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Dollarization as a Signaling Device

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Abstract

The objective of this paper is to point out that dollarization, apart from being a commitment device, may also be used as a signaling device if there is uncertainty about the government's intentions. To this end, we modify the standard approach to modeling monetary policy by introducing two types of government: *good* and *bad*. It is assumed that the *good* government conducts optimal policy while the *bad* government prefers to finance higher (than optimal) government expenditure by printing money. People do not observe the type of government, however they know the probability distribution over the two government types. Due to this uncertainty, the *good* government cannot achieve the first best even if it conducts optimal monetary policy. Hence, the *good* government has an incentive to dollarize, while the *bad* governments avoids this step. As a result, we obtain a separating equilibrium where dollarization is a perfect signal of the government type.

JEL: E42, F40

Keywords: dollarization, monetary policy

Non-technical Summary

This paper contributes to the debate about optimal dollarization. The existing literature points out that on the one hand dollarization is costly since it strips a country of independent monetary policy. On the other hand dollarization has its benefits for countries with the time inconsistency issues, since it can be used as a commitment device to solve them. This paper points out that there is yet another potential benefit from dollarization, it might improve credibility of government since it allows it to signal its intentions, thus serving as a signaling device rather than a commitment device.

We employ a standard general equilibrium model with money and extend it to allow for uncertainty about the macroeconomic policy. To make our argument clear we simplify the economy as much as possible. In our economy there are two types of goods: cash and credit goods. In order to purchase cash goods one needs cash, but credit goods can be purchased both with cash and credit (repaid at the end of each period). Both consumption and credit goods are produced with the same constant returns to scale technology that uses labor as an input.

Our economy is populated by households, firms and government. Government runs a balanced budget in each period (this is a simplifying assumption that allows to avoid the time inconsistency problem that would blur the picture) and conducts monetary and fiscal policy. We assume that there are two types of government, *good* and *bad*. The *Good* government wants to conduct optimal monetary and fiscal policy while the *bad* government wants to increase the government expenditure above the optimal level. Since, we assume that it is not possible to finance this increase with the regular taxes, government has to use the inflation tax instead. In the beginning of each period government decides whether to dollarize or not. If the government decides to dollarize then it cannot use the inflation tax as a source of income and the government expenditure are set at the optimal level, if the government does not decide to dollarize it can use the inflation tax as a source of revenue. Households act in the assets markets, the labor market and the goods markets. In the beginning of each period household do not know the type of government they only know the probabilities and observe whether government dollarized or not. In the assets market they trade cash and state contingent bonds. In the labor market, without knowledge of macroeconomic policy (and the type of government), they supply labor. Finally, in the goods market they observe macroeconomic policy and then buy cash and credit goods. Firms do not play any important role here they just produce cash and credit goods using labor. Agents, while making their labor supply decision, are uncertain about the type of government, therefore they also are uncertain about inflation. This uncertainty distorts their choice and results in equilibrium allocation that is not optimal.

In equilibrium the *good* government dollarizes and the *bad* government does not dollarize. Why is that? Note that since, in this simple cash-in-

advance economy with no nominal stickiness the optimal monetary policy satisfies the Friedman rule. Furthermore, we assume that dollarization brings monetary policy that satisfies the Friedman rule. Thus, by dollarizing the *good* government imports optimal monetary policy. But, if dollarization were not possible the *good* government would conduct exactly the same policy, anyway. Nevertheless the outcome would not be optimal because of the uncertainty about the type of government. Thus, the *good* government does not dollarize to solve the time inconsistency problem, because there is no time inconsistency problem. The problem here is that the uncertainty about the type of governments distorts the decision of private agents in the economy and dollarization allows the *good* government to reveal its type, thus eliminating the uncertainty and, in result, the distortion. Therefore, here it plays the role of a signaling device rather than a commitment device. Furthermore, dollarization has real effects as it allows to bring down inflation expectations.

The assumption that a dollarized country imports optimal monetary policy is not crucial for the result. The result would still go through as long as the imported monetary policy were not "far" from optimal and the probability that government is *bad* were high enough. Though, this set up just makes our argument clearer.

1 Introduction

There are many countries, for example in Latin America, that have a long history of high inflation rates. In a number of these countries, governments conducted policies, that were not necessarily optimal for the societies they governed. As a result, in these countries, the public does not trust its government. Furthermore, many countries do not have long stable tradition of independent central bank. In some countries, even the guarantee of the independence of central bank in the constitution, does not ensure public belief in the low inflation policy. As the result of this heritage, a government that wants to implement optimal policy has low credibility. In such cases, establishing reputation is costly both in terms of welfare and GDP hence, dollarization may lead to savings on the costs of gaining credibility. We want to study this problem from the point of view of such a government, and see how dollarization can solve the problem of the lack of trust.

The standard argument for dollarization is that it brings credibility since it is a commitment device. We propose a new mechanism for building reputation through dollarization. We argue that dollarization may bring credibility since it provides the way to signal the intentions of government. Therefore, we build a model with two types of government: *good* and *bad*¹. The *good* government wants to conduct optimal policy, and the *bad* government wants to use inflationary taxation in order to increase government expenditure above the socially optimal level². The knowledge of the type of government is private, the public knows only the probability distribution over the government types. Since the *good* government is overshadowed by the *bad* government, it cannot achieve optimal outcome, even if it conducts optimal policy. In the model there is a separating equilibrium: the *good* government dollarizes and the *bad* government does not dollarize. Hence, dollarization has real effects, even though it does not change the actual policy, as it would be the case if dollarization was a commitment device. Thus in our model dollarization plays the role of a signaling device rather than a commitment device. It allows the *good* government to signal its type.

The model is a standard cash-credit goods model. We also assume that the government's budget is balanced in each period to avoid any complications with time inconsistency (coming from the fact that government may want to default on its debt). The only source of uncertainty in the model is the type of government.

The key force that drives the result is the fact that expected inflation is costly even if at the end the actual inflation is low. We assume that people decide how much labor to supply before they know monetary policy therefore, they base their decision on expectations. Dollarization brings down inflation expectations, so it improves welfare. In this view dollarization

¹The idea of having two types of government is taken from Phelan (2006).

²Click (1998) documents that seigniorage accounted for a large share of government income in many Latin American countries in the 1970s and 1980s.

1

brings instantaneous reputation at no cost. The results are not driven by time inconsistency, since the only reason why the *good* government cannot achieve an optimal allocation is the fact that people are unsure whether they deal with the *good* or the *bad* government. Dollarization allows the *good* government to separate itself from the *bad* government.

There is an extensive literature on the pros and cons of dollarization (see Borensztein and Berg, 2000). The two most important arguments in favor of dollarization are that it allows to import credibility which results in lower inflation, and can increase trade by eliminating the exchange rate risk and the transaction costs associated with the currency exchange, for example see Alesina and Barro (2002). Similarly Cooper and Kempf. (2001) argue that dollarization may solve the time inconsistency problem, and Mendoza (2001) analyzes how dollarization can be beneficial by eliminating the distortions created by the exchange rate uncertainty and by weakening the informational and institutional frictions in the credit market. The main argument against dollarization is that it strips countries off the monetary independence. For example Cooley and Quadrini (2001) analyze the effect of dollarization in the case of Mexico. They assume that the Mexican government conducts optimal policy and that the US policy is not optimal for Mexico. As the result in their model dollarization leads to non optimal policy, and does not improve the Mexican welfare. There are many more arguments for dollarization than presented above. To name just a few, Calvo (2001) argues that dollarization solves the 'fear of floating' problem, and in the recent paper Arellano and Heathcote (2007) show that dollarization may broaden the access to financial markets. They show, that since dollarization increases the value of maintaining access to international financial markets, it makes it costlier for governments to default, thereby increasing the amount of debt that can be supported in equilibrium.

The crucial contribution of this paper to the literature is to point out that dollarization may improve credibility of government by signaling its intentions. We show that in the presence of uncertainty regarding the goals of government dollarization provides means to signal those goals. Hence, our work shows the mechanism of credibility building through dollarization that to the best of our knowledge has been absent from the debate. We want to stress that our argument complements the existing literature instead of rivaling it.

The structure of this paper is as follows. In section 2 we show how governments behave in our framework. In section 3 we present the model. In section 4 we show the results. Section 5 concludes the paper.

2 Preliminaries

Our paper extends and modifies the Lucas and Stokey (1983) economy. First we introduce the uncertainty of the type of government, second we allow each government to dollarize or not. Furthermore, following Svensson (1985) and Albanesi et al. (2003), we require households to use money accumulated in the previous period to purchase cash good in the current period. We use a version of a cash-credit good model with households, producers and government. Households buy consumption, supply labor and trade assets. Government collects taxes, issues money and finances the stream of government expenditure.

In this section we take a closer look at the behavior of government in a world with no uncertainty about the type of government and no possibility of dollarization. We examine the behavior of both types of government when agents know exactly the type of government they face. In the next section we introduce a fully specified model with the uncertainty about the type of government and the choice of whether to dollarize or not.

There are 2 types of government: *good* government, θ_g , and *bad* government, θ_b . Denote the type of government as, $\theta \in \{\theta_g, \theta_b\}$. Government decides on the level of government expenditure G and on the growth rate of money μ . Denote the government's policy as π .

2.1 Households

There is measure one of households, Households take government's policy, π , as given. Each household starts each period with nominal assets a . In the beginning of each period in the assets market, the households trade money, m , and one-period bonds, b . Each bond costs q and pays one unit of nominal value in the next period. The asset market constraint has the following form

$$m + qb \leq a \quad (1)$$

We also impose a no-Ponzi constraint of the form $b \leq \bar{b}$, where \bar{b} is a large, finite upper bound. Next the households split into two parties. One party goes to the goods market and buys cash goods, c_1 , with money, credit goods, c_2 , with credit, and next period assets, a' . The other party goes to the labor market and supplies labor, l . Since cash goods can only be bought with money each household faces the cash-in-advance constraint

$$Pc_1 \leq m \quad (2)$$

where P denotes the price level. The budget constraint in the goods market has the following form

$$\mu a' + Pc_2 + Pc_1 \leq Wl + m - PT + b \quad (3)$$

where T denotes lump sum taxes. Denote aggregate values with capital letters, and individual values with small letters. We follow Albanesi et al. (2003) in normalizing all nominal variables by dividing each nominal variable (money, nominal assets, bonds, price and wage) in each period by the aggregate stock of nominal assets, so $A = 1$. Due to this normalization we have μ in the households budget constraint (3). The household have the following instantaneous utility function

$$u(c_1, c_2, G, l) = \log c_1 + \log c_2 + \xi \log G + \log(1 - l)$$

Denote the vector (m, b, c_1, c_2, l, a') as x , the problem of the household, given governments' policy π , takes the following form

$$V(a; \pi) = \max_x \left\{ \begin{array}{l} \log c_1 + \log c_2 + \xi \log G + \log(1 - l) + \beta V(a'; \pi) \\ \text{subject to (1) - (3)} \end{array} \right\} \quad (4)$$

2.2 Government

We assume that a government runs a balanced budget³.

$$G = T + \frac{\mu - 1}{P} M \quad (5)$$

where M denotes the money supply⁴. Furthermore, we assume that government has only limited ability to collect taxes⁵. Let \bar{T} be an upper limit on taxes. The value of the limit is provided at the end of this section. This limit puts a constraint on a government and it cannot freely choose the level of government expenditure and the growth rate of money.

2.3 Producers and Resource Constraint

For simplicity we assume the following production function

$$y = l$$

Furthermore, we assume that cash, credit and government goods are produced with the same technology, which implies that all goods have the same price P . Zero profit condition implies

$$P = W \quad (6)$$

³We assume that the budget is balanced to avoid the time inconsistency problems associated with incentives to deflate government debt, for details see Lucas and Stokey (1983).

⁴We also impose a standard constraint that the interest rates are non-negative which translates into the following constraint $\mu \geq \beta$.

⁵There are many possible reasons for that. For example could be due to inefficient tax collection or due to political constraints.

Feasibility condition takes the following form

$$C_1 + C_2 + G = Y = L \quad (7)$$

In the assets market, since government cannot borrow or lend, the aggregate stock of bonds is equal to zero

$$B = 0 \quad (8)$$

Furthermore, since the aggregate stock of nominal assets is normalized to one, we have the constraint in the nominal assets market

$$A = 1 \quad (9)$$

Also, given that $B = 0$, we have the constraint for the money market

$$M = 1 \quad (10)$$

2.4 Recursive Competitive Equilibrium

Next we use the standard concept of recursive competitive equilibrium to describe the behavior of the private economy. Agents in the economy take the government's policy as given and optimize their decisions.

Definition 1 *A recursive competitive equilibrium, given the government policy π , is an individual policy function $x(a; \pi)$, a value function $V(a; \pi)$, an aggregate policy function $X(\pi)$, and prices $(P(\pi), W(\pi), q(\pi))$ such that*

- (i) $x(a; \pi)$ and $V(a; \pi)$, given π , $X(\pi)$ and prices, solve the household's problem (4).
- (ii) aggregate and individual choices coincide $x(1; \pi) = X(\pi)$.
- (iii) producers satisfy (6).
- (iv) the government budget, (5), is satisfied
- (v) all markets clear, (8) – (10) are satisfied.

A recursive competitive equilibrium is fully characterized by the following equations

$$C_1 = \beta \frac{1 - G}{\beta + 2\mu} \quad (11)$$

$$C_2 = \mu \frac{1 - G}{\beta + 2\mu} \quad (12)$$

$$1 - L = \mu \frac{1 - G}{\beta + 2\mu} \quad (13)$$

$$G = (\mu - 1)\beta \frac{1 - G}{\beta + 2\mu} + T, \quad T \leq \bar{T} \quad (14)$$

Note that social optimality requires $C_1 = C_2$, and in our case we have $\mu C_1 = \beta C_2$. Thus, if growth rate of money is higher than the one implied by the Friedman rule⁶, $\mu > \beta$, it creates a wedge in cash good-credit good choice, that distorts economy away from social optimum. Also the higher μ the farther away is the economy from optimum.

2.5 Markov Problem

In this subsection we describe the behavior of both types of government. We specify their objectives and later we describe the choices that both governments make in a Markov equilibrium. Since we focus on the case when governments have no ability to commit, we are going to use the concept of Markov problem rather than the Ramsey problem. Governments here choose the policy today and take the future policy as given. The precise definition of Markov equilibrium is presented at the end of this subsection. Both types of government solve the following problem

$$\max_{(G, \mu)} \left\{ \begin{array}{l} u^\theta(c_1, c_2, G, l) + \beta V^\theta(1; \pi) \\ \text{subject to (11) - (14)} \end{array} \right\} \quad (15)$$

where, $V^\theta(1, \pi)$ is defined on the equilibrium path of (c_1, c_2, G, l) given government policy π according to the following formula

$$V^\theta(1, \pi) = u^\theta(c_1, c_2, G, l) + \beta V^\theta(1; \pi)$$

where $u^{\theta_g}(c_1, c_2, G, l) = \log c_1 + \log c_2 + \xi \log G + \log(1 - l)$, $u^{\theta_b}(c_1, c_2, G, l) = \log c_1 + \log c_2 + \xi_b \log G + \log(1 - l)$, $\xi_b > \xi$. We assume that the *good* government maximizes the utility of the representative agent, but the *bad* government maximizes the utility that assigns higher value to the government expenditure than the representative agent's utility.

The limit on lump sum taxes, \bar{T} , is such that it is enough to finance the socially optimal level of government expenditure, but not the level that is preferred by the *bad* government. Thus if the *bad* government wants to increase the government expenditure it has to print money. We set $\bar{T} = (1 + \bar{\xi} - \beta)/(3 + \bar{\xi})$, where $\xi < \bar{\xi} < \xi_b$. We would like to stress that there is more than one way of modelling why governments do bad things. Our way of modeling *bad* government captures simple intuition, that there are situations that governments print too much money. Next we define a Markov equilibrium.

Definition 2 *A Markov equilibrium is: (1) a policy $\pi(\theta)$; and (2) a recursive competitive equilibrium, s.t.*

(i) *the policy of type θ government solves the Markov problem, (15), given RCE.*

⁶Since this is the cash-credit goods model with no nominal stickiness optimal monetary policy satisfies the Friedman rule, and the optimal growth rate of money is equal to $\beta - 1$.

It is straightforward to find a Markov equilibrium. We find that in a Markov equilibrium the *good* government chooses $G = \frac{\xi}{3+\xi}$, $\mu = \beta$ and the *bad* government chooses $G = \frac{\xi_b(1+\bar{\xi})}{(1+\xi_b)(3+\xi)} > \frac{\xi}{3+\xi}$, $\mu = \beta \frac{1+\xi_b}{1+\xi} > \beta$. Define $G_L = \frac{\xi}{3+\xi}$ and $G_H = \frac{\xi_b(1+\bar{\xi})}{(1+\xi_b)(3+\xi)}$. Note that without the limit on taxes the *bad* government would have chosen government expenditure at an even higher level. In our situation the *bad* government faces a trade off. When it increases the government expenditure, it enjoys higher level of government expenditure, but pays for it with creating more distortions in the economy.

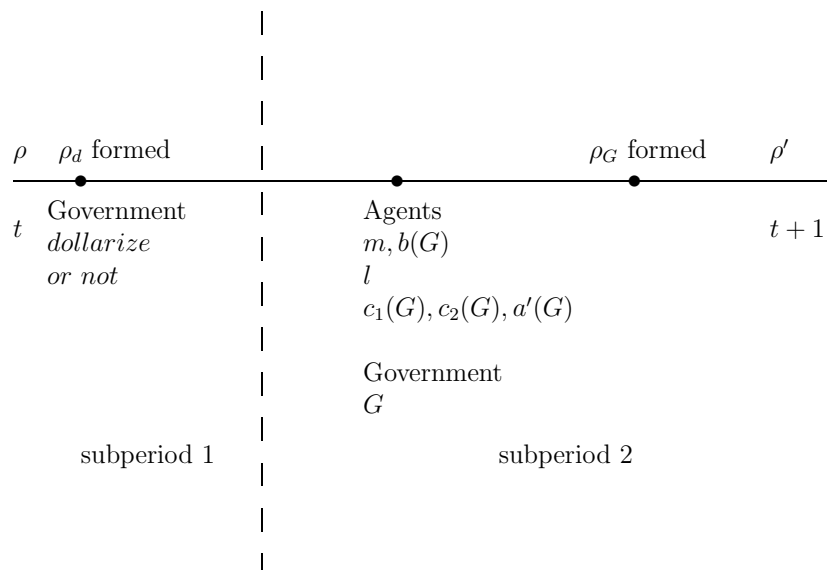
3 Model

In this section we introduce uncertainty about the type of government, which creates uncertainty about the government's policy. To simplify analysis we restrict the set of possible values of G to $\{G_L, G_H\}$. From the previous section we can see that this is not a very restrictive assumption, because this is what these governments want to do anyway. Each government faces the decision whether to dollarize or not. If a government dollarizes, then it has to follow US monetary policy, and fiscal policy has to be adjusted to that. It will be explained later what US monetary policy means. If a government does not dollarize, it has to decide on both fiscal and monetary policy. The difference between governments is that the *good* government maximizes welfare of the representative agent; and the *bad* government would like to have higher than optimal level of government expenditure. The prior probability that the government's type is *good* is equal to ρ , and the prior probability that the government's type is *bad* is equal to $(1 - \rho)$.

3.1 Timing

The prior probability that the type of government is *good*, ρ , is publicly known. Each period t is divided into two subperiods. The timing is illustrated in Figure 1.

Figure 1: Timing of the model



3.1.1 Subperiod 1

In the first subperiod the government decides whether to dollarize or not. The state of the government $s_1 = (\rho, \theta)$. Agents do not make any move in

this subperiod.

3.1.2 Subperiod 2

In the second subperiod households first observe the decision of the government d and update their belief ρ_d . Each household starts each period with nominal assets holding a . These assets at the beginning of the second subperiod are used to buy money, m , and state contingent bonds (bonds are contingent on the government's policy⁷, which is the only source of uncertainty in this economy), $b(G)$. Then each household splits into two parties and one party goes to the labor market where it has to sign a contract on hours worked, l , for an expected competitive wage. This decision is made before G is observed and cannot be contingent on G . The other party goes to the goods market, learns government policy G and uses money to buy cash goods $c_1(G)$ and credit to buy credit goods $c_2(G)$. Since the party that goes to the goods market observes G , these decisions are contingent on G (they are made by households before splitting).

In the second subperiod, if the economy is dollarized then a government does nothing in the second subperiod, otherwise it has to choose its monetary and fiscal policy.

The public state of the world for agents is denoted as $s_2 = (\rho_d, d)$. The state of the world for an individual agent is (s_2, a) . The state of the world for a government is (s_2, θ) .

3.2 Government

A government moves in two stages, in the first stage a government decides whether to dollarize or not $d \in \{D, N\}$ (where D – denotes dollarization and N – no dollarization).

If the government in the first stage decides not to dollarize, then in the second stage it has to pick government expenditure, $G \in \{G_L, G_H\}$, and monetary policy, $\mu \in [\beta, \infty)$. To finance government expenditure government can use lump sum taxes $T \leq \bar{T} = \frac{1+\bar{\xi}-\beta}{3+\bar{\xi}}$, where \bar{T} is a limit on taxes and $\xi < \bar{\xi} < \xi_b$. The introduction of the limit on taxes plays a very important role here. The limit is such that it allows to the government to finance $G_L = \frac{\xi}{3+\xi}$, but does not allow to finance $G_H = \frac{\xi_b(1+\bar{\xi})}{(1+\xi_b)(3+\bar{\xi})}$. If the government chooses G_H , it has to print money. The relation between monetary policy and fiscal policy is given by the balanced government budget

$$G = T(G) + \frac{\mu(G) - 1}{P(G)}M \quad (16)$$

Thus the choice of G completely describes the behavior of the government. Denote the strategy of government as $\gamma(s_2, \theta)$, where $\gamma(s_2, \theta)$ – probability that type θ government chooses G_L .

⁷This is to show that the result does not follow from asset markets incompleteness.

If the government in the first stage decides to dollarize, then monetary policy is fixed by this decision, we assume that then $\mu = \mu^{US} = \beta$. Given that the government runs a balanced budget, the government cannot afford G_H , thus G has to be equal to G_L .

The dynamics of the types of government is given by the following rule

$$\begin{aligned}\Pr(\theta_g|\theta_g) &= 1 - \epsilon_g, \Pr(\theta_b|\theta_g) = \epsilon_g \\ \Pr(\theta_b|\theta_b) &= 1 - \epsilon_b, \Pr(\theta_g|\theta_b) = \epsilon_b\end{aligned}\quad (17)$$

where $\epsilon_g, \epsilon_b < 0.5$.

3.3 Households

First, households observe whether there is dollarization or not $d \in \{D, N\}$. Given this observation, they update their belief⁸ about the probability of facing the *good* government, ρ_d , $d \in \{D, N\}$. The state of the world for agents is now (s_2, a) . For convenience we suppressed notation by dropping s_2 whenever possible.

In each period each household decides how much to work, and how much of cash good and credit good to consume. They form their belief about the probability distribution over the government types, which together with the strategy of both governments γ allows households to compute the probability of each G , $\Pr(G)$, according to the following formula $\Pr(G_L) = \rho_d\gamma(\theta_g) + (1 - \rho_d)\gamma(\theta_b)$ and $\Pr(G_H) = \rho_d(1 - \gamma(\theta_g)) + (1 - \rho_d)(1 - \gamma(\theta_b))$. Furthermore, we assume that households are cautious, and they form their plans for all possible values of G , even if their probabilities are zero (i.e. even for G such that $\Pr(G) = 0$). The instantaneous utility function is given by

$$\lim_{\varepsilon \rightarrow 0} \sum_{G \in \{G_L, G_H\}} \Pr_\varepsilon(G) \{ \log c_1(G) + \log c_2(G) + \zeta \log G + \log(1 - l) \} \quad (18)$$

where $\Pr_\varepsilon(G) = \{\Pr(G), \text{ if } \Pr(G) \in [\varepsilon, 1 - \varepsilon]; = \varepsilon, \text{ if } \Pr(G) < \varepsilon; \text{ and } = 1 - \varepsilon, \text{ if } \Pr(G) \geq 1 - \varepsilon\}$. Notice that without this modification, for G s.t. $\Pr(G) = 0$ households would not care about the choice of $c_1(G), c_2(G)$ and the strategies for the government (defined later) would not be well defined.

Denote the nominal household's assets holdings, carried over from the previous period, as a . Households use this assets to buy money m , and state contingent bonds $b(G)$, where $G \in \{G_L, G_H\}$ and $\Pr_\varepsilon(G)q(G)$ is a price of bond $b(G)$ that pays one if government expenditure are equal to G and zero otherwise. Thus households face the following budget constraint

$$m + \sum_{G \in \{G_L, G_H\}} \Pr_\varepsilon(G)q(G)b(G) \leq a \quad (19)$$

Again we normalize all nominal variables, so that $A = 1$. Money is used to

⁸All the updating rules are presented in the Appendix.

purchase cash goods subject to the cash in advance constraint.

$$P(G)c_1(G) \leq m \quad (20)$$

where P denotes the price of goods. Nominal assets have to satisfy the following constraint for $G \in \{G_L, G_H\}$.

$$\begin{aligned} \mu(G) a'(G) + P(G)c_2(G) + P(G)c_1(G) &\leq W(G)l \\ &+ m - P(G)T(G) + b(G) \end{aligned} \quad (21)$$

$a'(G)$ is multiplied by $\mu(G)$, because of normalization.

Denote the variables describing choice of households by $x = (m, b(G_L), b(G_H), c_1(G_L), c_1(G_H), c_2(G_L), c_2(G_H), l, a'(G_L), a'(G_H))$ and the aggregate policy rules by X . The aggregate policy rules are given by

$$X = X(s_2) \quad (22)$$

Recall, that before the next period starts, agents observe the value of the government expenditure and update their beliefs about the type of government, the new belief is denoted by ρ_G . Afterwards, given the transition probabilities from (17), they form the next period belief ρ' . Agents take the governments' strategy $\delta(\rho, \theta)$, $\gamma(s_2, \theta)$ and the beliefs ρ , ρ_d , ρ_G as given and solve the following problem⁹

$$V(a, \rho, d) = \lim_{\varepsilon \rightarrow 0} \left\{ \begin{array}{l} \max_x \sum_{G \in \{G_L, G_H\}} \Pr_\varepsilon(G) [u(c_1(G), c_2(G), G, l) \\ \quad + \beta E_{\rho_G} [E_\delta [V(a'(G), \rho', d') | \theta]]] \\ \text{subject to (19) - (22)} \end{array} \right\} \quad (23)$$

Denote the policy functions for individuals (which solve the problem above) as

$$x = x(s_2, a)$$

3.4 Firms and Resource Constraint

For simplicity we assume the following production function

$$y = l \quad (24)$$

Cash, credit and government goods are produced with the same technology by the same firm, which implies that the nominal price of the three goods is the same P . Firms are competitive which, together with the production function, implies that

$$P(G) = W(G) \quad (25)$$

⁹Note: $E_\delta [V(a', \rho', d') | \theta] = \delta(\rho', \theta)V(a', \rho', D) + (1 - \delta(\rho', \theta))V(a', \rho', N)$ and $E_{\rho_G} [E_\delta [V(a'(G), \rho', d') | \theta]] = \sum_\theta \Pr(\theta; \rho_G) E_\delta [V(a'(G), \rho', d') | \theta]$.

Profits are zero.

Feasibility condition is:

$$C_1(G) + C_2(G) + G = L \quad (26)$$

where C_1, C_2, L are aggregate values of, respectively, cash good, credit good, and labor supply.

We assume that the government budget is balanced so the aggregate bonds holdings are zero

$$B(G) = 0 \quad (27)$$

All nominal variables are normalized by the beginning of period aggregate nominal assets holdings which, since the aggregate bond holdings add up to zero, is equal to the stock of money. Given this normalization in each period the aggregate stock of money is

$$M = 1 \quad (28)$$

and the aggregate nominal assets holdings is

$$A = 1 \quad (29)$$

3.5 Recursive Competitive Equilibrium

Next we define a recursive competitive equilibrium given the decision of the government $d \in \{D, N\}$, the governments' policy rules and the updating rules. See Appendix for the updating rules.

Definition 3 *A recursive competitive equilibrium given: (1) the governments' policy $\delta(\rho, \theta), \gamma(s_2, \theta)$; (2) the event $d \in \{D, N\}$; and (3) the updating rules for ρ_d, ρ_G and ρ ; is a collection of functions: $\{P(G), W(G), q(G), x(a, s_2), X_2(s_2)\}$ and a value function $V(a, \rho, d)$ such that*

- (i) $x(a, s_2)$ and $V(a, \rho, d)$ solve the household's problem (23).
- (ii) the aggregate and the individual policy rules coincide $x(1, s_2) = X(s_2)$
- (iii) producers satisfy (25).
- (iv) the government budget (16) is satisfied.
- (v) the asset markets clear, (27) – (29) are satisfied.
- (vi) the goods market clears, (26) is satisfied.

Equilibrium is fully described by

$$q(G)c_1(G) = c_2(G) \quad (30)$$

$$\frac{1}{1-l} = \sum_{G \in \{G_L, G_H\}} \Pr(G) \frac{1}{c_2(G)} \quad (31)$$

$$P(G)c_1(G) = M = 1 \quad (32)$$

$$q(G)\mu(G) = \beta \quad (33)$$

plus the government budget constraint (21), and the feasibility constraint (26). Notice that $q(G)$ (if different from 1) distorts the economy away from optimum. The optimal allocation requires $c_1 = c_2 = 1 - l$.

3.6 Markov problem

Next we define the problems solved by governments. Once the dollarization decision is made governments solve the following problems. If $d = N$, the *good* government solves

$$\max_{\gamma} \left\{ \begin{array}{l} \gamma \{u(c_1(G_L), c_2(G_L), G_L, l) + \beta E_{\rho_G} [E_{\delta} [V(1, \rho', d') | \theta]]\} \\ \quad + (1 - \gamma) \{u(c_1(G_H), c_2(G_H), G_H, l) \\ \quad \quad + \beta E_{\rho_G} [E_{\delta} [V(1, \rho', d') | \theta]]\} \\ \text{subject to RCE} \end{array} \right\} \quad (34)$$

If $d = N$, the *bad* government solves

$$\max_{\gamma} \left\{ \begin{array}{l} \gamma \{u^b(c_1(G_L), c_2(G_L), G_L, l) + \beta E_{\rho_G} [E_{\delta} [V^b(1, \rho', d') | \theta]]\} \\ \quad + (1 - \gamma) \{u^b(c_1(G_H), c_2(G_H), G_H, l) \\ \quad \quad + \beta E_{\rho_G} [E_{\delta} [V^b(1, \rho', d') | \theta]]\} \\ \text{subject to RCE} \end{array} \right\} \quad (35)$$

where $u^b(c_1, c_2, G, l) = \log c_1 + \log c_2 + \zeta_b \log G + \log(1 - l)$, and $\zeta_b > \zeta$. V^b and V are defined given the future government strategies $\gamma(\cdot)$, $\delta(\cdot)$, the households' policy function $X(\cdot)$, and the updating rules for ρ, ρ_d, ρ_G as

$$V(1, \rho, d) = \sum_{G \in \{G_L, G_H\}} \Pr(G) \left[\begin{array}{l} u(c_1(\cdot), c_2(\cdot), G, l(\cdot)) \\ + \beta E_{\rho_G} [E_{\delta} [V(1, \rho', d') | \theta]] \end{array} \right] \quad (36)$$

$$V^b(1, \rho, d) = \sum_{G \in \{G_L, G_H\}} \Pr(G) \left[\begin{array}{l} u^b(c_1(\cdot), c_2(\cdot), G, l(\cdot)) \\ + \beta E_{\rho_G} [E_{\delta} [V^b(1, \rho', d') | \theta]] \end{array} \right] \quad (37)$$

Let's define government's problem in the first subperiod. *Good* government wants to conduct optimal policy (it maximizes utility of the representative agent). Let $\delta(\rho, \theta_g)$ be a policy of the *good* government, and let it denote the probability of dollarization by the *good* government. This policy solves

$$\max_{\delta} \delta V(1, \rho, D) + (1 - \delta) V(1, \rho, N) \quad (38)$$

Bad government maximizes its own utility function. Let $\delta(S, \theta_b)$ be a policy of the *bad* government, and let it denote the probability of dollarization by the *bad* government. This policy solves

$$\max_{\delta} \delta V^b(1, \rho, D) + (1 - \delta) V^b(1, \rho, N) \quad (39)$$

Notice that, in equilibrium agents, take the policy of future governments as given, hence, by solving (38) and (39), the governments also implicitly do. Next we define a Markov equilibrium.

Definition 4 A Markov equilibrium is: (1) policy rules $\delta(\cdot), \gamma(\cdot, N)$; and (2) a recursive competitive equilibrium, s.t.

(i) policy of the good government, $\gamma(\cdot, N, \theta_g)$, solves (34), given $\delta(\cdot), \gamma(\cdot, N, \theta_b)$ and RCE.

(ii) policy of the bad government, $\gamma(\cdot, N, \theta_b)$, solves (35), given $\delta(\cdot), \gamma(\cdot, N, \theta_g)$ and RCE.

(iii) policy of the good government, $\delta(\cdot, \theta_g)$, solves (38), given $\delta(\cdot, \theta_b), \gamma(\cdot)$ and RCE.

(iv) policy of the bad government, $\delta(\cdot, \theta_b)$, solves (39), given $\delta(\cdot, \theta_g), \gamma(\cdot)$ and RCE.

(v) updating rules for ρ, ρ_d, ρ_G are consistent with strategies and dynamics of government.

4 Results

In this section we describe the behavior of governments in equilibrium.

Proposition 1 *In a pure strategies Markov equilibrium:*

- (i) in case of no dollarization, the *good* government chooses $G = G_L$ (i.e. $\gamma(\cdot, N, \theta_g) = 1$).
- (ii) in case of no dollarization, the *bad* government chooses $G = G_H$ (i.e. $\gamma(\cdot, N, \theta_b) = 0$).
- (iii) the *good* government dollarizes, $\delta(\cdot, \theta_g) = 1$ (unless $\rho = 1$, then it is indifferent).
- (iv) the *bad* government does not dollarize, $\delta(\cdot, \theta_b) = 0$.

Proof. See Appendix. ■

In equilibrium if the *bad* government does not dollarize, then in order to finance high government expenditure it has to print money. Thus the *bad* government creates distortions in the economy. Furthermore, since dollarization makes it impossible to finance high level of government expenditure, the *bad* government will not choose dollarization. Given this strategy of the *bad* government, the *good* government decides to dollarize. The main reason for dollarization is to distinguish itself from the *bad* government.

Notice, that after dollarization the *good* government has to choose $G = G_L$, but without dollarization it would have chosen the same. If there is no dollarization we have the following strategies, the *good* government chooses the low level of government expenditure, and the *bad* government chooses the high level of government expenditure. Thus, government does not dollarize in order to commit and escape the time inconsistency problem. The only reason for dollarization is the fact that it allows the *good* government to distinguish itself from the *bad* government, and thus signal its type. Dollarization allows the *good* government to signal its type before the choice of labor supply is made, so that l is not distorted, and even though it does not change the policy (by policy we mean the choice of G) it has real effects. Since dollarization does not change the policy, real effects come from the fact that dollarization plays the role of a signaling device rather than a commitment device.

Let us stress here that the result does not rely on the fact that dollarization is not costly for the *good* government. The result still goes through if the costs of dollarization are smaller than gains. Precisely, it can be shown that dollarization is an optimal solution, even if dollarization means implementing the US policy, that is not optimal from the point of view of the dollarizing country (i.e. $\mu^{US} > \beta$), but is not "far" from optimal (i.e. μ^{US} is not too big).

5 Conclusion

In this paper, we find that governments faced with the lack of public trust may find it optimal to dollarize. We find a very specific motivation for how dollarization can help credibility issues. It allows the *good* government to separate itself from the *bad* government. Thus dollarization works as a signal. This view on dollarization differs from the standard one, which views dollarization as a commitment device. In our framework, by dollarizing the government is not trying to escape the time inconsistency problem, because, even without dollarization, it would have chosen the same policy (here the low value of government expenditure). Thus dollarization plays the role of signaling device. Dollarization has real effects as it allows to bring down the inflation expectations.

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Appendix

A.1 Updating rules.

In order to obtain consistent with strategies beliefs ρ_d , use the following formulas

$$\rho_D = \begin{cases} \frac{\delta(\rho, \theta_g)\rho}{\delta(\rho, \theta_g)\rho + \delta(\rho, \theta_b)(1-\rho)}, & \text{if possible} \\ 0, & \text{if } \rho = 0 \\ 1, & \text{otherwise} \end{cases} \quad (40)$$

$$\rho_N = \begin{cases} \frac{(1-\delta(\rho, \theta_g))\rho}{(1-\delta(\rho, \theta_g))\rho + (1-\delta(\rho, \theta_b))(1-\rho)}, & \text{if possible} \\ 1, & \text{if } \rho = 1 \\ 0, & \text{otherwise} \end{cases} \quad (41)$$

In order to obtain consistent with strategies beliefs ρ_G , use the following formulas

$$\rho_{G_L} = \begin{cases} \frac{\gamma(\theta_g)\rho_d}{\gamma(\theta_g)\rho_d + \gamma(\theta_b)\rho_d}, & \text{if possible} \\ 0, & \text{if } \rho = 0 \\ 1, & \text{otherwise} \end{cases} \quad (42)$$

$$\rho_{G_H} = \begin{cases} \frac{(1-\gamma(\theta_g))\rho_d}{(1-\gamma(\theta_g))\rho_d + (1-\gamma(\theta_b))\rho_d}, & \text{if possible} \\ 1, & \text{if } \rho = 1 \\ 0, & \text{otherwise} \end{cases} \quad (43)$$

Similarly, to obtain ρ' use ρ_G and (17)

$$\rho' = \rho_G(1 - \epsilon_g) + (1 - \rho_G)\epsilon_b$$

A.2 Proof of Proposition 1

First notice that for any ρ after dollarization, $d = D$, we have: $(C_1(D), C_2(D), G, l(D)) = (1/(3 + \xi), 1/(3 + \xi), \xi/(3 + \xi), (2 + \xi)/(3 + \xi))$ and for any $\rho \neq 1$ after no dollarization, $d = N$, we have $\rho_N = 0$ and $(C_1(N, G_H), C_2(N, G_H), G, l(N)) = ((1 + \bar{\xi})/[(1 + \xi_b)(3 + \bar{\xi})], 1/(3 + \bar{\xi}), [\xi_b(1 + \bar{\xi})]/[(1 + \xi_b)(3 + \bar{\xi})], (2 + \bar{\xi})/(3 + \bar{\xi}))$. It is easy to show that the current period utility after dollarization¹⁰ $u(D)$ is higher than after no dollarization $u(N)$, $u(D) > u(N)$, thus, as the *good* government dollarizes and the *bad* government does not dollarize, it implies that the future value $\beta E_{\rho_G} [E_\delta [V(a'(G), \rho', d')|\theta]]$ is increasing in ρ_G . Furthermore, it is easy to show that the current period utility for the *bad* government after dollarization¹¹ $u^b(D)$, is lower than after no dollarization $u^b(N)$, $u^b(D) < u^b(N)$, thus the future value $\beta E_{\rho_G} [E_\delta [V^b(a'(G), \rho', d')|\theta]]$ is decreasing with ρ_G . Next we show that there do not exist profitable deviations. We consider deviations for each government.

¹⁰Denote the equilibrium value of $\lim_{\epsilon \rightarrow 0} \sum_{G \in \{G_L, G_H\}} \Pr_\epsilon(G) u(C_1(G), C_2(G), G, L)$ after dollarization as $u(D)$ and after no dollarization as $u(N)$.

¹¹Denote the equilibrium value of $\sum_{G \in \{G_L, G_H\}} \Pr(G) u^b(C_1(G), C_2(G), G, L)$ after dollarization as $u^b(D)$ and after no dollarization as $u^b(N)$.

Good government

Consider deviation from G_L to G_H . First notice that in a competitive equilibrium: $(C_1(G_L), C_2(G_L), G_L, l) = (1/(3 + \xi), 1/(3 + \xi), \xi/(3 + \xi), (2 + \xi)/(3 + \xi))$ which is efficient (instantaneous utility is the highest possible). Furthermore notice that from government's budget $\mu(G_H) > \beta$, so $q(G_H) < 1$ and $C_1(G_H) \neq C_2(G_H)$ which, together with feasibility and the fact that $G_H > G_L$, implies¹² $u(G_L) > u(G_H)$. Also, since ρ_G does not change, the future value $\beta E_{\rho_G} [E_{\delta} [V(a'(G), \rho', d')|\theta]]$ does not change either. Thus, in problem (34) instantaneous utility decreases while the future value does not change. This deviation is not profitable.

Consider deviation from D to N . As we showed earlier $u(D) > u(N)$, thus the current period utility falls. Furthermore, since the future value $\beta E_{\rho_G} [E_{\delta} [V(a'(G), \rho', d')|\theta]]$ is increasing in ρ_G and this deviation changes ρ_d from 1 to 0, the future value also falls. Thus in problem (38) both the instantaneous utility and the future value decrease. Hence this deviation is not profitable.

Bad government

Consider deviation from G_H to G_L . First notice that in a competitive equilibrium: $(C_1(G_H), C_2(G_H), G_H, l) = ((1 + \bar{\xi})/[(1 + \xi_b)(3 + \bar{\xi})], 1/(3 + \bar{\xi}), [\xi_b(1 + \bar{\xi})]/[(1 + \xi_b)(3 + \bar{\xi})], (2 + \bar{\xi})/(3 + \bar{\xi}))$ and $(C_1(G_L), C_2(G_L), G_L, l) = ((1 + \bar{\xi})/[(1 + \xi_b)(3 + \bar{\xi})], 1/(3 + \bar{\xi}), \xi/(3 + \xi), (2 + \bar{\xi})/(3 + \bar{\xi}))$. It is easy to show that¹³ $u^b(G_L) < u^b(G_H)$. Also since ρ_G does not change, the future value $\beta E_{\rho_G} [E_{\delta} [V^b(a'(G), \rho', d')|\theta]]$ does not change either. Thus, in problem (35) the instantaneous utility decreases while the future value does not change. This deviation is not profitable.

Consider deviation from N to D . As we showed earlier $u^b(D) < u^b(N)$, thus the current period utility falls. Furthermore, since the future value $\beta E_{\rho_G} [E_{\delta} [V^b(a'(G), \rho', d')|\theta]]$ is decreasing in ρ_G and this deviation changes ρ_d from 0 to 1, the future value also falls. Thus, in problem (35) both the instantaneous utility and the future value decrease. Thus this deviation is not profitable.

¹²Denote the equilibrium value of $u(C_1(G_L), C_2(G_L), G_L, L)$ after no dollarization as $u(G_L)$ and the equilibrium value of $u(C_1(G_H), C_2(G_H), G_H, L)$ after no dollarization as $u(G_H)$.

¹³Denote the equilibrium value of $u^b(C_1(G_L), C_2(G_L), G_L, L)$ after no dollarization as $u^b(G_L)$ and the equilibrium value of $u^b(C_1(G_H), C_2(G_H), G_H, L)$ after no dollarization as $u^b(G_H)$.