

The Russian Financial Crisis : An Empirical Analysis

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The purpose of this paper is to investigate empirically the relevant contribution of deferent domestic and external factors suggested to cause the Russian financial crisis in 1998. The results imply that the highest share in the increased crisis probability is to be attributed to the indicators associated with the financial sector weakness. The other powerful crisis predictors were the external capital flows and measures of international liquidity. The government finance problems and exchange rate misalignments contributed to the episode of the sharp devaluation to a lesser extent than banking sector fragility and external capital movements.

JEL classification: C3

Key words: Russia, financial crisis, exchange market pressure, probit

1. Introduction

Currency crises are not recent features; they have a long history, almost as long as the history of currencies themselves. Economists consider financial turmoil to be an essential economic phenomenon that happens with an average frequency of at least one per decade. Yet, the 1990s has set up a new record, having witnessed the whole series of crises: in 1992-93 currency crises occurred in the exchange rate mechanism (ERM) of the European Monetary System, in 1994-95 Latin America's so-called "tequila crisis" erupted, these were followed by East Asian countries' exchange rate and banking crises in 1997-98 and accompanied with crises in East European transition economies (1996-1997), in Russia (1998), in several republics of the former Soviet Union, after which the financial woes revisited Latin America in the new century ...

The Russian financial crisis in August 1998 took many observers completely by surprise. By the middle of 1997 Russia succeeded in fighting its stubborn inflation, in maintaining the preannounced exchange rate; the output was slowly recovering, GDP growth turned to positive values and the perspectives for the next year looked very promising. But in the year 1998 Russia underwent one of the most spectacular crises among the preceding national currency collapses in different parts of the world. On August 17 the government was forced to devalue the rouble, declare default on its internal debt and a moratorium on debt payments to foreign creditors.

The severity of the collapse and the great impact it had on the financial markets of emerging economies worldwide prompted the domestic and foreign researchers to inquire into the causes and mechanisms of the Russian malady. Yet, there is no unanimity in the existing explanations of the Russian crisis case; they vary considerably in regard to what was the nature of the crisis and which of the three dimensions – currency, debt or banking – was the basic one. There is even less consensus as to whether the origin of the crisis was primarily domestic or external. It may be the case that no single reason is responsible for the dramatic events in Russia. Still, it would be worthwhile then to compare the contributions of the different economic variables to the incidence of the crisis.

The goal of this study is to conduct an empirical analysis of the Russian crisis along the lines of those undertaken to explain the European, Latin American and Asian crises experiences. The empirical analysis of the factors which are suspected to be responsible for the crisis eruption can shed a light on the causes of the crisis by allowing to evaluate them simultaneously. The conventional theories of financial crises and the developed explanations of the particular Russian experience will be helpful in identifying the set of variables to test.

The remainder of the paper is organized as follows. Section 2 reviews the theories of financial crises with their empirical implications. Section 3 summarizes the existing explanations of the August financial crash. Section 4 presents the methodology of the empirical analysis and implements a test to the Russian case. Section 5 concludes.

2. Crises: types, theories and empirical implications

The theoretical literature distinguishes between three broad types of financial crises: currency, debt and banking ones.¹ A *currency crisis* occurs when, as a result of a speculative attack on the currency, the monetary authorities are forced to devalue or depreciate the exchange rate substantially, or to defend the currency by expending large volumes of international reserves or by hiking interest rates. A *debt crisis* (applied to sovereign or private debt) reflects an unexpected breakdown in the credit relationship: the borrower's inability or unwillingness to serve repayment obligations or the lenders' loss of confidence on the borrower's ability to pay. The term includes cases of unilateral default, a debt restructuring, or exceptional bail out by the international financial organizations to avoid a default. Finally, a *banking crisis* is characterized by suspending the internal convertibility of banks' liabilities or preventive compelled government assistance on a large scale in the occurrence or in the prospect of bank runs or failures.

The three types of crises in the above classification are by no mean mutually exclusive. Financial liberalization played an important role of creating the environment where one type of crisis can easily develop into the others.² With significantly increased interaction between the domestic and international financial systems, recent financial turmoil tended to combine the features of currency, debt and banking crises simultaneously, which is also reflected in the theoretical literature that has developed from the models explaining solely speculative attacks and currency collapses to comprehensive theories of financial sector crisis.

Theoretical models intending to explain mechanisms of financial crises have organized them in three "generations", which blame respectively expansionary domestic macroeconomic policy, volatile international financial markets, and weak domestic financial structure for inducing a crisis.

In the *first generation* model a speculative attack is triggered by the deterioration of fundamentals – typically, balance-of-payments problems with gradual depletion of foreign exchange reserves.³ This canonical approach considers fundamental macroeconomic imbalances (such as expansionary monetary and fiscal policy inconsistent with the fixed exchange rate) to lie at the root of a crisis. The empirical implications of the original model and its modifications point out the following indicators of a looming crisis: persistent fiscal deficits, excessive credit growth, inflation rate or excess real money balances, increasingly appreciating real exchange rate, deterioration of the trade and current account, and gradual

¹ The definitions are taken from IMF (1998), and Hemming et al. (2003).

² Montes and Popov (2000) stress this point. See also Kaminsky and Reinhart (1999) for the discussion of "twin crises" (banking problems accompanied by balance-of-payments crises).

³ Krugman (1979), Krugman (1997).

decline in international reserves.⁴

The model fitted well those crises in Latin America (Mexico 1973-1982 and Argentina 1978-1981), where the extremely expansive fiscal policies and large debt burden led to the breakdown of the fixed-rates regimes. However, it failed to explain speculative attacks in Europe in the 1990s, since they were not necessarily connected to worsening in fundamentals predicted by the first-generation models. The theoretical ground for these episodes was developed as *second generation* models of currency crises that capture self-fulfilling features of speculative attacks.⁵

In these models the government faces a trade-off between maintaining the peg and pursuing other policy targets, and abandons the fixed parity when the costs of fending off speculative attacks on a currency exceed the benefits from the fixed exchange rate policy. A self-fulfilling element of a crisis implies that speculators attack a currency only when they expect the government to shift to more expansionary policy and to abandon the peg under the growing social costs of maintaining it. Therefore, the underlying sources of vulnerability to the second generation crises are the internal imbalances rather than external ones: rising unemployment, domestic recession, bank weakness or large government debt, which will make the defense of the peg by raising the interest rates unbearably costly and thus provide the temptation to devalue the currency when attacked.⁶

Hence, the likelihood of a self-fulfilling speculative attack is not completely uncorrelated with the fundamentals – only countries with some degree of weakness (though sustainable in the absence of an attack) in the economic fundamentals are vulnerable to speculative pressure of investors anticipating devaluation. In this sense, justifying a speculative attack in the second generation approach is quite similar to that of the first generation models. There are differences, however, between the empirical implications of the models: they suggest different sets of vulnerable indicators and the trend of the crisis probability, while increasing with the steady deterioration of underlying fundamentals in the canonical model, does not show this tendency in its self-fulfilling run.⁷

The second generation models succeeded in explaining European crises in 1992-93, when Britain, Italy and Spain were forced to leave ERM. However, the Asian crisis of 1997-98 appeared not to fit either of the aforementioned models. The economic weakness and vulnerability to crises lay in financial sphere with a bubble of assets prices and the financial intermediaries playing a crucial role in the Asian meltdown. This motivated the development

⁴ A good survey of the model extensions is provided by Agenor et al. (1992). See also Flood and Marion (1999) for the recent elaborations. Eichengreen et al. (1994, 1995), Kaminsky et al. (1998) and Aziz et al. (2000) focus on the empirical implications of the original “first-generation” model and its modifications.

⁵ Obstfeld (1986, 1994, and 1996)

⁶ See Obstfeld (1996), Krugman (1997), Eichengreen et al. (1994, 1995).

⁷ Goldfajn and Valdes (1998), Berg et al. (1999), IMF (2003).

of the *third generation*⁸ models to deal with financial sector crises rather than with speculative attacks or currency crises *per se*.

Most models emphasize the relevance of the moral hazard problem, when under the implicit government guarantee borrowers and lenders are more likely to downplay the risk that leads to over-borrowing and over-investment. This generates domestic asset price bubbles, the ultimate burst of which reveals the insolvency of the financial intermediaries and triggers capital flight with consequent collapse in the external value of the currency⁹.

Thus, the third generation models focus on the fragility in the banking and financial sectors, suggesting financial leverage (debt-to-equity ratios), liquidity (short-term debt over working capital), and non-performing loans to be main vulnerability areas. The models also emphasize the role of financial liberalization in magnifying the effect of adverse implication of moral hazard on macroeconomic stability, and stress the excessive buildup of external debt among crisis factors. External indicators of vulnerability include the structure and reversibility of capital flows (the ratio of foreign debt in total debt; the ratio of short-term debt in total foreign debt); and external liquidity (the ratios of short-term external debt to reserves, of broad money to reserves, of reserves to imports). The key difference from the first generation in identifying the timing of attack is that speculators watch not the steady decline of reserves *per se*, but the steady rise of the liabilities over the time, with its critical level given by the level of international reserves.

There is a common feature for all the major financial crises of the 1990s that needs to be mentioned here — the phenomenon of “*contagion*”, spreading of a crisis from one country to others, with the “tequila effect”, the “Asian flu” being the well-known examples. Possible channels of regional contagion include trade linkages and financial linkages between the country already in crisis and the next victim of speculative attacks. The global character of contagion can be explained by financial panic or herd behavior (see Berg et al. (1999), Caves et al. (2002)), or the “wake-up call” hypothesis, suggesting that a crisis anywhere in the world makes market participants reevaluate their perceptions about the countries that are seen to have common weakness.

Which of the aforementioned mechanisms best describes the Russian crisis? The next section reviews the existing explanations of the cause and the nature of the financial woes in August 1998.

⁸ It is not a widely agreed view as to what constitutes the “third generation”. Presented here is the main strand of the theoretical literature that attempts to explain the Asian and other recent crises by emphasizing the structural flaws vs. multiple equilibria and policy inconsistency of the earlier models.

⁹ Krugman (1998), Corsetti et al. (1998 and 1999)

3. The Russian financial crisis: existing explanations

By 1997, the macroeconomic stabilization program seemed to succeed in attaining the goal of single-digit inflation and reviving the economy - GDP growth turned positive for the first time since the beginning of transition. The achievements of the stabilization program had generated immense interest on the foreign investors' side: the Russian stock market, fuelled by the inflows of foreign capital, grew in the year 1997 alone by three times in dollar terms and became the world's best performing stock market for that year.

Only half a year later, in August 1998, Russia experienced an overall financial collapse, involving its exchange rate, the public debt and the banking system. In a matter of days the rouble that had remained relatively stable during the preceding 3 years lost more than half of its value, within three months after the crisis the consumer prices shot up by 50% and GDP shrank by about 6% in spite of all optimistic expectations of the year before. In total some \$30 billion of foreign exchange (about one-six of GDP) vanished in defending the fixed exchange rate before the rouble was floated on September 1998; several interest rate hikes and ensuing problems in rolling-over short term debt ruined the banking system¹⁰.

On August 17, the government announced emergency measures including the devaluation of the rouble, a unilateral restructuring of its rouble-denominated public debt, and a 90-day moratorium on the repayment of external debt incurred by commercial entities. To recapitulate, the Russian financial crisis was characterized by:

- 1) a currency collapse (sharp depreciation by 300% from the pre-crisis rate of 6.2 roubles per dollar to over 20 roubles per dollar in September);
- 2) a sovereign debt default (first, only on rouble-denominated short-term treasury bills maturing up to the end of 1999, but later also on Soviet era external debt);
- 3) a crash of the banking sector (with great amount of domestic debt instruments in their portfolios and substantial off-balance-sheet hedging operations of foreign investors, the banks were very vulnerable to a devaluation and to several interest rate hikes).

Thus, the Russian financial turmoil incorporated three dimensions in its manifestation – the currency, sovereign debt and banking crises. This explains the absence of unanimity of views on the driving forces and the primary cause of the dramatic event. The existing explanations either focus on one of its aforementioned dimensions considering the exchange rate, debt or bank problems to be at the root of the meltdown, or suspect a combination of several reasons (including a contagion effect from the Asian crisis) to provoke the collapse. The representative examples of each of these views are summarized below with an accent on

¹⁰ Thorough descriptions of the crisis developments include Buchs (1999), Chiodo and Owyang (2002), Desai (2000), Kharas et al. (2001). Although a detailed discussion of the pre-crisis economic situation and unfolding of the collapse lies beyond the scope of this paper, a brief chronology of the events preceding the demise of the Russian economy is presented in Appendix 1.

the factors considered to be the main areas of the country's vulnerability to the crisis.¹¹

3.1 Currency crisis

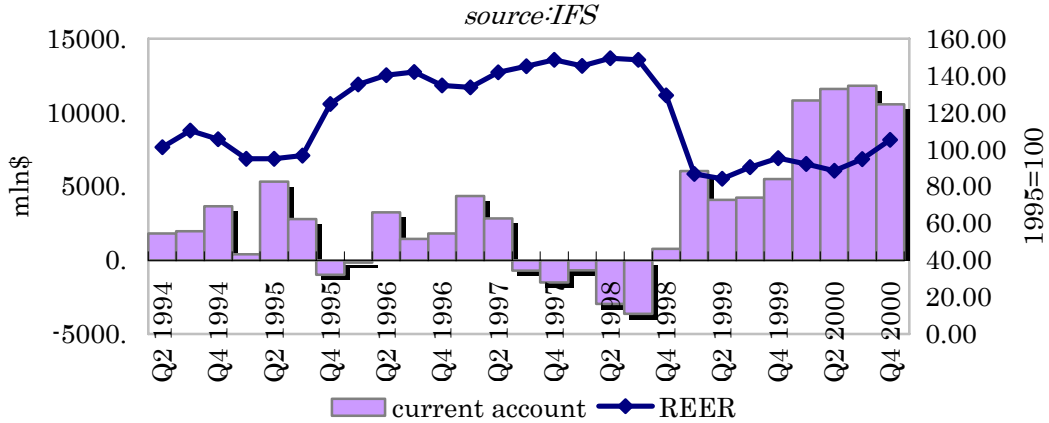
The proponents of purely currency nature of the crisis¹² assure that its root lay in the real appreciation of the rouble, which is traced to the exchange-rate-based price stabilization that was implemented in 1995 and used pegged exchange rate as a “nominal anchor” to fight inflation. The overvaluation of the rouble is accused in undermining the export competitiveness with subsequent declining of the trade surplus. Together with the injury from falling oil prices in the world market, the switch of the current account balance from positive to negative in the first half of 1998 is seen as a major symptom of a pure balance of payments crisis. Thus, the August collapse is described in the context of the first generation models where the unsustainable exchange rate led to a balance of payments crisis, and accumulation of the excessive government debt as a consequence of the budget deficit or the Asian contagion alone are not seen to be sufficient for inducing the crisis. Furthermore, from this point of view, the default on the government debt was by no means necessary, the debt crisis and the run on the banks were provoked by the ill-suited actions of the government and the Central Bank of Russia.

Indeed, the recent exchange-rate stabilizations where disinflation strategy included preannounced limits on nominal exchange rate movements were marked with a tendency for the real appreciation of the domestic currencies during the first three years of the program (Mussa et al. (2000)); this caused a loss of competitiveness and a worsening of current account balances in many transition economies (see McGettigan (2000)). Russia was not an exception to this rule in that the real rate of the rouble had appreciated almost twice by 1998 as compared to its level in 1995, although the current account balance was still positive up to 1997, when the slowdown in the export growth with still rising imports, wiped out the trade surplus and generated the current account deficit. Figure 1 illustrates this facts showing that the balance of the current account is negatively correlated with the movements in the real rate of the rouble.

¹¹ Note that the explanations of the Russian crisis presented below are classified not by the aforementioned three generations of theoretical models, but rather by the crisis nature – exchange rate misalignments, government debt problems or banking sector fragility.

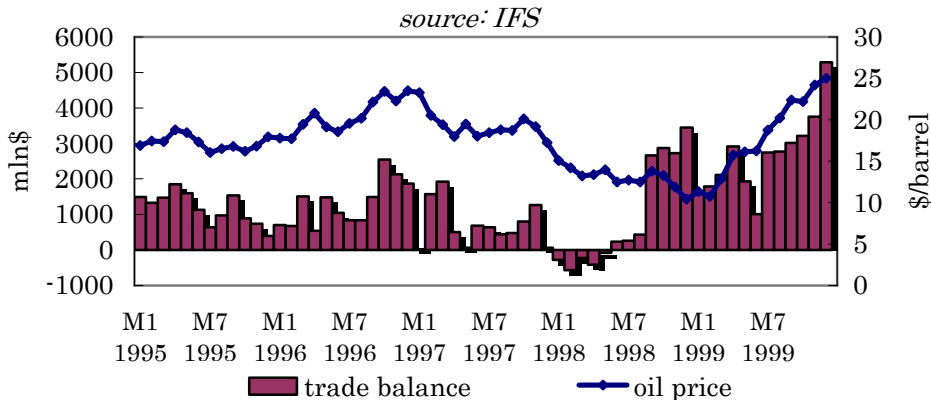
¹² See, for example, Montes and Popov (1999), Popov (2000); Illarionov (1999 and 2000).

Figure 1. Real effective exchange rate and current account



The data also provides support to the crucial role of the falling oil prices in the worsening of the trade balance. Figure 2 shows that the trade balance turned negative in the beginning of 1998 as oil prices fell to 12 \$ from some 24 \$ per barrel in 1997.

Figure 2. Oil prices and the trade balance



3.2 Sovereign debt and budget crisis

Institute of the Economic Problems of the Transitional Period (IEPTP) denies the contention that Russia’s central problem lay in the exchange rate misalignment, arguing by contrast that “the principal cause of Russia’s great vulnerability as the world financial crisis developed was the imbalance in state finance”, and “inability of the authorities to reduce spending to the necessary extent and thereby to eliminate the budget deficit” (IEPTP (1999)). While the overall debt burden (about 50% of GDP) was relatively low, the short-term nature of the sovereign debt with its large proportion belonging to nonresidents and rising monthly debt servicing payments are regarded to be the crucial features (IET (1999)).

The IMF staff’s explanations of the Russian financial crash are also based mostly on the stressing the crucial role of the government deficit and debt problems. In their opinion, the

crisis stemmed from the government's inability to get the fiscal problems under control and reliance on short-term financing of public debt (McGettigan (2000), Hemming et al. (2003), Mussa et al. (2000)). Although the internal factors are suggested to be mainly responsible for the Russian meltdown, external factors are proved to play an important role in the burst of the crisis: in October 1997, fallout from the Asian turmoil manifested the reduction in foreign investors confidence, and decline in commodity (especially oil and gas) prices, arose partly from the Asian crisis, further eroded the Russian balance of payments.

Table 1 confirms the dangerous bias to the short-term government securities (government short-term obligations GKO and coupon-bearing bonds OFZ) in financing the federal budget deficit: in 1995-1997 up to 70% of the deficit was covered with these debt instruments which constituted the half of the overall domestic debt; the debt servicing expenses amounted to 5 % of GDP by 1997 (Гранвилл (1999), 塩原(2004)). Besides, by the end of 1997 an estimated 33 % of the total stock of the GKO and OFZ were held by nonresidents attracted by the high yields of the Russian government securities (EBRD (1998)), which made the credit market very sensitive to the foreign investors' expectations.

Table 1. GKO-OFZ and financing the federal budget deficit (as % of GDP)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998.1.6 |
|--|------|------|-------|-------|-------|----------|
| Federal budget deficit | 15.6 | 10.6 | 5.3 | 7.9 | 6.5 | 4.8 |
| Financing with GKO-OFZ | 0.1 | 1.0 | 3.1 | 5.7 | 4.6 | |
| The % share of the deficit financed with GKO-OFZ | 0.64 | 9.43 | 58.49 | 72.15 | 70.77 | 15.3 |
| Outstanding GKO-OFZ | 0.1 | 1.7 | 4.1 | 9.3 | 14.4 | |
| Domestic debt | 26.2 | 18.9 | 14.8 | 20.4 | 28.4 | |
| Debt servicing | 1.8 | 1.8 | 3.0 | 5.5 | 4.8 | 5.2 |

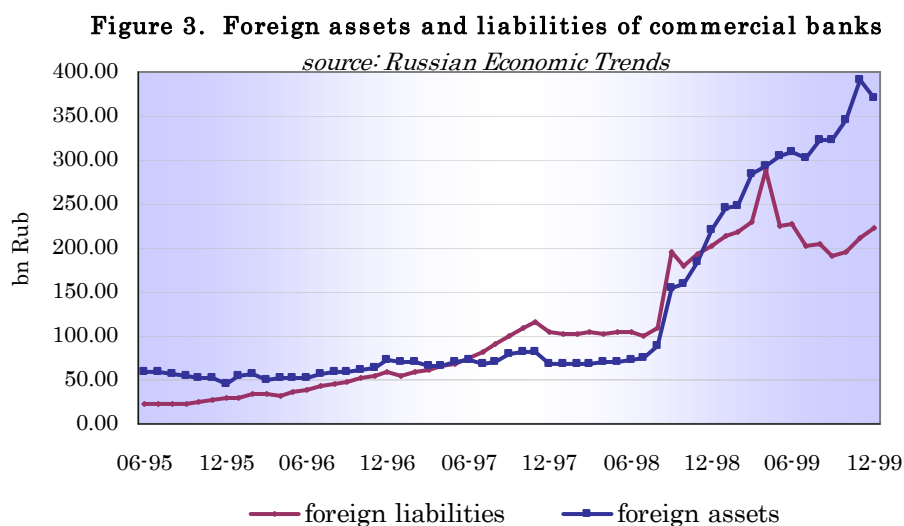
source: Гранвилл (1999), 塩原(2004)

3.3 Banking crisis

A study on the causes of the banking crisis, provided by RECEP (Russian European Center for Economic Reform) (1998), identifies the causes of the banking sector problems in the moral hazard line, consistent with the emphases of the third generation models. The main factors of the Russian banking sector fragility are specified as large amount of non-performing enterprise loans, increasing mismatch of foreign currency assets and liabilities, significant amount of unhedged off-balance sheet forward contracts, and substantial ratio of government bonds in banks' assets. Under these conditions, the freezing of the sovereign debt and the fall in the equity markets on August 1998 resulted in a sharp depreciation of banks' assets and consequent liquidity problem with a series of closures in the following months.

Indeed, there is statistical evidence of increased exposure of the commercial banks to the

foreign debt: the share of foreign liabilities in the assets jumped from 7 % in 1994 to 17 % in 1997, so from the beginning of 1998 about 30% of all foreign liabilities of commercial banks were not covered with assets as data from Russian Economic Trends database suggest (see Figure 3).



3.4 Double/triple crisis and contagion

Since the crisis in its manifestation pertained to several financial spheres, the abundance of composite explanations that stress several reasons to cause it is not surprising.¹³ For example, Desai (2000) asserts that “the Russian malaise combined elements of the first- and third-generation currency-crisis models: Russian policymakers’ attempts to maintain a stable rouble in the midst of a government-borrowing-financed budget deficit were overwhelmed by plummeting values of government GKO’s as external shocks hit Russia’s balance of payments”. From his point of view, the collapse of the rouble resulted from the interaction of exogenous factors and inherited weakness of fundamentals that made Russian economy vulnerable to large external shocks (the Asian crisis and the decline in price of main Russian export commodities).

Another example of the composite explanations of the crisis is Kharas et al. (2001). This detailed study refutes the view that the collapse is best explained by an inconsistency between the fiscal imbalances and the fixed exchange rate band along the lines of the first generation models. The crisis is said to be attributed to three factors: fiscal deficits, an unfavorable maturity structure of public debt, and contagion effect from the Asian crisis combined with a decline in oil and gas prices.

In the attempt to formalize the transmission mechanism of external shocks into the currency collapse in Russia, Kirsanova and Vines (2002) develop a model of the government

¹³ Among the studies of this line not presented here are EBRD (1998), Fries et al. (1999), Pinto et al. (2004), 上川・新岡・増田 (2000), 塩原(2004).

choice in the second-generation type, with the sudden capital outflow due to unanticipated shock to the world oil prices and the public knowledge of the government's trade-off between maintaining the peg and bearing the increasing cost of debt servicing, shift in expectations results in self-fulfilling crisis. According to this logic, the Russian crisis was not a consequence of the domestic debt growing out of control (the ratio of the domestic debt to GDP was relatively low), instead it was a logical outcome of the policy trade-off under the exogenous shock.

Chiodo and Owyang (2002) argue that “an understanding of all three generations of models is necessary to evaluate the Russian devaluation”: the first-generation models explain the factors that made Russia vulnerable to the crisis (high government debt and increasing fiscal deficit); the second-generation models show that expectations of Russia's impending devaluation (with investors' sensitivity raised after the Asian crisis and political perturbations fueling the fears) had a role in triggering the crisis; the third-generation models address the financial sector fragility as an essential component of the Russian crisis.

Buchs (1999) is an example of explaining the Russian crisis through emphasizing the crucial role of spillover effect from Asia. The main conclusion is that “the Russian financial disaster is a typical example of crisis contagion”, “without the Asian crisis, there was no obvious reason investors should have left Russia in great haste at that particular time”. But the study acknowledges that although the timing and the speed of the Russian crisis was definitely linked to the Asian events, the underlying vulnerability of the fiscal situation and of the banking system was a serious problem which no investor could ignore.

The above interpretations of the Russian crisis reveal a set of factors suspected in the rouble crash, but show no unanimity about the relative importance of these factors in the onset of the crisis. Each explanation has some evidence in support when the pre-crisis behaviour of the stressed economic indicator is considered. The nature of the crisis seems to be ambiguous due to its complex manifestation on August 17, and fitting one of the theoretical models remains questionable.

Looking at individual indicators of the Russian crisis does not clear its primary reason – all of the aforementioned factors seem to be relevant: the real appreciation under the nominal peg “corridor” system and worsening of the trade balance, the federal budget imbalances and growing government debt, weakness of the banking sector and increasing share of foreign liabilities, the fall in the world energy prices and contagion effect from the Asian financial markets. For an unbiased analysis the methodology that allows for evaluating numerous factors simultaneously is needed. An empirical test, based on the statistical evidence, along the lines of those undertaken to explain the European, Latin American and Asian crises can be helpful in assessing the role of each factor of the crisis while controlling for the effects of the other factors simultaneously.

4. Empirical test

The series of international financial crises in 1990s stimulated great academic interest in not only theoretical models to formalize the stylized facts and mechanisms of the phenomenon, but also in empirical studies to prove or reject the theories and to find out common elements that might help in constructing of an “early warning system” for future distresses. While numerous studies were devoted to Latin American financial crashes, European exchange rate problems and to the Asian crisis, the financial crises in transition economies and in Russia particularly (although being not less severe and destructive) are much less empirically studied.

The objective reason for such academic negligence so far was the lack of data on transition economies and noncomparability of the data before and after the fall of the Soviet Union. Now, when almost a decade has passed from the crisis eruption, the amount of data necessary to extract statistically significant results is available, but there is still no published empirical research that deals solely with the crisis episode in Russia on the basis of statistical tools. The Russian crisis appears in some works as a “ground zero” (the country from which contagion is spread) or as a part of a panel analysis with large number of countries included, but seldom as a subject of the detailed empirical test by itself¹⁴. However, an individual country crisis study is justified by the acknowledgement that potential determinants of crises differ across countries and the same macroeconomic factors may play different role in different crisis types, thus panel estimation on the large number of countries may be not as informative and country-by-country basis may be more appropriate¹⁵.

This study, employing econometric techniques, aims to establish the determinants of the Russian collapse and to assess the degree to which different factors contributed to the outbreak of the crisis. The next section applies an empirical test to the possible crisis variables identified by the literature reviewed above to shed an additional light on the causes and the nature of the Russian crisis.

4.1 Methodology

A currency crisis is defined as a significant depreciation/devaluation of the exchange rate,

¹⁴ Empirical studies that cover the Russian crisis to some extent are Brüggemann and Linne (1999), Bussiere and Mulder (1999), Caramazza et al. (2000), Cartapanis et al. (1999), Feridun (2004), Gelos and Sahay (2000), Goldfajn and Biag (2000), Yano (2002). The main findings are summarized in Appendix 2.

¹⁵ Jeanne (1997), Flood and Marion (1999) and Orii (2003a, b) indicate this fact. Empirical crisis studies on an individual country basis include Blanco and Garber (1986), Calvo and Mendoza (1996), Cerra and Saxena (2000 a, b), González-Hermosillo et al. (1997), Karfakis and Moschos (1999), Pazarbaşıoğlu and Ötker (1997).

or large fall in the international reserves and sharp increase of interest rates if authorities choose to defend the currency under a speculative attack. In other words, monetary authorities respond to an attack either by devaluing the currency or by preventing the depreciation with running down international reserves or raising interest rates. In line with this definition, one of the main approaches in empirical studies of the crises uses the exchange market pressure (EMP) index, combining the three possible outcomes of a speculative attack on a currency (change in the nominal exchange rate, the level of international reserves and interest rates) for identifying a speculative attack (and hence a possibility of a crisis)¹⁶. This index is calculated as a weighted average of the nominal exchange rate depreciation, (the negative of) changes in international reserves, and changes in short term interest rates:

$$\text{EMP}_t \equiv \alpha \Delta e_t - \beta \Delta r_t + \gamma \Delta i_t, \quad \text{where}$$

Δe_t : percentage rate of the nominal exchange rate depreciation,

Δr_t : percentage changes in liquid international reserves, which exclude gold,

Δi_t : changes in short term interest rates.

Movements in an unweighted index may be strongly driven by the component with the higher variance. In order to equalize the conditional volatilities of the components the weights attached to the changes in the exchange rate, interest rates and reserves (α , β , and γ) are the inverses of the standard deviation for each series. This weighting scheme gives a larger weight to the component with a smaller variance, thus preventing any one of the series from dominating the index. As the index increases with depreciation, with a loss in reserves and with interest rates hikes, an increase in index reflects a stronger selling pressure on the domestic currency. Thus, a higher index indicates greater pressure on the exchange market.

As the index increases with depreciation, with a loss in reserves and with interest rates hikes, an increase in index reflects a stronger selling pressure on the domestic currency. Thus, a higher index indicates greater pressure on the exchange market and reflects higher values of any of the three variables, depending on the nature of the intervention of the respective central bank. This allows one to focus not exclusively on successful speculative attacks (that is those where the exchange rate depreciates rapidly by a large amount), but also on speculative pressures that were either accommodated by a loss of reserves or fended off by the monetary authorities through an increase in interest rates. An index so defined can be applied not only to the fixed exchange rate, but also to other exchange rate regimes (crawling pegs, exchange rate bands and so on).

The crises theories discussed in Section 2 suggest that speculative pressure on exchange

¹⁶ The index is widely used in empirical studies on financial crises to measure the exchange market pressure, see Eichengreen et al. (1994, 1995), Frankel and Rose (1996), Kaminsky and Reinhart (1999), Kaminsky et al. (1997), Sachs et al. (1996), among others, and the IMF's World Economic Outlook (May 1999) for the application of a similar methodology.

markets should be a function of macroeconomic fundamentals and the state of a country's financial system. The quantitative index of speculative market pressure constructed as described above is regarded as a proxy of crisis index and therefore can be used as a dependent variable in regression models with indicators of macroeconomic imbalances, financial fragility and fundamental performance being explanatory variables, thus allowing to test for the causality and severity of the crisis.

4.2 Exchange market pressure: the Russian case

Before estimating empirically the influence of suggested crisis variables on the constructed index of exchange market pressure, a detailed look at the EMP values may be useful in revealing periods of strong exchange market pressure. In related literature, a crisis episode is defined as a period of excessive market volatility when the index of exchange market pressure rises above a pre-specified threshold, usually from 1 to 1.645 standard deviations (σ) above the sample mean (μ)¹⁷.

$$\text{Crisis if } EMP_t > \mu_{EMP} + 1.645 \times \sigma \text{ or } EMP_t > \mu_{EMP} + 1 \times \sigma$$

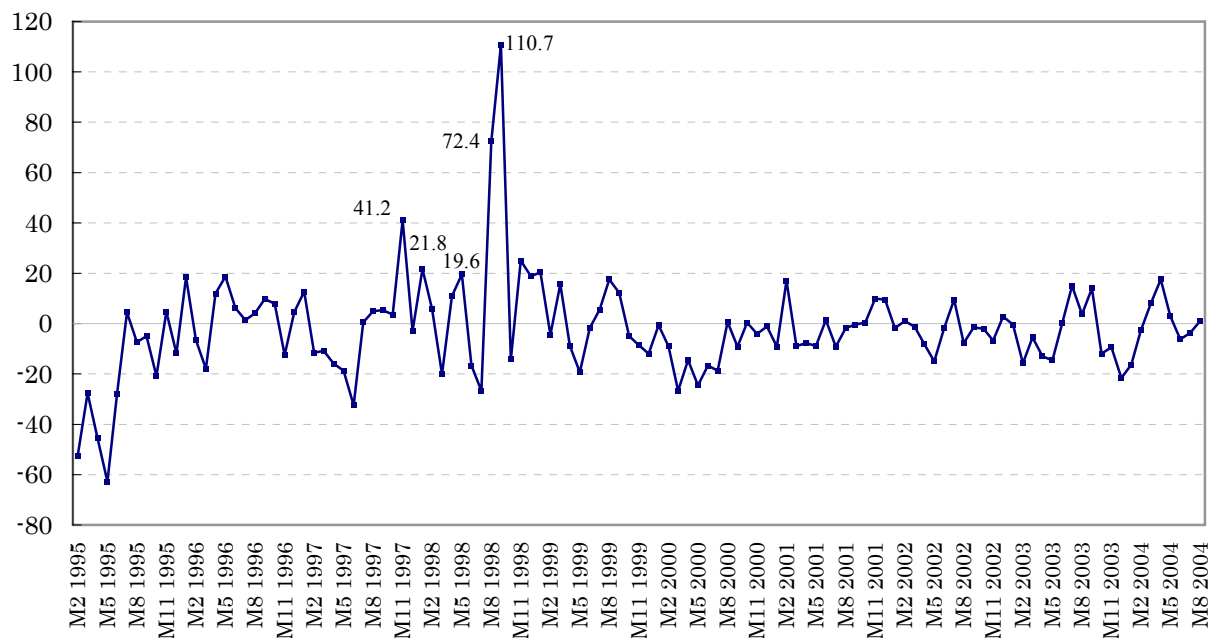
The quantitative equivalent for pressure on the Russian exchange market – the EMP index, constructed as described in the above section, is displayed in Figure 6 (data for the official exchange rate, international reserves minus gold and money market interest rates are from IFS line ae, 1 L.d, and 60b respectively).

The figure reveals three periods of strong exchange market pressure before the actual devaluation in August 1998: in November 1997, in January and May 1998, with the first one exceeding the conventional threshold of 1.645 standard deviations and the latter two being more than one standard deviation above the mean (the estimated EMP values for these crisis episodes and the calculated thresholds of 1 and 1.645 standard deviations from the EMP sample mean are indicated on Figure 4). The same periods of exchange market pressure after the onset of the Asian crisis and before the Russian financial collapse are identified in other empirical works (Caramazza et al. (2000), Gelos and Sahay (2000) (see Appendix 2)) and descriptive studies devoted to the Russian crisis (as summarized in Appendix 1).

¹⁷ Under normally distributed errors, the threshold of 1.645 standard deviations from the mean is equivalent to a one-sided confidence level of 5 percent.

**Figure 4. Index of exchange market pressure
(February 1995-August 2004)**

crisis if $EMP > 29.9$ (= mean + 1.645*SD = -2.01 + 1.645*19.04)
or if $EMP > 17.4$ (= mean + 1*SD = -2.01 + 1*19.04)



Percentage changes in the three components of EMP (the nominal exchange rate, the international reserves and interest rates) corresponding to these instances of high values of the constructed EMP index are presented in Table 2 (percentage changes are calculated in respect to the level of the series one month earlier).

Table 2. Periods of strong exchange market pressure

| | EMP | % Δe | % Δr | % Δi | Remarks |
|-----------------------|---------------|--------------|--------------|--------------|------------------------------------|
| November 1997 | 41.17 | 0.54 | -33.86 | 12.64 | Asian crisis spillover |
| January 1998 | 21.81 | 1.11 | -18.73 | -15.14 | Second attack on the rouble |
| May 1998 | 19.63 | 0.50 | -12.15 | 61.36 | Third speculative attack |
| August 1998 | 72.41 | 26.72 | -40.62 | -22.96 | De facto devaluation |
| September 1998 | 110.72 | 103.21 | 7.84 | 208.33 | The rouble is floated |
| November 1998 | 25.09 | 11.68 | -15.34 | -56.77 | Post-crisis pressure on the rouble |
| December 1998 | 18.90 | 15.49 | -4.57 | -24.25 | |
| January 1999 | 20.38 | 9.44 | -9.27 | 1.08 | |

Comparing the respective reserves losses, falls in exchange rate, and raises in interest rates for the identified crisis episodes clearly shows the attempts made by the monetary authorities to ward off the speculative attacks that continued after the onset of the crisis in

East Asia – for the three episodes preceding the devaluation in August 1998 fluctuations in the stocks of reserves and interest rates were far beyond the movements in the exchange rate which remained almost unchanged. This implies that during these episodes of strong pressure on the currency, which started after the crisis in Asia and continued up to the summer of 1998, the government and the Central Bank of Russia chose not to devalue the rouble and preferred to defend the preannounced peg through hiking interest rates and running down international reserves as it was described in Section 2 and summarized in the crisis timeline in Appendix 1.

The values of the crisis index and the corresponding changes in the three index constituents during post-crisis episodes of excessive exchange market pressure (from November 1998 to January 1999) indicate that devaluation failed to relieve the pressure on the currency at once (the floated rouble was losing its value until the beginning of the next year, and the international reserves melted further though much slower than before the crisis), but it helped to obviate a necessity of maintaining unbearably high interest rates. Thus, during the post-crisis period, after the peg was abandoned, the remaining pressure on the exchange market was relieved to a greater extent through the rouble floating with the monetary authorities' interventions playing a minor role as compared to the pre-crisis period.

4.3 Variables

Following the methodology adopted in previous studies on the determinants of currency crises, probit regression with the binary dependent crisis variable were estimated to identify the main reasons of the financial crisis incident in Russia and to evaluate their relative contributions to increasing crisis probability. (The crisis variable is assigned the value 1 when the constructed EMP variable exceeds the specified threshold and 0 otherwise. See also about 2-year the crisis episode window below.)

The advantage of using limited-dependent variable models, as probit and logit, over the linear regressions in the studies of currency and banking crises stems from the fact that crises tend to be associated with the abrupt and almost simultaneous deterioration of the key macroeconomic indicators, even if the underlying vulnerability to a crisis had been built up slowly over time. This indicates highly non-linear relationships between the occurrence of a crisis and its causes, and might make it difficult to reveal the effect of accumulated policy and imbalances to a sudden crisis outburst in the framework of econometric models that presuppose linearity between the causes and the outcome.¹⁸ Another advantage of probability models for examining a crisis cases is that, in contrast to OLS, they can provide an explicit

¹⁸ Kamin et al.(2001) point out this fact. OLS regressions of the continuous crisis index were conducted by Sachs et al. (1996), Glick and Rose (1998), Bussiere and Mulder (1999), Corsetti et al. (1999b), Tornell (1999), Nitithanprapas and Willet (2000), Kwack (2000).

measure of the probability of an event and the estimates in terms of crisis probability¹⁹.

The advantage of using parametric techniques like probit over non-parametric analysis tools as leading-indicator methodology (so called signal approach) comes from the possibility to test for the statistical significance of the individual variables, to take into account correlations between different explanatory variables and to combine the information from the various indicators into a single estimate of crisis probability in a more plausible way.²⁰

The choice between the probit and logit was made based on the characteristics of the respective underlying probability distribution functions. With logistic distribution having slightly flatter tails, and normal distribution approaching 1 or 0 with higher rate, the latter seems to be more appropriate for applying to the analysis of crises.²¹

The estimated probit model takes the form $P(y_{it} = 1 | x_t, \beta_t) = F(x_t, \beta_t)$, where x_t represents a set of explanatory variables and β_t is a vector of estimated coefficients.

Since the crisis often culminates deterioration of the macroeconomic indicators form well before the exchange rate market or financial system come under the actual distress, the value 1 is assigned to the dependent crisis variable y_{it} not only in the month when the constructed index of exchange market pressure exceed the specified threshold, but also 23 months before, i.e. there is a 2-year crisis window.²² Threshold of 1.645 standard deviations from the sample mean is chosen as indicative of extreme pressure on the exchange market and used for identifying crises episodes.²³

The set of independent variables used to explain the exchange market turbulence index includes indicators of a country's vulnerability to a crisis suggested by the three generation of theoretical models explained above as well as the factors blamed by previous studies for the crisis triggering in the particular case of Russia. (Explanations of the role of a particular indicator in a crisis and literature references are summarized in Table 3. The description of the data sources is provided in Appendix 3.)

¹⁹ Cerra and Sexena (2000) indicate this property of Probit and other probability models.

²⁰ This advantages of probit model are noticed by Berg and Pattillo (1998, 1999a) with the results of probit estimation outperforming the findings of signal approach when the same set of the explanatory variables used. Signal approach, originally introduced by Kaminsky et al. (1998), is widely used in crisis-related research, see for example Brüggemann and Linne (1999) and Yano (2002) whose studies include Russia among other countries.

²¹ See Liao (1994) on the properties of probability models.

²² Earlier studies employ one- or two-year crisis windows (Komulainen and Lukkarila (2003), Berg and Pattillo (1999), Kaminsky (2006)). The justification for including this long pre-crisis period into the definition of a crisis episode can be found in the stylized facts on the behaviour of macroeconomic variables leading up to a collapse – depending on an indicator, its deterioration sends first warning signals from as earlier as (on average) 12-19 months in advance of the actual crisis (see Kaminsky et al. (1998)).

The sensitivity test on the length of a crisis window (with 11 months before the extreme values of the constructed exchange market pressure index included to a crisis episode) gave qualitatively similar results.

²³ Thresholds of 2 and 3 standard deviations give similar results.

Table 3. Crisis indicators

| <i>Crisis indicators</i> | <i>Explanation & references</i> |
|--|---|
| <i>Government finance, credit & monetary policy</i> | |
| <i>Budget Deficit/ GDP</i> <i>Net credit to the government</i> <i>Government total net borrowing</i> | 1 st generation crisis type; Krugman (1979). Budget deficit, financed through printing money or borrowing, is associated with expansionary credit or monetary policy of the government which becomes inconsistent with fixed exchange rate. |
| <i>Domestic debt service / GDP</i> <i>Short-term domestic public debt</i> | 2 nd generation theory; Dabrowski (2003). Quantity and structure of the government domestic debt and the government debt burden are seen as the government incentive to inflate the debt away by devaluation, influencing investors' expectations accordingly. |
| <i>Exchange rate, trade and current account balances</i> | |
| <i>Real exchange rate appreciation</i> | 1 st generation crisis type, stems from expansionary monetary policy. |
| <i>Real exchange rate overvaluation</i> | Falling international competitiveness (not all real appreciations represent disequilibrium in exchange rate and real overvaluation is defined as deviation from the long-run trend). |
| <i>Trade balance deficit / GDP</i> | 1 st generation crisis type. Signs of appreciating exchange rate. |
| <i>Current account deficit / GDP</i> | Signs of appreciating exchange rate. |
| <i>Broad money/ Reserves ratio growth</i> | 2 nd generation. Dabrowski (2003); Sachs, Tornell, Velasco (1996). Fast growth of money supply lead to the currency overvaluation, falling reserves imply inappropriately high exchange rate. The ratio M2/Reserves indicates backing the liabilities of banking system with international reserves, forming investors' expectations about the exchange rate credibility. Intermediate level of reserves gives the rise to multiple equilibria and vulnerability to a financial panic. |
| <i>External capital flows</i> | |
| <i>Short term capital inflows/ reserves</i> | 3 rd generation, Radelet and Sachs (1998). Volatile portfolio inflows induce vulnerability to sudden stops. |
| <i>Foreign debt / foreign assets</i> | 3 rd generation. Higher level means greater share of foreign liabilities not covered with assets and unbalanced reliance on foreign finance. |
| <i>Capital flight</i> | Bruggemann and Linne (1999) Capital fleeing from a country show that domestic residents, informed better than foreigners about the state of the domestic banking sector, loose faith in banking system ability to function effectively and relocate the capital. |
| <i>Short term foreign debt / reserves</i> | IMF (2000). Single most important indicator of reserve adequacy under the uncertain access to capital market, indicator of a country's international liquidity. |
| <i>Fall in the stock market index</i> | 2 nd generation, contagion. Associated with falling investors' confidence. |
| <i>Financial sector</i> | |
| <i>Bank foreign liabilities/assets</i> | The gap between the two is the measure of fragility of domestic banking system with respect to international finance. |
| <i>Banks' foreign liabilities/ GDP</i> | Komulainen and Lukkarila (2003); Hardy and Pazarbasioglu (1998). High ratio reflects extensive borrowing from foreign banks and boosts vulnerability to sudden stops. Measure the extent to which the banking system relies on foreign capital to fund its operations; a proxy for banks' vulnerability to a sudden withdrawal of private capital inflows and to exchange rate risk. |
| <i>Banks loans/GDP ratio growth (lending boom)</i> | Sachs, Tornell, Velasco (1996) Associated with increase in non-performing loans and thus represents banks' fragility. |
| <i>Net foreign liabilities/ domestic assets (currency mismatch)</i> | Błaszkiwicz (2000). Indicates the exposure of banking system to exchange rate risk in case of devaluation of domestic currency. |
| <i>Banks' assets / reserves</i> | Wyplosz (2002), Eichengreen and Rose (1998). The inverse ratio (bank reserves /assets) indicates the share of bank lending to a private sector, with larger values representing higher liquidity and banking sector soundness. |

As the Russian crisis in its manifestation revealed the features of government debt problems, currency overvaluation, banking sector weakness, and seemed to be related to the changes in investors' expectations and international capital flows, variables from each of these four groups are included to the probit regressions to control simultaneously for alternative crisis explanations taking into consideration all spheres of possible economic deterioration. One variable from each group at a time is included into an estimated model to avoid possible multicollinearity between the indicators of essentially the same phenomena, be it government finance problems, exchange rate misalignment or banking sector and financial flows group of indicators. Several replacements are made to ensure that the qualitative results are not sensitive to the choice of the particular variable inside the group.

To gain a sense of the basic interplay between the explanatory variables and the incidence of the crisis, the summary statistics on the values of explanatory variables during the crisis episode and tranquil times are compared in Table 4.

Table 4 Explanatory variables: Basic Statistics

| | Crisis observations | | | | Non-crisis observations | | | |
|--|---------------------|---------|--------|--------|-------------------------|---------|---------|--------|
| | mean | st.dev. | min | max | mean | st.dev. | min | max |
| Government budget balance/GDP | -6.16 | 2.81 | -11.99 | -0.55 | 1.46 | 5.55 | -11.91 | 14.81 |
| Net claims on the government | 362.05 | 60.65 | 279.89 | 587.93 | 207.35 | 851.80 | -2702.8 | 910.20 |
| Government total net borrowing | 12.59 | 5.58 | 3.05 | 25.18 | -38.84 | 69.061 | -268.1 | 86.33 |
| Domestic debt service/GDP | 4.26 | 1.89 | 0.43 | 8.15 | 1.59 | 2.76 | 0.15 | 19.52 |
| Short-term domestic government debt | 321.67 | 99.84 | 0.00 | 436.04 | 170.74 | 76.87 | 0.00 | 266.90 |
| Real effective exchange rate level | 146.42 | 12.51 | 95.08 | 155.53 | 124.09 | 20.66 | 81.97 | 158.28 |
| Deviation of REER from trend | 16.69 | 9.88 | -22.97 | 23.76 | -4.93 | 12.75 | -41.75 | 11.54 |
| Trade balance/GDP | 2.60 | 4.11 | -1.93 | 18.02 | 14.76 | 5.52 | 3.50 | 26.18 |
| Current account/GDP | -0.01 | 2.89 | -4.41 | 4.64 | 10.06 | 5.29 | -2.10 | 22.07 |
| Broad money M2/Reserves ratio | 5.55 | 1.25 | 3.58 | 7.96 | 2.63 | 1.24 | 1.21 | 5.22 |
| Broad money M2/Reserves ratio growth | 18.93 | 36.14 | -30.48 | 109.83 | -14.80 | 17.97 | -52.63 | 40.53 |
| Short-term capital inflows / Reserves | 8.23 | 8.01 | -9.35 | 19.51 | -0.73 | 3.64 | -23.55 | 7.12 |
| Foreign debt / Foreign assets | 380.13 | 54.75 | 303.74 | 465.49 | 190.98 | 143.65 | 47.88 | 498.91 |
| Capital flight | 121.3 | 21.30 | 87.60 | 156.3 | 108.5 | 40.41 | 69.42 | 234.1 |
| Short term debt / reserves | 254.0 | 49.90 | 184.5 | 350.8 | 86.31 | 77.88 | 20.29 | 333.6 |
| Stock market index growth | 1.25 | 38.26 | -67.50 | 69.52 | 13.59 | 29.37 | -66.83 | 151.08 |
| Banks foreign liabilities / foreign assets | 125.93 | 27.13 | 80.81 | 163.00 | 75.58 | 23.41 | 38.36 | 131.59 |
| Banks foreign liabilities / GDP | 3.82 | 1.26 | 2.37 | 8.43 | 4.57 | 1.60 | 1.87 | 8.42 |
| Banks loans / GDP ratio growth | 21.72 | 19.54 | -13.35 | 55.64 | 9.86 | 13.20 | -29.14 | 37.49 |
| Net foreign liabilities/ domestic assets | 3.50 | 3.92 | -3.51 | 8.18 | -7.11 | 6.68 | -18.77 | 5.29 |
| Bank assets / reserves | 874.6 | 100.5 | 673.2 | 1228. | 678.0 | 125 | 430.3 | 1073. |

The mean values of the variables in question almost uniformly confirm the implications of theoretical models. For example, the large deficit of the government finance is persistent in pre-crisis period changes to positive figures during non-crisis months, and the level of short-term debt to reserves is about three times higher in the period leading up to the crisis as compared to tranquil months.

Binary probit estimates (not presented here for the sake of compactness) confirm the expected sign of all the variables²⁴, and statistical significance of all the variables strengthen the findings of the descriptive studies about the relevance of numerous factors to the incidence of crisis in Russia.

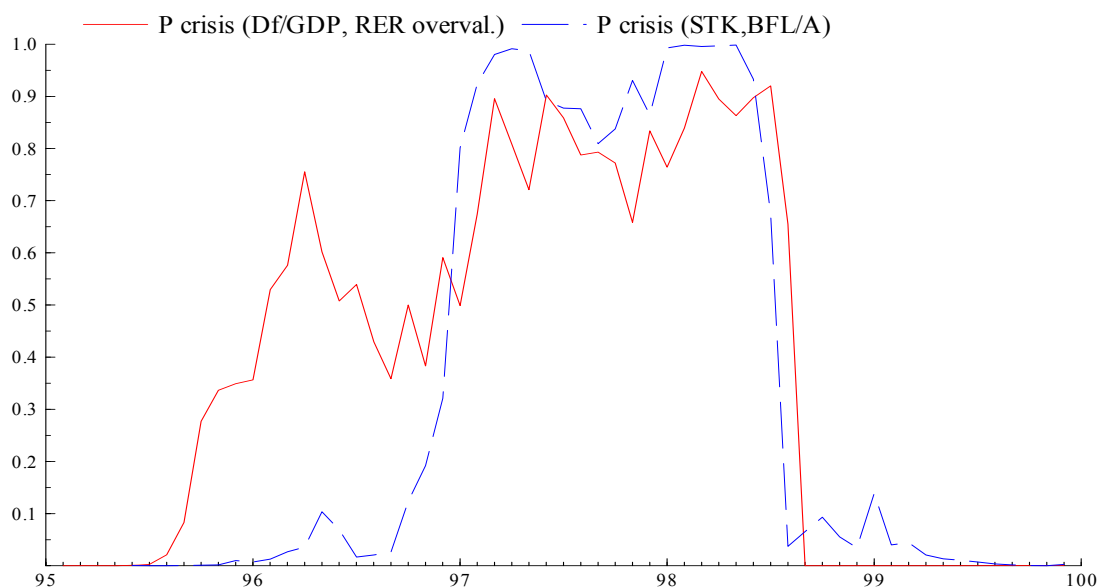
4.4 Analysis of the results

The multivariate Probit estimation results are summarized in Appendix 4. Since the estimated coefficients in the probit model are difficult to interpret, the marginal effects, i.e. the effects of one-unit changes in the regressors on the probability of crisis, are reported. For example, if the marginal effect of the budget deficit/GDP to a crisis probability is 1.01, this means that one unit increase in the government deficit, for example from 4% of GDP to 5% of GDP, leads to 1% percentage point increase in the probability of devaluation. The marginal effect of x_i is calculated as: $\frac{\delta E(y_i / x_i)}{\delta x_i} = \frac{\delta F(x_i \beta)}{\delta(x_i \beta)} \cdot \beta_i$, where $\frac{\delta F(x_i \beta)}{\delta(x_i \beta)}$ is a density function associated with F (see Green, 1999). The marginal contribution of each variable in the model is non-linear and depends on the overall simulated probability of crisis, and hence on the values of the other explanatory variables in the models.

To start with, consider the model which would depict the traditional 1st generation type of crisis with weaknesses of the economy induced by high levels of government deficit and overvaluated currency (see regression (a) in Appendix 4). Conversely, consider the crisis of the 3rd generation with volatile short term capital inflows and fragile position of domestic banks with signs of over-borrowing from abroad in the balance of foreign liabilities and foreign assets (regression (b) in Appendix 4). Both have high explanatory power and the fitted probability of crisis calculated on the basis of the two models estimation depicts the danger of a currency crisis from well before an actual devaluation took place (see Figure 5).

²⁴ The variables with “deficit”, “loss”, “fall” representation are the respective surpluses or growth rates multiplied by -1, i.e. the increase in all the variables should theoretically increase the crisis probability.

Figure 5. Fitted probabilities of crisis on the basis of Probit estimation of 2 models



The Figure makes clear the difference in the pattern of crisis probability calculated on the basis of Probit estimations of two different crisis model. The fitted probability from the first model is steadily increasing during relatively long period before an actual speculative attack which is the perfect match with the theoretical predictions and implications of the 1st generation models. In contrast there is no such a pattern in the case when financial flows and banking sector variables constitute the model tested – here the fitted probability jumps to high level in the mid-1997, just after the financial liberalization when foreign investors were allowed to enter the Russian market and domestic commercial firms – to borrow abroad.

The result of the series of Probit regressions with explanatory variables from each group of described areas of the economy (government finance, exchange rate, external capital flows and banking sector) are summarized in Appendix 4, columns marked with figures (1)-(10). All the variables have the expected positive sign of the estimated coefficient and hence of the reported marginal effect to a crisis probability. The relevancy of numerous macroeconomic variables found by the existing descriptive studies is also confirmed by their statistical significance in the *ceteris paribus* setting, i.e. when other possible crisis factors are simultaneously accounted for.

Having confirmed the high goodness-of-fit of the probit models and the statistical significance of all the 4 groups of the variables to inducing the crisis, the next step is to decompose the simulated crisis probabilities into the parts attributable to each group of the variables in order to assess their relative effect on the exchange market pressure. For this purpose the contribution (in percentage points) to the crisis probability due to the individual variable is calculated so that the sum of all contributions equals to the overall simulated crisis probability (Appendix 5).²⁵

²⁵ There is no unique way to decompose the simulated probabilities from probit models,

Note that since Probit implies non-linearity between the dependent and explanatory variables, the percentage contribution of each variable depends on the overall probability of crisis and hence the values of other explanatory variables as well. Thus there may be cases when the contribution of any particular variable fluctuates considerably depending on the other variables in the regression and the overall performance of the model. To avoid the possible bias in empirical results due to this characteristic of Probit, several models were randomly fitted with the variables from each group of the macroeconomic weaknesses. Also, to preclude the results from being driven by any one of variables of the group, the attempt was made to include all the variables with the same frequency, i.e. the same amount of times.²⁶

As it is clear from the mean value of the relative crisis contributions for each group of the variables (see the column labeled “average in crisis months” in Appendix 5), the problems in banking sector (measured by the different specifications of bank foreign liabilities stocks, with alternative indicators of lending boom and currency mismatch) seem to dominate the list of the macroeconomic variables which contributed to the crisis incidence. Their share accounts almost up to 40% of the induced pressure on the exchange rate, even after the effects of deteriorating government finance and appreciating exchange rate are taken into account (0.316 is a part attributable to the weakness in banking sector from the average overall crisis probability of 0.828).

The high contribution of the banking sector vulnerabilities to the rise of crisis probability in Russia is unexpected to some extent, given the fact that most researchers had characterized the Russian event as the breakdown of the expansionary government finance, opposing it to the series of crises in East Asia where the banking sector was the main vulnerability area. Short comparison to the pre-crisis state of financial sector in East Asian countries and in Russia below aims to prove the plausibility of the above Probit estimations suggesting the crucial role played by the banks’ weakness in the wake of the rouble collapse.

With the notorious barter problem in Russia the level of bank lending to the private sector as a share of GDP was about 10-15% which is much lower than in East Asia (the lowest ratio of claims on private sector to GDP among the five countries that suffered from the Asian crisis

because of the non-linearity in relationships between the dependent and explanatory variables. Based on the approach suggested by Berg and Pattillo (1999), for the simulated crisis probability p_t , the share due to variable x_k is calculated as $(\beta_k x_{kt} / \sum_i \beta_i x_{it}) p_t$, where the underlying model is the standard probit formulation $p_t = \Phi(\beta x)$.

²⁶ Exclusion is made for short-term government domestic debt because of the short length of data available for the series and because of its high correlation with variables of other groups. Exclusion is also made for trade and current account deficits which appear to have negative overall effect on the crisis probability even during the period of crisis and thus there is a fear of overestimating the relative positive effect of the other variables entering the model with these two.

was in Philippines: about 30-35% on average in 5 years preceding the crisis). However, Sachs et al (1996) among others stressed the importance of distinguishing between the level of lending and the rates of its increase, claiming the rapid growth in commercial bank lending (so called “lending boom”) to be a good predictor of subsequent financial crisis. Indeed, although the stock of commercial bank credit to the private sector as share of GDP was relatively modest in Russia as described above, the average annual growth of bank lending to the private sector for 4 years before the rouble collapse reached some 55% (which far exceeds the average 27% annual bank credit expansion in Asian countries for the same time span before the financial turmoil in East Asia).²⁷

Besides, the rapid fall in the net foreign assets of the Russian banking system in the wake of the crisis was not of smaller magnitude than that of Asia: for 5 years preceding the Russian crisis net foreign assets of the country fell to zero from the level of almost 17% of GDP; this figure is comparable only to Thailand which experienced the sharpest drop of net foreign assets among the Asian countries hit by the crisis (see Table 5). In all the countries hit by crisis, an increased offshore borrowing by commercial banks exceeded the amount of their foreign assets, turning the net balance of banks’ external capital operations to negative figures (the last two columns of Table 5).

Table 5 Net foreign assets of banking system

| | Net foreign assets of the banking system (monetary authorities and commercial banks included) | | of which: | |
|-------------|---|----------------|--|----------------|
| | | | Net foreign assets of commercial banks | |
| | 1992 (1993) | 1996 (1997) | 1992 (1993) | 1996 (1997) |
| Indonesia | 11.4 | 9.6 | -1.2 | -1.7 |
| Malaysia | 23.0 | 23.7 | -9.2 | -4.9 |
| Philippines | 2.6 | 3.2 | 3.1 | -7.4 |
| Thailand | 15.9 | -1.7 | -3.2 | -22.6 |
| Korea | 5.1 | 5.2 | -0.6 | -2.0 |
| Russia | (17) | (0.5) | (6.5) | (-1.4) |

Sources: Radelet and Sachs (1998b), IMF, International Financial Statistics database.

This mismatch between foreign liabilities and foreign assets of commercial banks suggest their excessive borrowing abroad and lending mostly to domestic investors, and this currency mismatch in its turn implies a substantial exchange rate risk. If the market expects higher values of liabilities in the foreign currency terms, international lenders may suddenly refuse

²⁷ Radelet and Sachs (1998b), International Financial Statistics.

to extend the existing credit lines, precipitating a banking crisis. This is what happened in 1997 to Asia, where the ratio of foreign liabilities to assets was above unity for several years before the bank run. The danger of exposure to the market confidence was aggravated with the maturity structure of the foreign flows – a share of short-term foreign liabilities above 50% was the norm in the region by the end of 1996 (see Table 6) and was deemed “particularly problematic”. As for Russia, capital account liberalization and financial deregulation resulted in the reversal of the balance in foreign liabilities and assets to the extent comparable with some Asian countries (Philippines and Malaysia), and the share of short-term liabilities even exceeded the East Asian counterparts reaching an unacceptably high level of 87.5 % already in 1996, two years before the financial demise (Table 6).

Table 6. Foreign assets and liabilities: five East Asian countries in 1996 and Russia in 1997

| | Korea | Indonesia | Malaysia | Philippines | Thailand | Russia |
|---|-------|-----------|----------|-------------|----------|--------|
| Foreign liabilities / assets | 3.75 | 4.24 | 1.48 | 1.72 | 11.03 | 1.59 |
| Short-term liabilities (% of total liabilities) | 67% | 61% | 50% | 58% | 65% | 81% |

Source: Corsetti et al. (1998), Chapman and Marcello (2001); CBR, *Consolidated dynamics of Foreign Assets and Liabilities of the Banking System of the Russian Federation*

The second strongest impact on the country’s probability of devaluation is stemming from the flows of external capital – volatile short-term capital inflows, high level of the foreign debt and capital flight from the country had increased the probability of devaluation by about one-third (mean of 0.250 from the average devaluation probability of 0.828).

The relative importance of this category of variables, describing an international financial position of a country as a whole (including public sector, commercial banks and non-bank private enterprises), is explained by the sharp fall of the international liquidity in Russia from 1995 – the coverage of the country’s foreign liabilities with assets was below 30% -40% and the ratio of short term foreign debt to reserves for 3 years from 1995 became twice higher from 1.4 to 3.0 (see Table 7).

Table 7. Indicators of international liquidity

| | <i>end 95</i> | <i>end 96</i> | <i>mid 97</i> | <i>end 97</i> | <i>mid 98</i> |
|--|---------------|---------------|---------------|---------------|---------------|
| Short-term assets / liabilities | | | 0.6 | 0.45 | 0.38 |
| Short-term assets / liabilities (with demand deposit in domestic currency) | | | 0.41 | 0.31 | 0.27 |
| Short-term foreign debt / Reserves | 1.53 | 2.40 | 1.91 | 2.53 | 3.15 |

Source: Chapman and Mulino (2001), *Joint BIS-IMF-OECD-World Bank statistics on External debt*

Comparison of the ratio of short-term foreign debt to reserves in Russia with the level of this indicator in East Asian countries can give insight into its dangerously high level: in 1997 and 1998, Russian short-term foreign liabilities exceeded its reserves by 2.5 and 3 times respectively, which at least twice larger than the average of 1.3 for the Asian countries (in 1997 this ratio was 0.61 for Malaysia, 0.85 for Philippines, 1.45 for Thailand, 1.7 for Indonesia, 2.06 for Korea, see Radelet and Sachs (1998)).

The role of short-term foreign capital in inducing the crisis is easy to be captured from the following estimations of its influence on the Russian financial market. Immense capital inflows to the Russian economy started from the last quarter of 1996, and they were largely represented by short-term portfolio inflows attracted by the short-term government securities market which promised high yields with low exchange rate risk under the fixed exchange rate. By the end of 1997 the share of the Treasury bills held by non-residents amounted to 30-40% of the outstanding \$60bn market of short-term government securities which started to exceed the value of the country's foreign exchange reserves at that time.²⁸ From 1997, foreign capital flowed to the corporate securities market and acquired control over no less than 10% of the Russian stock market with the capitalization of \$100bn.²⁹

Volatile short-term inflows exposed the country to the sharp change in investors' confidence and sudden reversals of foreign capital. Large gross outflows of capital were associated with negative developments in Asia and there is evidence that non-residents' herding behaviour had destabilized the Russian security market and largely determined the timing of the crisis.³⁰ Besides, foreign investors were not the only ones leaving the state bond and stock markets – residents (individual investors and Russian banks) increased dollar assets and left the Russian financial market during the initial crisis stage in October-November of 1997.³¹

The third decisive element in the Russian crisis was in the most traditional area of government finance – such variables as budget deficit and growing borrowing for its financing contribute to the crisis cumulated probability by about 20% (0.189 from 0.828). This may look surprising given that the fact that many studies of the Russian crisis are focused solely on the

²⁸ The purchase of government securities by non-residents was officially allowed in the beginning of 1996, and the Central Bank of Russia further relaxed temporary restrictions on repatriation of proceeds. See Medvedev (2001), *Economist* (May 23, 1998).

²⁹ See Chapman and Mulino (2001).

³⁰ Medvedev (2001) points to the episodes of large capital outflows from the government bond market during the time of renewed turbulence in Asian financial markets in October - November 1997, in January and May-June 1998 which was associated with the currency crisis and social unrest in Indonesia, and in July 1998 during the time of uncertainty over financial aid to Russia. Medvedev and Kolodyazhny (2001) found that the behaviour of non-residents in the security market imitated the actions of the leaders' (large investment funds).

³¹ Sutela (1999), Medvedev (2001).

government policy mistakes. The possible explanation of this unexpected result may be found in the fact that the government finance stance was slowly improving starting from 1996 due to efforts to raise revenues and cut expenditures (Table 8), so it could just built up the constant base level of vulnerability, but it would need some additional factors to turn the country into a situation when devaluation becomes inevitable.

Table 8. **Government budget deficit (% of GDP)**

| Budget | 1996 | 1997 | 1998 | 97Q1 | 97Q2 | 97Q3 | 97Q4 | 98Q1 | 98Q2 | 98Q3 | 98Q4 |
|---------|------|------|------|------|------|------|------|------|------|------|------|
| deficit | 7.9 | 7.1 | 5.0 | 9.0 | 7.8 | 6.4 | 5.7 | 4.9 | 5.6 | 3.0 | 6.3 |

Source: RECEP, *Russian Economic Trends*, April 1999

The group of indicators measuring misalignments in the exchange rate (real appreciation and overvaluation, deterioration of trade and current account balances) contributed to the probability of devaluation by about 10% (average value of 0.085 from the mean devaluation probability of 0.829). This relatively small share can be explained by the fact that after the sharp real appreciation of about 40% right after introducing the fixed exchange rate as a nominal anchor to fight domestic inflation, the rouble had gained only 10% more in its value for the following two years, i.e. until the end of 1997.³²

Interestingly, the shares due to the trade balance and current account deficits (which sign misalignments of the exchange rate) are even negative. With the statistically significant marginal contributions of the both variables in the probit regression results (i.e. with the higher values of deficits definitely causing higher pressure on the exchange rate), this indicates the fact that from 24 months identified as a crisis period in this study only in several of them the trade balance and the current account balance fall into negative figures. Moreover, the mean values of the two indicators, as stated in Table 4, even for the crisis months are 2.60 (surplus of 2.6% of GDP) for the trade balance and -0.0086 (less than 1% of GDP deficit) for the current account respectively, which implies that trade and current account imbalances were yet too small by the time the crisis erupted to induce a serious pressure on the exchange rate market.

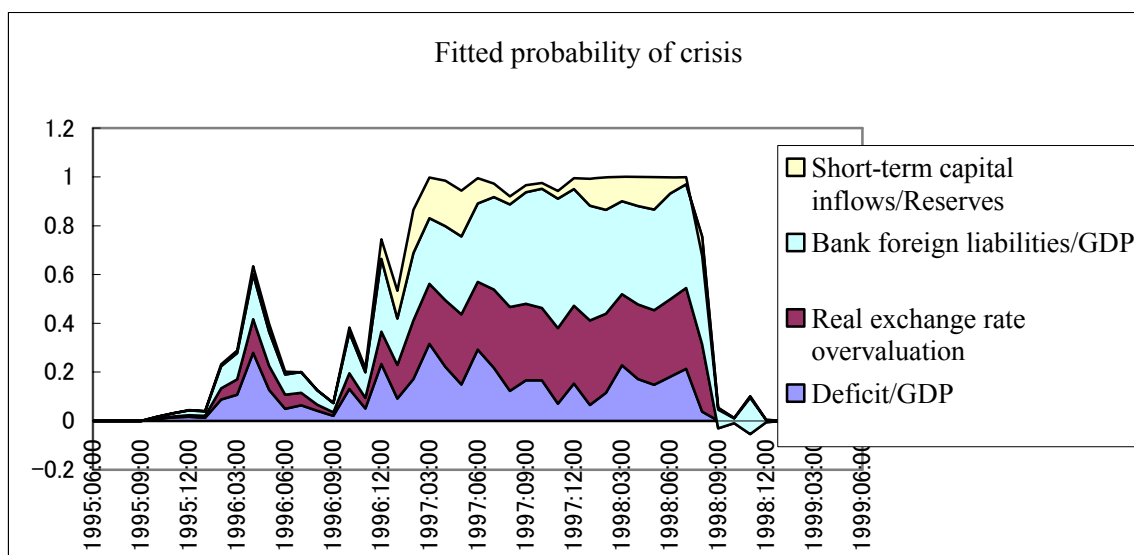
Another evidence of the relative importance of the discussed 4 categories of vulnerabilities can be seen from the comparison of the difference (the change) in the groups' relative crisis contributions during the crisis and non-crisis months (see the last column of the table in Appendix 5). The differences for the indicators of the exchange rate misalignment and the government finance variables in absolute values are much smaller than the gap between the roles that the financial sector variables and flows of external capital played in the crisis

³² Calculated as an annual percentage change in real effective exchange rate (IFS line rec).

episode as compared to non-crisis months (cf. 0.097 difference for the exchange rate impact in crisis compared to non-crisis years, and 0.253 change for the variables of the financial sector weakness).

To make all said above more visible, the calculated shares of the individual variables to the simulated crisis probabilities are graphically depicted below (Figure 6). As the quantitative results discussed above suggest, the contributions of the financial sector weakness and of the real overvaluation are strikingly high, following by the lower impact of external finance and stable percent of vulnerability to a crisis provided by the budget deficit.

Figure 6. **Relative contributions of individual crisis factors to the devaluation probability**



The relative importance of these particular variables from different areas of macroeconomic fragility has some discrepancy with the results based on the larger number of regressions, but there is clear vulnerability build-up due to the government deficit and real exchange rate appreciation problem, which cumulate to crisis only with the substantial contribution of the weaknesses in the financial sector and external capital movements.

5. Concluding remarks

The results of the empirical test above suggest that the crisis in Russia is difficult to be explained by only one set of the variables representing respectively government finance problems, overvaluation in the real exchange rate under the fixed nominal values, abrupt change in investors' expectations, external capital flows or banking related variables. All these variables matter, the question is just of the extent to which the particular group of the variables contributed to the crisis in Russia.

Decomposing the overall simulated crisis probabilities to the relative shares due to the explanatory variables of different categories implies the highest contribution to the increased crisis probability is to be attributed to the indicators of the financial sector weakness. The next powerful crisis predictors were external capital flows and alternative measures international liquidity. These two groups are followed by the problems in areas that characterize the more traditional crisis type – government finance and exchange rate which were relatively less important to the devaluation probabilities than fragilities in private domestic or international financial sectors. Government finance problems and the appreciating rouble, almost commonly thought to be the main causes of the crisis, had just built up to some extent constant crisis probability and did not contribute to the episode of the sharp devaluation in a way visibly different from the behaviour in tranquil non-crisis months.

The attribution of the Russian crisis case to one of the existing theoretical models seems to be questionable. The only sure thing is that it could not be explained solely in the framework of the traditional first generation models – the elements of the 3rd generation of currency and financial crises are too evident and the extent of their deterioration is even comparable with that of the East Asian economies that were typical crises of financial excess involving international capital. In sum, the deterioration of indicators on the external finance side combined with the financial sector weakness explained the greater part of the pressure on the Russian currency than both government finance and exchange rate related variables.

The Russian case reminds of the perils of financial liberalization. The great difference with which the banking sector weakness contributes to probabilities of devaluation assures the fact that financial sector regulations and soundness of banks are as important for a country's economic prosperity as healthy government finance. Equivalently, the sudden stops or sudden outflow of volatile external capital is not less harmful to the stability of the currency and banking system than the inappropriate level of the exchange rate itself. The same amount of care should be taken for keeping in order both - the domestic economy and the financial relations with the external world.

Appendix 1

Timeline of events prior to the crisis

| | |
|--------------|---|
| 1997 | |
| Mid 1997 | Trade surplus moving toward balance. Oil sells at \$23 per barrel. Monthly inflation rate is less than 1%. Large foreign capital inflows. |
| November | The Asian crisis causes a speculative attack on the rouble. CBR defends the currency band, losing \$6 billion of reserves and increasing its refinancing rate from 21% to 28%. |
| December | Prices of oil and nonferrous metals begin to drop. |
| 1998 | |
| January 1 | Complete liberalization of the domestic debt market for nonresidents. |
| Late January | A second bout of the exchange market instability. The RTS stock exchange index fell by 50% from October 1997. |
| March 23 | Yeltsin fires the entire government. |
| May | The Indonesian political and financial crisis erupts, igniting a third (eventually conclusive) speculative attack on the rouble. |
| May 19 | CBR increases the refinancing rate from 30% to 50% and defends the rouble with \$1 billion. |
| Mid-May | Oil prices drop to \$11 per barrel. Oil and gas oligarchs advocate the devaluation to increase value of the exports. |
| May 27 | The Central Bank of Russia (CBR) increases the refinancing rate again to 150%. |
| June | CBR defends the rouble, losing \$5 billion of reserves. |
| July | The IMF approves an emergency aid package (the first disbursement to be \$4.8 billion) |
| August 13 | Russian stock, bond, and currency markets weaken as a result of investors' fear of devaluation. |
| August 17 | Devaluation of the rouble; default on domestic government debt; 90-day moratorium on debt payments to foreign creditors. |
| September 2 | The rouble is floated after \$2.8 billion of reserves lost. |

Source: Chiodo and Owyang (2002); Institute for the Economy in Transition (1999); Kharas et al. (2001)

Appendix 2

Empirical studies covering the Russian crisis

| study | sample | approach | variables | findings related to the Russian crisis |
|--|---|---|---|--|
| Brüggemann and Linne (1999) | 5 East European transition economies with Russia; 1991-98; annual and monthly data | Signal approach – individual economic indicators' behaviour. | 16 economic and financial variables | The Russian crisis was certainly home made and not a result of Asian contagion. The crisis was signaled by the abnormal behaviour of the real exchange rate, budget deficit, domestic credit, exports, reserves, M2/reserves. This mirrors well the state of the Russian economy in the beginning of 1998 with a sizable currency overvaluation, government deficit, and dwindling reserves. |
| Bussiere and Mulder (1999) | 23 countries; 3 crises episodes (1994, 1997, 1998); quarterly and monthly data. | OLS of a crisis index (weighted average of exchange rate and reserves changes) as dependent variable. | Liquidity ratios, lending boom, the real effective exchange rate. | A strong liquidity element, the real effective exchange rate appreciation and credit to the government sector contributed to the 1998 crisis. Lending boom to the private sector, so significant for earlier crises, is to a contra indicator in 1998. |
| Caramazza et al. (2000) | 61 industrial and developing countries; 1990-1998; monthly data | Panel probit for Mexican, Asian, Russian crises) with the index of speculative market pressure used for identifying crises. | The real exchange rate, liquidity ratios, current account deficit, budget deficit, trade and financial contagion. | Financial linkages and weakness play a significant role in explaining the spread of emerging market crises after controlling for fundamentals and trade contagion. Russia experienced substantial currency pressure during the Asian crisis as identified by the constructed crisis index. |
| Cartapanis, Dropsy, and Mametz (1999) | 27 countries (European, Latin American and East Asian groups); 1990-1997; annual data | Logit with the binary crisis index (a weighted average of changes in reserves and real exchange rate); simulated crisis probabilities for Russia in 1998. Financial vulnerability and non-sustainability model. | Financial vulnerability: fundamentals (current account, real appreciation); liquidity (short-term external debt, reserves). Non-sustainability: fundamental disequilibrium (budget deficit, domestic credit growth, gap with sustainable current account, real overvaluation). External shocks (world interest rates, oil prices) in both models. | For Russia the financial vulnerability model could much better predict the actual crisis than the non-sustainability model which failed to capture the collapse. The actual crisis was mostly of the financial origin. The macroeconomic situation in Russia looked promising; the fundamentals were in the sustainable norms, as well as the external debt & other leading indicators. These results confirm the superiority of multiple equilibria models, and the fact that changes of investors' expectations do not always follow fundamentals. |
| Feridun (2004) | Russia; monthly data; 1988.01-1998.08 | Probit model; binary dependent variable on the basis of exchange market pressure index (weighted sum of exchange rate and reserves changes). | 20 macroeconomic and financial sector indicators. | Significant explanatory variables are FDI/GDP, inflation, world oil prices, real interest rates, current account, GDP per capita, foreign exchange reserves, stock prices, real exchange rate, export growth. Unexpected signs on the public debt, bank reserves/assets ratio, and real interest rates. |
| Gelos and Sahay (2000) | East European countries; 1993-1998; monthly data | Cross-country EMP (exchange market pressure) index correlations; VAR; Granger causality test. | Stock market returns, trade shares, reserves adequacy ratio, current account balance. | The pressure to a currency is determined by the reserves adequacy and current account deficit. During the Asian crisis Russia experienced strong exchange market pressure given by the raised interest rates and reserves' losses. |
| Goldfajn and Biag (2000) | Russia, Brazil; monthly, daily data; 1997-99 | OLS of financial flows; VAR of stock market data. | Stock- and exchange markets' variables; good/bad news dummies. | For Russia only bad political and economic news from own country (not from Brazil) had a significant adverse effect on the stock market. |
| 矢野順治 (2002) (Yano (2002), in Japanese) | Mexico, Brazil, Korea, Indonesia, Philippines, Thai, Russia | Signal approach of Kaminsky et al. (1998) | 17 indicators of macroeconomic condition and banking sector weaknesses | Only two indicators (money supply and the ratio M2/ reserves) sent signals of the impending crisis. The behaviour of other indicators (reserves, trade balance, real exchange rate, bank foreign liabilities and lending boom to private sector) was not extremely different from tranquil periods. |

Appendix 3

Data sample: monthly data, 01.1995-08.2006

Sources: *International Financial Statistics* (IFS) CD-ROM, International Monetary Fund (IMF); *Russian Economic Trends* (RET), Russian-European Centre for Economic Policy (RECEP); *Bank for International Settlements* (BIS).

| Exchange market pressure (EMP) index: | |
|---|--|
| <i>nominal exchange rate</i> | IFS line ae. |
| <i>international reserves</i> | IFS line 1 L.d. |
| <i>money market interest rates</i> | IFS line 60b. |
| Macroeconomic indicators: | |
| <i>Government budget balance/GDP</i> | IFS line 80 over line 99bp (interpolated from quarterly data). |
| <i>Net claims on the government/GDP</i> | IFS line 32an over line 99bp |
| <i>Government total net borrowing/GDP</i> | IFS line 84 over line 99bp |
| <i>Domestic debt service/GDP</i> | RET data on domestic debt servicing divided by IFS line 99bp (interpolated from quarterly data). |
| <i>Short-term domestic government debt</i> | RET data on outstanding GKO (short-term treasury bills). |
| <i>Real effective exchange rate</i> | IFS line rec; appreciation is defined as 12-month percentage change, overvaluation is defined as deviation from the time trend. |
| <i>Trade balance/GDP</i> | IFS line 70 (exports) minus line 71 (imports), over line 99bp. |
| <i>Current account/GDP</i> | IFS line 78ald (interpolated from quarterly data) over line 99bp |
| <i>Broad money M2/Reserves ratio growth</i> | IFS lines 34 plus 35 (converted into US dollars using IFS line ae) divided by line 1 L.d, 12-month percentage change. |
| <i>Short-term capital inflows / Reserves</i> | IFS line 78bgd (portfolio investment liabilities) over line 1L.d. |
| <i>Foreign debt / Foreign assets</i> | BIS series J over M (total liabilities to BIS reporting banks/total claims on BIS reporting banks, interpolated from quarterly data) |
| <i>Capital flight</i> | BIS series M (deposits of domestic residents in BIS reporting banks, interpolated from quarterly data, over reserves IFS1L.d) |
| <i>Short-term foreign debt / Reserves</i> | BIS series G (liabilities to BIS reporting banks with maturity up to 1 year, interpolated from quarterly data) over IFS line 1L.d. |
| <i>Stock market index</i> | RTS (Russian Trading System) stock market index, average for the month; one quarter (3-month) percentage change. |
| <i>Bank foreign liabilities/ foreign assets</i> | IFS line 26c divided by line 21. |
| <i>Bank foreign liabilities / GDP</i> | IFS line 26c divided by 99bp (interpolated from annual data). |
| <i>Bank loans / GDP ratio growth</i> | IFS line 22d over the line 99bp (interpolated from quarterly data). |
| <i>Net foreign liabilities/ domestic assets</i> | IFS line 26c minus line 21, over the sum of lines from 22a to 22f. |
| <i>Bank liquid reserves/ assets</i> | IFS line 20 over the sum of lines 21, 22a, 22c, 22d, 22f |

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Appendix 4. **Probit regression** (marginal effect of 1 unit change in the explanatory variable;***;**;*; † indicate statistical significance at 1%, 5%,10% and 15%)

| | (a) | (b) | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|--|-------------|-------------|--|-------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|------------|-------------|
| Government finance, credit & monetary policy | | | | | | | | | | | | | |
| Budget Deficit/ GDP | 1.34 ** | | | 1.52 *** | | | | | | | | 0.62 | |
| Net credit to the government / GDP | | | | | | | | | 0.58 * | | 0.94 *** | | 0.18 |
| Government total net borrowing/GDP | | | | | | | 0.93 * | 4.18 *** | | | | | |
| Domestic debt service / GDP | | | | | | 4.91 *** | | | | 1.61 * | | | |
| Short-term domestic government debt | | | | | 0.075 ** | | | | | | | | |
| Exchange rate, trade & current account balances | | | | | | | | | | | | | |
| Real exchange rate overvaluation | 1.05 *** | | | 0.83 *** | | | 0.50 ** | 0.53 *** | | | | | |
| Real exchange rate appreciation | | | | | | | | | | 0.36 ** | 0.53 *** | 0.17 * | |
| Trade balance deficit / GDP | | | | | 1.84 *** | | | | | | | | |
| Current account deficit / GDP | | | | | | | | | 1.85 *** | | | | |
| M2 / Reserves ratio growth | | | | | | 0.24 ** | | | | | | | 0.04 *** |
| External capital flows | | | | | | | | | | | | | |
| Short term capital inflows / reserves | | 1.71 ** | | 0.52 † | 1.18 ** | | | | | | | | |
| Foreign debt / foreign assets | | | | | | | 0.03 ** | | | | | | 0.03 |
| Capital flight | | | | | | | | 0.09 | | | 0.267 ** | | |
| Short term foreign debt / reserves | | | | | | | | | | 0.46 *** | | 0.22 * | |
| Fall in the stock market index | | | | | | 0.35 * | | | 0.02 | | | | |
| Financial sector | | | | | | | | | | | | | |
| Banks foreign liabilities / assets ratio | | 0.37 *** | | | | | | | | | | 0.16 ** | 0.44 *** |
| Banks' foreign liabilities/ GDP | | | | 5.93 *** | 4.5 ** | | | | | | | | |
| Banks loans/GDP ratio growth (lending boom) | | | | | | | 0.21 * | 0.34 ** | | | | | |
| Net foreign liabilities/ domestic assets (currency mismatch) | | | | | | | | | 1.63 ** | | 3.39 *** | | |
| Banks liquid assets / reserves | | | | | | 0.08 ** | | | | 0.07 † | | | |
| Pseudo R2 | 0.57 | 0.60 | | 0.73 | 0.72 | 0.73 | 0.88 | 0.61 | 0.84 | 0.782 | 0.744 | 0.93 | 0.86 |
| No. of observations | 134 | 130 | | 130 | 86 | 77 | 115 | 115 | 123 | 78 | 121 | 121 | 120 |
| Fraction of correct predictions | 0.93 | 0.95 | | 0.95 | 0.94 | 0.87 | 0.96 | 0.91 | 0.95 | 0.90 | 0.94 | 0.98 | 0.97 |

Appendix 5. Average contributions of the explanatory variables to the crisis probability (calculated from the Probit estimation results)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | | Average crisis | Average non-crisis | difference |
|--|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|--|-------------------|-----------------------|------------|
| Government finance, credit & monetary policy | | | | | | | | | | | | 0.189 | 0.015 | 0.174 |
| Budget Deficit/ GDP | 0.150 | | | | | | | | 0.046 | | | | | |
| Net credit to the government | | | | | | 0.224 | | 0.192 | | 0.034 | | | | |
| Government total net borrowing | | | | 0.192 | 0.423 | | | | | | | | | |
| Domestic debt service / GDP | | | 0.178 | | | | 0.031 | | | | | | | |
| Short-term domestic government debt | | 0.420 | | | | | | | | | | | | |
| Exchange rate, trade and current account balances | | | | | | | | | | | | 0.085 | -0.012 | 0.097 |
| Real exchange rate overvaluation | 0.243 | | | 0.260 | 0.327 | | | | | | | | | |
| Real exchange rate appreciation | | | | | | | 0.003 | 0.020 | 0.006 | | | | | |
| Trade balance deficit / GDP | | -0.06 | | | | | | | | | | | | |
| Current account deficit / GDP | | | | | | -0.119 | | | | | | | | |
| M2 / Reserves ratio growth | | | 0.045 | | | | | | | 0.074 | | | | |
| External capital flows | | | | | | | | | | | | 0.250 | 0.017 | 0.233 |
| Short term capital inflows / reserves | 0.075 | 0.175 | | | | | | | | | | | | |
| Foreign debt / foreign assets | | | | 0.364 | | | | | | 0.143 | | | | |
| Capital flight | | | | | 0.167 | | | 0.403 | | | | | | |
| Short term foreign debt / reserves | | | | | | | 0.524 | | 0.654 | | | | | |
| Fall in the stock market index | | | 0.008 | | | -0.007 | | | | | | | | |
| Financial sector | | | | | | | | | | | | 0.316 | 0.253 | 0.253 |
| Bank foreign liabilities/assets ratio | | | | | | | | | 0.235 | 0.635 | | | | |
| Banks' foreign liabilities/ GDP | 0.341 | 0.272 | | | | | | | | | | | | |
| Banks loans/GDP ratio growth (lending boom) | | | | 0.080 | 0.068 | | | | | | | | | |
| Net foreign liabilities/ domestic assets (currency mismatch) | | | | | | 0.526 | | 0.183 | | | | | | |
| Banks assets / reserves | | | 0.540 | | | | 0.248 | | | | | | | |
| Average P(crisis) in crisis months | 0.809 | 0.811 | 0.771 | 0.897 | 0.691 | 0.863 | 0.807 | 0.799 | 0.940 | 0.887 | | 0.828 | | |
| in non-crisis months | 0.048 | 0.087 | 0.101 | 0.028 | 0.085 | 0.033 | 0.092 | 0.053 | 0.016 | 0.028 | | | 0.057 | |

