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**COMPETING MONIES IN GUATEMALA: WHAT  
SHOULD WE EXPECT?**

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## **BANCO DE GUATEMALA**

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# COMPETING MONIES IN GUATEMALA: WHAT SHOULD WE EXPECT?

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On December 2000, the National Congress of Guatemala enacted a bill named "Ley de Libre Negociación de Divisas", which makes it legal to trade in any foreign currency, eliminates the legal tender feature of the "quetzal" (the Guatemalan national currency), and allows the domestic banking sector to engage in financial intermediation operations denominated in any foreign currency. This law will be effective on May 1, 2001.

This paper develops a model intended to analyze the effects of the new law on the Guatemalan economy. In particular, a dynamic, perfect-foresight, general equilibrium model of a small-open economy with imperfect capital mobility is solved. The change in the legal regime is modeled as a change in some preference parameters. The model shows that, in the most plausible scenario, we should not expect to observe very important macroeconomic or foreign-exchange effects at the time when the new law becomes effective.

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## 1 INTRODUCTION

On December 2000, the National Congress of Guatemala enacted a bill named "Ley de Libre Negociación de Divisas", which makes it legal to trade in any foreign currency, eliminates the legal tender feature of the "quetzal" (the Guatemalan national currency), and allows the domestic banking sector to engage in financial intermediation operations denominated in any foreign currency. This law is to be effective on May 1, 2001.<sup>1</sup>

As a matter of fact, the US dollar has been used for several years in Guatemala as a unit of account, deposit of value, and/or medium of exchange in a limited but important subset of economic transactions. Nevertheless, the enactment of the new law has caused a lively discussion in Guatemala regarding its possible immediate effects on the main macroeconomic and monetary variables. The basic premise in the discussion seems to be that the new law will encourage the process of currency substitution (the US dollar replacing the Guatemalan quetzal) to an extent greater than what is already observed.<sup>2</sup>

This paper develops a model intended to analyze the effects of the new law on the Guatemalan economy. The model shows that, in the most plausible scenario, we should not expect to observe very important macroeconomic or foreign-exchange effects at the time when the new law becomes effective.

We will now comment on the main features of the analytical framework used in the paper. We develop a dynamic, perfect-foresight, general equilibrium model of a small-open economy with imperfect capital mobility.<sup>3</sup> There are four sectors in the model: the households, the domestic banking sector, the offshore banking sector, and the government.

There is a continuum of identical households, each of which is endowed with a constant amount of the unique consumption good per period and with initial stocks of six different types of monetary assets: quetzal-denominated currency, dollar-denominated currency, quetzal-deposits, dollar-deposits in the domestic banking sector, dollar-deposits in the offshore banking sector,

<sup>1</sup>Congreso de la República de Guatemala (2000).

<sup>2</sup>See, for example, CIEN (2001), Facultad de Ciencias Económicas (2001), and Sosa (2001).

<sup>3</sup>In essence, we present a portfolio-allocation model for analyzing currency substitution, in the tradition of Calvo (1996a) and other references therein. However, the way we model the imperfect capital mobility feature is different from the most usual approaches that can be found in the relevant literature (as will become clear below.)

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and foreign deposits. The representative household gets utility from consumption and from holding stocks of the monetary assets mentioned above. These monetary assets produce liquidity services and are imperfect substitutes for one another. The household makes a consumption/investment decision each period in order to maximize the present value of its utility; it also decides how to allocate its wealth among the different monetary assets.

It is important to notice that the household cannot have a short position in any asset (either domestic or foreign.) This restrictive assumption is introduced to make it possible for the domestic interest rate to be permanently influenced by the central bank (an apparent feature of the Guatemalan economy.)<sup>4 5</sup>

The domestic banking sector is perfectly competitive. It gets funds on deposit from the households and invests those funds on public bonds, bar a reserve requirement. Both deposits and bonds can be denominated in either quetzals or dollars. The offshore banking sector is also perfectly competitive. It also gets funds on deposit from the households and invests those funds on public bonds, but it operates in dollar-denominated assets only. The offshore banking sector is not subject to a legal reserve requirement, but it voluntarily holds a fraction of its deposits in the form of liquid foreign assets. The offshore banking sector is included in the model because its importance is acknowledged (though not quantified) in the Guatemalan financial market.<sup>6</sup> Again, both the domestic banking sector and the offshore one are precluded from borrowing from abroad in order to preserve the 'imperfect capital mobility' feature of the model.

The public sector includes a fiscal authority and a monetary authority. The fiscal authority gives lump-sum transfers to the households or exacts lump-sum taxes from them. There is no public expenditure or public investment in the model, and there are no distortionary taxes (other than inflation.) The monetary authority or central bank issues currency denom-

<sup>4</sup>Since the model is a perfect foresight one, it has no room for 'country risk' (or for any kind of risk.)

<sup>5</sup>If this assumption were relaxed and the household could borrow from abroad, then the domestic interest rate would be necessarily equal (in real terms) to the international one. Even if borrowing from abroad were precluded but the household were allowed to borrow from the domestic credit market, then the domestic real interest rate in steady state could not be different from the subjective discount rate and, hence, could not be an independent policy variable.

<sup>6</sup>See, for example, International Monetary Fund and The World Bank (2000).

inated in quetzals, gets funds on deposit from the domestic banking sector as reserve requirement (in both quetzals and dollars), and issues bonds (in quetzals and dollars.) It devotes the proceeds to foreign-asset accumulation (international reserves) or to transfers to the fiscal authority.

The policy regime in the model is such that the central bank pre-determines the exchange rate and fixes the domestic interest rate, while the fiscal authority's transfers to the households equal exactly the central bank's net interest revenue. This is a particular case of monetary dominance and fiscal accommodation that guarantees that the consolidated government's intertemporal budget constraint holds. In this regime, the central bank's international reserves and the monetary aggregates are endogenously determined in equilibrium. Although the model's policy setup does not literally represent the Guatemalan actual fiscal/monetary policy combination, it is a simplification that underscores the disposition of both the monetary and the fiscal authority to preserve the macroeconomic stability (in particular, the exchange rate and the financial stability) at the time when the new law is to become effective.

The 'monetary-dominance/fiscal-accommodation' feature distinguishes this model from others that also deal with currency substitution. Most of the theoretical literature on currency substitution assumes that seigniorage is a key element in fiscal deficit's financing; moreover, most of the empirical literature deals with historical experiences in which that seems to be the case.<sup>7</sup> However, the law under analysis will become effective in Guatemala in an environment in which the inflation rate has been moderate for ten years: less than 15% a year in the 1991-2000 period, and less than 10% a year in the 1997-2000 period.<sup>8</sup> In addition, the central bank has a historically high level of international reserves (for the country's standards)<sup>9</sup> and has shown a predisposition to use them in order to substantially reduce the exchange rate's volatility.<sup>10</sup>

In the model, the effect of the new law in question is to cause an increase in the share parameter in the utility function corresponding to dollar-deposits in the domestic banking sector and a decrease by the same amount of the share

<sup>7</sup>See, for example, Calvo (1996), Calvo and Végh (1992), ILADES (1992), and references therein.

<sup>8</sup>Banco de Guatemala (2001).

<sup>9</sup>See Banco de Guatemala (2000).

<sup>10</sup>See Edwards (2000).

parameter corresponding to quetzal-deposits.<sup>11</sup> These changes in parameter values are announced four periods before they are materialized (one period representing one month.)<sup>12</sup> The nature of the analytical experiment is the following: the artificial economy is at the original steady state before period 0. On period 0, it is announced that from period 4 on, a new set of parameter values will be effective. The problem is to find the original steady state of the artificial economy, as well as the new steady state and the transition paths for all relevant variables. The analysis focuses on the two relevant steady states and the transition paths between them because it tries to isolate the permanent effects of the new law from the day-to-day operation of the economy. This is also why the model was designed as a perfect-foresight one, and the policy setup was modeled as invariant to the changes implied by the new law.

The remainder of this paper is organized as follows: the second part presents the model and its calibration in detail; the third part presents the solution technique applied and the results obtained; and the last part contains a conclusion that wraps up the main ideas in the paper.

## 2 THE MODEL

The following perfect-foresight model corresponds to a deterministic, endowment, monetary, small-open economy. There are four sectors: the households, the domestic banking sector, the offshore banking sector, and the government. We now proceed to examine the model's features in detail.

### 2.1 Some Definitions and Conventions

In what follows, the variable  $c_t$  represents consumption;  $m_t$  is the household's nominal domestic currency balance,  $m_{\$,t}$  is its nominal foreign currency balance,  $d_t$  represents nominal domestic quetzal-denominated deposits,  $d_{\$,t}$  represents nominal domestic dollar-denominated deposits;  $d_{\$,off,t}$  represents

<sup>11</sup>The strategy of modeling an increase in one country's level of currency substitution as a change in parameter values of dynamic, general equilibrium models has antecedents in the currency substitution literature; it is used, for instance, in Bufman and Leiderman (1992) and in McNeils and Asilis (1992).

<sup>12</sup>The new law ("Ley de Libre Negociación de Divisas") was enacted on December 2000 and expected to be effective four months later, on May 1, 2001.



nominal offshore dollar-denominated deposits,  $d_{\$,t}^*$  represents nominal foreign dollar-denominated deposits, and  $f_t$  is a nominal quetzal-denominated lump-sum transfer from the government (which, in principle, can be positive, negative, or zero.)

The symbol  $i_{d,t}$  denotes the nominal interest rate on domestic quetzal-denominated deposits,  $i_{d\$,t}$  is the nominal interest rate on domestic dollar-denominated deposits,  $i_{d\$\text{off},t}$  is the nominal interest rate on offshore dollar-denominated deposits, and  $i_t^*$  is the nominal interest rate on all foreign assets (including deposits);  $P_t$  is the price (measured in quetzals) of one unit of the good in period  $t$ , and  $E_t$  is the nominal exchange rate (the price of one dollar in terms of quetzals.)

In period  $t$ , the household chooses the  $t$  value of each asset, taking the  $t - 1$  value of each asset as given.

Interest rates indexed  $t - 1$  clear the financial assets markets in period  $t - 1$  and must be paid in period  $t$ , and those indexed  $t$  clear the markets in period  $t$  and must be paid in period  $t + 1$ .

Lower case variables correspond to the individual household, while capital case variables are aggregate per capita averages.

We assume that the law of one price holds in this economy:

$$P_t = E_t \cdot P_t^*, \forall t \quad (1)$$

where  $P_t^*$  is the foreign price level. Hence, in terms of rates of growth, the following equation holds:

$$1 + \pi_t = (1 + \varepsilon_t) \cdot (1 + \pi_t^*), \forall t \quad (2)$$

where:

$$1 + \pi_t \equiv \frac{P_t}{P_{t-1}} \quad (3)$$

$$1 + \varepsilon_t \equiv \frac{E_t}{E_{t-1}} \quad (4)$$

$$1 + \pi_t^* \equiv \frac{P_t^*}{P_{t-1}^*} \quad (5)$$

Moreover, we assume that the foreign inflation rate is always zero:

$$\pi_t^* = \pi^* = 0, \forall t \quad (6)$$

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Therefore, it must be the case that in this economy the inflation rate is always equal to the rate of devaluation:

$$\pi_t = \varepsilon_t, \forall t \quad (7)$$

Besides, for normalization purposes, we assume that:

$$P_t^* = 1, \forall t \quad (8)$$

and, hence:

$$P_t = E_t, \forall t \quad (9)$$

We also assume that the foreign interest rate is constant and smaller than the subjective discount rate of the household:

$$i_{\$,t}^* = i_{\$}^* \in \left(0, \frac{1}{\beta} - 1\right), \forall t \quad (10)$$

In addition, in order to simplify the notation, we define the following variables:

$$\widehat{m}_t \equiv \frac{m_t}{P_t} \quad (11)$$

$$\widehat{m}_{\$,t} \equiv \frac{E_t \cdot m_{\$,t}}{P_t} \quad (12)$$

$$\widehat{d}_t \equiv \frac{d_t}{P_t} \quad (13)$$

$$\widehat{d}_{\$,t} \equiv \frac{E_t \cdot d_{\$,t}}{P_t} \quad (14)$$

$$\widehat{d}_{\$,off,t} \equiv \frac{E_t \cdot d_{\$,off,t}}{P_t} \quad (15)$$

$$\widehat{d}_{\$,t}^* \equiv \frac{E_t \cdot d_{\$,t}^*}{P_t} \quad (16)$$

$$\widehat{f}_t \equiv \frac{f_t}{P_t} \quad (17)$$

and, in general, a 'hat variable' is the corresponding nominal variable measured in real terms (i.e., measured in units of the consumption good.)

## 2.2 The Household

There is a continuum of infinitely-lived households. Each household has a fixed endowment of  $y$  units per period of the unique, perishable consumption good. The household also has initial stocks of the following financial assets: domestic currency  $m_{-1}$ ; foreign currency  $m_{\$, -1}$ ; domestic, quetzal-denominated deposits  $d_{-1}$ ; domestic, dollar-denominated deposits  $d_{\$, -1}$ ; offshore, dollar-denominated deposits  $d_{\$off, -1}$ ; and foreign, dollar-denominated deposits  $d_{\$, -1}^*$ . The household also gets a nominal (quetzal-denominated) transfer  $f_t$  per period from the government. Each period, the household decides how to allocate its wealth between consumption and asset accumulation, and how to divide its wealth among the different financial assets.

The household maximizes an intertemporal, time-separable utility function, which adds up the discounted utility flow of each period. The arguments of the period-utility function are the quantity consumed of the unique good during the period, and the real values of the stocks of the monetary assets (currencies and deposits). The latter belong to the utility function because of the liquidity services that they provide to the household. The household has no access to any form of credit, either domestic or foreign.

### 2.2.1 Household's Problem

The household solves the following problem:

$$\begin{aligned} & \max_{\{c_t, \widehat{m}_t, \widehat{m}_{\$, t}, \widehat{d}_t, \widehat{d}_{\$, t}, \widehat{d}_{\$off, t}, \widehat{d}_{\$, t}^*\}_{t=0}^{\infty}} \\ U &= \sum_{t=0}^{\infty} \beta^t \cdot u(c_t, \widehat{m}_t, \widehat{m}_{\$, t}, \widehat{d}_t, \widehat{d}_{\$, t}, \widehat{d}_{\$off, t}, \widehat{d}_{\$, t}^*) \end{aligned} \quad (18)$$

subject to:

$$\begin{aligned} c_t + \widehat{m}_t + \widehat{m}_{\$, t} + \widehat{d}_t + \widehat{d}_{\$, t} + \widehat{d}_{\$off, t} + \widehat{d}_{\$, t}^* &= \\ y + \frac{\widehat{m}_{t-1}}{(1 + \pi_t)} + \widehat{m}_{\$, t-1} + \frac{(1 + i_{d, t-1}) \cdot \widehat{d}_{t-1}}{(1 + \pi_t)} + \\ (1 + i_{d\$, t-1}) \cdot \widehat{d}_{\$, t-1} + (1 + i_{d\$, t-1}) \cdot \widehat{d}_{\$off, t-1} + \end{aligned}$$

$$(1 + i_{\$,t-1}^*) \cdot \widehat{d}_{\$,t-1}^* + \widehat{f}_t; \quad (19)$$

and

$$c_t, \widehat{m}_{t-1}, \widehat{m}_{\$,t-1}, \widehat{d}_{t-1}, \widehat{d}_{\$,t-1}, \widehat{d}_{\$off,t-1}, \widehat{d}_{\$,t-1}^* \geq 0, \forall t \quad (20)$$

where:

$$\begin{aligned} u(c_t, \widehat{m}_t, \widehat{m}_{\$,t}, \widehat{d}_t, \widehat{d}_{\$,t}, \widehat{d}_{\$off,t}, \widehat{d}_{\$,t}^*) = \\ [\alpha_1 \log(c_t) + \alpha_2 \log(\widehat{m}_t) + \alpha_3 \log(\widehat{m}_{\$,t}) + \alpha_4 \log(\widehat{d}_t) \\ + \alpha_5 \log(\widehat{d}_{\$,t}) + \alpha_6 \log(\widehat{d}_{\$off,t}) + \alpha_7 \log(\widehat{d}_{\$,t}^*)] \end{aligned} \quad (21)$$

$$\alpha_1, \alpha_2, \dots, \alpha_7 \in (0, 1) \quad (22)$$

$$\sum_{j=1}^7 \alpha_j = 1 \quad (23)$$

$i_{d,-1}, i_{d\$, -1}, i_{d\$off,-1}, i_{\$, -1}^*, i_{-1}, i_{\$, -1}$  are given;  
current and future prices are known and taken as given.

In the problem above, equation (19) is the period budget constraint. In addition, prevention of Ponzi schemes is guaranteed by the fact that the household is not allowed to hold short positions in any financial asset (inequality (20).)

### 2.2.2 First Order Conditions

The following six equations are the first order conditions of utility maximization for the household with respect to the variables  $\widehat{m}_t, \widehat{m}_{\$,t}, \widehat{d}_t, \widehat{d}_{\$,t}, \widehat{d}_{\$off,t}, \widehat{d}_{\$,t}^*$ , respectively:

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_2 \cdot \frac{1}{\widehat{m}_t} = \beta \cdot \alpha_1 \cdot \frac{1}{1 + \varepsilon_{t+1}} \cdot \frac{1}{c_{t+1}} \quad (24)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_3 \cdot \frac{1}{\widehat{m}_{\$,t}} = \beta \cdot \alpha_1 \cdot \frac{1}{c_{t+1}} \quad (25)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_4 \cdot \frac{1}{\widehat{d}_t} = \beta \cdot \alpha_1 \cdot \frac{1}{1 + \varepsilon_{t+1}} \cdot (1 + i_{d,t}) \cdot \frac{1}{c_{t+1}} \quad (26)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_5 \cdot \frac{1}{\widehat{d}_{\$,t}} = \beta \cdot \alpha_1 \cdot (1 + i_{d\$,t}) \cdot \frac{1}{c_{t+1}} \quad (27)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_6 \cdot \frac{1}{\widehat{d}_{\$off,t}} = \beta \cdot \alpha_1 \cdot (1 + i_{d\$off,t}) \cdot \frac{1}{c_{t+1}} \quad (28)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_7 \cdot \frac{1}{\widehat{d}_{\$,t}^*} = \beta \cdot \alpha_1 \cdot (1 + i_{\$,t}^*) \cdot \frac{1}{c_{t+1}} \quad (29)$$

### 2.3 The Domestic Banking Sector

There is a generally available, constant-returns-to-scale, domestic banking technology in the artificial economy. Because of the constant-returns-to-scale feature, there are zero profits in this banking sector and, without loss of generality, we can assume that there is only one domestic banking firm that behaves competitively.

The balance sheet of the domestic banking firm is the following:

$$\frac{R_{b,t}}{E_t} + R_{\$,t} + \frac{B_{b,t}}{E_t} + B_{\$,t} = \frac{D_t}{E_t} + D_{\$,t} \quad (30)$$

In the left-hand-side,  $R_{b,t}$  represents quetzal-denominated reserves,  $R_{\$,t}$  represents dollar-denominated reserves,  $B_{b,t}$  is quetzal-denominated bonds, and  $B_{\$,t}$  is dollar-denominated bonds. In the right-hand-side,  $D_t$  represents quetzal-denominated deposits, and  $D_{\$,t}$  represents dollar-denominated deposits (all variables in nominal and per capita terms). We assume that the domestic bank does not have access to the international capital market at all, and does not have any net worth.

The bank does not use real resources to operate; however, it is subject to a reserve requirement: it needs to hold a fraction  $\tau_1 \in (0, 1)$  of its deposits in the form of deposits at the central bank. That is:

$$R_{b,t} = \tau_1 \cdot D_t \quad (31)$$

$$R_{\$,t} = \tau_1 \cdot D_{\$,t} \quad (32)$$

and, hence:

$$\frac{B_{b,t}}{E_t} + B_{\$b,t} = (1 - \tau_1) \cdot \left( \frac{D_t}{E_t} + D_{\$,t} \right) \quad (33)$$

Since the bank is assumed to have zero net worth, the zero-profits condition implies that total nominal revenue equals total nominal cost each period:

$$\begin{aligned} \frac{R_{b,t}}{E_{t+1}} + R_{\$b,t} + (1 + i_t) \cdot \left( \frac{B_{b,t}}{E_{t+1}} \right) + (1 + i_{\$,t}) \cdot B_{\$b,t} = \\ (1 + i_{d,t}) \cdot \left( \frac{D_t}{E_{t+1}} \right) + (1 + i_{d\$,t}) \cdot D_{\$,t} \end{aligned} \quad (34)$$

where  $i_t$  is the nominal interest rate on domestic, quetzal-denominated bonds, and  $i_{\$,t}$  is the nominal interest rate on domestic, dollar-denominated bonds.

Moreover, because of the constant-returns-to-scale feature prevailing in the banking technology, it must be the case that there are zero profits in each possible banking operation.<sup>13</sup> This statement implies that the following four conditions must hold:

$$\tau_1 \cdot D_t + (1 + i_t) \cdot [(1 - \tau_1) \cdot D_t] = (1 + i_{d,t}) \cdot D_t \quad (35)$$

$$\tau_1 \cdot D_{\$,t} + (1 + i_{\$,t}) \cdot [(1 - \tau_1) \cdot D_{\$,t}] = (1 + i_{d\$,t}) \cdot D_{\$,t} \quad (36)$$

$$\begin{aligned} \tau_1 \cdot D_{\$,t} + (1 + i_t) \cdot [(1 - \tau_1) \cdot D_{\$,t} \cdot E_t] \cdot \left( \frac{1}{E_{t+1}} \right) \\ = (1 + i_{d\$,t}) \cdot D_{\$,t} \end{aligned} \quad (37)$$

$$\tau_1 \cdot D_t + (1 + i_{\$,t}) \cdot \left[ \frac{(1 - \tau_1) \cdot D_t}{E_t} \right] \cdot E_{t+1} = (1 + i_{dt}) \cdot D_t \quad (38)$$

<sup>13</sup>For example, prices cannot be such that there are losses in quetzal-denominated intermediation, even if they are offset by profits in dollar-denominated intermediation. The reason is that a new bank could be established to operate in dollar-intermediation only with unlimited profits at such prices. Of course, that situation could not possibly characterize an equilibrium.

Equation (35) corresponds to quetzal-denominated investments financed with quetzal-denominated deposits; (36) corresponds to dollar-denominated investments financed with dollar-denominated deposits; (37) corresponds to quetzal-denominated investments financed with dollar-denominated deposits; and (38) corresponds to dollar-denominated investments financed with quetzal-denominated deposits. Equations (35) to (38) imply the following conditions:

$$i_{d,t} = (1 - \tau_1) \cdot i_t \quad (39)$$

$$i_{d\$,t} = (1 - \tau_1) \cdot i_{\$,t} \quad (40)$$

$$i_{d\$,t} = \tau_1 + (1 - \tau_1) \cdot (1 + i_t) \cdot \left( \frac{1}{1 + \varepsilon_{t+1}} \right) - 1 \quad (41)$$

$$i_{dt} = \tau_1 + (1 - \tau_1) \cdot (1 + i_{\$,t}) \cdot (1 + \varepsilon_{t+1}) - 1 \quad (42)$$

In addition, combining equations (39) and (42) we get:

$$i_t = (1 + i_{\$,t}) (1 + \varepsilon_{t+1}) - 1 \quad (43)$$

And combining (39) and (43) we obtain:

$$i_{d,t} = (1 - \tau) \cdot [(1 + i_{\$,t}) (1 + \varepsilon_{t+1}) - 1] \quad (44)$$

These results imply that if one the four interest rates ( $i_t, i_{\$,t}, i_{d,t}, i_{d\$,t}$ ) is given, the other three are automatically determined in equilibrium. In particular, if  $i_{\$,t}$  is known, then  $i_{d\$,t}, i_t$ , and  $i_{d,t}$  are determined by equations (40), (43), and (44), respectively. Besides, equation (43) implies that the interest rate on quetzal-bonds is equal in real terms to the interest rate on domestic dollar-bonds.

## 2.4 The Offshore Banking Sector

There is also a generally available, constant-returns-to-scale, offshore banking technology. We also assume that there is only one offshore bank that behaves competitively.

The balance sheet of the offshore banking firm is the following (all variables in nominal and per capita terms):

$$R_{\$off,t}^* + B_{\$off,t} = D_{\$off,t} \quad (45)$$

In the left-hand-side,  $R_{\$off,t}^*$  represents dollar reserves held by the offshore bank in the international capital market, and  $B_{\$off,t}$  represents dollar-denominated bonds held by the offshore bank in the Guatemalan domestic credit market. In the right-hand-side,  $D_{\$off,t}$  represents dollar-denominated deposits. We assume that the offshore bank cannot borrow in the international capital market, but it can hold international assets that yield the international interest rate  $i_{\$,t}^*$ .

As the domestic bank, the offshore bank does not use real resources to operate. Moreover, and unlike the domestic one, the offshore bank is not subject to a legal reserve requirement. Nevertheless, we assume that in order to operate the offshore bank needs to hold a fraction  $\tau_2 \in (0, 1)$  of its deposits in the form of liquid assets  $R_{\$off,t}^*$  at the international capital market:

$$R_{\$off,t}^* = \tau_2 \cdot D_{\$,t} \quad (46)$$

and, hence:

$$B_{\$off,t} = (1 - \tau_2) \cdot D_{\$off,t} \quad (47)$$

It is also the case that for this bank the zero-profits condition implies that total nominal revenue equals total nominal cost each period:

$$(1 + i_{\$,t}^*) \cdot R_{\$off,t}^* + (1 + i_{\$,t}) \cdot B_{\$off,t} = (1 + i_{d\$off,t}) \cdot D_{\$off,t} \quad (48)$$

where  $i_{d\$off,t}$  is the nominal interest rate on offshore dollar-denominated deposits, and  $i_{\$,t}^*$  and  $i_{\$,t}$  are as previously defined.



Since the offshore bank invests a fraction  $\tau_2$  of its assets in internationally liquid reserves, then the zero-profits condition requires that:

$$\begin{aligned} & (1 + i_{\$,t}^*) \cdot [\tau_2 \cdot D_{\$off,t}] + (1 + i_{\$,t}) \cdot [(1 - \tau_2) \cdot D_{\$off,t}] \\ & = (1 + i_{d\$off,t}) \cdot D_{\$off,t} \end{aligned} \quad (49)$$

Hence, in equilibrium, the offshore nominal interest rate on deposits is completely determined by the international nominal interest rate  $i_{\$,t}^*$ ; the nominal interest rate on domestic, dollar-denominated bonds  $i_{\$,t}$ ; and the offshore reserve parameter  $\tau_2$ :

$$i_{d\$off,t} = \tau_2 \cdot (1 + i_{\$,t}^*) + (1 - \tau_2) \cdot (1 + i_{\$,t}) - 1 \quad (50)$$

## 2.5 The Government

### 2.5.1 Budget Constraint

The period budget constraint of the government (in nominal and per capita terms) is the following:<sup>14</sup>

$$\begin{aligned} & \frac{F_t}{E_t} + \frac{(1 + i_{t-1})B_{t-1}}{E_t} + (1 + i_{\$,t-1})B_{\$,t-1} + R_{\$,t}^* = \\ & \frac{(M0_t - M0_{t-1})}{E_t} + (R_{\$,t} - R_{\$,t-1}) + \frac{B_t}{E_t} + B_{\$,t} + (1 + i_{\$,t-1}^*)R_{\$,t-1}^* \end{aligned} \quad (51)$$

In equation (51),  $F_t$  represents the primary fiscal deficit (lump-sum transfers to the household minus lump-sum taxes<sup>15</sup>);  $B_{t-1}$  is the domestic, nominal (quetzal-denominated) public debt issued on period  $t - 1$  that must be paid (along with the corresponding interest) on period  $t$ ;  $B_{\$,t-1}$  is the domestic, nominal (dollar-denominated) public debt issued on period  $t - 1$  that must be paid in period  $t$ ;  $R_{\$,t-1}^*$  is the stock of foreign, nominal (dollar-denominated)

<sup>14</sup>This budget constraint corresponds to the 'consolidated' government (i.e., the fiscal and monetary branches of government taken together.)

<sup>15</sup>There are no public expenditures in the model.

public net assets<sup>16</sup> determined on period  $t-1$  that matures (and yields interest at the rate  $i_{\$,t-1}^*$ ) on period  $t$ ;  $R_{\$,t-1}$  is the stock of dollar-denominated bank reserves determined on  $t-1$  and taken as given on  $t$ ;  $M0_{t-1}$  is the (quetzal-denominated) nominal monetary base determined on period  $t-1$  and taken as given on period  $t$ . The monetary base is, in turn, equal to the sum of quetzal-denominated currency and quetzal-denominated bank reserves:

$$M0_t = M_t + R_{b,t} \quad (52)$$

where  $M_t$  is quetzal-denominated currency in the public's hands and  $R_{b,t}$  is the stock of quetzal-denominated bank reserves, both determined on  $t$ .

Prevention of Ponzi schemes and a full use of resources on the part of the government are guaranteed by the following conditions:

$$\frac{B_t}{P_t}, \frac{E_t \cdot B_{\$,t}}{P_t}, \frac{E_t \cdot R_{\$,t}^*}{P_t} \in (-\Gamma, \Gamma), \forall t \quad (53)$$

where  $\Gamma$  is a very big (but finite) number.

### 2.5.2 Fiscal and Monetary Branches

The government is divided in two branches: the fiscal branch and the monetary one. The fiscal branch is in charge of disbursing lump-sum transfers to the households (or exacting lump-sum taxes from them, when the transfers have a negative sign.) The fiscal branch does not accumulate assets or liabilities at all, but it can get transfers from the monetary branch.

The monetary branch (or central bank) issues high-powered money and public debt, and holds international reserves. The central bank's balance sheet is as follows (in dollars per capita):

$$R_{\$,t}^* = \frac{M0_t}{E_t} + R_{\$,b,t} + \frac{B_t}{E_t} + B_{\$,t} + NW_t \quad (54)$$

where  $NW_t$  is the net worth of the central bank on period  $t$  and all other variables are as previously defined.

<sup>16</sup>That is, international reserves minus public external debt.

In addition, we can measure central bank's profits using the following formula:

$$\begin{aligned} \Pi_{\$,t} = & \\ & (1 + i_{\$,t-1}^*) \cdot R_{\$,t-1}^* - \frac{MO_{t-1}}{E_t} - R_{\$,b,t-1} - (1 + i_{t-1}) \cdot \frac{B_{t-1}}{E_t} \\ & - (1 + i_{\$,t-1}) \cdot B_{\$,t-1} - \frac{T_t}{E_t} \end{aligned} \quad (55)$$

where  $\Pi_{\$,t}$  stands for nominal profits (measured in dollars) determined on period  $t$ ; and  $T_t$  represents nominal, per capita, quetzal-denominated transfers from the central bank to the fiscal branch. In real terms, the formula for central bank's profits is:

$$\begin{aligned} \hat{\Pi}_{\$,t} = & \\ & (1 + i_{\$,t-1}^*) \cdot \hat{R}_{\$,t-1}^* - \left( \frac{1}{1 + \varepsilon} \right) \cdot \widehat{MO}_{t-1} - \hat{R}_{\$,b,t} \\ & - (1 + i_{t-1}) \cdot \left( \frac{1}{1 + \varepsilon} \right) \cdot \hat{B}_{t-1} - (1 + i_{\$,t-1}) \cdot \hat{B}_{\$,t-1} - \hat{T}_t \end{aligned} \quad (56)$$

### 2.5.3 Public Policy

We will explore the behavior of the model under a particular policy regime. Under this regime, the government predetermines the exchange rate and fixes the interest rate. That is, the government sets the value of the following variables:

$$E_0 = \overline{E}_0 \in (0, \infty) \quad (57)$$

$$\varepsilon_t = \varepsilon \in [0, \infty), \forall t > 0 \quad (58)$$

$$i_{\$,t} = i_{\$} \in (i_{\$}^*, \frac{1}{\beta} - 1), \forall t > 0 \quad (59)$$

$$\hat{F}_t = \hat{T}_t \quad (60)$$

$$\hat{T}_t = (1 + i_{\$,t-1}^*) \cdot \hat{R}_{\$,t-1}^* -$$

$$\left(\frac{1}{1+\varepsilon}\right) \cdot \widehat{M0}_{t-1} - \widehat{R}_{\$b,t} - (1+i_{t-1}) \cdot \left(\frac{1}{1+\varepsilon}\right) \cdot \widehat{B}_{t-1} - (1+i_{\$,t-1}) \cdot \widehat{B}_{\$,t-1} \quad (61)$$

In words, the government sets the path for the exchange rate and the devaluation rate (equations (57) and (58)). Since the law of one price prevails and foreign inflation is zero, this means that the government also sets the path for the price level and the inflation rate.

Equation (59) implies that the government also exogenously determines the domestic interest rate on dollar-denominated bonds. This rate is restricted to be greater than the international interest rate for the model to deliver relevant results for the Guatemalan economy. It is also restricted to be less than the household's subjective discount rate to make sure that interest rate on offshore deposits is always low enough for a stationary equilibrium to exist.<sup>17</sup>

Equation (60) indicates that the fiscal primary deficit is equal to the transfer that the fiscal authority gets from the central bank, and equation (61) implies that such transfer is equal to the amount of net financial revenue of the central bank. This is a special case of fiscal/monetary coordination in which monetary policy is dominant and fiscal policy accommodates in order to satisfy the requirements of the government's intertemporal budget constraint. Combining equations (51), (56), (60), and (61) we get the following expression for the level of international reserves:

$$\widehat{R}_{\$,t}^* = \frac{\widehat{M0}_t}{E_t} + \widehat{R}_{\$b,t} + \frac{\widehat{B}_t}{E_t} + \widehat{B}_{\$,t} \quad (62)$$

## 2.6 Market Clearing Conditions

In equilibrium, the following market clearing conditions must hold every period:

<sup>17</sup>Otherwise, if  $i_{\$}$  could be greater than  $\frac{1}{\beta} - 1$ , it would be possible that the interest rate on offshore deposits were greater than the subjective discount rate. In that case, the household would choose an ever increasing per capita consumption path that would be infeasible.

Goods market:<sup>18</sup>

$$y + \widehat{m}_{\$,t-1} + (1 + i_{\$,t-1}^*) \cdot [\widehat{d}_{\$,t-1}^* + \widehat{R}_{\$,t-1}^* + \widehat{R}_{\$,off,t-1}^*] = c_t + \widehat{m}_{\$,t} + \widehat{d}_{\$,t}^* + \widehat{R}_{\$,t}^* + \widehat{R}_{\$,off,t}^* \quad (63)$$

Dollar-denominated currency:

$$m_{\$,t} = M_{\$,t} \quad (64)$$

Quetzal-denominated deposits:

$$d_t = D_t \quad (65)$$

Domestic dollar-denominated deposits:

$$d_{\$,t} = D_{\$,t} \quad (66)$$

Offshore dollar-denominated deposits:

$$d_{\$,off,t} = D_{\$,off,t} \quad (67)$$

Foreign dollar-denominated deposits:

$$d_{\$,t}^* = D_{\$,t}^* \quad (68)$$

Banks' bonds:

$$\frac{B_t}{E_t} + B_{\$,t} = (1 - \tau_1) \cdot \left( \frac{D_t}{E_t} + D_{\$,t} \right) + (1 - \tau_2) \cdot D_{\$,off,t} \quad (69)$$

Quetzal-denominated currency:

$$m_t = M0_t - \tau_1 \cdot D_t \quad (70)$$

Quetzal-denominated domestic-bank's reserves:

$$R_{b,t} = \tau_1 \cdot D_t \quad (71)$$

Dollar-denominated domestic-bank's reserves:

$$R_{\$,b,t} = \tau_1 \cdot D_{\$,t} \quad (72)$$

Offshore bank's reserves:

$$R_{\$,off,t}^* = \tau_2 \cdot D_{\$,off,t} \quad (73)$$

Primary fiscal deficit:

$$f_t = F_t \quad (74)$$

<sup>18</sup>This is the relevant per capita resource constraint for this small open economy.

## 2.7 Calibration

There are fifteen parameters in this model. They were calibrated to the Guatemalan economy for monthly data. We will briefly comment on the strategy followed for calibrating each parameter.

There are eight parameters in the household's utility function: the discount factor parameter and the share parameters of the seven arguments of the period-utility function. The strategy for calibrating these parameters was to get their values from the first order conditions for the household's utility maximization in steady state, using for that purpose some relevant information from the Guatemalan data. However, the assumption that the household has no access to any sort of borrowing implied that the discount factor parameter  $\beta$  was not uniquely determined. Hence, an arbitrary value was assigned to  $\beta$ , such that the implied discount rate was slightly greater than the highest interest rate at which the household could invest. The values for the share parameters  $\alpha_1, \alpha_2, \alpha_4, \alpha_5, \alpha_6$ , and  $\alpha_7$  were determined from the first order conditions in steady state, as functions of some parameters  $(\beta, i_{\$}^*, i, i_{\$}, i_d, i_{d\$}, i_{d\$off}, \tau_1, \varepsilon)$  and some average values from the data:

$$\overline{\left(\frac{M0}{c}\right)}, \overline{\left(\frac{D}{c}\right)}, \overline{\left(\frac{D_{\$}}{c}\right)}, \overline{\left(\frac{D_{\$off}}{c}\right)}$$

The value of the parameter  $\alpha_3$  was arbitrarily set to be equal to one tenth of  $\alpha_2$ , since there are no data available about the amount of dollar-currency held by Guatemalan residents.

The values for the parameters  $i, \tau_1$ , and  $\varepsilon$  were taken from the Guatemalan data. The  $i$  parameter was equated to the average lending rate of the Guatemalan banking system during the period 1991-2000 (using monthly data.) The  $\varepsilon$  parameter was equated to the average monthly rate of change of the exchange rate (the price of one US dollar in terms of Guatemalan quetzals) for the same period. The  $\tau_1$  parameter was equated to the current (as of April 2001) legal reserve requirement for Guatemalan banks. The values for  $i_{\$}, i_d, i_{d\$}$  were determined using equations (40), (43), and (44), as functions of  $i$  and  $\tau_1$ .

The foreign interest rate parameter  $i_{\$}^*$  was equated to the average rate on certificates of deposit reported by the US Federal Reserve Board for the period 1965:12-2001:03 (monthly data.) The offshore interest rate parameter  $i_{d\$off}$  was set arbitrarily (since there are no official data for that variable)

at some point between the interest rate on dollar-deposits at the domestic banking sector and the discount rate.

The average ratios  $\overline{\left(\frac{M0}{c}\right)}$ ,  $\overline{\left(\frac{D}{c}\right)}$ ,  $\overline{\left(\frac{D_{\$}}{c}\right)}$  were computed from the Guatemalan data.<sup>19</sup> Since there are no data for  $D_{\$off,t}$  available, the  $\overline{\left(\frac{D_{\$off}}{c}\right)}$  ratio was arbitrarily estimated to be half the size of the  $\overline{\left(\frac{D}{c}\right)}$  ratio.<sup>20</sup>

The reserve ratio for the offshore banking sector  $\tau_2$  was determined from equation (50), given the values of  $i_{\$}$ ,  $i_{d\$off}$ , and  $i_{\$}^*$ .

Lastly, the monthly consumption-good endowment was normalized to be equal to one.

The values for all the parameters are given below:

$y$	=	1
$\alpha_1$	=	0.89076
$\alpha_2$	=	0.010849
$\alpha_3$	=	0.0010849
$\alpha_4$	=	0.0057825
$\alpha_5$	=	$1.0681 \times 10^{-5}$
$\alpha_6$	=	0.0015186
$\alpha_7$	=	0.089995
$\beta$	=	1/1.015
$\tau_1$	=	0.14
$\tau_2$	=	0.095661
$\varepsilon$	=	0.003202
$i$	=	0.017519
$i_{d\$off}$	=	0.013333
$i_{\$}^*$	=	0.004462

And the average ratios used in the calibration are the following:

<sup>19</sup>The monthly series for consumption was obtained by a cubic interpolation of the corresponding annual series divided by twelve.

<sup>20</sup>This figure is consistent with the gross assessment contained in International Monetary Fund and The World Bank (2000).

$$\overline{\left(\frac{M0}{c}\right)} = 0.970228$$

$$\overline{\left(\frac{D}{c}\right)} = 2.076500$$

$$\overline{\left(\frac{D_{\$}}{c}\right)} = 0.004464$$

$$\overline{\left(\frac{D_{\$off}}{c}\right)} = 1.0382$$

### 3 SOLUTION

#### 3.1 Equilibrium Definition

"Equilibrium" in this economy is a set of sequences for consumption allocations, asset stocks, and prices, such that each household solves its utility maximization problem, the domestic bank solves its profit maximization problem, the offshore bank also solves its profit maximization problem, the government's period and intertemporal budget constraints hold, the equations that characterize the policy regime hold, and all markets clear. In other words, in equilibrium equations (24)-(29) hold (household maximization); as well as equations (39)-(44) (domestic bank's maximization), equation (50) (offshore bank maximization), equations (51) and (56) and condition (53) (government's constraints and central bank's profits), equations (57)-(62) (policy-regime equations), and the market clearing conditions (63)-(74).

#### 3.2 Equilibrium Dynamical System

After substituting equations (39)-(44), (50), (51), (56), (57)-(62), and (64)-(74), into equations (63) and (24)-(29), we get the following nonlinear system of seven first-order difference equations in seven variables ( $c$ ,  $\widehat{M0}$ ,  $\widehat{M}_{\$}$ ,  $\widehat{D}$ ,  $\widehat{D}_{\$}$ ,  $\widehat{D}_{\$off}$ , and  $\widehat{D}_{\$}^*$ ) that represents the equilibrium dynamical system:

$$\begin{aligned} & y + \widehat{M}_{\$,t-1} + \\ & (1 + i_{\$}^*) \cdot \left[ \widehat{D}_{\$,t-1}^* + \widehat{M0}_{t-1} + (1 - \tau_1) \cdot \widehat{D}_{t-1} + \widehat{D}_{\$,t-1} + \widehat{D}_{\$off,t-1} \right] \\ & = c_t + \widehat{M}_{\$,t} + \widehat{D}_{\$,t}^* + \widehat{M0}_t + (1 - \tau_1) \cdot \widehat{D}_t + \widehat{D}_{\$,t} + \widehat{D}_{\$off,t} \end{aligned} \quad (75)$$



$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_2 \cdot \frac{1}{(\widehat{M0}_t - \tau_1 \cdot \widehat{D}_t)} = \beta \cdot \alpha_1 \cdot \frac{1}{1 + \varepsilon} \cdot \frac{1}{c_{t+1}} \quad (76)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_3 \cdot \frac{1}{\widehat{M}_{\$,t}} = \beta \cdot \alpha_1 \cdot \frac{1}{c_{t+1}} \quad (77)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_4 \cdot \frac{1}{\widehat{D}_t} = \beta \cdot \alpha_1 \cdot \frac{1}{1 + \varepsilon} \cdot (1 + i_d) \cdot \frac{1}{c_{t+1}} \quad (78)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_5 \cdot \frac{1}{\widehat{D}_{\$,t}} = \beta \cdot \alpha_1 \cdot (1 + i_{d\$}) \cdot \frac{1}{c_{t+1}} \quad (79)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_6 \cdot \frac{1}{\widehat{D}_{\$,off,t}} = \beta \cdot \alpha_1 \cdot (1 + i_{d\$,off}) \cdot \frac{1}{c_{t+1}} \quad (80)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_7 \cdot \frac{1}{\widehat{D}_{\$,t}^*} = \beta \cdot \alpha_1 \cdot (1 + i_{\$}^*) \cdot \frac{1}{c_{t+1}} \quad (81)$$

where:

$$(1 + i_d) = \{1 + (1 - \tau_1) \cdot [(1 + i_{\$}) \cdot (1 + \varepsilon) - 1]\} \quad (82)$$

$$(1 + i_{d\$}) = [1 + (1 - \tau_1) \cdot i_{\$}] \quad (83)$$

$$(1 + i_{d\$,off}) = [\tau_2 \cdot (1 + i_{\$}^*) + (1 - \tau_2) \cdot (1 + i_{\$})] \quad (84)$$

### 3.3 The Experiment

The new law ("Ley de Libre Negociación de Divisas") was enacted on December 2000 and expected to be effective on May 1, 2001. In the model, the effect of the new law is to cause an increase in  $\alpha_5$  (the share parameter in the utility function corresponding to dollar-deposits in the domestic banking sector) and a decrease by the same amount of  $\alpha_4$  (the share parameter corresponding to quetzal-deposits.) These changes in parameter values occur in period 4, but they are announced in period 0 (one period representing one month.)

The nature of the analytical experiment is the following: the artificial economy is at the original steady state before period 0. On period 0, it is announced that from period 4 on, a new set of parameter values will be effective. In particular,  $\alpha_4$  and  $\alpha_5$  will change from  $\alpha_{4,0}$  and  $\alpha_{5,0}$  to  $\alpha_{4,1}$  and  $\alpha_{5,1}$ , respectively, subject to the following restrictions:

$$\alpha_{4,0}, \alpha_{5,0}, \alpha_{4,1}, \alpha_{5,1} \in (0, 1) \quad (85)$$

$$(\alpha_{5,1} - \alpha_{5,0}) + (\alpha_{4,1} - \alpha_{4,0}) = 0 \quad (86)$$

$$\alpha_{5,1} > \alpha_{5,0} \quad (87)$$

Actually, the following parameter values were used:<sup>21</sup>

$$\alpha_{4,0} = 0.0057825; \quad \alpha_{4,1} = \frac{\alpha_{4,0} + \alpha_{5,0}}{2}$$

$$\alpha_{5,0} = 1.0681 \times 10^{-5}; \quad \alpha_{5,1} = \frac{\alpha_{4,0} + \alpha_{5,0}}{2}$$

The problem is to find the original steady state of the artificial economy, as well as the new steady state and the transition paths for all relevant variables.

### 3.4 Solution Method

Both steady states of the economy were found by evaluating the fixed point of the equilibrium dynamical system (75)-(81) at each of the two sets of parameter values. The dynamical system was linearized around both steady states, and it was verified that the system displayed saddle-path stability at both points. Then, the linearized version of the saddle-path around the new steady state was derived.<sup>22</sup>

In order to solve for the transition paths, the following idea was pursued: after a large number of periods  $T$ , the dynamical system is close enough to the new steady state so that the linearized version of the saddle-path is a

<sup>21</sup>The choice of the values used for  $\alpha_{4,0}$  and  $\alpha_{5,0}$  is explained in the Calibration section of this paper. The arbitrary values chosen for  $\alpha_{4,1}$  and  $\alpha_{5,1}$  imply that both quetzal- and dollar-deposits have the same weight in the representative household's utility function after the new law becomes effective.

<sup>22</sup>The general methodology for linearizing a nonlinear dynamical system of difference equations around the relevant steady state is explained in Farmer (1999).

good approximation to the true saddle-path. Consequently, an approximate solution for the transition paths would be a set of trajectories (one for each of relevant variable) such that:

- (i) the initial conditions for the predetermined variables<sup>23</sup> of the system (provided by the original steady state) are satisfied on period 0;
- (ii) the laws of motion of all variables (provided by the nonlinear, equilibrium dynamical system (75)-(81)) hold from period 0 to period  $T$  (taking into account that two parameter values change on period 4); and
- (iii) the linearized version of the saddle-path around the new steady state holds on period  $T$ .

The value for  $T$  was chosen so that a further increase in  $T$  caused only a negligible change in  $c_0$  (the value for consumption on the period of the announcement of the new law.) Using  $T = 119$  guaranteed that result.

### 3.5 Results

The macroeconomic effects of the analyzed experiment are rather mild. In what follows, we discuss those effects in detail. The model's solution for the relevant variables can be observed in Figures 1 and 2. Figures 1.1, 1.2, and 1.3 show the behavior of exogenous variables that remain constant along the experiment. The main and obvious effect of the experiment is the conversion of a fraction of quetzal-deposits into dollar-deposits at the domestic banking sector on period 4, when the values of the corresponding preference parameters change (see Figures 2.1 and 2.2.) Other variables do not seem to be affected in Figures 1 and 2, except for a slight increase in the level of international reserves (Figure 2.6.) However, as will be clear soon, there are marginal effects in all variables that become apparent when the scales on the vertical axes are suitably modified.

It might look puzzling that the significant shift from quetzal-deposits to dollar-deposits in the domestic banking sector on period 4 causes only very mild macroeconomic effects. In particular, the greater demand for dollar-deposits does not cause a drop in international reserves; quite on the contrary, international reserves increase slightly as a result. The explanation rests on the fact that, under the prevailing assumptions, that shift from quetzal-

<sup>23</sup>The definition of 'predetermined variable' that we are using can be found in Farmer (1999, Ch. 3.) In our system, the predetermined variables are the following:  $\widehat{M}_{t-1}$ ,  $\widehat{M}_{\$,t-1}$ ,  $\widehat{D}_{t-1}$ ,  $\widehat{D}_{\$,t-1}$ ,  $\widehat{D}_{\$,off,t-1}$ , and  $\widehat{D}_{\$,t-1}^*$

deposits to dollar-deposits does not itself affect the foreign exchange market at all, since it is accomplished by a simple change in the unit of account of the corresponding deposits at the domestic bank.<sup>24</sup> <sup>25</sup> In other words, the currency substitution process that we are modeling here is not one in which domestic currency is replaced by foreign assets, but rather one in which domestic currency is replaced by domestic assets denominated in a foreign unit of account.

Now let us look at the marginal effects in operation. The key to understanding these effects can be found in Figure 3, where we can appreciate the behavior of consumption. Let us notice first that the steady state value of consumption increases from period 4 on (i.e., after the parameter change.) We can also observe that the current consumption level drops on impact at period 0 (when the new law is announced) and remains lower than the original steady state level from period 0 to period 4; then, it engages in a path that converges to the new (higher) steady state value. In other words, the representative family increases its savings for a while in order to increase the value of its portfolio and achieve a permanently higher level of consumption. In turn, this behavior of consumption is explained by the behavior of the domestic banking sector, to which we turn our attention now.

Dollar-deposits at the domestic banking sector yield a higher interest rate (in real terms) than quetzal-deposits. This is so because under perfect competition total revenue must be equal to total cost in both quetzal and dollar operations. While both quetzal- and dollar-bonds yield the same interest rates in real terms, the dollar-banking reserves yield a higher real-interest rate than the quetzal-reserves.<sup>26</sup> Hence, the quetzal-deposits interest rate must be less than the dollar-deposits rate if the domestic bank is to operate in both currencies.

When it is announced that there will be a shift in preferences from quetzal-deposits to domestic dollar-deposits, it becomes clear that a fraction of the former will be converted into the latter. This, in turn, means that the marginal yield on the whole household's portfolio will increase. However,

<sup>24</sup>At the same time, there is a change in the unit of account of a fraction of the reserve requirement, but, again, the net demand of foreign exchange is not affected at all.

<sup>25</sup>An important assumption here is that the domestic bank does not invest abroad, so the increased amount of dollar-deposits is still offset by domestic bonds (either quetzal- or dollar-denominated), in addition to the reserve requirement.

<sup>26</sup>Both types of reserves yield zero nominal interest rate, but quetzal-reserves are affected by the devaluation rate.

in steady state the sum of the marginal yield and the marginal utility of the portfolio must be equal to the subjective discount rate. If the marginal yield of the portfolio increases, the marginal cost of saving becomes less than the marginal benefit, so the representative family saves more. As the family saves more, the value of the portfolio increases and its marginal utility decreases. Eventually, the marginal utility of any asset is low enough so that the sum of the marginal yield and the marginal utility of the portfolio is just equal to the subjective discount rate; at that point, a new steady state is reached in which the consumption level is permanently higher than before. This chain of results explains the behavior of consumption in Figure 3.

In Figure 4 we can observe the behavior of the offshore deposits. As we can see, the new steady state level (from period 4 on) is higher than the original one. In addition, from period 0 to period 3, the level of offshore deposits is increasing and higher than the original steady state; this is what we would expect since the savings level increases at that time. However, on period 4 the level of offshore deposits drops, and then it increases gradually until it gets to its new (higher) steady state level. The drop on period 4 is explained by the increased convenience of using dollar-deposits at the domestic bank from that period on.

Figures 5, 6, and 7 show the workings of foreign deposits, dollar-currency, and quetzal-currency, respectively. In all cases, the new steady state is higher than the original one. As in the case of the offshore deposits, the levels of these variables increase from period 0 to period 3, drop in period 4, and increase gradually from period 4 on, approaching the new steady state. However, unlike the case of the offshore deposits, these variables drop slightly on impact on period 0. The cause for this drop is the low interest rate that these assets yield (as compared to the subjective discount rate); it turns out to be optimal to concentrate the saving effort in the high-return assets (like the offshore deposits and the deposits at the domestic bank.)

The behavior of the international reserves can be observed in Figure 8. Again, the steady state level increases from period 4 on. The saving effort is reflected in the increase observed from period 0 to period 3 and from period 4 on. On period 4, the variable undergoes a sudden increase caused by the conversion of small fractions of the stocks of dollar-currency, foreign deposits, and offshore deposits into domestic dollar-deposits (as was explained above.) It is important to notice that while the conversion of a fraction of the stock of quetzal-deposits into domestic dollar-deposits is a direct consequence of the assumed change in preferences, the conversion of some parts of the stocks

of other dollar-denominated assets into domestic dollar-deposits is rather an optimal response of the representative family to the parameter change.

Figure 9 shows how the primary fiscal deficit needs to be reduced (or the primary fiscal surplus needs to be increased) in order to keep both the devaluation rate and the domestic interest rate constant. The reduction in the deficit is caused by an equal reduction in the central bank's net interest revenue for two reasons: (i) the central bank issues more bonds and at the same time accumulates more international reserves, but the former yield an interest rate greater than the latter; and (ii) the quetzal-denominated reserve requirement decreases while the dollar-denominated one increases (but the latter yields a real interest rate greater than the former.)

#### 4 CONCLUSION

This paper develops a model intended to analyze the currency-substitution effects of a new law ("Ley de Libre Negociación de Divisas") on the Guatemalan economy. In particular, a dynamic, perfect-foresight, general equilibrium model of a small-open economy with imperfect capital mobility is solved. The change in the legal regime is modeled as a change in some preference parameters: it is assumed that the share parameters in the utility function corresponding to the quetzal-denominated deposits decrease when the new law becomes effective, while those corresponding to the domestic, dollar-denominated deposits increase by the same magnitude.

The model shows that, in the most plausible scenario, we should not expect to observe very important macroeconomic or foreign-exchange effects at the time when the new law becomes effective. Such a scenario would involve the following elements: (i) the new law increases the Guatemalan residents' preference for holding assets denominated in a foreign unit of account; (ii) however, the new law does not increase the Guatemalan residents' preference for holding foreign assets; (iii) both monetary and fiscal policies support macroeconomic stability; and (iv) Guatemalan banks use only domestic assets (either dollar- or quetzal-denominated) to offset their dollar-deposit liabilities.

The main cause for this result is the fact that the conversion of quetzal-denominated deposits into dollar-denominated deposits at the domestic banking sector can be accomplished just by performing the adequate accounting

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operations, so the conversion itself does not affect the net demand of foreign exchange.



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FIGURA 1

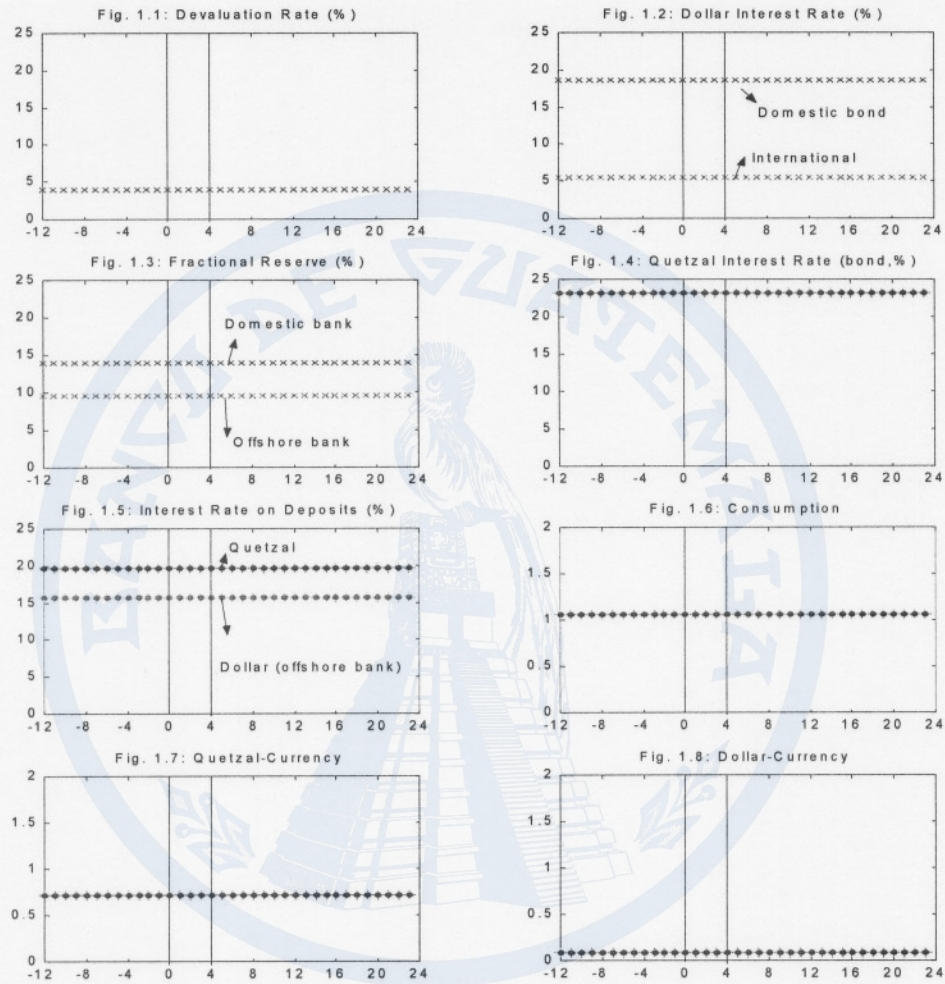


Figure 1:



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FIGURE 2

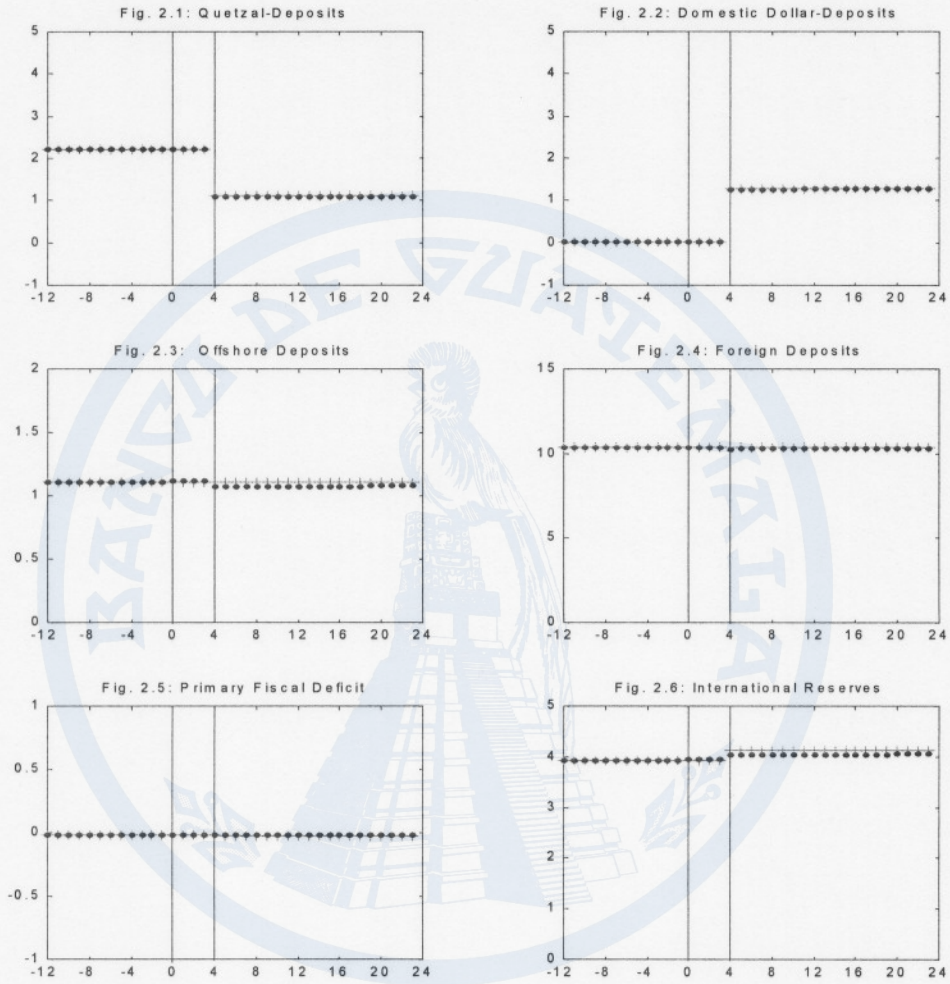


Figure 2:

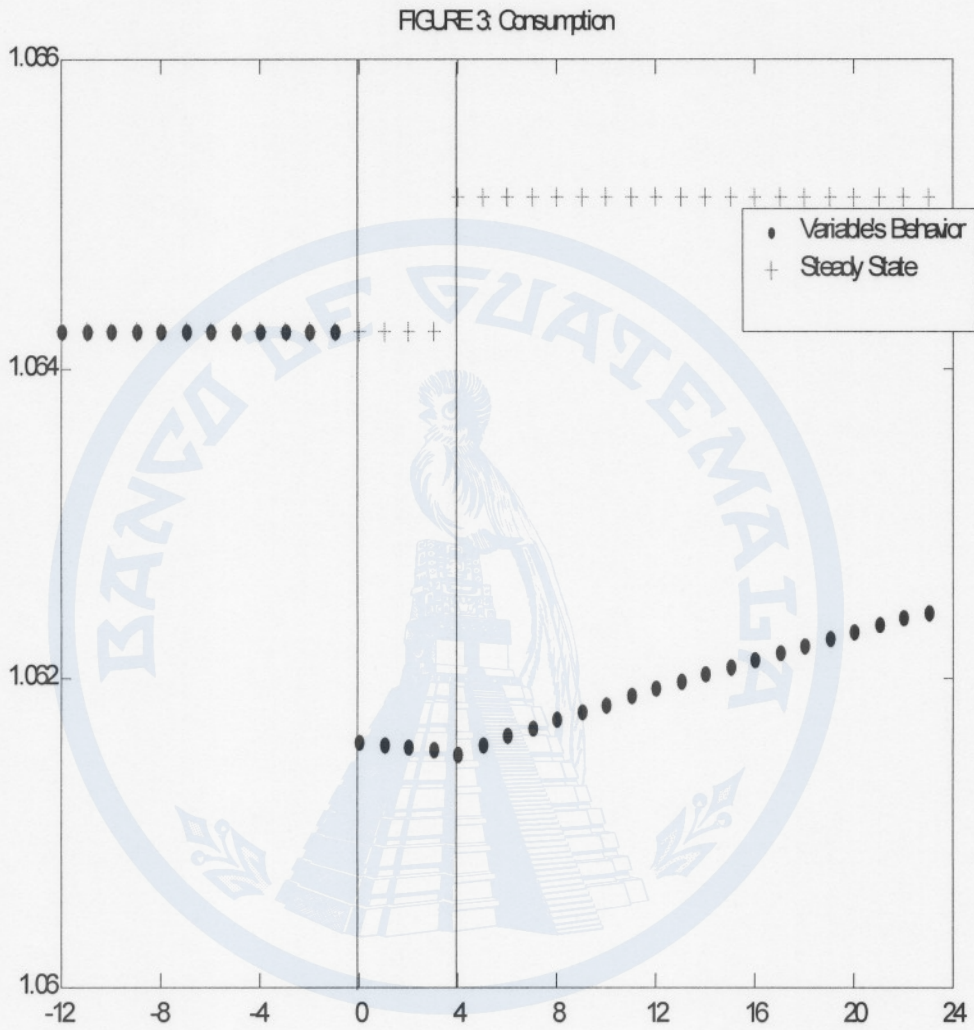


Figure 3:

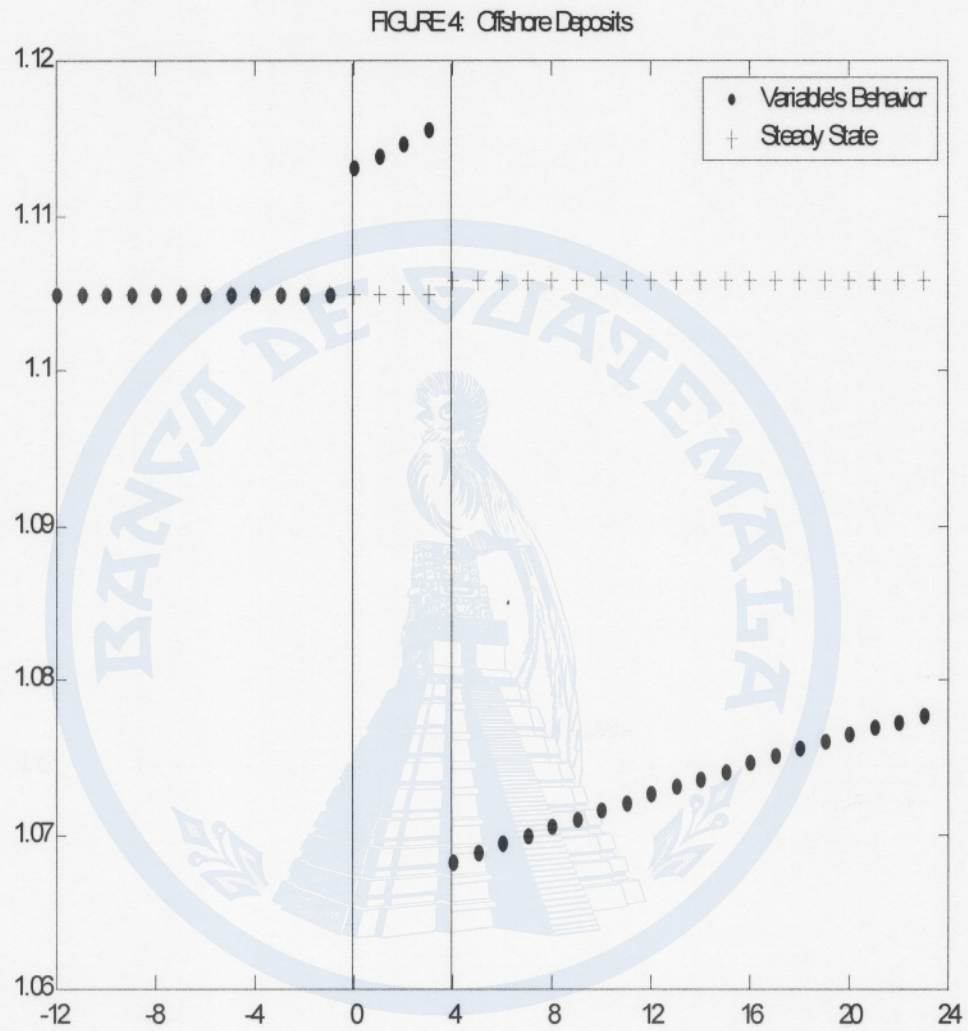


Figure 4:

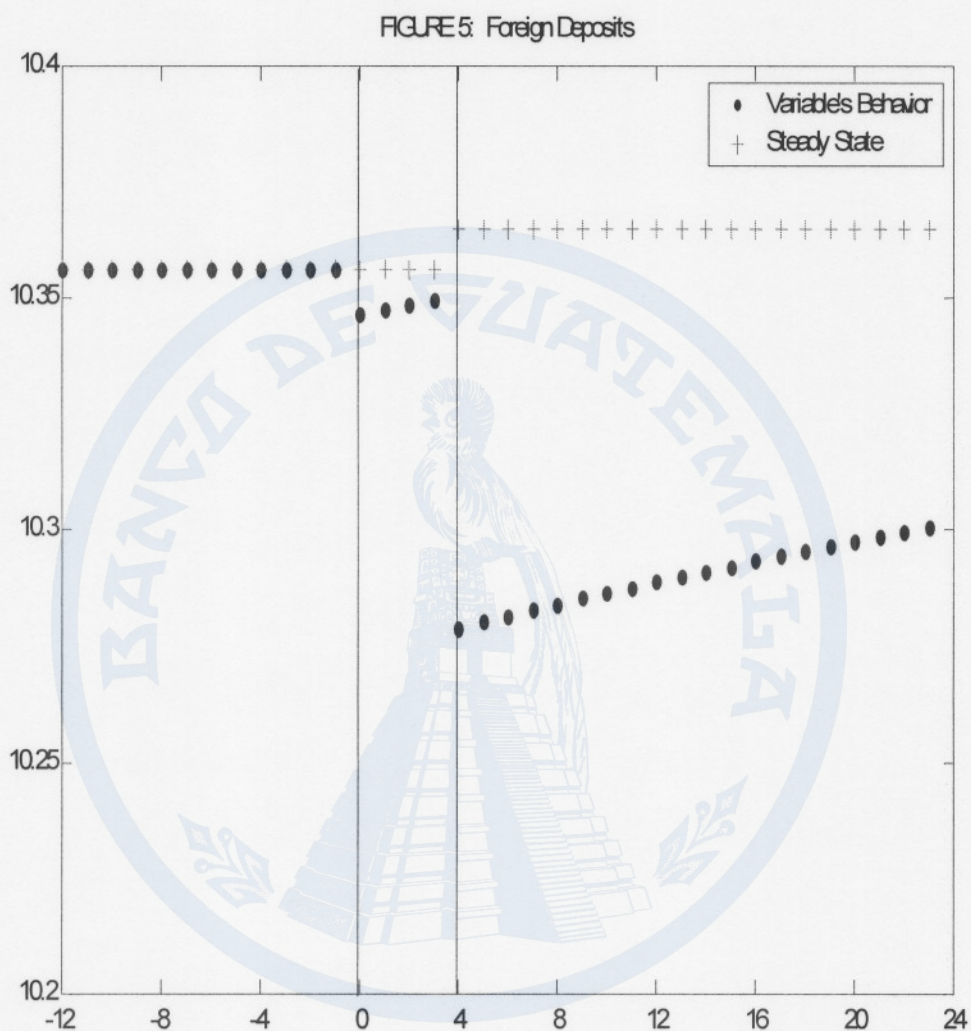


Figure 5:

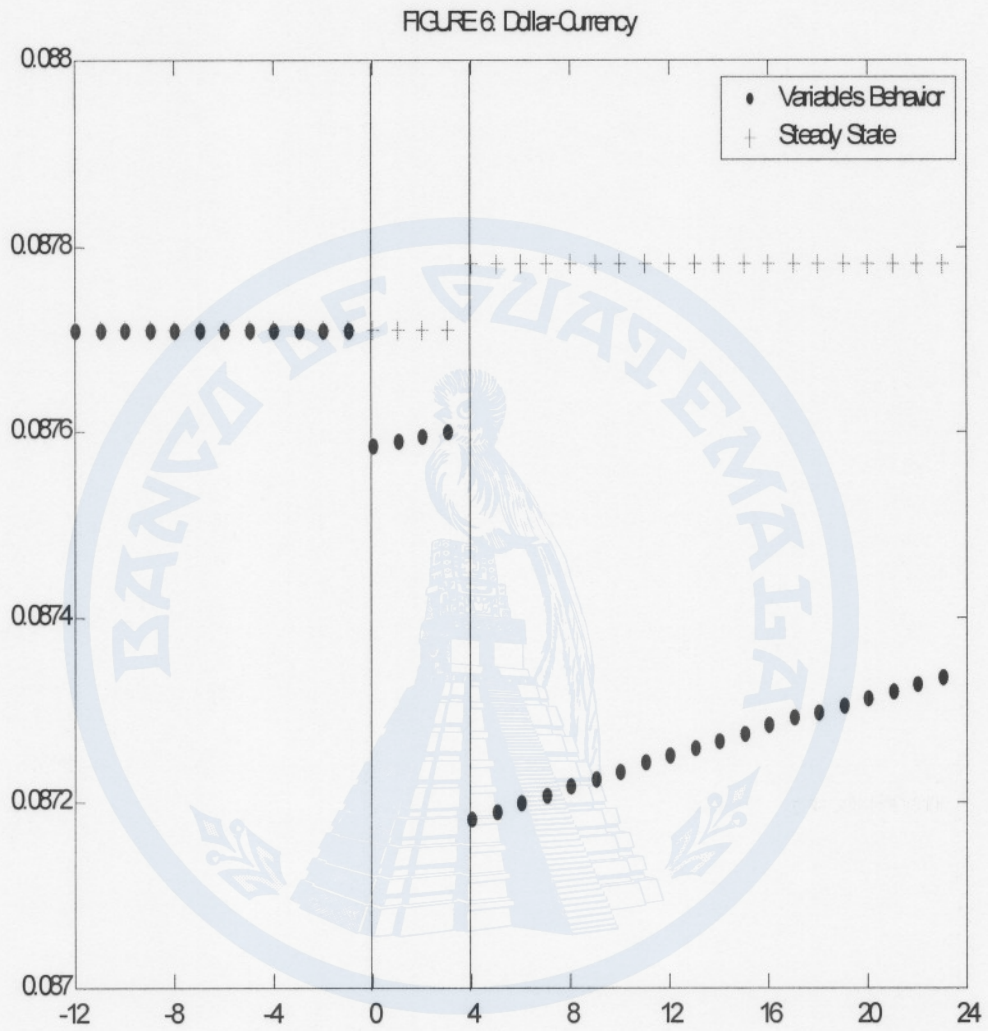


Figure 6:

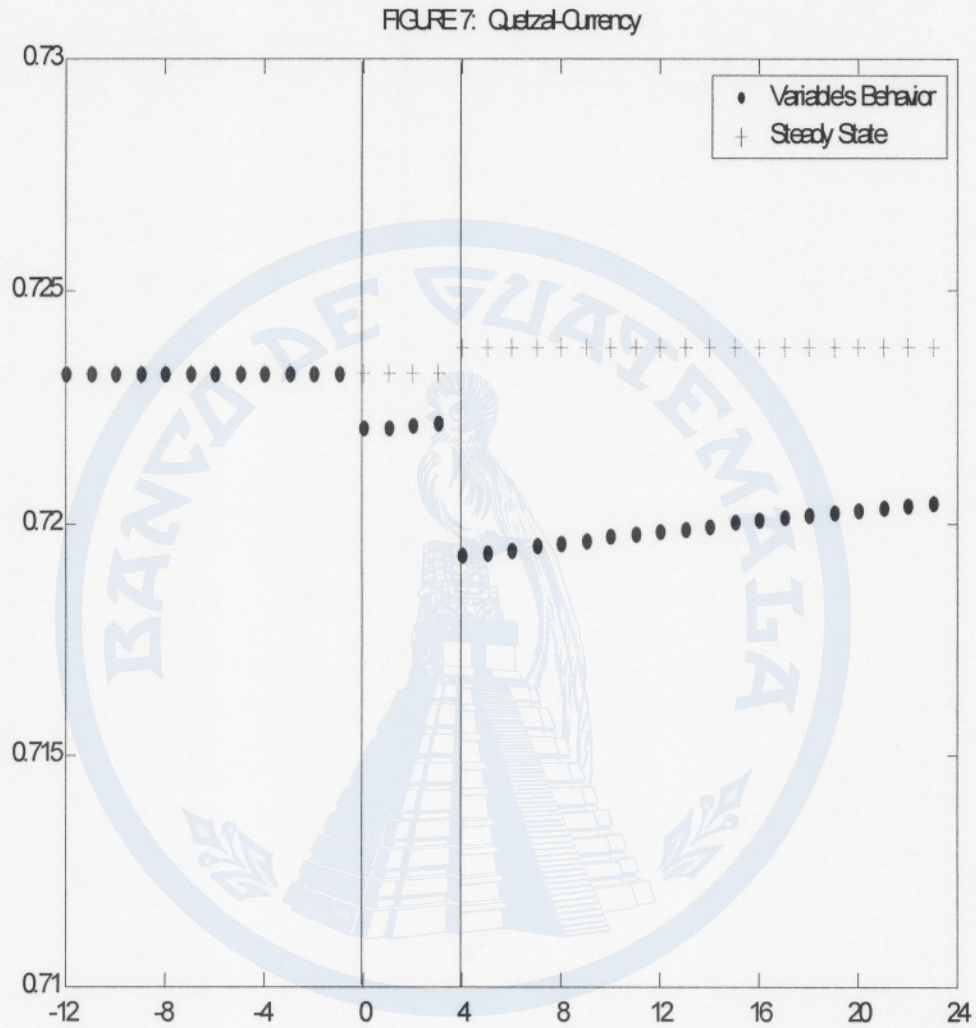


Figure 7:

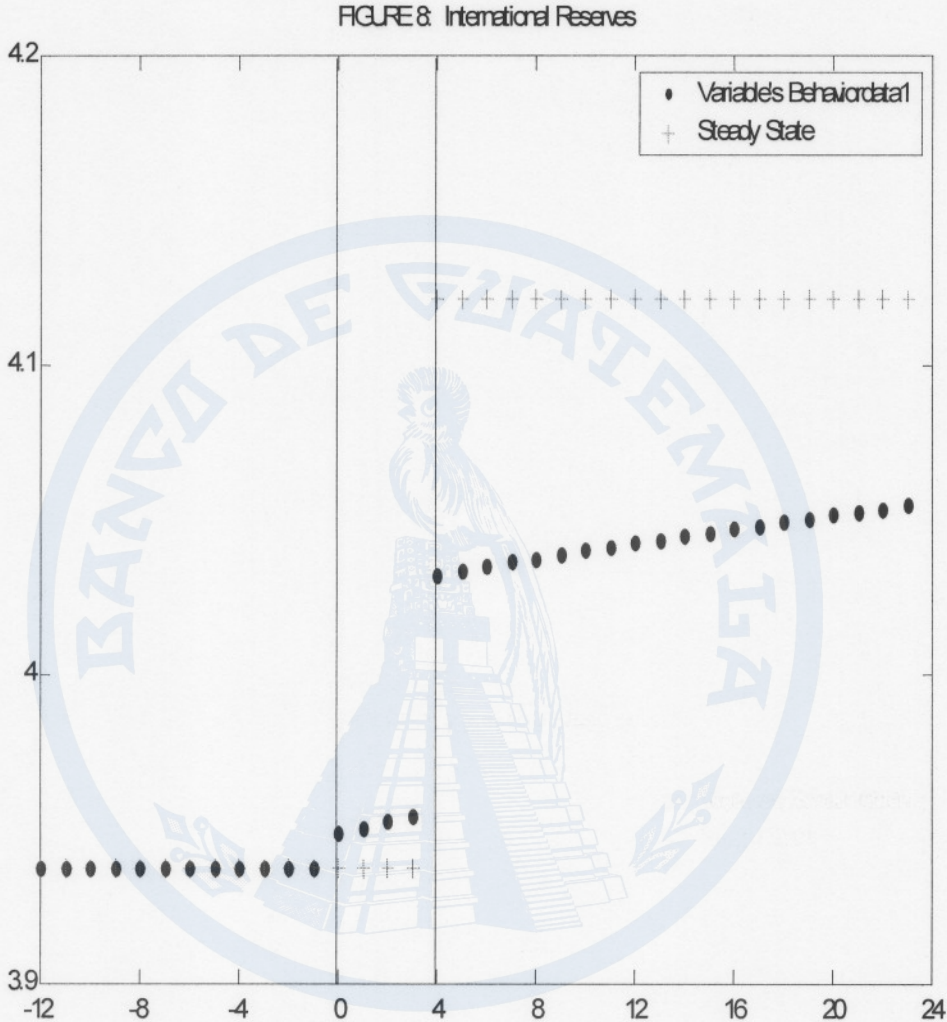


Figure 8:

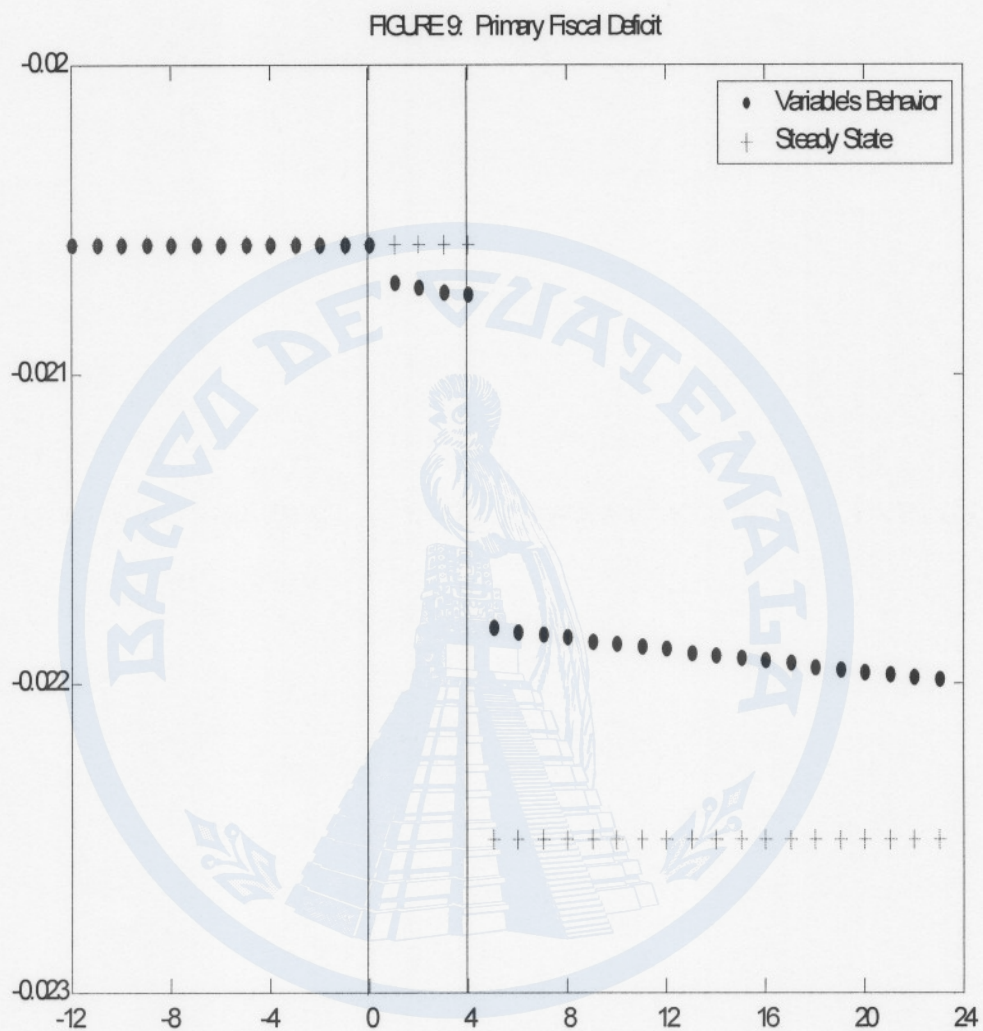


Figure 9:



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