

Moreira, Ricardo Ramalhete

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Alternative economic policy under a regime with inflation targeting, primary surpluses and a floating exchange rate: an analysis for developing economies

Ricardo Ramalhete Moreira*

Professor of Economics, Federal University of Espírito Santo, Brazil

Inflation targeting, primary surpluses and a floating exchange rate under supply and exchange-rate shocks can combine to create deleterious effects on the economic dynamic. This paper reports on computer simulation experiments using a dynamic and stochastic model that can incorporate different restrictions. In general, the data show that under supply and exchange-rate shocks, a better method for minimising social loss includes flexible inflation targeting, counter-cyclical primary surpluses and capital control without eliminating the floating exchange rate.

Keywords: *inflation targeting, primary surpluses, exchange-rate fluctuation*

JEL codes: *E52, E63, F32*

1 INTRODUCTION

In recent decades, economic policy management in certain countries, including developing economies, has been largely based on three pillars: (i) monetary management through an inflation-targeting system; (ii) fiscal management through primary surplus targets; and (iii) external ‘management’ through a freely floating exchange rate and capital mobility. For example, this has been the regime or policy mix in Brazil, particularly after 1999, when the country abandoned the fixed exchange-rate regime (liberalising exchange-rate fluctuations) and adopted a system that targets inflation and primary surpluses.

Individually, each such pillar or economic policy component has specific advantages and disadvantages, which have been highlighted in the literature and analysed repeatedly in stagnant debates. However, where such policies are combined, a country’s economic dynamic may suffer serious restrictions when confronted with certain shocks, which depends on the configuration of each policy and, consequently, the synergy among such policies.

In particular, supply shocks, such as from variations in commodity prices, which are more frequent, and exchange-rate shocks due to abrupt speculative capital flow movement, which are not uncommon, can impose unwanted trajectories on relevant economic variables in economies that adopt such a policy combination. This result is likely exacerbated by the following factors: (i) rigidity in the inflation-targeting system that copes with inflation

* Email: ricardo.moreira@ufes.br.

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shocks; (ii) inflexibility for the primary surplus targets confronted with economic activity variations; and (iii) short-term international capital mobility with a floating exchange rate.

This study investigated this topic by conducting computer simulation experiments using a *dynamic stochastic model with inflation targeting, primary surpluses and a floating exchange rate*. The model analyses different policy regimes confronted with supply and exchange-rate shocks. Given such shocks, it is used to observe the trajectories that result from relevant variables, such as inflation, GDP growth rate, interest rates, public debt–GDP ratio and exchange rates. In general, these experiments showed that a *conventional economic policy regime* yields worse dynamics for such variables (that is, more volatile dynamics) when under supply and exchange-rate shocks. *Conventional regimes* are defined herein as regimes supported by *rigid inflation targets, pro-cyclical primary surpluses and strong short-term capital mobility*. However, *alternative policy regimes* formed by *flexible inflation targets, counter-cyclical primary surpluses and short-term capital controls* are better able to minimise economic (and social) losses caused by shocks imposed on the system studied.

This article has the following structure. Section 2 addresses the theoretical framework by subdividing it into three parts. The first addresses the inflation-targeting regime, the second addresses primary surplus policy and the third analyses floating exchange rates, capital mobility and capital controls. Thus, this analysis includes the framework for the contemporary economic policy tripod. Section 3 presents the stochastic dynamic model, which is the foundation for the simulations and analyses thereafter. Section 4 presents the methodology and simulation results. Lastly, final considerations and bibliographic references are presented.

2 THEORETICAL FRAMEWORK: INFLATION TARGETING, PRIMARY SURPLUSES AND A FLOATING EXCHANGE RATE

2.1 Inflation targeting, shocks and the need for flexibility

An inflation-targeting (IT) regime is a nominal anchor, wherein price stability is primarily sought through announcing a numerical target for the inflation rate or range of inflation rates over a period of time (Mishkin 1999). Under this regime, central banks (CBs) adjust their monetary policy instrument(s) and use information relevant to determining inflation to modulate current and prospective inflation rates to reach the targets adopted. In general, countries that adopt an IT regime use a nominal short-term interest rate or an inter-bank rate as the policy instrument (Svensson 1997; 1999; Ball 1999a).

Moreover, fundamental procedures for CB communication with and transparency to the public are established by considering relevant information for policy strategies. Such strategies include the measures used for deviations between the observed and target inflation and the expectations of the authority and public concerning future economic dynamics. Enhanced transparency for CBs facilitates credibility and reduced sacrifice rates for disinflation; furthermore, the public has better information for monitoring and evaluating the economic outcomes with respect to the targets and declarations made by the authorities (King 1996; Mishkin 1999).

Advocates for adopting an IT regime agree on the need to adopt flexible mechanisms or ‘escape clauses’ as institutional instruments (Lohmann 1992), which provide a greater margin for managing inflation shocks that do not originate from aggregate demand and production activity. Such inflation shocks include those that do not originate from an output gap (the difference between an economy’s output and potential or normal output),

such as supply shocks (for example, increases in taxes, food prices, energy, fuels, wages and profit margins that are not generated by increased economic activity) and exchange-rate shocks, which should be addressed only partially if at all. Such mechanisms would prevent social costs and losses in economic activity, employment and income.

In practice, all countries that adopt an IT regime have the flexibility to accommodate, to some degree, short-term policies aimed at stabilising output and employment. Furthermore, to avoid major output losses, disinflation has been demonstrated as gradual for such countries because the inflation target converges with the desirable inflation in the long term and in accordance with a gradual reduction in inflation expectations. Thus, an IT regime is not *necessarily* linked to the rational expectations (RE) hypothesis, which is held by the new classical economics from the 1970s and the new Keynesians, nor it is linked to the perfect credibility hypothesis. Authors such as Debelle/Fischer (1994), King (1996) and Ball (1999a; 1999b) are part of the mainstream theoretical lineage but show that, at least while building reputation and credibility, expectations have a strong backward-looking component (adaptive expectations). Such observations are consistent with the large body of evidence that supports a strong inertial and autoregressive component for inflation and output in many countries.

Brazil can be presented as an example, with an IT regime that was implemented on 1 July 1999 upon abandoning an exchange-rate anchor, which was the institutional and operational framework selected for the primary long-term monetary policy objective: maintaining low and stable inflation rates. This goal was expressed in the inflation-target announcement, which was the new nominal anchor for inflation expectations and policy decisions. It was expected that this would increase transparency and communication for the monetary authority to the public.¹

Moreover, it was expected that this new system would provide greater information to policy-makers on the relationships between short-term policy decisions and their long-term consequences. Bogdanski et al. (2000) noted the initial importance of the declining Brazilian inflation target from 1999 to 2001. The inflation rise in this country throughout 1999 was motivated by the exchange-rate devaluation shock during this year, which generated an increase in certain once-and-for-all prices. When the shock passed, inflation did not continue to rise; therefore, to accommodate the shock during the initial year, a higher inflation target (8 per cent) was fixed.

As the authorities believed that the proper function of the targeting regime would facilitate a downward trend in inflation over the following years, the targets were also fixed at gradually smaller levels. However, after 2000 in Brazil, certain prices for goods and services increased not due to aggregate demand shocks but to exchange-rate devaluation, inertia in regulated prices and increases in commodity prices.

For Bofinger et al. (2006), a monetary policy response to a supply shock depends on the preference for inflation stability vis-à-vis output stability. For a greater preference for output stability, parsimonious increases in interest rates should be greater to combat supply shock. Thus, accommodating the shock and preserving output and employment is preferred. This notion follows conclusions from authors such as Bernanke/Mishkin (1997), Svensson (1997), Ball (1999a) and Clarida et al. (1999).

Ball (1999b) and others demonstrate why an IT regime should be flexible in open economies. Generally, exchange-rate variations create a pass-through effect on the prices for goods and services, which alters the monetary policy and affects both the output dynamic and exchange-rate behaviour, increasing the latter's volatility. Thus, the author

1. However, Brazil moved its inflation target over the first years of the regime. Such a target became stable only from 2005, at 4.5 per cent per year, based on the Broad Consumer Prices Index.

proposes that a CB should use a price index to define the regime, which will purge the effects from transitory variations in the exchange rate on market price formation. That is, a CB should consider an inflation target for a price index with a measurement consistent with an equilibrium exchange rate, excluding the temporary effects from exchange-rate valuations and devaluations. Obviously, such a strategy is conceptually and technically difficult due to the definition of and estimation for an equilibrium exchange rate. However, the strong relationship between exchange rates and interest rates, particularly between the exchange-rate and interest-rate differential (domestic and external), promotes side effects such as variations in the latter through multiple relevant economic variables. An IT regime that undergoes recurring supply and exchange-rate shocks and is not sufficiently flexible will inevitably create a trend of exchange-rate volatility, which generates clear instability in the economy.

2.2 Fiscal policy regimes and primary surpluses

Governments must manage their intertemporal budget constraints. Flow for different types of non-financial payments (not resulting from debt) and financial payments (resulting from debt) must be accounted for, either through taxes, new debt or issuing currency ('seigniorage revenue'). The conventional literature establishes two coordination regimes for fiscal and monetary policies: a *Ricardian* regime and a *non-Ricardian* regime.

In a Ricardian regime, the public sector budgetary constraint is satisfied without issuing currency (Sargent 1982). The government should adjust its fiscal balance over time to maintain solvency, where monetary policy follows its own path and is not subordinate to fiscal or policy stimuli. In this regime, monetary policy is active, and fiscal policy is passive; this instance illustrates monetary dominance (Leeper 1991).

In a non-Ricardian regime, the government satisfies its budget constraint over time and influences the monetary policy trajectory through issuing currency or interest-rate adjustments (Sargent 1982; Aiyagari/Gertler 1985). The public sector honours its payments not only through adjusted fiscal balances but also through passivity or subordination to monetary policy. Thus, in this regime, fiscal policy is active, and monetary policy is passive. In this case, there is fiscal dominance. Moreover, authors such as Woodford (1995) and Cochrane (2001) associate non-Ricardian regimes with conditions wherein fiscal policy can influence the inflation trajectory by affecting current or expected monetary policy; this is the *fiscal theory of the price level*.

Particularly for Brazil, the debate on primary surplus policy² follows the perspective of conventional literature, which imposes the requirement for accumulating a primary fiscal balance surplus from the public sector to honour financial commitments (that is, to maintain attractiveness, public debt solvency or GDP stability).

Giambiagi/Ronci (2004) propose a 'Law of Fiscal Solvency' for the country that would combine with the Fiscal Responsibility Act and force the Brazilian public sector to adopt the minimum primary surpluses necessary for medium-term public debt sustainability as a proportion of GDP. The underlying notion is that both proper institutional mechanisms and understanding the social importance of fiscal adjustment by the authorities and politicians are necessary to adopt primary surpluses under temporal credibility and consistency

2. Primary balances are the public sector balances, discounting nominal interest payments from public debt; nominal balances include these financial payments. Recently, Brazil has generated primary surpluses (positive primary balances) but nominal deficits (negative nominal balances) because the nominal interest account is larger than the primary balances.

conditions, which reduces the trade-off between fiscal adjustment and economic growth. Thus, larger primary surpluses would accompany a declining trend in inflation expectations, short-term interest rates and public debt as a proportion of GDP in a virtuous circle of sustained growth.

However, from this perspective, the following aspects were ignored: (i) the nature of inflationary shocks to the economy over time; (ii) the CB response to such shocks in an IT regime; (iii) transmitting the response to fiscal balances and the public debt dynamic over time; (iv) the impact of such elements on the economic activity dynamics and, consequently, on the trajectory of relevant fiscal variables related to the GDP; and (v) the potential for a *structuralist channel* of inflation, wherein higher interest rates induce oligopolistic sectors to pass along greater financial costs to the prices, which render the monetary policy effect on inflation ambiguous.

Aspects (i) and (ii) are due to combined inflation targeting and inflationary supply or exchange-rate shocks. Authors such as Ball (1999a; 1999b), Clarida et al. (1999), Svensson (1999) and Eichengreen (2002) show that when an economy encounters inflation shocks that are not due to economic activity dynamics, an anti-inflationary response through monetary policy can produce an undesirable impact. Supply or exchange-rate shocks generate a trade-off between inflation volatility and output volatility, wherein reducing the level of inflation implies reduced economic activity because the inflationary shock did not originate from aggregate demand. If an IT regime does not provide mechanisms to accommodate such shocks or such mechanisms are very tight, the economy can survive with the inevitable high short-term interest-rate trend under recurrent supply or exchange-rate shocks.

Strachman (2009) showed that regulated prices in Brazil (for example, fuel, energy, public transport and rent prices), which are highly sensitive to exchange-rate and international price variations, can perpetuate high interest rates when the country maintains ambitious inflation targeting. Thus, in countries with a strong pass-through effect (that is, passing along exchange-rate variations to the price of goods and services) and inflation targeting that does not expurgate the effect of price indices adopted as a monetary policy guide, such as in Brazil, higher primary surpluses may be accompanied, paradoxically, by greater nominal deficits, public debt/GDP and interest rates as well as weak economic activity; this results in conflict with predictions by primary surplus target defenders (for example, Giambiagi/Ronci 2004). Therefore, the overvaluation of the domestic currency can be an important intermediate target of the CB, so that it contributes to the convergence of the inflation rate to its target over time and to increase the standard of living of the population, despite the negative impacts of such an overvaluation on the industrial development (Bresser-Pereira 2013).

Aspects (iii) and (iv) are used to analyse how the IT regime response impacts the fiscal dynamics under cost or exchange-rate shocks. If public debt is tied to short-term interest rates, which compose monetary policy instruments, then combating recurrent inflationary shocks can produce a reduced economic activity dynamic and deteriorate the public sector's fiscal results and indicators. In this instance, imposing a *Ricardian* regime on an economy with supply and exchange-rate price shocks and under a 'tight' IT regime may yield increasing and continuous social costs through slow economic growth and periodic near-insolvency in the public sector, despite significant primary balances.

For aspect (v) and under inflationary pressures, an increase in the CB's interest rates may increase the agents' financial costs and raise the inflation rate through the *Wright Patman effect* (Kriesler/Lavoie 2007). Particularly for post-Keynesians and post-Kaleckians, inflation has a strong and systematic cost component.

An inflexible IT regime combined with recurrent inflationary shocks that do not originate from aggregate demand and a Ricardian regime may negate rising primary

surpluses. Such conditions may also be introduced through fiscal and output behaviours that are less observable than under an alternative policy regime. Such conditions are more relevant because they are rarely or never considered by conventional literature, especially the recessive effect of primary surpluses and ambiguous effects of interest rates on inflation dynamics. Alternatively, fiscal and monetary policies could be combined to include a counter-cyclical primary surplus regime and a more flexible IT regime under supply and/or exchange-rate shocks. This policy combination will be analysed through the model proposed and tested using computer simulations below. However, it is necessary to first consider exchange-rate dynamics.

2.3 A floating exchange rate, capital mobility and economic dynamics

In open economies, particularly for developing economies, a floating exchange-rate regime combined with capital mobility without a payment balance provides a strong correlation between variations in basic domestic interest rates and exchange rates over time.

Considering a global market with short-term capital (portfolio) that adjusts almost instantaneously, changes in the domestic and external interest-rate differentials introduce changes to highly liquid resource allocation decisions by global financial operators. Such changes impact short-term capital flow and exchange rates in a domestic economy. A floating exchange rate and strong capital mobility are associated with greater exchange-rate volatility, external vulnerability and loss of autonomy in domestic fiscal and monetary policies, especially for emerging economies (Tobin 1978; Eichengreen et al. 1995; Ferrari-Filho/Paula 2009).

According to Eichengreen (2002), emerging economies with inflation targeting are particularly affected by high interest rates under a floating exchange rate and capital mobility due to 'fear of floating'. 'Fear of floating' describes conditions where monetary authorities are averse to currency depreciation because they prefer to pass inflation to the consumer through the pass-through effect, which impedes inflation target aims. In this case, high domestic interest rates maintain domestic currency appreciation and facilitate inflation stability, although CBs may not indicate such a result. The large domestic and external interest-rate differential enhances the search for foreign investors in such domestic bonds. The resulting short-term capital influx promotes national currency appreciation and downward pressure on consumer inflation.

Likewise, due to policy factors and the international economy, changes in confidence for foreign investors who do not have a direct relationship with the economic fundamentals of emerging economies may seriously impact the behaviour of interest-rate and exchange-rate differentials, affecting monetary and fiscal policies for those economies.

Speculative processes against domestic currencies and capital inflows force the CBs to adjust interest rates to prevent unwanted currency depreciation and inflationary deviations related to the adopted targets. The impact of this response on fiscal balances is clear: higher nominal interest payments by governments and growth in nominal deficits force fiscal authorities to increase primary surpluses to stabilise the public debt–GDP ratio.

The response to exchange-rate shocks by an increase in interest rates and higher primary surpluses combines to produce a significant depressing effect on the output dynamic. In this case, through both exchange-rate and supply shocks, the economic policy tripod, based on inflation targeting, primary surpluses and a floating exchange rate (with short-term capital mobility), produces a restrictive effect on real activity, employment and income.

At first glance, exchange-rate volatility could be eliminated through a fixed exchange-rate regime or exchange-rate targets. However, as Mishkin (1999) and others argue, an exchange-rate anchor is disadvantageous due to loss of monetary policy autonomy for

managing goals that conflict with the required international capital flow. Maintaining a certain desired exchange rate or exchange rates within a certain desired range requires an interest-rate policy to control the flow of capital and the country's international reserves. Such policies maintain such levels as are necessary and consistent with the required exchange rates.

From 1995 to 1999, the Brazilian economy was a typical example of the loss of monetary policy autonomy in managing domestic goals beyond regulating international flow and dollar reserves. Under such a regime, speculative processes against the domestic currency pushed for exchange-rate devaluations and forced the Central Bank of Brazil to raise the basic interest rate (Selic rate) to prevent short-term capital outflow and maintain the exchange-rate anchor with the dollar. This mechanism was used during crises in Mexico (1995), the Asian tigers (1997) and Russia (1998). Here, the exchange-rate anchor and its maintenance were destabilising and potentiated an economic downturn and external account deterioration.

The literature has analysed alternative mechanisms for containing exchange-rate volatility even with free-floating exchange rates. The remedy is to adopt mechanisms that control foreign capital inflow, particularly for short- and very-short-term capital, such as federal-bond and share investments. For example, minimum time-period requirements can be used to retain incoming foreign capital and/or taxes thereon (Ferrari-Filho/Paula 2009).

However, foreign direct capital (FDI) inflow may be stimulated in the long term to offset the potential for falling short-term capital inflow. Such stimulations would maintain capital account balances, which is especially necessary for economies with deficits in current transactions through payment balances, and reduce reliance on speculative capital. Thus, capital controls do not necessarily prompt a fall in the foreign savings inflow and, therefore, do not necessarily represent economies that have not effected the necessary adjustments to reduce the need for external resources. The purpose of such controls is not to prevent capital surpluses, but to stimulate a less volatile composition of such surpluses (that is, to stimulate a long-term influx of foreign savings), which generates employment and income and has a positive effect on the rest of the economy.

If they are implemented well, policies to control volatile capital can reduce the correlation between interest rates and exchange-rate differential variations. Under such policies, CBs secure more autonomy for implementing policies aimed at realising economic growth and domestic inflation objectives and responding to shocks without generating unwanted exchange-rate movement.

3 A DYNAMIC AND STOCHASTIC SIMULATION MODEL WITH INFLATION TARGETING, PRIMARY SURPLUSES AND A FLOATING EXCHANGE RATE

The following model belongs to the current trend toward using Dynamic Stochastic General Equilibrium (DSGE) models on a small scale. Because such models simulate economic trajectories under different structural parameter combinations, they are important for responding to policy questions for different constraints and/or hypotheses (Walsh 2003). Thus, such models and simulations serve as guides or provide additional information in decision-making for various policies. It is worth stressing that although the following DSGE model presents the basic building blocks of New Consensus Macroeconomics (NCM) models, such as the IS and Phillips curves, as well as a Taylor rule, it also takes into account several other building blocks, which are fundamental to highlighting real macroeconomic trends and allowing an analysis in post-Keynesian terms. This exercise of extending NCM models to more realistic aspects of modern economies, along with the

theoretical particularity of post-Keynesian models, is better considered and explained in Fontana/Setterfield (2009; 2010) and Dullien (2010).

3.1 Fiscal and financial equations for the public sector

The model begins with a *behavioural equation for the consolidated public sector public debt/GDP*:

$$\phi_t = \phi_{t-1} + \alpha_1(j_t - sp_t) + \varepsilon_{1t}, \quad (1)$$

where ϕ_t is the public debt/GDP during period t , j_t is the nominal interest rate paid by the government, and sp_t is the primary surplus; both are a proportion of GDP. Let $\alpha_1 > 0$ and ε_{1t} be a random shock with a zero mean and constant variance (white noise shock). The value for $(j_t - sp_t)$ is the government's nominal deficit. Thus, the *interest paid* is defined as follows:

$$j_t = \alpha_2 i_t \phi_{t-1} + \varepsilon_{2t}, \quad (2)$$

where i_t is the nominal short-term interest rate set by the CB, ϕ_{t-1} is the public debt/GDP from period $t - 1$, $\alpha_2 > 0$, and ε_{2t} is a random shock.

In a Ricardian regime, fiscal policy is defined to maintain conditions for government solvency, and monetary policy is not stimulated by fiscal means. Primary payments and government interest payments are not financed by seigniorage revenue nor through changes in the basic interest rate, which is consistent with the IT regime. Thus, primary surplus is defined to stabilise the public debt/GDP. The fiscal policy rule (that is, the rule of the Consolidated Public Sector's primary surplus) is as follows:

$$sp_t = sp_{t-1} + k(\phi_{t-1} - \phi_{t-2}) + \varepsilon_{3t}. \quad (3)$$

The primary surplus in t is greater than $t - 1$ in accordance with the value of ϕ_{t-1} over ϕ_{t-2} . k is a positive coefficient that measures the fiscal policy sensitively relative to past variations in the public debt/GDP, and ε_{3t} is a random fiscal policy shock.

3.2 Determining economic activity and inflation

It is necessary to specify how the economic activity and inflation dynamics are determined. The following is a dynamic IS function:

$$Y_t = Yp + \beta_1(Y_{t-1} - Yp) - \beta_2(i_{t-1} - i_{t-2}) - \beta_3(sp_t - sp_{t-1}) + \beta_4(e_{t-1} - e_{t-2}) + g_{1t}. \quad (4)$$

Y_t is the output growth rate during period t , Yp the potential output growth rate, i_{t-i} the nominal short-term interest rate observed during period $t - i$, sp_{t-i} is the primary surplus during period $t - i$, e_{t-i} is the nominal exchange rate during period $t - i$, and g_1 is a demand shock with a zero mean and constant variance (white noise). The parameters β_1 , β_2 , β_3 and β_4 are positive. Furthermore, a *structuralist dynamic Phillips* equation is used:

$$P_t = P^T + \delta_1(P_{t-1} - P^T) + \delta_2(Y_{t-1} - Y_{t-2}) + \delta_3(i_{t-1} - i_{t-2}) + \delta_4(e_t - e_{t-1}) + g_{2t}. \quad (5)$$

P_t is the current inflation rate, and P^T is the inflation target. The equation indicates that current inflation depends positively on past inflation deviations from the target as well as

past variations in the output growth rate and short-term interest rate, which describes the *structural inflation rate*. This model is consistent with post-Kaleckian and post-Keynesian cost inflation models. In addition, current variation in the exchange rate positively affects inflation or π_t . The parameters δ_1 , δ_2 , δ_3 and δ are positive, and g_{2t} is a supply shock with a zero mean and constant variance.³

Furthermore, CBs increase interest rates to control inflation through activity contraction, which may generate the opposite effect for prices through financial cost inflation, which primarily depends on the relative values of the parameters β_2 , δ_2 and δ_3 .

3.3 Monetary policy rules under inflation targeting

The CB has monetary policy rules for inflation targeting, which follow the traditional Taylor rules, wherein economic activity and inflation deviations are the primary factors considered.

$$i_t^T = r^* + P^T + [\lambda_1(Y_{t-1} - Y_{t-2}) + \lambda_2(P_{t+1}^e - P^T)] \quad (6)$$

i_t^T is the optimal target for short-term interest rates at t , which is defined by the CB; r^* is an *exogenous or conventional* interest rate that is observed when $Y_{t-1} = Y_{t-2}$ and $P_{t+1}^e = P^T$;⁴ P_{t+1}^e is the expected inflation for the $t + 1$ period, while P^T is the *inflation target*; and λ_1 and λ_2 are positive parameters, and λ_2 is higher than unity (that is, the Taylor principle).⁵ We will regard the inflationary expectations as presenting a simple adaptive behaviour, such that:

$$P_{t+1}^e = P_{t-1}. \quad (7)$$

That is, the expected inflation for the $t + 1$ period is assumed to be equal to the observed inflation in the $t - 1$ period. Moreover, the CB is assumed to adjust short-term interest rates by especially weighting previously adopted values, the ‘interest rate smoothing’ (Galí/Gertler 2007: 37).

$$i_t = (1 - \rho)i_t^T + \rho i_{t-1} \quad (8)$$

i_t is the effective interest-rate target charged by the CB and ρ is the coefficient (greater than zero) for interest-rate smoothing, which provides the weight for i_{t-1} to form the current basic rate.

3. Equations (4) and (5) can be specified in forward-looking terms, thereby including expectations regarding future output growth and inflation respectively. However, the empirical literature is consistent with backward components or inertia in output and inflation over time.

4. To be consistent with the principles of the Keynes’s *General Theory* (1936), we adopt the notion of an exogenous (or a conventional) interest rate, instead of adopting the mainstream concept of natural interest rates. Under the former definition, the current model becomes compatible with post-Keynesian ideas, such as in Moreira (2011).

5. Therefore, the Taylor principle is defined in *ex post* terms, because only lagged inflation is added into the monetary policy rule. It is noteworthy that this is the original modelling in Taylor (1993: 202), as it included the previous inflation as ‘a proxy for expected inflation’ (emphasis added). In contrast, a rule with inflationary expectations applies the Taylor principle in *ex ante* terms.

3.4 Interest-rate parity and exchange-rate formation

International investors behave speculatively when they encounter various fixed income securities options, and they consider the interest differentials and potential variations in exchange rates between currencies and sovereign risks. Thus, interest-rate parity is assumed:

$$i_t = i_t^* + \tau(e_{t+1}^e - e_t). \quad (9)$$

i_t^* is the foreign interest-rate reference, e_{t+1}^e is the expected exchange rate for $t + 1$; and e_t is the current exchange rate. The positive parameter τ indicates domestic interest-rate sensitivity to variations in the expected exchange-rate differential. Using the exchange-rate expectation as determined by the exchange rate in $t - 1$ ($e_{t+1}^e = e_{t-1}$)⁶ and isolating the current exchange rate yields the following rule of inverse correlation between exchange and interest rates with a random exchange-rate shock (white noise):

$$e_t = e_{t-1} - \tau^*(i_t - i_t^*) + \varphi_t. \quad (10)$$

Equation (10) shows an inverse correlation between the interest-rate differential ($i_t - i_t^*$) and the current exchange rate as $\tau^* = (1/\tau) > 0$. Given the past exchange rate and international interest rate, exchange-rate appreciation (decline) accompanies an increase in the basic domestic interest rate, and an exchange-rate depreciation (increase) accompanies a reduction in the basic domestic interest rate. Such variations are due to the stylised speculative behaviour of international investors. An increased differential renders domestic fixed income assets more attractive relative to purchasing foreign assets, which force an exchange-rate reduction, given the enhanced foreign-exchange inflow.

The parameter τ^* is important because it yields the exchange-rate sensitivity to interest-rate differential changes. For enhanced short-term foreign capital mobility, τ^* is greater. In theory, measures to control and restrict short-term capital mitigate exchange-rate volatility upon changes in the interest-rate differential and investors' risk perception, which reduces τ^* . Finally, the component φ_t (a shock with a zero mean and constant variance) expresses non-systematic factors that modify the current exchange rate, such as changes in risk perception by foreign investors and in international financial policy.

4 METHODOLOGY AND SIMULATION RESULTS

4.1 Methodology

The computer experiments were performed for two alternative policy regimes. The economy's dynamic trajectories were simulated through *calibration*, which comprises adopting certain values for the parameters and initial system conditions. Thus, convergence or relative correspondence is verified for the simulation results and certain *stylised facts*⁷ (that

6. An assumption such that $e_{t+1}^e = e_{t-1}$ should be regarded as an analytical solution for a complex phenomenon. Indeed, other specifications were possible, but it would increase the number of parameters in the model, so that the computational simulation would become more complex. On the other hand, it is known that the exchange rate has some inertia over time. Thus the assumption $e_{t+1}^e = e_{t-1}$ is appropriate from an empirical perspective.

7. See Hansen/Heckman (1996).

is, regular relationships or phenomena among relevant variables, which are, therefore, predictable through economic science).

In a *conventional* economic policy regime, the economy encounters the following policies:

1. *aggressive inflation targets*: low accommodation for supply and exchange-rate shocks, which are expressed through higher λ_2 values ($\lambda_2 = \lambda_2^c$ under a conventional regime) and lower ρ values ($\rho = \rho^c$ under a conventional regime);
2. *orthodox rule of primary surpluses*: given by equation (3), wherein the primary surplus is set through variations in the public debt/GDP; and
3. *strong speculative capital mobility (absence or semi-absence of short-term capital controls)*: changes in the interest-rate differential and foreign investor perceptions create strong exchange-rate volatility, which is expressed through high τ^* values ($\tau^* = \tau^{*c}$ under a conventional regime).

In contrast, a *non-conventional* economic policy regime comprises the following:

1. *flexible inflation targets*: high accommodation of supply and exchange-rate shocks, which are expressed through lower λ_2 values ($\lambda_2 = \lambda_2^n$ under a non-conventional regime) and higher ρ values ($\rho = \rho^n$ under a non-conventional regime);
2. *counter-cyclical rule of primary surpluses*: substituting (3), this notion is expressed as follows:

$$sp_t = sp_{t-1} + k(\phi_{t-1} - \phi_{t-2}) + k'(Y_{t-1} - Y_{t-2}), \quad (3')$$

where the primary surplus in t is set by variations in the public debt/GDP and the rate of GDP growth given a positive parameter k' ; and

3. *low speculative capital mobility (adoption of short-term capital controls)*: the exchange rate is less volatile for changes in the interest-rate differential and investor perceptions, which is reflected in lower τ^* values ($\tau^* = \tau^{*n}$ under a non-conventional regime). Thus, the two regimes are described in Table 1.

Both regimes were applied to the model composed of the above equations, and two basic types of shocks were imposed: (i) inflationary supply shock, which is represented by a positive value for the random disturbance g_2 at a certain point during the simulation; and (ii) an exchange-rate devaluation shock, which is represented by a positive value for the random disturbance ϕ_t at a certain point.

Thus, Table 2 shows the values for the initial parameters and conditions used in the simulations under the two regimes and for the two shock sources (supply and exchange rate).

It should be emphasised that the only concern was to adopt values that would not generate hypersensitivities in the structural relationships for the studied system (that is, values that are consistent with stability for the relevant variables). Moreover, the values in Table 2 describe one among several possible combinations. However, it can be inferred that many combinations can produce a similar range of results as herein, which may yield similar qualitative results as reported and analysed below. Thus, although the results are not necessarily universal, they indicate relative or conditional strengths.⁸

8. The current values for g_t and ϕ_t allow a clear graphical view of the dynamic implications from each such shock. Smaller (or bigger) values for the shocks are possible.

Table 1 Conventional and non-conventional economic policy regimes faced with supply and exchange-rate shocks

	Conventional regime	Non-conventional regime
Monetary policy	λ_2^c and ρ^c	λ_2^n and ρ^n with $\lambda_2^c > \lambda_2^n$ and $\rho^c < \rho^n$
Fiscal policy	$sp_t = sp_{t-1} + k(\phi_{t-1} - \phi_{t-2})$ (3)	$sp_t = sp_{t-1} + k(\phi_{t-1} - \phi_{t-2}) + k'(Y_{t-1} - Y_{t-2})$ (3')
Short-term capital mobility	Strong mobility: τ^{*c} (absence of or few capital controls)	Low mobility: τ^{*n} with $\tau^{*c} > \tau^{*n}$ (significant capital controls)

Source: Own elaboration.

Table 2 Values for the initial parameters and conditions

sp_{t-1}	$\phi_{t-1,t-2}$	α_1	α_2	k'	κ
3.0	50.0	0.7	0.01	0.5	0.5
Yp	β_1	β_2	β_3	β_4	δ_1
5.0	0.8	0.3	0.4	0.5	0.7
δ_2	δ_3	δ_4	r^*	P^T	λ_1
0.1	0.6	0.7	2.0	4.0	0.5
λ_2^c	λ_2^n	ρ^c	ρ^n	$e_{t-1,t-2}$	$Y_{t-1,t-2}$
1.5	1.2	0.8	0.9	3.0	0.5
i^*	τ^{*c}	τ^{*n}	$g_{2,t+1}$	Φ_{t+1}	$i_{t-1,t-2}$
6.0	0.9	0.2	2.0	1.0	0.6

Source: Own elaboration.

4.2 Results

4.2.1 Supply shock

Figures A1–A5 in Appendix 1 show trajectories for the relevant variables under supply shocks in both regimes; the solid grey curves (—) are for the conventional regime, and dashed black curves (---) are for the non-conventional regime in each graph.⁹

A supply shock at 2.0 percentage points has the primary effect of an abrupt and intense rise in inflation, which is above the 4.0 per cent target for both regimes (6.0 per cent) (Figure A1). However, the monetary policy response is more aggressive for the conventional regime. Thus, the domestic interest rate increased to almost 6.8 per cent. However, in the non-conventional regime, the response is more parsimonious, and the

9. The current comparison could be made alternatively with a type of *loss function*, which would express the social losses as the sum of the squared deviations (for example, of the inflation rate and the GDP growth rate) over time.

interest rate is set at a level near 6.5 per cent (Figure A2).¹⁰ The impact of the different monetary policy responses will also be absorbed differently by the economic activity dynamic.

Under the conventional regime, the economy endures a greater reduction in the GDP growth rate (Figure A3), from 5 per cent to 3.9 per cent, and greater volatility over time until it resumes the trajectory 5 per cent per period. On the other hand, under the non-conventional regime, the GDP growth rate only decreases from 5 per cent to 4.7 per cent, which is a negligible decrease. Furthermore, the rate returns to 5 per cent with increased smoothness over time, compared with the conventional regime.

The public debt–GDP ratio also shows distinct trajectories under both regimes (Figure A4). In the non-conventional regime, under supply shocks, this ratio reached higher levels (50.74 per cent) compared with observations for the conventional regime (50.58 per cent); although this difference is marginal. The explanation for this difference is largely in the fiscal policy response or primary surplus response under both regimes. In the non-conventional regime, the primary surplus response is counter-cyclical (equation 3'), whereas the response is Ricardian (equation (3)) under the conventional regime.

Thus, similar to greater primary surplus growth, the debt–GDP ratio increases by a smaller amount under the conventional regime but with a negative impact on economic activity, which contributes to the large decrease in the GDP growth rate (Figure A3). In the non-conventional regime (equation 3'), the primary surplus is also calibrated for variations in the GDP growth rate. As the monetary policy response reduces the economic activity, the primary surplus growth decreases with a rise in the public debt–GDP ratio. This reflects positively on economic growth and contributes to a smaller decrease in the GDP growth rate.

The exchange rate is more significantly affected under the conventional regime (Figure A5). It decreases from 3 monetary units (m.u.) to 0.28 m.u. and stabilises at 0.83 m.u. (that is, the exchange rate significantly appreciates), which also contributes to the deleterious effects on the GDP growth rate. This appreciation under the conventional regime is due to the absence of capital controls. In this case, the interest-rate differential imposed by a monetary policy in response to an inflationary shock increases the inflow of short-term foreign capital, which depreciates foreign currency on a large scale.

In the non-conventional regime, the exchange-rate appreciation is moderate. The exchange rate falls gently to 1.96 m.u.; while this may be harmful to economic activity, the effect is lower compared with the conventional regime. Adopting short-term capital controls decreases the exchange-rate sensitivity to changes in interest-rate differentials imposed by the CB; such differentials are inclusive and smaller in the non-conventional regime, given the regime's greater flexibility for inflation targeting under supply shocks.

4.2.2 *Exchange-rate shocks*

Figures A6–A10 in Appendix 2 show the trajectories for the relevant variables under exchange-rate shocks in both comparison regimes; the solid grey curves (—) are for the conventional regime, and the dashed black curves (– –) are for the non-conventional regime in each graph.

The exchange-rate shock at 1.0 percentage point imposes different trajectories on the economy depending on the policy regime response. Initially, for the conventional case, the

10. Although such an interest-rate value can be uncommon in developed countries, especially those with the problem of 'zero lower bound', several emerging economies present high (nominal and real) interest-rate levels, including Brazil.

exchange rate depreciates, and the inflation rate consequently rises (through the pass-through effect), which goes from a rate of 4.0 per cent to 4.7 per cent (Figure A7). These primary effects are the same as observed for the non-conventional regime.

However, beginning with the monetary policy response and investor arbitration responses to changes in interest-rate differentials, the two regimes develop differently. In the conventional regime, which operates under a rigid framework of inflation targeting, the domestic interest rate increases from 6.0 per cent to 6.32 per cent. However, in the non-conventional regime, wherein the inflation targeting framework is more flexible, the rate increases from 6.0 per cent to 6.19 per cent (Figure A8). Although this difference is small, its effects on the economic activity dynamic and exchange rate are significant.

The primary effect from the exchange-rate devaluation is an increase in the GDP growth rate (Figure A9) via liquid exports. In both regimes, it increases from 5.0 per cent to a peak of 5.5 per cent per period. However, in the conventional regime, after the greater monetary tightening, the growth rate reduces by 0.7 percentage points (5.5 per cent to 4.8 per cent) in only four periods. Under the non-conventional regime, the monetary policy response is consistent with a 'soft landing' for the growth rate; after approximately 11 periods, the rate returns to its stationary value (5 per cent) without presenting lower values. The higher volatility or output instability for the conventional regime is dramatic compared with the alternative regime.

The public debt–GDP ratio (Figure A10) initially increases slightly under the conventional regime (from 50 per cent to 50.22 per cent), while it decreases almost immediately under the alternative regime (50 per cent to 49.9 per cent). Such differences are marginal, but the underlying rationale is enlightening. The fiscal policy response from the non-conventional regime is counter-cyclical, which indicates that a higher primary surplus is the initial response to the increased GDP growth. Because monetary tightening due to such expansion is more parsimonious compared with the conventional regime, the alternative regime generates a nominal surplus from period 5 to period 6.

The conventional regime produces a nominal deficit (debt interest greater than the primary surplus) from period 4 to period 8 such that the public debt–GDP ratio rises in this interim. Although the trend value (50 per cent) for this ratio stabilises under both regimes and the short-term cyclical differences are marginal (up to 0.32 percentage points), such differences may be significant where the parameters α_1 , α_2 and k are greater α than the values adopted therein.

Finally, the exchange-rate trajectory is unfavourable under the conventional regime (Figure A6); while the exchange rate stabilises at 3.64 m.u. in the alternative regime, it remains at 3.24 m.u. in the conventional regime and through increased volatility. This difference is primarily due to the short-term capital control mechanisms coupled with a more flexible monetary policy in the first instance. Such conditions yield lower interest differentials and exchange-rate sensitivity to such differentials. In response to exchange-rate shocks, the conventional regime requires higher interest differentials and higher exchange-rate sensitivity to such differentials because it does not include control mechanisms for speculative inflow.

5 CONCLUDING REMARKS

Supply and/or exchange-rate shocks can have different impacts on dynamics for an economy's relevant variables, depending on policies' response to such deviations. Although the policies for inflation targeting, primary surpluses and a floating exchange rate have advantages (and disadvantages) for an economic policy, it is important that such policies are properly calibrated to minimise the resulting instabilities.

Generally, based on the proposed model and simulations herein, short-term foreign capital controls with a counter-cyclical fiscal policy and flexible monetary policy can compose an economic policy response that mitigates the destabilising effects of exchange-rate and supply shocks over time.

Recently, the Brazilian economy simultaneously adopted inflation targeting, primary surplus and free-floating exchange-rate policies. However, it has not yielded a superior performance since 1999 (on average) compared with countries such as China and India. Certain relevant variables may support this difference, but such considerations are too numerous for the analysis herein.

Particularly in 2011, excessive appreciation of the Real against the US dollar was extensively discussed as an effect from the high interest differential between the Brazilian and foreign rates. The inflationary band of rates for Brazil's IT regime already works as a mechanism for flexibility under supply and exchange-rate shocks. However, the country's performance could be enhanced if effective mechanisms for controlling speculative capital and a primary surplus policy with a counter-cyclical rule were adopted.

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APPENDIX 1 THE DYNAMICS OF RELEVANT VARIABLES UNDER CONVENTIONAL (—) AND NON-CONVENTIONAL (---) REGIMES AND A SUPPLY SHOCK

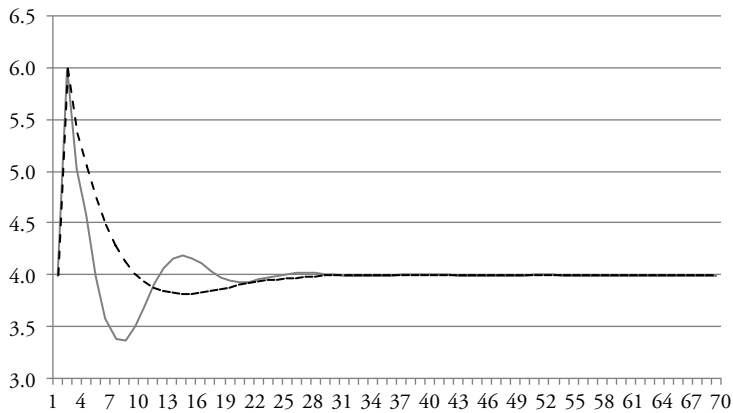


Figure A1 Rate of inflation (P) under a supply shock

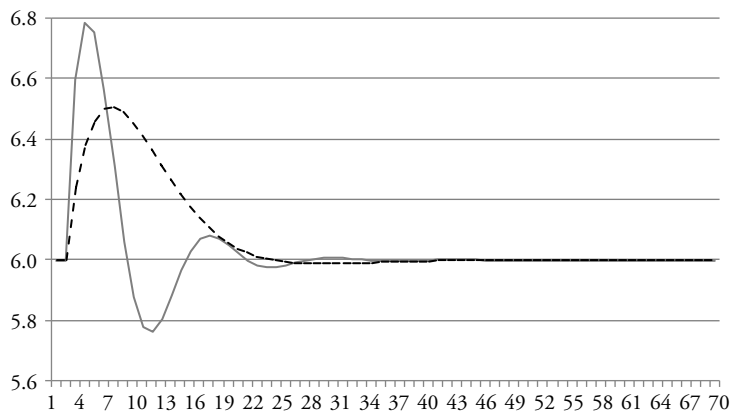


Figure A2 Domestic interest rate (i) under a supply shock

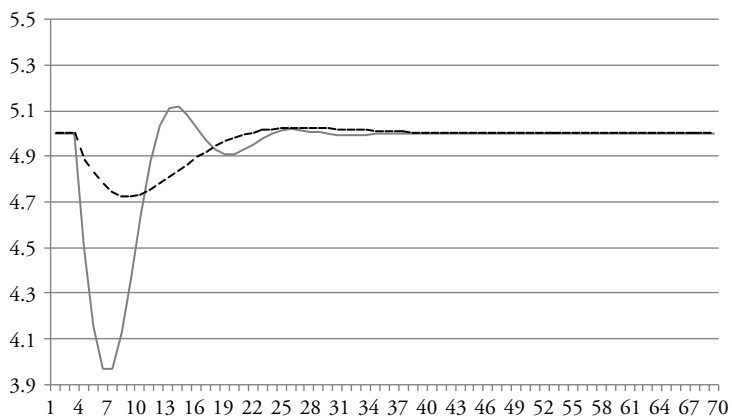


Figure A3 GDP growth rate (Y) under a supply shock

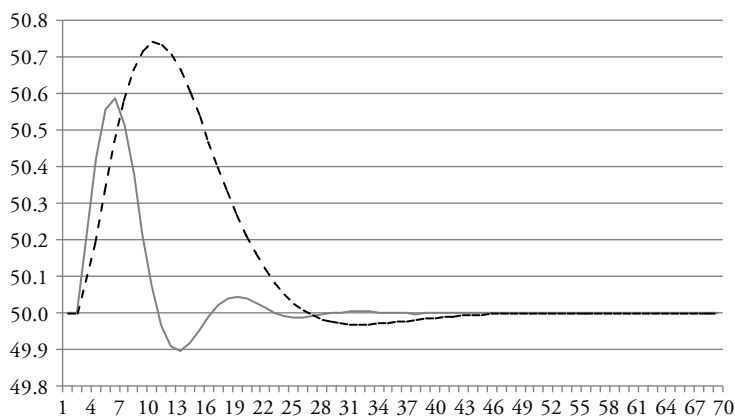


Figure A4 Public debt/GDP (ϕ) under a supply shock

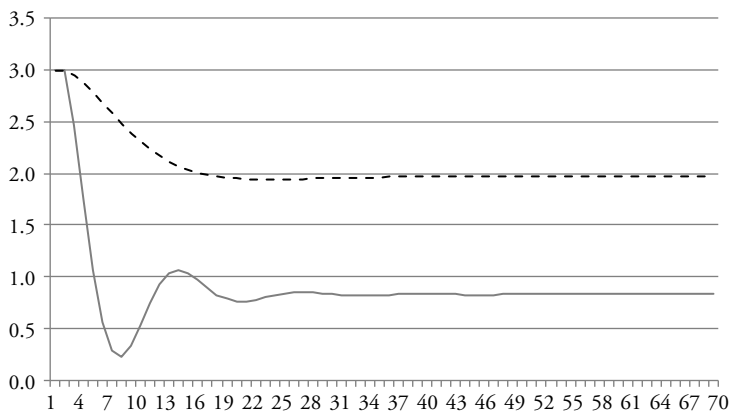


Figure A5 Exchange rate (e) under a supply shock

APPENDIX 2 THE DYNAMICS FOR RELEVANT VARIABLES UNDER CONVENTIONAL (—) AND NON-CONVENTIONAL (- -) REGIMES AND AN EXCHANGE-RATE SHOCK

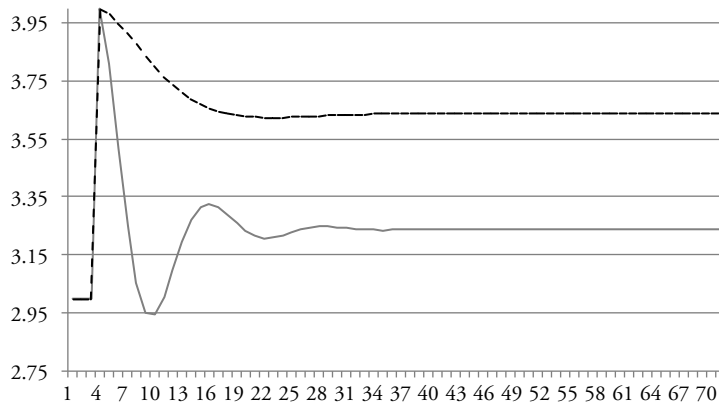


Figure A6 Exchange rate (e) under an exchange-rate shock

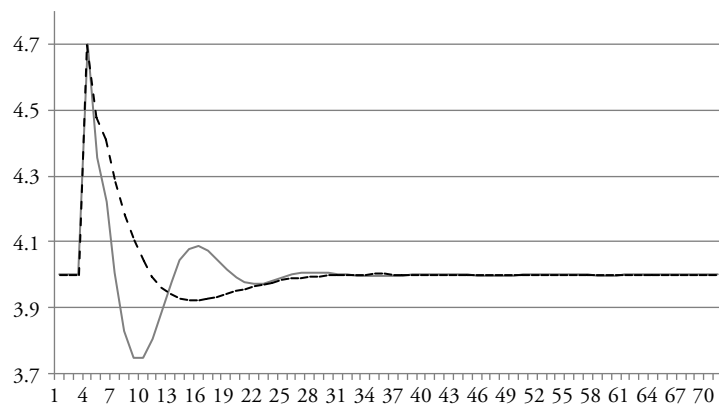


Figure A7 Rate of inflation (P) under an exchange-rate shock

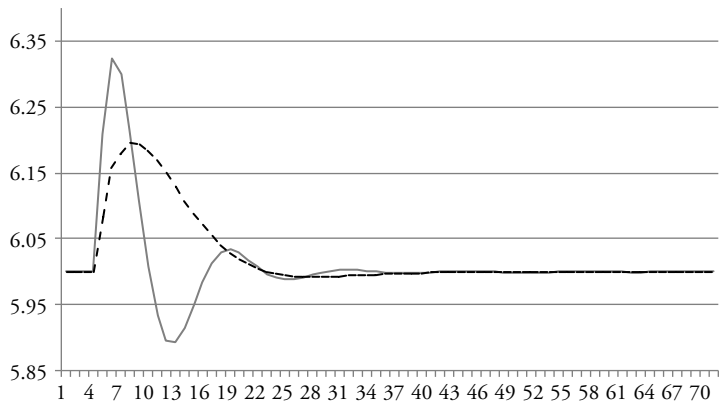


Figure A8 Domestic interest rate (i) under an exchange-rate shock

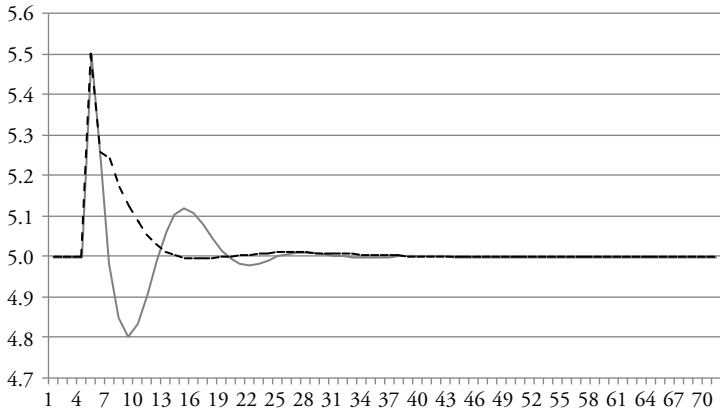


Figure A9 GDP growth rate (Y) under an exchange-rate shock

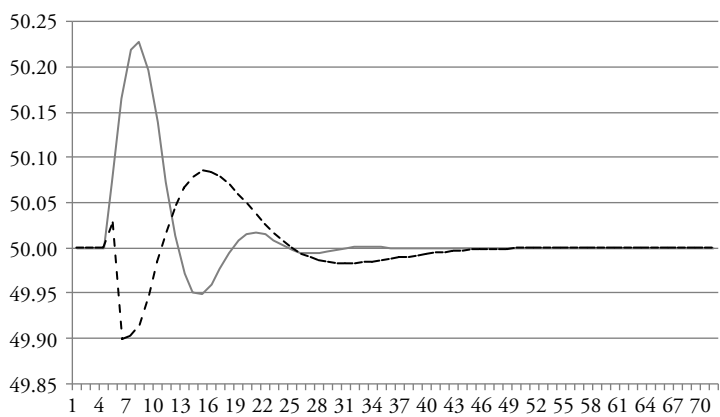


Figure A10 Public debt/PIB (ϕ) under an exchange-rate shock