A NOTE ON MANAGED FLOATING IN A SMALL ECONOMIC MODEL

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Abstract

While standard monetary policy models assume a purely floating exchange rate regime, managed floating exchange rates are found in many Latin American economies, as well as in other developing regions. We aim at filling this gap by building a model that includes sterilized intervention, and assessing macroeconomic performance of the managed floating regime against alternative schemes - a pure float, a "hard" peg and a dirty float where only the nominal interest rate acts in response to the nominal exchange rate. The model is estimated for the Argentine economy in 2003-2009 using Bayesian methods; it can be extended to other economies, providing a convenient framework for comparative monetary policy analysis.

We find that, taking into account the actual kind of shocks that the economy experienced during the estimation period, and for preferences that include some weight on output, inflation, interest rate and real exchange rate variability, a managed floating exchange rate policy dominates alternative regimes.

JEL classification codes: E17, E52, E58

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‡All views expressed are the authors’ own and do not necessarily represent those of the Central Bank of Argentina.
1 Introduction

The conventional representation of monetary policy, embodied in the so-called "new neoclassical synthesis" or New Keynesian model, rests largely on a depiction of the economy by two equations that summarize demand and supply conditions and a third one that describes central bank behaviour. The latter is typically formulated through a "Taylor rule", where the main tool of the central bank is the nominal interest rate, which reacts to changes in inflation from its (implicit or explicit) target and in the output gap. Naturally suited to the conduct of so-called "inflation targeting" central banks, this model has more generally become the representation of monetary policy, as evidenced by the widespread use of the "three equation model" for policy making purposes in both industrial and developing economies (Gál and Gertler, 2007, Berg et al, 2006).

There are, however, a number of caveats to "monetary models without the LM": whereas the (short term) nominal interest rate is the main monetary policy tool in industrial countries, a number of other resources have more or less systematically been used by central banks in developing economies - sterilized intervention in the foreign exchange market, fractional reserve requirements, quantitative monetary targets, and so on. Indeed, while a purely floating exchange rate regime is associated to the implementation of a Taylor rule, managed floating exchange rates are more often than not found in many economies. Moreover, policies that focus on reserve accumulation and (more generally) financial stabilization have come to the foreground in the developing world (Bastourre et al, 2009). To take the case of Latin America, even inflation targeting countries in the region apply measures that are somewhat far from the standard paradigm, including substantial intervention in the foreign exchange market and international reserves' accumulation (Chang, 2008).

Thus, there is a notorious gap between standard theoretical representations of monetary policy and its actual conduct: we aim at filling that gap by building a model that actually incorporates sterilized intervention (in the line of Elosegui et al, 2007), and assessing macroeconomic performance of the managed floating regime vis-a-vis alternative schemes - namely, a purely floating exchange rate, a "hard" peg and a "dirty" float, where only one instrument - the nominal interest rate - acts in response to changes in the nominal exchange rate. Our hypothesis is that the managed floating regime has more desirable properties in terms of key variables' volatility (inflation, output, real exchange rate, interest rate) than its alternatives. The model is estimated for the Argentine economy in the 2003-2009 period using Bayesian methods.

Several models do account for the role of exchange rates in monetary policy: Svensson (1998), and Gál and Monacelli (2005), who build a new
Keynesian model for a small open economy - incorporating the real exchange rate in the IS and Phillips curves, and the nominal exchange rate in the Taylor rule. A number of authors, such as Lubik and Schorfheide (2007), Sturzenegger and Talvi (2008), among others, estimate the latter model for different economies through Bayesian methods, finding a significant coefficient for the exchange rate in the central bank reaction function. In turn, Felices and Tuesta (2007) and Batini et al (2008) develop models with financial frictions and dollarization in a two-country setting, once again enlarging the conventional setup with a place for exchange rate policy. Still, all these attempts share a common shortcoming: the only way in which monetary policy reacts to the exchange rate is by changing the short term nominal interest rate, in the line of Taylor (2001).

Only a few studies allow for a richer representation of open economy central banks’ procedures: Elosegui et al (2007) add an LM curve and represent sterilized intervention, as do Polovnov and Nikolaychuk (2006), in small-scale models. Perhaps the most ambitious project is that of Escudé (2008, 2009), who builds a full dynamic stochastic general equilibrium (DSGE) model for a small open economy with financial intermediation, analyzes the welfare properties of simple rules, and determines optimal policy rules under alternative central bank’s "styles" - i.e. preferences concerning deviations of macroeconomic variables from their steady state values. He finds that a managed floating regime which combines two rules, a Taylor one plus central bank intervention in the foreign exchange market, is the optimal policy under several different central bank styles.

Our approach is based on a small-scale model, with the aim of representing in the simplest possible way the main features of a managed floating regime and the channels through which central bank policy operates, illustrating these workings for the case of Argentina. Although lacking by construction the details of a full-scale DSGE model, we believe our model has definite advantages: in keeping with Occam’s razor, it allows for the depiction and identification of the specific policy environment we focus on; it improves upon specifications of previous small-scale models for Argentina; it is convenient for short-term forecasting exercises that are useful for monetary policy making. In the same breath, the model’s small scale has the advantage of providing a manageable framework for comparative analysis of the monetary policy stance in Latin America. It is also to our knowledge the first Bayesian estimation of a small-scale model that includes a managed floating regime for Argentina.

The rest of the paper is organized as follows. Section 2 presents the basic model we use; section 3 describes its estimation and impulse-response functions; section 4 assesses the performance of the managed floating regime...
in contrast with alternative schemes. Section 5 concludes.

2 The model

As usual in the applied literature\(^2\), the model includes an IS-type equation (1), a Phillips curve (2) and a Taylor rule (3) - the first two of which can be obtained as log-linear approximations of first order conditions of consumers’ and firms’ optimization problems in a monopolistic competition setting where price adjustments are sluggish\(^3\). The IS equation is augmented to reflect the impact of open economy variables, namely the real exchange rate, on consumption decisions and hence on output. In the same breath, the Phillips curve evidences the effect of foreign prices in the domestic economy, through an "imported inflation" component via the real exchange rate\(^4\), as well as inflation due to money growth exceeding output growth - a form of quantity theory of money term, included mainly for the sake of "goodness of fit"\(^5\). The Taylor rule also includes a coefficient on nominal exchange rate depreciation, so that the central bank’s behaviour not only depends on the output gap and inflation. In addition, we include an LM equation (4) that depicts equilibrium in the money market. We improve on the framework of previous models by adding: an equation to determine the nominal exchange rate, modifying or "augmenting" the uncovered interest rate parity (UIP) (5); another one to describe nominal exchange rate smoothing as desired by the central bank, by which reserves change as a function of exchange rate variability (6); the central bank’s balance sheet (7), which reflects the monetary authority’s operations in (5) and (6); and a fiscal policy component in the IS. Definitions of several variables of interest are specified (8-12). Finally, exogenous variables, mostly those that belong in the open economy, follow autoregressive processes (13-19), namely the foreign short term rate of interest, the exogenous component of risk premium in (5), foreign inflation, two measures of the bilateral exchange rate, the fiscal balance (actually, deviations from steady-state fiscal balance in (1)) and potential output. In what follows, equations and their variables are detailed; as customary, a circumflex denotes deviations from variables’ steady state values.

\[
y_t = \beta_1 E_t y_{t+1} + \beta_2 y_{t-1} - \beta_3 \hat{\pi}_{t} + \beta_4 \Delta \hat{\sigma}_t + \beta_5 \Delta f_t + \varepsilon_t^y
\]  

\(^{1}\text{See Elosegui et al (2007) and their MEP II, }\textit{Modelo Económico Pequeño II} \text{ for the case of Argentina.}\)

\(^{2}\text{See Woodford (2003) and Galí (2008).}\)

\(^{3}\text{We use the real effective exchange rate of Argentina with its main three trading partners (Brazil, the US and the EU), weighted by trade.}\)

\(^{4}\text{Small scale models such as this one are used for forecasting; our experience shows that inflation forecasting performance improves substantially when such term is included. Still, our qualitative results are not altered by its inclusion.}\)
\[ y : \text{output gap}, \ r : \text{real interest rate}, \ e^{tri} : \text{trilateral real exchange rate (RER)}, \ sf : \text{fiscal surplus to GDP ratio} \]

**Phillips Curve:**

\[ \hat{\pi}_t = \alpha_1 \hat{\pi}^e_{t+1} + (1 - \alpha_1') \hat{\pi}_{t-1} + a_3 y_{t-1} + a_4 \Delta e^{tri}_t + \varepsilon^\pi_t \]  

(2)

\[ \hat{\pi}^e_{t+1} = \tau E \hat{\pi}_{t+1} + (1 - \tau) (\hat{\mu}_{t-2} - \hat{g}_t^{\text{fr}}) \]

\[ \pi : \text{inflation}, \ \pi^e : \text{expected inflation}, \ \mu : \text{money growth rate}, \ g^{\text{fr}} : \text{GDP growth rate} \]

\[ \hat{\pi}_t = a_1 E_t \hat{\pi}_{t+1} + a_2 (\hat{\mu}_{t-2} - \hat{g}_t^{\text{fr}}) + (1 - a_1 - a_2') \hat{\pi}_{t-1} + a_3 y_{t-1} + a_4 \Delta e^{tri}_t + \varepsilon^\pi_t \]

\[ \alpha_1 = a_1', \alpha_2 = a_1'(1 - \tau) \]

**Taylor Rule**

\[ \hat{i}_t = \gamma_1 \hat{i}_{t-1} + \gamma_2 y_t + \gamma_3 E_t \hat{\pi}^a_{t+1} + \gamma_4 \hat{\delta}_t + \varepsilon^i_t \]  

(3)

\[ \pi^a : \text{annual inflation} \]

**Money demand / LM curve**

\[ \hat{m}_t = -\eta_1 \hat{i}_t + \eta_2 \hat{\pi}_t + \eta_3 \hat{\delta}_t + \eta_4 \hat{m}_{t-1} + \varepsilon^m_t \]  

(4)

\[ m : \text{money to GDP ratio} \]

**Modified UIP**

\[ \hat{i}_t = \hat{i}^* + \omega_1 E_t \hat{\delta}_{t+1} + (1 - \omega_1) \hat{\delta}_t + \omega_2 \hat{\delta}_t + \omega_3 \Delta r \hat{\text{res}}_t + \hat{\lambda}_t \]  

(5)

\[ i : \text{nominal interest rate}, \ i^* : \text{international interest rate}, \ \delta : \$/USD depreciation rate, \ \lambda : \text{exogenous risk-premium}, \ b : \text{CB bonds to GDP ratio}, \ \text{res} : \text{international reserves to GDP ratio} \]

**Managed Floating Rule**

\[ \hat{r} \hat{\text{res}}_t = \kappa_1 \hat{\text{res}}_{t-1} - \kappa_2 \hat{\delta}_t + \varepsilon^{\text{res}}_t \]  

(6)

**CB Balance Sheet**

\[ \hat{b}_t = \frac{1}{1 - \phi} \left( \hat{r} \hat{\text{res}}_t + \hat{c}^d_t \right) - \frac{\phi}{1 - \phi} \hat{m}_t \]  

(7)
\[ \phi = \frac{m}{m + b} \]

d \text{d} : $/USD RER

Identities

\[ \widehat{c}^{\text{tri}}_t = \widehat{c}^d_t + c_1 \widehat{c}^{\text{US,R}}_t + c_2 \widehat{c}^{\text{US,E}}_t \]  
(8)

\[ \widehat{\tau}_t = \widehat{\tau}_t - E_t \widehat{\pi}_{t+1} \]  
(9)

\[ \Delta \widehat{c}^d_t = \widehat{\pi}_t + \pi^*_t - \widehat{\pi}_t \]  
(10)

\[ \widehat{g}^\text{yt}_t = \Delta y_t + \widehat{g}^\text{yt}_t \]  
(11)

\[ \widehat{\mu}_t = \Delta \widehat{\pi}_t + \pi^*_t + \widehat{g}^\text{yt}_t \]  
(12)

\[ \widehat{c}^{\text{US,R}}_t: \text{USD/REAL RER}, \widehat{c}^{\text{US,E}}_t: \text{UDS/EURO RER}, \pi^*: \text{international inflation, } \widehat{g}^\text{yt}_t: \text{potential output growth rate} \]

Exogenous variables

\[ \widehat{\pi}^*_t = \rho_1 \widehat{\pi}^*_{t-1} + \varepsilon^*_t \]  
(13)

\[ \widehat{\lambda}_t = \rho_2 \widehat{\lambda}_{t-1} + \varepsilon^\lambda_t \]  
(14)

\[ \widehat{\tau}_t = \rho_3 \pi^*_t - \varepsilon^\pi_t \]  
(15)

\[ \widehat{c}^{\text{US,R}}_t = \rho_4 \widehat{c}^{\text{US,R}}_{t-1} + \varepsilon^{\text{US,R}}_t \]  
(16)

\[ \widehat{c}^{\text{US,E}}_t = \rho_5 \widehat{c}^{\text{US,E}}_{t-1} + \varepsilon^{\text{US,E}}_t \]  
(17)

\[ \widehat{s}^f_t = \rho_6 \widehat{s}^f_{t-1} + \varepsilon^f_t \]  
(18)

\[ \widehat{g}^\text{yt}_t = \rho_7 \widehat{g}^\text{yt}_{t-1} + \varepsilon^\text{yt}_t \]  
(19)

This specification merits some further explanation. Introducing a policy of sterilized intervention can be thought of as "augmenting" or modifying the uncovered interest rate parity (5); actually, what we have is a new equation for the determination of the nominal exchange rate - after all, the purpose of sterilized intervention is precisely to "block" in a way the conditions imposed by UIP in its normal form. In our setting, the nominal exchange rate depends on expected depreciation, the difference between the local and the international interest rate, and a country risk premium that is made up of an endogenous component and an exogenous shock, with the former determined by interventions in the currency market: the central bank intervenes by buying or selling international reserves, and issuing or withdrawing bonds from circulation in order to sterilize the effects of intervention on the

\footnote{See Florián et al (2008) for a specification along these lines.}
money supply. In turn, the exogenous shock to the exchange rate, which we model as an autoregressive process in (14), may be thought of both "idiosyncratic" and "systemic", i.e. comprising both exogenous risk perceptions on the country as well as changes in international financial conditions that, for instance, affect the whole class of emerging market countries.

Central bank interventions are ruled by a "propensity" to avoid exchange rate movements to a certain extent as measured by the coefficient $\kappa_2$ in (6), in keeping with the aim of a managed floating regime of smoothing short term "excessive" fluctuations of the nominal exchange rate. Thus, any external financial shocks are smoothed by the central bank in line with its aim of minimising short run disruption in the foreign exchange market. A desire to act gradually is reflected by the autoregressive coefficient $\kappa_1$, which can be rationalized on the grounds of financial stability.

As the central bank intervenes, it partially sterilizes intervention by the increase in the money supply by issuing notes, which is reflected in its balance sheet (7). It should be noted that any rise in the nominal interest rate that is necessary to support additional sterilization efforts will show in the LM curve, as well as in the modified UIP condition.

The interactions between the variables in the model are presented in Figure 1. For example, an exogenous shock to the local interest rate impinges directly on output, money and the nominal exchange rate (NER). As both output and inflation are affected, this entails a change in monetary policy via the Taylor rule. But this is not the only way in which monetary policy acts: as the NER changes, so does the real exchange rate, and so the central bank intervenes in order to dampen the full effect of the shock on the NER. In order to do so, it buys or sells international reserves, whose monetary effect is partially sterilised through the issuance of central bank bonds. Likewise (although not depicted in the figure) an exogenous shock to the nominal exchange rate implies a change in the RER which in turn impinges on both output and inflation. Monetary policy reacts in two ways to this: directly to the shock, as the Taylor rule carries a coefficient on the NER and so does the the intervention rule, by which the central bank buys or sells international reserves in order to smooth the NER according to its preferences; indirectly, as the RER weighs on output and inflation and this brings about changes in the interest rate.
The way we present the "policy block" of the model is consistent with imperfect substitution between local and foreign assets: actually, for intervention to have any effect on the foreign exchange rate, one must assume that two different assets, those denominated in local and foreign currency, are imperfect substitutes in the eyes of risk-averse investors. Central bank intervention changes the relative supply of local and foreign currency-denominated assets, leading private agents to reallocate their portfolios in the face of a change in the risk premium.

Rationalizing a managed floating strategy is far from straightforward - and exceeds the scope of this note. Suffice it to say here that the monetary authority may desire to smooth changes in the nominal exchange rate for a number of reasons, many of them classed under the general term "fear of floating"\(^7\): in developing economies, the exchange rate is a very important determinant of domestic prices through "imported" inflation, and it also weighs significantly on financial stability -specially in financially dollarized economies- and the real economy -through its effects on competitiveness. Adverse effects of devaluations have long been identified in the Argentine economy (Díaz Alejandro, 1965) as well as in developing countries at large (Krugman and Taylor, 1978); more recently, a growing number of studies discuss real effects of nominal devaluations in developing economies, using both DSGE (Tovar, 2006) and econometric models (Bebczuk et al, 2006).

In what follows, we study how exchange rate smoothing compares to a pure floating and to a fixed exchange rate regime in the model just presented.

\(^7\)In the discussion of monetary policy design for emerging economies, we believe this is something of a misnomer, as it implies that the “brave” thing to do is to float –but there may be very good economic reasons not to float freely, as our model tries to illustrate.
3 Estimation and impulse-response functions

We estimated the model presented above (equations 1-19) using Bayesian methods. Define $\theta \in \Theta$ as the vector of parameters. Given the prior information $g(\theta)$, the observed data $Y_T = [Y_1, Y_2, ..., Y_T]$ and the sample information $f (Y_T/\theta)$, the posterior density of the parameters is given by

$$g (\theta/Y_T) = \frac{f (Y_T/\theta) g (\theta)}{\int_{\Theta} f (Y_T/\theta) g (\theta) d\theta}$$

Notice that $f (Y_T)$ (the marginal likelihood) is constant, hence the posterior density is proportional to the product of the likelihood function $f (Y_T/\theta)$ and the prior density.

Posterior draws of the distributions are obtained using a Random Walk Metropolis-Hastings algorithm. We used two chains of 50000 replications each. The variance of the jumps is calibrated to achieve an acceptance rate between 0.2 and 0.4. We checked the convergence of the first three moments of the distributions.

We considered an estimation period ranging from the third quarter of 2003 to the second quarter of 2009. The set of observed variables $Y$ is

$$Y = \{\tilde{\pi}, \tilde{i}, \tilde{\pi}^a, \tilde{\pi}^b, \delta, \delta^m, \tilde{r}, \tilde{es}, sf, c^{US,R}, c^{US,E}\}$$

Parameter estimation is presented in table 1; estimated standard deviation of shocks are shown in table 2.

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*aWe use the following definition and sources, on a quarterly basis. GDP growth: national accounts (INDEC), seasonally adjusted. Inflation, measured alternatively as change in the CPI (INDEC) and in the implicit price deflator (consumption, national accounts). Domestic interest rate: rate on fixed term deposits in AR pesos, 30-59 day maturity (BCRA). Foreign interest rate: USD Libor, 3 months (Bloomberg). Foreign inflation, changes in: US CPI (FRED), Brazil CPI (Bloomberg), Euro-zone CPI (Bloomberg). Bilateral exchange rates and exchange rate depreciation (Bloomberg). Money: currency in circulation in AR peso million (BCRA). International reserves in USD million (BCRA). Fiscal surplus: revenues minus spending (primary), Ministry of Economy.*
Table 1

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It is worth pointing out that the model estimated in this way portrays not only the features relevant to the Argentine economy in the estimation period as captured by the coefficients of equations 1-7 but also the particular shocks that the economy underwent during that period -as the mean and variance of the shocks included in those equations are also estimated. Thus, exercises carried out with the models reflect both economic behaviour of different agents as implicit in our structural model and the magnitude and type of shocks they were facing.
Together with model estimation, we look for different ways of monetary policy implementation, as described by (3), (5) and (6); we choose alternative coefficients to contrast different regimes: a purely floating regime (coefficients \( \gamma_4, \kappa_1 \) and \( \kappa_2 \) equal to zero); a floating regime with an "augmented" Taylor rule to reflect interest rate changes in response to exchange rate changes (\( \kappa_1 \) and \( \kappa_2 \) equal to zero, but \( \gamma_4 \) different from zero); a managed floating regime with both the "augmented" Taylor rule and sterilized intervention as described in section II; and a fixed exchange rate, in the manner of a currency board or "hard peg". In the latter, the central bank intervenes in the foreign exchange market as is necessary in order to prevent the exchange rate from deviating from its "desired" level (implying both coefficients \( \gamma_4 \) and \( \kappa_2 \) tending to infinity). This is somewhat different from the usual way of portraying a foreign exchange peg by leaving out equations (3) and (6), changing equation (5) so that there is a fixed level of the exchange rate preferred by the monetary authority and reintroducing the uncovered interest rate parity in (5); this procedure, however, does not explicitly address the mechanisms by which the central bank actually keeps a peg in place, whereas our setting aims precisely at this, by showing how a (quasi) infinitely high response to exchange rate change in the foreign policy equations is what is required to put in place a peg -this way of depicting policy allows us to focus on the consequences for the rest of the economy of such a regime.

With this estimation, we obtain impulse-response functions for a shock in the exogenous component of the foreign exchange risk premium in (5), \( \lambda_t \). This shock can be thought of as any disruption of financial conditions unrelated to the macroeconomic fundamentals in (1) and (2) and to the conduct of monetary policy in (3) and (4); thus, it could be interpreted as a worsening of international conditions that weigh on the foreign exchange market, as experienced since mid-2007 by many developing economies, showing the financial side of the effects of a so-called "sudden stop". The shock shows as a (potential or actual, depending on the regime) nominal depreciation of the foreign exchange rate.

The exercise clearly shows that, as expected, once the sudden stop so defined takes place, a central bank that has a managed floating regime in place reacts by using foreign exchange reserves to intervene and partially sterilize its intervention through the issuance of bills, as depicted in panel (a) of figure 2; this clearly contrast with a "pure floater" who uses no reserves at all, and -on the other end of the spectrum- with a central bank that keeps a pegged regime and uses as much reserves as necessary to keep nominal depreciation at zero. Under managed floating, there is a smoother response in the nominal exchange rate than that seen when no intervention takes place.

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9In order to portray the full effects of a sudden stop, one should also consider the effect on net exports and the terms of trade.
place (panel (b)).

How does the impact of the shock shows on the main macroeconomic variables? If compared to a central bank with a Taylor rule as its only instrument, inflation is generally lower under managed floating with sterilized intervention following a shock on the exogenous risk premium -something that goes in line with the evidence found by Aguirre and Burdisso (2008), particularly for developing countries. On the other hand, the managed floating regime delivers higher inflation than a hard peg -actually, the latter actually shows deflation, as real exchange rate depreciation is called for in the face of an adverse shock (figure 2, panel (c)). When it comes to the output gap (panel (d)), the managed floating regime shows somewhat lower growth following the shock than a pure float -as discussed below, moderating nominal depreciation also moderates its expansionary impact on activity; but growth performance is certainly better under managed floating than when a peg is implemented, in keeping with deflationary pressures as commented before. This is closely related with the role of interest rates in the model (panel (e)): keeping a hard peg requires a very sharp adjustment of the interest rate when a shock hits the economy, with the consequent blow on economic activity, which is avoided to a significant extent if the central bank manages the exchange rate; in turn, if the currency floats freely, most of the burden of the adjustment is just carried by the exchange rate, with little reaction of the interest rate.

Figure 2: Impulse response functions following an exogenous shock to the exchange rate premium
Overall, the managed floating regime delivers a less volatile response in terms of output and inflation than both a pure float and a peg\textsuperscript{10}, when the economy is hit by an exogenous foreign exchange shock; and, although not depicted in the figure, it is also less volatile than a regime with an "augmented" Taylor rule, in which there is no outright intervention but only adjustment of the policy rate in response to movements in the nominal exchange rate. Interest rates and reserves adjust accordingly: less volatile than under a peg, but more than if a pure float prevailed.

What are the channels through which monetary policy with sterilized intervention gives way to such performance? It is relatively straightforward to see how, with the real exchange rate entering the Phillips curve, direct intervention in the foreign exchange market is more effective in dampening the inflationary effect of an exogenous shock than rules that either ignore such effect, or that only rest on an indirect channel -the interest rate. In the same breath, foreign exchange intervention acts directly on the LM curve, altering the quantity of money and thus the inflationary impact of money growth. As for the IS relationship, whether a real depreciation is expansionary or contractionary is a matter of empirical debate: in our estimation, the short run impact is initially positive on output, but after four quarters this effect is partially reversed. There is no explicit account for a financial channel, such as liability dollarization, linking the nominal depreciation and the real economy; still, should they suggest an inverse relationship -as much of the applied literature has found-, the short-run positive impact on output found under a pure float and managed floating may not be such, but volatility would still be reduced with a managed floating in place.

\textsuperscript{10}That both growth and inflation may be lower under a "hard" peg is consistent with the empirical findings of Tavlas et al (2008).
Exchange rate regime choice should naturally be linked to how alternative schemes perform in the face of a variety of shocks - not just an exogenous shock to the exchange rate as that shown by these impulse-response functions - and to the weights assigned to different variables in policymakers preferences. We focus on this kind of considerations in the following section.

4 Estimated shocks and macroeconomic volatility: assessing alternative regimes

Model estimation as described in section III allows us to perform a related exercise: assessing the impact of shocks on the Argentine economy under alternative foreign exchange regimes through volatility on macroeconomic variables. We simulate repeated realizations of all shocks included in the model, using the first two moments as estimated; this is a way of replicating the actual workings of the economy in the sample period - which is the one we are interested in: once Argentina abandoned the currency board and put in place a managed floating scheme. We compute the standard deviations of macroeconomic variables based on those simulations.

The exercise is revealing in that, once the actual shocks that hit the economy during 2003-2009 are factored in, inflation is less volatile under managed floating than under any other regime, including "dirty floating" where only the interest rate reacts to the nominal exchange rate, but there is no intervention in the foreign exchange market; likewise, the lowest volatility for the interest rate is reached under the managed floating arrangement (see table 3). When it comes to the output gap, volatility when managed floating is implemented comes second only to the pure float scheme - a natural outcome if one thinks of the role of the exchange rate as a potential "shock absorber" under the latter. In turn, by construction, exchange rate volatility is zero under a peg, while it is lower under managed floating than under "dirty floating" and, of course, pure floating - actually, volatility is reduced over 40% than in the latter. Finally, real exchange rate volatility (both with respect to the US dollar and to Argentina’s three most important trading partners) under managed floating is second only to the pegged regime. Therefore, the managed floating arrangement yields the less volatile performance in terms of inflation and interest rates, and the second lowest volatility when it comes to the output gap and the real exchange rate, when our model economy is exposed to the same type of shocks that the Argentine economy went through during the period we consider.
Table 3. Standard deviations of selected variables

<table>
<thead>
<tr>
<th></th>
<th>Inflation</th>
<th>Output gap</th>
<th>Nominal depreciation</th>
<th>Interest rate</th>
<th>Bilateral exchange rate depreciation</th>
<th>Tri-lateral exchange rate depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managed floating</td>
<td>0.0181</td>
<td>0.0363</td>
<td>0.0397</td>
<td>0.0112</td>
<td>0.0425</td>
<td>0.0529</td>
</tr>
<tr>
<td>Pure float</td>
<td>0.0508</td>
<td>0.0317</td>
<td>0.1158</td>
<td>0.0224</td>
<td>0.0937</td>
<td>0.0996</td>
</tr>
<tr>
<td>Fixed</td>
<td>0.0304</td>
<td>0.0429</td>
<td>0</td>
<td>0.0473</td>
<td>0.0319</td>
<td>0.0453</td>
</tr>
<tr>
<td>&quot;Dirty&quot; float</td>
<td>0.0184</td>
<td>0.037</td>
<td>0.0451</td>
<td>0.0146</td>
<td>0.0458</td>
<td>0.0555</td>
</tr>
</tbody>
</table>

Having examined these results, it is only natural to assess the combined performance of managed floating on all fronts vis-à-vis the alternative regimes. We do so by considering a loss function that penalizes squared deviations from steady state values of four variables: inflation, output, the real exchange rate and the interest rate; we consider convex combinations of coefficients on each loss term that range from zero to one -i.e. from no loss for deviation from steady state of a given variable to loss arising exclusively from any such deviation-, as in the following expression:

\[
L_t = w_1 \hat{\pi}_t^2 + w_2 y_t^2 + w_3 \Delta c_{tri}^2 + w_4 a_t^2
\]

Results are depicted as a simplex in figure 3, where the triangular surface is the locus of all the points where loss is minimum for different values of each \( w_i \) weight. In panel (a), the coefficient on the interest rate (\( w_4 \)) is assumed to be zero, and the rest are free; when only output gap variability matters (as shown by the point \( w_1 = 0; w_2 = 1; w_3 = 0 \)), a pure float will be preferred; in (almost) any other case, either the peg or the managed floating regime will be favoured -the former, when higher weight is given to real exchange rate depreciation; the latter, when more importance is given to inflation. Panel (b) shows results of the same exercise for a slightly positive weight given to interest rate variability (\( w_4 = 0.2 \)): the change is dramatic, as for almost any weight on the rest of the variables the managed floating regime will be preferred; only very high values on the output gap or on real depreciation will make alternative regimes (a pure float or a peg, respectively) appear more favourable in terms of macroeconomic volatility. If any importance is given to inflation, then the managed floating arrangement will dominate the others. Finally, in panel (c) results are displayed for the case of more important concern for interest rate variability (\( w_4 = 0.4 \)); in this case, no matter what value the rest of the coefficients take, managed floating will be the preferred regime.
What do we make of these results? Typically, policymakers show concern for volatility in terms of economic activity, inflation, the real exchange rate and for financial stability -as embodied, for instance, in interest rate volatility. As long as very "extreme" preferences on output or the real exchange rate are ruled out, an Argentine policymaker who is averse to macroeconomic volatility, and facing the shocks that the economy experienced from 2003 onwards, will choose to implement a managed floating regime; likewise, as long as some weight is put on financial stability concerns and inflation (a highly reasonable assumption, especially after the international events that have taken place since mid-2007), managed floating will be the foreign exchange regime of choice.

In other words, the foreign exchange policy actually put in place after the 2001-2002 Argentine crisis has been more appropriate than its alternatives in the light of both the economy's own features and the type and magnitude of shocks it has been subject to, with "appropriate" defined as policymaker's preferences that give some non-zero weight to financial stability, inflation, the output gap and the real exchange rate, and do not assign extreme values to volatility of the last two variables. Furthermore, managed floating as implemented by both a Taylor rule and outright interventions in the foreign exchange market is superior to just adjusting the interest rate for changes in the local currency value vis-à-vis the US dollar and other currencies -a result we share with Escudé (2009).
5 Concluding remarks

We have examined the implementation of a managed floating regime in a small-scale economic model of Argentina estimated through Bayesian methods, assessing its macroeconomic performance against alternative regimes. We provide a richer representation of monetary policy than the standard one, as we incorporate sterilized intervention as a separate tool of monetary policy in addition to a Taylor rule. This also allows us to introduce new and relevant shocks to the economy, namely an exogenous change in the exchange rate risk premium, something that can be interpreted as the kind of shock that developing economies underwent when the international financial crisis hit starting in 2007 -in other words, the financial side of a "sudden stop". In this setting, our main findings are twofold.

- In the face of an exogenous shock to the exchange rate risk premium, a managed floating regime with sterilized intervention delivers less inflation and output variability than its free floating and pegged counterparts, as well as the "dirty floating" arrangement -whereby the interest rate moves in response to the exchange rate, but there is no direct intervention in the foreign exchange market.

- When considering the impact of the whole set of estimated shocks to the Argentine economy in 2003-2009, the managed floating regime is preferred to alternative schemes as long as some weight is put on inflation (or deflation) and financial stability in the policymaker’s preferences. We show that only a central banker solely concerned with output stability or the real exchange rate would choose a regime other than managed floating. That is, except for very extreme preferences, a policymaker that is averse to macroeconomic volatility will favour a managed floating regime.

Our results also provide insights in terms of monetary policy evaluation in small, open economies. It has usually been argued that concern for exchange rate movements clashes with price stability -indeed, conventional wisdom has it that an implicit or explicit exchange rate target is at odds with an inflation target. For instance, a recent review of monetary policy in Latin America (Sturzenegger and Talvi, 2008) assesses central banks according to the coefficients of Taylor rules, distinguishing between those that care for inflation and those with other aims, such as the exchange rate -as reflected in estimated Taylor rule coefficients. Our model contrasts starkly with such assessment: policy evaluation based only on the Taylor appears incomplete when other policies are pursued, and it is perfectly possible to obtain lower inflation together with active exchange rate management, depending on the particular shocks that the economy is subject to -something that goes in line with the findings in Aguirre and Burdisso (2008). In other
words, not complying with the so called "Taylor principle" does not, in and of itself, imply that price and output stability may not be achieved. At a more instrumental level, the model provides a manageable framework for comparative monetary policy analysis across different countries -specially due to its small scale.

An active role for exchange rate management is only gradually becoming an acceptable alternative in the policymaker’s "toolbox" (Blanchard et al, 2010), at least as far as conventional monetary policy strategies -in the sense of Mishkin (2007)- are concerned. The small scale model presented here provides support for the implementation of policies such as managed floating, which, for the case of a small open economy as Argentina, may imply lower volatility than "corner solution" regimes for key macroeconomic variables.

References


