrical and international asset markets are incomplete. We therefore think it unlikely that optimal monetary responses to country-specific real shocks would ever imply rigid exchange rates in practice. Like DE, we have limited our analysis to the qualitative dimensions of monetary policy, leaving for the future a close quantitative study of how alternative pricing arrangements and economic structures affect the optimal amount of exchange-rate volatility.

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