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Abstract

This paper investigates an array of nominal systems for the Russian economy, of domestic price level, import prices, exchange rates, money stock, barter, nominal wages, and output, and conducts I(1) and I(2) cointegration analyses. Post-stabilization monthly data are used, 1995:6-2001:5.

The price-wage spiral presence is tested, and the effects of money and real exchange rate. In the last system, barter is introduced, and the effect of that on the comparative Polish-Russian analysis is discussed.

It is found that in Russia inflation has had mostly monetary roots, that exchange rate was important for the price dynamics, and that ruble was inefficiently over-valued. While the wage-price spiral was not found in the system without barter, in the system corrected for barter the role of wages significantly increased.

The paper concludes with a comparative policy analysis to Poland, which updates the previous version in Vostroknutova (2003).

JEL codes: C32, E63, E64

Keywords: cointegration, I(2), monetary policy, incomes policy, stabilization, Russia

1 Introduction

Russia has always been considered one of the least successful transition countries: both concerning its stabilization path and the percentage of GDP recovered since the beginning of transition. After the liberalization in January 1992, there were several attempts to stabilize the economy that resulted in periods of tight monetary policy, followed by increases of prices. Nevertheless, the trend of prices was more or less downward sloping. Finally, in 1995 the government succeeded in stabilizing the economy. Russia then found itself struggling to achieve output growth, which seemed unattainable until the crisis of 1998. Due to the crisis, the exchange rate finally depreciated to its natural level, creating better conditions for import substitution. Growth was finally achieved in 2000, some eight years after liberalization. Compared to Poland's two years, this is a tremendous amount of time. Russia still lacks foreign direct investments,[1] and the quality of growth achieved is questionable, as the GDP figure was heavily driven by the growth of oil prices in 2000.[2]

Nevertheless, the IMF has recently expressed a positive view on the Russian economy: "the large external current account and fiscal surpluses, together with the relatively comfortable level of foreign reserves, have placed Russia in a strong position to deal with the less favorable environment. The [IMF] also found that the Government's plans and priorities suggest that the impressive momentum that has emerged in the structural reform area in 2001 is likely to be maintained next year". However, the situation is still fragile and the government has failed several times to keep the inflation goal, notwithstanding the latest improvements in the external environment (oil price growth). While the IMF considers the present improvement in the Russian economy as a delayed consequence of its efforts in the region, some economists object to this view. Stiglitz (2002, 2003) suggests that it was the "shock therapy" stabilization, over-appreciation caused by fear of second round of hyper-inflation, and the inability of the IMF to see the enormous excess capacity of the Russian economy, that led to decade of decline.

One of the object puzzles of transition economics is the apparent difference between Polish and Russian paths of stabilization, even though the reform packages were of the same "shock therapy" type in both countries. The question that is often asked is why in Russia stabilization took ten years, compared to two years in Poland. In this paper, I am trying to shed some light on this question, by carrying out an empirical analysis of the Russian economy. An empirical investigation into Stiglitz's suggestion will not only contribute to the discussion on Russian stabilization, but will also help us to understand the monetary transmission mechanism that is effective now, and to outline the long-run relations. In this analysis, I draw comparisons to the analogous Polish analysis (Vostroknutova, 2003).

There exists surprisingly little empirical literature about the Russian stabilization. The existing papers use only real systems, which are known to loose some important information about the longer run. This paper uses the nominal system, instead of a real one, in order to better understand the short-run and immediate effects that stabilization policies had on the

[1] The highest per capita inflow of FDI was registered in Estonia ($401) followed by the Czech Republic and Lithuania (around $250). Croatia, Hungary, and Poland came next with sums below $200 per capita. In Bulgaria, Romania, and Slovakia per capita FDI was below $100, and in Russia and Ukraine that number remained at around $15. The World Bank Transition Newsletter, 1999 (http://www.worldbank.org/html/prddr/trans/so99/pgs7-8.htm).

[2] While Rautava (2002) finds that oil prices were not the sole factor of output growth, he does show that a 10% permanent increase in oil prices leads to 2.4% of growth in Russian GDP.

output and prices. I use an I(2) cointegration analysis to find an econometrically plausible nominal-to-real transformation, and then make the final conclusions in the I(1) framework.

The rest of the paper is organized as follows. The next section puts the paper in the perspective of the existing literature and the stabilization plans and events, it also outlines the econometric model. Section 3 describes the data, reports the analysis of an array of nominal systems and considers the robustness of the results; in the last subsection barter is included into the analysis, which changes the interpretation of the results. The last two section conclude and report a comparison to Polish stabilization.

2 Background and the Model

Economic theory suggests that there are three main channels that fuel inflation: monetary, labor, and external sectors. These are supposed to generate inflation due to excess money supply, nominal wage increases above productivity level, or due to transmission of foreign (dis)inflation. In transition countries, in addition, real variables (such as output) were found to be important for the dynamics of nominal variables (such as prices). Due to this, heterodox[3] stabilization programs were advised by the international organizations for the countries of transition, and Russia and Poland in particular (Dibooglu and Kutan, 2001).

It has often been found that monetary explanation (namely, that inflation occurs when money stock grows faster than output, Friedman, 1989) does not hold for transition countries (Nikolic, 2000). This can be due to the undermined central bank independence during transition, underdevelopment of the financial system, and reduced importance of the interest rates.[4] However, the CB of Russia claims a mostly monetary axis for inflation, along with Kim (2001) and Nikolic (2000). Some of the studies (sometimes the same ones) question this result: Nikolic (2000) and Alan et al. (1996) found that a systematic pattern for money-price relationship is fading in the new environment in Russia, and the broad money - inflation relationship has proved to be unstable and sensitive to institutional changes. Buch (1998) argues that the Russian CB could not fully control broad money, and also gave up control over the foreign component of the money base. The final answer about the importance of money in Russian transition has been delayed, due to the short sample after the 1998 crisis.

Incomes policies were effectively introduced in Russia before the collapse of the USSR. However, they did not play any substantial role in repressing wage growth (especially in the state sector) as some high-priority industries were exempted from income ceilings. Such exemptions quickly spread out further to other industries and income policies were soon abolished. However, in 1990 incomes policies were modified. Wages exceeding the ceiling were most heavily taxed in 1992, although the average level of wages was still quite low and did not bind enterprises (Marrese, 1994). It seems that bounding wage policies existed in the

[3] In contrast to orthodox (money-based) programs, heterodox programs have an inflation target, a nominal exchange rate target in the form of a crawling peg, and incomes policy to be implemented through a concerted action of the government, trade unions, and enterprise managers (Buch, 1998).

[4] Soft budget constraints (that were severe in Russia) are found to be the reason why economic agents do not react adequately to the interest rate changes. Also, massive privatization by foreign firms reduces the power of monetary policy over them (Barada and Kutan, 1999). Buch (1998) extensively studies the reasons why money becomes endogenous during the transition period, focusing especially on Russia. She mentions directed credits, keeping insolvent banks liquid by the CB, and substitution of bank credit by trade credit and tax arrears, as the features that can eventually counteract restrictive monetary policies.

concealed form of in-kind payments to workers, and of widespread wage arrears.[5] The official wage variable might not account for wage arrears. Thus, I am losing in the analysis of system without barter payments, while gaining in the systems with barter (see explanations on pg. 21).

Fischer and Sahay (2000) present Russia as an example of not exiting into a more flexible exchange rate regime in time in the context of unsustainable mobility, and compare it to Poland, which represents one of the most successful exits from such a regime. The econometric analysis of the Russian exchange rate dynamic with respect to output and performance is scarce. Rautava (2002) studies the influence of the oil prices and real effective exchange rate on Russian output and finds that 10% real appreciation is associated with 2.4% decrease in output, in the long run. Moreover, he finds that in the short run the exchange rate is the most important factor of output dynamics.

The importance of real variables during the transition period has been investigated and accepted. Many researchers have found it beneficial to include output into econometric models, and have analyzed a two-way relationship between output and inflation (Fischer and Sahay, 2000; Brada and Kutan, 1999; Enev and Koford, 2000; Rautava, 2002). Thus, I might expect to find the output variable significant in the long-run relations for the Russian economy.

An important role is often attributed to barter payments. Kim et al. (2001) define barter as the volume of enterprise transactions that take place without money, which includes pure barter (exchange of goods) as well as offsets (writing off the mutual debts) and *veksels* (special bills of exchange issued by companies and traded for goods by banks, firms and local governments). This form of payment functioned as a means of payment in the demonetized economy. In Fig.1 the percentage of barter in sales is shown, the series that is used in the later analysis (see section 3.4).

Kim et al. (2001) find that the effect of barter on prices is less than that of money, although a macro model that excludes barter will fail to capture all the relevant information about interference in money and inflation in Russia. Indeed, we see that the percentage of barter is an I(1) variable, and therefore might have a significant impact on the nominal system of the Russian economy. In Section 3.4 I analyze such systems and find that barter was important in the inflation formation in Russia.

In what follows, I will implement cointegration analysis to study an array of systems of the Russian economy. I exclude the interest rates, due to the sharp evidence of their unimportance. I take barter payments into account in the last system only, and the general choice of variables is often constrained by the data availability.

A stochastic process integrated of order two, $x_t \sim I(2)$, is a process that is made stationary only by differencing it twice: $\Delta x_t \sim I(1)$, $\Delta^2 x_t \sim I(0)$. In the analysis in this paper, it might sometimes be unclear why it is possible to use the tests from the I(1) framework in

[5] "Wage arrears began to grow rapidly in mid-1995. In the midst of faltering state authority and the collapse of contractual obligations and their enforcement, the government resorted to more wage cuts, enterprises withheld tax and wage payments, and local governments diverted federal funds earmarked for employee remuneration. The level of arrears in March 1997 reached 27.7 percent of total state sector wages. Wage arrears afflicted virtually every region. Many workers were waiting six to eight months for their wages. More than half of employees in state enterprises were claiming at least two months unpaid wages." (The WB, Transition Newsletter, 1998)

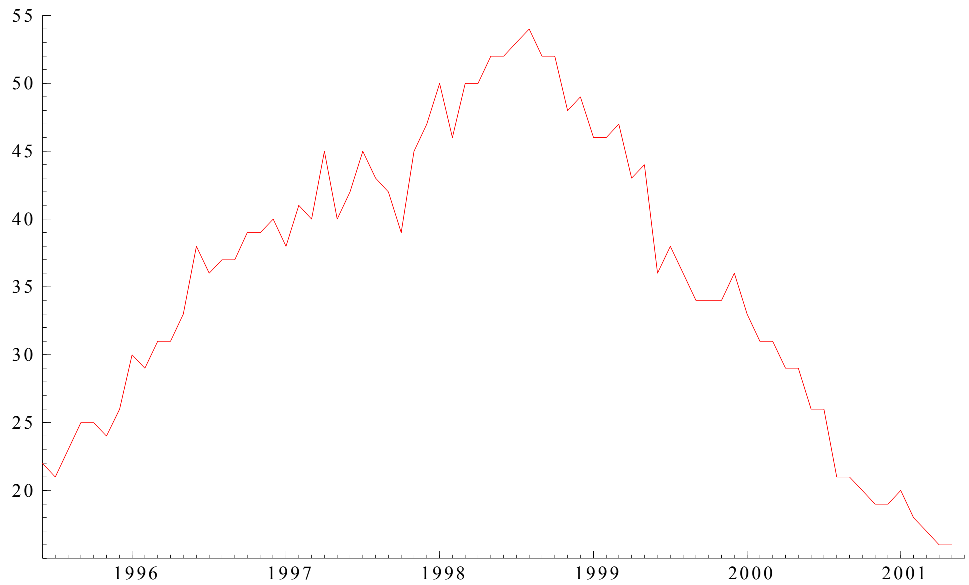

Figure 1: Percentage of barter in total sales in Russia. Source: Russian Economic Barometer.

order to make inferences in the I(2) model. Under certain conditions, explained below, it is, however, possible. The I(1) VAR framework is described by the following equation:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \epsilon_t,\ t = 1, .., T, \tag{1}$$

where $\Pi = \sum_{i=1}^{k} \Pi_i - I$, $\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j$, and D_t is the deterministic term. Errors are assumed to be $i.i.d.$ in this model.

Let us assume that the system is actually I(2), i.e. it is best described by the equation:

$$\Delta^2 X_t = \Pi X_{t-1} - \Gamma \Delta X_{t-1} + \sum_{i=1}^{k-2} \Psi_i \Delta^2 X_{t-i} + \Phi D_t + \epsilon_t,\ t = 1, .., T, \tag{2}$$

where $\Gamma = I - \sum_{i=1}^{k-1} \Gamma_i$, as above, and $\Psi_i = -\sum_{j=i+1}^{k-1} \Gamma_j, i = 1, .., k-2$. The I(2) model has two reduced rank conditions (for Π and Γ matrices), while the I(1) model has just one, $\Pi = \alpha\beta'$, see Johansen (1999).

Then, the concentrated model of the I(1) analysis looks like this (see Juselius, 2002, Johansen, 1995):

$$\underbrace{R_{0t}}_{I(0)} = \alpha\beta' \underbrace{R_{1t}}_{I(2)} + \epsilon_t, \tag{3}$$

where

$$\underbrace{R_{0t}}_{I(0)} = \underbrace{\Delta x_t}_{I(1)} - \widehat{B_0}\underbrace{\Delta x_{t-1}}_{I(1)},$$

$$\underbrace{R_{1t}}_{I(2)} = \underbrace{x_{t-1}}_{I(2)} - \widehat{B_1}\underbrace{\Delta x_{t-1}}_{I(1)}.$$

In order to be found as a cointegrating relation, $\beta' R_{1t}$ has to be I(0):

$$\beta' R_{1t} = \underbrace{\beta' x_{t-1}}_{I(1)} - \underbrace{\beta' \widehat{B_1} \Delta x_{t-1}}_{I(1)} \sim I(0) \text{ via } CI(1,0) \text{ cointegration.}$$

Thus, if $x_t \sim I(2)$, then $\beta' x_t \sim I(1)$, and still $\beta' R_{1t} \sim I(0)$, and one can still use the tests provided by the I(1) procedure to make an inference in the I(2) model. Then, tests for stationarity will become tests for I(1)ness. Standard weak exogeneity tests will actually test long-run weak exogeneity, i.e. zero columns in the $\{\alpha_0, \alpha_1\}$ space only. Exclusion tests will become tests for long-run exclusion from stationary cointegrating relations and from levels part of the polynomially cointegrating ones. More detailed theoretical background for this analysis can be found in Johansen (1995), Juselius (2002), and Jørgensen, Kongsted, and Rahbek (1999).

3 Analysis

The data is from the International Monetary Fund database, apart from the barter data, which is from the Russian Economic Barometer. It is monthly, from 1995:6 till 2001:5, i.e. 71 observations. The graphs in Fig. 2 and Fig. 3 demonstrate the levels and differences for the data. The domestic price series (*pr*) is a logarithm of the consumer price index, import price (*pi*) is a logarithm of the constructed import price index,[6] exchange rate (s) is a logarithm of the exchange rate (rub/US$), (*re*) is a logarithm of the real effective exchange rate (IFS definition), money (m) is a logarithm of ruble broad money (M2), wage series (w) is a logarithm of the nominal average wage, and a proxy for output (y) is a logarithm of industrial production index. In what follows, the Polish analysis is closely followed (Vostroknutova, 2003). Finally, a full comparison of the two countries is presented in the last section.

[6] A usual proxy for import price, i.e. the German price index, did not work either for Poland, or for Russia. This is probably because of its comparatively much lower integration level, which gave a very large coefficient in the cointegrating relations and zero coefficient in the I(2) trend. To construct this index for Russia, her main importers' price indices were taken, weighted by the (period average) share of their imports (alltogether they accounted for about 53% of all Russian imports). The price indices were export prices where available, and wholesale or production prices otherwise. The data are from IMF IFS and from the IMF country report on Russia (2000).

As nothing but price *indices* (initially in the local currencies) was available, it was impossible to construct an IFS-defined import price index for Russia. The one that is finally analysed is not evaluated in rubles: its units are index numbers that are constructed from index series that were reduced from the original series evaluated in local currencies. Hence, it is an index "reduced" from a basket of currencies, and therefore a nominal effective exchange rate (currency/rub) would need to be substracted from it, to get closer to the official definiton.

To be able to compare the Russian and Polish systems, we should probably add Polish $pi(zloty) + ne(currency/zloty) = pi(currency)$, and consider a system that includes this variable. The closest that we get to this is in the Polish analysis, System 4 (Vostroknutova, 2003).

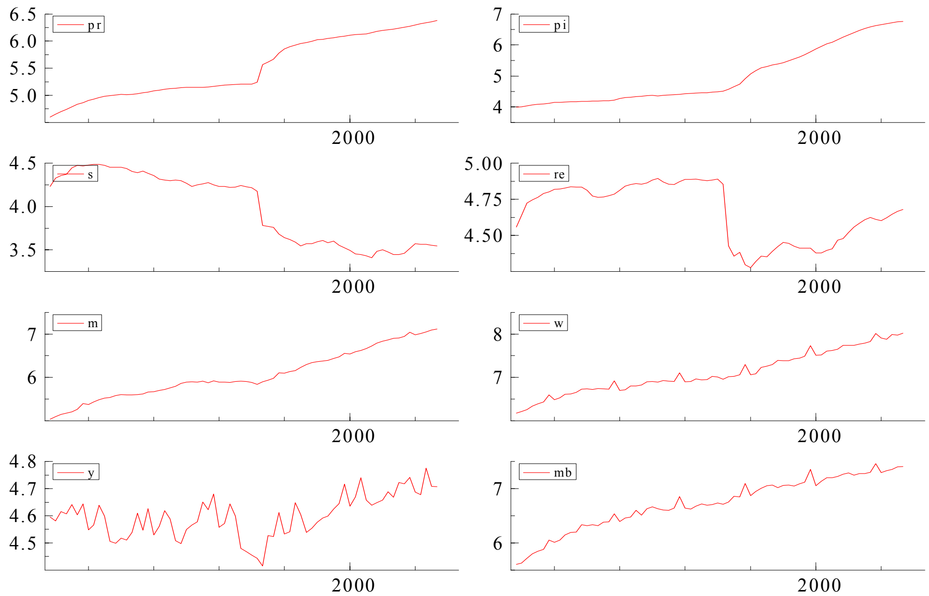

Figure 2: Data in levels

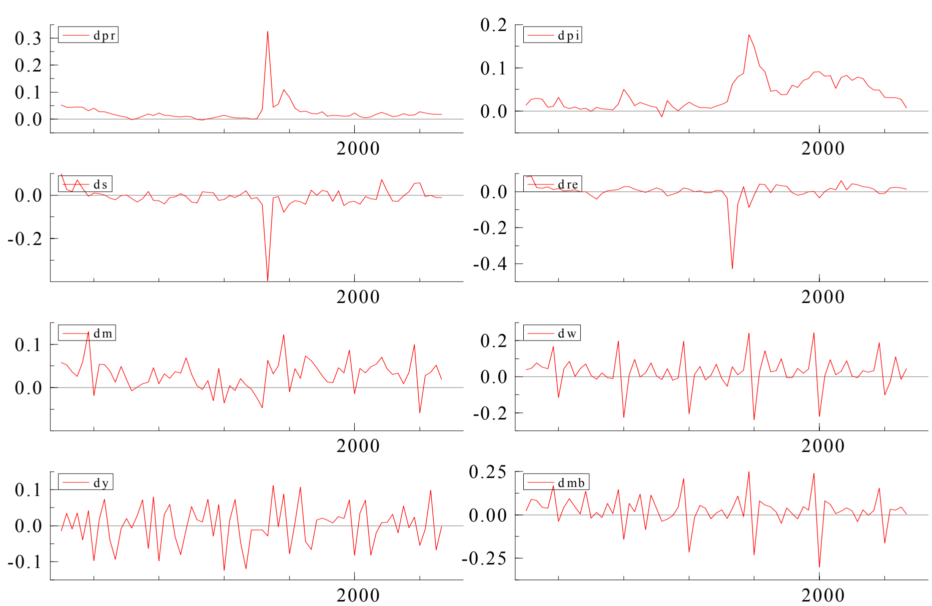

Figure 3: Data in differences

In Table 1 the single variable unit root tests are reported. One can see that for some variables I(2)-ness cannot be rejected.

Table 1. ADF tests for unit root.[7]

Variable	t-adf	Lag	Variable	t-adf	Lag
pr	-1.77	1	w	-0.23	11
$\Delta pr*$	-2.95	2	$\Delta w**$	-4.20	10
$\Delta^2 pr**$	-9.44	1	$\Delta^2 w**$	-3.56	10
pi	-2.26	1	re	-1.46	1
Δpi	-2.70	3	$\Delta re*$	-3.3	2
$\Delta^2 pi**$	-4.29	5	$\Delta^2 re$	-2.56	2
s	-1.59	3	y	-1.71	12
Δs	-2.46	9	$\Delta y**$	-5.97	10
$\Delta^2 s**$	-9.46	1	$\Delta^2 y**$	-9.32	10
m	-1.60	12	mb	-2.59	11
Δm	-1.38	11	$\Delta mb**$	-4.25	10
$\Delta^2 m**$	-4.57	10	$\Delta^2 mb**$	-3.95	9

The following facts contribute to the difficulties in analyzing the Russian data: (1) the sample is short, due to the later start of the stabilization; (2) the policies conducted were much less transparent than in Poland; (3) there are fewer variables available for Russia (for example, nominal effective exchange rate data is absent and the import price variable was constructed); (4) last but not least, there is the structural break of the 1998 crisis that has created difficulties[8] for the I(2) analysis on the software available to date. An array of systems for the Russian economy has been analyzed.

Table 2. Systems analyzed.

System	Restricted variables								Unrestr.
1.	pr	pg	s_{DM}	m	w	y		t	
2.	pr	pi	$s_{\$}$	m	w	y		t	
3.	pr		s	m	w			t	
4.	pr	pi	re	m	w	y	$d98$[9]	-[10]	dummy[11]
5.	pr		re	m	w	y	$d98$	-	dummy
6.	$pr + re$			m	w	y		t	dummy
7.	$pr + re$			bm	w	y		-	dummy[12]

The results for systems $1-3$ are not reported here; instead, they are given in the last

[7] The null hypothesis it that of the unit root, the tests are conducted in PcGive, and the standard procedure for lag determination is used (see Hendry and Doornik, 1996). Trend and constant were fitted into the level series (critical values are -3.46 for 5%, and -4.062 for 1% significance), and a constant alone into the differences and second differences (critical values are -2.894 for 5%, and -3.504 for 1% significance). Two stars indicate rejection on the 5% level, and one star corresponds to one percent.

[8] It is impossible to restrict an exogenous variable to the cointegration space in the I(2) procedure. It is also known that dummies have a very significant impact on the I(2) basis, and if the dummy cannot be excluded from the cointegrating space (which is the case), it has to be there.

[9] This is a step dummy, that should catch the effect of the $1998:8$ crisis on the levels of the involved variables.

[10] The trend was included, but was then tested out of the system.

[11] Unrestricted in this system, this dummy is an impulse (centered) dummy for the structural break in $1998:9$, that corresponds to the default on the government bonds and abrupt devaluation of the ruble.

[12] This dummy is not centered, and accumulates to a broken trend.

section, where a comparison with the analogous Polish systems is made.

3.1 Nominal System $\{p, pi, re, m, w, y, d98\}$

Let us consider nominal System 4, $\{pr, pi, re, m, w, y, d98\}$, and try to make inferences, under the assumption that the data is I(2).

In Table 2, the trace test results are reported, and the hypothesis of $r = 3$ cannot be rejected. This choice is also supported by the sharp eigenvalue drop from $r = 2$ to $r = 3$ (Table 2) and by the elimination of one of the three roots of the companion matrix, that are close to one, when rank changes from $r = 4$ to $r = 3$ (Table 23). The last sign also points to the natural choice for this system $(p = 6) : r = 3, s_2 = 2, s_1 = 1$. The two I(2) trends are chosen, also due to the Table 23 result that two large roots remain after the rank is constrained to 3.

Table 3. Misspecification tests

	autocorrelation $F(5,37)$	ARCH $F(5,32)$	Skewness	Normality $\chi^2(2)$
sys[13]	1.38 [0.08]	0.10 [1.00]		42.99 [0.00] **
pr	1.07 [0.39]	1.00 [0.43]	0.57	10.81 [0.00] **
pi	1.51 [0.21]	1.00 [0.43]	0.05	0.51 [0.77]
re	0.74 [0.59]	0.21 [0.95]	0.66	12.15 [0.00] **
m	1.37 [0.25]	1.70 [0.17]	0.33	2.59 [0.27]
w	1.57 [0.19]	0.15 [0.97]	0.32	29.14 [0.00] **
y	1.15 [0.35]	0.44 [0.81]	-0.15	2.80 [0.25]

Table 4. Trace test results.

$Ho : rank \leq r$	*eigenvalue*	$-T\backslash SumLog$	95%
$r = 0$	0.68	212**	94.2
$r \leq 1$	0.65	129**	68.5
$r \leq 2$	0.43	58.07**	47.2
$r \leq 3$	0.17	27.23	29.7
$r \leq 4$	0.15	12.65	15.4
$r \leq 5$	0.02	1.42	3.8

Table 5. The largest roots.

unrestricted	**0.95**	**0.87**	**0.87**	0.76	0.74	0.74	0.58
$r = 5$	1	**1.00**	**0.84**	**0.84**	0.66	0.66	0.57
$r = 4$	1	1	**0.96**	**0.82**	**0.82**	0.67	0.67
$r = 3$	1	1	1	**0.89**	**0.89**	0.64	0.64
$r = 2$	1	1	1	1	**0.89**	**0.83**	0.64
$r = 1$	1	1	1	1	1	**0.86**	**0.73**

Therefore, we need to conduct the I(2) analysis in order to obtain proper results on the long-run and medium-run dynamics. Table 6 provides the results of the (single variable) tests for long-run exclusion, I(1)ness, and zero raws in the long-run adjustment matrix. We see that money is weakly exogenous in the long run, and that the real exchange rate is an I(1) variable, if $r = 4$. All variables enter long-run relations.

[13] The test statistics are $F(180, 49)$ for autocorrelation, $F(525, 36)$ for ARCH, and $\chi^2(10)$ for normality tests.

Table 6. Tests.

r	d	$\chi^2(d)$	pr	pi	re	m	w	y	$d98$
					Long-run exclusion, $\chi^2(r)$				
3	3	7.8	46.4	26.0	22.5	33.7	49.8	16.2	39.5
4	4	9.5	48.1	27.9	24.3	33.7	49.8	16.8	40.3
					I(1)ness, $\chi^2(p-r)$				
3	4	9.49	32.84	34.88	23.58	33.73	33.95	34.25	
4	3	7.81	11.70	12.86	**2.68**	13.00	12.91	11.73	
					Zero coefficient in α, $\chi^2(r)$				
3	3	7.81	56.09	24.57	25.06	**1.80**	41.67	14.44	
4	4	9.49	58.04	25.54	26.55	**1.80**	42.71	15.14	

In Table 7, the Π matrix is presented (significant values are in bold). It supports the previous conclusion that money is weakly exogenous in the long run while it fuels into wage and exchange rate dynamics.

Table 7. The Π matrix.

	pr	pi	re	m	w	y	$d98$
Δpr	**-0.21**	-0.01	0.05	-0.04	**0.17**	**-0.10**	**0.16**
Δpi	**-0.26**	-0.01	-0.06	0.03	**0.18**	**-0.15**	**0.12**
Δre	0.1	**0.04**	**-0.31**	**0.35**	**-0.45**	-0.09	**-0.20**
Δm	-0.03	0.01	0.06	-0.00	-0.03	-0.02	0.06
Δw	**-0.14**	**0.09**	0.05	**0.29**	**-0.49**	**-0.21**	**0.19**
Δy	**-0.23**	-0.01	**-0.19**	0.13	0.07	**-0.18**	0.04

From the Π matrix above, one can define the following relations:

(1) wages contribute to inflation, price increases harm output growth (see also equation for Δy), the crisis dummy has a significant positive impact on price level and inflation:

$$pr_t = 0.8pr_{t-1} + 0.17w_{t-1} - 0.1y_{t-1} + 0.16d98_{t-1};$$

(2) domestic inflation is explained by the imported inflation from the trade partners, changes in output and price level: $\Delta pr = \Delta pi - 0.01w + 0.04(pr + y + d98)$;

(3) growth in price levels harms output, and depreciation is good for producers: $y_t = 0.8y_{t-1} - 0.23pr_{t-1} - 0.19re_{t-1}$, which suggests that the ruble was indeed inefficiently overvalued.

However, identification of the system is needed, in order to distinguish between long-term and short-term relations, as well as to test a more theoretically founded hypothesis.

3.1.1 Identification

In this section, we are trying to identify the space β_0, which is actually the space $\{\beta_0, \beta_1\}$ in the I(2) framework. The relationships found are at most I(1), and the hypothesis cannot be rejected with $\chi^2(3) = 3.72[0.29]$.

Table 8. Identified cointegration space (β_0, β_1)

pr	pi	re	m	w	y	$d98$
0	0.21 (0.03)	1	0.45 (0.13)	−1.47 (0.17)	0	0.82 (0.05)
−1	0	−1.5 (0.1)	1	0	−1	−0.25 (0.03)
0	0	1	−0.35 (0.02)	0	0.31 (0.07)	0.63 (0.03)

and adjustment coefficients α_0.

pr	**-0.11**	**0.21**	**0.50**
pi	**-0.12**	**0.26**	**0.49**
re	**0.32**	**-0.16**	**-0.97**
m	**0.02**	0.03	0.097
w	**0.34**	**0.15**	-0.01
y	-0.06	**0.24**	0.26

From the two last vectors above, one can obtain: $pr = 0.55(m - y) + 0.65d98$, which suggests a completely monetary inflation. It is also easy to see that import and internal prices do not enter the same long-run relations, which suggests that import prices were important only in the short-run. Also, import prices and real effective exchange rate do not enter the same relationships. This is because we actually do not need these variables together in the system: we would like to have pr, pi and nominal effective exchange rate, but unfortunately we do not have ne for Russia. Therefore, we move to the next system that should give us a more consistent picture, after the impact of pi on output and other variables has been described in System 4.

3.2 Nominal System $\{(p, re, m, w, y, d98), d\}$

Let us consider in this section a nominal system, $\{pr, re, m, w, y, d98\}, ddd98$. Table 9 represents the misspecification test results. The trace test results are shown in the next table. We would have to choose between $r = 1$ and $r = 2$ in the analysis that follows.

Table 11 presents the largest roots of the companion matrix. We see that it is difficult to draw conclusions, as there are too many large roots, but it seems that $r = 1$ or $r = 2$, and $s_2 = 3$, because these are the cases when only three large roots remain.

Table 9. Misspecification tests

	autocorrelation $F(5, 40)$	ARCH $F(5, 35)$	Skewness	Normality $\chi^2(2)$
sys[14]	1.12 [0.29]	331.99 [0.24]		37.09 [0.00] **
pr	1.24 [0.31]	1.33 [0.28]	0.59	12.20 [0.00] **
re	1.57 [0.19]	0.76 [0.58]	0.41	18.97 [0.00] **
m	1.36 [0.26]	1.75 [0.15]	0.33	2.84 [0.24]
w	1.47 [0.22]	0.17 [0.97]	0.59	17.06 [0.00] **
y	0.64 [0.67]	0.70 [0.62]	-0.25	2.60 [0.27]

[14] The test statistics are: $F(125, 83)$ for autocorrelation, $\chi^2(315)$ for ARCH, and $\chi^2(10)$ for normality tests.

Table 10. Trace test results.

$Ho: rank \leq r$	*eigenvalue*	$-T\backslash SumLog$	95%
$r = 0$	0.43	89.23**	68.5
$r \leq 1$	0.29	49.89*	47.2
$r \leq 2$	0.18	26.50	29.7
$r \leq 3$	0.14	12.53	15.4
$r \leq 4$	0.03	2.09	3.8

Table 11. The largest roots.

unrestricted	**0.94**	**0.88**	**0.88**	**0.73**	**0.73**	**0.64**	0.49
$r = 4$	1	**1.00**	**0.81**	**0.71**	**0.71**	**0.70**	0.49
$r = 3$	1	1	**0.91**	**0.77**	**0.70**	**0.70**	0.53
$r = 2$	1	1	1	**0.92**	**0.65**	**0.65**	0.54
$r = 1$	1	1	1	1	**0.70**	**0.69**	**0.69**

This choice is supported by the following table of tests on I(1)ness, long-run exclusion and long-run weak exogeneity. We see that money is weakly exogenous in the long run, as expected. The important finding in Table 12 is that we cannot exclude the step dummy from the analysis and also cannot ignore the I(2) properties of the data. In the next section, we use a property of the 1998 default crisis that helps us to eliminate the necessity of having the step dummy in the cointegration space, and to conduct proper I(2) analysis of an analogous system.

Table 12. Tests for exclusion, I(1)ness, and 'weak exogeneity'.

r	d	$\chi^2(d)$	*pr*	*re*	*m*	*w*	*y*	*d*98
				Long-run exclusion, $\chi^2(r)$				
1	1	3.84	30.34	**0.05**	**0.18**	5.92	15.91	17.99
2	2	5.99	41.93	7.43	7.08	24.84	28.71	41.79
				I(1)ness, $\chi^2(p-r)$				
1	5	11.07	67.68	61.81	69.09	69.12	67.20	
2	4	9.49	38.27	34.10	39.29	39.52	40.86	
				Zero coefficient in α, $\chi^2(r)$				
1	1	3.84	29.97	3.99	**0.42**	**2.25**	9.05	
2	2	5.99	51.75	**4.53**	**1.29**	29.90	9.13	

The following two tables represent the I(2) models corresponding to these systems, without the step dummy in the cointegration space. We consider both cases of $r = 1$ and $r = 2$. One can see that there is a third stochastic trend in the system that is driven by the prices and exchange rate together. Output has a large coefficient, because it is a nominal indicator, and we can attribute it to the price-driven stochastic trend. Therefore, if we could sum up the *pr* and *re* variables, we should get a system with only two stochastic trends. We are trying to achieve this in the next section.

Table 13. The I(2) space, $r = 1, s_1 = 0, s_2 = 3$

	β_1	$k1$	$\beta_{\perp 1}$	$\beta_{\perp 2.1}$	$\beta_{\perp 2.2}$	$\beta_{\perp 2.3}$
pr	1	0.33	1.64	-0.20	0.94	**-22.39**
re	0.5	1.22	0.14	-8.50	1.19	**-21.45**
m	0.5	1.34	-15.81	-0.06	0.54	17.44
w	-1.7	1.17	12.94	-1.86	0.91	-1.85
y	1.3	0.26	20.23	1.22	-0.24	16.78
			and adjustment coefficients.			
	α_1		$\alpha_{\perp 1}$	$\alpha_{\perp 2.1}$	$\alpha_{\perp 2.2}$	$\alpha_{\perp 2.3}$
dpr	-0.1		-0.00	0.01	0.02	0.15
dre	0.08		0.00	-0.02	0.01	0.06
dm	0.01		-0.01	0.01	0.07	0.13
dw	0.1		0.04	0.01	0.02	0.07
dy	-0.12		0.04	-0.01	0.01	-0.01

Table 14. The I(2) space, $r = 2, s_1 = 0, s_2 = 3$

	β_1	$k1$	β_2	k_2	$\beta_{\perp 2.1}$	$\beta_{\perp 2.2}$	$\beta_{\perp 2.3}$
pr	1	0.4	0.59	-0.15	1.53	1.30	**-16.26**
re	0.53	1.34	1	1.22	-0.59	-7.07	**-16.19**
m	0.50	1.59	-1.89	−1.37	-0.51	-2.84	3.32
w	-1.67	0.94	1.66	-1.51	-0.21	-0.39	8.07
y	1.35	-0.19	0.68	-1.77	1.29	2.33	27.32
			and adjustment coefficients.				
	α_1		α_2		$\alpha_{\perp 2.1}$	$\alpha_{\perp 2.2}$	$\alpha_{\perp 2.3}$
dpr	-0.10		0.00		0.69	0.04	-0.04
dre	0.08		-0.10		0.08	0.04	-0.03
dm	0.01		0.01		-0.24	0.12	0.01
dw	0.11		-0.08		0.26	-0.02	0.01
dy	-0.12		-0.09		-0.33	-0.01	0.02

3.3 Transformation: Nominal System $\{(p + re, m, w, y, t), d\}$

Let us consider System 6: $\{pr + re, m, w, y, t\}, ddd98$. We have used the property of the previous system, i.e. that the shock to prices was almost fully absorbed by the change in the real effective exchange rate (see Fig. 2), and therefore by adding these variables we could get rid of the structural break, and test the step dummy out. This transformation is not only dictated by technical considerations. From the IFS definition of the real effective exchange rate, we know that

$$re_{\frac{C}{R}} = pr_R - pi_C + ne_{\frac{C}{R}}. \tag{4}$$

Here, the indices mean units from which the index variables were constructed. C stands for the importing countries' aggregated currency, and R stands for *ruble*; ne is nominal effective exchange rate. The above relation transforms to

$$pr_R + re_{\frac{C}{R}} = pr_R + (pr_C - pi_C), \tag{5}$$

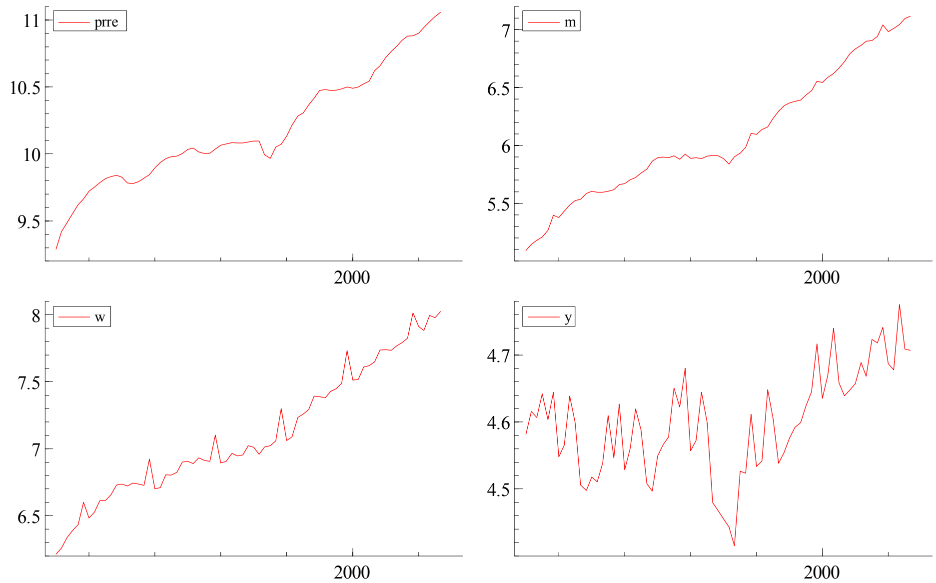

Figure 4: Russia, data levels for System 6.

which shows that the transformation makes sense in an economy that is heavily dependent on the external sector, namely exchange rate and import prices. This new variable would represent a price, corrected for import-local price differential. It should not be a problem to sum prices in two different currencies, as all variables are indices; however, this implicitly includes exchange rate in the analysis. Numerous studies of the Russian economy have stressed the importance of the external sector embodied in the dollarization of the monetary system. Anecdotal evidence of the transactions still being evaluated in dollars (or, so-called 'conditional units') suggests the same. The graphs of the levels and first differences are presented in Fig.4 and Fig.5.

In Table 15, the specification of the model is presented. One can see that the model is correctly specified, and the normality failure is not at all associated with non-symmetric measures. The specification has also significantly improved, in comparison to the system 4 analysis.

Table 15. Misspecification tests.

	autocorrelation	ARCH	Skewness	Normality
	$F(5,42)$	$F(5,37)$	$\chi^2(2)$	
sys[15]	1.17[0.23]	587.06[0.08]		20.03[0.01]
$prre$	3.29[0.01]	0.63[0.68]	-0.00	2.24[0.33]
m	0.46[0.80]	1.37[0.26]	0.21	0.69[0.71]
w	1.35[0.26]	0.09[0.99]	0.01	15.39[0.00]**
y	0.39[0.85]	0.48[0.78]	-0.23	1.74[0.42]

[15] The system test statistics are: $F(80,97)$ for autocorrelation, $\chi^2(540)$ for ARCH, and $\chi^2(8)$ for normality test.

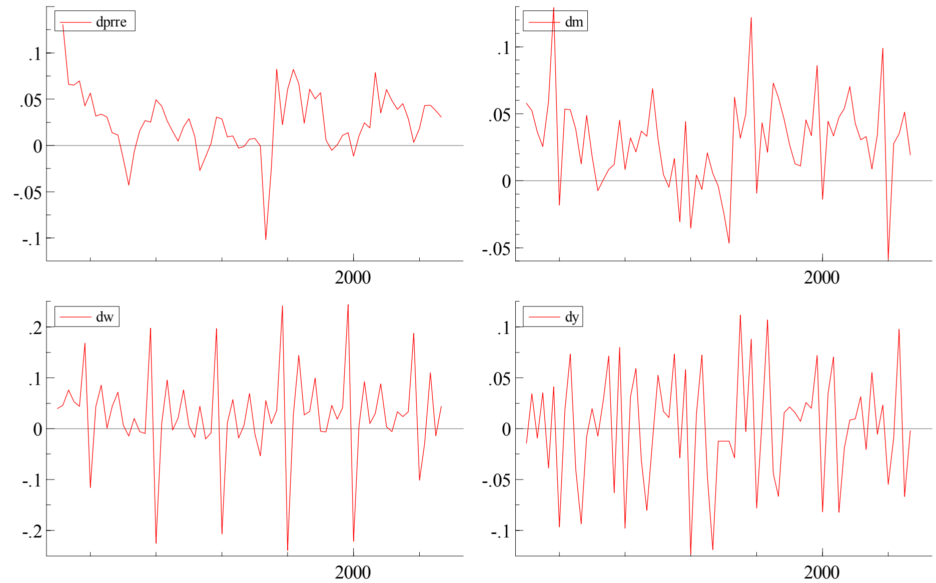

Figure 5: Russia, data first differences for System 6.

The trace test shows a very low rank. Considering Tables 34 and 35, and taking into account the analysis of System 5 in the previous section, we decide on the $r = 1$, as it brings most of the large roots down, leaving only two.

Table 16. Trace test results

$Ho : rank \leq r$	$eigenvalue$	$-T\backslash SumLog$	95%
$r = 0$	0.35	58.36	63.0
$r \leq 1$	**0.19**	28.6	42.4
$r \leq 2$	0.15	13.68	25.3
$r \leq 3$	0.04	2.56	12.3

Table 17. The largest roots.

$unrestricted$	**0.90**	**0.75**	**0.75**	**0.75**	**0.73**	**0.73**	0.42
$r = 3$	1	**0.74**	**0.74**	**0.73**	**0.73**	**0.72**	**0.72**
$r = 2$	1	1	**0.74**	**0.74**	**0.73**	**0.73**	0.48
$r = 1$	1	1	1	**0.72**	**0.72**	0.67	0.48

Our choice is therefore $r = 1, s_2 = 2$, which leaves $s_1 = 1$ and corresponds to System 5 analysis.

Table 18. Trace test for I(2) model.

r	$S(r\|s_1)$				$Q(r)$
0	236.7	146.2	90.6	**67.7**	**58.4**
	(132.02)	*(107.91)*	*(87.9)*	*(71.33)*	*(59.02)*
1		145.9	**65.4**	**35.5**	**28.6**
		(82.29)	*(64.23)*	*(49.69)*	*(39.26)*
2			99.5	**25.3**	**13.7**
			(44.5)	*(31.61)*	*(22.98)*
3				**15.3**	**2.6**
				(17.57)	*(10.63)*
s_2	4	3	2	1	0

I perform an I(2) analysis of the chosen system, after considering the exclusion and I(1)ness tests below. None of the variables is I(1), and m and w show long-run weak exogeneity. This can actually be an indication of these variables being very close to I(1) process, in the I(2) system. In this case, these variables would constitute the medium-run dynamics, and we do not exclude them, remembering also that that specification was fine. However, an exclusion of m is the sign of all systems considered so far, as money is supposed to be exogenous. And we could also explain the weak exogeneity of wages in Russia, as wage arrears, barter payments, and shadow wages are not included into the wage variable.

Table 19. Tests.

r	d	$\chi^2(d)$	$prre$	m	w	y	$trend$
			Long-run exclusion, $\chi^2(r)$				
1	1	3.84	5.79	**2.81**	**1.38**	10.75	10.17
2	2	5.99	9.04	**4.50**	**1.87**	12.81	10.94
			I(1)ness, $\chi^2(p-r)$				
1	2	9.49	25.73	24.93	24.79	28.18	
2	1	9.49	14.22	14.36	14.55	13.36	
			Zero coefficient in α, $\chi^2(r)$				
1	1	3.84	**1.91**	**0.91**	**0.03**	14.23	
2	2	5.99	**5.07**	**2.20**	**0.08**	16.24	

The next table represents the I(2) space basis. For the choice of rank and two I(2) trends we do not have a long-run stable relationship, and only polynomially cointegrating relations, and one pure I(1) trend.

Table 20. The I(2) space, $r = 1, s_1 = 1, s_2 = 2$

	β_1	k	$\beta_{\perp 1}$	$\beta_{\perp 2.1}$	$\beta_{\perp 2.2}$
prre	1	2.32	2.12	11.16	-16.60
m	-0.95	-1.78	4.96	-9.08	10.98
w	-0.65	0.03	-9.63	-0.07	-0.87
y	1.88	-2.12	-1.96	-10.56	14.10
trend	0.02				

and adjustment coefficients.

	α_1		$\alpha_{\perp 1}$	$\alpha_{\perp 2.1}$	$\alpha_{\perp 2.2}$
dprre	-0.07		0.01	0.03	-0.03
dm	-0.04		0.05	-0.02	-0.01
dw	-0.01		-0.11	-0.00	-0.01
dy	-0.17		-0.01	-0.01	0.01

If we take into account the fact that output is a nominal index variable, and therefore all signs of I(2)ness that it displays are due to the Laspeyres formula that it is calculated from (and, therefore, to the price level), we see that money remains the only source of price growth, as indicated by the constructed variable *prre*. Wages could be excluded not only from the system (see above) but also do not significantly contribute to the I(2) trend. Wage behavior is the opposite to the Polish case, where wages were the main source of inflation.

3.3.1 Identification

Unfortunately, we do not have the statistics for the coefficients obtained in the I(2) analysis. In this section, we try to identify the relation $\beta_1 x$ that is I(1), and that is made I(0) with the addition of the product $k'\Delta x$. The following just-identifying restrictions were imposed and could not be rejected with statistics $\chi^2(3) = 6.62[0.1]$.

Therefore, the following long-run relation is I(1):

$pr + re - m + y + 0.003t \sim I(1)$.

In Fig. 6 the graph and difference of the variable are presented, and it does look like an I(1) process. It can be made stationary by adding the differences times the vector k, which is proportional to the I(2) trends from Table 20. Without doing this, it could be viewed as the money velocity equation, but corrected for the external sector. As mentioned above, this is a reasonable correction for Russia, where dollarization of the economy, dependence on imports and export of oil have become the main features of transition.

Table 21. Identified cointegration space β_1

prre	*m*	*w*	*y*	*t*
1	-1	0	1	0.003 (0.0006)

and adjustment coefficients α_1.

prre	**-0.12**
m	-0.03
w	-0.03
y	**-0.18**

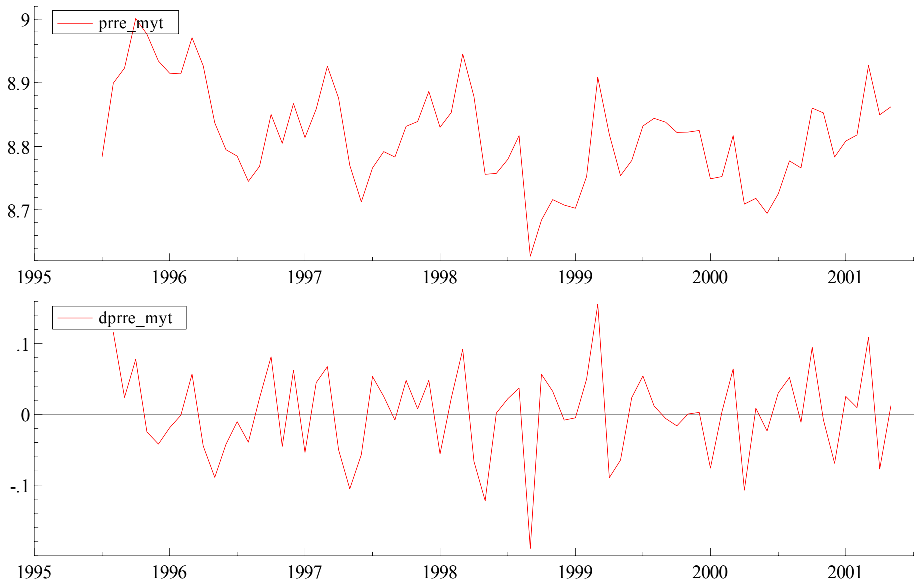

Figure 6: I(1) relation $\beta_1' x$, System 6 for Russia.

For the real output equation, we would get the following:

$$2pr + re - m + (y - pr) + 0.003t \sim I(1),$$

even though the output should be corrected by the PPI index, it shows good cointegration with CPI-based pr as well.

It is interesting to note that wages are statistically weakly exogenous in the long run, unlike in Poland, where they have become the main instrument of stabilization. However, from Table 20 (relation $\beta_{\perp 1}$ that can be made stationary only by taking differences, and therefore represents the medium run) we could extract a dependence of the inflation rate on wage increases, in the medium run:

$$\Delta pr = -\Delta re - 2.5\Delta m + 5\Delta w + \Delta y.$$

Even though we cannot say anything about causality here, increases in wages were associated with increases in inflation in the medium run.

3.4 Introducing Barter Payments: Nominal System $\{(p + re, mb, w, y, t), d\}$

Let us now consider system 7: $\{pr + re, mb, w, y, t\}, ddd98$, where mb is the money mass from the previous analysis, corrected for barter payments expressed in nominal rubles ($mb = m + by$, where b is the percentage of barter in total sales, see Fig.1).

Table 22. Misspecification tests.

	autocorrelation $F(5,43)$	ARCH $F(5,38)$	Skewness	Normality $\chi^2(2)$
sys[16]	1.56 [0.02] *	556.87 [0.3]		16.52 [0.04] *
$prre$	2.19 [0.07]	0.84 [0.53]	0.03	4.35 [0.11]
mb	0.99 [0.44]	0.52 [0.76]	0.12	0.22 [0.90]
w	0.13 [0.98]	0.23 [0.94]	0.40	12.36 [0.002] **
y	0.08 [0.99]	0.17 [0.97]	0.30	1.64 [0.44]

The trace test shows that rank is either one or two, and from the analysis of the roots of the companion matrix, we conclude the same, and also see that the system probably has two common I(2) trends, due to at least the two largest roots remaining in all systems.

Table 23. Trace test results

$Ho: rank \leq r$	$eigenvalue$	$-T\backslash SumLog$	95%
$r = 0$	0.48	85.37**	63.0
$r \leq 1$	0.25	40.25	42.4
$r \leq 2$	0.19	19.73	25.3
$r \leq 3$	0.07	5.214	12.3

Table 24. The roots.

$unrestricted$	**0.97**	**0.81**	**0.81**	**0.73**	**0.73**	0.42	0.26
$r = 3$	1	**0.82**	**0.82**	**0.73**	**0.73**	0.41	0.23
$r = 2$	1	1	**0.79**	**0.79**	0.63	0.43	0.21
$r = 1$	1	1	1	**0.77**	**0.77**	0.46	0.22

The I(2) trace test shows that if this system has rank two, it also has either one or two I(2) trends. In the analysis that follows we consider system $\{r = 1, s_2 = 2\}$ in order to compare it to the previous analysis in the framework with one cointegrating vector, and then move to the system $\{r = 2, s_2 = 2\}$ which seems the natural choice here.

Table 25. Trace test for I(2) model.

r	$S(r\|s_1)$				$Q(r)$
0	282.99	211.69	142.49	86.48	72.06
	132.02	*107.91*	*87.9*	*71.33*	*59.02*
1		164.87	99.55	56.06	**38.25**
		82.29	*64.23*	*49.69*	*39.26*
2			**34.24**	**20.49**	**20.24**
			44.5	*31.61*	*22.98*
3				44.33	**3.83**
				17.57	*10.63*
s_2	4	3	2	1	0

From Table 26 one can see that y can be excluded from the long-run relations, and that either $prre$ or w is weakly exogenous. Additional tests are needed to see if they are weakly exogenous simultaneously. As there are no variables that can be both weakly exogenous and excludable from the long-run relations, I proceed with the present system, which is well

[16] The system test statistics are: $F(80,97)$ for autocorrelation, $\chi^2(540)$ for ARCH, and $\chi^2(8)$ for normality test.

specified. Interestingly, in comparison to Table 19, the role of the variables has changed: if in the classic analysis money and wages were excludable, and these and *prre* appeared to be (separately) weakly exogenous, after the inclusion of barter into analysis, output can be excluded from the long-run relations, while only wages and *prre* appear to be (separately) weakly exogenous. Apparently, information that is in the dynamics of barter changed the long-run relations in the system. Even though the same result holds for the main variable under consideration (w), it is now weaker.

Table 26. Tests.

r	d	$\chi^2(d)$	$prre$	mb	w	y	$trend$
			Long-run exclusion, $\chi^2(r)$				
1	1	3.48	8.08	9.52	6.68	**0.00**	8.47
2	2	5.99	9.34	9.57	6.73	**0.62**	10.15
			I(1)ness, $\chi^2(p-r)$				
1	4	9.49	25.28	20.78	24.21	28.67	
2	3	7.81	14.48	13.33	15.07	14.01	
			Zero coefficient in α, $\chi^2(r)$				
1	1	3.48	**0.51**	7.27	**0.58**	8.53	
2	2	5.99	**1.77**	7.28	**0.59**	8.81	

For the case analogous to the previous analysis, with rank equal to one and two common I(2) trends, we obtain the following space basis:

Table 27. The I(2) space, $r = 1, s_1 = 1, s_2 = 2$

	β_1	k	$\beta_{\perp 1}$	$\beta_{\perp 2.1}$	$\beta_{\perp 2.2}$
$prre$	1.00	0.52	2.43	-1.13	-0.11
mb	-0.64	1.97	-7.73	0.08	4.77
w	-1.05	-0.62	7.13	-1.06	-2.73
y	-0.02	-5.17	-3.55	-3.07	-15.95
$trend$	0.02				
	and adjustment coefficients.				
	α_1		$\alpha_{\perp 1}$	$\alpha_{\perp 2.1}$	$\alpha_{\perp 2.2}$
$dprre$	-0.04		-0.02	0.21	0.11
dmb	0.33		-0.02	-0.02	-0.02
dw	0.03		0.06	0.01	-0.02
dy	-0.14		-0.03	-0.1	-0.08

It is easy to see from the table that the inclusion of barter changes the system considerably. There are more signs of wages being correlated one to one with *prre* than before, and the role of money has diminished. If in system 6 money was the main explosive force, strongly correlated with *prre*, in system 7 it is still one of the drivers of the explosive vectors, but not the sole driver. Concerning wages, the signs of their cointegration with prices, even though strengthened, are still weaker than in Poland.

The next table corresponds to the more likely case of $r = 2$, for the same system. It can be seen that the result does not change much from the previous table. However, it makes more sense: one of the explosive trends is driven by the money and wages together, and another is driven by all the nominal variables.

Table 28. The I(2) space, $r = 2, s_1 = 0, s_2 = 2$

	β_1	$k1$	β_2	k_2	$\beta_{\perp 2.1}$	$\beta_{\perp 2.2}$
prre	1.00	0.18	1.00	-1.06	1.51	1.60
mb	-0.65	0.08	0.11	0.07	-1.67	-9.77
w	-1.05	0.12	-0.26	-1.04	2.47	7.54
y	-0.02	0.09	-1.71	-0.46	0.41	-0.79
t	0.02		-0.01			
and adjustment coefficients.						
	α_1		α_2		$\alpha_{\perp 2.1}$	$\alpha_{\perp 2.2}$
dprre	-0.04		-0.12		-0.28	0.13
dmb	0.33		0.02		0.54	-0.10
dw	0.03		0.01		0.06	-0.01
dy	-0.14		0.04		-0.15	0.00

In the next subsection the cointegration basis in the I(1) framework is identified (see section 2).

3.4.1 Identification

The following hypothesis about the cointegration space was accepted with statistics $\chi^2(4) = 6.62[0.58]$. It strongly supports the hypothesis that *prre* and wages are both weakly exogenous and can be excluded from the basis. However, one should not forget that these tests were performed in the I(1) framework, and even if the variables can be excluded from the long-run relations, their differences would still enter polynomially cointegrating relations etc.

Table 29. Identified cointegration space β_1

prre	*mb*	*w*	*y*	*t*
0	3.9 (0.76)	0	1	-0.7 (0.18)
and adjustment coefficients α_1.				
prre	0			
mb	-0.37 (0.07)			
w	0			
y	0.12 (0.04)			

Therefore, the following long-run relation is I(1): $4mb + y - 0.7t \sim I(1)$. Increases in total money (or barter) were harmful for the output.

The following hypothesis is accepted with statistics $\chi^2(8) = 14.9[0.06]$ (the hypothesis with α unrestricted was accepted with $\chi^2(4) = 8.2[0.08]$). Wages could not be tested out of this system. This shows the increased importance of this variable, after the inclusion of barter into analysis. However, its role in the economy is still weak, as it is weakly exogenous in the long run.

Table 30. Identified cointegration space β_1

$prre$	mb	w	y	t
1	-1	-1	0	0.021 (0.001)
1	-0.5	-1	0.5	0.011 (0.001)

and adjustment coefficients α_1.

$prre$	0	0
mb	0.39 (0.08)	-0.34 (0.12)
w	0	0
y	-0.04 (0.05)	-0.09 (0.07)

$pr + re - mb - w + 0.02t \sim I(1)$ or $pr = -re + mb + w - 0.02t$

$re + 0.5(y - mb) - (w - pr) + 0.01t \sim I(0)$ or $y = mb + 2(w - pr) - 2re + 0.02t$

The following story may apply concerning the change of the result with the introduction of barter. As noted before, the wages variable is not the actual wage payments to the workers. In the Russia of this period, it includes the wage arrears, i.e. the part of wages that workers were entitled to receive but did not in practice (see footnote on page 3). Therefore, the fact that this variable did not play a role in the system with all other "virtual" variables was easily explained by this. Indeed, after the introduction of barter, wages started playing a more important role.

It is interesting that we might actually have a natural experiment here: we observe a variable as it was supposed to be, while it was not such in practice. Thus, any result that we obtain is an "if" result, i.e. given that there were no arrears. If there had been no arrears and no barter, system 6 would tell us everything we needed to know about such an economy, and wages would not play any substantial role (indeed, it is so). However, when barter is introduced along with the "wrong" wages, we see that the wage variable becomes binding, and if it had been a true wage, a reduction would have been beneficial, in order to curb inflation. This seems to be exactly what happened in Russia: an overly restrictive monetary policy created barter, and then when the wages became explosive, arrears emerged as a natural substitute for the never implemented incomes policy. Causality must however be controlled for, although this would not change the logic of this paper, as I do not study the data on wage arrears.

4 Conclusion

The analysis above shows the following features of the Russian economy: (1) import prices do not influence domestic prices in the long run; (2) exchange rate is very important for the price dynamics; (2) inflation has a very large monetary root; (3) wages are not important in the system without barter; (4) in the system with barter, the long-run relations change, and wages gain more weight, while money and exchange rate still play the important role; (5) wage-price one-to-one long-run stationary relation is found in the system with barter, and also some evidence of money-for-wages printing.

The distinctive feature of the Russian analysis is the change of the results after the introduction of barter. While in the system with money, wages and exchange rates, wages could be excluded, in the same system with money variable corrected for barter payments, the role of wages increases, and the stochastic trends changed significantly. This fact might point to an important detail of Russian transition. Apparently, wage arrears and barter are two closely connected processes, both related to the policy of monetary tightening. They also served as natural buffers in the demonetized economy: barter as an extension to the monetary stock, and wage arrears as a cap on the nominal wages. While it is good that, notwithstanding the too restrictive policies, spontaneous mechanisms were created, it is obvious that they have had a detrimental impact on the long-run output and have not brought fast financial stabilization (more than ten years in Russia, in comparison with two years in Poland, where proper policies were implemented).

This partly solves the Russia-Poland puzzle, and supports Stiglitz's view on the Russian transition and the role of the policy-makers in it.

5 Comparison to the Polish Case

After a comparison to the Polish case studied in Vostroknutova (2003), it turns out that money was endogenous in the short run and exogenous in the long run for both Poland and Russia. In Poland, re was led by both monetary and real shocks. In Russia, its dynamics were most influenced by monetary shocks in the long run and by shocks to the domestic price level in the short run. Appreciation of the re was good for the Polish producers, while it was detrimental for the Russian output, which is consistent with the fact that there was initial over-depreciation in Poland, and initial over-appreciation in Russia. Price level growth benefited Polish production, while it was harmful in Russia. Whereas in Russia real variables significantly influence the dynamics of nominal systems, in Poland this is true only for the re. From the main systems analyzed, Polish inflation had its roots in the wage growth, while in Russia it was mainly due to money growth and exchange rate policy. However, after correction of the Russian money variable for barter, the picture changed. Wages started to play a more important role in the new system. Still all variables contributed to the stochastic trends, and neither of them could be excluded from the long-run relations.

It is postulated that for the CB to be able to control inflation, its independence, along with stable money-price relationship, and exogeneity of money, are required. Having analyzed two different transition economies, it is argued that money can be assumed to be exogenous for both of them. In Russia, the existence of a stable long-run money-price relationship is undermined, while money has a very large impact on the dynamics of the stochastic component of prices. In Poland, money did not play the most important role in price dynamics, and had only an indirect effect on the real system, through the exchange rate. In both countries, an I(1) relation between money and prices was found, which contradicts classical theory, and might be an indication of the dependence on institutional changes during the transition period. These findings generally support previous research on transition countries that has not discovered a stable direct relationship between money and prices. However, I argue that in Russia money had a greater effect on the overall nominal price performance than in Poland, and that inflation had monetary roots in Russia as opposed to the wage-driven inflation in Poland.

Fischer and Sahay (2000) mention Poland and Russia as two examples of on-time and "too late" exiting from the peg regime correspondingly. This can also be seen in the data, as the exchange rate is a binding constraint in the Russian system (and has a strong impact on prices), while it is weakly exogenous to the Polish system and does not influence stochastic dynamics (although it enters stable relations with correct sign). It is an interesting result that in Poland real appreciation had a positive effect on the output, while in Russia it had a negative effect.[17] This finding is generally consistent with the theory that claims over-depreciation in Poland, and over-appreciation in Russia before 1998 (see, for example, Fischer and Sahay, 2001).

Polish output is moderately influenced by money variable (monetary easing is associated with more output). In Russia, on the other hand, if barter is taken into account, growth in the new *mb* variable is harmful for the output. Growth in the money base only is, however, positively influencing output. These results might suggest that monetary policy was too restrictive, and in the absence of other regulations, it created "natural stabilizers" like barter and arrears. These instruments were harmful for the output and turned out to be less efficient in bringing the inflation down (comparatively to Poland).

One can see that the policies implemented in Poland did, in fact, work, and stabilized the economy, while in Russia the ability of the CB to control the money stock and exchange rate is doubtful in the long run. The main ingredient of the Polish stabilization remains the *popiwek* tax on wage increases, while in Russia the external sector and money stock are the main channels of nominal price growth.[18] After accounting for barter in the Russian case, we see the role of wages increasing, but money still remains very important. The wage arrears that were present in the Russian economy and took approximately 27.7% of the state sector wages in 1997, seem to be an 'unofficial' mechanism of curbing inflation, analogous to the 'official' *popiwek* tax in Poland.

Two stabilization policies were compared. The Polish one has been called the "scorched earth" policy, because of its harmful social effect, and due to the belief that a much less restrictive monetary (and especially incomes) policy would have had the same stabilizing effect. I found that the Polish government 'scorched the earth' for a reason: the analysis shows that the *popiwek* tax on wage increases was the main and, indeed, almost the only instrument of stabilization, without which inflation would probably have been of an explosive nature. However, it also follows from the data that more inflation would have been beneficial for output growth.

The Russian stabilization was also assumed to be a Big Bang policy, until it was realized that the reforms and stabilization packages were not implemented fully and were often reversed (Buch, 1998, among others). It is beyond the scope of this paper to understand the reality of the threats of the Russian ex-ante political constraints, and what would have happened if a Polish-type policy had indeed been implemented fully there. It is obvious, however, that the inertia in stabilization, a too restrictive monetary policy combined with an over-appreciated exchange rate of the *ruble*, caused a decade of stagnation in Russia and, by extension, in many countries of the CIS as well.

[17] The fact that we used nominal output for Russia should not matter, as the real output can be extracted by summation.

[18] It is interesting, when reading the reports about Russian transition, 90 percent of the government announcements promise to increase the minimum wage, but no similar promises are made in Poland. This might be dependent on the severe political constraints that took place in Russia during the whole period of transition, and supplied a reason for the prolonged stabilization in the country.

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