Distributional Effects of Boom-Bust Cycles in Developing Countries with Financial Frictions

Abstract

This paper sheds light on the distributional implications of the exchange rate based stabilizations with financial imperfections when a country is populated by heterogeneous agents with respect to their source of income. This paper shows that boom-bust cycles in developing countries lead to income redistribution from tradable to nontradable sectors. Since the share of tradable sectors in aggregate GDP increases above its usual share with the devaluation of the currency, the individuals in tradable sectors pay more tax than what they receive as capital inflow in the expansion phase of the economy. The opposite holds for the individuals in nontradable sectors who gain more from the capital inflow as compared to what they lose from taxation.

Key words: Distributional Effects, Boom-Bust Cycles, Financial Frictions,

JEL Classifications: F41, F34, G15

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1. Introduction

Inflation stabilization programs appeared to be one of the identifying features of developing countries in recent decades. These programs are initiated with the intention to reduce inflation and bring long run economic stability. However experiences of many developing countries suggest a pattern of boom-bust cycles associated with the stabilization programs. Countries implementing various sorts of stabilization programs are characterized by economic boom and sustained real appreciation, but later in stabilization episodes economic contraction takes place and programs come to the end with a "sudden-stop" associated with crisis. Experiences of Southern Cone Latin America (Argentina, Chile, Uruguay) in 1970s and early 1980s exactly fit to this common pattern, which is later in 1990s repeated by Mexican Peso Crisis and recently by Turkish and Argentine crises.

The central objective of this paper is to unravel the distributional consequences of these boom-bust cycles inherent in many stabilization episodes. Hence, this paper provides a model to show that boom-bust cycles in developing countries lead to income redistribution from Tradable (T) to Nontradable (NT) sectors. The existing literature on stabilization programs is more concerned with explaining the reasons behind observed boom-bust cycles. However much less attention is given to the question of whether the stabilization programs have distributional implications as well. There are some empirical studies explaining the distributional consequences of stabilization policies. However there are not many theoretical models to address this issue. Hence this paper contributes to the literature by showing that temporary exchange rate stabilization programs can have zero cost for the country, but individuals in the country can be affected asymmetrically depending on their source of income. This paper also shows that the speed of capital outflow from the country affects the distributional consequences of the temporary exchange rate based stabilization programs. Moreover, this paper sheds light on the question of why the stabilization programs are adopted at the first place and later continued even though they are believed to be temporary in connection with Aysan (2006).

Aysan (2006) shows that even though exchange rate realignments are recognized to be temporary and inefficient, country may still implement them, because it allows redistribution of income among various groups. Here in this paper, we just model how stylized facts of boom-bust cycles in developing countries can generate redistribution from T to NT sectors. When individuals in NT sectors are politically more powerful than the individuals in T sectors, adoption of inefficient policies in favor of NT sectors can be a political outcome.

The next issue is that if one of the reasons to adopt temporary policies is to redistribute income, why don't countries implement redistributions directly in a more efficient manner? One possible answer is that by allowing inefficient policies politicians can hide redistributional aspects of new programs initially and win the public support when the policies are adopted at the beginning. In our model redistribution is realized over time. Initially, everyone benefits from the policy change but later the cost of previously adopted policies falls more on certain groups. Hence, if the individuals are not well informed about the consequences of new policies, inefficient temporary programs can help hide the income redistribution over time.

In our model, we benefit from temporariness hypothesis and financial frictions to model redistribution. Temporariness hypothesis helps us account for boom-bust cycles and increasing NT to T output ratio before crises. On the other hand, financial frictions in the form of financial constraints and bailouts are employed to generate redistributional consequences of temporary policies.

Stabilization programs are designed differently depending on the country characteristics, choice of policy instruments, and combined with structural reforms like privatization, financial market reforms. However, the exchange rate based stabilization programs seem to be more widespread mechanism employed to stabilize the economy. An examination of exchange rate based stabilization programs suggests the following regularities:

(i) A boom in economic activity, consumption, investment and GDP followed by a later slowdown

(ii) Slow convergence of inflation to the devaluation rate

(iii) Real exchange rate appreciation associated with a rise in the relative price of NT goods

(iv) Deterioration of trade balance and current account balance

(v) An ambiguous response of real interest rates depending on the orthodox or heterodox plan

(vi) A boom in the real estate market

(vii) Surge in capital inflows, especially in the form of bank lending in early stages of the plans that is later reversed with sudden-stop.

Various models are offered in an attempt to account for these stylized facts. Sticky inflation due to adaptive expectations (Dornbush, 1982 and Rodriquez, 1982) and temporariness hypothesis due to lack of credibility (Calvo, 1986 and Calvo and Vegh, 1993) still provide significant contributions to the research on the open economy macroeconomics. Later, fiscal policy induced wealth effect proposed by Helpman and Razin (1987) and Drazen and Helpman (1988) claims that reduction in inflation generates wealth effect and thus the economic expansion. Later attempts to explain the stylized facts emphasize the supply side effects that may result from removing the inflationary distortion on the labor supply (Roldos, 1993) or capital accumulation (Roldos, 1995 and Uribe, 1997). Each of these various approaches has some merits in revealing the mechanism behind stabilization programs. However as pointed out by Rebelo and Vegh (1996), no single hypothesis is sufficient to account for all empirical regularities at qualitative level. The only hypotheses that generate a boom-recession cycles are temporariness and sticky wages and prices hypotheses.

In an attempt to account for disparities between theoretical models and empirical regularities, Calvo and Drazen (1998) focus on the role of uncertainty and incomplete contingent claim markets and illustrate gradual consumption boom. More recently, Mendoza and Uribe (2000) use a general equilibrium model of a two-sector, small open economy in which agents expect a devaluation and a switch to a higher rate of depreciation of currency and they show that risk of devaluation induces large distortions on wealth and relative prices in incomplete insurance market settings. Their model generates macroeconomic dynamics that mimic important features of stabilization programs implemented in many developing countries. These recent attempts are remarkably important contributions to the literature because they not only better account for the quantitative regularities of data, but also draw attention to imperfect credit markets and collateral constraints (Mendoza, 2000-a, Caballero and Krishnamurthy, 2000).

Alfaro (2002) analyzes an endowment economy where temporary real exchange rate appreciation generates wealth effect in favor of the owners of nontradables. His main conclusion on redistrubutive effects of temporary stabilizations largely depends on the parameter values of the utility function and initial distribution of wealth. This paper offers an alternative model with more realistic representation of temporary stabilizations by considering financial frictions as collateral constraints and bailouts and governments' response to crises as an increase in taxation.

Due to the reasons stated above, the paper employs temporary nominal exchange rate reduction combined with financial constraints in an attempt to model the distributional consequences of exchange rate based stabilization programs for the individuals in T and NT sectors. The evolution of exchange rate based stabilization suggested by temporariness hypothesis is the following. The nominal exchange rate is reduced initially which is known to be reversed later in the program. These temporary reductions in nominal exchange rate implies that effective price of consumption is lower now as compared to the future in a cash-in-advance constraint economy. That induces higher consumption of tradables and this higher consumption of tradables is accompanied by higher consumption and production of nontradables. Higher demand for the nontradables increases the relative price of nontradables and leads to exchange rate appreciation. As the real exchange rate appreciates overtime, consumption and production of nontradables fall from its highest level gradually. When nominal exchange rate is reversed, the discrete fall in demand for tradables and nontradables occurs and nontradable production converges to its long run level over time.

In Calvo and Vegh (1993) model, T sector is characterized as endowment economy and nontradables are produced in a sticky prices setting. Furthermore, investment is not explicitly considered in the model and thus, financial markets and any imperfections like liquidity constraints, collateral constraints, which later become a subject for extensive research, are ignored in their model. This paper emphasizes the role played by financial constraints to explain how temporary stabilization programs can have distributional consequences for the economy.

In our model, relaxation of financial constraints associated with rising value of nontradable production generates a boom in capital inflow for the country in the early stages of stabilization episodes. Financial constraints take two forms. Relaxation of international liquidity constraint escalates the capital inflow into the country. International investors do not directly invest in domestic firms. Banks emerge as intermediary mechanism to channel the international capital inflows to the individuals in the country. Similar to the international liquidity constraint, the banks use domestic liquidity requirements as a mechanism to screen the borrowers. Furthermore, government guarantees the loans of the international investors to domestic banks and repays their debt in case of systematic banking crises. In other words, state bails out the banks to avoid the collapse of the banking system.

In our model, real exchange rate appreciation-rise in relative price of nontradables- increases the collateral value of the country and induces the international investors to invest more to the country. At the same time, the domestic banks have a similar liquidity constraint criterion to lend money to the prospective borrowers. The individuals with higher collateral in the form of higher income borrow more. The shares of nontradables and tradables in aggregate GDP play a crucial role in the distribution of international capital inflow. With the introduction of exchange rate based stabilization, the share of nontradables production in aggregate GDP increases due to surge in the nontradable production and prices of nontradables. This further implies that at the peak of economic boom, NT sectors increase their share of collateral value in total collateral of the country while the share of collateral value of T sectors declines. Hence, NT sectors increase their share of borrowing in domestic financial markets during the expansion of economy. Therefore, timing of the international capital inflow is crucial for the asymmetric progress of T and NT sectors. In our model, the capital inflow takes place during the economic expansion starting with a discrete jump. This increase in capital inflow is later reversed to a capital outflow when international collateral constraint binds again at the bottom of contraction caused by the reversal of exchange rate based stabilization program. With the announcement of the rise in nominal exchange rate (reversal of policy), we assume that all the banks collapse and the state bails out the banks by repaying their loans. The government finances the bail out by imposing a flat income tax at the bottom of economic contraction. However, when flat income tax is levied, the share of income from NT sectors in aggregate GDP is less than the share of NT sectors in aggregate GDP at the time when the capital inflow is carried out. Hence, NT sectors enjoy the benefit of expansion more than they suffer from the burden of taxation. On the other hand, T sectors also benefit from the stabilization program during the expansion of economy by receiving a fraction of total capital inflow, but in the contraction episode, T sectors lose more than they gain in the economic expansion.

As a consequence, the exchange rate based stabilization policy can have a redistributive effect from T to NT sectors under financial frictions. The expansion in NT sectors exceeds the magnitude of later contraction. On the contrary, the net effect of boom-bust cycle on T sectors becomes negative at the end. This framework suggests redistribution from T and NT sectors where the temporary stabilizations are at work. In Calvo and Vegh model (1993), the cost of temporary stabilization program comes in the form of non-smoothing of the consumption. Other than consumption volatility, there is no cost for the economy, while output expands and contracts symmetrically. In our model, overall for the country, the cost of temporary exchange rate based stabilization can be zero but individuals in the country can be affected asymmetrically depending on their source of income.

The outline of the paper is as follows: the next section first presents the benchmark model of temporariness hypothesis of Calvo and Vegh (1993) and later, the benchmark model is extended by including the international and domestic financial imperfections to point out the distributional aspects of the temporary plans for T and NT sectors; Section 3 concludes.

2. The Model

This section builds on a cash in advance, staggered prices model combined with temporary exchange rate reduction and financial constraints both in international and domestic levels to account for above mentioned stylized facts and moreover to shed light on potential distributional consequences of temporary exchange rate policies.

The economy is characterized by two types of individuals depending on their source of income. Each agent in the economy receives income either from T or NT sectors. We assume certain fixed cost that prevents the individuals to move between T and NT sectors to illustrate the redistribution better. The lifetime utility of each individual is given by:

$$\int_0^\infty [U(C_t^{NT}) + V(C_t^T)] \exp(-\beta t) dt \qquad (1)$$

Where U and V represent the separable utility functions, C_t^{NT} and C_t^T denote the consumption of tradables and nontradables at time t respectively and β is the usual discount factor.

The budget constraints of the representative individuals in T and NT sectors at time t are:

$$y_t^{NT} / e_t = C_t^{NT} / e_t + C_t^T + i_t m_t - rb_t \qquad (2)$$

$$y_t^T = C_t^{NT} / e_t + C_t^T + i_t m_t - rb_t \qquad (3)$$

Where b_t and m_t denote the stock of real assets and money balances respectively. y_t^{NT} and y_t^T denote the output of nontradables and tradables respectively, *e* indicates the real exchange rate–relative price of tradables in terms of nontradables and *i* is the nominal interest rate. Individuals are required to hold domestic money to carry out consumption, therefore the cash in advance constraint stands as:

$$\alpha(C_t^{NT} / e_t + C_t^T) \le m_t \qquad (4)$$

Where real monetary balances are positive function of consumption expenditures. Due to the positive nominal interest rate, *i*, individuals prefer to hold minimum monetary balances. By substituting equation (4), equation (2) and (3) can be rewritten as:

$$y_t^{NT} / e_t = (C_t^{NT} / e_t + C_t^T)(1 + \alpha i_t) - rb_t \qquad (5)$$

$$y_t^T / e_t = (C_t^{NT} / e_t + C_t^T)(1 + \alpha i_t) - rb_t \qquad (6)$$

Individuals maximize their utility function in (1) with respect to their budget constraints (5) and (6). By assuming $r=\beta$ the first order conditions of this optimizations are:

$$V'(C_t^T) = \lambda_1(1+\alpha i_t) \qquad (7)$$

$$V'(C_t^T)/U'(C_t^{NT}) = e_t \qquad (8)$$

Where λ_1 is the time invariant Lagrange multiplier of budget constraints (5) and (6). The model incorporates seignorage revenue for the government from money creation, which is assumed to be wasted to keep the model simple. The nontradables are consumed in the country and the equilibrium in NT sectors requires:

$$C_t^{NT} = y_t^{NT} \qquad (10)$$

Nominal interest rate is equal to real interest rate r plus devaluation rate, ε under perfect capital mobility assumption.

$$i_t = r + \varepsilon_t \qquad (11)$$

For the sake of simplicity, supply of tradables is assumed to be exogenously given and constant. While NT sector operates under staggered price setting and supply is demand determined. Therefore staggered prices imply the following:

$$\frac{d\pi}{dt} = -\Theta(y_t^{NT} - \bar{y}) \qquad \Theta > 0 \qquad (12)$$

which indicates that the rate change in inflation, π, is a decreasing function of excess demand, $y_t^{NT} - \bar{y}$. Equation (12) asserts that the higher the excess demand at time t, the sharper will be the drop in the inflation rate after t. Equation (8) indicates that consumption of nontradables is a positive function of both real exchange rate and consumption of tradables. Therefore we can rewrite (12) as:

$$\frac{d\pi}{dt} = \Theta[\bar{y} - y_t^{NT}(e_t, c_t^T)] \qquad (13)$$

The real interest rate is defined as the relative price of tradables in terms of nontradables and thus written as $e = \frac{EP^T}{P^{NT}}$ where P^T and P^{NT} are the prices of tradables and nontradables respectively. Therefore evolution of real exchange rate is the following:

$$\frac{de}{dt} = (\varepsilon - \pi_t)e_t \qquad (14)$$

We can now address the main issues of the temporariness hypothesis. Temporariness hypothesis is based on the lack of credibility assumption. The policy makers announce a permanent reduction in the devaluation rate but the public believes that the reduction in devaluation rate will last for a certain period of time. The "present" is represented by time 0. Between time 0 and *T* the devaluation rate is believed to be lower and it will be back to higher rate at time *T*. So the public believes the following policy:

$$\varepsilon_t = \varepsilon^\ell \quad \text{for} \quad 0 \le t < T \qquad (15\text{-a})$$

$$\varepsilon_t = \varepsilon^h \quad \text{for} \quad t \ge T \qquad (15\text{-b})$$

where $t > 0$ and $\varepsilon^\ell < \varepsilon^h$

Equation (11) implies that during the transition period from 0 to *T*, the domestic nominal interest rate, *i*, is lower than after *T*. This induces higher level of consumption of tradables by first order condition (7) between time 0 and *T*. The increased consumption of tradables is supplied by trade deficit, which is later compensated by trade surplus after time *T*. Therefore, initially the current account jumps into deficit as a result of surge in the consumption of tradables and the balance is restored at time *T* with a discrete fall in the consumption of tradables. At time *T*, the new steady state consumption of tradables must be less than the endowments of tradables to offset the earlier increase in the consumption of tradables. The fall in the consumption of tradables requires higher real exchange rate due to equation (8). The consumption of nontradables is shown to be a positive function of real exchange rate and consumption of tradables (equation (8)). Since the consumption of tradables jumps up at time 0 and fall at time *T*, the consumption of nontradables makes the same jumps given that real exchange rate is a predetermined variable and makes no discrete movements. The appreciation of real exchange rate implies a decrease in the consumption of nontradables between time 0 and *T*. At time *T* consumption of nontradables makes a discrete fall and gradually increases as real exchange rate depreciates. At time 0 and at time *T* the jumps in the consumption of tradables must be accompanied by the same jumps in the consumption of nontradables because real exchange at a point of time is a predetermined variable, consumers do not want to change the consumption of nontradables relative to the consumption of tradables. The domestic real interest rate, r^d, falls because inflation of nontradables declines by less than the rate of devaluation, ($r^d = r + \varepsilon_t - \pi$). At time *T*, the rise in *i* implies a jump in r^d. Figures in the appendix show the evolution of the relevant variables.

2.1. The Model with Financial Constraints

So far, we introduced the temporariness hypothesis to account for the main features of the stabilization experiences of developing countries. Next, we will include financial frictions in the form of liquidity constraints into the model to show the distributional aspects of temporary exchange rate based stabilizations. The first liquidity constraint prevails at the international level. We assume that in international financial markets, investors regard the aggregate GDP of the country as criterion to flow their capital into the country and lend proportional to the GDP of the country. Given that debt to GDP ratio is still considered to be an indicator of the well-being of the economy in many occasions, this international liquidity constraint is not an unrealistic assumption. Hence, the international liquidity constraint is given as:

$$\left(\frac{y_t^{NT}}{e_t} + y_t^T\right) \geq I_{critical} \qquad \text{(16-a)}$$

where $I_{critical}$ denotes the threshold level after which the country receives capital inflow and below which the country receives no capital inflow. $I_{critical}$ can be considered in a following manner: the country is already indebted and international investors do not give more credit unless the economy operates above its steady state level. The threshold $I_{critical}$ is a function of steady state income of the country. Therefore, countries with lower steady state income have higher threshold and subsequently receive less capital inflow in their expansion phases. If the economy is operating above its steady state equilibrium, the country receives capital inflow proportional to its current output. When the current output falls short of steady state level, international investors react by withdrawing their capital from the country. The country receives $\theta(\frac{y_t^{NT}}{e_t}+y_t^T)$ (16-b) as an investment after the threshold level is reached. The above mentioned temporary nominal exchange rate reduction generates an expansion in the production of nontradables with the policy announcement. The output of tradables is considered to be given as a constant endowment and real exchange rate is a predetermined variable. Therefore, internatonal liquidity constraint, equation (16-a) is relaxed while y_t^{NT} jumps upwards with the announcement of policy change. This further implies that the country can borrow now in international markets. Throughout the paper, we will assume that by the introduction of temporary exchange rate reduction, the country escapes from binding international liquidty constraint. At time *T*, as y_t^{NT} jumps downwards, the country again runs into international liquidity constraint. However, between time 0 and time *T*, the country receives higher capital inflow.

2.1.1. Endogenous Timing of the Devaluation

We also change the above-mentioned model by introducing endogenous date of reversal of temporary exchange rate policy. In our model, the timing of nominal exchange rate devaluation is determined by the international liquidity constraint. When aggregate output of the country in terms of tradable goods reduces to its pre-stabilization level the international liquidity constraint binds again and the international investors recall their capital. This reaction of international investors triggers the crises at time *T*.

The international investors do not suffer from the devaluation at time T. The model incorporates the actual experiences of the stabilization plans such that international investors deposit their capital into the banks in terms of tradables and the repayment is made again in terms of tradables. Given that there is an explicit or implicit government guarantee on the deposits of domestic banks, international investors are immune to devaluation risk unless the government defaults.

2.1.2. Domestic Financial Constraint

The model assumes that domestic banks play an intermediary role by borrowing in international markets and lending to individuals in the country without any transaction cost and profit. However the banks employ a domestic liquidity constraint in their lending practices similar to the international financial constraint. Each individual is constraint to borrow up to a fraction of their current income, which seems to be an actual practice of many banks to screen their customers. Hence domestic liquidity constraint takes the following form for the individuals in T and NT sectors respectively.

$$\Phi\left(\frac{y_t^{NT}}{e_t}\right) \geq L^{NT} \quad , \quad \Phi > 0 \qquad (17\text{-a})$$

$$\Phi(y_t^T) \geq L^T \quad , \quad \Phi > 0 \qquad (17\text{-b})$$

where L^{NT} and L^T indicate the loan received by individuals in NT and T sectors respectively. Since the aggregate output of the country is sufficient to exceed the threshold level such that the international liqudty constraint does not bind, the surge in the international capital inflow CI_t at time *t*, between time 0 and time *T* is given by:

$$CI_t = \theta\left(\frac{y_t^{NT}}{e_t} + y_t^T\right) \qquad (18\text{-a})$$

Thus, the country receives the following capital inflow between time 0 and time *T* for *r=0*:

$$\int_0^T \theta\left(\frac{y_t^{NT}}{e_t} + y_t^T\right) dt = CI \qquad (18\text{-b})$$

The capital inflow is transferred to the domestic financial system through the banks. Since the banks use the income as a screening mechanism to allocate their funds to their customers, the individuals in T and NT sectors receive this capital inflow, CI, proportional to their share in aggregate income. Thus, the following shows how the capital inflow is distributed between T and NT sectors at time *t* between time *0* and time *T*.

$$\frac{y_t^{NT}/e_t}{y_t^{NT}/e_t + y_t^T} = S_t^{NT} \tag{19-a}$$

$$\frac{y_t^T}{y_t^{NT}/e_t + y_t^T} = S_t^T = 1 - S_t^{NT} \tag{19-b}$$

where S_t^{NT} and S_t^T denote the shares of NT and T sectors in aggregate GDP at time t respectively. Therefore individuals in T and NT sectors receive $S_t^T CI_t$ and $S_t^{NT} CI_t$ at time t. The important point here is that the shares of T and NT sectors in GDP evolve over time. Due to the expansion in NT sectors with the announcement exchange rate plan, the share of nontradables jumps up to its peak and decreases gradually over time. Therefore, the NT sectors receive more capital inflow during the transition period (0,*T*) as compared to the case when the country receives capital inflow while operating at its steady state or the case that the current income is not used as a screening device in the domestic financial markets. Consequently, the temporary nominal exchange rate reduction plays a role in the distribution of international capital inflow in the country by changing the shares of T and NT sectors in aggregate output.

By the reversal of exchange rate policy at time *T*, the output of nontradables makes a discrete decline and falls below to its steady state and then increases gradually as real exchange rate depreciates over time. By time *T*, international liquidity constraint starts binding again and international investors stop lending and even recall their loans. This triggers a discrete devaluation such that the domestic banks run into a financial distress as the customers of these banks face difficulties to fulfill their repayment obligations.

To simplify the model, we first assume that the banking sector collapses without collecting its loans and subsequently government comes to bail out the banks and carries out the repayment obligations of the banks to international investors. We will discuss the case where the banks collect some of their loans in the following section, but this assumption does not change the main idea of the distributional consequences of the model. At time *T*, the government levies a flat income tax to cover the cost of bail out of the domestic banks. Therefore, the total tax collection must be equal to CI (equation 18-b) plus the interest cost. For the simplicity, the international interest rate is assumed to be 0. The flat income tax lasts from time T to time T_2. The duration of taxation depends on the speed of withdrawal of international investment. If the international investment is recalled at a point of time, the government imposes a tax at that point of time to carry out the debt obligations of the banks. Therefore, the speed of capital outflow is crucial to determine the burden of taxation on T and NT sectors. For example, if all the international debt is recalled at time T, when devaluation takes place, the individuals in NT sectors pay less tax than the usual times because their share in aggregate income is the lowest at time T as compared to other times as a result of discrete fall in the production of nontradables at time T.

Thus, the tax rate is given by the following equation:

$$\text{tax} = \frac{CI}{\int_T^{T_2} \left[\frac{y_t^{NT}}{e_t} + y_t^T \right] dt} \tag{20}$$

The individuals in NT and T sectors, therefore, pay the following taxes respectively:

$$\int_T^{T_2} \text{tax} \frac{y_t^{NT}}{e_t} dt \tag{21-a}$$

$$\int_T^{T_2} \text{tax}\, y_t^T dt \tag{21-b}$$

Proposition 1:

The tax paid by individuals in NT sectors between time T and T_2 is less than the capital inflow they receive between time 0 and time T. Similarly the tax paid by individuals in T sectors between time T and T_2 is greater than what they borrow between time 0 and time T. Hence, the model generates income redistribution from T to NT sectors.

Proof:

The second part of the proposition is easier to show because the income of the individuals in T sectors is constant. We want to show that the following inequality holds:

$$\int_0^T S_t^T CI_t dt \leq \int_T^{T_2} \text{tax}\, y_t^T dt \qquad (22)$$

The LHS of (22) shows the amount capital inflow received by individuals in T sectors between time 0 and time *T*. The RHS is equal to the amount of taxation paid by the individuals in T sectors between time *T* and T_2. Substituting (18-a) and (20) in (22) we can rewrite (22) as:

$$\int_0^T \theta y_t^T dt \leq \int_T^{T_2} \text{tax}\, y_t^T dt \qquad (23)$$

To simplify the proof, the duration of the capital inflow and the duration of taxation are assumed to be equal. Then if $\text{tax} \geq \theta$, the individuals in T sectors pay more tax than what they receive as capital inflow. Upon substituting (18-b) into (20), equation (20) can be rewritten as:

$$\theta \frac{\int_0^T [\frac{y_t^{NT}}{e_t} + y_t^T]dt}{\int_T^{T_2} [\frac{y_t^{NT}}{e_t} + y_t^T]dt} = tax \qquad \text{(20-a)}$$

Since y_t^{NT} / e_t, between time 0 and time *T*, is greater than y_t^{NT} / e_t between time *T* and T_2 thus, $\int_0^T [\frac{y_t^{NT}}{e_t} + y_t^T]dt \geq \int_T^{T_2} [\frac{y_t^{NT}}{e_t} + y_t^T]dt$ in (20-a) then the $\text{tax} \geq \theta$ so the individuals in the T sectors pay more tax than what they receive as capital inflow.

The first part of the proposition follows from the second part of the proposition. If the individuals in T sectors pay more than they receive, the individuals in NT sectors receive more than they pay given that the total capital inflow is equal to the total tax collected.

The duration of tax payment exaggerates the distributional effects the model. So far we assume that temporary stabilization program lasts between time 0 and *T* and the tax is also collected in the same time length. However if the tax is collected in a shorter time period, $T_2 - T < T$, the burden of taxation falls even more on T sectors.

Proposition 2:

if the tax is collected in a shorter time period, T_2 - T < T, the burden of taxation falls even more on T sectors. Similarly, since the taxation at time t is equal to the capital outflow at time t, we can restate the proposition by the following: if the capital outflow takes place in a shorter period of time then the burden of taxation falls even more on the individuals in T sectors.

Proof: see the appendix for formal proof.

Table 1: Time	**Before**		**O**		**Between 0 and T**		**T**		**Between T and** T_2	
			Exchange rate based stabilization starts				**Exchange rate based stabilization ends**		**After the devaluation**	
			Discrete jump in the production of nontradables Jump in the share of nontradables secor Relaxation of financial constraints		Appreciation of real exchange rate Nontradabales production decreses gradually from its peak Relaxation of financial constraints		Discrete fall in the share of nontradables International liquidity constraint binds Banking Crisis Government bails out the banks Government levies tax to carry out bail out expenditure		Depreciation of real exchange rate Production and share of nontradables incrseses gradually Individuals bear the burden of tax proportional to their current income	
An Example: The shares of T and NT sectors in aggregate GDP	S_t^{NT}	S_t^{T}	S_t^{NT}	S_t^{T}	S_t^{NT}	S_t^{T}	S_t^{NT} = **tax burden**	S_t^{T} = **tax burden**	S_t^{NT} = **tax burden**	S_t^{T} = **tax burden**
%	**50**	**50**	**60**	**40**	**60…50**	**40…50**	**40**	**60**	**40…50**	**60…50**

3. Conclusion

This study sheds light on the distributional implications of the exchange rate based stabilizations in a heterogeneous agents setting with financial imperfections. The model suggests redistribution from T to NT sectors. The literature on the exchange rate based stabilizations assumes homogenous agent economy. As a result, the distributional consequences of the temporary policies are not well addressed in the literature. This paper attempts to build this gap by considering heterogeneous agents with respect to their source of income. The heterogeneous agents assumption is more realistic given the fact that individuals receive their income either from T sectors or from NT sectors. Moreover, the income shares of T and NT sectors in aggregate GDP evolve over time.

The model is based on the stylized facts of the temporary exchange rate based stabilization programs. With the introduction of the temporary program, the share of NT sectors in GDP jumps up to its highest level and during the expansion of the economy, the share of NT sectors exceeds its pre-stabilization level. Moreover, the country receives capital inflow in its expansion period due to the relaxation of the international financial constraints. This international capital inflow is distributed to the individuals in T and NT sectors proportional to their current income by the domestic banking sector. Therefore, the individuals in NT sectors increase their share in domestic borrowing as compared to the usual times. Exactly the opposite holds for T sectors. The timing of the collapse of the exchange rate based stabilization program is determined by the international financial constraint when the aggregate output of the country falls below a certain threshold. After the devaluation of the domestic currency takes place, the international investors recall their capital inflows from the domestic banks. The banks suffer from difficulties to carry out repayment obligations due to the currency crisis. The government comes in and bails out the domestic banks by paying the debt of the banking sector to the international financial markets. The burden of bail out expenditure falls on the individuals in the country due to the imposition of the flat income tax. Since the share of T sectors in aggregate GDP increases above its usual share with the devaluation of the currency, the individuals in T sectors pay more tax than what they receive as capital inflow in the expansion phase of the economy. On the other hand, the opposite holds for the individuals in NT sectors who gain more from the capital inflow as compared to what they lose from taxation. Consequently, when individuals receive their income either from T sectors or from NT sectors, the temporary exchange rate based stabilization with financial market imperfections generates adverse distributional consequences for the individuals in T sectors.

Appendix

Proof of proposition 2:

To show that the burden of taxation on the individuals in T sectors increases as the time length to collect the tax shortens; we need to prove the following:

$$\frac{\partial(tax\int_{T}^{T_2} y_t^T dt)}{\partial T_2} \leq 0 \qquad \text{(A-1)}$$

after taking derivative (A-1) can rewritten as:

$$\frac{\partial tax}{\partial T_2}\int_{T}^{T_2} y_t^T dt + tax y_{T_2}^T \leq 0 \qquad \text{(A-2)}$$

and from (20-a)

$$\frac{\partial tax}{\partial T_2} = [-\theta \frac{\int_{0}^{T}[\frac{y_t^{NT}}{e_t} + y_t^T]dt}{\{\int_{T}^{T_2}[\frac{y_t^{NT}}{e_t} + y_t^T]dt\}^2}][\frac{y_{T_2}^{NT}}{e_{T_2}} + y_{T_2}^T] \qquad \text{(A-3)}$$

hence (A-2) is:

$$[-\theta \frac{\int_{0}^{T}[\frac{y_t^{NT}}{e_t} + y_t^T]dt}{\{\int_{T}^{T_2}[\frac{y_t^{NT}}{e_t} + y_t^T]dt\}^2}]\{(\frac{y_{T_2}^{NT}}{e_{T_2}} + y_{T_2}^T)\int_{T}^{T_2} y_t^T dt - y_{T_2}^T\int_{T}^{T_2}(\frac{y_t^{NT}}{e_t} + y_t^T)dt\} \qquad \text{(A-4)}$$

$$-\theta \frac{\int_{0}^{T}[\frac{y_t^{NT}}{e_t} + y_t^T]dt}{\{\int_{T}^{T_2}[\frac{y_t^{NT}}{e_t} + y_t^T]dt\}^2} = A \qquad \text{(A-5)}$$

$$\{(\frac{y_{T_2}^{NT}}{e_{T_2}} + y_{T_2}^T)\int_{T}^{T_2} y_t^T dt - y_{T_2}^T\int_{T}^{T_2}(\frac{y_t^{NT}}{e_t} + y_t^T)dt = B \qquad \text{(A-6)}$$

since $A \leq 0$, for (A-1) to be satisfied; $B \geq 0$

$y_{T_2}^T \int_T^{T_2} y_t^T dt$ cancels each other in (A-6),therefore (A-6) can be rewritten as:

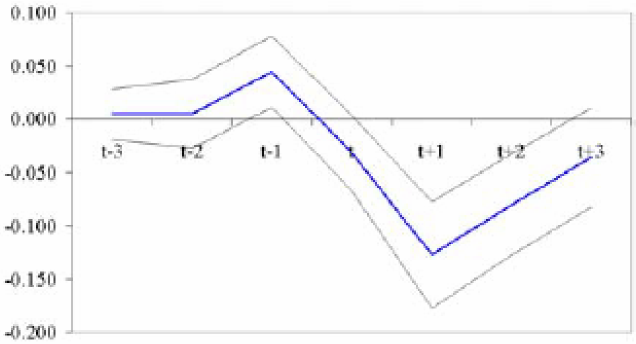
$$\frac{y_{T_2}^{NT}}{e_{T_2}} \int_T^{T_2} y_t^T dt - y_{T_2}^T \int_T^{T_2} \frac{y_t^{NT}}{e_t} dt = B \qquad \text{(A-7)}$$

dividing (A-7) by $\{\frac{y_{T_2}^{NT}}{e_{T_2}} y_{T_2}^T \geq 0\}$, (A-7) can be rewritten as:

$$\int_T^{T_2} [\frac{y_t^T}{y_{T_2}^T}] dt - \int_T^{T_2} [\frac{\frac{y_t^{NT}}{e_t}}{\frac{y_{T_2}^{NT}}{e_{T_2}}}] dt = B \qquad \text{(A-8)}$$

Since y_t^T is constant, $\frac{y_t^T}{y_{T_2}^T}$ is equal to 1. Moreover, $\frac{y_t^{NT}}{e_t}$ is an increasing function between time *T* and time T_2. So $\frac{\frac{y_t^{NT}}{e_t}}{\frac{y_{T_2}^{NT}}{e_{T_2}}}$ is less than 1 between time *T* and time T_2. Therefore; $\int_T^{T_2} [\frac{y_t^T}{y_{T_2}^T}] dt \geq \int_T^{T_2} [\frac{\frac{y_t^{NT}}{e_t}}{\frac{y_{T_2}^{NT}}{e_{T_2}}}] dt$ in (A-8) and this implies that B is greater than 0 which prove (A-1).

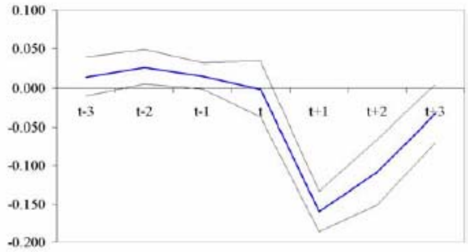
Figure 1: Real Appreciation



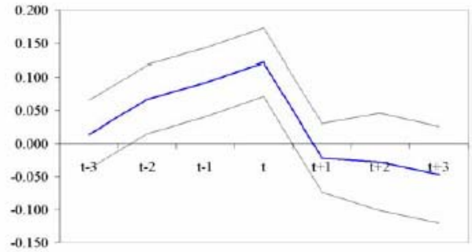
Note: the real exchange rate is proxied by the ratio of PPI/CPI

Figure 2: Bank Credit

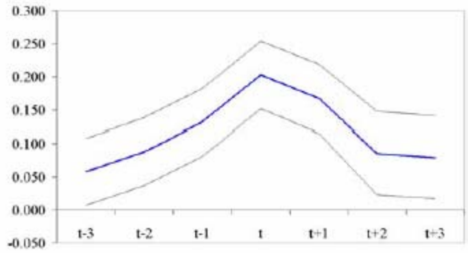
a) Real Credit (growth rates)



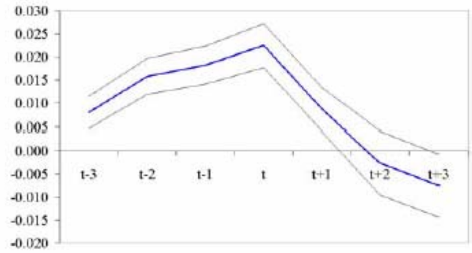
b) Real Credit (deviations from HP-Trend)



c) Credit/GDP



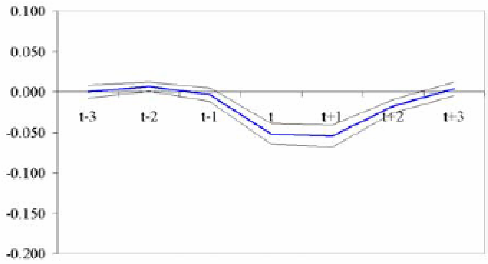
d) Credit/Deposits



Note: "Credit" is the credit provided by domestic deposit money banks to the non-government -, non financial institution – private Sector. The Hodrick-Prescott trend is constructed with λ =100. Deposits are the sum of demand deposits and time-, savings- and foreign currency deposits, by domestic deposit money banks.

Figure 3: Aggregate Output

a) Real GDP (growth rates)



b) Real GDP (deviations from HP-Trend)

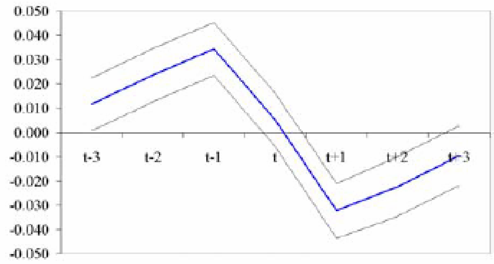
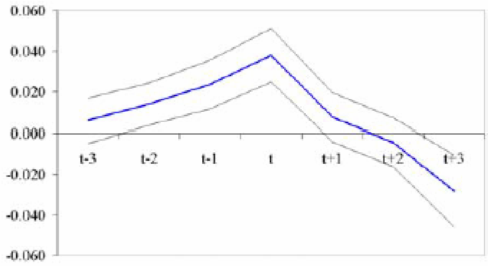


Figure 4: Non-tradables-to-Tradables Output Ratio



Note: Construction, Services and Manufacturing where classified as N or T, according to the variance of the sectorial real exchange rate reported in the appendix. In cases where sectoral price data where not available for Construction, Construction was classified as N by default.

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