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WHY JOIN A CURRENCY UNION? A NOTE ON THE IMPACT OF BELIEFS ON THE CHOICE OF MONETARY POLICY

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We argue that a fixed exchange rate can be an optimal choice even if a policy maker could commit to the first-best monetary policy whenever the private sector's beliefs reflect incomplete information about the policy maker's dependability. This model implies that joining a currency area may be optimal for its impact not on the behavior of the policy maker, but on the beliefs of the private sector. Monetary policies are evaluated using a new Keynesian model of a small open economy solved under imperfect policy credibility. We quantify the minimum distance between announced policy and the private sector's beliefs that is necessary for a peg to perform better than an independent monetary policy when the policy maker can commit to the first-best policy.

Keywords: Monetary Union, Small Open Economy, Exchange Rate Regimes, Monetary Policy, Nominal Rigidities, Credibility

1. INTRODUCTION

As of 2011, five out of the twelve new member states that entered the European Union in 2004 and 2007 had joined the Euro currency area, and two more pegged their currency to the Euro. Yet most of these countries are under many respects emerging market economies, where a monetary policy independent from that of industrialized Euro area countries could be of advantage in allowing movements in the real exchange rate led by productivity differentials [Ravenna and Natalucci (2008)].

What are the incentives to join the Euro currency area so soon? A forceful and often cited argument for a fixed exchange rate as an optimal monetary policy was made by Giavazzi and Pagano (1988), who suggest that a peg can correct the inflationary bias of a monetary policy maker lacking access to a commitment

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technology. The argument rests on the assumption that fixing the exchange rate amounts to the indirect appointment of a precommitted foreign central banker.

This paper shows that a fixed exchange rate can be the optimal choice even if the policy maker can enforce the optimal commitment policy, whenever the private sector's beliefs reflect incomplete information about the policy maker's dependability. Our model implies that irrevocably fixing the exchange rate by joining a currency union is an optimal choice not because it affects the behavior of the policy maker, but because it affects the beliefs of the private sector. This result obtains because in the rational expectations equilibrium most of the gain from the first-best policy relative to fixing the exchange rate comes from the impact on expectations rather than from allowing the policy maker to respond better to shocks by following the commitment policy.

The mechanism underlying our results was initially suggested by Cukierman and Liviatan (1991). As in Backus and Driffill (1985) and Barro (1986), Cukierman and Liviatan (1991) assume that there exists uncertainty about whether the policy maker can commit to the optimal policy ("strong" type policy maker), or whether the time-consistent policy is the only rational expectations equilibrium (the case of a "weak"-type policy maker). Under incomplete information the weak type has an incentive to mimic the strong type, making announced policy objectives by *any* type only partially credible. If the strong policy maker is allowed to react optimally to expectations, it will choose to deviate from the complete-information first-best policy, despite having access to the commitment technology.

We embed this mechanism in a microfounded dynamic stochastic general equilibrium (DSGE) model for business cycle analysis and provide a quantitative analysis of its impact. Because our objective is to discuss the incentives of the policy maker to adopt one particular policy—a fixed exchange rate—we employ some simplifying assumptions. First, we restrict the range of available policies to a family of simple policy rules, which includes a peg. Second, we do not model the private sector's expectations as the endogenous outcome of uncertainty about the policy maker type. Instead, we parameterize the expectations of the private sector, taking them as a primitive of the model. The larger the distance between policy announcements and the private sector's beliefs, the less the credibility enjoyed by the policy. Joining a currency union allows the monetary authority to reduce to zero the distance between announced policy and beliefs.

Our approach sheds new light on the results of the earlier literature based on nonmicrofounded models of optimal policy making. By using a DSGE model with nominal rigidities, we can illustrate how mistaken private sector beliefs can combine with the policy maker's behavior to generate inefficient movements in inflation and markups. Following an inflationary shock, if firms choose prices conditional on wrong expectations about future markups, the monetary authority is forced to a more contractionary policy to stabilize inflation, leading to higher markup volatility. In our new-Keynesian model, the equilibrium outcome resulting from the interaction of mistaken belief and aggressive inflation stabilization may lead to a large loss.

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In addition, the parametric approach to private sector beliefs makes it possible to quantify separately the impact of the expectations channel and of the policy behavior channel on the policy maker loss function as functions of the distance between actual and believed policy. If expectations are model-consistent, the advantage of the first-best commitment policy derives from both expectations and policy behavior changing simultaneously. We disentangle the "policy behavior" and the "expectations" channels through which monetary policy operates. We can then show that in the rational expectations equilibrium (REE) a large enough distance between the enforced policy and the first-best policy is needed for a peg to be optimal. In contrast, in the equilibrium with mistaken beliefs a smaller distance between the expected policy and the first-best policy is sufficient for a peg to be optimal. Our results do not imply that a fixed exchange rate is always optimal when beliefs are mistaken: if deviations from perfect credibility are not large enough, independent monetary policy is still optimal from the point of view of the policy maker.

The results in the paper rests on the following intuition. Let the k-type policy be the private sector's expected policy (consistent with its beliefs on policy maker types). Consider the cost from implementing under incomplete information the first-best policy chosen by the strong type, relative to the first-best REE. A first portion of the total cost can be interpreted as the cost of adopting the k-type policy in the REE, relative to the first-best REE (the "policy gap"). The remaining portion of the total cost measures the cost of implementing the first-best policy conditional on the expectation that the policy maker is of the k type, relative to the k-type policy REE (the "implementation gap"). If the loss measured by the policy gap is larger than the loss under a fixed exchange rate, the policy gap can explain the gain from adopting a fixed exchange rate with a shift from the domestic k to the foreign strong policy maker type, as in Giavazzi and Pagano (1988). The existence of an additional implementation gap under incomplete information can explain the gain from adopting a fixed exchange rate with a shift in the private sector's expectations—or a shift in the private sector's believed probability distribution over the policy maker type. Even if the loss measured by the policy gap is smaller than the loss under a fixed exchange rate—as is the case in our analysis—the implementation gap can still make a fixed exchange rate the dominant strategy.

The paper is organized as follows. Section 2 describes the model. Section 3 presents the results under complete and incomplete information, and discusses the policy and implementation gaps in a new-Keynesian model. Section 4 concludes. The Appendix contains a detailed description of the model.

2. THE MODEL

The small open economy is described by a monetary business cycle model with nominal rigidities, along the lines of Devereux (2003), Gali and Monacelli (2005), and Monacelli (2004). The economy is exposed to the volatility of foreign variables through exogenous shocks to the terms of trade, the cost of borrowing on the international capital market, and the volume of export demand. This model provides a stylized framework for analyzing a small open economy with nominal rigidities and a parsimonious parameterization of the business cycle shock propagation mechanism. The qualitative results are robust to the choice of parameters, which are chosen following the new-Keynesian open-economy literature.

The domestic sector produces a consumption-good basket that is both consumed by domestic households and exported, in exchange for a foreign-produced consumption good. Firms in the home and foreign countries set prices in their respective currencies, so that the law of one price holds for each traded good. Domestic firms in the monopolistically competitive production sector can reset the price in any period with constant probability, as in the Calvo (1983) model. Households trade a foreign currency–denominated bond yielding an exogenous nominal riskless return and hold a positive amount of the zero-interest domestic nominal asset because of the utility it yields.

2.1. Household and Foreign Sectors

The preferences of the representative household are described by the utility function

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ [\ln C_t] D_t - \frac{l N_t^{1+\eta}}{1+\eta} + \frac{\mu}{1-\frac{1}{\zeta}} \left(\frac{M_t}{P_t} \right)^{1-\frac{1}{\zeta}} \right\}, \quad (1)$$

where M_t/P_t is real money balances and N_t is the amount of labor services supplied. D_t is a stochastic preference shock that distorts the labor–leisure decision. C_t is an aggregate consumption index defined over a basket of domestic (C_H) and foreign (C_F) goods,

$$C_t = \left[(1-\gamma)^{\frac{1}{\rho}} (C_{H,t})^{\frac{\rho-1}{\rho}} + \gamma^{\frac{1}{\rho}} (C_{F,t})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \quad (2)$$

where $0 \leq \gamma \leq 1$ is the share of the foreign-produced good and $\rho > 0$ is the elasticity of substitution between domestic and foreign goods. The variables P_t, $P_{H,t}$, $P_{F,t}$ indicate the corresponding consumption price indices. The domestic-produced good H and the foreign-produced good F are Dixit–Stiglitz aggregates defined over a continuum of differentiated goods $i \in [0, 1]$ with elasticity of substitution ϑ. The imported good aggregate is purchased at the exogenously given foreign-currency price $P_{F,t}^*$.

Let v_t (v_t^*) indicate the price of a zero-coupon riskless bond priced in domestic (foreign) currency, B_t (B_t^*) the amount of the domestic (foreign) asset purchased, e_t the nominal exchange rate, W_t the nominal wage, $\mathrm{pr_t}$ the share of profit from the monopolistic firms rebated to the household, and τ a lump-sum government tax. The household's budget constraint is

$$P_t C_t + M_t + e_t v_t^* B_t^* + v_t B_t \leq W_t N_t + M_{t-1} + e_t B_{t-1}^* + B_{t-1} + \mathrm{pr_t} - \tau_t. \quad (3)$$

Foreign households' demand for the home-produced good is price-elastic. Export demand for the aggregate basket $C_{H,t}^*$ and for good i, $C_{H,t}^*(i)$, is assumed

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to be symmetric to the optimal domestic household's choice of $C_{H,t}$, $C_{H,t}(i)$:

$$C^*_{H,t}(i) = \left[\frac{P_{H,t}(i)}{P_{H,t}}\right]^{-\vartheta} C^*_{H,t} \qquad C^*_{H,t} = \gamma^* \left[\frac{P_{H,t}}{e_t P^*_t}\right]^{-\rho^*} C^*_t, \tag{4}$$

where C^*_t is the exogenous foreign consumption, $S_t = P_{F,t}/P_{H,t}$ defines the home-country terms of trade, and we assume that the share of home-produced imported goods in the rest of the world consumption basket is infinitely small, so that $P^*_t = P^*_{F,t}$.

2.2. Firms

A domestic firm produces good i employing labor services supplied by households and an exogenous production technology A_t:

$$Y_{H,t}(i) = A_t N_t(i). \tag{5}$$

In every period t firms adjust their prices with probability $(1 - \theta_p)$. This assumption generates the time-dependent Calvo (1983) pricing model. Given the real marginal cost MC^N_t, equal across all firms, and the aggregate demand schedule $Y_{H,t}(i) = [P_{H,t}(i)/P_{H,t}]^{-\vartheta}(C_{H,t} + C^*_{H,t})$, the problem of the firm setting the price at time t consists of choosing $P_{H,t}(i)$ to maximize

$$E_t \sum_{j=0}^{\infty} (\theta_p \beta)^j \Lambda_{t,t+j} \left[\frac{P_{H,t}(i)}{P_{H,t+j}} Y_{H,t+j}(i) - \frac{MC^N_{t+j}}{P_{H,t+j}} Y_{H,t+j}(i)\right]. \tag{6}$$

In (6), $Y_{H,t+j}(i)$ is the demand function for firm's output at time $t + j$, conditional on the price set j periods in advance at time t, $P_{H,t}(i)$. $\beta^j \Lambda_{t,t+j}$ is the stochastic discount factor between t and $t + j$, defined in terms of the home-produced good basket.

2.3. Government and Monetary Authority

The government rebates the seigniorage revenues to households in the form of lump-sum transfers, so that at any time t the government budget is balanced: $-\tau_t = M^s_t - M^s_{t-1}$. The central bank monetary policy is described by an interest-rate rule, where the instrument is a function of the models' state and control variables. A monetary regime is defined by the policy rule S_L,

$$\frac{(1 + i_t)}{(1 + i_{ss})} = S_L(s_t, s_{t-1})\, \varepsilon_{i,t}, \tag{7}$$

where i_{ss} is the steady state level of the interest rate, s_t is a vector of endogenous variables, and $\varepsilon_{i,t}$ is a random shock summarizing exogenous shifts in monetary policy. Inflation is set at 5% in the steady state—consistent with the inflation rates among the twelve countries that have joined the EU since 2004, where HICP

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inflation was 4.6% in 2004 and 4.4% in 2006 (excluding countries that joined the Euro).

3. MONETARY POLICY CHOICES UNDER INCOMPLETE INFORMATION

3.1. Solution Method with Parameterized Expectations

The model is solved by taking a linear approximation around the nonstochastic steady state. We allow the private sector's beliefs to differ from the monetary policy rule S_L followed by the central bank, and expectations to be formed accordingly. We label as "imperfect credibility" any equilibrium where the private sector's expectations are not consistent with the complete information equilibrium.[1]

Let $\tilde{E}_t^L$ indicate the expectation of a variable conditional on private sector's beliefs being parameterized by the policy L. Write the model in matrix form as

$$0 = \mathbf{F}E_t(s_{t+1}) + \mathbf{G}s_t + \mathbf{H}s_{t-1} + \mathbf{R}\varepsilon_t, \tag{8}$$

where both control and state variables are elements of the vector s_t, and ε_t is a vector of i.i.d. random innovations to the exogenous states. Conditional on policy L_a, the REE law of motion is

$$s_t = \mathbf{\Gamma}_a s_{t-1} + \mathbf{\Lambda}_a \varepsilon_t. \tag{9}$$

If the private sector's beliefs are described by the policy L_b, expectations are consistent with the REE:

$$s_t = \mathbf{\Gamma}_b s_{t-1} + \mathbf{\Lambda}_b \varepsilon_t. \tag{10}$$

Given policy L_a and beliefs L_b, the model can be written as

$$\begin{aligned} 0 &= \mathbf{F}\tilde{E}_t^b(s_{t+1}) + \mathbf{G}s_t + \mathbf{H}s_{t-1} + \mathbf{R}\varepsilon_t \\ &= \mathbf{F}\left[\Gamma_b s_t\right] + \mathbf{G}s_t + \mathbf{H}s_{t-1} + \mathbf{R}\varepsilon_t. \end{aligned} \tag{11}$$

The model in (11) can be solved, yielding the equilibrium law of motion $s_t = \mathbf{\Gamma}_c s_{t-1} + \mathbf{\Lambda}_c \varepsilon_t$, where $\mathbf{\Gamma}_c = -(\mathbf{F}\mathbf{\Gamma}_b + \mathbf{G})^{-1}\mathbf{H}$ and $\mathbf{\Lambda}_c = -(\mathbf{F}\mathbf{\Gamma}_b + \mathbf{G})^{-1}\mathbf{R}$. Clearly $(\mathbf{\Gamma}_c, \mathbf{\Lambda}_c) \neq (\mathbf{\Gamma}_b, \mathbf{\Lambda}_b)$, except when $(\mathbf{\Gamma}_b, \mathbf{\Lambda}_b) = (\mathbf{\Gamma}_a, \mathbf{\Lambda}_a)$, in which case we obtain the complete information equilibrium. But it is also true that $(\mathbf{\Gamma}_c, \mathbf{\Lambda}_c) \neq (\mathbf{\Gamma}_a, \mathbf{\Lambda}_a)$, implying that the monetary authority cannot rely on its policy affecting the shocks' propagation mechanism through its impact on expectations.

3.2. Expectations and Policy Performance

This section discusses the ranking of alternative monetary policies as the distance between the policy announcement and the private sector's beliefs exogenously changes. The performance of alternative policy rules is assessed by assuming that the policy maker's objective function depends on consumer price inflation (CPI) inflation and a consumption gap:

$$\text{Loss} = \text{Var}[c_t - \widetilde{c}_t] + \text{Var}[\pi_t], \tag{12}$$

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where lowercase variables indicate log deviations from the steady state and $\widetilde{c}_t$ is the flexible-price level of consumption conditional on the exogenous states. The objective function (12) reflects the policy maker's concern for distortions that are negatively correlated with the household's welfare. First, because prices cannot be adjusted optimally, firms' average markup fluctuates inefficiently, and the dynamics of aggregate consumption c will deviate from the flexible price level $\widetilde{c}$. Second, the existence of the nominal rigidity implies that inflation is costly, because it generates dispersion in relative prices.[2]

The monetary authority minimizes the loss function (12) choosing a policy within the family of simple (log-linear) policy rules,

$$i_t = \chi i_{t-1} + (1-\chi)(\omega_\pi \pi_{H,t} + \omega_e \Delta e_t) + \varepsilon_{i,t}, \qquad \textbf{(13)}$$

parameterized by $\omega_\pi \in [0, 2]$, $\omega_e \in [0, 1]$, where ω_π and ω_e are the feedback coefficients to producer price inflation π_H and nominal exchange rate depreciation Δe, and we assumed that the policy maker adjusts the interest rate only gradually to the target rate.[3] The exogenous shock $\varepsilon_{i,t}$ represents nonsystematic movements in monetary policy. A policy maker concerned only with the inflation objective will set $\omega_e = 0$. A managed–exchange rate float would instead imply that $\omega_e > 0$, $\omega_\pi \to 0$. The monetary authority also has the option of delegating policy to a foreign policy maker by fixing the exchange rate against the foreign currency.

Let the enforced monetary policy be described by policy L_a. Private sector expectations are consistent with policy L_b. Under complete information $L_b = L_a$, and the private sector's expectations are consistent with the monetary authority's announcement. Given the model parameterization, the complete-information equilibrium, best-performing policy within the family of instrument rules in (13) is

$$L^* = [\omega_\pi = 2, \omega_e = 0]. \qquad \textbf{(14)}$$

When $L_b = L_a$, as the weight ω_π on the inflation target in the policy rule gets smaller, policy performance monotonically worsens.

To measure the impact of incomplete information *conditional* on the monetary authority using the complete-information first-best policy L^*, we evaluate the loss function (12) in the case of imperfect credibility. Assume that $L_a = L^*$ and the private sector's expectations are formed according to $L_b \neq L_a$, where L_b indicates policy beliefs ranging from $L^{\text{low}} = [\omega_\pi \to 0, \omega_e = 1]$ to $L^{\text{high}} = L^*$. As the credibility of the central bank–announced policy improves, the coefficient ω_π in the expected policy L_b increases toward the true value of 2 and ω_e decreases toward the true value of 0. When credibility is low and $L_b = L^{\text{low}}$, the private sector expects the policy maker to put only a small weight on producer price inflation deviations from the target.

Figure 1 shows the policy maker's loss under complete and incomplete information for the family of instrument rules in (13).

In the complete-information case, the policy enjoys full credibility, and Figure 1 plots the loss corresponding to any policy $L_a \in [L^{\text{low}}, L^{\text{high}}]$, where for each

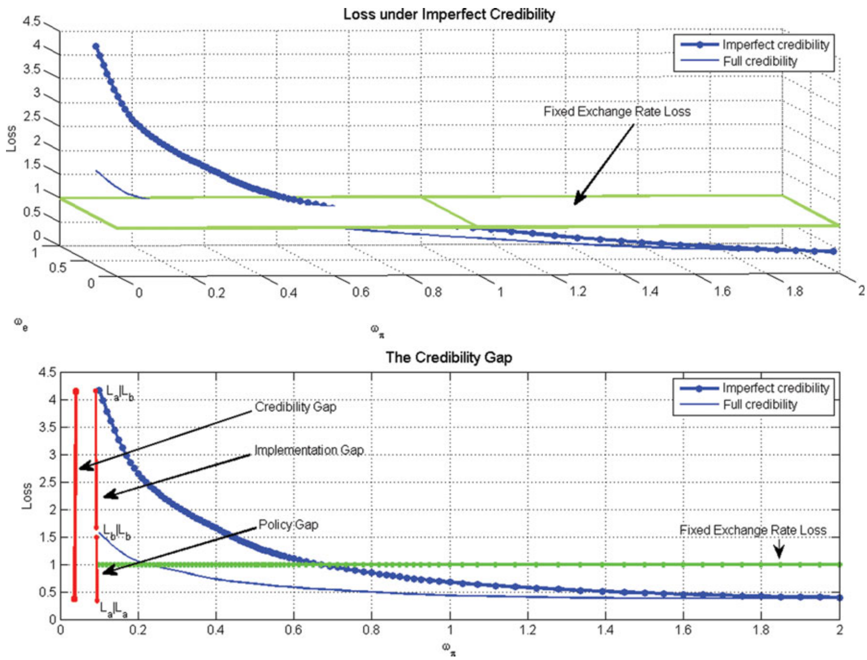

FIGURE 1. Imperfect credibility: loss for enforced policy $L_a = L^{\text{high}}$ and beliefs L_b varying linearly in the range $[L^{\text{low}}, L^{\text{high}}]$, where $L^{\text{low}} = [\omega_\pi \to 0, \omega_e = 1]$ and $L^{\text{high}} = [\omega_\pi = 2, \omega_e = 0]$. L^{high} is the complete-information first-best policy. Full credibility: loss for enforced policy L_a and beliefs $L_b = L_a$ for L_a varying linearly in the range $[L^{\text{low}}, L^{\text{high}}]$. Surface shows fixed–exchange rate loss. Loss computed as a fraction of fixed–exchange rate loss. Variation in ω_e not shown in bottom panel.

policy the private sector's beliefs are correct: $L_b = L_a$. In the case of incomplete information about the policy maker type, Figure 1 plots the loss for a single policy, $L_a = L^*$, as a function of the private sector's beliefs $L_b \in [L^{\text{low}}, L^{\text{high}}]$. In contrast to the complete information case, the plot evaluates outcomes not as a function of beliefs and policy changing simultaneously but as a function of the private sector's beliefs only. When the distance between L_a and L_b is not too large, for given beliefs L_b the performance of the policy maker enforcing $L_a = L_b$ or $L_a = L^*$ is very close. That is, conditional on beliefs, the policy maker is paying little or no penalty for using a policy that is more inflation-averse relative to expectations. As the distance between L_a and L_b increases, the unexpected component of the policy maker's behavior generates large losses.

For comparison purposes, in Figure 1 we represent with a surface the loss level achieved under a fixed–exchange rate regime, where $L_a = L^{\text{fix}} = [\omega_\pi = 0, \omega_e \to \infty]$. For a country that pegs its exchange rate by joining a currency union, the policy enjoys full credibility thanks to the common knowledge of the commitment mechanism, and $L_b = L^{\text{fix}}$. The monetary authority complies with the announced policy under either regime $L_a = L^*$ or $L_a = L^{\text{fix}}$—but may enjoy less than full credibility when conducting an independent monetary policy, implying that $L_b \neq L_a$. Given the private sector beliefs, the monetary authority will prefer an (imperfectly credible) independent monetary policy only if it yields a loss no larger than for a credible exchange rate peg.

For any model parameterization, it is possible to compute the minimum distance between announced policy and the private sector's beliefs necessary for a peg to perform better than an independent monetary policy. For our choice of parameters, Figure 1 shows that for L_b approximately equal to $[\omega_\pi = 0.8, \omega_e = 0.5]$ the two policies yield the same loss. Therefore, even for a substantial distance between the enforced policy and the private sector's beliefs, the policy maker will find the fixed exchange rate regime L^{fix} a dominated monetary regime. As beliefs get further away from the announced policy, the penalty paid by the policy maker for enforcing policy $L_a = L^*$ through movements in the interest rate that are not predicted by the private sector gets very large.

3.3. The Cost of Imperfect Credibility

Let $L_a \mid L_b$ indicate the loss associated with policy L_a conditional on beliefs L_b. Define the *credibility gap* as the loss $L_a \mid L_b - L_a \mid L_a$ generated in the imperfect-credibility equilibrium by incomplete information about the policy maker type. This loss can be read as the sum of two terms:

$$L_a \mid L_b - L_a \mid L_a = [L_b|L_b - L_a \mid L_a] + [L_a|L_b - L_b|L_b]. \qquad \textbf{(15)}$$

The first term $[L_b \mid L_b - L_a \mid L_a]$ is the *policy gap*. This is the loss relative to policy L_a for any enforced policy $L_b \in [L^{\text{low}}, L^{\text{high}}]$ when the private sector's beliefs are correct. It represents the cost associated with the REE conditional on a policy L_b that performs worse than L_a.

The bottom panel of Figure 1 shows that the loss from the policy maker enforcing the worse policy L_b conditional on an expected policy L_b is only a portion of the credibility gap $L_a|L_b - L_a \mid L_a$. Holding fixed the beliefs L_b, assume the policy maker could adopt any other policy. The extra loss generated by implementing policy L_a rather than policy L_b is the *implementation gap* and is equal to $[L_a|L_b - L_b|L_b]$. The monetary authority faces this cost only because it is trying to implement a policy different from the expected one—it has to fight wrong expectations by the private sector. As L_a changes, the law of motion for the private sector's expectations is constant, and all that changes is the policy actually implemented. In other words, the credibility gap arises not only from the private sector holding expectations of a worse policy, but also from the policy maker enforcing policy L_a to achieve a desired level of the instrument i_t in response to equilibrium movements in the target variables, despite the private sector's beliefs.

The existence of a policy gap echoes the traditional argument made by Giavazzi and Pagano (1988) for a peg being an optimal policy choice. The policy maker can choose between a credible external anchor, and achieving loss given by L^{fix}, or an independent monetary policy L_a. But there exists an external constraint to the best possible performance—lack of a commitment mechanism in the case of these authors—and the first-best outcome L^* cannot be achieved.

Under complete information, there may be a vast range of policies L_a for which the peg is a dominated choice. The full credibility loss plot in Figure 1 shows that for values of ω_π larger than 0.2 the independent policy performs better than a fixed exchange rate. The choice faced by the policy maker under incomplete information is different: choose between a credible external anchor, and achieving loss given by L^{fix}, or implementing the first-best policy conditional on the private sector's expectations that policy L_b is being implemented. Fighting against expectations generates a large "implementation gap" and makes the L^* policy a poor choice. As policy credibility improves, the implementation gap narrows rapidly. This shows that in the REE most of the gain from the first-best policy relative to fixing the exchange rate comes from the impact on expectations rather than from allowing the policy maker to better respond to shocks.

The intuition for the existence of a sizable implementation gap can be illustrated by looking at the impulse response function to an annualized 1% expansionary policy shock to ε_{i_t} (Figure 2).

Consider the rational expectations equilibrium given policies $L_a = [\omega_\pi = 2, \omega_e = 0.1]$ and $L_b = [\omega_\pi = 0.4, \omega_e = 0.9]$. The policy rule L_b implies that the decrease in i_t below the steady state value following the initial expansionary shock is smaller than under policy L_a. Conditional on L_b, the monetary authority responds more aggressively to the nominal exchange rate depreciation, which fully adjusts each period and on impact has a larger movement than producer price inflation.

In the imperfect-credibility equilibrium, given the state of the economy and enforced policy L_a, the interest rate i_t is lower than predicted by the private sector, which forms expectations conditional on L_b. Effectively, in the beliefs of the private sector, the movement in i_t is interpreted as the outcome of a larger initial expansionary shock. In addition, conditional on L_b, firms increase the price by a larger amount then they would conditional on L_a, because they expect that inflation will trigger smaller future interest-rate hikes by the monetary authority, which would curb future demand. Given $\tilde{E}_t^b \pi_{H,t+1}$ and $\tilde{E}_t^b i_{t+1}$, domestic inflation will be higher relative to the case of a fully credible policy L_a *and* relative to the case of a fully credible policy L_b. Because an increase in π_H requires a drop in the average markup, the larger drop also leads to a larger increase in output and consumption. Because this increase is all due to the nominal rigidity, it fully translates into an inefficient consumption gap.

Notice that in general the "implementation gap" may be positive or negative. The intuition for why, in our example with Calvo pricing, we obtain a positive implementation gap, or a worsening of performance relative to the "policy gap"

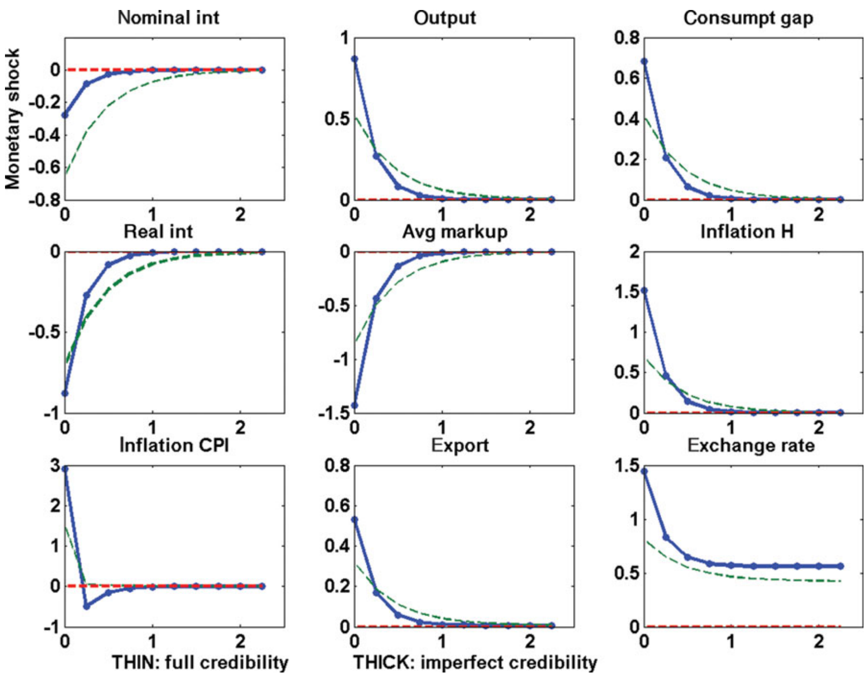

FIGURE 2. Impulse response function for an unanticipated annualized 1% drop in the nominal interest rate i_t. True policy $L_a = [\omega_\pi = 2, \omega_e = 0.1]$. Under imperfect credibility, private sector expects policy $L_b = [\omega_\pi = 0.4, \omega_e = 0.9]$. Time is measured in years. Deviations are in percentage terms.

loss, can be explained as follows. Suppose the policy maker enforced a policy such that inflation volatility was exactly the same as under complete information, but the private sector expected a less inflation-averse policy. Without loss of generality, set the policy maker target for inflation variance at zero. To achieve this target, in the face of inflationary shocks the enforced policy must be more contractionary than under complete information, resulting in higher volatility of domestic producers' markups, and thus in higher volatility of the consumption gap. This is because under complete information zero-inflation volatility implies that markups are constant at the steady state level. But as firms choose prices based on wrong expectations of future movement in markups, the monetary authority must contract current demand until the point where the expected discounted sum of markups is zero, and domestic inflation does not move. The incorrect beliefs unlock the relationship between constant markups and zero inflation following an inflationary shock that exists in the rational expectations equilibrium. If the policy maker places some weight on the consumption gap, incomplete information generates an "implementation gap," because for given inflation variance the consumption gap volatility is higher relative to the complete information case. This intuition extends to the case of a small open economy, where a fixed exchange

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rate is—under complete information—suboptimal because it shifts the burden of relative price adjustment from the nominal exchange rate to sticky domestic prices. The implementation gap generates an additional cost for a policy maker trying to stabilize domestic prices more than expected and can thus reverse the policy ranking observed under RE.

4. CONCLUSIONS

This paper argues that a peg can be the optimal choice even if a policy maker can enforce the optimal commitment policy, whenever the private sector's beliefs reflect incomplete information about the policy maker's dependability. We embed in a DSGE model of a small open economy a mechanism suggested by Cukierman and Liviatan (1991) by solving for the equilibrium conditional on exogenously parameterized private sectors expectations for the policy maker's preferences. The private sector's beliefs can be self-fulfilling, because a policy maker may find adopting a fixed exchange rate regime optimal despite the fact that it could commit to the policy that is the first-best under complete information. We show that the cost of the private sector's incomplete information when the policy maker implements the first-best policy can be substantial and reflects partly the loss that would obtain on implementing a dominated policy conditional on correct private sector beliefs (the policy gap), and partly the loss of implementing the first-best policy despite the private sector's expectations of a dominated policy (the implementation gap). Our quantitative results show that the improvement from a better policy in the REE depend much more on the change in how the central bank policy is *perceived* by the private sector than on the change in how the policy is *actually* implemented. In our new-Keynesian model, this outcome depends on the interaction of mistaken belief and aggressive inflation stabilization (optimal with complete information). Following an inflationary shock, if firms choose prices conditional on wrong expectations about future markups, the monetary authority is forced to a more contractionary policy to stabilize inflation, leading to higher markups volatility. Finally, we quantify the minimum distance between announced policy and private sectors beliefs necessary for a peg to perform better than an independent monetary policy.

An open question is the role played by the private sector's learning dynamics. Our approach assumed that the policy maker ranks policies according to a worst-case scenario where policy credibility never improves. Even in this case, a peg may be a dominated equilibrium *despite learning never happening*. Allowing the private sector's beliefs over the policy maker type to be optimally updated adds an extra layer to the policy choice problem: a policy rule may in fact be preferable because it speeds up learning [as in Wieland (2000)].

NOTES

1. In the following we refer to the private sector's "beliefs" and "expected policy" as the same concept, though in a full-blown model the expectation on the policy enforced would be the equilibrium outcome conditional on prior beliefs.

2. The policy maker loss function (12) includes a consumption gap, to take into account how policy impacts the composition of the domestic and foreign good basket entering the household utility function. Using the domestic output gap does not alter qualitatively the results. Foreign goods are uniformly priced; therefore only domestic producers' price inflation π_H introduces a welfare-reducing distortion. A policy objective expressed in terms of the CPI does not alter qualitatively the result. The results are also robust to the introduction of an additional interest rate–stabilization objective.

3. We parameterize policy so that for $\omega_\pi = x, \omega_e = [\max(x) - x]/2$. Therefore, policies (beliefs) that place a lower weight on the inflation target also place a higher weight on the exchange-rate target. This choice of policy ensures local uniqueness of the equilibrium. For values of ω_π giving a unique equilibrium, our results are robust to alternative choices of ω_e.

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APPENDIX

A.1. EQUILIBRIUM CONDITIONS

The solution to the household decision problem gives the first-order conditions (FOCs)

$$\frac{C_{F,t}}{C_{H,t}} = \frac{\gamma}{1-\gamma}\left(\frac{P_{F,t}}{P_{H,t}}\right)^{-\rho}, \tag{A.1}$$

$$\text{MUC}_t \frac{W_t}{P_t} = \ell N_t^{\eta}, \tag{A.2}$$

$$\mathrm{MUC}_t = \beta E_t \left\{ \mathrm{MUC}_{t+1} (1 + i_t) \frac{P_t}{P_{t+1}} \right\}, \tag{A.3}$$

$$0 = E_t \left\{ \mathrm{MUC}_{t+1} \frac{P_t}{P_{t+1}} \left[\frac{e_{t+1}}{e_t} (1 + i_t^*) - (1 + i_t) \right] \right\}, \tag{A.4}$$

where $\mathrm{MUC}_t = D_t/C_t$ is the marginal utility of consumption, $(1 + i_t) = v_t^{-1}$ is the gross nominal interest rate, and $(1 + i_t^*) = v_t^{*-1}$ is the interest rate paid by domestic residents to borrow on the international capital market, which we assume includes a premium increasing in the real value of the stock of foreign debt to ensure stationarity.

Cost minimization for the domestic production sector implies $\mathrm{MC}_t^N = P_{H,t}\mathrm{MC}_t = W_t/A_t$, where MC^N and MC are the nominal and real marginal cost. The FOC for the firm's profit-maximization problem in (6) is

$$P_{H,t}(i) E_t \sum_{j=0}^{\infty} (\theta_p \beta)^j \Lambda_{t,t+j} \left[\frac{P_{H,t}(i)}{P_{H,t+j}} \right]^{1-\vartheta} Y_{H,t+j}$$

$$= \frac{\vartheta}{\vartheta - 1} E_t \sum_{j=0}^{\infty} (\theta_p \beta)^j \Lambda_{t,t+j} \mathrm{MC}_{t+j}^N \left[\frac{P_{H,t}(i)}{P_{H,t+j}} \right]^{1-\vartheta} Y_{H,t+j}. \tag{A.5}$$

Because we assume a nonzero steady state inflation rate, log-linearization of the firm's FOC does not return the standard forward-looking new-Keynesian inflation equation. A detailed derivation of the log-linear inflation equation is available from the author. The resource constraint in the domestic production sector is given by

$$Y_{H,t} = \int_0^1 A_t N_t(i) di = A_t N_t = (C_{H,t} + C_{H,t}^*) \int_0^1 \left[\frac{P_{H,t}(i)}{P_{H,t}} \right]^{-\vartheta} di. \tag{A.6}$$

Assuming that domestic bonds are in zero net supply, the current account (in nominal terms) reads as

$$e_t B_t^* = (1 + i_{t-1}^*) e_t B_{t-1}^* + P_{H,t} C_{H,t}^* - e_t P_{F,t}^* C_{F,t}. \tag{A.7}$$

A.2. PARAMETERIZATION

The model parameterization follows closely Monacelli (2004) and Gali and Monacelli (2005). The discount rate β is set to 0.99 and the elasticity of substitution between home and foreign consumption baskets ρ is set to 1. We assume a labor supply elasticity equal to 1/2, implying that $\eta = 2$. The probability of firms' price adjustment $(1 - \theta_p)$ is set to obtain an average price duration of four quarters. The elasticity of substitution between goods ϑ is equal to 11, implying a flexible-price markup of 10%. We parameterize the home-goods bias γ to Canadian data and set γ to match the Canadian import/output ratio, approximately equal to 0.4. World demand for the home-produced good is assumed to be less price-elastic than domestic demand, and we choose a foreign price-elasticity of demand $\rho^* = 0.5$.

The model is log-linearized around a zero-net foreign asset steady state. The exogenous stochastic processes for the preference shifter D_t, the technology shock A_t, the world interest rate $(1 + i_t^*)$, the imports' price $P_{F,t}^*$, and the aggregate foreign consumption demand C_t^* follow an AR(1) specification in logs with autoregressive parameter ρ_j, where the innovation $\varepsilon_{j,t}$ is normally distributed with variance $\sigma_{\varepsilon_j}^2$. The technology shock innovation volatility is parameterized following Gali and Monacelli (2005), who estimate a first-order autoregression for HP-filtered (log) labor productivity in Canada over the sample 1963:1–2002:4 and find $\rho_A = 0.66$ and $\sigma_A = 0.0071$. Over the same period, these authors estimate the parameters for the foreign consumption demand using HP filtered U.S. (log) GDP to be $\rho_{C^*} = 0.86$ and $\sigma_{C^*} = 0.0078$. This is a reasonable approximation for the case of Canada, where the average share of total exports going to the United States averaged around 80% over the past 15 years. To parameterize the process for the world interest rate, we use data on the U.S. three-month T-bill quarterly yield and estimate over the sample 1963:1–2002:4 $\rho_{i^*} = 0.95$ and $\sigma_{i^*} = 0.0021$. The endogenous risk premium paid by domestic residents on foreign borrowing is parameterized so that for a 10% increase in the ratio of net foreign debt to steady-state GDP, the premium increases by 0.4%, a conservative figure for emerging markets. The stochastic process for the imported-good price level is estimated using data for the Canadian Laspeyres fixed-weight price index for imports from the United States, 1992:1–2002:4. Estimation results in $\rho_{P_F^*} = 0.89$ and $\sigma_{P_F^*} = 0.015$. Following Monacelli (2004), the standard deviation of the preference shock σ_D is set to 0.011 and the autocorrelation parameter is set to $\rho_D = 0.9$. We assume that the domestic policy innovation ε_i is an i.i.d. shock with $\sigma_i = 0.0015$, a low value that reflects evidence on the small role played by nonsystematic monetary policy in business cycle fluctuations in a number of countries.