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THE IMPACT OF RUSSIAN RUBLE DEVALUATION ON TRADE AND CURRENCIES OF THE CIS COUNTRIES

Working paper # BSP/99/020

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Moscow
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Ïåðåõîäöåâ Ä. Ì. Âëèÿíèå äåâàëüâàöèè Ðîññèéñêîãî ðóáëÿ íà òîðãîâëþ è âàëþòû ñòðàí ÑÍÃ/ Препринт # BSP/99/ 020 E.- М.: Российская экономическая школа, 1999 – 44 с. (Англ.)

Âàëþòíûå êðèçèñû çà÷àñòóþ íîñÿò ðåãèîíàëüíûé õàðàêòåð, ïîðàæàÿ ñòðàíû â ãåîãðàôè÷åñêîé áëèçîñòè. Ýòî ïðåäïîëàãàåò, ÷òî ñòðóêòóðà ìåæäóíàðîäíîé òîðãîâëè âàæíà äëÿ ïîíèìàíèÿ òîãî, êàê ðàñïðîñòðàíÿþòñÿ êðèçèñ. Ñóùåñòâóåò ìíîãî ïóòåé ÷åðåç êîòîðûå íåñòàáèëüíîñòü íà âàëþòíîì ðûíêå ìîæåò ïåðåêèíóòüñÿ íà äðóãèå ñòðàíû. Îäíèì èç íèõ ÿâëÿåòñÿ âëèÿíèå ñïåêóëÿòèâíîé àòàêè íà ìåæäóíàðîäíóþ êîíêóðåíòîñïîñîáíîñòü ðàññìàòðèâàåìûõ ñòðàí è, ñëåäîâàòåëüíî, íà ñ÷åò òåêóùèõ îïåðàöèé ýòèõ ñòðàí. Òåì íå ìåíåå, òîðãîâûå ñâÿçè íå ÿâëÿþòñÿ åäèíñòâåííûì ïóòåì ðàñïðîñòðàíåíèÿ êðèçèñà.

Äàííûé äèïëîì ðàññìàòðèâàåò ïðîáëåìó ðàñïðîñòðàíåíèÿ êðèçèñà íà ïðèìåðå êðèçèñà â Ðîññèè è ñîñåäíèõ ñòðàí, òàêèõ êàê Óêðàèíà, Áåëàðóñü, Êàçàõñòàí, Ìîëäîâà. Áûë ïðîâåäåí àíàëèç ÷óâñòâèòåëüíîñòè ðåàëüíûõ óñëîâèé òîðãîâëè íà ýêñïîðòíûå è èìïîðòíûå ïîòîêè ìåæäó Ðîññèåé è ýòèìè ñòðàíàìè. Â ðåçóëüòàòå àíàëèçà ïî ìîäåëè Äîðíáóøà áûëè ïîëó÷åíû îöåíêè âëèÿíèÿ äåâàëüâàöèè ðóáëÿ íà òîðãîâûé áàëàíñ ýòèõ ñòðàí. Èñõîäÿ èç ïðîãíîçèðóåìîãî èçìåíåíèÿ â òîðãîâîì áàëàíñå, áûëè ñäåëàíû îöåíêè äåâàëüâàöèè íàöèîíàëüíûõ âàëþò.

Äëÿ èçó÷åíèÿ äèíàìèêè ðàñïðîñòðàíåíèÿ êðèçèñà áûëà ðàññìîòðåíà äèíàìè÷åñêàÿ ìàêðîýêîíîìè÷åñêàÿ ìîäåëü â ïðèëîæåíèè ê Ðîññèè è ñòðàíàì ÑÍÃ.

Îíà ïîêàçàëà, ÷òî íàëè÷èå òîðãîâûõ ñâÿçåé ñ Ðîññèåé çíà÷èòåëüíî ïðèáëèæàþò íàñòóïëåíèå âàëþòíîãî êðèçèñà â ñòðàíàõ ÑÍÃ.

Ðåçóëüòàòû ìîäåëåé ïðèâåäåííûõ â äèïëîìíîé ðàáîòå ìîæíî ñðàâíèòü ñ ðåàëüíîé ñèòóàöèåé â ñòðàíàõ ÑÍÃ êðàòêî îïèñàííîé â äèïëîìíîé ðàáîòå.

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Currency crises tend to be regional, they affect countries in geographic proximity. This suggests that patterns of international trade are important in understanding how currency crises spread. There seems to exist a number of channels through which instability in foreign exchange markets might be transmitted across countries. One is the impact of a speculative attack on the current and prospective international competitiveness of the countries concerned and hence on their current accounts. Though, trade links may not be the only channels of such transmissions.

The master thesis is concerned with the problem of the contagion on the example of Russian currency crisis and the neighbor countries of Ukraine, Belarus, Kazakhstan and Moldova. The analysis of the sensitivity of real trade between Russia and these countries on the terms of trade was carried out and as a result, the estimations of the impact of ruble devaluation on the trade balance of the CIS countries was obtained on the basis of Dornbush model. Consequently, the incurred devaluation of the currencies of these countries resulting from the change in the trade balance was estimated. To study the dynamics of contagious currency crises a dynamic macroeconomic model is considered in application to Russia and the CIS countries. It shows that the certain trade links made the currency crises in the CIS countries occur faster in the presence of Russian crisis. The results of the models' predictions may be compared to the current situation in the CIS countries briefly described in the master thesis.

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1. Introduction

On August 17, 1998 financial crisis occurred in Russia. Among all its outcomes the most evident was the rapid devaluation of Russian currency, ruble. Within a day the exchange rate fell from 6 rubles per dollar to 9. By September the devaluation amounted to 200 to 300 per cent. This dramatic change immediately influenced Russian trade with other countries, especially with the most closely connected ones, the members of the Commonwealth of Independent States. Though, according to the name, these countries are independent now, their relations are still very close indeed, much closer than those of just neighbor countries are. The weight of the countries of the CIS in the trade of these countries takes from 40 to 70 per cent of the total trade. The weight of Russia in the trade of these countries with the countries of the CIS varies from 80 to 90 per cent. The main reasons for this are the following:

- Most goods produced in the countries of the CIS may be traded only between those countries since they are not competitive beyond the CIS
- There are too many trade links established in the times of Soviet Union which are very hard to break and these links are likely to make the trade inelastic to external factors.
- For many goods traded between the countries of CIS special prices exist within the CIS
- The Custom Union and other favorable custom and tariff regulations encourage trade within the CIS making the transition to the other markets even more painful.

This does not seem to be the first example of the so-called contagious currency crises when speculative attacks appear to pass «contagiously» from one country to another. Similar effects were observed in 1992-1993 when the speculative attack, which led to the floating of the Finnish markka appeared to trigger speculation against Swedish krona. The further abandonment of the Swedish krona's ECU parity caused substantial pressure on the parity of Norwegian krone. Another example is that of the Mexican peso which was attacked in late 1994 and floated shortly after an unsuccessful devaluation. Speculative attacks on other Latin American countries occurred immediately. The most prominent targets of the «Tequila Hangover» were especially Argentina and Brazil, but also including Peru and Venezuela. The attack on the United Kingdom in September 1992 and sterling's subsequent depreciation are said to have damaged the international competitiveness of the Republic of Ireland, for which the UK is the single most important export market, and to have provoked the attack on the punt at the beginning of 1993. Attacks on Spain in 1992-3 and the depreciation of the peseta are said to have damaged the international competitiveness of Portugal, which relies heavily on the Spanish export market, and to have provoked an attack on the escudo despite the virtual absence of imbalances in domestic fundamentals.

These contagious crises have been widely studied in the west after the chain of currency crises in the beginning of 90s. Perhaps the first systematic theoretical treatment of this question was due to Gerlach and Smets (1995). Inspired by the links between the fall of the Finnish markka in 1992 and the subsequent attack on the Swedish krona, they consider two countries linked together by trade in merchandise and financial assets. In their model, a successful attack on one currency rate leads to its real depreciation, which enhances the competitiveness of the country's merchandise exports. This produces a trade deficit in the second country, a gradual decline in the international reserves of its central bank, and ultimately an attack on its currency. A second way for contagion is the impact of crisis and depreciation in the first country on the import prices and the overall price level in the second. Post-crisis real depreciation in the first country reduces import prices in the second. In turn, this reduces its consumer price index and the demand for money by its residents. Their efforts to change domestic currency for foreign exchange then deplete the foreign reserves of the central bank. This may shift the second economy from a no-attack equilibrium, in which reserves are enough to absorb the volume of possible speculative sales to a second equilibrium in which an attack can succeed and in which speculators thus have an incentive to launch it.

Barry Eichengreen, Andrew Rose and Charles Wyplosz performed an encompassing empirical work providing the evidence for the contagion of crises in 1997. The paper analyzes the contagious nature of currency crises empirically. A panel of quarterly macroeconomic and political data covering twenty industrial countries from 1959 through 1993 (a total of 2800 observations) was analyzed. The authors posed the following question: is the incidence of a currency crisis in a particular country at a given point in time (e.g., France in the third quarter of 1992) correlated with the incidence of a currency crisis in a different country (e.g., the United Kingdom) at the same point in time, even after taking into account the effects of current and lagged domestic macroeconomic and political influences? The finding of a strong positive partial correlation was consistent with the existence of contagion, since it implies that speculative attacks are temporally correlated even after conditioning on domestic factors. Using data for 20 industrial countries spanning more than three decades, a large set of empirical specifications failed to reject the hypothesis of contagion at high levels of significance. The authors found that a speculative attack elsewhere in the world increases the probability of an attack on the domestic currency. Without conditioning on the size or relevance of these other attacks, their best estimate is that attacks on foreign currencies raise the probability of a domestic attack by eight per cent. But this does not disprove the hypothesis of common unobservable shocks, nor does it identify the channels by which contagion is transmitted. Accordingly, the authors have also tested for contagion in foreign exchange markets using a framework that distinguishes two channels of international transmission of speculative attacks. The first channel is trade links, and the hypothesis is that attacks spill over contagiously to other countries with which the subject country trades. The second channel is macroeconomic similarities, where the hypothesis is that attacks spread to other countries where economic policies and conditions are broadly similar. The effect of contagion operating through trade proved to be stronger than that of contagion spreading as a result of macroeconomic similarities.

Finally, a work of Reuven Glick and Andrew K. Rose, 1998 analyzes the contagious nature of the recent waves of speculative attacks. The authors provide empirical support for the hypothesis that patterns of international trade are important in understanding how currency crises spread, above and beyond any macroeconomic phenomena. Using data for five different currency crises (in 1971, 1973, 1992, 1994, and 1997) they show that currency crises affect clusters of countries tied together by international trade. That is, countries may be attacked because of the actions (or inaction) of their neighbors, who tend to be trading partners merely because of geographic proximity. The authors find the implications of this externality important for policy. If this effect exists, it is a strong argument for international monitoring. A lower threshold for international and regional assistance is also warranted than would be the case if speculative attacks were solely the result of domestic factors.

Among the works studying the sensitivity of trade flows on the real exchange rate remarkable are those of Hassan Shirvani and Barry Wilbratte, 1997 and A.-C. Arize, 1996.

In the paper wrote by Hassan Shirvani and Barry Wilbratte from University of Saint Thomas in 1997 the authors present an empirical reassessment of the relationship between the real exchange rate and the trade balance, using the multivariate cointegration approach. Based on bilateral trade between the U.S. and other G7 countries, they found evidence that the trade balance is unresponsive to the exchange rate in the very short run but is significantly affected by it within two years. Note that in the case of the countries of the CIS the real exchange rate was found to affect the trade balance within a quarter. This difference is likely to be attributed to the fact that the real exchange rate is much more volatile among the countries of the CIS than among G7 and the USA. Due to the certain trade barriers like tariffs and quotas, relatively stable real exchange rate of developed countries cannot change the trade balance immediately in contrast to that of the countries of the CIS.

They also find evidence supporting the empirical validity of the Marshall-Lerner condition, indicating that devaluation does improve the trade balance in the long run. The work of A.-C. Arize on Real Exchange-Rate Volatility and Trade Flows in 1996 examines the impact of real exchange rate volatility on the trade flows of eight European economies in the context of a multivariate error-correction model. The advantages of this statistical approach vis-a-vis earlier approaches is that it provides more efficient short-run and long run coefficient estimates and avoids the problems of spurious regressions. The main results show that increases in the volatility of the real exchange rate, approximating exchange rate uncertainty, exert a significant negative effect upon export demand in both the short run and the long run, regardless of whether the countries are members of the European Exchange Rate Mechanism (ERM) or not. Similar analysis was carried out by A.-C. Arize in 1995 on the example of trade flows of Denmark, the Netherlands, Sweden, and

Switzerland in the context of a multivariate error-correction model. This work supports the suggestion that highly volatile real exchange rate is likely to affect the trade balance both in short run and in long run.

The present paper is structured as follows. First, the section Current Situation provides the data on the actual effect of Russian crisis on the biggest countries of the Commonwealth of Independent States.

The current work will try to answer the following questions: to what extent is ruble devaluation likely to affect the trade with the countries of the CIS and the «soft currencies». For that case a model studying the effect of the real exchange rate change on the balance of payment will be used in the section Model 1. The implications of this model to the relations of Russia with the CIS countries will be considered in the section Experiment 1.

It seems to be interesting to consider the dynamics of this contagious crisis in more details. To model the contagion process a two-country version of Krugman's model of speculative attack is considered in the section Model 2. The model makes the collapse moments of the two countries interdependent and allows us to solve for the collapse times. In section Experiment 2 the collapse times for the countries of CIS are found with the aid of the framework of Model 2.

The paper uses data from Custom Statistics of Russian Federation; Reference book of Interstate Statistical Committee of Independent States 1994 - 1998;International Monetary Fund, Country Reports.

Unfortunately, the accuracy of data leaves much to be desired. Since the Commonwealth exists only eight years and the data collection now still seems to be rather poor there is a certain lack of data. The coefficients required to perform the analysis in the section Experiment 1 are estimated using the quarterly data from 1995, I to 1998, II.

2. Current situation

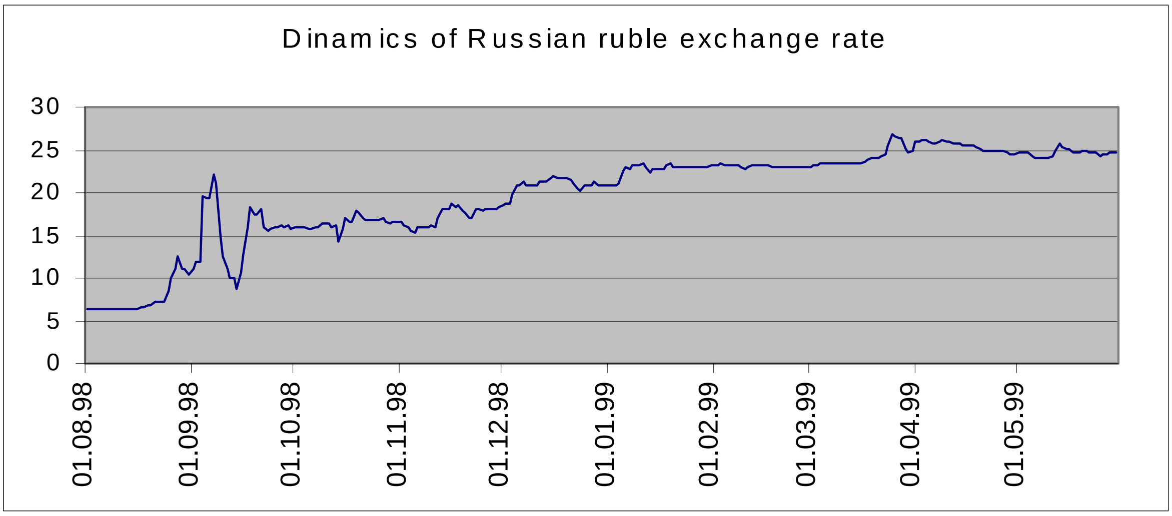
After almost nine months elapsed since Russian crisis of August 17 it can already be seen how it affected the economies of the countries of the CIS. Due to the loss of competitiveness on Russian market these countries faced negative balance of trade. As a result they had to devalue their currencies to different extents. However, the governments of these countries tried to delay the devaluation as long as possible involving some non-market mechanisms as multiple exchange rates, import restrictions and obligatory sale of exporters' foreign currency revenue. Here are some brief facts about this overall influence.

(i) General situation

In August 1998 Russia experienced a substantial fall in ruble exchange rate with respect to US dollar. By the end of August ruble exchange rate declined 26% relative to July. The situation in the other countries of the CIS remained relatively stable except Belarus. During that period Belarus ruble fell 19.6% with respect to US dollar. The growth of all national currencies of the CIS with respect to Russian ruble was observed during this period.

Starting from September 1 Russian Central Bank ceased keeping the ceiling of the currency corridor set to be 9.5RUR/USD and by the end of the first decade Russian ruble devalued more than thrice in comparison to the level of the beginning of the crisis. By the end of September the exchange rate of Russian ruble was stabilized at the level 2 times higher with respect to August. Minor oscillations of ruble exchange rate were observed through October and by the end of October it virtually remained on the level of September. The overall path of ruble exchange rate looks as follows:

By November 1998 the official exchange rates of national currencies of the CIS countries have risen in comparison to the beginning of 1998 by 157% in Belarus, 19.6% in Georgia, 9.7% in Kazakhstan, 67.5% in Kirgizia, 106.8% in Moldova, 17.1% in Tadjikistan, 24.8% in Turkmenistan, 35.3% in Uzbekistan and 80.5% in Ukraine.



(ii) Belarus

In fact, unstable situation on Belarus currency market started long before August 17. The signs of Belarus currency crisis appeared in March 1998 after the National Bank of the Republic of Belarus (NBRB) forced by the government issued in circulation a large amount of money in order to finance government's expenditures at the end of 1997. This did not lead to depreciation of Belarus ruble at once since NBRB was carrying out active intervention policy until after 2 to 3 months the currency reserves were substantially exhausted. Starting from this point Belarus government implemented restraining policies that led to the transition to multiple exchange rates. For example, non-resident companies now could not obtain Belarus currency, they could only transfer BYBs (Belarus rubles) to Belarus companies. Non-resident banks started to get rid of Belarus rubles at any exchange rate rising dollar to 65,000 – 70,000 BYB/$ in non-cash transaction from about 40,000 BYB/$. Black market cash exchange rate went up to 46,000 – 49,000 BYB/$.

The response of Belarus currency market to Russian crisis was very rapid. It was already on August 19 that market exchange rate of Belarus ruble has fallen from 68,000 to 80,000 BYB/$, the official exchange rate of Belarus ruble being mantained at an artificially low level of some 44,000 BYB/$.

Though NBRB assured that the steps to minimize the impact of Russian crisis had already been taken, the crisis did affect Belarus economy substantially. Belarus exports to Russia fell 28% in September, 1998 in comparison to August 1998. Since the main items of Belarus export are the products of oil processing, the world prices for which fell substantially during 1997 – 1998, Belarus lost additionally $29 million during that period. All this caused further fall of Belarus ruble.

By the end of 1998 at least five exchange rates of Belarus ruble existed: the official rate set by the National Bank (53,000 BYB/$), non-resident exchange rate (170,000 - 180,000 BYB/$), local interbank rate (200,000 – 250,000 BYB/$), banking cash rate (74,000BYB/$) and black market cash rate (100,000 – 115,000 BYB/$).

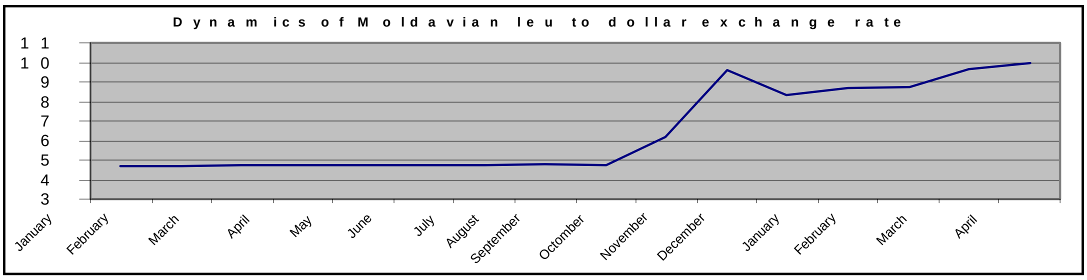
In order to stop the rise of BYB exchange rate Belarus government imposed certain restrictions in order to decrease the demand for foreign currency. These restrictions are mainly directed to non-residents and their accounts in Belarus banks and importers. Limited access to the interbank exchange is also a practice in Belarus.

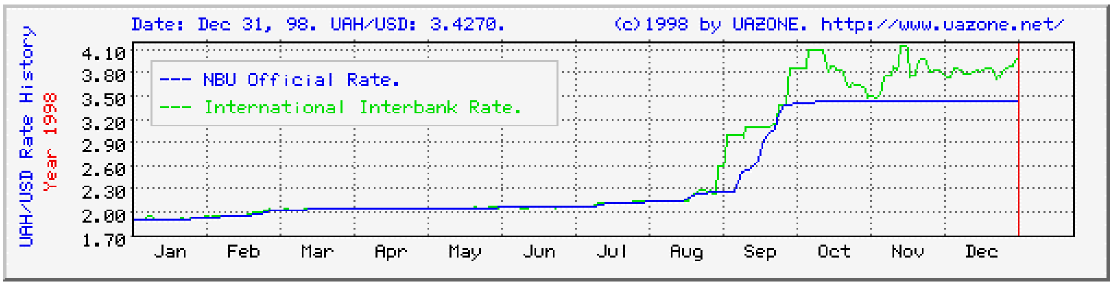
(iii) Ukraine

By the end of 1998 crisis situation occurred on currency market of Ukraine. Difficult financial situation and the impossibility to stand the influence of Russian crisis caused remarkable fall of the exchange rate of Ukrainian hryvnia. By the end of September the exchange rate of hryvnia with respect to US dollar decreased 51% relative to August. Nevertheless, National Bank of Ukraine did not completely abandon the pegged exchange rate as Russian Central Bank did. Instead, it followed the policy of shifting the currency corridor. Starting from February 10 a new currency corridor was set for Ukrainian hryvnia by National Bank of Ukraine. The exchange rate was allowed to vary within 3.4 to 4.6 UAH/$ till the end of 1999. The preceding corridor was set on September 5 from 2.5 to 3.5 UAH/$. The official exchange rate in October amounted to 3.427UAH/$. This figure was sustained for four months by virtue of total demolishing of legal currency market. Banks and enterprises were allowed to buy foreign currency only on currency exchange and only for certain import contracts and even this rule was not always held. The average daily volume of trade on Ukrainian Interbank Exchange amounted to $1 million, the excess demand being $100 thousand. The black market exchange rate was often higher than 4 UAH/$. The change in the boundaries of the exchange rate corridor is the condition of IMF for obtaining next credits.

In February, 1999 foreign currency reserves of National Bank of Ukraine amounted to $1.049 billion. In the first quarter of 1999 Ukraine had to pay $440 million of foreign debt. Credits from IMF of $158 million and $150 million from World Bank were expected in March.

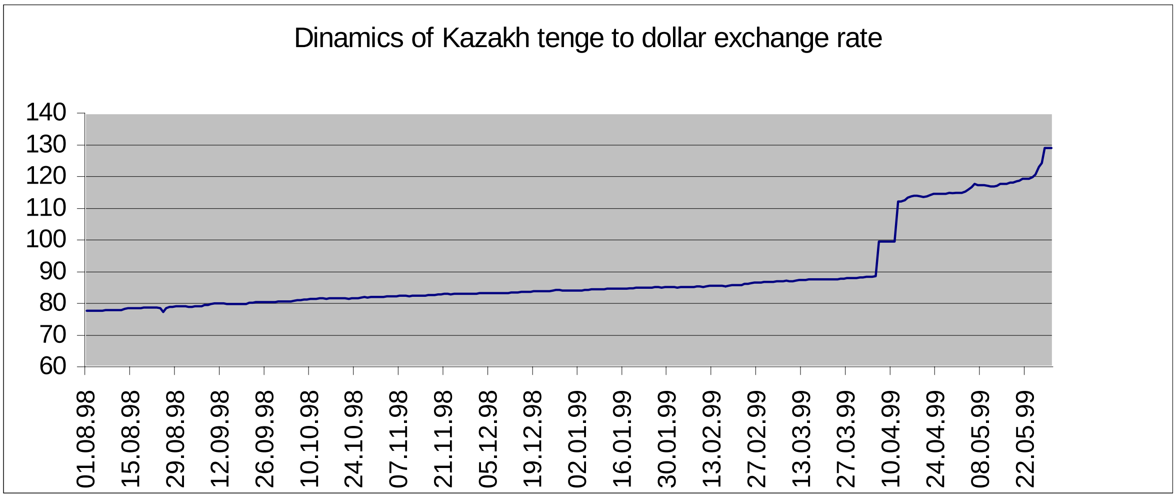
Exports to Russia fell 32% in September 1998 in comparison to August 1998. The total trade balance is negative and due to the fact that trade balance with Russia is also substantially negative the rates of hryvnia devaluation should be adjusted to the dynamics of ruble to dollar exchange rate in order to retain price competitiveness on Russian market**.**





(iv) Kazakhstan

The national currency of Kazakhstan seemed to be the most resistant to Russian crisis until April 5 when the central bank of Kazakhstan floated the currency, the tenge in response to heavy pressures on reserve levels and the need to improve export competitiveness. As the defense of the currency ceased, effective



depreciation brought down the tenge by as much as 40%. Though these measures were scarcely enforceable, they seem to have delayed the float of tenge. During the peg regime official currency reserves shrunk by an estimated $0.5 billion in 1998 to $1.9 billion.

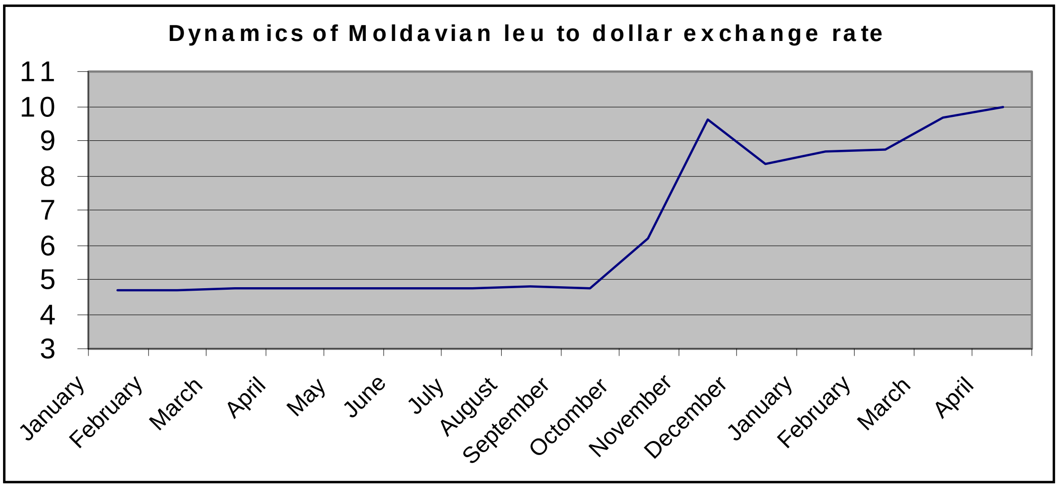
The devaluation should be beneficial by bringing down the overvalued KZT (Kazakh tenge) to competitive levels, thereby eliminating the need for recent trade barriers erected to curb cheaper CIS imports.

Kazakhstan could not resist the slump in world oil and metal prices and the deep crisis in Russia. Fuel (mainly oil) and metals make up about 40% and 35% of Kazakh export respectively. Total exports represent almost 30% of GDP, of which more than 40% is directed to CIS countries with Russia absorbing over 30%. In result the trade deficit widened from under 2% of GDP in 1997 to some 6% of GDP, which is about $1.3 billion. The current account deficit has also widened from 4% of GDP in 1997 to 8% in 1998.

Such late timing of the devaluation may be attributed to the facts that Russian crisis indeed did not affect Kazakh economy that much. In addition, Kazakh government implemented protective policies in order to keep the exchange rate, such as protective import tariffs, running contrary to the principles of the customs unions with Russia and Central Asian Free Trade Zone. For example, temporary customs duties of 200 percent on certain foodstuffs, alcohol and tobacco products imported were imposed. IMF loan of $217 million obtained in December 1998 also delayed the currency float.

(v) Moldova

National Bank of Moldova refused to support the exchange rate of leu by currency interventions what caused the fall of one of the most stable currencies of the CIS.



By the end of October the leu exchange rate with respect to US dollar decreased 28.9% relative to September.

During first two months of 1999 negative trade balance of $17.3 million was first registered in the recent eight years of trade relations with Russia. The negative sign of it is caused by the cut of export of meat, sugar and cigarettes; export of vine shrunk by 82%. The total volume of Moldavian export to Russia reduced by about 71%, import from Russia dropped by 33%. Trade deficit with Ukraine amounted to $10.6 million, which is $5.6 million less than it used to be before.

3. Model 1

In this work a simple model which explains the dependence of current account of a country on real exchange rate is used. Like all models it does not seem to explain everything but it tends to account for the main outcomes of devaluation.

Consider an economy whose domestic currency price of goods is P. Given the foreign currency price level P^* and domestic currency price for foreign exchange e, the real exchange rate is defined as:

$$p = eP^*/P$$

Define now the functions of foreign demand for our goods and home demand for imported goods as functions of the real exchange rate:

$$M^* = M^*(p) \quad M = M(p,Y)$$

The Trade balance, measured in terms of domestic output is equal to the excess of exports over imports:

$$T = M^*(p) - pM(p,Y)$$

It is interesting that the increase in relative price of imports here does not necessarily improve the trade balance. Though our goods are more competitive now and imports decline in real terms, we now pay more per unit of import. The condition under which cost effect dominates and thus, exports and imports in real terms are price inelastic was introduced by Marshall and Lerner and it will be dealt closer further.

Define now the price elasticity of foreign demand for our goods and domestic demand for imports as follows:

$$\alpha^* = (\partial M^*/\partial p)p/M^* > 0 \quad \alpha = -(\partial M/\partial p)p/M > 0$$

Differentiating now the relation for trade balance we obtain:

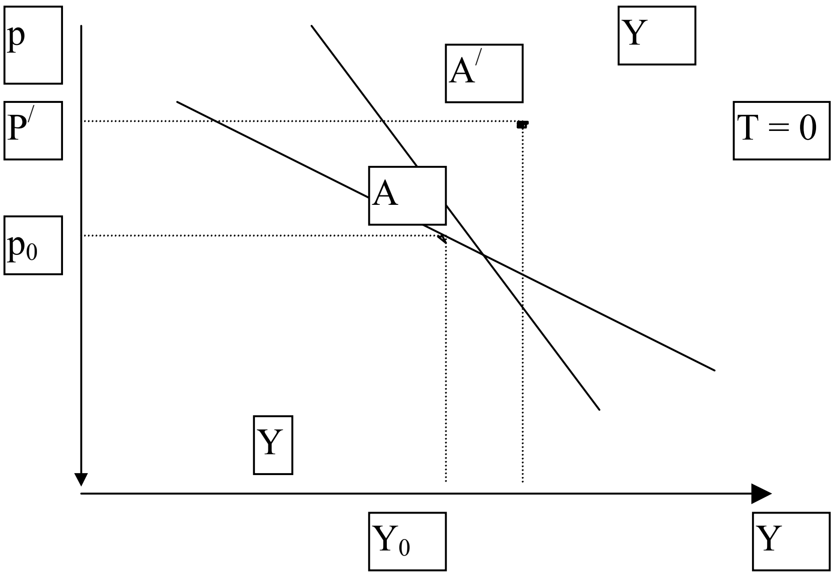
$$\partial T/\partial p = \partial M^*/\partial p - M - p\,\partial M/\partial p = M(\alpha^* + \alpha - 1),$$

Here the initial trade balance is assumed to be zero, so that $M^* = pM$. It is seen now that Marshall-Lerner condition boils down to $\alpha^* + \alpha > 1$. We shall see that for our problem this condition is satisfied.

Now add the equilibrium condition which tells us that aggregate spending by domestic residents *E* plus net exports *T* equal output:

$$Y = E(Y) + T(p,Y)$$

Now introduce two more variables: $1-s = \partial E/\partial Y$ $(0<s<1)$- marginal propensity to spend and $-m = \partial T/\partial Y$- marginal propensity to import.



The schedule YY on the graph represents the equilibrium on the goods market, its slope is provided by Marshall-Lerner condition. The slope of the YY schedule is given by:

$$dp/dY = (s+m)/M(\alpha^* + \alpha - 1)$$

We assume that economy is in equilibrium any moment and therefore, moves along YY curve. A movement up results in growing trade surplus and visa versa. The schedule is flatter the higher the price responsiveness of exports and imports and the higher the propensity to spend on domestic goods $d=1-s-m$.

The schedule T=0 represents the points where trade is balanced. The slope of this curve is given by

$$dp/dY = m/M(^{*}\alpha^{*} + \alpha - 1)$$

The schedule T=0 is thus flatter than YY and positively sloped.

Now suppose that there is a change in p and $dp/p = \hat{p}$. If the economy was initially in point A with balanced trade then now we are in point $A^{/}$ with higher output and trade surplus. From the relation for the equilibrium of the goods market the change in Y is given by:

$$dY = [M^{*}(\alpha^{*} + \alpha - 1)/(s + m)]\,\hat{p}$$

Thus, the trade effect of depreciation can be calculated as:

$$dT = M^{*}(\alpha^{*} + \alpha - 1)\,\hat{p} - mdY = [s/(m + s)]M^{*}(\alpha^{*} + \alpha - 1)\,\hat{p}\ (*)$$

Now imagine ourselves to be one of the countries of the CIS. The trade balance of our country can be given as $T = T_{rus} + T_{others}$, where T_{rus} stands for the net export to Russia and T_{others} for the net exports to other countries. According to statistics, all of the countries of the CIS had nearly balanced trade with Russia by August 17, thus we can use the model described above for measuring the change in T_{rus} separately. Note also that for different countries of the CIS T_{rus} takes from 60 to 80 per cent of the total T. The devaluation of Russian ruble means that p fell and trade balance is likely to reduce by dT calculated by equation (*).

If our country implements the policy of fixed exchange rate, we now are able to estimate the effect of the ruble devaluation on the reserves of national central bank.

$$dR = C + dT = CA,$$

where C is capital account, CA is current account and dR is the change of national bank reserves. Given the initial amount of reserves R_0 one can guess whether it is likely that the government devalue the national currency or not.

4. Experiment 1

In this part the attempt to estimate the parameters α^*, α, s and m was made. To do this quarterly data on exports and imports between Russia, Ukraine, Belarus and Kazakhstan from the Collection of Custom Statistics of Russian Federation was used as well as the data on exchange rates, price levels and GDP from the Statistical Reference Book written by Interstate Statistical Committee of the Commonwealth of Independent States.

The coefficients α and α^* were estimated by the model:

$$\ln M_i = C + \alpha \ln p_i + \varepsilon_i \quad \text{and} \quad \ln M^*_i = C + \alpha^* \ln p_i + \varepsilon_i$$

The short form of the models is justified by the small number of observations (14 observations, from 1995, I to 1998, II). The constant is included since the price levels and therefore, the real exchange rate p are determined by the tables up to a constant.

The coefficients s and m were estimated in a similar way through the models:

$$\Delta E_i = (1 - s)\,\Delta Y_i + \varepsilon_i \quad \text{and} \quad \Delta T_i = - m \Delta Y_i + \varepsilon_i$$

In order to substitute for real values dollar values of T, M, M^*, E and Y were taken. The analysis was carried out for Ukraine, Belarus and Kazakhstan and here it is in more detail.

(i) Ukraine.

In the structure of Ukrainian import from Russia prevail energy products: crude oil, gas, processed oil. They account for about 77 per cent of the total Ukrainian import from Russia. As for Ukrainian export to Russia, it mainly includes the items of the products of metal processing (31.3%), chemical and oil processing (6.7%), machinery (32%) and agriculture (7.2%). Since the weight of processed products is relatively high in Ukrainian export, Ukrainian export is likely to be very sensitive to devaluation in Russia since processed products are less competitive and it is harder to find new markets for them.

Note that the weight of Russia in the trade of Ukraine with the countries of CIS amounted to 85.9% by the end of 1997. The weight of the countries of the CIS in the total Ukrainian trade was 44%. Thus, our model will allow for the change of 38% of the Ukraine's trade balance.

Real exchange rate elasticity of the foreign demand for export and domestic demand for import proved to be:

α^*:

LS // Dependent Variable is LIMPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.619660	16.23967	0.415653	0.685
LREAL	0.934745	7.243874	1,898052	0,082

R-squared	0.237541	Mean dependent var	14.066995
Adj. R-squared	0.257613	S.D. dependent var	0.3384345
S.E. of regression	0.198735	Akaike info criterion	-2.312636
Sum squared resid	0.436254	Schwarz criterion	-2.213242
Log likelihood	3.264532	F-statistic	0.336546
Durbin-Watson stat	1.452437	Prob(F-statistic)	0.475346

α:

LS // Dependent Variable is LEXPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.330559	19.91205	0.181782	0.858
LREAL	0.407260	4.314184	1.715152	0.112

R-squared	0.374714	Mean dependent var	14.37628
Adj. R-squared	0.376136	S.D. dependent var	0.192982
S.E. of regression	0.198464	Akaike info criterion	-3.102736
Sum squared resid	0.472653	Schwarz criterion	-3.011442
Log likelihood	3.854012	F-statistic	0.291825
Durbin-Watson stat	1.749567	Prob(F-statistic)	0.638936

The propensities to spend and to import turned to be:

$$s = 0.5242 \quad m = 0.09191$$
$$(0.002) \qquad\qquad (0.044)$$

Thus, assuming that $\hat{p}$ is equal to 2/3 what seems to reflect the real situation in Russia by the end of 1998, the change in the Ukraine's net export to Russia in the coming year will amount to:

$$\Delta T_{rus} = -\$757 \text{ million}$$

Ukraine's exchange rate by August, 1998 could be called fixed since National Bank of Ukraine interfered in currency auctions. Thus, if the National Bank sustains fixed grivna, it is likely that it will face the \$0.8 million cut in reserves, what means that the reserves nearly clear. Thus, it is very likely that National Bank of Ukraine will devalue grivna.

The actual change in the trade balance was not so large as it is predicted. Russian imports from Ukraine decreased a lot almost as much as it is predicted by the model, however, the contrarily to the prediction, the Ukraine's imports from Russia did not rise, moreover they actually fell and this fall is likely to be attributed to the evaluation of hryvnia implemented by Ukrainian government rather rapidly.

(ii) Belarus

Belarus export to Russia consists mainly of trucks, tractors, tires and products of chemical processing. Belarus import from Russia includes mainly raw materials, mostly gas, oil, coal. Belarus export to Russia is even less competitive than that of Ukraine due to its high extent of processing.

Of the CIS countries Belarus seems to be the most closely related to Russia. 66 per cent of Belarus trade is within the CIS, of which 79.5 per cent is taken by Russia. Thus, the trade with Russia accounts for 52 per cent of the total Belarus trade.

Applying to Belarus the same treatment as to Ukraine we can obtain real exchange rate elasticity of demand for export and import. Demand for Belarus export proved to be more real exchange rate elastic than that of Ukraine:

α^*:

LS // Dependent Variable is LIMPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.645672	19.16450	0.751215	0.467
LREAL	1.277735	7.348568	1.607145	0.134
R-squared	0.256346	Mean dependent var		13.564951
Adj. R-squared	0.257613	S.D. dependent var		0.4235434

S.E. of regression	0.218876	Akaike info criterion	-3.102736
Sum squared resid	0.562238	Schwarz criterion	-3.011442
Log likelihood	4.373591	F-statistic	0.321825
Durbin-Watson stat	1.564978	Prob(F-statistic)	0.573463

α:

LS // Dependent Variable is LEXPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.27869	21.63656	0.347825	0.734
LREAL	0.44585	8.934184	1.340213	0.205

R-squared	0.278961	Mean dependent var	13.734293
Adj. R-squared	0.281764	S.D. dependent var	0.2552595
S.E. of regression	0.215436	Akaike info criterion	-3.625476
Sum squared resid	0.546756	Schwarz criterion	-3.464452
Log likelihood	4.356063	F-statistic	0.236345
Durbin-Watson stat	1.974353	Prob(F-statistic)	0.687936

Propensity to spend and to import are:

$$s = 0.456819 \qquad m = 0.178151$$
$$(0.048) \qquad (0.021)$$

From this it can be inferred that Belarus is more import dependent than Ukraine. Finally, the change in Belarus net export due to ruble devaluation (assume $\hat{p}$ be equal to 2/3 as before) is:

$$\Delta T_{rus} = -\$1.795\ billion$$

Note that this amounts to more than 16 per cent of Belarus GDP ($11 billion in 1996). This result is more than striking and it may be partially attributed to the lack of accuracy of Belarus data and to possible mistakes due to the multiple exchange rate of Belarus currency. Anyway, it seems to be clear that the outcomes of ruble devaluation for Belarus can be the most severe in the CIS.

Belarus sustains flexible exchange rate with multiple exchange rates. Thus, the change in the trade balance will just add approximately $\Delta T/T$ to the long run depreciation of Belarus ruble what is equal to 84.5 per cent.

The predicted values of the fall of Russian imports from Belarus are lower than actual values observed in the 3rd and the 4th quarters of 1998. Likewise Ukraine, actual Belarus imports from Russia fell, though a rise in imports is expected. There is no any rise in imports from Russia since Belarus currency is virtually floating, while the model considers the neighbor's currency fixed. Therefore, Belarus trade partially adjusted to the terms of trade through the depreciation.

(iii) Kazakhstan

The structure of Kazakh export to Russia is following: the major part is taken by energy products (31.4%), mainly oil and coal, ferrous and non-ferrous ore (8.2%), chemical products (13.9%). Russia instead exports machinery, equipment and means of transportation (32.8%), energy products (23.8%), steel products (7%). It is seen that in contrast to Ukraine and Belarus Kazakhstan exports mainly raw materials to Russia importing processed items. Thus, it can be expected that Kazakhstan will suffer the less from ruble devaluation.

Kazakh real exchange rate elasticity were estimated to be:

α^*:

LS // Dependent Variable is LIMPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.252386	17.34679	1.327639	0.2097
LREAL	0.722856	3.317198	1.634955	0.1288

R-squared	0.437415	Mean dependent var	13.43276
Adj. R-squared	0.439643	S.D. dependent var	0.184949
S.E. of regression	0.158261	Akaike info criterion	-3.102423
Sum squared resid	0.347263	Schwarz criterion	-3.013185
Log likelihood	4.864112	F-statistic	0.371431
Durbin-Watson stat	1.884561	Prob(F-statistic)	0.438318

α:

LS // Dependent Variable is LEXPORT
Date: 06/10/99 Time: 15:37
Sample: 1995:1 1998:2
Included observations: 14

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.175383	19.43546	0.604143	0.5577
LREAL	0.524653	3.613184	1.616293	0.1325

R-squared	0.423784	Mean dependent var	13.32385
Adj. R-squared	0.429731	S.D. dependent var	0.200215
S.E. of regression	0.167392	Akaike info criterion	-3.443756
Sum squared resid	0.342557	Schwarz criterion	-3.314653
Log likelihood	4.253856	F-statistic	0.311287
Durbin-Watson stat	1.863644	Prob(F-statistic)	0.598936

The propencity to spend and to import are:

$$s = 0.67624 \qquad m = 0.3138$$
$$(0.032) \qquad (0.044)$$

The effect of ruble devauation on Kazakh net export tends to be:

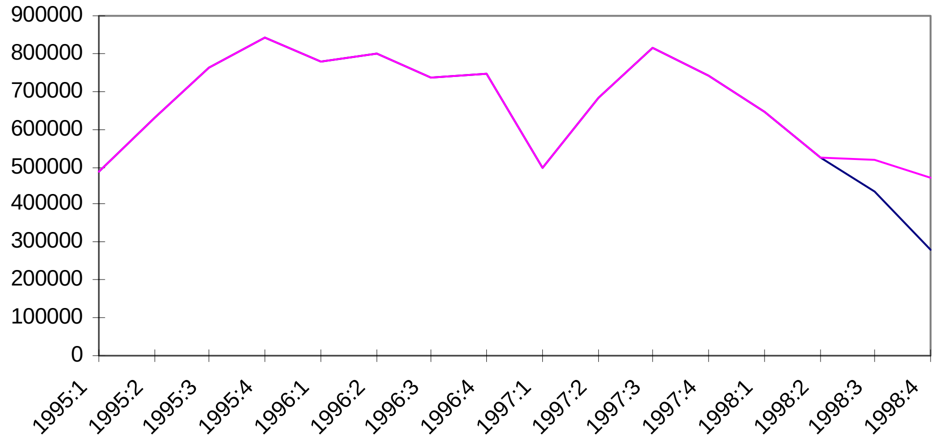
$$\Delta T_{rus} = -\$303.9 \text{ million}$$

Thus, given Kazakh GDP in 1996 equal $16 billion, it can be assumed that ruble devaluation will be of a minor effect on Kazakh economy.

protection of the home market from cheap import from Russia. The actual trade

Actual change in Russian imports from Kazakhstan is more severe than the model predicts, however, Russian export from Kazakhstan also fell due to the Kazakh policies directed to the

Russian imports from Kazakhstan



deficit by 4th quarter of 1998 is almost zero, though the predicted value is substantially negative. This effect may be attributed to the policies implemented in order to save the fixed exchange rate regime.

In most cases the real situation in trade does not match to the prediction of the model since the model assumes the national currency exchange rate and the rate of protection policies to be fixed. It is likely that the governments of the countries of the CIS foresaw the possible trade balance deficit and implemented certain policies in order to avoid it. Most countries of the CIS devalued very soon after the change in terms of trade occurred and therefore, did not experience the predicted trade balance deficit. Kazakhstan, who kept its currency fixed through the 3rd and the 4th quarters, restricted the growth of import from Russia, thus making trade balance clear.

5. Model 2

This model can be considered to be the extension of Krugman's model of currency crisis to the two-country case. The countries are free to influence on each other's economies through the fact that each of the countries has a certain proportion of the products of the other country in the consumption basket. The other way for influence is that the demand for domestic product in each country depends on the real exchange rate.

All variables except interest rates are in natural logarithms. Term r used in the model stands for $ln(1+i)$, where i is interest rate or if i is small enough it may be thought that $r = i$. We consider two countries which are countries 1 and 2, where country 1 is the leader, the country 2 being the follower in currency crisis. However, both countries initially are considered symmetrical and all the equations for both countries are exactly the same. All variables are assumed to be dependent on time.

First comes the equation for the demand for money:

$$m_i - p_i = y_i - \gamma_i r_i, \quad i = 1, 2 \qquad (1)$$

Here m denotes money stock, p is domestic price level, y is the level of real income and r is the nominal interest rate.

In addition to the two countries under consideration it is assumed there exists a third country to which both countries initially peg their currencies (say United States). Denote the nominal interest rate in the third country by r^*. Then uncovered interest parity implies that

$$r_i = E\dot{s}_i + r^*, \quad i = 1, 2 \qquad (2)$$

where s_i denotes logarithm of the price of one unit of the third currency in terms of currency i.

The three countries produce separate goods and the domestic price level of one of the two countries p_i is a weighted average of the domestic currency price of the three goods. Assuming that the price of the goods of the two countries is determined by the wage level in the country of production, the domestic price level is:

$$p_i = \alpha_i w_i + \varepsilon_i(w_i + s_{i,j}) + (1 - \alpha_i - \varepsilon_i)(p^* + s_i), \qquad (3)$$

Here w_i stands for the wage level in country i, $s_{i,j} = s_i - s_j$ is the cost of one unit of currency j in terms of currency i, p^* is the price of the third-country good, α_i and ε_i are the weights of competing goods of countries 1 and 2 in country's i consumption basket. It is remarkable that setting these weights equal zero will take us to the standard speculative attack model and equation (3) will turn to the equation for purchasing power parity.

Now turn to the behavior of wages. Since countries 1 and 2 produce competing goods and since there are no real disturbances, units of labor cost must be identical in the long run. In the short run, however, goods market arbitrage is imperfect and wages are sticky, so that labor costs may differ in the two countries. In order to account for this stickiness of wages assume that the rate of change of nominal wages depends on some measure of core inflation and on the output gap,

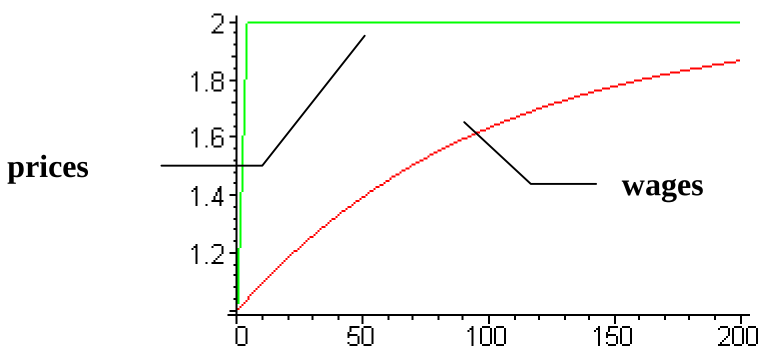
$$\dot{w}_i = c_i + \psi(y_i - \bar{y}), \quad i = 1,2 \qquad (4)$$

where ψ measures the rate of adjustment of wages to excess demand. If ψ is infinity real wages adjust instantaneously and output always equals potential output. As for the core inflation, we assume that it adjusts only sluggishly to actual inflation,

$$\dot{c}_i = \delta(\dot{p}_i - c_i), \quad i = 1,2 \qquad (5)$$

where δ measures the sensitivity of adjustment of core inflation to actual inflation: the larger is δ, the faster wages adjust to changes in prices. However, in the steady state nominal wage growth and core and actual inflation are equal. Thus, the term of core inflation here is introduced in order to model the wage stickiness. For $\delta = 1$ wages adjust to prices like:

When $\delta = 0.01$, wages almost never adjust to prices



Finally, assume that aggregate demand for the domestic good is inversely related to the real exchange rate:

$$y_i = \beta(s_{i,j} + w_j - w_i), \qquad i, j = 1, 2 \qquad (6)$$

To interpret this, remember that $s_{i,j} + w_j$ denotes the wage level in country j expressed in terms of currency i. The parameter β captures the degree of substitutability of goods of country 1 and 2. If $\beta = \infty$, the goods of the both countries are perfectly substitutable.

Turning to the monetary side of the model, we assume for simplicity that the money multiplier is constant (and normalized to zero) so that the money supply equals the sum of central bank holdings of domestic assets, D_i, and the domestic currency value of the foreign exchange reserves, R_i. The following equation is the log-linear approximation for this identity:

$$m_i = \eta D_i + (1 - \eta)R_i, \qquad i = 1, 2 \tag{7}$$

where η denotes the equilibrium fraction of the central bank's assets that is held in the form of domestic assets. We close the model with the assumption that domestic credit growth is endogenously determined and is given by

$$\dot{D}_i = \mu_i, \; i = 1, 2 \tag{8}$$

We may further normalize all the equations, setting $y = i^* = p^* = 0$. If we also assume the perfect foresight, $E\dot{s}_i = \dot{s}_i$ and combine equations (1), (2) and (3) we get

$$m_i = \alpha_i w_i + \varepsilon_i (w_j - s_j) + (1-\alpha_i)s_i + y_i - \gamma_i \dot{s}_i, \quad i = 1,2 \tag{9}$$

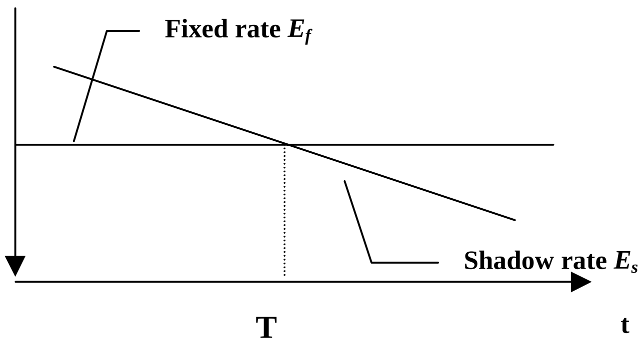
Under fixed exchange rates the central bank accommodates any change in the domestic demand for money through the purchase or sale of international reserves. Setting $s_i = \bar{s}_i$ (where $\bar{s}_i$ is the fixed exchange rate level) and $\dot{s}_i = 0$, one can derive the evolution of international reserves. To see this, substitute (6), (7) and (8) in (9) and solve for R_i.

$$R_i(t) = \frac{(1-\alpha)\bar{s}_i - \eta D_{0i}}{1-\eta} - \frac{\eta}{1-\eta}\mu_i t + \frac{\alpha}{1-\eta} w_i(t)$$

$$+ \frac{\varepsilon}{1-\eta}(w_j(t) - s_j(t)) + \frac{1}{1-\eta} y_i(t) \tag{10}$$

This equation shows that the stock of reserves falls gradually over time as the central bank expands credit. Furthermore, the stock of reserves depends positively on the price of the goods of both countries determined by wage rates in these countries, and negatively depends on the exchange rate of the neighbor country. Thus, having country 1 with floating exchange rate and country 2 with fixed exchange rate, it can be seen that depreciation of the currency 1 negatively affects foreign reserves of country 2 in two different ways. First, the depreciation reduces the prices of goods of country 1 in country 2 and therefore, the price level of country 2. Secondly, since wages are sticky, the floating of currency 1 leads to a loss of competitiveness in country 2. The resulting deflationary pressures on wages and output also reduce the demand for money, which in turn leads to capital outflows and reserve losses. Thus, the collapse of country's 1 parity speeds up the collapse of country's 2 parity.

To determine the moments of collapse we will use Krugman's framework of perfect foresight. That means that the exchange rate will have to be abandoned before the central bank has completely exhausted its reserves through debt monetization. It is assumed that in the country with fixed exchange regime every moment of time there exists the so-called shadow exchange rate parallel to the fixed level. This rate indicates what exchange rate would be if the crisis occurs in the given moment.



It is assumed that the exchange rate should move smoothly and cannot jump. This will help us to find the timing of the crisis from the intersection of the shadow exchange rate line and fixed exchange level. The reason for this framework is following. The crisis cannot occur before point *T* since if the speculators buy all the central bank's reserves, the currency exchange would immediately appreciate to reach the shadow rate. Anticipating a large negative return on the speculations against home currency no one would like to attack the central bank before time *T*. Neither can the crisis occur after point *T* since that would mean that the exchange rate path makes a jump. Such a jump implies an instantaneously infinite rate of capital gain, and therefore presents an incipient arbitrage opportunity that motivates speculators to buy all the central bank's remaining reserves before they gradually reach zero on their own.

To find both collapse times we will have to consider the model under three regimes. The first one is the simplest, both countries still peg their currencies. In the second regime country 1 has already floated its currency, while country 2 still have the exchange rate fixed. Finally, the third regime corresponds to the case when both currencies float.

We start by solving the system of differential equations in the 3rd regime. Both currencies are floating and international reserves are zero. Substituting equations (6), (7) and (8) in (9) and solving for $\dot{s}_i$ gives two equations determining the changes in the forward-looking exchange rates. Substituting equation (6) in (4) gives another two equations determining the change in nominal wages in both countries. Finally, equation (3) and the first four equations of our system can be used to derive the last two equations for the core inflation. Together this gives the system of differential equation:

$$\frac{d\mathbf{x}(t)}{dt} = M\mathbf{x}(t) + \mathbf{b}(t)$$

where **x** is the vector $\begin{bmatrix} s_1(t) \\ s_2(t) \\ w_1(t) \\ w_2(t) \\ c_1(t) \\ c_2(t) \end{bmatrix}$, matrix *M* and vector *b(t)* are presented in Appendix (I).

Matrix *M* has four negative eigenvalues and two positive eigenvalues. Using the transversality condition to rule out the divergent paths, we get the general solution of the homogeneous system with four constants of integration. Using the method of undetermined coefficients find a particular to the non-homogeneous solution. Adding the two together leads to the following general solution:

$$\begin{bmatrix} s_1^3 \\ s_2^3 \\ w_1^3 \\ w_2^3 \\ c_1^3 \\ c_2^3 \end{bmatrix} = \begin{bmatrix} \eta(D_{01}+\gamma_1\mu_1) \\ \eta(D_{02}+\gamma_2\mu_2) \\ \eta(D_{01}+\gamma_1\mu_1) \\ \eta(D_{02}+\gamma_2\mu_2) \\ \eta\mu_1 \\ \eta\mu_2 \end{bmatrix} + \begin{bmatrix} \eta\mu_1 \\ \eta\mu_2 \\ \eta\mu_1 \\ \eta\mu_2 \\ 0 \\ 0 \end{bmatrix} t + \sum_{k=1}^{4} \vec{A}_k A_k e^{\rho_k t} \qquad (11)$$

where subscript 3 denotes the number of the regime under consideration, $\vec{A}_K$ is the eigenvector corresponding to the negative eigenvalues ρ_k of matrix of system Appendix (I). The four constants of integration A_k are determined by four initial conditions for the wage levels and the core inflation in both countries.

Next we solve for the 2nd regime where country's 1 currency is floating and country's 2 currency remains pegged at level $\bar{s}_2$. The equations of motion are the same as before, except for $s_2^2 = \bar{s}_2$ and $\dot{s}_2 = 0$. Furthermore, the foreign reserves of country 1 have been depleted in the speculative attack and equal zero. The foreign reserves of the country 2 are however positive and follow the equation (10). Thus, the system in the 2nd regime reduces to five equations Appendix (II).

The matrix of this system now has four negative and one positive eigenvalue. We use the same procedure to find the particular solution to find the paths of exchange rates and wages. This results in the following equations:

$$\begin{bmatrix} s_1^2 \\ w_1^2 \\ w_2^2 \\ c_1^2 \\ c_2^2 \end{bmatrix} = \begin{bmatrix} \eta(D_{01}+\gamma_1) \\ \eta(D_{01}+\gamma_1) \\ \bar{s}_2 \\ \eta\mu_1 \\ 0 \end{bmatrix} + \begin{bmatrix} \eta\mu_1 \\ \eta\mu_1 \\ 0 \\ 0 \\ 0 \end{bmatrix} t + \sum_{k=1}^{4} \vec{B}_k B_k e^{\lambda_k t} \qquad (12)$$

As before, $\vec{B}_K$ is the eigenvector correspondent to the eigenvalue λ_k and B_k are the constants of integration found from initial conditions.

As for the 1st regime, rates are fixed there as well as the wages and the core inflation is equal to actual inflation, which is zero. The reserves of central banks are gradually depleted.

Having in mind the condition that the exchange rate cannot jump under the perfect foresight and equations (11) and (12) we may now determine the collapse times of both currencies from conditions:

$$s_2^3(T_2) = \bar{s}_2, \qquad (13)$$

$$s_1^2(T_1) = \bar{s}_1, \qquad (14)$$

We will use the following initial conditions to find the vectors of constants A_k and B_k:

$$w_1^2(T_1) = w_1^1, \qquad w_2^2(T_1) = w_2^1, \qquad (15)$$

$$c_1^2(T_1) = 0,\ c_2^2(T_1) = 0 \qquad (16)$$

$$w_1^3(T_2) = w_1^2(T_2),\ w_2^3(T_2) = w_2^2(T_2) \qquad (17)$$

$$c_1^3(T_2) = c_1^2(T_2),\ c_2^3(T_2) = c_2^2(T_2),\ s_1^3(T_2) = s_1^2(T_2) \qquad (18)$$

6. Experiment 2

Now let us start application of the model described above to the case of Russia and the countries of the CIS.

The model is not expected to give precise quantitative results, instead, it is likely to shed some light to the tendencies of the dynamics of the relation between the countries under consideration. That is why we will not preoccupy with finding the exact values of the coefficients and initial conditions used in the model. It will be quite satisfactory if the cross-country relations of the coefficients and the initial conditions meet the real situation.

First, let us define the parameters of the model. The most general parameters are γ and η. The elasticity of money demand γ is often used in literature in the range between 0.4 and 0.6. This elasticity seems to be lower in the countries of the CIS than in western countries due to the imperfection of assets markets in these countries, therefore it will be supposed that for all countries under consideration $\gamma = 0.4$. The equilibrium share of domestic credit in money supply will be considered to be $\eta = 0.5$.

The two most critical parameters of the model are the degrees of wage stickiness δ and ψ. We will assume δ, which captures the speed with which nominal wages adjust to current inflation to be equal to *0.2*. This implies that it takes four units of time for two-third of inflation to be caught by nominal wages. Note that throughout the model a quarter stands for the unit of time.

Estimation on ψ made by Bini Smaghi and Vori (1993) show low values of ψ of order of 0.1 for developed countries and high values about 0.4 – 0.6 for underdeveloped countries. We here assume $\psi = 0.5$.

Now turn to the parameters of the model, which are crucial in explaining the contagion. These are mainly the proportions which domestic goods, and the goods of the neighbor country take in price index of countries α and ε. In contrast to Gerlach and Smeths (1994) who assumed these parameters unique for both countries we will find these parameters immanent to each country. It is remarkable that these coefficients will differ much across the countries. According to the trade statistics, these parameters are:

	α	ε
Russia	0.699	
Ukraine	0.538	0.179
Belarus	0.359	0.339
Kazakhstan	0.535	0.260
Moldova	0.426	0.262

Note that for Russia parameter ε differs according to relation with which country is considered:

	Ukraine	Belarus	Kazakhstan	Moldova
ε	0.045	0.017	0.019	0.005

Having the data for the domestic credit in these countries it is easy to find the approximation for the rates of credit creation in the countries studied:

	μ
Russia	0.183
Ukraine	0.074
Belarus	0.088
Kazakhstan	0.112
Moldova	0.137

Following the paper of Gerlach and Smets (1994) carry out all necessary normalizations ($r^* = 0$, $p^* = 0$, $y = 0$). Normalizing further the initial exchange rates so that $\bar{s}_1 = \bar{s}_2 = 1$ will allow us to transit to dimensionless variables rather than measuring the initial conditions in terms of national currencies.

This will give us the following initial values of domestic credit and nominal wage rate:

	D0	W_0
Russia	0.904	1.000
Ukraine	0.761	0.769
Belarus	0.775	0.462
Kazakhstan	0.671	0.538
Moldova	0.620	0.385

Furthermore, assume that β, the elasticity of aggregate demand with respect to competitiveness between the two countries, is 0.5. The initial conditions were taken according to the data of 1997 and the starting point is the beginning of 1998, the unit of time is one quarter.

(i) Russia and Ukraine

Let us study first what happens in the absence of contagion. For this purpose solve the equations (11) paying no attention to the exponential part. This will give the following pattern:

The model thus predicts the crisis in Russia to occur in the second half of 1998 which is more or less close to what has happened in fact. It is seen that in absence of contagion Ukrainian shadow exchange rate moves steeper given the rate of credit creation and the government has over three years to change the policy to avoid the exhaust of foreign exchange reserves.

Turning on the contagion brings us to a new equilibrium:

The path of Russian shadow exchange rate changed slightly, while Ukraine now faces a prospective of the crisis in the second half of 1999.

(ii) Russia and Belarus

In the absence of contagion, the model predicts the fall of Belarus currency in the end of 1999.
However, when the contagion is switched on, the picture changes dramatically. It is hard to interpret such a result, though it is tempting to say that Belarus currency could not be sustained under the existing exchange rate almost from the very beginning of 1998. Moreover, this instability of Belarus currency is likely to be attributed to the influence of Russia and were it not for this influence, Belarus currency would be stable till the end of 1999.

(iii) Russia and Kazakhstan

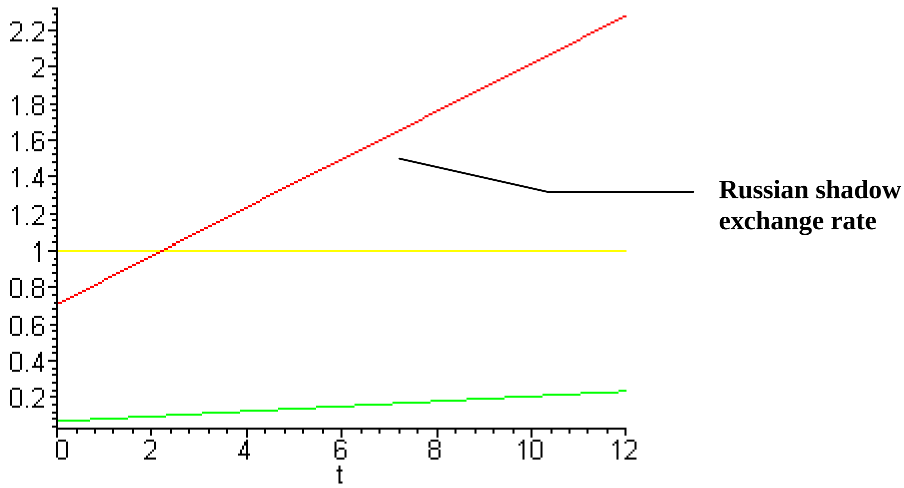
In the absence of contagion Kazakh currency seems to be very stable. If the existing rate of credit creation persists, Kazakh would face currency crisis only in 2003, as the model predicts. The pattern changes when Russia influences Kazakh economy. The model predicts the currency crisis in Kazakhstan in the second quarter of 2000. Though, in practice, Kazakh currency devalued in the first quarter of 1999.

(iv) Russia and Moldova

Were it not for the crisis in Russia, Moldavian currency would be the most stable among the CIS. However, the model predicts currency crisis in Moldova in late 2000 if Russian crisis is taken in consideration. In practice the fall of Moldavian currency started almost together with the Russian crisis. Nevertheless, the model shows that the interstate relation is strong enough to bring the situation to the new equilibrium

Moldavian shadow exchange rate

The case of no relation with Russia



The case of contagion

7. Conclusion

This paper presents a study on the impact of Russian ruble devaluation on the trade between the countries of the CIS and the currencies of these countries. The review presented in the paper shows that this impact was rather remarkable and its outcomes will still long be observed.

The first model presents an attempt to find the real exchange rate elasticities of the demand for import and export and further to solve quantitatively for the change in the foreign exchange reserves of national central banks using the found elasticities. The second model is a dynamic one, which partially explains the contagion effects on speculative attacks against fixed exchange rates applied to the case of Russia and the CIS countries. It is shown here that ruble devaluation affects the competitiveness of the countries whose currencies are still pegged. This increases the speculative pressure and speeds up their collapse. Even if the currency peg is strong enough, the contagion effects can cause a speculative attack and force the depreciation of considered currency. Comparing the effects of Russian crisis on the countries of the CIS one can infer that the contagion effects are stronger the higher the degree of trade integration between the countries and the less integrated the country is with the third anchor country (USA in our case).

8. References

1. Hole, P., Berre, G., 1995, IMF Economic Reviews: Ukraine
2. Lorie, H., Roushdy, J., 1995, IMF Economic Review: Belarus
3. Kapur, I., Bonilla, M., 1995, IMF Economic Review: Kazakhstan
4. Carson, C.S., Bloem, A.M., 1998 IMF Direction of Trade Statistics Quarterly
5. Mikhalopulos, C., Tarr, D., 1992, Trade and payment mechanisms for the countries of the former USSR, International Bank of Reconstruction and Development, Washington, D.C.
6. Belkindas, M.V., Ivanova, O.V., 1995, Foreign Trade Statistics in the USSR and Successor States, The World Bank, Washington, D.C.
7. Mikhalopulos, C., Tarr, D., 1995, External Trade in the New Independent States, World Bank, Washington, D.C.
8. Interstate Statistical Committee of the Commonwealth of Independent States, Commonwealth of Independent States in 1996 (digest of provisional statistical results), 1997, Moscow
9. Statistical Reference Book of Russian Customs, Quarterly 1995 - 1998, Moscow
10. Dornbush, R., Open Economy Macroeconomics, 1980
11. Rogoff, K., Obstfield, M. Foundations of International Macroeconomics, 1996, MIT
12. Gerlach, S., Smets, F., Contagious Speculative Attacks, 1994, European Journal of Political Economy 11(1), 1995

Dynamic system under 3rd regime

$$\begin{bmatrix} \dot{s}_1 \\ \dot{s}_2 \\ \dot{w}_1 \\ \dot{w}_2 \\ \dot{c}_1 \\ \dot{c}_2 \end{bmatrix} = \begin{bmatrix} \frac{1-\alpha_1+\beta}{\gamma} & -\frac{\varepsilon_1+\beta}{\gamma} & \frac{\alpha_1-\beta}{\gamma} & \frac{\varepsilon_1+\beta}{\gamma} & 0 & 0 \\ -\frac{\varepsilon_2+\beta}{\gamma} & \frac{1-\alpha_2+\beta}{\gamma} & \frac{\varepsilon_2+\beta}{\gamma} & \frac{\alpha_2-\beta}{\gamma} & 0 & 0 \\ \psi\beta & -\psi\beta & -\psi\beta & \psi\beta & 1 & 0 \\ -\psi\beta & \psi\beta & \psi\beta & -\psi\beta & 0 & 1 \\ \delta\left[\theta_1+\frac{\varepsilon_1\varepsilon_2+(1-\alpha_1)^2}{\gamma}\right] & -\delta\left[\theta_1+\frac{\varepsilon_1(2-\alpha_1-\alpha_2)}{\gamma}\right] & -\delta\left[\theta_1+\frac{\varepsilon_1\varepsilon_2+\alpha_1(1-\alpha_1)}{\gamma}\right] & \delta\left[\theta_1+\frac{\varepsilon_1(1-\alpha_1-\alpha_2)}{\gamma}\right] & \delta(\alpha_1-1) & \delta\varepsilon_1 \\ -\delta\left[\theta_1+\frac{\varepsilon_2(1-\alpha_1)+\varepsilon_1(1-\alpha_2)}{\gamma}\right] & \delta\left[\theta_1+\frac{\varepsilon_1\varepsilon_2+(1-\alpha_1)(1-\alpha_2)}{\gamma}\right] & \delta\left[\theta_1+\frac{\varepsilon_1(1-\alpha_2)-\varepsilon_2\alpha_1}{\gamma}\right] & -\delta\left[\theta_1+\frac{\varepsilon_1\varepsilon_2-\alpha_2(1-\alpha_2)}{\gamma}\right] & \delta\varepsilon_2 & \delta(1-\alpha_2) \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \\ w_1 \\ w_2 \\ c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \frac{\eta(D_{01}+\mu_1 t)}{\gamma} \\ \frac{\eta(D_{02}+\mu_2 t)}{\gamma} \\ 0 \\ 0 \\ \delta\eta\left[-\frac{\varepsilon_1(D_{02}+\mu_2 t)}{\gamma}+\frac{(1-\alpha_1)(D_{01}+\mu_1 t)}{\gamma}\right] \\ \delta\eta\left[-\frac{\varepsilon_1(D_{01}+\mu_1 t)}{\gamma}+\frac{(1-\alpha_2)(D_{02}+\mu_2 t)}{\gamma}\right] \end{bmatrix}$$

where

$$\theta_1 = (\alpha_1-\varepsilon_1)\psi\beta + \frac{(1-\alpha_1-\varepsilon_1)\beta}{\gamma} \qquad \theta_2 = (\alpha_2-\varepsilon_2)\psi\beta + \frac{(1-\alpha_2-\varepsilon_2)\beta}{\gamma}$$

Dynamic system under 2nd regime

$$\begin{bmatrix} \dot{s}_1 \\ \dot{w}_1 \\ \dot{w}_2 \\ \dot{c}_1 \\ \dot{c}_2 \end{bmatrix} = \begin{bmatrix} \frac{1-\alpha_1+\beta}{\gamma} & \frac{\alpha_1-\beta}{\gamma} & \frac{\varepsilon_1+\beta}{\gamma} & 0 & 0 \\ \psi\beta & -\psi\beta & \psi\beta & 1 & 0 \\ -\psi\beta & \psi\beta & -\psi\beta & 0 & 1 \\ \delta\left[\vartheta_1+\frac{(1-\alpha_1)^2}{\gamma}\right] & -\delta\left[\vartheta_1-\frac{\alpha_1(1-\alpha_1)}{\gamma}\right] & \delta\left[\vartheta_1+\frac{\varepsilon_1(1-\alpha_1)}{\gamma}\right] & \delta(\alpha_1-1) & \delta\varepsilon_1 \\ -\delta\left[\vartheta_2+\frac{\varepsilon_2(1-\alpha_1)}{\gamma}\right] & \delta\left[\vartheta_2-\frac{\alpha_1\varepsilon_2}{\gamma}\right] & -\delta\left[\vartheta_2+\frac{\varepsilon_1\varepsilon_2}{\gamma}\right] & \delta\varepsilon_2 & \delta(1-\alpha_2) \end{bmatrix} \begin{bmatrix} s_1 \\ w_1 \\ w_2 \\ c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} -\frac{\eta(D_{01}+\mu_1 t)}{\gamma}-\frac{\varepsilon_1+\beta}{\gamma}\bar{s}_2 \\ -\psi\beta\bar{s}_2 \\ \psi\beta\bar{s}_2 \\ -\delta\left[\frac{(1-\alpha_1)\eta(D_{01}+\mu_1 t)}{\gamma}+\left(\vartheta_1+\frac{\varepsilon_1(1-\alpha_1)}{\gamma}\right)\bar{s}_2\right] \\ \delta\left[\frac{\varepsilon_2\eta(D_{01}+\mu_1 t)}{\gamma}+\left(\vartheta_2+\frac{\varepsilon_1\varepsilon_2}{\gamma}\right)\bar{s}_2\right] \end{bmatrix}$$

where

$$\vartheta_2 = (\alpha_2-\varepsilon_2)\psi\beta + \frac{\varepsilon_2\beta}{\gamma} \qquad \vartheta_1 = (\alpha_1-\varepsilon_1)\psi\beta + \frac{(1-\alpha_1)\beta}{\gamma}$$