Accounting for the Choice of Exchange Rate Regimes

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Abstract

I study how the countries choose their exchange rate regime, specifically, whether to fix or float. I propose a model in which the policymaker must consider how each arrangement impacts growth and inflation. Because there is uncertainty about this, the model allows the policymaker learns it from his own experience as well as from others. As result, the model is able to generate intuitive connections between the choices and some associated economic variables, in addition to predict well the observed data.

1 Introduction

In this paper, I investigate how the countries choose their exchange rate regime. This is a relevant question in international economics that remains unsolved. Much of this open question is due to ambiguous results in literature relating exchange rate regime and economic variables. In turn, this uncertainty entails a herd of beliefs over time about whether fixed or floating regime is better for the economy. To handle this subject, I adapt from Buera et al. (2011) and propose a model able to get along the beliefs changing over time.

In the model, the policymaker must choose the better exchange rate regime for the economy aiming greater economic growth and lower inflation. It is assumed a semi-structural environment, where the policymaker has a perceived relation between exchange rate regime and economic growth and the economy has a reduced relation between exchange rate regime and inflation. The former feature can be a driver force in determining the herd of exchange rate arrangement observed over the time.

The perceived relation arises as the policymaker does not know how each regime impacts growth. Instead, he learns it from own experience as well as from the others. Basically, this perceived relation is backed by the unreliable relationship between the regimes and growth available in literature. Besides, the analysis of how the exchange rate arrangement impacts growth is theoretically complex. For example, on the one hand, a fixed regime reduces relative
price volatility, stimulating trade and investment and generating positive effect on growth. On the other hand, the regime is unable to adjust real external shocks. This, together with price rigidity, contributes to price distortion and misallocation, resulting in output volatility and low economic growth. Moreover, the regime is associated with greater susceptibility to financial and currency crises.

With respect to inflation, I assume that the policymaker knows its relation with exchange rate regime. The relation between exchange rate and inflation is more consensual.\(^1\) For example, when credible, fixed regime has strong impact on private sector inflation’s expectations, since it provides a nominal anchor. So, the public believes that the monetary authority is committed to a sustained monetary policy, abandoning discretionary polices that may be inflationary. Furthermore, also when credible, the regime limits the use of exchange rate to handle external disequilibrium issues, reinforcing a supportive environment for inflation issues. I assume that this relationship changes over time, so the policymaker makes new inferences whenever new information on inflation is available, in adaptive learning scheme. The herd of regimes and the relations between regime, growth and inflation can be seen in Figure 1.

The model also tries to rationalize a particularity that emerges in studying optimal choice of exchange rate arrangement. Despite many countries has assumed to follow a floating exchange rate regime since the 1990s, indeed, the most do not. As showed by Calvo and Reinhart (2002), it seems to exist what the authors called “Fear of Floating”. In this sense, mainly developing countries fears sharp movements on the value of their currencies. In a direct way, when the currency depreciates, the authorities worry about the exchange rate pass through and balance sheet impact. On the other hand, when the currency appreciates, the authorities worry about the lost of competitiveness on export sector. The model handle this question incorporating a cost of switching between regimes.

Besides this introduction, the work proceed as follows. Section 2 presents a brief literature review, focusing on relationship between exchange rate regime and key economic variables. Section 3 describes the model, initially without a profound discussion, and derives the optimal policy for the policymaker. Section 4 reports the estimation methodology. Section 5 examines the data on exchange rate regime used in the paper. Section 6 discuss the results. And, finally, section 7 concludes the paper.

### 2 Exchange Rate and The Economy

In the literature, there exists a uncertainty about the impact of exchange rate regime on key economic variables, mainly on growth. Comparing two periods under distinct regimes, Baxter and Stockman (1989) found little impact of exchange rate regime on macroeconomic variables. However, for the same period, Mundell (1997) concluded that real economic growth performed

\(^1\)See Ghosh et al. (1997), Bleaney (1999), Engel (2009) and Clerc et al. (2011).
better under fixed exchange rate. Using a descriptive analysis, Ghosh et al. (1997) suggest that a pegged exchange rate can lead to lower inflation and slower productivity growth. However, also in a descriptive analysis, Moreno (2003) supports the view that pegged regime is more positively correlated to economic growth.

In an effort to capture a causal relationship between exchange rate regime and economic variables, the works of Levy-Yeyati and Sturzenegger (2003) and Husain et al. (2005) must be highlighted. The former found that, for developing countries, more fixed exchange rate regimes are associated with slower growth and greater output volatility, whilst there is no significant impact for industrial economies. The latter evidences that pegs are responsible for relatively low inflation in developing economies with little exposure to international capital markets and floats are associated with higher growth in advanced economies.

Concerning about how the countries choose theirs exchange rate regime, Levy Yeyati et al. (2010) consider three theoretical approaches that should explain the choice of the arrangements: the optimal currency area theory, the financial view and the political view. The authors found that the authorities considers variables related to these theories when choosing the exchange rate regime. Other works on choices are Alesina and Wagner (2006) and Von Hagen and Zhou (2009).
That uncertainty on optimal choice of exchange rate regime is not concentrated only in academic agenda. This issue is also a concerning for policymakers. In last fifteen years, the International Monetary Fund (IMF) has produced studies with different guidance for exchange rate. On its view, in the early 1990s, countries seeking for economic stabilization must choose peg their currency to a strong one, often the dollar, to import monetary credibility. Nonetheless, the late 1990s saw growing cases of capital account crises in emerging countries. The resultant capital outflow led to collapses in their currencies and showed some fragility on fixed exchange rate regime.

As consequence, the IMF revisited the role of exchange rate with Mussa et al. (2000) and propose the adoption of hard pegs (e.g. currency boards, monetary unions) or free floats to mitigate the probability of occurrence of balance of payment crises. Nevertheless, that bipolar prescription does not last long, since the Argentinian economy succumbed in 2002 with its peso hard pegged to dollar. This time around, the IMF reviewed again what regime is most appropriate to be adopted by countries and, as exposed by Rogoff et al. (2003), suggested the use of freely floating exchange rate to avoid financial crises in a increasingly integrated world.

The last IMF study proposed a more flexible view for exchange rate regime choice. In work of Ghosh et al. (2011), the fund suggests that the choice of exchange rate regime must be made according to particular economic challenges of each country. Thus, the idea of “one-size-fits-all” exchange rate regime was abandoned. Besides, the work reinforced that more fixed regimes are associated with low nominal volatility and deeper trade integration, enhancing economic growth, whilst more flexible regimes are associated to smoother external adjustment and lower susceptibility to financial crises.

3 The Model

In our economy, when choosing exchange rate regime (henceforth, ERR), the policymaker cares about growth and inflation. So, I present a model that (i) captures the policymaker’s perceived relation between ERR and growth and (ii) allows the generated inflation dynamic be affected by ERR. Besides, additional features of the model encompass floating ERR cost and ERR switching cost. This last feature tries to rationalize the Calvo and Reinhart’s Fear of Floating.

Specifically, the policymaker is in power for only one period and must choose between floating and fixed ERR. Let \( \theta_t \) be an indicator variable that equals one if the policymaker chooses floating and equals zero otherwise. Then, the objective function of the policymaker on country \( n \) in period \( t \) is

\[ \text{Objective Function} = \text{Growth} - \text{Inflation} \]

However, the IMF warns that countries with weak macroeconomic fundamentals could suffer from potential financial crisis if a pegged regime are adopted.
\[ E_{n,t-1} \left[ y_{n,t} - \frac{1}{2} |\pi_{n,t} - \pi_{n,t}^*| - \theta_{n,t} K_{n,t} - \varphi^F (\theta_{n,t} - \theta_{n,t-1}) \theta_{n,t} + \varphi^P (\theta_{n,t} - \theta_{n,t-1}) (1 - \theta_{n,t}) \right] \]

where \( y_{n,t} \) is the growth rate of the per capita GDP, \( |\pi_{n,t} - \pi_{n,t}^*| \) is the absolute deviation of the inflation from a target, \( K_{n,t} \equiv f_n + \xi \Pi_{n,t} + k_{n,t} \) is the floating ERR cost, \( f_n \) is the country fixed effect, \( \Pi_{n,t} \) represents some variables associated to ERR, \( k_{n,t} \) i.i.d \( \sim N (0, \theta_n^2) \), \( \varphi^F \) is the switching cost from fixed to floating regime and \( \varphi^P \) is the switching cost from floating to fixed regime.

The policymaker must choose \( \theta_{n,t} \) to maximize (1) while obeying his perceived relation between ERR and growth and the reduced form relation between ERR and inflation gap dynamic, to be discussed right below.

### 3.1 Exchange Rate Regime and Growth

I adapt from Buera et al. (2011) and assume that country \( n \) policymaker’s perceived relation between ERR and growth is given by

\[ y_{n,t} = \beta_{n,t}^P (1 - \theta_{n,t}) + \beta_{n,t}^F \theta_{n,t} + \varepsilon_{n,t}, \]

where \( \beta_{n,t}^P \) and \( \beta_{n,t}^F \) are the perceived economic growth under fixed and floating ERR in period \( t \), respectively, and \( \varepsilon_{n,t} \) i.i.d \( \sim N (0, \Sigma_{n,t}) \).

Real values of \( \beta_{n,t}^P \) and \( \beta_{n,t}^F \) are not known by policymakers. However, they make inferences about their distributions according with new information that arrives in each period. Particularly, at the end of period \( t - 1 \), they observe the relation between ERR choices and growth from all countries and update their beliefs about \( \beta_{n,t}^P \) and \( \beta_{n,t}^F \). Lastly, at the beginning of period \( t \), they observe the realization of \( K_{n,t} \), estimate the inflation gap \( (\pi_{n,t} - \pi_{n,t}^*) \) and, with the knowledge of \( \varphi^F \) and \( \varphi^P \), choose what ERR to foster.

For each period \( t \), the policymaker believes that \( \beta_t \sim N \left( \hat{\beta}_t, P_t^{-1} \right) \), with \( \beta_t = [\beta_{1,t}, ..., \beta_{N,t}, \beta_{1,t}^F, ..., \beta_{N,t}^F]' \) and where \( \hat{\beta}_t \) and \( P_t^{-1} \) are updated as soon as new data is available. Obeying the timing of events and applying the Bayes’ Rule, we obtain the following optimal updating that shapes the policymaker’s beliefs:

\[
\begin{align*}
P_t &= P_{t-1} + X_t \Sigma_t^{-1} X_t, \\
\hat{\beta}_t &= \hat{\beta}_{t-1} + P_t^{-1} X_t' \Sigma_t^{-1} (y_t - X_t \hat{\beta}_{t-1}), \quad \text{for } t = 1, \ldots, T,
\end{align*}
\]

\( ^3 \)In this draft, the variables used are the ratio of international reserves over, the ratio of external debt and the relative GDP per capita.
where \( y_t \equiv [y_{1,t}, ..., y_{N,t}]' \), \( X_t \equiv [\text{diag} (1 - \theta_t) , \text{diag} (\theta_t)] \) and \( \theta_t \equiv [\theta_{1,t}, ..., \theta_{N,t}]' \).

In period \( t = 0 \), I set \( \beta_0 \) according to average value in pre-sample data. For \( P_{0}^{-1} \), I follow Buera et al. (2011) and parametrize it as
\[
P_{0}^{-1} = I_2 \otimes (V \cdot R^{-1} \cdot V),
\]
where \( V = \text{diag} ([\nu_1, ..., \nu_N]) \) and \( R_{ij} = \exp (-z_{i,j} \gamma) \).

The format of \( P_{0}^{-1} \), the prior covariance matrix, accounting for a uncorrelated impact of different ERR on economic growth within countries. Besides, the uncertainty of the impact of ERR on economic growth, parametrized by \( \{\nu_n\}_n \), is the same for both regimes and \( z_{i,j} \) accounts for the distance between the country \( i \) and \( j \). Thus, in the policymaker’s learning process, the closer the neighbor, the less the uncertainty about how the relation between ERR and growth in this country can explain the relation in his own country.

### 3.2 Exchange Rate Regime and Inflation

As the policymakers concern about inflation gap prediction when choosing the ERR, I propose a reduced form for inflation gap dynamic. Thus, the persistence of inflation gap is supposed to be related to ERR. However, rather than solely related to ERR chosen, the model allows the switching of ERR has different impact on inflation gap dynamic.

Specifically, the relation between ERR and inflation gap is assumed to be
\[
\hat{\pi}_{n,t} = \alpha_t + \alpha_t^F \theta_{n,t} + \rho_{FF}^t [1 - |\theta_{n,t} - \theta_{n,t-1}|] \theta_{n,t} \hat{\pi}_{n,t-1} + \rho_{FF}^t [1 - |\theta_{n,t} - \theta_{n,t-1}|] \hat{\pi}_{n,t-1} - \ldots + \rho_{FF}^t |\theta_{n,t} - \theta_{n,t-1}| \theta_{n,t} \hat{\pi}_{n,t-1} + \rho_{PP}^t |\theta_{n,t} - \theta_{n,t-1}| (1 - \theta_{n,t}) \hat{\pi}_{n,t-1} + \varepsilon_{n,t},
\]
where \( \hat{\pi}_{n,t} = |\pi_{n,t} - \pi_n^*| \) is the inflation gap, \( E(\varepsilon_{n,t}^2) = 0 \) and \( \text{var}(\varepsilon_{n,t}^2) = \sigma_{n,t}^2 \).

Therefore, the parameters \( \rho_{FF}^t \) accounts for persistence of inflation gap if the ERR chosen is floating and the ERR in last period is also floating, \( \rho_{PP}^t \) accounts for persistence of inflation gap if the ERR chosen is fixed and the ERR in last period is also fixed, \( \rho_{PF}^t \) accounts for persistence of inflation gap if the ERR chosen is fixed and the ERR in last period is floating and \( \rho_{FP}^t \) account for persistence of inflation gap if the ERR chosen is floating and the ERR in last period is fixed.

I model inflation gap since there exists data on hyperinflation in our sample and the \( \rho \)'s are estimated in a panel sense.\(^4\) The target of inflation is extracted by using a HP Filter, due to fact that few data on inflation are available for some countries, which prevent us to performing a more structural estimation. Besides, the filter uses the entire sample to capture the forward looking nature of inflation’s target.

\(^4\)There is a large number of parameters in the model, so I avoid remove any data.
The time varying parameter reduced form can also be justified by assuming that the policymaker does not know exactly how exchange rate regime impacts the inflation gap. Thereat, he makes inference about the impact whenever a new data on the own country arrives. This new inference in each period relies on the fact that this relationship may change over time. In this case, the policymaker discards this relationship from the others countries, since we can assume this is an intrinsic issue of each country. For example, it is feasible to take on that the cited channel route of monetary stance’s credibility are not correlated between countries. Besides, usually the policymaker gives a greater weight on growth over the inflation, so that, the observed heard on exchange rate regime may reflect the worldwide changing beliefs of regime’s impact on growth. Possibly, this movements are feedbacked with information from others countries.

Modeling agents as econometricians is known in the literature as adaptive learning. A appropriate procedure for estimate the time varying parameters is by using the Kalman Filter recursion. So, If we set

\[
\hat{\pi}_{n,t} = X'_{n,t} \Gamma_{n,t} + \varepsilon_{\pi_{n,t}},
\]

\[
\Gamma_{n,t} = \Gamma_{n,t-1} + \varepsilon_{\Gamma_{n,t}},
\]

where \( \Gamma_{n,t} = \begin{bmatrix} \alpha_{n,t} F_{n,t}^F & \rho_{n,t}^F & \rho_{n,t}^P & \rho_{n,t}^F \\ \end{bmatrix}' \), \( E(\varepsilon_{\Gamma_{n,t}}) = 0 \), \( E(\varepsilon_{\Gamma_{n,t}}\varepsilon_{\Gamma_{n,t}}') = \Sigma_{\Gamma_{n,t}} \)

and

\[
X_{n,t} = \begin{bmatrix} 1 \\ \theta_{n,t} \\ [1 - |\theta_{n,t} - \theta_{n,t-1}|] \theta_{n,t} \hat{\pi}_{n,t-1} \\ [1 - |\theta_{n,t} - \theta_{n,t-1}|] \hat{\pi}_{n,t-1} \\ |\theta_{n,t} - \theta_{n,t-1}| \theta_{n,t} \hat{\pi}_{n,t-1} \\ |\theta_{n,t} - \theta_{n,t-1}| (1 - \theta_{n,t}) \hat{\pi}_{n,t-1} \end{bmatrix},
\]

a direct application of the Kalman Filter algorithm delivers

\[
\hat{\Gamma}_{n,t} = \hat{\Gamma}_{n,t-1} + \mathbb{K}_{n,t} \left( \hat{\pi}_{n,t} - X'_{n,t} \hat{\Gamma}_{n,t-1} \right),
\]

\[
\mathbb{K}_{n,t} = \frac{P_{n,t-1} X_{n,t}}{X_n' P_{n,t-1} X_{n,t} + \sigma_{\pi_{n,t}}^2},
\]

\[
P_{n,t} = \left( I - \frac{P_{n,t-1} X_{n,t} X'_{n,t}}{X_n' P_{n,t-1} X_{n,t} + \sigma_{\pi_{n,t}}^2} \right) P_{n,t-1} + \Sigma_{\Gamma_{n,t}},
\]

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\(^5^\text{See Evans and Honkapohja (2001) for a profound analysis of learning in economics.}

\(^6^\text{See Hamilton (1994) for derivation details.} \)
where $K_t$ is known as the Kalman Gain and $P_{n,t} = E \left[ \left( \Gamma_{n,t} - \hat{\Gamma}_{n,t} \right) \left( \Gamma_{n,t} - \hat{\Gamma}_{n,t} \right)' \right]$ is the covariance matrix of the coefficients estimates.

Assumptions about $\sigma^2_{n,t}$ and $\Sigma_{\Gamma_{n,t}}$ deliver different learning rules, such as recursive least squares and constant gain least squares (CGLS). I set $\sigma^2_{n,t} = 1 - \gamma$ and $\Sigma_{\Gamma_{n,t}} = \gamma^{1 - \gamma} P_{n,t-1}$, so I adopt the CGLS algorithm. This rule is more robust to structural change since it discards past observations at geometric rate (Branch and Evans (2006)). The parameter $\gamma$ is referred to as the “gain” and it will be estimated. Finally, the recursion initialization is based on pre-sample estimation.

### 3.3 Optimal Policy

Solving the policymaker problem\(^7\), we obtain the following optimal policy:

$$\theta_{n,t} = \left[ \beta^P_{n,t} - \beta^P_{n,t-1} + \frac{1}{2} (\alpha^F + \rho^P_{n,t}) \pi_{n,t-1} - K_{n,t} + \varphi^P (1 - \theta_{n,t-1}) - \rho^P \theta_{n,t-1} - \varphi^P \theta_{n,t-1} \right].$$

### 4 Inference

The model is estimated by using Bayesian techniques.\(^8\) In this way, we are interested in the posterior density of $\alpha \equiv \left\{ \beta^P_{n,0}, \beta^F_{n,0}, \{ \hat{\beta}^P_{n} \}, \{ \hat{\beta}^F_{n} \}, \{ \hat{\theta}^P_{n,t} \}, \{ \hat{\theta}^F_{n,t} \}, \{ \varphi^P \}, \{ \varphi^F \}, \alpha^F_0, \gamma \right\}$. If we define $D_t = \left\{ y_t, \hat{\pi}_t, \theta_t, \Pi_t \right\} \equiv \left\{ \{ y_{n,t} \}, \{ \hat{\pi}^P_{n,t} \}, \{ \theta^P_{n,t} \}, \{ \Pi^P_{n,t} \} \right\}$ and $D^T \equiv \left\{ D_t \right\}_{t=1}^T$, the application of Bayes’ rule results in $p \left( \alpha | D^T \right) \propto \mathcal{P} (D^T | \alpha) \cdot p (\alpha)$, where $p \left( \alpha | D^T \right)$ is the posterior density of $\alpha$, $\mathcal{P} (D^T | \alpha)$ is likelihood function and $p (\alpha)$ is the prior density of $\alpha$.

### 4.1 Likelihood Function

As seen above, in order to perform the posterior distribution, we must build up the likelihood function. Writing it as product of conditional densities, we have

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\(^7\)See appendix for derivation.

\(^8\)The model with no learning can be viewed as standard Probit model. However, in advance, the estimated parameters strengthening the learning mechanism are statistically significant. Besides, the incidental parameters problem can arise in estimation of binary nonlinear models with fixed effects, such as the proposed model.
\[ \mathcal{P}(D^T|\alpha) = \mathcal{P}(y_T, \hat{\pi}_T, \theta_T, \Pi_T|y_{T-1}, ..., \Pi_1, \alpha) \]

\[ \cdot \mathcal{P}(y_{T-1}, ..., \Pi_1|\alpha), \]

\[ = \mathcal{P}(D_T|D^{T-1}, \alpha) \]

\[ \cdot \mathcal{P}(y_{T-1}, \hat{\pi}_{T-1}, \theta_{T-1}, \Pi_{T-1}|y_{T-2}, ..., \Pi_1, \alpha) \]

\[ \cdot \mathcal{P}(y_{T-2}, ..., \Pi_1|\alpha), \]

\[ \vdots \]

\[ = \mathcal{P}(D_1|\alpha) \cdot \prod_{t=2}^{T} \mathcal{P}(D_t|D^{t-1}, \alpha). \]

The individuals factors can also be written as product of conditional densities. Thus,

\[ \mathcal{P}(D_t|D^{t-1}, \alpha) = \mathcal{P}(y_t|\hat{\pi}_t, \theta_t, \Pi_t, D^{t-1}, \alpha) \cdot \mathcal{P}(\hat{\pi}_t|\theta_t, \Pi_t, D^{t-1}, \alpha) \]

\[ \cdot \mathcal{P}(\theta_t|\Pi_t, D^{t-1}, \alpha) \cdot \mathcal{P}(\Pi_t|D^{t-1}, \alpha). \] (2)

Moreover, I assume that the economic growth, the inflation gap and the variables in the floating ERR cost do not depend on the policymaker’s beliefs, but only on actual ERR. Thus, the equation (2) can be simplified into

\[ \mathcal{P}(D_t|D^{t-1}, \alpha) = \mathcal{P}(y_t|\hat{\pi}_t, \theta_t, \Pi_t, D^{t-1}, \alpha) \cdot \mathcal{P}(\hat{\pi}_t|\theta_t, \Pi_t, D^{t-1}, \alpha) \]

\[ \cdot \mathcal{P}(\theta_t|\Pi_t, D^{t-1}, \alpha) \cdot \mathcal{P}(\Pi_t|D^{t-1}, \alpha). \]

So that,

\[ \mathcal{P}(D_t|D^{t-1}, \alpha) = \mathcal{C} \cdot \prod_{t=2}^{T} \mathcal{P}(\theta_t|\Pi_t, D^{t-1}, \alpha), \]

\[ = \mathcal{C} \cdot \prod_{n=1}^{N} \mathcal{P}(\theta_{n,t}|\Pi_{n,t}, \alpha) \cdot \prod_{t=2}^{T} \mathcal{P}(\theta_{n,t}|\Pi_{n,t}, D^{t-1}, \alpha), \]

where \( \mathcal{C} \) is a constant term relative to \( \alpha \).

Using the optimal policy, we obtain\(^9\)

\(^9\)See appendix for details.
where $\Phi(\cdot)$ is the standard Gaussian cumulative distribution.

### 4.2 Priors densities

Informative priors are used to mitigate the overparameterization problem in the model. Therefore, the parameters has the following prior distribution:

\[
\begin{align*}
\hat{\beta}_P^{n,0} & \sim N\left(\bar{\beta}_0^P, \omega^2_\beta\right), \quad n = 1, \ldots, N, \\
\hat{\beta}_F^{n,0} & \sim N\left(\bar{\beta}_0^F, \omega^2_\beta\right), \quad n = 1, \ldots, N, \\
\nu_n & \sim IG\left(s_\nu, d_\nu\right), \quad n = 1, \ldots, N, \\
\theta_n & \sim IG\left(s_\theta, d_\theta\right), \quad n = 1, \ldots, N, \\
f_n & \sim N\left(\bar{f}, \omega^2_f\right), \\
\alpha^F & \sim \text{Uniform}, \\
\xi & \sim \text{Uniform}, \\
\gamma & \sim \text{Uniform}.
\end{align*}
\]

I set $\hat{\beta}_0^P = 3.05\%$ and $\hat{\beta}_0^F = 2.19\%$ according to pre-sample average data; $\omega^2_\beta = 0.03$ to adopt a skeptical view on $\beta_{n,0}$; $s_\nu = d_\nu = 0.26$ according to Buera et al. (2011); $s_\theta = d_\theta = 0.01$ to avoid the model fits the data using a large variance in $K_{n,t}$; $\bar{f} = 0$ to allow for no prior about how the ERR floating cost impacts the choice, on average; and $\omega^2_f = 0.02$ to adopt a skeptical view on $f_n$.

### 4.3 Estimation procedure and identification issues

The estimate for $\hat{\alpha}$ is obtained by maximization the posterior of the model. Specifically, we have

\[
\hat{\alpha} = \arg \max_\alpha \left\{ \prod_{j \in J} p(\alpha_j) \prod_{n=1}^N \frac{\prod_{t=2}^T P(\theta_{n,t} | \Pi_{n,t}, \alpha)}{P(\theta_{n,1} | \Pi_{n,1}, \alpha)} \right\},
\]
where $\alpha_j$ accounts for individuals parameters that compose $\alpha$, $J$ is the set of all estimated parameters in model, $p(\alpha_j)$ is the prior density of parameter $\alpha_j$ according to the subsection 4.2 and $P(\cdot)$ is the likelihood function as developed in subsection 4.1.

The posterior in not necessarily strictly concave. So on, it may exists identification issues in the maximization procedure. To handle this question, the optimization is performed starting from some different initial points. Finally, the estimates are the ones that returns the maximum posterior among all maximizers.

5 Data on Exchange Rate Regime Dynamic

There is an official country classification on exchange rate regime published in the IMF’s Annual Report on Exchange Rate Arrangements and Exchange Restrictions. The report ask to members to self-declare their arrangement as fixed, limited flexibility, managed floating or independently floating. However, it seems to exist a gap between officially reported and actually prevailing exchange rate arrangements, as shown by Reinhart and Rogoff (2004) and Levy-Yeyati and Sturzenegger (2005). I use the reclassification made by Reinhart and Rogoff (2004) as data for exchange rate arrangements.
According to Reinhart and Rogoff (2004), the history of exchange rate policy may look very different when using official rates. Thus, the authors develop a system using database on market-determined parallel exchange rates and reinterpret the history of exchange rate arrangements. As one result, they find evidence suggesting that exchange rate arrangements may be quite important for growth, trade and inflation.

The finest Reinhart and Rogoff’s reclassification sorts the regimes between 1 and 15, from more fixed to more floating, obeying the following criteria:

1. No separate legal tender;
2. Pre announced peg or currency board arrangement;
3. Pre announced horizontal band that is narrower than or equal to +/-2%;
4. De facto peg;
5. Pre announced crawling peg;
6. Pre announced crawling band that is narrower than or equal to +/-2%;
7. De factor crawling peg;
8. De facto crawling band that is narrower than or equal to +/-2%;
9. Pre announced crawling band that is wider than or equal to +/-2%;
10. De facto crawling band that is narrower than or equal to +/-5%;
11. Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time);
12. Managed floating;
13. Freely floating;
14. Freely falling;
15. Dual market in which parallel market data is missing.

To adapt this data to the model, I select a cohort that separate each fine regime in whether fixed or floating regime. So on, I assume the regimes indexed between 1 and 10, inclusive, as fixed regime, while the complementary, as floating regime. The Figure 2 describes the dynamic of growth and inflation given that dual scheme regime. For the period analyzed, countries under fixed regime had mean growth of 1.36% and mean inflation of 16.14%, while countries under floating regime had mean growth of 2.54% and mean inflation of 6.22%. Once again, it seems to have less uncertain about the relation between exchange rate arrangement and inflation.

The Figure 3 reports the proportion of countries adopting floating exchange rate regime inside their correspondent income level. We can note similar dynamic for each one, except for the upper middle level between 1980’s and late 1990’s. In this period, gross capital flows to emerging countries increasing the potential for sudden reversals in net flows and making fixed regimes more costly to maintain.

6 Results

The 459 parameters in model is estimated with annually data, ranging from 1970 to 2000 and covering 90 countries. Because of missing data, the total observations is 2197. As briefly discussed early, the possible overparametrization problem is mitigate by using priors in the estimation procedure. Besides, a future implementation of out-of-sample forecasting will help to a better understanding of that issue.

Table 1 reports the point estimates of the interested parameters with standard errors in parenthesis. As we can see, the prior belief of the cross-country correlation decreases with geographic distance, since the coefficient $\lambda$ is positive. This result has a intuitive interpretation: in the learning process, the policymaker gives more weight to observed relationship between regimes and growth in closer countries. For example, a Brazilian policymaker is less uncertain
<table>
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<th>Description</th>
<th>Estimates</th>
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<tr>
<td><strong>Prior Correlation</strong></td>
<td></td>
</tr>
<tr>
<td>$\lambda$ geographic</td>
<td>0.6884 (0.2338)</td>
</tr>
<tr>
<td>distance</td>
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<tr>
<td><strong>Floating Costs</strong></td>
<td></td>
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<tr>
<td>$\xi_1$ reserves over GDP</td>
<td>0.0187 (0.0146)</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>$\xi_2$ debt services</td>
<td>−0.0005 (0.0002)</td>
</tr>
<tr>
<td>over GDP</td>
<td></td>
</tr>
<tr>
<td>$\xi_3$ relative GDP per</td>
<td>−0.9745 (0.2907)</td>
</tr>
<tr>
<td>capita</td>
<td></td>
</tr>
<tr>
<td><strong>Switching Costs</strong></td>
<td></td>
</tr>
<tr>
<td>$\varphi^F$ cost from</td>
<td>0.0032 (0.0070)</td>
</tr>
<tr>
<td>floating to fixed regime</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>$\varphi^P$ cost from</td>
<td>0.0136 (0.0067)</td>
</tr>
<tr>
<td>fixed to floating regime</td>
<td></td>
</tr>
<tr>
<td><strong>Inflation Dynamic</strong></td>
<td></td>
</tr>
<tr>
<td>$\alpha^F$ additional</td>
<td>−0.0040 (0.0032)</td>
</tr>
<tr>
<td>inflation if floating</td>
<td></td>
</tr>
<tr>
<td>$\gamma$ gain with adaptive</td>
<td>0.1329 (0.0352)</td>
</tr>
<tr>
<td>learning</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Estimation Results

about how this relationship in Argentina could be related to his country than this relationship in China.

Regarding floating costs, the results suggest that the larger reserves, the lower the cost of floating exchange rate regime. In other words, the policymaker tend to choose a fixed regime when the reserves are high. It makes sense, since a high reserves help to lessen the probability of currency attack, generating a auspicious environment for fixed regime. This finding is consistent with the early reported IMF’s concerns about the arrangements.

With respect to debt services, there is a slight evidence this variable encourages a floating regime. The interpretation of this finding relied on credibility issues. Besides the reserves, the policymaker can also use the interest rate as tool for pegged his currency to another. However, if the country lack credibility in maintain the fixed regime, the international market will request increasing interest rate to offset a expected undervaluation. But, there exist internal issues which limits the increase in interest rate, such as unemployment.\textsuperscript{10} So on, a country with high debt must stay prone to choose a floating regime. A similar interpretation can be found in Bleaney and Ozkan (2011), where the authors claim that the perceived likelihood of using a

\textsuperscript{10}For example, the Brazil undervaluation in 1999.
“escape clause” in pegged regime raises its cost.

The results evidence a positive impact of the GDP per capita on choosing a floating regime. Questions about political economy view is more appropriate to interpret this result. Governments aiming low inflation, but with also low institutional credibility, may adopt fixed regime to tame inflationary expectations, unlike countries with high institutional quality. It follows that the formers are more prone to foster a fixed regime in handling commitment issues, while the latter may embrace a floating regime. These results are in agreement with the findings in Levy Yeyati et al. (2010). The model also sheds some light on “Fear of Floating”, as coined in Calvo and Reinhart (2002). According to the results, it seems to exist an additional cost, not explained by variables in model, in switching from fixed to floating arrangement. The reverse is not evidenced.

Figure 4 reports the model’s ability to fit the observed data. The predicted series corresponds to the one-step-ahead prediction with no shock to the floating ERR. As we can see, the predicted data is able to match fairly well the observed data. Besides, the model predicts 96.6% of the observed policy choices. However, this results must be seen gently. Additional analysis is requested to assess potential overparametrization problem, since the large number of parameters are estimated in sample. Future works encompass out-of-sample forecasting and
better understanding of learning rule in prediction.

7 Conclusion

The paper analyzed how the countries choose their exchange rate regime, whether to fix or float. To do so, I proposed a model in which the policymaker learns the regimes’ impact on growth and inflation. Beyond the learning process, relevant economic variables in a open economy are also considered on choice. The model was estimated by using bayesian techniques and find evidence of existing learning mechanism. The results indicate that higher reserves encourage fixed regime, while higher debt service and GDP per capita encourage floating regime. The model is also able to match the observed data on choice.

References


G. A. Calvo, C. M. Reinhart, Fear of Floating, Quaterly journal of economics .


Appendix

Derivation of optimal policy and likelihood function

The general problem of the policymaker is
\[
\max_{\theta_{n,t}} E_{n,t-1} \left[ y_{n,t} - \lambda^F \left| \pi_{n,t} - \pi_{n,t}^* \right| - \theta_{n,t} K_{n,t} - \varphi^F (\theta_{n,t} - \theta_{n,t-1}) \right] \\
\text{subject to} \quad \begin{align*}
\hat{y}_{n,t} &= \beta_n^F (1 - \theta_{n,t}) + \beta_n^e \theta_{n,t} + \varepsilon_{n,t}, \\
\hat{\pi}_{n,t} &= \pi_{n,t} - \hat{\pi}_{n,t}^*, \\
\hat{\pi}_{n,t}^* &= \alpha_t + \alpha_t^F \theta_{n,t} + \rho_{n,t}^F \left[ 1 - |\theta_{n,t} - \theta_{n,t-1}| \right] \hat{\pi}_{n,t} \hat{\pi}_{n,t-1} + \rho_{n,t}^{FP} \left[ 1 - |\theta_{n,t} - \theta_{n,t-1}| \right] \hat{\pi}_{n,t-1} \\
K_{n,t} &= f_n + \xi \Pi_{n,t} + k_{n,t}, \\
\varepsilon_{n,t} &\sim \text{i.i.d.} N(0, \Sigma), \\
\hat{\varepsilon}_{n,t} &\sim \text{i.i.d.} N(0, \Sigma^*) , \\
k_{n,t} &\sim \text{i.i.d.} N(0, \sigma_k^2).
\end{align*}
\]

Simplifying, we have
\[
\max_{\theta_{n,t}} \left[ \theta_{n,t} \left[ E_{n,t-1} \left( \beta_n^F - \beta_n^e \right) + \frac{1}{2} \alpha_n^F - K_n \right] - \frac{1}{2} \left( |\theta_{n,t} - \theta_{n,t-1}| \right) \pi_{n,t} + \rho_{n,t}^{FP} \left[ 1 - |\theta_{n,t} - \theta_{n,t-1}| \right] \hat{\pi}_{n,t-1} \\
\right]
\]

Solving for each case, we obtain:

- case \( \theta_{n,t-1} = 0 \):

\[
\begin{align*}
V^* (\theta_{n,t} = 1|\theta_{n,t-1} = 0) &= \quad E_{n,t-1} \left( \beta_n^F - \beta_n^e \right) + \frac{1}{2} \alpha_n^F - K_n \pi_{n,t} + \varphi^F - \varphi^F \\
V^* (\theta_{n,t} = 0|\theta_{n,t-1} = 0) &= -\frac{1}{2} \rho_{n,t}^{FP} \hat{\pi}_{n,t-1}
\end{align*}
\]

.. \quad .. \quad .. 

\[
V^*(1|0) > V^*(0|0) \Leftrightarrow E_{n,t-1} \left( \beta_n^F - \beta_n^e \right) + \frac{1}{2} \left( \alpha_n^F + \rho_{n,t}^{FP} - \rho_{n,t}^F \right) \pi_n > K_n + \varphi^F
\]

- case \( \theta_{n,t-1} = 1 \):

\[
\begin{align*}
V^* (\theta_{n,t} = 1|\theta_{n,t-1} = 1) &= \quad E_{n,t-1} \left( \beta_n^F - \beta_n^e \right) + \frac{1}{2} \alpha_n^F - K_n \pi_{n,t} + \varphi^F - \varphi^F \\
V^* (\theta_{n,t} = 0|\theta_{n,t-1} = 1) &= -\frac{1}{2} \rho_{n,t}^{FP} \hat{\pi}_{n,t-1} - \varphi^F
\end{align*}
\]

.. \quad .. \quad .. 

\[
V^*(1|1) > V^*(0|1) \Leftrightarrow E_{n,t-1} \left( \beta_n^F - \beta_n^e \right) + \frac{1}{2} \left( \alpha_n^F + \rho_{n,t}^{FP} - \rho_{n,t}^F \right) \pi_n > K_n + \varphi^F
\]

So,

\[
\text{Prob} \left( \theta_{n,t} = 1|\Pi_{n,t}, D^{n-1}, \alpha, \theta_{n,t-1} = 0 \right) = \quad ..
\]
\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} > K_{n,t} - \varphi_F \right], \]

\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} > f_n + \xi \Pi_{n,t} + k_{n,t} + \varphi^F \right], \]

\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} > -f_n - \xi \Pi_{n,t} - \varphi^F > k_{n,t}, \right. \]

\[ \Phi \left( \frac{\beta^F_{n,t-1} - \beta_{n,t-1} + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} - f_n - \xi \Pi_{n,t} - \varphi^F}{\theta_n} \right), \]

and

\[ \text{Prob} \left( \theta_{n,t} = 0 | \Pi_{n,t}, D^{t-1}, \alpha \text{ with } \theta_{n,t-1} = 0 \right) = \]

\[ 1 - \Phi \left( \frac{\beta^F_{n,t-1} - \beta_{n,t-1} + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} - f_n - \xi \Pi_{n,t} - \varphi^F}{\theta_n} \right). \]

In addition,

\[ \text{Prob} \left( \theta_{n,t} = 1 | \Pi_{n,t}, D^{t-1}, \alpha \text{ with } \theta_{n,t-1} = 1 \right) = \]

\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} > K_{n,t} - \varphi^F \right], \]

\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} > f_n + \xi \Pi_{n,t} + k_{n,t} - \varphi^F \right], \]

\[ \text{Prob} \left[ E_{n,t-1} \left( \beta^F_n - \beta_n \right) + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} - f_n - \xi \Pi_{n,t} + \varphi^F > k_{n,t}, \right. \]

\[ \Phi \left( \frac{\beta^F_{n,t-1} - \beta_{n,t-1} + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} - f_n - \xi \Pi_{n,t} + \varphi^F}{\theta_n} \right), \]

and

\[ \text{Prob} \left( \theta_{n,t} = 0 | \Pi_{n,t}, D^{t-1}, \alpha \text{ with } \theta_{n,t-1} = 1 \right) = \]

\[ 1 - \Phi \left( \frac{\beta^F_{n,t-1} - \beta_{n,t-1} + \frac{1}{2} \left( \alpha_n + \rho_n - \rho_{n,t} \right) \pi_{n,t-1} - \xi \Pi_{n,t} + \varphi^F}{\theta_n} \right). \]