

Dollarization Hysteresis in Russia

Andrei Shinkevich and Nienke Oomes¹

andrei.shinkevich@usa.net

nienke.oomes@usa.net

January 2002

¹We are grateful to the Economics Education and Research Consortium (EERC) in Russia for professional and financial support of project # R00-0871. (This project was previously titled "Causes and Consequences of Dollarization in Russia".) We also thank William Brock, Steven Durlauf, Charles Engel, Bruce Hansen, Arend Kouwenaar, Miguel Savastano, and the participants of the July and December 2000 EERC workshops in Moscow for valuable comments and suggestions. Special thanks to Edgar Feige, Nadezhda Ivanova, Marina Malyutina, Sergey Nikolaenko, N. Rimashevskaya, and Aleksey Verbetsky for generously sharing their data.

Abstract

During the 1990s, dollarization in Russia quickly increased from almost zero to over 70%, and failed to decrease in spite of exchange rate stabilization. This persistence, or hysteresis, in the dollarization ratio has been observed in other countries as well, and is often explained by assuming that temporarily high levels of currency depreciation or inflation are long remembered by agents, and thus can have long-term effects on agents' expectations.

In this paper it is shown that an additional, and perhaps alternative explanation of dollarization hysteresis is the existence of network externalities in the demand for currency. A new theoretical model is developed, and is estimated using a new source of data on dollar currency holdings. Evidence is found for the existence of multiple steady state levels of dollarization, suggesting that the observed dollarization hysteresis in Russia can be explained as a 'phase transition' from a low to a high stable steady state.

In terms of policy implications, the results suggest that a decrease in dollarization can be obtained by an appreciation of the ruble and/or an increase in enforcement of the law that forbids transactions in dollars. Interestingly, such policies would only need to be implemented temporarily in order for a permanent decrease in dollarization to result.

Contents

1	Introduction	2
2	Explaining Dollarization Hysteresis	6
2.1	Ratchet Effects	7
2.2	Network Externalities	8
3	The Model	11
3.1	Setup and Main Assumptions	11
3.2	Best Response Functions	14
3.3	Expectations	16
3.4	Steady States and Dynamics	18
4	Data	21
5	Empirical Estimation	23
5.1	Estimation Procedure	23
5.2	Results	26
5.3	Interpretation	28
6	Policy Implications	31
6.1	Exchange Rate Policy	32
6.2	Fiscal Policy	33
6.3	Enforcement Policy	35
7	Conclusion	36

1 Introduction

Many developing countries and transition economies today are significantly "dollarized". The process by which this happens has been observed to typically consist of three stages (Calvo and Vegh 1992). The first stage begins during times of high inflation and currency depreciation, when people lose confidence in their local currency, and start to hold a foreign currency, often the U.S. dollar, as a store of value ("asset substitution"). During the second stage, as the local currency continues to depreciate, many prices and wages start to be quoted in the foreign currency, which then acquires an additional function as a unit of account. The third and last stage of the dollarization process is the use of foreign currency as a medium of exchange, which is sometimes referred to as "currency substitution".¹

The Russian economy appears to have reached this third stage. Anecdotal evidence indicates that foreign currency, in particular the U.S. dollar, is widely used, not just as a store of value and as unit of account, but also as a medium of exchange, even though accepting payments in foreign currency is illegal. Moreover, dollarization in Russia appears to be of vast proportions - according to some estimates Russia is now second only to the United States in turnover of dollar currency.²

Given the above, it is surprising that very little research has been done on dollarization in Russia thus far. While the existing literature on dollarization is extensive, most studies of dollarization have focussed on Latin America,³ and it is only recently that papers on dollarization in transition economies

¹ Calvo and Vegh (1992) define currency substitution as "the use in a given country of multiple currencies as medium of exchange", and argue that "currency substitution is normally the last stage of the dollarization process." (p. 3) However, many authors do not clearly distinguish between the terms 'dollarization', 'asset substitution, and 'currency substitution', which has led to much confusion.

² According to the Federal Reserve System, world circulation of US dollars in April 2000 totaled \$560 bln in cash, of which 70% was estimated to be located outside of the US, and mainly in Russia. (Felicia Wiggins, Assistant Vice President of the Federal Reserve Bank of New York, at an Interfax news conference on June 14, 2000. See also *Moscow Times Business Review* 8(7), July 2000, p. 61.)

³ E.g., Mexico (Ortiz 1983), the Dominican Republic (Canto 1985), Venezuela (Marquez 1987), Bolivia (Clements and Schwartz 1992), Peru (Rojas-Suarez 1992), Argentina (Kamin and Ericsson 1993), Uruguay and Paraguay (Brand 1993). A few papers have studied dollarized countries in the Middle East, including Egypt (Alami 1995) and Lebanon (Bolbol 1999).

have started to appear.⁴ So far, we are aware of only two studies on dollarization in Russia.⁵

Following Balino *et al.* (1999: 1), dollarization could be defined as "the holding by residents of a significant share of their assets in the form of foreign-currency-denominated assets". Since data on foreign currency in circulation are usually unavailable, however, dollarization ratios in practice are typically measured as the ratio of foreign currency deposits to broad money. In this paper, we diverge from this practice by presenting a new source of data of dollar currency in circulation, based on the Currency and Monetary Instrument Reports (CMIR). As Figure 1 shows, holdings of dollar currency relative to dollar denominated deposits in Russia increased rapidly during the early 1990s, and since 1996 dollar denominated deposits have constituted only about 10 percent of the effective broad money supply (total currency plus total deposits). This suggests that using a deposit based definition of dollarization would severely understate the importance of dollarization in Russia.⁶

In this paper we will focus on currency rather than deposits, and the "dollarization ratio" we study is measured simply as the ratio of dollar currency to total currency in circulation.⁷ As can be seen in Figure 2, the salient characteristic of this dollarization ratio is its strong persistence, which we call *dollarization hysteresis*. That is, when ruble depreciation was high in the early 1990s, the dollarization ratio increased rapidly, but when the ruble stabilized between mid 1995 and mid 1998, the dollarization ratio did not fall back.⁸ Similar instances of dollarization hysteresis have been observed in many other dollarized countries as well, but no good explanations for this phenomenon exist. Econometrically, hysteresis can be accounted for by including so-called ratchet variables in the regression, but which can be interpreted as the notion that temporarily high levels of currency

⁴They include studies of Armenia (Horvath, Thacker, and Ha 1998), Croatia (Feige, Faulend, Sonje, and Sosic 2001), Latvia (Sarajevs 2000), Lithuania (Korhonen 1996), the Kyrgyz Republic (Mongardini and Mueller 1999), and Poland (Stanczak 1992). For general discussions of dollarization in transition economies, see Sahay and Vegh (1995a, 1995b), Van Aarle and Budina (1995), and Mongardini and Mueller (1999).

⁵Brodsky (1997) and Friedman and Verbetsky (2000). Two related studies are Morrien (1997), who does not provide any empirical analysis, and Choudhry (1998), whose estimates of a Cagan money demand function for Russia suggest that there is significant currency substitution, but who does not explicitly try to test for it.

⁶For a description of the deposit data used in Figure 1, see section 4.

⁷The reason we do not include deposits in the definition of the dollarization ratio is that checks do not exist in Russia, hence deposits and currency are not perfect substitutes.

⁸The jump in both depreciation and dollarization at the end of 1998 corresponds to the August 1998 financial crisis, when the ruble lost 65 percent of its value in one month, and another 55 percent in September 1998.

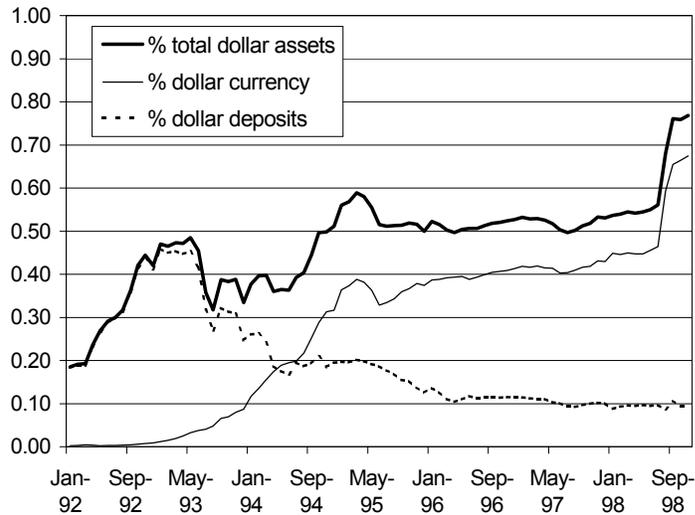


Figure 1: Dollarization Ratios for Russia

depreciation or inflation are long remembered by agents, and thus can have long-term effects on agents' expectations.

In this paper, we argue that an additional, and possibly alternative explanation for dollarization hysteresis is the existence of network externalities. Network externalities occur when the benefits for a given agent of holding a certain currency increase with the use of this currency by other agents. In other words, when the use of dollars in a given "trade network" grows, this increases the value of holding dollars for each member of the network, irrespective of the depreciation rate or other rate of return considerations. If network externalities are strong enough, therefore, a high degree of dollarization can persist after macroeconomic stabilization, even in the absence of ratchet variables.⁹

Standard portfolio balance models cannot account for network externalities or hysteresis, first of all, because they are based on a representative agent framework, and secondly, because they

⁹In addition, network externalities may help explain why in certain countries (mainly in Latin America and the former Soviet Union) dollarization has taken place in the form of U.S. dollars, while in other countries (mainly in Central and Eastern Europe) people have preferred to use the Deutschmark, and now the Euro, as their stable foreign currency.

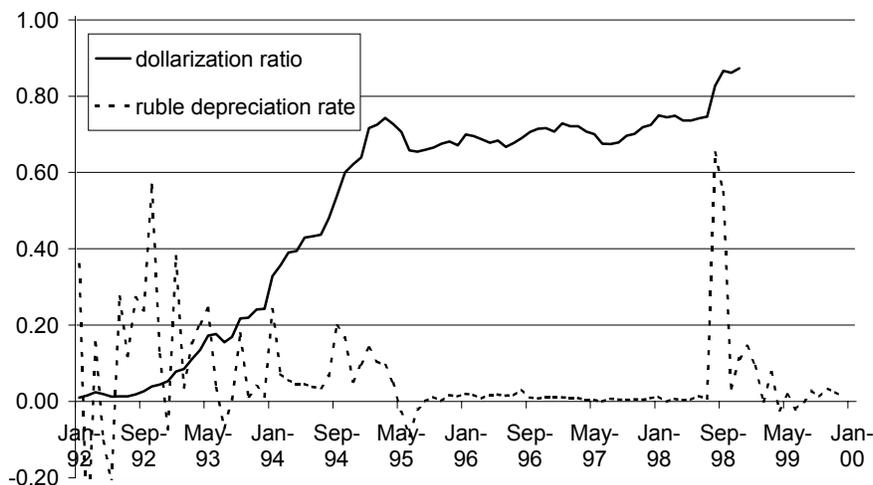


Figure 2: Dollarization and Ruble Depreciation

typically assume that the share of dollars in producing "liquidity services" is constant over time, and independent of the dollarization ratio. As an alternative, this paper presents a discrete choice model with social interactions, inspired by the interactions based framework of Brock and Durlauf (2000, 2001), which constitutes a novel approach to the study of dollarization. The model predicts that network externalities lead to multiple steady states for the dollarization ratio, thus explaining dollarization hysteresis as the movement from a low to a high steady state.¹⁰

The setup of this paper is as follows. After discussing several different explanations for dollarization hysteresis in section 2, we develop our own model in section 3. This model is then estimated using a new estimate of dollar currency in Russia, which is described in section 4, and in more detail in the Appendix. Section 5 describes the estimation procedure and empirical results, which are consistent with the existence of multiple steady states. Finally, section 6 discusses several policy instruments that could be used to reduce dollarization. In particular, we show that a permanent decrease in

¹⁰Other models with multiple equilibria have been used to explain similar 'coordination failures' in transition economies. See, e.g., Roland and Verdier (1994) on privatization; Blanchard and Kremer (1997) on "disorganization"; Roland and Verdier (2000) on law enforcement; Earle and Sabirianova (2000) on wage arrears.

dollarization could be obtained by a temporary appreciation of the ruble and by a temporary increase in enforcement of the law that prohibits dollar transactions. Section 7 summarizes and concludes.

2 Explaining Dollarization Hysteresis

It is no surprise that dollarization ratios typically increase with variables such as inflation and currency depreciation. What is puzzling, however, is that subsequent reductions in such variables do not always induce de-dollarization. Indeed, this phenomenon of "dollarization hysteresis" has been observed so often that Mongardini and Mueller (1999), following Mueller (1994), even *define* a dollarized economy as an economy in which "the demand for foreign currency rises when the local currency depreciates, but falls *by a lesser extent* when the local currency appreciates." (Mongardini and Mueller 1999, footnote 3)

Interestingly, evidence of dollarization hysteresis has been found most often in cases where estimates of dollar currency in circulation were used instead of, or in addition to, data on dollar denominated deposits. A seminal paper in this respect is Kamin and Ericsson (1993), who used data on recorded inflows and outflows of dollar currency between Argentina and the U.S. which were based, like the data presented in this paper, on the Currency and Monetary Instrument Reports (CMIRs). They found that a high degree of dollarization persisted in Argentina during the early 1990s, even after inflation returned to very low rates. A similar phenomenon was observed by Peiers and Wrase (1997), who estimated dollar currency in circulation in Bolivia by using loan data from informal credit markets. They found that the ratio of dollar to domestic bank deposits increased, rather than decreased, following successful monetary and fiscal reform in 1985. Finally, Mongardini and Mueller (1999) found evidence for dollarization hysteresis in the Kyrgyz Republic, based on daily data of flows of foreign currency through foreign exchange bureaus.¹¹ They also observed that, in

¹¹Interestingly, these authors found evidence of hysteresis in the ratio of foreign to domestic deposits, while they did not find such evidence when their estimate of foreign currency was included in the dollarization ratio. However, this result may be partially due to the fact that, prior to 1996, "the data were extrapolated by assuming that foreign cash

most former Soviet Union Republics, including Russia, prices and exchange rates rose rapidly in the early 1990s, then stabilized in the mid 1990s, and yet dollarization ratios remained at high levels.

There exist several different explanations for dollarization hysteresis, which more generally can be seen as different explanations for the existence of "ratchet effects" in money demand. These explanations are discussed below.

2.1 Ratchet Effects

A "ratchet effect" is said to occur when the dependent variable (in our case, the dollarization ratio) reacts asymmetrically to changes in one or more independent variables (in our case, the rate of ruble depreciation), depending on whether the latter is falling or rising. A common way to account for such asymmetric processes is by means of a so-called ratchet variable, which is defined as the maximum value of a key independent variable (or sometimes of the dependent variable itself) over the past n periods. When such ratchet variables are found to be significant in a regression, this is then interpreted as evidence for ratchet effects or "hysteresis".

Ratchet variables have frequently been included in estimations of money demand functions.¹² More recently, several authors have found empirical evidence for the existence of ratchet effects in the demand for foreign currency. For example, Kamin and Ericsson (1993) found evidence for a significant ratchet variable for inflation in explaining dollarization hysteresis in Argentina, while Peiers and Wrase (1997) found significant ratchet effects for inflation, inflation volatility, and the volatility of currency depreciation in Bolivia. Somewhat unconventionally, Mueller (1994) and Mongardini and Mueller (1999), in their studies of dollarization in Lebanon and the Kyrgyz Republic, respectively, included as a ratchet variable the past maximum value of the dollarization ratio itself.

holdings moved proportionally to foreign currency deposits... [which] is equivalent to assuming that the [dollarization] ratio only moves on account of foreign currency deposits." (Mongardini and Mueller 1999: 6)

¹²For example, in the late 1970s and early 1980s in order to explain the impact of volatile and high interest rates on the United States, and during the 1980s for various high inflation countries. See Mongardini and Mueller (1999, section V) for a list of references to this literature.

It is not always clear, however, how to interpret the existence of a ratchet effect. One interpretation is that ratchet effects result from the fact that it takes time to develop, learn, and apply new financial instruments that provide substitutes for domestic currency (e.g., Dornbusch *et al.* 1990, Mueller 1994). This is often modeled by introducing an adjustment or "switching" cost associated with learning how to use foreign currency instruments (e.g., Guidotti and Rodriguez 1992, Sturzenegger 1992, Engineer 2000), which naturally creates a certain range of values for inflation or currency depreciation within which there is no incentive to de-dollarize.¹³ Another interpretation is that ratchet variables capture the fact that there exist "learning or expectations adjustment periods before domestic agents become convinced that current macroeconomic stability has permanence and inflationary policies will not be repeated" (Peiers and Wrase 1997: 12).

The first explanation for ratchet effects does not seem very relevant for Russia, given the fact that the foreign currency instruments used by Russians mainly consisted of foreign currency itself, and there hardly seem to exist any adjustment costs associated with learning how to use foreign currency. The second explanation, i.e., the existence of psychological adjustment periods, certainly seems to have played a role in Russia, and will be taken into account in the way we model exchange rate expectations. In addition, however, we focus on a third explanation for the presence of ratchet effects, which is described below: the existence of network externalities in the use of currency.

2.2 Network Externalities

Network externalities in the use of currency exist because one agent's benefits from holding a certain currency increase with the extent to which this currency is accepted as a means of payment, i.e. with the number of others who wish to hold this currency. The idea that network externalities can explain

¹³Cf. Mueller (1994): "The existence of the ratchet effect is attributed to prolonged periods of financial innovation and the related fixed costs of developing, learning, and applying these new money management techniques to beat inflation. Once these fixed costs are overcome, households and enterprises have little incentive to switch back to domestic currency after the period of instability ends. As a result, the effect on the relative demand for foreign and domestic currency is more long-lasting."

the emergence of a dominant currency as a medium of exchange can already be found, to some extent, in the infamous Kiyotaki and Wright (1989) model, in which fiat money appears as a self-fulfilling prophecy. In subsequent extensions of this model it has been shown that it is possible to construct "dual currency regimes" in which multiple fiat monies circulate within a given country with different acceptance rates.¹⁴ As far as we know, however, this framework has never been explicitly used to explain dollarization hysteresis, nor does it appear to have been used in any empirical way.

An explicit connection between network externalities and dollarization hysteresis was made by Uribe (1997). In his model, externalities exist because an increase in the aggregate level of dollarization reduces a given agent's marginal cost of performing transactions in dollars. He argues that "if the economy is not dollarized (i.e., if agents are not used to receiving foreign currency in exchange for goods) it is more costly for the consumer to carry out transactions in the foreign currency. Conversely, in an environment in which everybody is used to dealing in dollars, it is easier for the consumer to use dollars as a means of exchange" (Uribe 1997: 3). He models this notion of "getting used to" transacting in a foreign currency by assuming that each good purchased using foreign currency is subject to a transaction cost, which is a negative function of what he calls "dollarization capital": the knowledge accumulated by the economy up to period t in transacting in a foreign currency. Furthermore, he assumes that this dollarization capital evolves according to a specific law of motion that guarantees the existence of multiple steady states for dollarization. This, then, allows him to explain dollarization hysteresis as the transition from a low to a high steady state.

A somewhat similar model was developed, apparently independently, by Peiers and Wrase (1997). In their model, network externalities also occur because the increased "experience" with and "adaptation" to dollar-denominated transactions is assumed to reduce the marginal cost of borrowing and spending dollars. This is modeled by including the dollarization ratio as a "demand side externality" among the factors that determine a buyer's transaction costs, where the dollarization ratio is

¹⁴See Aiyagari and Wallace (1992); Matsuyama *et al.* (1993); Kiyotaki and Wright (1993).

measured empirically as the percentage of daily informal market loans denominated in dollars. This variable is found to be empirically significant, which is interpreted as evidence of hysteresis.

While they offer some interesting insights, the main drawback of the models mentioned above is that they do not easily lend themselves to empirical estimation. Uribe (1997) is able to calibrate his model using actual inflation data for Peru, but only after imposing some specific functional forms and assuming some very specific theoretical parameter values. He also recommends that standard econometric models of money velocity should include a proxy for "dollarization capital", but does not carry out any econometric estimation himself. While Peiers and Wrase (1997) do carry out an empirical estimation, this is not a direct estimation of their model.¹⁵

Our model, which is presented in section 3 below, aims to bridge the gap between the empirical literature on dollarization, which does not take network externalities into account, and the theoretical literature described above, which has empirical shortcomings. Like Uribe (1997), we show that network externalities lead to multiple steady states for the dollarization ratio, but unlike Uribe, we actually estimate the model and empirically confirm the existence of these steady states. Like Peiers and Rase (1997), we estimate a binary choice equation, but unlike them we derive this equation directly from an underlying discrete choice model. While we do include a ratchet variable for ruble depreciation in our specification of exchange rate expectations, we show that the presence of network externalities *per se* can lead to hysteresis even in the absence of such a ratchet variable.

¹⁵The model uses a general equilibrium setup to derive demand and supply functions for dollar and ruble denominated loans, which are continuous variables. In the empirical estimation, however, the equilibrium fraction of dollar loans is assumed to follow a probit distribution, which implicitly assumes a very different model, one in which agents make a binary choice between dollar and ruble loans.

3 The Model

3.1 Setup and Main Assumptions

Consider an economy that is inhabited by many, identical agents. Time is discrete, and at $t = 0$, each agent is randomly assigned to be either a buyer (consumer) or a seller (producer) of a composite consumption good. In subsequent periods, all agents are alternately sellers and buyers. At each time t , each buyer is randomly matched with a seller. Buyers are subject to a cash-in-advance constraint: before being matched, they need to hold currency equal to the price of the composite good, which is assumed to be constant.¹⁶

There are two types of currency: ruble currency (m) and dollar currency (m^*). Each payment is made either fully in rubles or fully in dollars. The cash-in-advance constraint therefore implies that each agent holds either rubles or dollars at any moment in time. In case of ruble depreciation, agents can benefit from holding dollar currency between the time they received a payment and before making a payment themselves. However, accepting payments in dollars is illegal, and a seller who accepts dollars is punished with probability q by confiscation of the dollar bills involved in the transaction.¹⁷ Purchasing dollars, on the other hand, is legal, but is discouraged by a tax rate τ that is levied on all purchases of foreign currency.

Timing is as follows: consider a given agent i who is a seller at time t , and will be a buyer at time $t + 1$. The decision problem faced by this agent at time t is to decide which currency to hold after having been paid by a random buyer at time t and before being matched with a random seller at time $t + 1$. This interval between time t and time $t + 1$ will be referred to as *period t* . As the analysis below will show, the benefits for i of holding a given currency during period t increase with

¹⁶As noted before, this paper focuses on the transactions demand for currency, and therefore does not consider the choice between ruble and dollar denominated deposits, which are of relatively little importance in Russia. However, including deposits in the choice set of agents would be an interesting extension of the model, and might be important if one were to apply this model to study dollarization in other countries.

¹⁷This confiscation risk could be interpreted so as to include the risk of accepting counterfeited dollars (after all, receiving a counterfeited dollar bill is equivalent to having the dollar bill confiscated).

the probability that j will want to hold this currency in period $t + 1$, thus implying the existence of network externalities.

Let $m_{i,t} \in \{m, m^*\}$ denote the currency choice of agent i , where the subscript t indicates that the choice is made at time t (and the currency is held during period t). Table 1 represents the costs for this agent associated with each currency choice, conditional on the currency choice $m_{j,t+1}$ of seller j at time $t + 1$. These costs are net of the cost of the good itself, which is normalized to unity.

	$m_{j,t+1} = m$	$m_{j,t+1} = m^*$
$m_{i,t} = m$	e	$e + \sigma + \tau$
$m_{i,t} = m^*$	σ	q

Table 1: Cost Matrix for agent i

Suppose agent i decides to hold rubles, and j prefers indeed to be paid in rubles (or more precisely, j prefers to hold rubles in the next period). In this case, which corresponds to the upper left cell of the matrix, the payment is made in rubles, and the cost for i associated with holding rubles is simply the rate of ruble depreciation, e , during the period that rubles are held (if depreciation is negative, i.e., if the ruble appreciates, then this cost is in fact a benefit).

If i holds rubles but j prefers to hold dollars in the next period, then i still faces the cost e but in addition, there are now transaction costs associated with the fact that either i or j will have to exchange rubles for dollars. These transaction costs consist of two elements: first of all, the shoe-leather cost σ of finding and walking to an exchange bureau, standing in line, etc., and secondly, the foreign currency tax τ that must be paid when dollars are purchased. If i were to exchange the rubles in order to pay j in dollars, the total costs for i would thus be $e + \sigma + \tau$. However, in this case the transaction would be carried out in dollars, which is risky for j since the amount of the transaction can be confiscated with probability q , thus leading to an expected cost equal to q which would be borne by the seller.¹⁸ In order to avoid this cost, the seller could either charge the buyer

¹⁸Since the price of the good is normalized to unity, the total tax amount that needs to be paid equals the tax rate τ , and the expected total cost of confiscation equals the probability of confiscation q .

In reality, the expected cost of confiscation may well be higher, i.e. sellers have a chance of losing their license. In

a markup over the price of the good equal to q , or the seller could choose to accept rubles but then charge a markup $\sigma + \tau$ to compensate for the transaction costs. In the first case, the total cost for i is $e + \sigma + \tau + q$, while in the second case it is only $e + \sigma + \tau$. Since the latter is always less than the former, it is therefore always optimal for the buyer to pay in rubles, and to compensate the seller for having to change the rubles into dollars.

Now consider the reverse case, where buyer i is holding dollars while seller j prefers to hold rubles in the next period (i.e., the lower left cell of the matrix). In that case, i avoids the potential cost associated with ruble depreciation, but again, someone will have to change the dollars into rubles. Since no tax is charged when dollars are sold, the transaction costs in this case equal simply σ . Following a similar logic as before, it is always optimal for the buyer to exchange dollars for rubles and pay only the transaction costs, as opposed to compensating the seller for both the transaction costs and the risk of confiscation.

Finally, consider the case where i holds dollars and j prefers to hold dollars in the next period as well. In this case, which corresponds to the lower right cell of the matrix, buyer and seller could either decide to exchange currencies twice, in which case the transaction costs would equal $2\sigma + \tau$, or they could decide to violate the law and carry out the transaction in dollars. As mentioned before, this is risky in the sense that the amount of the transaction will be confiscated with probability q . For simplicity, however, we will assume that $q < 2\sigma + \tau$, so that it is always optimal for i to pay a markup q to compensate the seller for the risk of confiscation.¹⁹ This case, then, is the only case in which the transaction is in fact carried out in dollars.

this model however, each seller sells only one good to only one buyer, hence confiscation of the license is equivalent to confiscation of the dollar currency involved in the transaction.

¹⁹Our estimates of q and σ , which are reported in section 5, satisfy this condition for all t .

3.2 Best Response Functions

So far, it may have seemed as if $e, \sigma, \tau,$ and q were all constant and known at the time of decision making. In reality, of course, this is not the case. At the time t that agent i decides which currency to hold during period t , the variables to be taken into account are the expected rate of ruble depreciation during period t (i.e. between time t and time $t + 1$), which will be denoted as \widehat{e}_t , the expected shoe-leather cost at time $t + 1$, denoted as $\widehat{\sigma}_{t+1}$, the expected tax rate at time $t + 1$, denoted as $\widehat{\tau}_{t+1}$, and finally, the expected confiscation risk \widehat{q}_{t+1} .

Let \widehat{p}_{t+1} denote the probability, expected by i , that a random seller j prefers to be paid in dollars at time $t + 1$, i.e., prefers to hold dollars during period $t + 1$. Since the seller is selected at random, \widehat{p}_{t+1} could be alternatively interpreted as the expected proportion of agents holding dollars during period $t + 1$, i.e., the "dollarization ratio" that i expects to see in period $t + 1$.

Using the information contained in Table 1, then, the expected cost for i associated with holding rubles during period t is:

$$c(m_t) = (1 - \widehat{p}_{t+1})\widehat{e}_t + \widehat{p}_{t+1}(\widehat{e}_t + \widehat{\sigma}_{t+1} + \widehat{\tau}_{t+1}). \quad (1)$$

Similarly, the expected cost associated with holding dollars is:

$$c(m_t^*) = (1 - \widehat{p}_{t+1})\widehat{\sigma}_{t+1} + \widehat{p}_{t+1}\widehat{q}_{t+1}. \quad (2)$$

Assuming that agents minimize cost, it would now be simple to conclude that agents will choose to hold dollars whenever $c(m_t^*) < c(m_t)$, and *vice versa* for rubles. However, it should be acknowledged that there may be many other reasons why agents prefer to hold dollars or rubles than the ones captured in this model. For example, the demand for dollars may depend on the moral values of agents, which affect their willingness to violate the law and accept payments in dollars; it may depend

on agents' confidence in the Russian economy, their incomes, the types of goods they purchase, and various other variables that are not included in this simple model. Such additional variables, which are unobservable to us but are observable to each individual agent, can be accounted for by including a so-called random utility term (or in this case a random disutility term) in the model.

Let $\epsilon_{i,t}$ and $\epsilon_{i,t}^*$ represent the unobserved variables that affect the costs (or benefits) of holding ruble currency and dollar currency, respectively, and let φ measure the impact of these variables on the total expected cost. The probability $p_{i,t}$ that a given agent i will hold dollars during period t can then be written as:

$$\begin{aligned} p_{i,t} &= \Pr\{c(m_t^*) + \varphi\epsilon_{i,t}^* < c(m_t) + \varphi\epsilon_{i,t}\} \\ &= \Pr\{\epsilon_{i,t}^* - \epsilon_{i,t} < \frac{1}{\varphi}[\hat{e}_t - \hat{\sigma}_{t+1} + (2\hat{\sigma}_{t+1} + \hat{\tau}_{t+1} - \hat{q}_{t+1})\hat{p}_{t+1}]\}. \end{aligned} \quad (3)$$

In order to ensure that the resulting values for $p_{i,t}$ are between 0 and 1, and to make the model econometrically estimable, a standard assumption in discrete choice theory is to assume that $\epsilon_{i,t}^*$ and $\epsilon_{i,t}$ are i.i.d. across i and t according to the extreme value distribution, which implies that the difference between $\epsilon_{i,t}^* - \epsilon_{i,t}$ is logistically distributed.²⁰ This gives:

$$p_{i,t} = (1 + \exp\{-\frac{1}{\varphi}[\hat{e}_t - \hat{\sigma}_{t+1} + (2\hat{\sigma}_{t+1} + \hat{\tau}_{t+1} - \hat{q}_{t+1})\hat{p}_{t+1}]\})^{-1}. \quad (4)$$

This equation, which can be interpreted as a "best response function", has many interesting properties.

First of all, it says that the probability that a given buyer i will hold dollars, *conditional on* \hat{p}_{t+1} , increases with the expected depreciation rate \hat{e}_t , just as is predicted by standard portfolio balance models.²¹

²⁰See Anderson *et. al* (1992: 39); Brock and Durlauf (2000, 2001). The fact that the logistic distribution is commonly used for discrete choice models is of course not enough to defend its use. However, assuming a normal (probit) distribution, as in Peiers and Wrase (1997), would most likely give similar results.

²¹The standard portfolio balance model goes back to Miles (1978). Note that we could have assumed, as in e.g., Calvo and Vegh (1995), that the domestic interest rate r is the opportunity cost of holding rubles, while the foreign interest rate r^* is the opportunity cost of holding dollars. However, it can be easily checked that imposing uncovered

Secondly, the conditional probability that i holds dollars decreases with the expected risk of confiscation \hat{q}_{t+1} , which seems natural, but increases with the expected tax rate $\hat{\tau}_{t+1}$, which seems less intuitive. Upon reflection, however, the latter result follows from the fact that the tax is one-sided, and only needs to be paid by buyers who are holding rubles but are matched with sellers who prefer dollars. Therefore, if buyers believe that it is likely that they will be matched with a "dollarized" seller (i.e., a seller who charges a lower price for buyers who pay in dollars), these buyers will be more likely to hold dollars, and thus accept payments in dollars themselves, since this will allow them to avoid the extra cost imposed by the foreign currency tax.²²

Finally, the effect of the expected shoe-leather cost, $\hat{\sigma}_{t+1}$, is ambiguous, and depends on \hat{p}_{t+1} . For $\hat{p}_{t+1} < 0.5$, i.e., a relatively low (expected) degree of dollarization in period $t + 1$, an increase in $\hat{\sigma}_{t+1}$ will have a negative effect on $p_{i,t}$, thus reducing the demand for dollars by agent i in the current period. For $\hat{p}_{t+1} > 0.5$, however, i.e., a relatively high degree of dollarization in period $t + 1$, an increase in $\hat{\sigma}_{t+1}$ will have a positive effect on $p_{i,t}$.

3.3 Expectations

It is important to note that the effects described above are true only for a given individual i , whose decisions are based on the expected dollarization ratio \hat{p}_{t+1} . This does not yet say, however, how the actual dollarization ratio, denoted by p_t , will depend on the various variables. In order to solve for the actual dollarization ratio, first note that, since all agents in a given period have the same probability of holding dollars, it must be the case that $p_t = p_{i,t}$. That is, by the law of large numbers, the dollarization ratio in the economy as a whole must equal the probability that a given buyer holds dollars.

In order to close the model, we now need to make assumptions on expectations. One possibility is

interest rate parity, i.e. $r - r^* = e$, would in that case have yielded the exact same best response function.

²²Note that the effect of τ_t increases with the expected dollarization ratio \hat{p}_{t+1} . In the special case that $\hat{p}_{t+1} = 0$, the tax will have no effect.

to assume perfect foresight, i.e., $\hat{x}_t = x_t$ for all x, t . What is strange about this assumption however, is that it implies that p_t is a function of p_{t+1} :

$$p_t = (1 + \exp\{-\frac{1}{\varphi}[e_t - \sigma_{t+1} + (2\sigma_{t+1} + \tau_{t+1} - q_{t+1})p_{t+1}]\})^{-1}. \quad (5)$$

Yet for agents to correctly predict the dollarization ratio p_{t+1} one period ahead, they must also know all other variables one step ahead, including p_{t+2} :

$$p_{t+1} = (1 + \exp\{-\frac{1}{\varphi}[e_{t+1} - \sigma_{t+2} + (2\sigma_{t+2} + \tau_{t+2} - q_{t+2})p_{t+2}]\})^{-1}. \quad (6)$$

And in order to predict p_{t+2} , they must know p_{t+3} , and so on and so forth. Clearly, this is unrealistic.

An alternative suggestion, then, would be to assume that agents have myopic or static expectations, i.e. they predict each variable to stay at its previous value. This assumption is generally considered reasonable in cases where agents repeatedly encounter similar situations, as is the case in this model. Myopic expectations imply $\hat{x}_{t+1} = x_t$ for all variables, except for the expected dollarization ratio, where we get $\hat{p}_{t+1} = p_{t-1}$ since agents who are sellers at time $t + 1$ are expected to behave in the same way as they did during the previous period when they were sellers, which is time $t - 1$.²³

While the assumption of myopic expectations seems reasonable for variables such as the shoe-leather cost, the foreign currency tax rate, and the confiscation risk, this assumption seems less reasonable for the rate of ruble depreciation, which can be predicted to some extent on the basis of information on the rate of money growth, the spread in the yields on ruble denominated and dollar denominated assets, etc. Without attempting to explicitly model this exchange rate formation process, we will simply assume, for now, that the expected rate of ruble depreciation is in fact the

²³Note that, in practice, agents may even have a hard time finding out the true value of p_{t-1} , given the difficulties with measuring dollarization described in section 4. An interesting extension of the model would therefore be to introduce a search process by which agents gradually come to learn the correct dollarization ratio in the economy.

actual rate.²⁴ This gives the following law of motion:

$$p_t = (1 + \exp\{-\frac{1}{\varphi}[e_t - \sigma_t + (2\sigma_t + \tau_t - q_t)p_{t-1}]\})^{-1}. \quad (7)$$

This equation allows us to predict how dollarization evolves over time, given the values for the "fundamental" variables, e_t , σ_t , τ_t , and q_t . As long as those fundamentals remain fixed, the dollarization ratio will converge to a steady state p^* , which solves $p_t = p_{t-1}$ for all t . When the fundamentals change, of course, the steady state itself will change. While there is no closed form solution for p^* , we can plot equation 7 in a graph, and vary the values of one or more fundamentals in order to see how the steady state dollarization ratio is affected. Interestingly, as is shown in the analysis below, p^* is not necessarily increasing with depreciation, as portfolio balance models would suggest. In fact, for a given level of depreciation, there may exist multiple steady states for dollarization. This is shown to provide an explanation for dollarization hysteresis.

3.4 Steady States and Dynamics

In order to focus on the effect of depreciation on dollarization, Figure 3 plots the law of motion for three different values of e_t , while keeping the other variables fixed at $\sigma_t = 0.25$, $\tau_t = 0.01$, $q_t = 0$, and $\varphi = 0.1$.

The lower curve assumes $e_t = -0.05$. This provides an example of a set of parameter values for which the model has a unique steady state, corresponding to a low degree of dollarization. This steady state is denoted by the letter A , and lies at the intersection with the 45-degree line, where $p_t = p_{t-1}$. Now consider an increase in e_t , i.e., a decrease in appreciation. This shifts the curve upwards, which at first leads only to a small increase in the steady state level of dollarization. At some critical point, however, which is called a "phase transition" in statistical mechanics, two additional steady states

²⁴This assumption will be relaxed in section 5, where we account for the existence of ratchet effects.

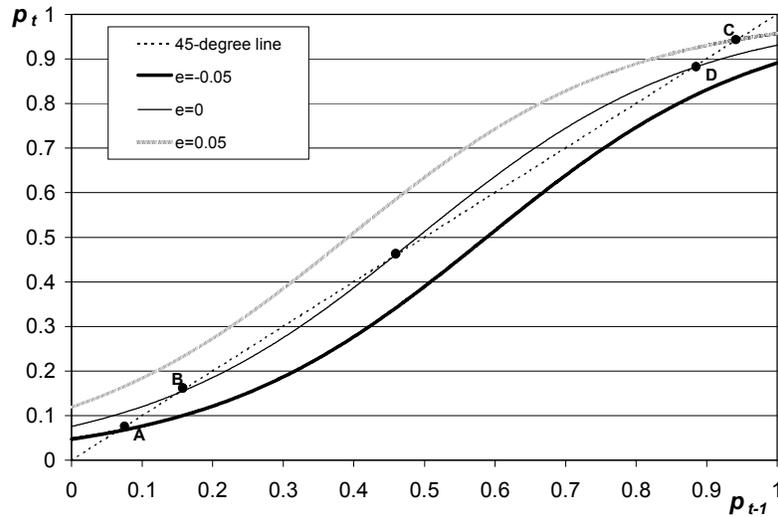


Figure 3: Dollarization Dynamics

emerge, so that the total number of steady states equals three. This situation is represented by the middle curve in Figure 3, for $e_t = 0$.

In order to illustrate the dynamics, another example of a curve with three steady states is plotted in Figure 4. As this phase diagram indicates, the intermediate steady state is unstable. That is, when the dollarization ratio starts out slightly below this steady state, it will fall in the next period, and will continue to decrease until the lower steady state is reached. Conversely, when the dollarization ratio starts out at a level slightly above the intermediate steady state, dollarization in the subsequent period will rise, and will continue to increase until the upper steady state is reached. Although this is not drawn in the phase diagram, one can see in a similar way that, when dollarization is temporarily below the lower steady state, it will increase again, and when dollarization is temporarily above the upper steady state, it will fall back to this steady state. This implies that the two outer steady states are stable.

Going back to Figure 3, assuming that the economy was originally in point A , then a gradual increase in depreciation implies a gradual movement from A to B . However, when e_t increases

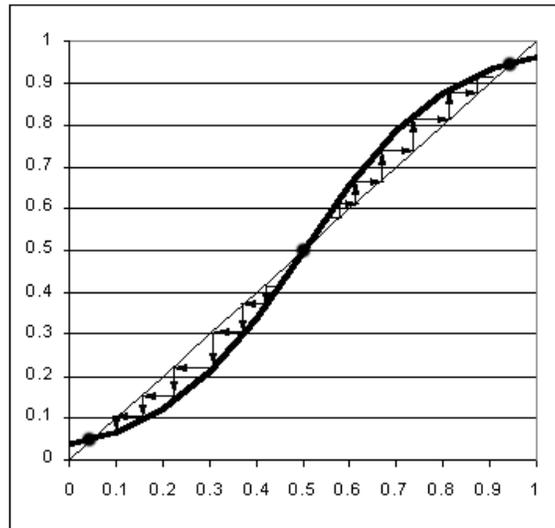


Figure 4: Phase Diagram for Dollarization

further and the depreciation rate becomes positive, as shown by the upper curve for $e_t = 0.05$, the lower and intermediate steady states eventually disappear and the economy ends up in a steady state which corresponds to a high degree of dollarization, represented by point C .

So far, the degree of dollarization does seem to increase with the depreciation rate, albeit not in a linear fashion. However, consider now what happens when depreciation falls back to $e_t = 0$ again. Rather than jumping back to steady state B , the dollarization ratio will fall only a little bit, to point D , and will stay at a high rate unless depreciation falls by a sufficiently high amount. Comparing points B and D , then, the depreciation rate is the same in both cases and yet dollarization has increased significantly.

The prediction of the standard portfolio balance model is now no longer true, that is, the steady state dollarization ratio p^* does not necessarily increase with ruble depreciation. Moreover, this model shows that network externalities can explain dollarization hysteresis even in the absence of ratchet variables.

Are the predictions of this model consistent with the observed evolution of dollarization in Russia?

Going back to Figure 2 on page 5, it appears that the answer is yes, at least when the CMIR estimate of dollarization is used. During the early 1990s the rate of ruble depreciation was high, and dollarization in Russia increased rapidly. When depreciation returned to low levels by mid 1995, however, dollarization fell only slightly, and then stabilized at a level of around 70 percent that could easily be interpreted as a stable steady state. According to the dollarization estimate provided by the Central Bank of Russia (CBR), dollarization in mid 1995 fell quite a bit but then continued to increase, which is less consistent with the model (although it is still an indication of hysteresis). Section 4 below compares the two estimates of dollarization and argues that, while both are subject to limitations, the CMIR data provide the better estimate. In section 5, therefore, the CMIR data are used to estimate equation 7.

4 Data

Our estimate of dollar currency in circulation in Russia is derived from the so-called "Currency and Monetary Instrument Reports" (CMIRs), which are collected by the U.S. Customs Service.²⁵ All transporting agents, except Federal Reserve Banks, are by law required to file a CMIR form. The data thus include all wholesale bulk shipments of dollar currency by large financial institutions specialized in international currency transport to and from commercial banks, and all retail currency shipments exceeding \$10,000 which are physically transported by currency retailers, non-financial businesses and individuals.

With the cooperation of U.S. Customs and the U.S. Treasury Department Financial Crimes Enforcement Network (FinCEN), the information contained in the millions of accumulated confidential CMIR forms was combined by Edgar Feige of the University of Wisconsin-Madison, using a specially designed algorithm that aggregated CMIR currency inflows and CMIR outflows by mode of trans-

²⁵For a more detailed discussion of the CMIR data see the Appendix. See also Feige (1996, 1997), Krueger and Ha (1995), Savastano (1996), and Kamin and Ericsson (1993).

portation, origin, and destination. In addition, Feige supplemented the CMIR data with data from the New York Federal Reserve Bank, which is the only Federal Reserve Bank that directly ships currency abroad.²⁶

Our estimate of dollar currency in Russia (m^*) is derived from Feige's data set, and is defined as net dollar flows from the U.S. into Russia. These data are available from January 1992 until December 1998. While they are based on both CMIR and New York Federal Reserve records, we will refer to them as "CMIR data" for short. In the Appendix, we compare these CMIR data to another estimate of dollar currency in circulation that can be obtained from the Central Bank of the Russian Federation (CBR), and we conclude that the CMIR data constitute the best estimate available.

Monthly data for the other variables were obtained from various sources, including the Central Bank of the Russian Federation (CBR)'s *Byulleten Bankovskoy Statistiki*, the IMF's *International Financial Statistics* database, *Russian Economic Trends* (RET), and the Moscow Interbank Currency Exchange (MICEX). Since the CMIR data were available only for the period January 1992 - November 1998, this was the sample period used for all variables (except for e , since exchange rate data back to March 1991 were used to construct the ratchet variable e^{\max}). The data sources for each variable are described below.

- m : Ruble currency (M0), published in RET.
- e : Ruble depreciation rate, measured as the growth rate in the nominal end-of-month ruble/dollar exchange rate, as published by MICEX, and included in the RET database.
- e^{\max} : Maximum ruble depreciation rate over the past 12 months
- τ : Tax rate on purchases of foreign currency (or more precisely, of foreign monetary instruments). This tax was first introduced on 21 July 1997, at which time the rate was 0.5 percent.

On July 2, 1998, the tax rate was increased to 1 percent. Hence we have $\tau = 0$ from January

²⁶See Feige (1996, 1997).

1992 up through July 1997, $\tau = 0.005$ from August 1997 through June 1998, and $\tau = 0.01$ from July 1998 until the end of the sample.

- d^* : Dollar denominated deposits (used only in Figure 2); approximated by the series "foreign currency deposits" published by the IMF. Given that the vast majority of all foreign currency in Russia appears to be held in the form of U.S. dollars,²⁷ this does not seem a bad approximation.
- d : Ruble denominated deposits (used only in Figure 2). It was difficult to find a consistent timeseries for this variable, which may be due to the fact that there is no clear distinction in Russia between "checking" and "savings" accounts. Official CBR data, which distinguish between different types of deposits (specified by duration), are not available earlier than 1996, since commercial banks were not required to report deposit data before this time. While the IMF publishes a series called "demand deposits", these data do not go back further than June 1995. Following RET, therefore, the difference between M2 and M0 was used as a measure of total ruble denominated deposits. Two types of M2 data were available from RET: an "old series" from December 1990-December 1997, and a "new series" from December 1996-present. Since the two series did not seem to be too different, the old series was used until November 1996, and the new series from its earliest possible date, i.e., December 1996.

5 Empirical Estimation

5.1 Estimation Procedure

Recall the structural form equation predicted by the model:

$$p_t = (1 + \exp\{-\frac{1}{\varphi}[e_t - \sigma_t + (2\sigma_t + \tau_t - q_t)p_{t-1}]\})^{-1}. \quad (8)$$

²⁷According to CBR data for 1998 (BBS, table 3.2.4), U.S. dollars constituted an average average 95.2 percent of all foreign currency purchases, and an average 95.9 percent of all foreign currency sales by foreign currency exchanges offices. The remaining purchases and sales were mainly in German Deutschmarks.

While this is a nonlinear function, one can take the inverse of the logistic function to obtain the "log odds ratio":

$$\ln\left(\frac{1-p_t}{p_t}\right) = -\frac{1}{\varphi}[e_t - \sigma_t + (2\sigma_t + \tau_t - q_t)p_{t-1}]. \quad (9)$$

Note that $\ln\left(\frac{1-p_t}{p_t}\right)$ has support $< -\infty, +\infty >$ so it no longer needs to be bounded between 0 and 1. Since this is now a linear function, it can in principle be estimated by OLS. However, before this can be done a few more assumptions need to be made.

First of all, since data on the confiscation risk q_t are not available, we will assume for simplicity that $q_t = q$ for all t , i.e., the confiscation risk is assumed to be constant throughout the period of study. This assumption allows us, first, to get an estimate of q , and secondly, to conduct policy experiments studying the effects of changes in q on the dollarization ratio.

Secondly, while we do not have data on σ_t either, assuming that shoe-leather costs are constant does not seem realistic. Instead, we will assume that the shoe-leather cost is decreasing with the dollarization ratio. This is based on the empirical observation that, as dollarization in Russia increased, increasingly more exchange bureaus started to emerge, which resulted in a lower cost of having to find and walk to an exchange bureau. To capture this idea, we assume the following functional form:

$$\sigma_t = 1 - \gamma p_{t-1}, \quad (10)$$

where the parameter γ is expected to satisfy the condition $0 \leq \gamma \leq 1$. This guarantees that σ_t cannot be negative, while allowing for the possibility of a positive shoe-leather cost even when the economy is completely dollarized.

Thirdly, in order to account for expectational adjustment periods (see section 2.1), we will assume that agents correctly predict the depreciation rate with probability α , and assume that depreciation will equal its maximum rate of the recent past with probability $(1 - \alpha)$. This gives as the expected

rate of ruble depreciation:

$$\hat{e}_t = \alpha e_t + (1 - \alpha)e_t^{\max} \quad (11)$$

where $e_t^{\max} = \max\{e_t, \dots, e_{t-n}\}$ is the ratchet variable.

Finally, a noise term ξ_t will be added to the regression so as to allow for unobservable variables and data mismeasurements. With these four modifications, we obtain the following reduced form equation:

$$\ln\left(\frac{1-p_t}{p_t}\right) = \lambda_0(1 + \tau_t p_{t-1} + e_t^{\max}) + \lambda_1(e_t - e_t^{\max}) + \lambda_2 p_{t-1} + \lambda_3 p_{t-1}^2 + \xi_t, \quad (12)$$

which in turn can be written as:

$$\ln\left(\frac{1-p_t}{p_t}\right) = \beta_0 + \beta_1 e_t + \beta_2 e_t^{\max} + \beta_3 \tau_t p_{t-1} + \beta_4 p_{t-1} + \beta_5 p_{t-1}^2 + \xi_t, \quad (13)$$

where

$$\begin{aligned} \beta_0 &= \lambda_0 = \frac{1}{\varphi} \\ \beta_1 &= \lambda_1 = -\frac{1}{\varphi}\alpha \\ \beta_2 &= \lambda_0 - \lambda_1 = -\frac{1}{\varphi}(1 - \alpha) \\ \beta_3 &= -\lambda_0 = -\frac{1}{\varphi} \\ \beta_4 &= \lambda_2 = -\frac{1}{\varphi}(2 + \gamma - q) \\ \beta_5 &= \lambda_3 = \frac{1}{\varphi}(2\gamma). \end{aligned}$$

Interestingly, Mongardini and Mueller (1999) estimate an equation very similar to equation 13, i.e., they regress $\ln\left(\frac{1-p_t}{p_t}\right)$ on a number of variables (including the lagged dollarization ratio, currency depreciation, and a ratchet variable) without however deriving this from an underlying model. What is interesting in our case is that the functional form is derived from a model, and that all structural form parameters can in fact be identified from the reduced form parameter estimates after imposing the necessary restrictions (i.e., $\beta_0 = -\beta_3$ and $\beta_1 + \beta_2 = \beta_3$).

5.2 Results

The model was estimated using the CMIR estimate of p_t , which limited the sample period to January 1992 - November 1998. Since a lagged value of the dollarization ratio was used as an explanatory variable, the time series effectively started February 1992. In addition, exchange rate data back to March 1991 were used to construct the ratchet variable, which was defined as the maximum depreciation rate of the past 12 months.

The estimated reduced form parameters, their standard errors, and the results of several residual tests are given in Tables 2 and 3.

variable	coefficient	std.error	t-statistic	p-value
β_0	4.325	0.311	13.916	0.000
β_1	-3.311	0.546	-6.064	0.000
β_2	-1.014	-0.138	38.688	0.000
β_3	-4.325	0.311	-13.916	0.000
β_4	-12.144	1.225	-9.917	0.000
β_5	7.214	1.338	5.393	0.000

Table 2: Estimated Parameters and Standard Errors

R^2	0.917	adjusted R^2	0.913
Jarque-Bera normality test	120.718	prob	0.000
Serial correlation LM (12) test	3.291	prob	0.001
Serial correlation LM (24) test	1.640	prob	0.067
White heteroskedasticity test	46.038	prob	0.000

Table 3: Goodness of Fit and Residual Tests

At first sight each variable appears to be highly significant. Moreover, the p-value for the Jarque-Bera test is essentially zero, suggesting that the residuals are approximately normal. However, the residual tests give some evidence of autocorrelation and heteroskedasticity. First of all, the Breusch-Godfrey serial correlation LM test indicates significant autocorrelation in the residuals when 12 lags are included, which is most likely due to the nonstationarity of some variables. However, when 24 lags are included this test statistic is no longer significant at the 5 percent level.

Secondly, the White test for heteroskedasticity shows a highly significant F-statistic. Since the null hypothesis underlying this test is that the errors are both homoskedastic and independent of the regressors, and that the linear specification of the model is correct, the rejection of the null implies that at least one of these conditions is violated.

Assuming that the model specification is correct, then the ordinary least squares parameter estimates are still consistent even in the presence of heteroskedasticity and autocorrelation. However, if some of the variables are indeed nonstationary, which seems likely, the conventionally computed standard errors are no longer valid, and without knowing the true processes of those nonstationary variables, we have no way of determining the correct standard errors. Whether this is a problem, however, depends on whether one believes that the true standard errors could possibly be so large that the parameter estimates would become insignificant. Given that the OLS standard errors are essentially zero for almost all parameters, this seems quite unlikely.²⁸

Using the reduced form parameter estimates, we can now solve for the structural form parameters. First of all, we find that $\alpha = -\frac{\beta_1}{\beta_0} = 0.76$, suggesting that there is indeed some sluggishness in the formation of exchange rate expectations (i.e., agents believe that, with probability 0.24, the ruble will depreciate by a rate equal to the maximum depreciation rate of the past year). Secondly, we find $\gamma = \frac{\beta_5}{2\beta_0} = 0.83$, implying that the shoe-leather cost is still 0.17 even when the economy is fully

²⁸Reestimating the model using White heteroskedasticity consistent and Newey-West heteroskedasticity and autocorrelation consistent covariance estimates, for example, still produced highly significant parameter estimates for all parameters.

dollarized. Finally, the estimated confiscation risk is $q = \frac{2\beta_0 + \beta_4 + 0.5\beta_5}{\beta_0} = 0.03$, that is, sellers who accept dollars have an estimated chance of three percent to be caught and have the dollars confiscated (or to be paid in worthless, counterfeited dollars). Note that these parameter estimates do satisfy the condition $q < 2\sigma + \tau$, as was assumed in the model.

5.3 Interpretation

The estimated equation,

$$p_t = (1 + \exp\{4.3 - 5.3e_t - e_t^{\max} - 4.3\tau_t p_{t-1} - 12.1p_{t-1} + 7.2p_{t-1}^2\})^{-1}, \quad (14)$$

is plotted in Figures 5 and 6 for several time periods (i.e., several combinations of e_t^{\max} , e_t , and τ_t).

Also shown are the actual data points (p_{t-1}, p_t) , connected by a dotted line, thus allowing us to track the evolution of the dollarization ratio over time.

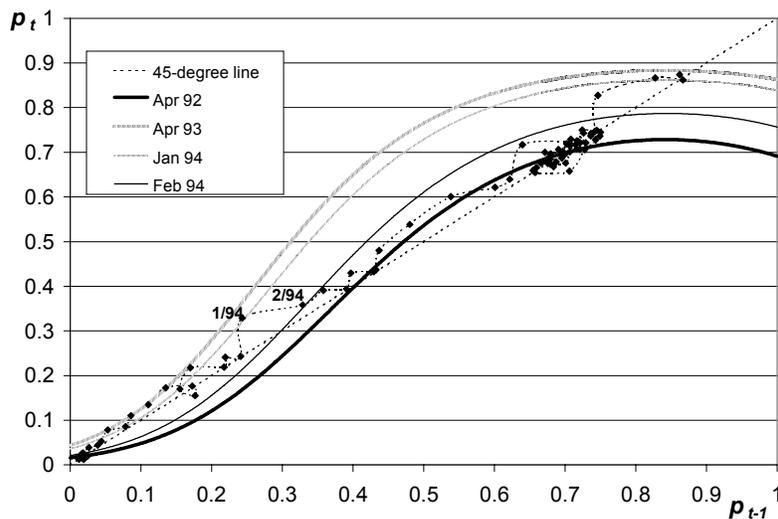


Figure 5: Estimated and actual relationship between p_t and p_{t-1} (a).

For most periods (i.e., for most combinations of e_t^{\max} , e_t , and τ_t), the estimated curve crosses

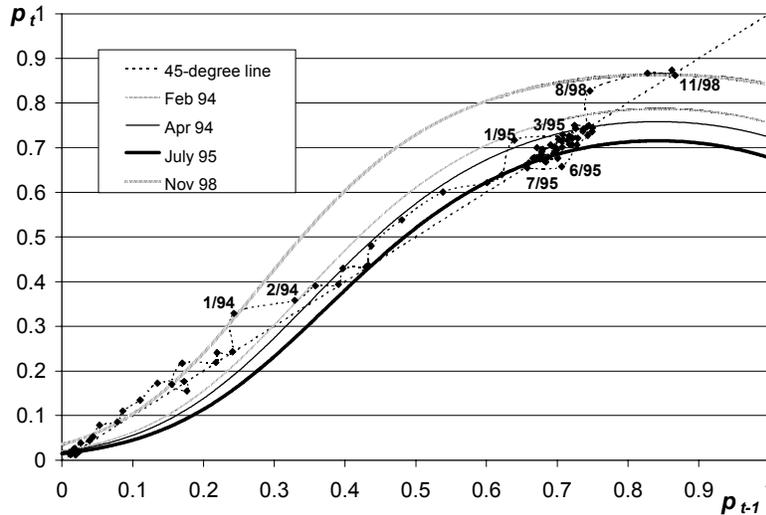


Figure 6: Estimated and actual relationship between p_t and p_{t-1} (b).

the 45-degree line at three points, implying the existence of a low, intermediate, and high steady state dollarization ratio, of which only the outer two are stable. While the lower steady states are always close to zero, thus fitting the data points of 1992, most upper steady states correspond to a dollarization ratio of 65-75 percent, which coincides with the cluster of data points from mid 1995 until mid 1998.

How did the economy move from one steady state to another? The estimates suggest the following explanation. At the beginning of the 1990s, the economy started out in the lower steady state with a dollarization ratio close to zero (during Soviet times, buying foreign currency was punished severely). With the liberalization of prices in 1992, however, the rate of ruble depreciation started to increase, which caused the lower steady state to disappear through a "phase transition". To see this, compare the estimated curves for April 1992 and April 1993 in Figure 5. While the lower steady state is still stable in April 1992, by April 1993 this steady state has disappeared, setting off an increase in dollarization.

Between December 1993 and January 1994, dollarization increases from 24 to 33 percent (this

point is marked as "1/94" in Figure 5). Then, in February 1994, both depreciation and the ratchet variable fall, causing the curve to shift down and the lower steady state to reappear. However, as indicated in the graph, point "2/94" lies above the unstable intermediate steady state of the curve, thus causing the dollarization ratio to move in the direction of the upper rather than the lower steady state.

The story continues in Figure 6. Between February 1994 and March 1995, dollarization increases rapidly, on its way to the upper steady state, and in the process more than doubles, increasing from 36 to 73 percent in one single year.²⁹ By March 1995, a new steady state of about 73 percent has been reached. Around this time, however, the CBR starts to take measures to stabilize monetary and credit policy by ending the new-issue financing of the budget deficit, which leads to a decrease in depreciation, and even to an appreciation of the ruble (by 3 percent in March, 9 percent in June, and 2 percent in July 1995). As a result, the dollarization ratio falls slightly, to 65 percent in July 1995.

In July 1995 a "crawling peg" exchange rate regime is introduced in order to further stabilize the exchange rate and exchange rate expectations. While the new regime is successful in that it manages to keep the depreciation rate close to zero for the subsequent three years, it does not succeed in making the upper steady state disappear. As a result, Russia remains dollarized for about 70 percent from mid 1995 to mid 1998.

The exchange rate regime collapses during the August 1998 financial crisis. Under the pressure of a rapidly increasing debt-to-GDP ratio, and a rapidly decreasing stock of foreign exchange reserves, the Russian government announces on August 17 a "new approach to currency policy", meaning a significant widening of the bandwidth within which the exchange rate is allowed to "crawl" (cf. Buchs 1999). This is immediately perceived as a *de facto* devaluation, and causes the ruble to lose 65 percent of its value in August alone, and another 55 percent in September 1998. By November 1998, the dollarization ratio has increased to 87 percent, and Russia has reached a new upper steady state,

²⁹ On 'Black Tuesday', 11 October 1994, the ruble loses 27% of its value in one single day, further spurting the growth of dollarization.

indicated by point "11/98" in Figure 6.

6 Policy Implications

There are many costs associated with a high dollarization ratio, including the loss of seigniorage revenues³⁰, foregone tax revenues³¹, an increase in crime and corruption,³² and the lack of control of monetary policy by the national central bank, in this case the CBR. However, dollarization may also have positive effects, such as the fact that it will limit governments' efforts to use inflationary finance as a method of implicit taxation, and the fact that it allows for better portfolio diversification, which may reduce capital flight.³³

While it is beyond the scope of this paper to carry out a full-fledged cost-benefit analysis, if costs and benefits were measured simply by the costs in Table 1, then we should conclude that it is suboptimal for agents to be in a "dollarized" equilibrium whenever $e < q$ (in this case $e < 0.03$). Since this condition held true for most of the period from mid 1995 to mid 1998, and has mostly been satisfied since 1999 as well, we can speak of a coordination failure: agents would have been better off in a non-dollarized economy than in a dollarized one.

It is interesting to explore, therefore, which policies could be used by the Russian government if its goal were to reduce dollarization. On the basis of the results above, three different policies can be considered: (1) exchange rate policy; (2) fiscal policy; (3) enforcement policy.

³⁰These seigniorage losses can be quite high: if the ratio of U.S. dollar currency to GDP in Russia is 100%, which seems not far from the truth, then seigniorage losses as a percentage of GDP would be equal to the growth rate of monetary aggregates, which could easily be 10 percent a year.

³¹The idea here is that dollarization leads to an increase in the size of the underground economy, where transactions remain unrecorded and hence taxes are evaded (Feige *et al.* 2001). However, this may not be true if unrecorded foreign cash transactions are merely a substitute of unrecorded local cash transactions, or if dollar transactions simply get recorded as ruble transactions, as seems often to be the case in Russia.

³²Feige *et al.* (2001) note that dollarization reduces the cost of enterprise theft, and may facilitate greater corruption and rent seeking. In addition, the knowledge that many individuals and businesses hold most of their wealth in the form of dollar currency will increase the expected rewards of burglary. Note that these problems could be overcome if agents were to shift from dollar currency to dollar denominated deposits.

³³Additional costs and benefits are mentioned by Fischer (1982), Sturzenegger (1997), Balino *et al.* (1999), and Schmitt-Grohe and Uribe (2001). However, most of these costs, and especially the benefits, apply only to the use of dollar denominated deposits, and not necessarily to the use of dollar currency. Berg and Borensztein (2000) compare the costs and benefits of 'full dollarization' (accepting the U.S. dollar as legal tender) with those of a currency board.

6.1 Exchange Rate Policy

As a first way to reduce dollarization, the estimates above suggest that a significant appreciation of the ruble, if sustained long enough, could bring about a second phase transition that would make the high dollarization steady state disappear. This is shown in Figure 7. As the middle curve indicates, a mere stabilization of the exchange rate ($e = 0$) is not enough for a phase transition, even if stabilization lasts long enough so that $e^{\max} = 0$. As soon as the ruble starts to appreciate, however, the upper steady state disappears and a dynamic adjustment process is set in motion that causes the dollarization ratio to fall back to the lower steady state.

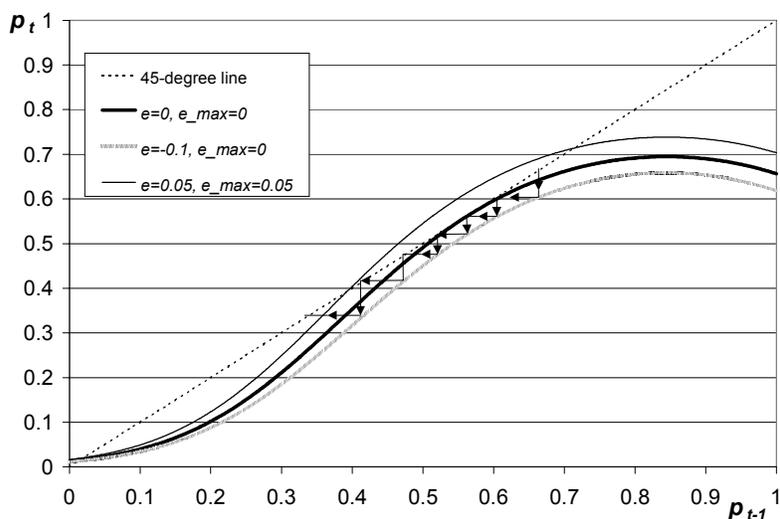


Figure 7: Reducing dollarization by ruble appreciation.

Note that the appreciation rate does not need to be maintained until the lower steady state is in fact reached. In fact, the dollarization ratio would only need to be reduced by an amount that is large enough so that, when the exchange rate stabilizes again, and the economy returns to the $e = 0$ curve, the dollarization ratio is below the intermediate, unstable steady-state level. This would then be enough for dollarization to continue to decrease by itself until it has reached the lower steady state.

To see this, consider a situation with both e and e^{\max} close to zero and $\tau = 0.01$, as is currently the case (this would correspond to a dollarization ratio of about 65 percent). Following the arrows in Figure 7, it can be seen that a temporary appreciation of the ruble by 5 percent per month, if maintained for at least four months in a row, is sufficient to permanently reduce dollarization. That is, after four months (i.e., four vertical arrows) dollarization is brought back to about 47 percent, which is below the intermediate steady state of the $e = 0$ curve.

Letting the ruble appreciate by 5 percent per month for three months in a row, however, implies a total appreciation of almost 22 percent, which might be considered quite high, and perhaps infeasible, to the extent that e would be forced below its "natural" or market determined rate. However, there is a way to prevent this from happening. As can be seen again in Figure 7, an appreciation rate of 5 percent that is maintained for six months in a row (thus resulting in a total appreciation of 34 percent) could be followed by a subsequent *depreciation* of the ruble by 5 percent for six months, without making dollarization return to the upper steady state. After one year, then, the exchange rate would be back at its old level, while dollarization would have decreased permanently.

6.2 Fiscal Policy

A second policy instrument to consider would be the tax on purchases of foreign currency. As noted before, this tax was introduced on 21 July 1997 at an initial rate of 0.5 percent, which was then raised to 1 percent on 2 July 1998. Recently, however (in April 2001), Russian president Vladimir Putin proposed to abolish the foreign currency tax by the year 2003. While the official reason for this proposal was that it fits in with the policy of eliminating all taxes on turnover in Russia, it is interesting to see whether this could have the additional benefit of reducing dollarization.

As noted earlier, a surprising implication of the model presented in section 3 was that the conditional probability of holding dollars (i.e., the probability that a given agent holds dollars, taken as given the demand for dollars by other agents) increases, rather than decreases, with the foreign

currency tax rate. This implies that an increase in the tax rate would shift the curve upward, while a decrease in the tax rate would imply a downward shift. The question, therefore, is whether the elimination of the tax will lead to a downward shift that is big enough to cause a phase transition, i.e., would it make the upper steady state disappear?

Figure 8 suggests that the answer is no. Merely reducing the tax rate from $\tau = 0.01$ to $\tau = 0$ has a virtually unnoticeable effect on the position of the curve, and hence on dollarization.³⁴ In other words, if all else remained the same, the model predicts that the proposed elimination of the tax on foreign currency in 2003 will have hardly any effect on dollarization in Russia. In order to make the upper steady state disappear, the tax rate would need to be much further reduced, to a negative rate of, e.g., $\tau = -0.05$. That is, for each dollar purchased, agents would have to receive a "subsidy" of 5 dollar cents.³⁵ This subsidy would only need to be maintained for four months in order to permanently reduce dollarization. That is, if the tax rate is again set to zero after those four months, the dollarization ratio at that point is below the intermediate steady state of the $\tau = 0$ curve, so that dollarization will continue to decrease by itself until it has reached the lower steady state.

Intuitively, it seems quite implausible that a subsidy on purchasing dollars would lead to a reduction in dollarization. Yet, theoretically, it does follow from the model: a subsidy would encourage buyers to hold rubles, so that, in the event a seller prefers dollars, the buyer has the opportunity to change these rubles into dollars and receive the 5 percent subsidy. At the same time, sellers would become less likely to prefer dollars, since even if they planned to hold dollars in the next period, they would rather be paid in rubles and change those rubles into dollars themselves, so as to receive the subsidy.

³⁴Both curves assume that $e = e^{\max} = 0$, and both still intersect the 45-degree line. It is possible that there exists a small range of (slightly negative) values for e or e^{\max} such that the $\tau = 0.01$ curve has three steady states whereas the $\tau = 0$ curve has only one (lower) steady state. Only in those extraordinary cases, the elimination of the foreign currency tax could have a drastic effect on dollarization.

³⁵Interestingly, this amounts in essence to an appreciation of the ruble by 5%, which coincides with the policy suggested in the previous subsection.

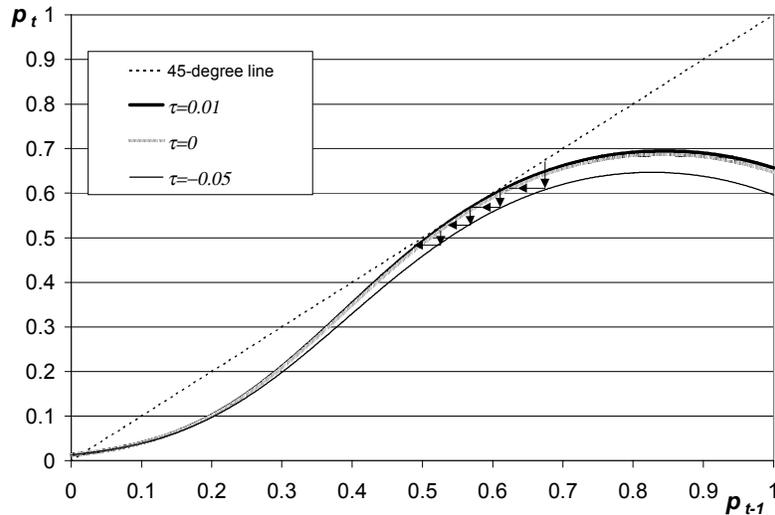


Figure 8: Reducing dollarization by a negative foreign currency tax.

In practice, however, providing a subsidy will of course cost money, and in fact would quickly make the government bankrupt. That is, the subsidy would create unlimited arbitrage opportunities, as agents could change rubles into dollars, receive the subsidy, change the dollars back into rubles, and start over again. The best the government can do, therefore, is to eliminate the foreign currency tax, and combine it with either an exchange rate policy or the enforcement policy discussed below.

6.3 Enforcement Policy

A final way for the Russian government to decrease dollarization would be to increase enforcement of the law that makes it illegal to carry out transactions in dollars. This will increase the risk of confiscation, q_t , and therefore the markup buyers would have to pay if they wanted to pay in dollars, thus diminishing the demand for dollar currency.

From the fact that q_t enters equation 9 in exactly the same (though opposite) way as τ_t , we can predict that a decrease in the foreign currency tax by 0.06 (from $\tau = 0.01$ to $\tau = -0.05$) would have exactly the same effect as an increase in enforcement by 0.06, which would triple the confiscation risk

(from $q = 0.03$ to $q = 0.09$). The graph in this case would look exactly the same as Figure 8. As before, enforcement would only need to increase temporarily (in this case, four months) in order to permanently decrease dollarization.

7 Conclusion

The ratio of dollar to total currency in Russia increased from almost zero in January 1992 to over 70 percent by mid 1995. However, even when the exchange rate subsequently stabilized for about three years, the dollarization ratio failed to decrease. This puzzling persistence, or hysteresis, in the dollarization ratio, has been observed in other dollarized countries as well. It is often "explained" by including a so-called ratchet variable in the regression, which can be interpreted as the fact that temporarily high levels of currency depreciation or inflation are long remembered by agents and thus can have long-term effects on agents' expectations.

In this paper we showed that an additional and perhaps alternative way to explain dollarization hysteresis is the existence of network externalities. These externalities arise from the fact that an individual's demand for a given currency depends not only on the current or past rate of currency depreciation, but also on the extent to which this currency is accepted as a means of payment within this individual's trade network. Intuitively, when currency depreciation or inflation leads to an increase in the dollarization ratio, this increase in dollarization itself makes dollars more valuable as a means of exchange. Therefore, a temporary shock to depreciation can have permanent effects even if agents do not "remember" the shock for a long time.

We developed a theoretical model to show that the existence of network externalities can lead to multiple steady-state levels of dollarization. We then estimated this model using a new source of data on dollar currency holdings in Russia, based on the Currency and Monetary Instrument Reports (CMIR). The results are consistent with the existence of multiple steady states and suggest that dollarization hysteresis in Russia can be explained as a "phase transition" from a low to a high stable

steady state.

In terms of policy implications, the model suggests that the Russian authorities can decrease dollarization in two ways: (i) by letting the ruble appreciate, and (ii) by more strictly enforcing the law that prohibits dollar transactions. Even if these policies are implemented only temporarily, they can lead to a permanent decrease in the dollarization ratio. According to our estimates, an appreciation rate of 5 percent or an enforcement rate of 9 percent, if maintained for at least four months, would essentially eliminate dollarization. These rates could be even lower, or would not need to be maintained as long, if a combination of (i) and (ii) were used, or if the tax on purchases of foreign currency were eliminated, as Russia plans to do in 2003. In summary, while dollarization in Russia has been very persistent, it need not be irreversible.

References

- AIYAGARI, S. R., AND N. WALLACE (1992): "Fiat Money in the Kiyotaki-Wright Model," *Economic Theory*, 2(4), 447–464.
- ALAMI, T. (1995): "Dollarization and the Demand for Money in Egypt," Ph.D. thesis, American University.
- ANDERSON, S. P., A. DEPALMA, AND J.-F. THISSE (1992): *Discrete Choice Theory of Product Differentiation*. MIT Press, Cambridge, MA.
- BALINO, T. J., A. BENNETT, AND E. BORENSZTEIN (1999): "Monetary Policy in Dollarized Economies," Occasional Paper 171, International Monetary Fund.
- BERG, A., AND E. BORENSZTEIN (2000): "The Pros and Cons of Full Dollarization," Working Paper 00/50, International Monetary Fund.
- BLANCHARD, O., AND M. KREMER (1997): "Disorganization," *Quarterly Journal of Economics*, 112(4), 1091–1126.
- BOLBOL, A. A. (1999): "Seigniorage, Dollarization and Public Debt: The Lebanese Civil War and Recovery Experience," *World Development*, 27(10), 1861–1873.
- BRAND, D. (1993): *Currency Substitution in Developing Countries: Theory and Empirical Analysis for Latin America and Eastern Europe*, no. 24 in Ifo-Studien zur Entwicklungsforschung. Weltforum, Munich and London.
- BROCK, W. A., AND S. N. DURLAUF (2001a): "Discrete Choice with Social Interactions," *Review of Economic Studies*, 68(2), 235–260.
- (2001b): "Interactions-Based Models," in *Handbook of Econometrics*, ed. by J. J. Heckman, and E. E. Learner, vol. 5. Elsevier North Holland, Amsterdam.
- BRODSKY, B. (1997): "Dollarization and Monetary Policy in Russia," *Review of Economics in Transition*, 6, 49–62, Bank of Finland, Unit for Eastern European Economies.
- BUCHS, T. D. (1999): "Financial Crisis in the Russian Federation: Are the Russians Learning to Tango?," *Economics of Transition*, 7(3), 687–715.
- CALVO, G. A., AND C. A. VEGH (1992): "Currency Substitution in Developing Countries: An Introduction," Working Paper 92/40, International Monetary Fund.
- (1995): "Fighting Inflation with High Interest Rates: The Small Open Economy Case under Flexible Prices," *Journal of Money, Credit, and Banking*, 27(1), 49–66.

- CANTO, V. (1985): “Monetary Policy, ‘Dollarization’, and Parallel Market Exchange Rates: The Case of the Dominican Republic,” *Journal of International Money and Finance*, 4(4), 507–21.
- CHOUDHRY, T. (1998): “Another Visit to the Cagan Model of Money Demand: The Latest Russian Experience,” *Journal of International Money and Finance*, 17, 355–376.
- CLEMENTS, B., AND G. SCHWARTZ (1992): “Currency Substitution: The Recent Experience of Bolivia,” Working Paper 92/65, International Monetary Fund.
- DORNBUSCH, R., F. STURZENEGGER, AND H. WOLF (1990): “Extreme Inflation: Dynamics and Stabilization,” *Brookings Papers on Economic Activity*, 2, 1–84.
- EARLE, J. S., AND K. Z. SABIRIANOVA (2000): “Equilibrium Wage Arrears: A Theoretical and Empirical Analysis of Institutional Lock-In,” Working Paper 321, Davidson Institute, University of Michigan.
- ENGINEER, M. (2000): “Currency Transactions Costs and Competing Fiat Currencies,” *Journal of International Economics*, 52, 113–136.
- FEIGE, E. L. (1996): “Overseas Holdings of U.S. Currency and the Underground Economy,” in *Exploring the Underground Economy*, ed. by S. Pozo, pp. 5–62. W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan.
- (1997): “Revised Estimates of the Underground Economy: Implications of US Currency Held Abroad,” in *The Underground Economy: Global Evidence of Its Size and Impact*, ed. by O. Lippert, and M. Walker. The Fraser Institute, Vancouver, British Columbia, Canada.
- FEIGE, E. L., M. FAULEND, V. SONJE, AND V. SOSIC (2001): “Currency Substitution, Unofficial Dollarization and Estimates of Foreign Currency Held Abroad: The Case of Croatia,” in *Financial Vulnerability and the Exchange Rate Regime*, ed. by M. Blejer, and M. Skreb. MIT Press, Cambridge, MA, forthcoming.
- FISCHER, S. (1982): “Seigniorage and the Case for a National Money,” *Journal of Political Economy*, 90(2), 295–313.
- FRIEDMAN, A., AND A. VERBETSKY (2000): “Currency Substitution in Russia,” Final report, Economics Education and Research Consortium, Moscow, Russia.
- GUIDOTTI, P. E., AND C. RODRIGUEZ (1992): “Dollarization in Latin America: Gresham’s Law in Reverse?,” *International Monetary Fund Staff Papers*, 39(3), 518–44.

- HORVATH, B., N. THACKER, AND J. HA (1998): "Achieving Stabilization in Armenia," Working Paper 98/38, International Monetary Fund.
- KAMIN, S., AND N. ERICSSON (1993): "Dollarization in Argentina," International Finance Discussion Paper 460, Board of Governors of the Federal Reserve System.
- KIYOTAKI, N., AND R. WRIGHT (1993): "A Search-Theoretic Approach to Monetary Economics," *American Economic Review*, 83(1), 63–77.
- KORHONEN, I. (1996): "Dollarization in Lithuania," *Review of Economics in Transition*, 5, 53–59, Bank of Finland, Unit for Eastern European Economies.
- KRUEGER, R., AND J. HA (1995): "Measurement of Cocirculation of Currencies," Working Paper 95/34, International Monetary Fund, reprinted in Mizen and Pentecost (1996), chapter 4.
- MARQUEZ, J. (1987): "Money Demand in Open Economies: A Currency Substitution Model for Venezuela," *Journal of International Money and Finance*, 6(2), 167–178.
- MATSUYAMA, K., N. KIYOTAKI, AND A. MATSUI (1993): "Toward a Theory of International Currency," *Review of Economic Studies*, 60, 283–307.
- MILES, M. A. (1978): "Currency Substitution, Flexible Exchange Rates, and Monetary Independence," *American Economic Review*, 68(3), 428–436.
- MIZEN, P., AND E. J. PENTECOST (1996): *The Macroeconomics of International Currencies: Theory, Policy and Evidence*. Elgar, Lyme, N. H.
- MONGARDINI, J., AND J. MUELLER (1999): "Ratchet Effects in Currency Substitution: An Application to the Kyrgyz Republic," Working Paper 99/102, International Monetary Fund.
- MORRIEN, H.-H. (1997): "Wachstumssubstitution und Währungswettbewerb - Eine Marktgetriebene Währungsreform Für Russland," Ph.D. thesis, Ruhr-Universität Bochum, Institut für Entwicklungsforschung und Entwicklungspolitik, in German.
- MUELLER, J. (1994): "Dollarization in Lebanon," Working Paper 94/12, International Monetary Fund.
- NIKOLAENKO, S. (1998): "Personal Savings," Information Bulletin 7, Russian Bureau of Economic Analysis, Moscow.
- ORTIZ, G. (1983): "Currency Substitution in Mexico: The Dollarization Problem," *Journal of Money, Credit, and Banking*, 15(2), 174–85.

- PEIERS, B. M., AND J. M. WRASE (1997): "Dollarization Hysteresis and Network Externalities: Theory and Evidence From an Informal Bolivian Credit Market," *Journal of International Money and Finance*, forthcoming. References refer to Working Paper 97-21, Federal Reserve Bank of Philadelphia.
- RIMASHEVSKAYA, N. M. (1998): "Sberezheniya Naseleniya I Vnutrennie Istochniki Ekonomicheskogo Rosta V Rossii: Resul'taty Eksperimentalnykh Issledovaniy," *Ekonomika i Matematicheskie Metody*, 34(3), in Russian.
- ROJAS-SUAREZ, L. (1992): "Currency Substitution and Inflation in Peru," *Revista de Análisis Económico*, 7(1), 153–176.
- ROLAND, G., AND T. VERDIER (1994): "Privatization in Eastern Europe: Irreversibility and Critical Mass Effects," *Journal of Public Economics*, 54(2), 161–183.
- (2000): "Law Enforcement and Transition," Working paper, Ecole Normale Supérieure - Delta.
- SAHAY, R., AND C. VEGH (1995a): "Dollarization in Transition Economies," *Finance and Development*, 32(1), 36–39.
- (1995b): "Dollarization in Transition Economies: Evidence and Policy Implications," Working Paper 95/96, International Monetary Fund, reprinted in Mizen and Pentecost (1996), chapter 11, pp. 193-224.
- SARAJEV, V. (2000): "Econometric Analysis of Currency Substitution: A Case of Latvia," BOFIT Discussion Paper 4, Bank of Finland Institute for Economies in Transition.
- SAVASTANO, M. A. (1996): "Dollarization in Latin America: Recent Evidence and Some Policy Issues," Working Paper 96/4, International Monetary Fund.
- SCHMITT-GROHE, S., AND M. URIBE (2001): "Stabilization Policy and the Costs of Dollarization," *Journal of Money, Credit, and Banking*, forthcoming.
- STANCZAK, K. (1992): "Competing Monies and the Big Polish Inflation of 1989," working paper 682, Department of Economics, University of California, Los Angeles.
- STURZENEGGER, F. A. (1992): "Currency Substitution and the Regressivity of Inflationary Taxation," working paper 656, Department of Economics, University of California, Los Angeles.
- (1997): "Understanding the Welfare Implications of Currency Substitution," *Journal of Economic Dynamics and Control*, 21, 391–416.

URIBE, M. (1997): “Hysteresis in a Simple Model of Currency Substitution,” *Journal of Monetary Economics*, 40(1), 185–202.

VANAARLE, B., AND N. BUDINA (1995): “Currency Substitution in Eastern Europe,” Center for Economic Research Discussion Paper 9502, Tilburg University, The Netherlands.

Appendix: Estimating Dollar Currency in Russia

Two possible data sources are available for estimating the amount of dollar currency in circulation in Russia. In addition to the CMIR data described in section 4, there exist data produced by the Central Bank of the Russian Federation (CBR) on reported purchases and sales of foreign currency by authorized banks.³⁶ On the basis of these data one can construct a series on accumulated net purchases of foreign currency as a first approximation of dollar currency circulating in Russia. This indeed was the estimate used in the two other studies of dollarization in Russia we are aware of (Brodsky 1997, Friedman and Verbetsky 2000).³⁷

Following Sergey Nikolaenko of the Russian Bureau of Economic Analysis, we can combine the CBR data with balance of payments data published in *Vestnik Banka Rossii* in order to adjust for the fact that dollar currency is taken out of the country by Russian tourists and by so-called shuttle traders (*chelnoki*). The latter tend to use large amounts of dollar currency to purchase goods abroad, mainly in Asia and the Middle East, in order to resell them in Russia. As reported in Nikolaenko (1998), this additional outflow of dollars (denoted by "unregistered imports" and "travel abroad expenses") is estimated to constitute about 10 percent of total consumption expenditures, and therefore should not be neglected. Subtracting Nikolaenko's "unregistered imports" and "travel abroad expenses" from the CBR's series on net purchases of foreign currency, we obtain an adjusted CBR estimate, which we call "CBR estimate" for short in Figure 9 below.

In some sense, the CMIR and CBR data represent two sides of the same coin. That is, when individuals start buying more dollars from Russian banks, these banks will order more dollars from the U.S. (typically, they order from one of the large wholesale shippers who transport the bulk currency directly to them). Similarly, when individuals start to sell more dollars to Russian banks,

³⁶These data are published in the CBR's *Byulleten Bankovskoy Statistiki*, Table 3.2.4. Since August 1997, they data have been supplemented with data on individuals' net withdrawals from foreign currency deposits.

³⁷Brodsky (1997), however, used only a very short time series (1994:5 – 1996:6), and was therefore not able to get any reliable empirical estimates. Friedman and Verbetsky (2000) had a longer series (1995:1 - 2000:6), but used a standard portfolio balance model with which they could not account for hysteresis.

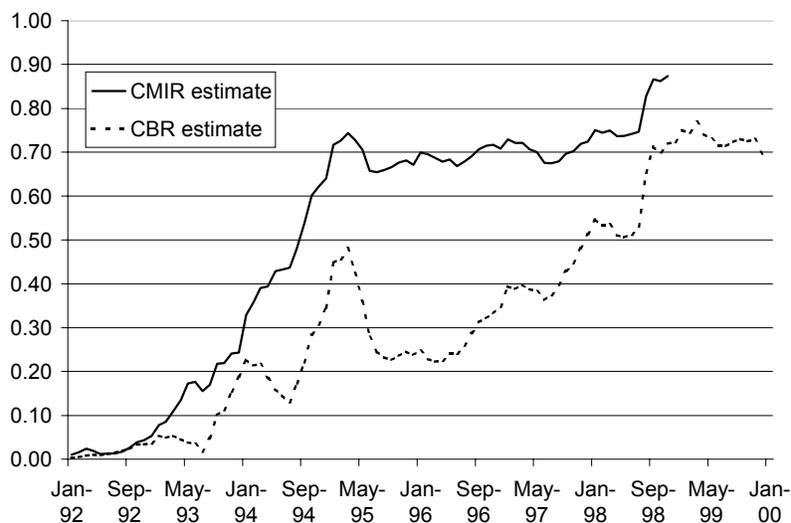


Figure 9: Estimated Dollarization Ratios

this will lead to a decrease in the amount of wholesale shipments from the U.S. to Russia.³⁸

In practice, however, the CMIR and CBR data differ for several reasons, and both have advantages and disadvantages. The main advantage of the CMIR estimate is that it includes any registered amounts physically carried into or out of Russia. These amounts are not necessarily converted into rubles, and therefore may not be included in the CBR estimate. The main disadvantage of the CMIR estimate, however, is that it does not include dollar flows between Russia and countries other than the U.S., and that currency flows below \$10,000 are not reported. The (adjusted) CBR data partially account for these flows to the extent that they pass through Russian banks, are used for tourism in countries other than the U.S., or are used for "shuttle trade". However, the main drawback of the CBR data is that they are based on reports by the currency exchange bureaus of banks, which are commonly known to underreport the total number and volume of transactions in order to evade taxes. It is not surprising, therefore, that the dollarization ratio estimated on the basis of the CBR data is

³⁸If the decrease continues, Russian banks may eventually find themselves with a surplus of dollars, in which case wholesale bulk shippers will be enlisted to transport the excess currency back to the US.

significantly lower than the estimate based on the CMIR data, as is shown in Figure 9.

While the CBR estimate is thus likely to understate the true amount of dollar currency in Russia, it is not obvious that the CMIR estimate is necessarily an overstatement. It overstates m^* to the extent that it does not account for imports from other countries than the U.S., but it understates m^* to the extent that additional dollars have flowed into Russia from other countries. In addition, it is known that individuals transporting currency from the U.S. to Russia are not monitored as carefully by U.S. Customs as individuals returning from Russia to the U.S., resulting in another source of understatement.

A similar analysis can be made for the currency flows between Russia and the U.S. that fall below the CMIR reporting requirement of \$10,000. Many of such flows are either from immigrant remittances by Russians living in the U.S. or from individual travelers between the U.S. and Russia. The omission of such remittances leads to an understatement of m^* , but this may well be negligible.³⁹ As for the relatively small amounts of dollars transported by individual tourists and businessmen, one might expect that more dollars are carried into Russia by Americans than are carried into the U.S. by Russians. If this is true, then that would be another reason why the CMIR data may understate, rather than overstate, the true amount of dollar currency in Russia.⁴⁰

Finally, we may compare the CMIR and CBR estimates to an independent estimate of dollar currency in Russia, which is reported in Rimashevskaya (1998). In October 1996, she conducted a survey among 7796 households in 13 regions of Russia, including Moscow and St. Petersburg. The goal of this survey, which was financed by the CBR, was to study the savings behavior of Russian households. Since people in the top of the income distribution usually do not participate in polls, 70 additional personal interviews were conducted with "rich" and "very rich" inhabitants of four

³⁹ On the basis of data on travelers' expenditures and net remittances, Feige (1996, 1997) found that cumulative net outflows of dollars below \$10,000 constitute a relatively small fraction of total estimated net outflows.

⁴⁰ Of course, the CMIR estimate could still be overstated to the extent that there are illegal flows of dollar currency out of Russia that circumvent any legal reporting requirements. However, most of this so-called 'capital flight' is likely to take place in the form of electronic transfers rather than cash, since traveling with large amounts of dollar currency is quite risky.

regional centers (Moscow, St. Petersburg, Rostov-on-Don and Ufa).⁴¹ The different categories of savings distinguished by the survey included personal accounts in Russian banks, securities, as well as ruble and foreign currency. For the "very rich" group, corporate accounts and accounts abroad were also taken into account.

Type of savings	bln rub	bln \$	% of total
<i>Accounts in Russian banks (personal)</i>	108.0	19.8	11.6
<i>Accounts in Russian banks (corporate)</i>	122.4	22.5	13.2
<i>Securities</i>	173.1	31.8	18.7
<i>Ruble currency</i>	96.3	17.7	10.4
<i>Foreign currency</i>	305.1	56.0	32.9
<i>Accounts abroad, including corporate</i>	199.8	36.7	19.9
TOTAL	1004.7	184.5	100.0

Table 4: Types of Saving in Russia. Source: Rimashvskaya (1998).

As can be seen from Table 4, the survey's estimate of the amount of foreign currency in Russia was about 56 billion dollars for October 1996.⁴² If about 90 percent of all foreign currency was held in dollars, this would give an estimate of about \$50 billion for dollar currency, which is quite close to the CMIR estimate of \$45 billion for October 1996. The CBR estimate for the same period is only \$10 billion, which seems to confirm the suspicion that these data seriously underestimate the true amount of dollar currency in Russia.

⁴¹The category 'rich' was defined as those people who earned 9 to 10 times the minimum living allowance (MLA), and this group was estimated to constitute about three percent of the population. The 'very rich' were defined as people with more than 10 times the MLA, constituting an estimated two percent of the population.

⁴²Two other interesting results of the survey are that 80 percent of foreign currency is owned by the 'rich' and 'very rich' groups, which together account for five percent of the population, and that 75 percent of foreign currency is located in Moscow.