



## Exchange rate movements and monetary policy in Brazil: Econometric and simulation evidence

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### ABSTRACT

The literature on monetary economy has aroused growing interest in macroeconomics. Due to computational advancements, models have become increasingly more complex and accurate, allowing for an in-depth analysis of the relationships between real economic variables and nominal variables. Therefore, using a dynamic stochastic general equilibrium (DSGE) model, based on Gali and Monacelli (2005), we propose and estimate a model for the Brazilian economy by employing Bayesian methods so as to assess whether the Central Bank of Brazil takes exchange rate fluctuations into account in the conduct of monetary policy. The most striking result of the present study is that the Central Bank of Brazil does not directly change the interest rate path due to exchange rate movements. A simulation exercise is also used. Our conclusion is that the economy quickly accommodates shocks induced separately on the exchange rate, on the terms of trade, interest rate, and global inflation.

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### 1. Introduction

According to Walsh (2003), the study of monetary economics can be defined as the process of investigating the relationships between real economic variables and nominal variables, i.e., relationships between real output, real interest rate, employment, real exchange rate, etc., with the inflation rate, nominal interest rate, nominal exchange rate, and money supply, among others.

After Keynes (1923), the literature on monetary economy has aroused a growing interest in macroeconomics which, with the advent of computational improvements, has encouraged the development of increasingly complex models to explain the dynamics of economies. The seminal works by Ramsey (1928) and Solow (1956), regarded as benchmark for current macroeconomic models, were the first ones to provide consistent explanations on the growth paths of different economies, determined solely by exogenous factors such as technological growth rate.

Thus, endogenous growth models, such as the AK models of Romer (1986, 1987), Lucas (1988), Rebelo (1987) and their variations in Romer (1990), Grossman and Helpman (1991a,b) and Aghion and

Howitt (1992) came into existence. These models, however, had serious shortcomings (e.g.: multiple equilibria). But the most serious problem is that they did not include money in their formulation, thus overlooking important impacts on the growth path, at least in the short run, and eventually affecting all neoclassical growth models.

A great deal of effort was put in and different methods that included money in the models of determination of economic relationships were developed to overcome this drawback, chiefly those devised by Sidrauski (1967), Baumol (1952), Tobin (1956), Kiyotaki and Wright (1989), Clower (1967) and Samuelson (1958). But none of the models commanded so much attention as the IS-LM model, shown in detail in Romer (2005).

The model obviously combines an IS curve with an LM curve, in which the monetary authority responds to economic shocks with increases in monetary aggregates. From the equilibrium between the IS and LM curves, it is possible to obtain an aggregate demand curve which, along with a Phillips curve – aggregate supply –, represents the dynamics of the economic equilibrium, given by the trade-off between output and inflation.

However, this type of model also contains some flaws, especially with regard to the explanation of mechanisms of monetary policy transmission to the economy. Several authors proposed solutions to these flaws, but none of the works considered the effects of

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expectations on economic equilibrium, something that is extremely important and that gave Lucas (1976) a Nobel prize. Lucas's criticism leads to the conclusion that monetary policy may have nontrivial effects on real variables, becoming a stabilization tool or an instrument that generates additional economic fluctuations.

As a result, numerous models were devised, in which expectations played a determining role in equilibrium relationships. The most successful models, albeit quite complex in terms of concept and implementation, were the dynamic and stochastic general equilibrium (DSGE) models, viewed as an improvement of the conventional IS-LM models.

In lieu of the LM curve, DSGE models use a Taylor rule, i.e., a monetary policy rule in which interests rather than monetary aggregates are the central bank's instruments for invigorating the economy. With the monetary policy rule and a dynamic IS curve, which includes expectations, one obtains the aggregate demand. Since the new Keynesian Phillips curve, which has this name for also considering the expectations of individuals, represents the aggregate demand, economic equilibrium is achieved by the relationship between aggregate supply and aggregate demand curves, rendering this type of model highly intuitive.

Note that DSGE models allow studying several aspects of the economy and have inspired many authors to put their efforts in developing them. In this regard, the work by Gali and Monacelli (2005) is noteworthy, as a dynamic and stochastic general equilibrium model for a small open economy is developed therein, based on Calvo's (1983) sticky price model. The authors also use the developed model to test three different monetary policy rules for the economy, using simulation methods: Taylor rule for domestic inflation, Taylor rule for the consumer price index and a pegged exchange rate regime.<sup>1</sup>

Other authors decided to apply models developed from real data to assess, for instance, the conduct of monetary policy by the central bank. This is the case of Lubik and Schorfheide (2007), who use a simplified version of the model developed by Gali and Monacelli (2005) to assess the conduct of monetary policy in Australia, Canada, New Zealand and the United Kingdom. The authors consider general Taylor rules in which the monetary authority reacts to movements in output, inflation and exchange rate, to test whether the central banks of these countries change the conduct of their monetary policy due to exchange rate fluctuations. The conclusion is that only the central banks of Canada and of the United Kingdom change their interest rates due to exchange rate movements.

Nevertheless, Lubik and Schorfheide (2007) are not the only ones to carry out this type of work. Clarida and Gertler (1997) provide estimates that lead to the conclusion that the central bank of Germany responds to real exchange rate devaluation by increasing short-term interest rates. While adjusting a model for the Australian economy, Brischetto and Voss (1999) and Dungey and Pagan (2000) found evidence that the central bank of Australia also reacts to exchange rate movements by increasing short-term interest rates.

Clarida et al. (1998) show reaction of nominal interest rates at the central banks of Germany, Japan and England to real exchange rate movements. Gerlach and Smets (2000) estimate a monetary policy rule for the central banks of New Zealand, Canada and Australia, concluding that the former two respond to nominal exchange rate movements with short-term interest rate increases, whereas the latter refrains from doing that.

Quite recently, Hüfner (2006), by investigating the behavior of the central banks of Australia, Canada, New Zealand, Sweden and the United Kingdom, found significant terms regarding the exchange

rates of the United Kingdom and New Zealand. For emerging economies, the works by Ades et al. (2002) are of note, as they analyzed the behavior of the central banks of Chile, Israel, South Africa, Czech Republic and Mexico, and found significant coefficients for the exchange rate of these countries.

Wollmershäuser (2006) assesses the impact of uncertainty on exchange rate for the conduct of monetary policy with the aim of elucidating the rationale of central banks for changing the conduct of monetary policy due to exchange rate movements. The results suggest that monetary policy rules that also consider exchange rate are superior to simple monetary policy rules, which only take inflation and output into account.

Thus, the present study uses a dynamic and stochastic general equilibrium model to assess the conduct of monetary policy by the central bank of Brazil (CBB). More specifically, the main goal is to test whether the CBB directly changes its conduct of monetary policy due to exchange rate movements, later on performing simulation exercises to assess how the economy accommodates induced shocks, contributing to an unparalleled application to the Brazilian economy. The importance of deeply understanding the characteristics of the Brazilian monetary authority is evident, especially for financial market agents, for whom this clearer understanding allows substantially increasing potential gains in the future interest rate market.

Besides the introduction, this paper is organized as follows: Section 2 presents the theoretical model used, alongside the simplifications that are necessary for econometric estimation, which is carried out in Section 3. Section 4 deals with the simulation exercises, performed to assess the behavior of the economy through induced shocks and the time elapsed until the variables return to their respective steady states. Section 5 provides the final comments and suggestions for future research.

## 2. The dynamic and stochastic general equilibrium model

The model used in the present paper belongs to the class of dynamic and stochastic general equilibrium (DSGE) models, a simplified version of the model developed by Gali and Monacelli (2005). The authors model the world economy based upon numerous open economies represented on the interval  $[0;1]$ , which means that each economy is extremely small and that its domestic policy decisions have no impact on other world economies. Economies are liable to different productivity shocks, but they share the same preferences, technology, and market structure.

The proposed simplifications are targeted at adjusting the model for estimation, since its original form produces some problems at this stage, such as identification problems. The hypotheses of intertemporal elasticity of substitution equal to one and the perfectly elastic labor supply<sup>2</sup> were added to the original model proposed by Gali and Monacelli (2005). Therefore, the dynamic IS curve can be written as:

$$y_t = E_t \{ y_{t+1} \} - \left[ \frac{1-\alpha(2-\alpha)(1-\sigma)}{\sigma} \right] (r_t - E_t \{ \pi_{t+1} \}) \quad (2.1)$$

$$+ \left[ \frac{1-\alpha(2-\alpha)(1-\sigma)}{\sigma} \right] \left( \frac{1}{\beta} - 1 \right) - \alpha \left[ \frac{1-\alpha(2-\alpha)(1-\sigma)}{\sigma} \right] E_t \{ \Delta s_{t+1} \}$$

$$- [\alpha(2-\alpha)(1-\sigma)] E_t \{ \Delta y_{t+1}^* \}$$

where  $y_t$  is the output at time  $t$ ,  $\alpha$  is a parameter inversely related to the level of preference for domestic products, restricted to interval  $[0;1]$ ,  $\sigma$  represents the intertemporal elasticity of substitution, also restricted to the interval  $[0;1]$ ,  $r_t$  is the nominal interest rate,  $\pi_t$  is the

<sup>1</sup> Other important works, which preceded the model of Gali and Monacelli (2005) and that should be cited, are those of Obstfeld and Rogoff (1995, 1999), Bacchetta and van Wincoop (2000), Betts and Devereux (2000) and Corsetti and Pesenti (2001), handsomely contributing to the development of this type of study.

<sup>2</sup> Such hypotheses are supported in the literature, as in the work conducted by Lubik and Schorfheide (2007).

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