Victor K. Shpringel [1]

The Russian Financial Crisis:

Why Ruble Devaluation Was Accompanied by the Sovereign Debt Crisis.

ABSTRACT

It is shown by original currency crisis model that mistakes in monetary and fiscal policy were at the root of the Russian financial crisis of 1998. A combination of high interest rates with high sensitivity of inflation rate to the rate of currency depreciation, low duration of debt and low GDP monetization generated exchange rate appreciation and rapid domestic-currency debt accumulation. When the debt became too high to service, investors started to flee. Protective interest rate hike by the monetary authorities was counterproductive, accelerating the approach of the crisis via the growth in the debt-servicing payments and GDP contraction. The budget restriction of 3% of GDP, used in EC countries, was too loose for Russia in the pre-crisis period.

JEL-Classification: E52, F32, F33, P24.

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I. Introduction

Last ten years a number of currency crises struck emerging markets. The most serious among them were the Mexican crisis of 1994 (tequila crisis), the crises of 1997-98, which hit several East Asian countries and then Russia and Brazil, the Argentine financial turmoil of 2001-2002. They were usually contractionary (Calvo and Reinhart, 2000; Eichengreen and Rose, 2001) and were associated with loss of access to international credit, chronic and marked volatility in domestic interest rates. Furthermore, exchange rate volatility appeared to be damaging to trade and the pass-through from exchange rate swung to inflation.

For example, the Russian debacle inflicted large losses on major financial institutions. In the period of August 1998 – January 1999 the ruble depreciated by more than 75%, international reserves of the Bank of Russia fell by 30%. Total capital of Russian banks dropped by 36% in nominal terms. Total losses of the banking system (direct and indirect) and the costs of its restructuring were estimated at more than 11% of GDP. The consequences of the Argentine crisis were even more drastical. In 2002 real GDP contracted by more than 15%, the nominal devaluation of peso was about 70% (Edwards, 2002). The authorities were compelled to default on their debt and to implement a deposit freeze and tight currency controls.

The recent currency crises differed much in the view of their genesis. The Mexican and East Asian crises were evidently generated by the liquidity and currency mismatches in the balance sheets of private companies and banks (Chang and Velasco, 1998; Cosetti, Pesenti, Roubini, 1998; Radelet and Sachs, 1998), whereas the Russian and the Argentine turmoils were mainly driven by the financial problems of the public sector (Montes and Popov, 19994 Edwards, 2002). The mechanisms of the last two episodes are close but not identical to the currency crisis of the 1970-80s. On the one hand, an important role of persistent fiscal imbalance – a key factor in the Latin American crises of 1970-80s - in generating both crises events was evident. But on the other hand, the Russian and the Argentine currency crises were associated with Sudden Stops in capital flows (Calvo, Izquierdo and Talvi (2003)), generated by the shifts in investors' behavior, and the use of restrictive monetary policy by the authorities.

Taking into account the role of fiscal imbalance in provoking a currency crisis, Entov (1999) and Montes and Popov (1999) tried to explain the Russian currency crisis by a canonical Krugman's model (Krugman 1979). In my opinion, this approach is not adequate.

First, Krugman uses an idea that domestic-currency interest rate is subject to international arbitrage condition. In other words, forward foreign exchange rates should have been based on interest rate parity to prevent the opportunity for profit-making arbitrage. But this was not the case both in Russia and in Argentina where the forward exchange rate differed much from the parity due

to high probability of sovereign default. Second, the Russian exchange rate system in the pre-crisis period can't be considered a fixed exchange rate system. In July 1995 Russian monetary authorities announced a wide crawling "corridor" (12-14% around the central rate) within which a ruble-dollar rate was allowed to fluctuate. Third, Krugman uses an idea that budget expansion provokes the growth in domestic credit. At the same time both Entov (1999) and Montes and Popov (1999) acknowledged that budget expansion was combined with the restrictive monetary policy in Russia. This was also the case in Argentina (Edwards, 2000). Fourth, according to Krugman's model a sovereign default is provoked by the sharp currency depreciation whereas in Russia ruble was doomed due to the government insolvency.

I consider the combination of tight monetary policy with budget expansion was exactly at the root of Russian financial crisis and could be severely blamed for the Argentine debacle. This combination is dangerous independently of what exchange rate arrangement is applied by monetary authorities: super-fixed, crawling peg or free floating.

To test these hypotheses theoretically I develop a currency crisis model. The model proceeds from the assumptions of risk-averse investors, rational expectations, imperfect capital mobility and free floating. An investor makes the decision comparing the expected returns of investment in government' securities of developed countries and emerging markets.

The model shows that persistent budget deficit combined with the restrictive monetary policy were at the root of the Russian financial crisis, generating rapid debt accumulation and an unsustainable increase in the debt-servicing payments. As investors incorporated growing sovereign default risk and exchange risk in their decision-making, the real exchange rate overvaluation, associated with a massive capital inflow, and debt pressure caused the capital flows at first to stop and then to reverse direction.

The choice of a protective interest rate policy by Russian monetary authorities in spring-summer 1998 was false, taking into account poor economic situation, fragility of the banking system and huge fiscal imbalance. The results of simulation show that if either interest rates were smaller, or the rate of currency depreciation was less sensitive to capital inflows the crisis wasn't so rapid and inevitable. They also demonstrate that budget deficit restriction of 3% of GDP, applied to EC countries, was too loose for Russia in the pre-crisis period.

The remainder of the paper proceeds as follows. In Section II I review Russian economy and financial market development in the pre-crisis period. In Section III I develop the model of the Russian currency crisis and present the results of model simulation. Section IV offers concluding remarks.

II. Russian economy and financial sector development in the pre-crisis period

An implementation of the financial stabilization program since April 1995 resulted in a radical change of the economic and financial situation. The aims of the program were to cure the continuing ruble inflation via strict control on monetary supply growth and to push an economic growth through the growth in investments and real personal income.

The GKO system had to substitute money printing as a source of budget deficit financing. Another important part of the stabilization program was a fixed band foreign exchange policy, used as a nominal anchor. Russian monetary authorities announced a wide sloping "corridor" of 12-14% around the central rate within which the ruble-dollar rate was allowed to fluctuate. As a result, the rate of currency depreciation seriously reduced. Due to high dependence of inflation rate on the rate of currency depreciation, associated with a high dollarization of economy (the prices of significant number of goods and services were denominated in US dollars), inflation was curbed in a few months.

Another goal of the program – acceleration of the economic growth – remained unattainable. As ruble inflationary pressure diminished the rate of the output decline abated but the real economy didn't start to recover. An important reason for the negative rate of GDP growth was substitution of GKO investment for loans in banks' portfolios. The attempts of the government to make GKO market more attractive, forced it to offer investors high rates. As a return on GKO was high and considered as risk-free the banking lending rate became prohibitively high for most of the enterprises. This resulted in the reduction of loan demand and to the growth in bad loans ratio due to adverse selection.

Since the government had serious troubles collecting the taxes due, the support of the GKO system relied on its own reproduction, thus, creating the danger of a financial pyramid. The financial resources to pay off the previous GKO obligations were coming from the issue of new GKOs. High debt-servicing costs in conjunction with the prevalence of short-term obligations resulted in a rapid growth in the GKO supply. Meanwhile, the demand for debt obligations was limited due to the scarce funds of Russian financial institutions.

In order to lower the cost of borrowings the Russian government facilitated the entrance to the GKO market for non-residents since the fall of 1996. High interest income and pegged exchange rate, which seemed to insure investors against exchange risk, generated massive capital inflow (19 bln. USD, or 10.7% of GDP) in the first half of 1997. This caused a gradual interest rate decline (Fig. 1) and allowed the government to increase the duration of the debt. The interest rates and debt-servicing costs reached the minimum in the mid-summer of 1997.

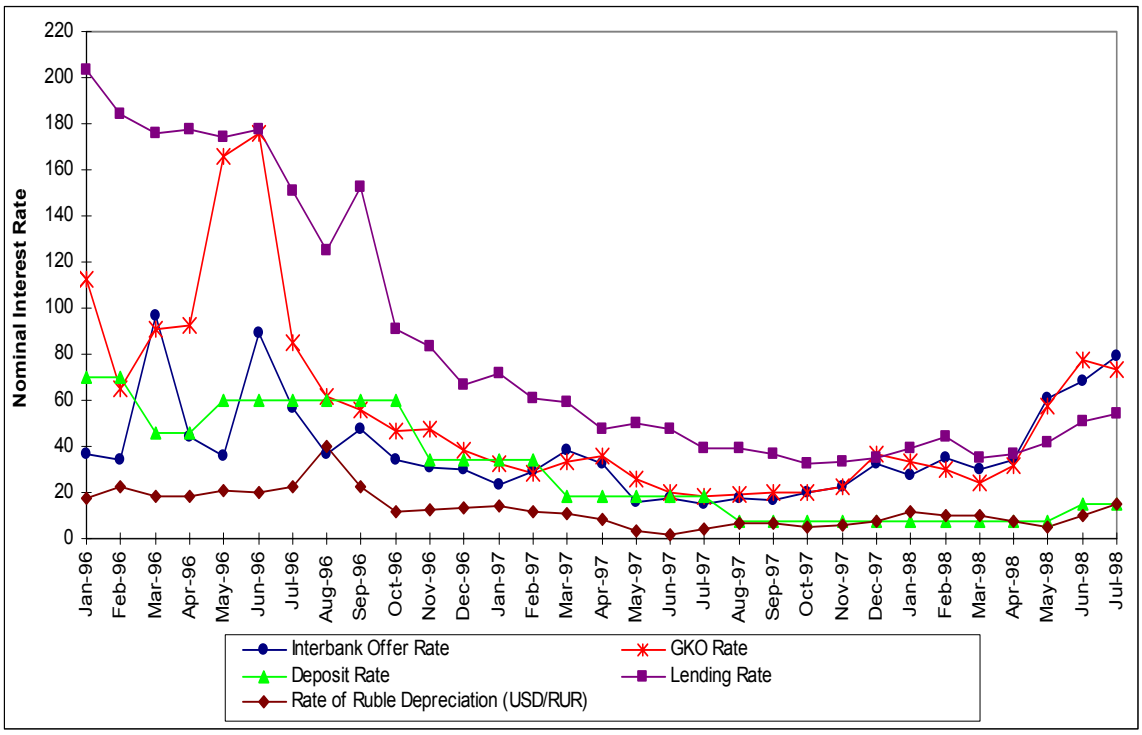

Fig. 1. Rates of return on the major financial instruments in Ruble, January 1996 – July 1998. Source: Central Bank of Russia.

This massive capital inflow also resulted in a rapid growth in the share of non-residents in the domestic-currency debt outstanding and made them the main creditors of the government, excluding the Bank of Russia. According to Entov (1999) a share of non-residents in the GKOs outstanding rose from 2-3% in the spring of 1996 to 30-35% in the mid-summer of 1998. The volume of GKO obligations owned by the foreign investors became two times more than Russia's international reserves by 1998.

As a result of the large-scale capital inflow the dependence of Russian financial assets' prices on conditions of international capital market grew significantly. This conclusion is confirmed by the results of statistical tests. In January 1996 – July 1998 the correlation of return on GKO obligations with return on US T-bills and the rate of ruble depreciation were 0.6 and 0.79 respectively (Shpringel, 2000).

As forward foreign exchange rates didn't comply with the interest rates spread there were the opportunities for profit-making arbitrage. The series of transactions: buying rubles for US dollars, investing them in GKO and simultaneous taking long position in appropriately timed forward dollar contracts produced high gross US dollar return which fluctuated from 10-15% in September 1997 to more than 100% in the mid-summer of 1996 (prior to the President elections) (Shpringel, 2000, Solodkov and Rock, 2001).

Though the domestic-currency debt was not large – approximately 20% of GDP by 1998 – the situation with its servicing was tense. Due to positive real interest rates and the necessity to finance primary budget deficit (it was about 2-3% of GDP in 1996-1997), domestic-currency debt and debt-servicing payments proliferated. The internal debt to nominal GDP ratio continued to grow even in 1997,[2] when interest rates were at their minimum and the rate of real output growth was close to zero.

The situation in the Russian financial market seriously deteriorated in the fall of 1997 when Russia began to feel spillover problems from the Asian financial meltdown. Because of the large losses on investment in the Asian financial markets international investors became more cautious about transactions on emerging markets. As a result the required return on GKO rose from 14% in September 1997 to 28% in November 1997 (Fig. 1). Interest rates growth was accompanied by decline in the rate of currency depreciation and inflation rate.

The real output decline in the Asian countries was a great shock to the primary commodities market. As the share of primary commodities in the Russian export was very large, the terms of trade deteriorated seriously. As oil-extracting companies were main taxpayers, revenues of the federal government declined as well.

Since the government received less revenues and the cost of borrowing rose, problems with debt-servicing began to mount. The debt-servicing costs to tax revenues ratio grew steadily during the first half of 1998. Monthly debt-servicing payments were two times more than federal budget tax revenues in the mid-summer of 1998. In July 1998 the inflow of purchases minus the interest payments and principal repayments became a net negative of $1 bln. each week. The government tried to unroll the situation by combating tax evasion and extending tax base (a tax administration program was submitted to parliament in May 1998) but it could hardly impact expectations of market participants since the government was believed to take much time to realize the program. The most of investors realized that the government had no funds to pay off the debt and began to withdraw capital.

When in May-June 1998 a pressure on the exchange rate became to mount the Bank of Russia tried to prevent a capital outflow by restrictive monetary policy. The Bank of Russia discount rate rose twofold from 30% to 60% (150% in the period of May, 28 – June, 4). This strategy was inspired by the IMF consultants who believed that pegged exchange policy was the only anchor for preventing a repetition of the hyperinflation problem of early 1990s.

Taking into account the conditions of Russian GKO market and real economy, restrictive monetary policy is supposed to be counterproductive. Discount rate hike by the Bank of Russia

[2] The domestic-currency debt to GDP ratio rose from 17% in January 1997 to 20% in November 1997.

caused the growth in debt-servicing costs for the government and the cost of borrowing for the commercial banks. As banks had significant maturity mismatches and heavily invested in the lucrative GKO market the interest rates hike inflicted high losses on them.

When capital outflow became irreversible in August 1998, the Russian government refused to meet significant part of its debt obligations and the Bank of Russia abandoned the peg.

III. A Model of Russian Currency Crisis

I study a small open economy in continuous time. There are two "countries" in the world (i = 1,2). Trade balances of both countries are equal to zero. Governments are the only issuers of bonds (zero-coupon bonds), which are denominated in domestic currency.

Investors regard the bonds, issued by the government of the first "country" (developed country), as risk-free. At the same time the bonds, issued by the government of the second "country" (emerging market), are characterized by non-zero risk of default.

The monetary authorities of the second "country" maintain the nominal interest rate on government bonds. There is no secondary market and investors acquire bonds and hold them until redemption. The domestic Central Bank has a commitment to acquire the bonds not purchased by private investors (B_t), thus increasing the monetary supply (M_t).

The monetary authorities use the quasi-fixed exchange rate arrangement, fixing the rate of currency depreciation ($\bar{\varepsilon}$

$$S_t \times IR_t, \tag{1}$$

where S_t is an exchange rate (domestic-currency[3] price of foreign exchange), controlled by the monetary authorities.

Two "countries" differ in real output ($Y_1 >> Y_2$) and wealth ($W_1 >> W_2$). Since demand for bonds depends positively on wealth, the main part of bonds, issued by the government of the second "country" and purchased by the private sector, are owned by residents of the first "country". Thus all bonds, issued by the government of the second "country", could be regarded as distributed between the residents of the first "country" and monetary authorities of the second "country":

$$D_t \cong F_t + B_t \tag{2}$$

where F_t and B_t are the nominal value of domestic-currency debt held by foreign investors and the domestic Central Bank respectively.

[3] Now and then I regard the currency of the second "country" as the domestic currency.

The investor will keep the assets portfolio' structure invariable only if the bonds provide the same expected return. Investing 1 money unit in the government bonds of the first "country", investor would receive the next moment e^{R^*t} with certainty.

On the contrary, investing the same sum in the government bonds of the second "country", she would receive $S_t \times e^{Rt}$ with the probability $(1-\phi_t)$, or l (a present value of debt-servicing payments of the government in the case of default, $l \leq 1$) with probability ϕ_t ($\phi \in [0;1]$),[4] where ϕ_t is a probability of sovereign default and R_t is an interest rate on the second "country" debt obligations. In the second case, the investor is also exposed to the risk of currency devaluation or to pay much for 1 unit of foreign exchange. Taking into account these assumptions, an expected return on investment in the government bonds of the second "country" ($E(I_{2t})$) is equal to:

$$E(I_{2t}) \cong \frac{(1+R_t)\times(1-\phi_t)+l\phi_t}{1+\varepsilon_t}\ , \tag{3}$$

$$\text{where } \varepsilon_t = \begin{cases} \varepsilon_t = \bar{\varepsilon} & \_\ \widetilde{S}_t \\ \varepsilon_t = \widetilde{\varepsilon}_t, \text{ if } S_t < \widetilde{S}_t \end{cases}$$

where $\widetilde{S}_t$ is a "shadow" exchange rate, balancing the currency market providing that the Central bank doesn't intervene, $\widetilde{\varepsilon}_t$ is a rate of change of the "shadow" exchange rate.

According to the first-generation models, the speculative attacks are successful, if the "shadow" exchange rate exceeds steadily the exchange rate, maintained by the authorities ($\widetilde{S}_t > \bar{S}_t$) (Krugman, 1979). Following the exhaustion of the international reserves, the "shadow" exchange rate becomes an official one.

The equation (3) implies that the condition of zero capital flows is given by:

$$1+R_t^* = \left[\frac{(1+R_t)\times(1-\phi_t)+l\phi_t}{1+\varepsilon_t}\right]^{1/\alpha},\ \alpha > 1, \tag{4}$$

where α – is a coefficient of personal investor's risk aversion.

I use power function in (4) in order to satisfy the basic assumption: risk-averse investor would prefer to invest in risk-free asset if it secures the same return as risky asset. The higher is parameter α, the more investor is risk-averse. If sovereign default probability (ϕ_t) is equal to zero, coefficient α is equal to 1 (risk-neutrality) and l is equal to 1, equation (4) transforms into equation of uncovered interest rate parity.

[4] The value of ϕ_t is determined by investors on the basis of debt to budget tax revenues ratio.

If α doesn't differ significantly from 1,[5] one could re-write equation (4) (using Taylor's series) in order to derive the condition of the currency market stability:

$$\bar{\varepsilon} = R_t \times (1-\phi_t) - \phi_t \times (1-l) - \alpha R_t^* \tag{4a}$$

The dynamics of the "shadow" exchange rate is determined by the direction and scale of the capital flows.

$$CF_t = \frac{g_1}{\alpha} \times [R_t \times (1-\phi_t) - \phi_t \times (1-l) - \varepsilon_t - \alpha R_t^*],\ g_1 > 0^{6} \tag{5}$$

If the expected return on the second "country" government bonds (expression in the right-hand side of (4)) is smaller than the yield on the first "country" government bonds (expression in the left-hand side), a capital outflow from the second "country" ($CF_t < 0$) is registered. According to equation (5) a decrease in the gross return on the second "country" government bonds (R_t) raises the probability of the capital outflow. In turn, the persistent capital outflow generates the depreciation of the "shadow" exchange rate, thus, making the currency crisis more probable.

$$\dot{\bar{\varepsilon}}_t = -g_2 \times [\frac{g_1}{\alpha}(R_t \times (1-\phi_t) - \phi_t \times (1-l) - \varepsilon_t - \alpha R_t^*)] > 0\ ,\quad g_2 > 0^{7} \tag{6}$$

where g_2 is a measure of sensitivity of the rate of change in the "shadow" exchange rate to capital inflows (outflows). It is evident that the higher the level of GDP monetization the lower the sensitivity of the rate of currency depreciation to the capital flows.

The model also captures an idea that investors estimate probability of sovereign default by comparison of the debt-servicing payments with the budget revenues (government liquidity ratio). According to it investors trust the government and readily purchase the bonds, thus financing the principal repayments, until the debt-servicing payments - budget revenues ratio does reach some extreme value. An increase in the debt or reduction of nominal GDP raises the probability of sovereign default, expected by investors – other things held constant:

$$\phi_t = \frac{k \times \delta \times D_t}{\tau \times P_t \times Y_t} \tag{7}$$

where P_t is the price level, Y_t is the real output, D_t is the value of the debt outstanding, τ is the tax rate, δ is the share of debt, refinanced every moment ($0 \le \delta \le 1$, the smaller is the value of δ the higher is the duration of debt outstanding), $1/k$ is the critical value of debt-servicing payments –

[5] The major investors in emerging market assets are hedge funds, which use risky strategies to earn higher profits.

[6] The value of parameter g_1 is completely determined by investor's decisions. The monetary authorities can not influence on it explicitly.

[7] It's assumed that parameter g_2 is constant.

budget revenues ratio, specific for an individual country and estimated rationally by an investor. The values of τ and δ influence much the time of the debt default: weak tax administration and low duration hastens the budget crisis.

Thus, a supposed dependence of expected sovereign default probability on macroeconomic variables is based on Ponzi scheme. Using a liquidity constraint I've modified the basic idea of Sargent and Wallace (1981), that "the public demand for bonds constrains the government by setting an upper limit of the real stock of the government bonds relative to the size of the economy".

I assume that the government issues new bonds not only to pay off the old ones, but also to finance primary budget deficit ("strong" Ponzi scheme). According to the scheme the debt evolution is given by:

$$\frac{\dot{D}_t}{D_t} = c_t + R_t, \tag{8}$$

where c_t – is a fraction of the debt growth, determined by the volume of primary budget deficit (surplus).

An expected sovereign default dynamics is derived by log-linearizing and differentiating (7) with respect to time and plugging (8) into the obtained expression:

$$\dot{\phi}_t = (c_t + R_t - \pi_t - y_t) \times \phi_t, \tag{9}$$

where π_t is an inflation rate (actual is equal to expected), y_t is a rate of a real GDP growth.

As it was demonstrated in the numerous studies (Edwards, 1993, 2002; Sachs, Tornell and Velasco, 1996), a high correlation between an inflation rate and rate of currency depreciation is a common feature of a number of emerging markets, including Russia (it grew significantly in the periods of high inflation, due to the growth in economy's dollarization) and it being known that a rate of currency depreciation determines an inflation dynamics. Taking into account this fact we use an assumption of linear dependence of the second "country" inflation rate on the rate of currency depreciation:

$$\pi_t = \beta_1 + \beta_2 \varepsilon_t, \quad \beta_2 > 0 \ ^{8} \tag{10}$$

The real GDP growth was insensitive to the interest rate changes in a number of transition economies, including in Russia in the pre-crisis period (Smirnov, 1997). This was mainly caused by the incompleteness of the financial market and weak interest of the bankers in developing long-term lending. As a result the rate of the GDP growth is fixed and given by:

$$y_t = \bar{y} \tag{11}$$

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[8] β_2 is the pass-through coefficient. In the case of high inflation parameter β_1 is not statistically different from 0 and parameter β_2 is not statistically different from 1.

Taking into account the assumptions of the GDP growth and exchange rate dynamics, the equation (9) could be presented as follows:

$$\dot{\phi}_t = [c_t + R_t - \beta_1 - \beta_2 \varepsilon_t - \bar{y}] \times \phi_t \quad (9a)$$

The authorities of the second "country" could preserve the fiscal system solvent (the invariability of the debt-servicing payments – budget revenues ratio) by adjusting an interest rate, budget deficit and exchange rate policy in response to the shifts of the structural parameters (β_1, β_2) and the rate of the GDP growth in order to satisfy:

$$c_t + R_t - \beta_1 - \beta_2 \varepsilon_t - \bar{y} = 0 \quad (12)$$

Combining (4a) and (12) one could obtain the condition of the stability both of the budget system and the currency market in the long run:

$$[R_t \times (1 - \bar{\phi}) - \bar{\phi} \times (1 - l) - \frac{c_t + R_t - \beta_1 - y_1}{\beta_2} - \alpha R_t^*] = 0, \quad (13)$$

where $\bar{\phi}$ is a target value of the debt-servicing payments – budget revenues ratio, maintained by the government of the second "country".

According to (13) the authorities, determining the rate of currency depreciation, must take into consideration the size of the budget deficit and the characteristics of the interest rate policy. The rate of currency depreciation must be higher in the countries with the persistent budget deficit and the restrictive monetary policy. In the opposite case, the growth in the debt-servicing payments would eventually induce the sovereign default. Thus, if the rate of currency depreciation is in line with the inflation rate, thus ensuring the real exchange rate constant, it could be too low to stabilize the debt-servicing payments – budget revenues ratio.

The authorities of the second "country" if they will preserve the budget balanced (c_t=0) and the international reserves ($\dot{IR}_t = 0$) invariable must adjust the interest rate and exchange rate policy to external shocks, increasing the discount rate (R_t) and the rate of currency depreciation ($\bar{\varepsilon}$

α):

$$\begin{cases} R_t = \dfrac{\bar{\phi} \times (1 - l) + \alpha \times \beta_2 \times R_t^* - \beta_1 - \bar{y}}{1 - \beta_2 \times (1 - \bar{\phi})}, \\ \dfrac{\partial R_t}{\partial \alpha} > 0, \dfrac{\partial R_t}{\partial R_t^*} > 0 \end{cases} \quad (14)$$

The change in the investors' attitude may launch a program of self-destruction, when the protective hike in the interest rates to stop a capital outflow isn't accompanied by an adjustment of the rate of currency depreciation. The growth in the debt-servicing payments – budget revenues ratio, associated with this policy, results in the increase of the investors' skepticism about the government solvency, thus, making the investors reluctant to invest in the government bonds.

According to the model the genesis of the Russian currency crisis could be presented as follows. High return on government debt obligations, associated with the government's need to finance large budget deficit and restrictive monetary policy, generated massive capital inflow, on the one hand, and stimulated rapid debt accumulation, on the other hand. Capital inflow caused ruble overvaluation relative to the level compatible with the one providing long-term solvency of the government. Due to large dependence of inflation rate on the rate of currency depreciation, the drop in the latter generated the growth in debt to tax revenues ratio. When investors estimated the Russian government debt as too high to service (this corresponded to an increase in the expected rate of default probability), they began to withdraw funds since the expected return on investment in Russian government debt obligations became less than return on bonds of the developed countries. The growth of the investors' skepticism about the emerging markets associated with the East Asian crisis added much to the process. As a result of massive capital outflow the rate of currency depreciation jumped up and the government was compelled to freeze debt-servicing payments.

The model is considered adequate if by plugging in it the actual values of the exogenous variables and initial values of the endogenous variables one could reproduce the motion of the latter. In order to test the adequacy of the model I simulate it by Power Sim program (v3.2). I plug in the model the actual pre-crisis period (January 1996 – August 1998) data on the return on the GKOs and other macroeconomic variables. The parameters of the model in the equations (4a) and (9a) were preliminary estimated by OLS, using an assumption that the "shadow" exchange rate was equal to the official ruble-dollar exchange rate. The results were as follows:

Table 1

Parameters	**Estimations (standard deviation)**
β_1	0,067** (0,036)
β_2	0,61* (0,277)
y	-0,002 [9]
h	0.102** (0.049)

[9] The value of y_1 is equal to a mean rate of the GDP growth in 1996-1998 in Russia.

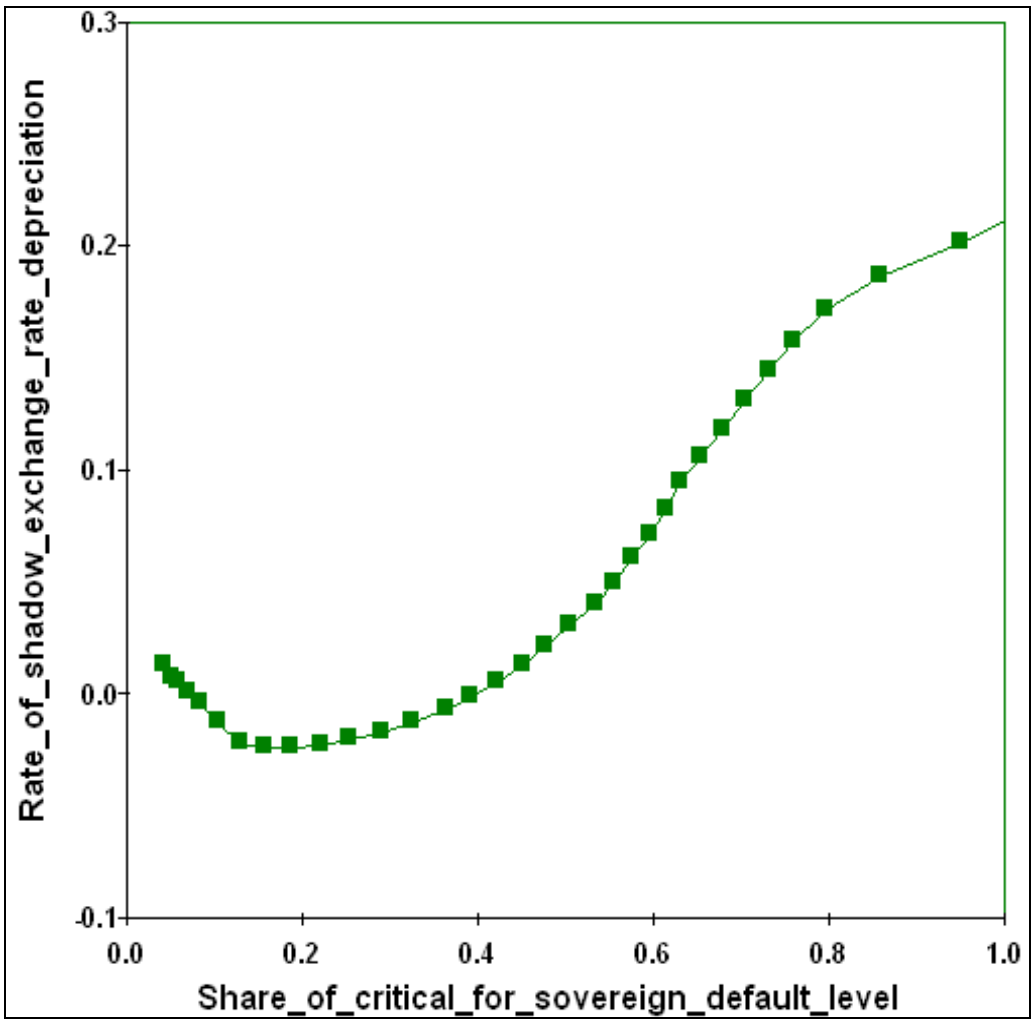

Figure 2a. Evolution of the shadow rate of currency depreciation and debt-servicing payments – budget revenues ratio under condition of exogenous variables equality to the actual pre-crisis data

($\phi_0 = 0.046$;[10] $\varepsilon_0 = 0.014$; R_t = monthly return on 90-days GKO; R_t^* = monthly return on 90-days US T-bills; c_t = budget deficit – domestic-currency debt outstanding ratio by the end of month. T=1 (January 1996); T=32 (August 1998)).

[10] The value of ϕ_0 is calculated by equation (7). The mean duration of debt equaled 0.25 and the mean monthly tax revenues totaled 13.5% of GDP in 1996-1998. The parameter k stood at 0.45 (the Russian government refused from servicing the debt, when the debt-servicing payments – budget revenues ratio reached 2.2). We also use the assumptions that the government is ready to pay 80% of the debt after its restructuring (l = 0.8) and the mean coefficient of risk aversion (α) equals 1.1.

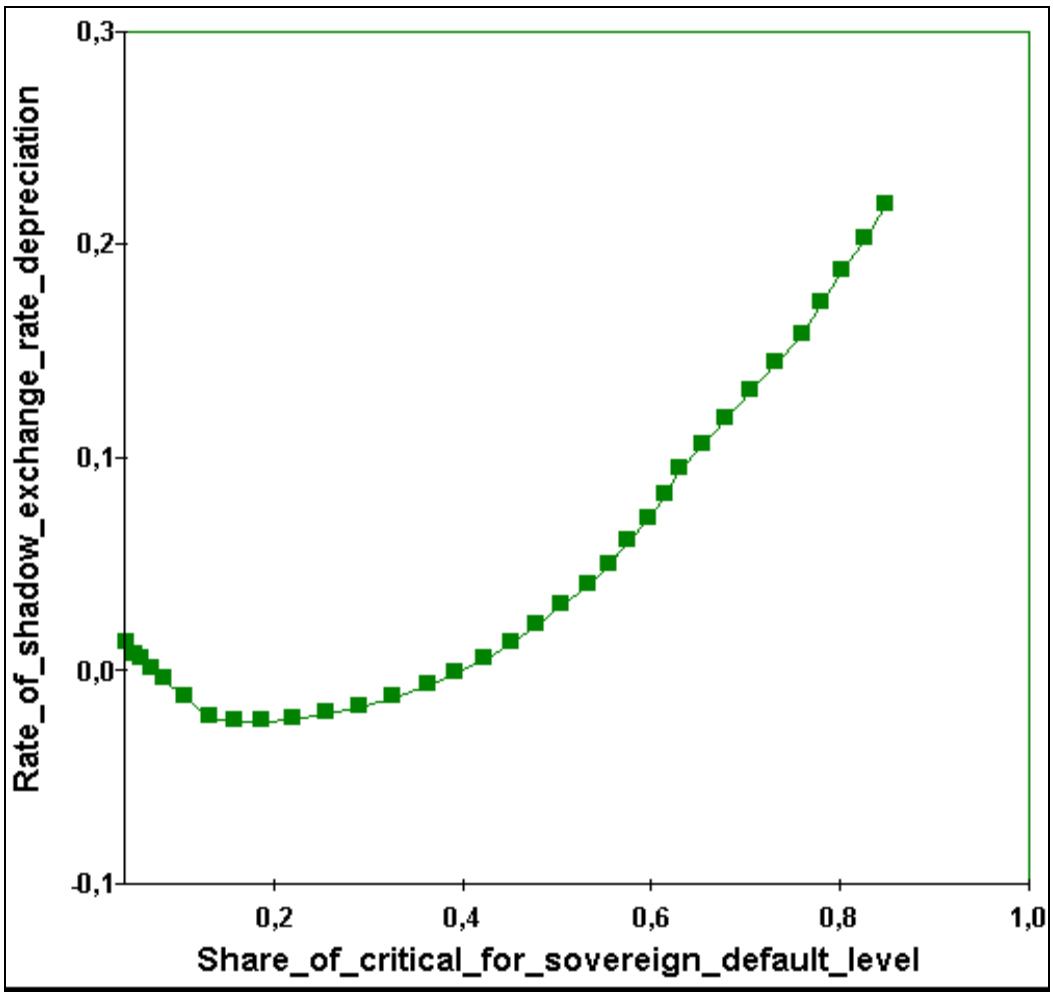

Figure 2b. Evolution of the shadow rate of currency depreciation and debt-servicing payments – budget revenues ratio under condition of loose monetary policy in November 1997 – August 1998.

(ϕ_0 = 0.046; ε_0 = 0.014; R_t = monthly return on 90-days GKO until November 1997, since then R_t = 0.01; $\overline{R}$ [illegible] R_t^* = monthly return on 90-days US T-bills; c_t = budget deficit – domestic-currency debt outstanding ratio by the end of month. T=1 (January 1996); T=32 (August 1998)).

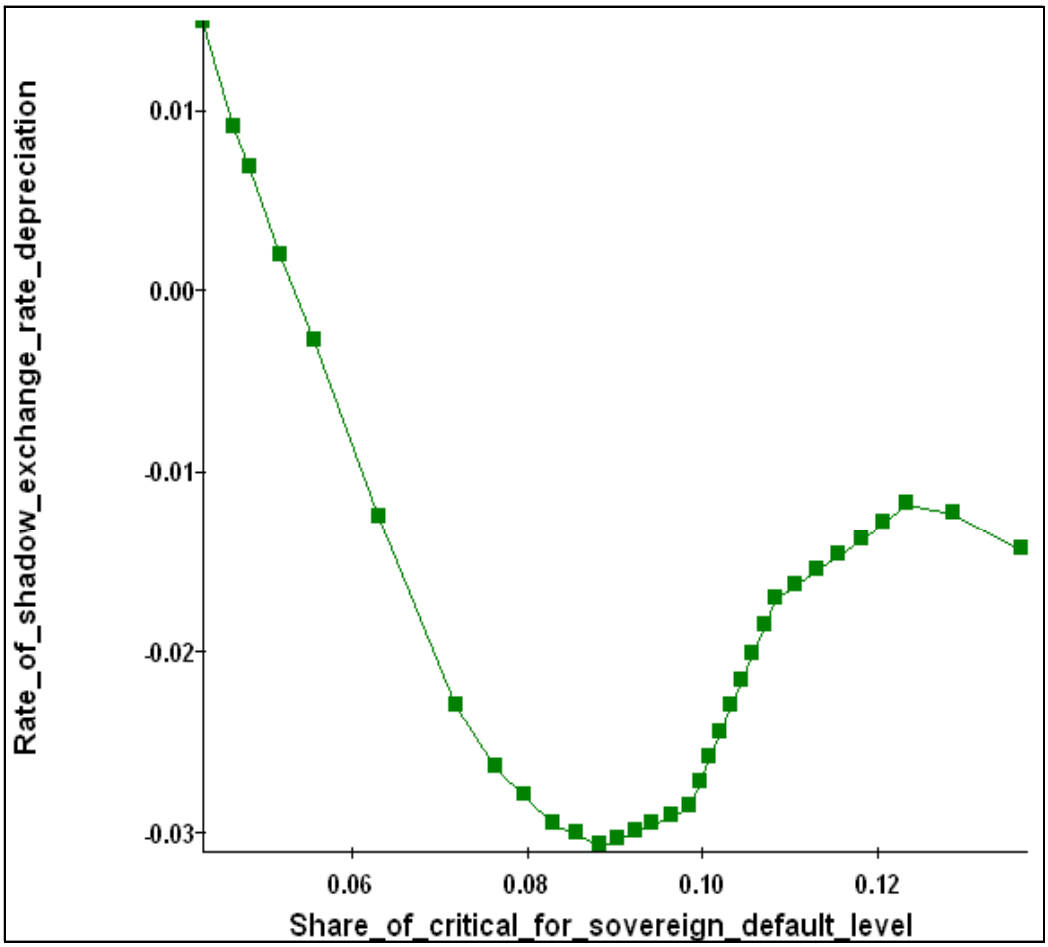

Figure 2c. Evolution of the shadow rate of currency depreciation and debt-servicing payments – budget revenues ratio under condition of zero budget deficit

($\phi_0 = 0.046$; $\varepsilon_0 = 0.014$; R_t = monthly return on 90-days GKO; R_t^* = monthly return on 90-days US T-bills; $c_t = 0$. T=1 (January 1996); T=32 (August 1998)).

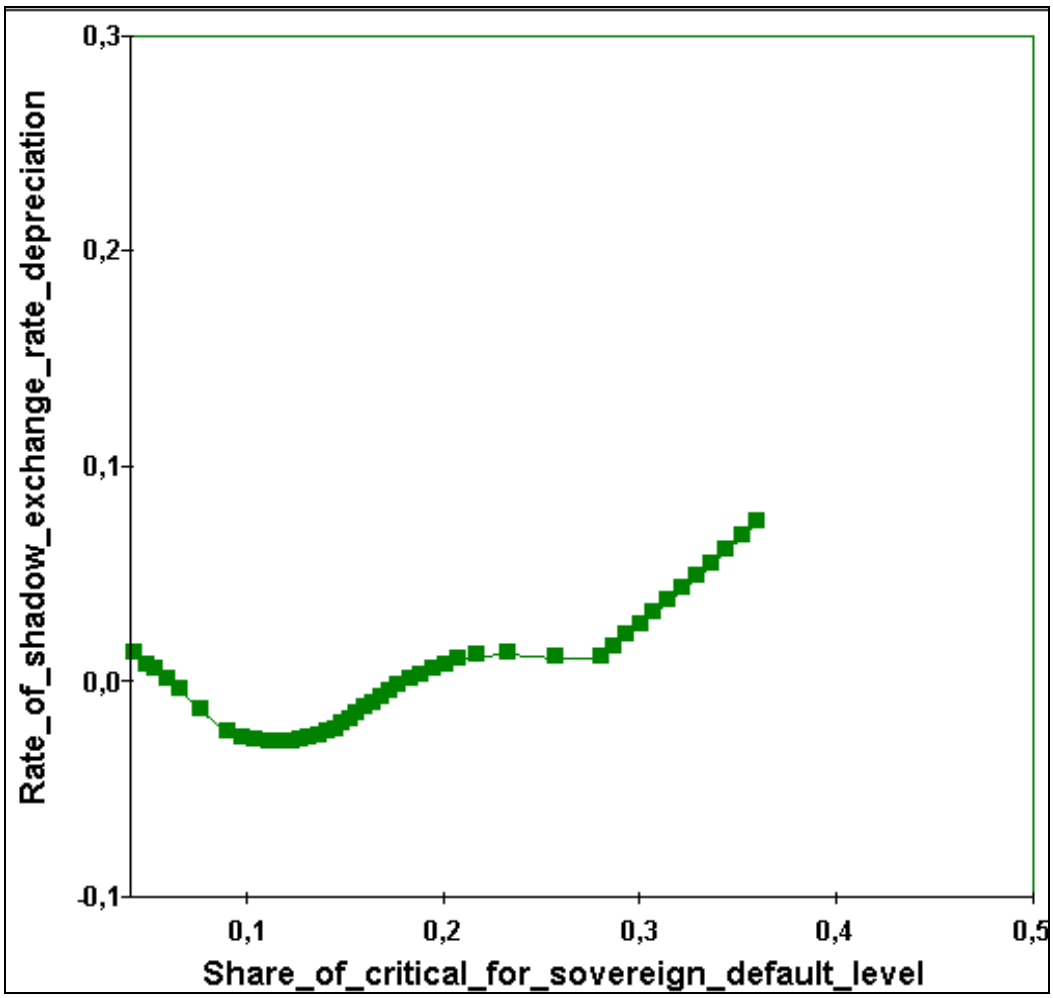

Figure 2d. Evolution of the shadow rate of currency depreciation and debt-servicing payments – budget revenues ratio under condition of the budget deficit stood at 3% of GDP.
($\phi_0 = 0.046$; $\varepsilon_0 = 0.014$; R_t = monthly return on 90-days GKO; R_t^* = monthly return on 90-days US T-bills; c_t = 3% of monthly GDP – domestic-currency debt outstanding ratio by the end of month.
T=1 (January 1996); T=32 (August 1998)).

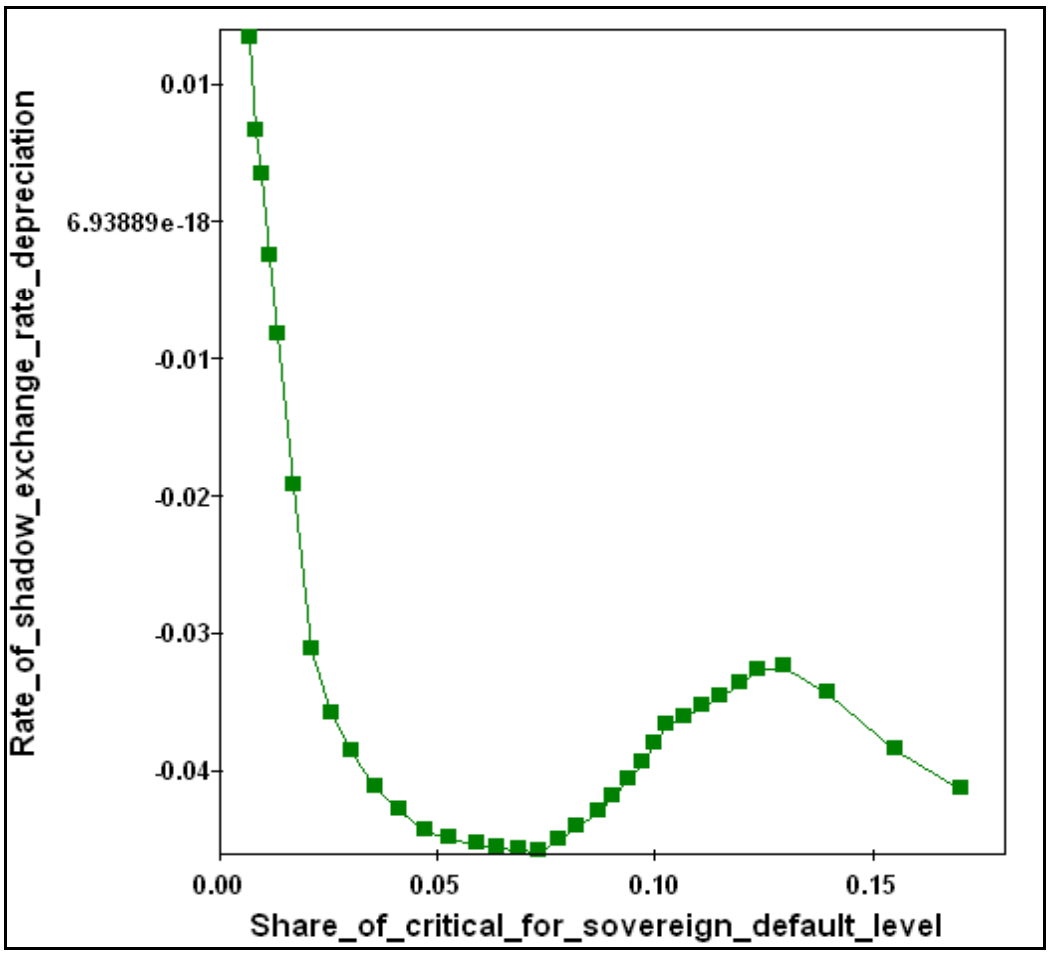

Figure 2e. Evolution of the shadow rate of currency depreciation and debt-servicing payments – budget revenues ratio under condition of doubling of the duration of domestic-currency debt obligations and tax revenues – GDP ratio.
($\phi_0 = 0.011$; $\varepsilon_0 = 0.014$; R_t = monthly return on 90-days GKO; R_t^* = monthly return on 90-days US T-bills; c_t = budget deficit – domestic-currency debt outstanding ratio by the end of month. T=1 (January 1996); T=32 (August 1998)).

The results of the simulation show, that the model adequately reproduces the peculiarities of the situation on the Russian financial market in the pre-crisis period: the change in the direction of the capital flows in the mid-summer of 1997 and the consecutive growth in the debt-servicing payments – budget revenues ratio (Fig. 2a). "Shadow" exchange rate, calculated on the basis of the results of the simulation, has exceeded the official exchange rate just on the eve of the crisis – in April, 1998 (Fig. 3), - when the investors really began to flee the Russian financial market and the speculative attack on ruble started.

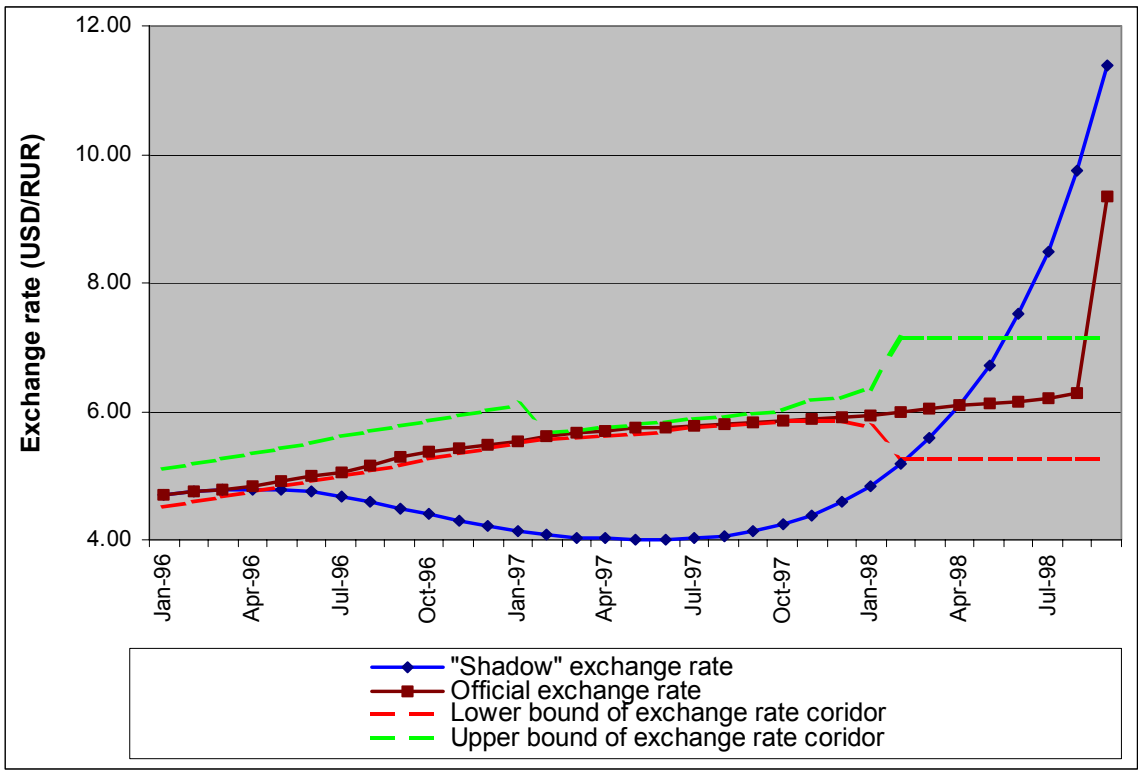

Figure 3. An official and "shadow" exchange rates.

Protective interest rate hike by the monetary authorities, inspired by the IMF, was counterproductive, since it generated the growth in the debt-servicing payments and GDP contraction, while influencing the attractiveness of the debt obligations poorly. But loose monetary policy couldn't change the situation radically. Montes and Popov (1999) argued that by lowering an interest rate and by devaluing ruble subtly (10-15%) on the eve of the crisis monetary authorities could prevent debt default crisis by inflating the debt. My results corroborate their idea partly. Moderate drop in monetary policy on the eve of the crisis could lead to acceleration of the ruble depreciation, influencing subtly on the state of budget (Fig. 2b illustrates this situation). At that time the authorities could avoid default only at the price of exchange rate collapse and hyperinflation, whereas in the fall of 1997 (after the start of the EA-5 crisis) these measures could be quite effective.

The collapse of the financial system could be prevented by the balanced fiscal policy. If the primary budget deficit stood at zero in 1996-1998, the debt-servicing payments – budget revenues ratio would not exceed 15% of the critical value and the rate of the "shadow" exchange rate depreciation would be below zero in August, 1998 (Fig. 2c). It stands to reason that if the Russian authorities applied the budget restriction of 3% of GDP, used in EC countries, they could only postpone the crisis (Fig. 2d). The collapse of the fixed band exchange rate policy would happen in

4Q1998. It's evident that the budget restriction good for the developed countries is not always suitable for the emerging markets.

According to the model the Russian currency crisis was generated to a considerable extent by the low level of GDP monetization, high sensitivity of inflation rate to the rate of currency depreciation, the prevalence of the short-term obligations in the debt structure and the weak tax administration. The first two ones were in charge of the high sensitivity of the budget to the changes in the investors' behavior and the last two ones were responsible for the high debt-servicing payments despite the domestic-currency debt was moderate in the view of the international standards. If the tax revenues and debt duration were twice higher their actual rates, the debt-servicing payments – budget revenues ratio would not exceed 18% of the critical value in August, 1998 (Fig. 4e).

V. Conclusions

This paper provides a theoretical framework, which suggests an explanation of the role of fiscal and monetary factors in the generation of Russian currency crises, which was combined with the sovereign default crisis. It was shown that mistakes of Russian government and monetary authorities were at the root of the crisis. A combination of high interest rates with persistent budget deficit, high inflation rate sensitivity to the rate of currency depreciation, low duration of debt and low GDP monetization generated exchange rate appreciation and rapid domestic-currency debt accumulation. When investors estimated the Russian government debt as too high to service, they began to withdraw funds.

The budget deficit was too high to sustain. But its reduction to the 3% of GDP level couldn't make the financial system sounder. The budget constraints, well suited for the developed economies, could be too loose for the emerging markets.

The decision of the Bank of Russia to protect ruble by an interest rate hike in the mid-summer of 1998 was counterproductive because it only accelerated the debt default coming through the debt to tax revenues ratio growth. It also made financial market more vulnerable to capital outflow due to GDP contraction and deterioration of the banks' liquidity. However, loose monetary policy couldn't be regarded as remedy as well. Debt default crisis could be prevented in Russia in 1998 only at the price of exchange rate collapse and hyperinflation.

The results of monetary policy are determined in great extent by the state of debt. The possibility that hike in the discount rate could prevent currency crisis without destruction of the fiscal system is higher if the domestic-currency debt is small and is characterized by the prevalence of the

long-term obligations. In the opposite case restrictive monetary policy undermines confidence of investors in the ability of government to operate debt outstanding, thus, provoking capital outflow.

The results of the study are rather close to the ones of Flood and Jeanne (2000), who found, that increasing the domestic-currency interest rate prior to a speculative attack, with no other policy adjustments, was never an effective exchange-rate defense. It stands to reason that by introducing risk factor in the uncovered interest rate parity equation they reproduce the situation, which is close to the actual one in the emerging markets, but not in the developed countries.

The impact of restrictive monetary policy on behavior of investors also depends much on the sensitivity of output growth rate to the interest rate volatility, monetization of GDP and a share of imported goods and services in consumption. If output level is highly sensitive to interest rate changes, restrictive monetary policy causes GDP contraction, thus, making internal debt operation more complicated. Low GDP monetization and high inflation rate sensitivity to the rate of currency depreciation cause disinflationary effect of capital inflow and, thus, growth in the real debt.

This work could be used as a basic for the future research. First, the model could be modified to study the Argentine financial meltdown. Second, a coordination problem between interest rate policy and operation of international reserves deserves special attention. Third, the model could be extended by an introduction of net export effects.

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