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Dynamic Relations between Exchange Rates and Stock Prices: Evidence from Russia†

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This study examines the relations between stock prices and exchange rates. The bi-variate vector autoregressive models suggest that in the crisis period of 1998, exchange rates led stock prices as in many developing countries, whereas in three sub-periods stock prices led exchange rates and in one sub-period the causality was bidirectional. These findings indicate the causal relations between these two variables after the financial turmoil in 2008 are different from those of the crisis in 1998. Variance decomposition clarifies that more than 50 percent of the error variance of stock prices is explained by exchange rates during the financial crisis in 1998.

JEL Classification: F30, G15, P20
Keywords: Exchange rates, Stock prices, Russian economy, VAR

1. Introduction

A substantial amount of multi-lateral transactions is made among stock markets around the world. The findings of Eun and Shim (1989) suggest that the dynamic pattern is found to be generally consistent with the notion of an informationally efficient international stock market. Therefore, investors have possibilities to select countries and companies for the maximization of their profits.

While it is significant for investors to evaluate the current and expected profits of companies, from which stock prices might be determined, exchange rates also bear considerable importance. According to the goods market approach of Dornbusch and Fischer (1980), exchange rate changes affect the competitiveness of a firm, which in turn influences the firm's earnings and its stock price. On the other hand, the portfolio balance approach of Frankel (1993) indicates that a rising stock market would attract capital flows, which increases the demand for domestic currency and causes the appreciation of exchange rates.

Many studies have empirically examined relations between exchange rates and stock prices, using a vector autoregressive model, and analyzed the Granger causality between them. Bahmani-Oskooee and Sohrabian (1992), Hatemi-J and Irandoust (2002) and Nieh and Lee (2001) discussed relations between exchange rates and stock prices in a developed country or countries.

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Specifically, Bahmani-Oskooee and Sohrabian (1992) examined causality between monthly stock prices and exchange rates in the U.S. over the period July 1973-December 1988. Their findings suggest that there is bidirectional causality between two variables in the short run, while there is no long run relationship between them.

Hatemi-J and Irandoust (2002) analyzed the Swedish case using monthly data from 1993 to 1998 and showed that Granger causality was unidirectional from stock prices to effective exchange rates and that the increase in stock prices was associated with the appreciation of the Swedish krona.

Nieh and Lee (2001), using daily data from October 1993 to February 1996, indicate that there is no long-run significant relationship between stock prices and exchange rates in the G-7 countries. As for the short run, currency depreciation will stimulate the Canadian and U.K. markets on the following day, while an increase in the stock price today causes currency depreciation tomorrow for Italy and Japan.

Ajayi et al. (1998) used daily data of advanced and emerging economies over the period April 1985-August 1991 and found unidirectional causality from stock prices to currency markets in the advanced economies, while no consistent causal relations were observed in the emerging economies.

The situations in Asian countries are examined in Abdalla and Murinde (1997), and Granger et al. (2000). Abdalla and Murinde (1997) found unidirectional causality from exchange rates to stock prices in India, Korea and Pakistan using monthly data from January 1985 to July 1994. Granger et al. (2000), on the basis of daily data of Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan from January 1986 to June 1998, suggest that most markets exhibit bidirectional causality between stock prices and exchange rates.

Pan et al. (2007) discuss the effects of the Asian currency crisis in 1997 on the relations between exchange rates and stock prices for Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand using daily data. Their empirical results showed a significant causal relation before the 1997 Asian financial crisis from exchange rates to stock prices for Hong Kong, Japan, Malaysia and Thailand, and from the equity market to the foreign exchange market for Hong Kong, Korea and Singapore. In addition, while no country showed a significant causality from stock prices to exchange rates during the Asian crisis, a causal relation from exchange rates to stock prices was found for all countries except Malaysia.

This article seeks to discuss causal relations between stock prices and exchange rates in Russia. The analysis on the Russian case could add especially indicative findings to the comparable analyses of other countries because the Russian economy experienced the federal government's default and the financial crisis in 1998, the rapid output recovery after 1999, the drastic rise of crude oil prices in international commodity markets, the global financial turmoil in 2008 and the following plunge in stock and oil prices.

The outline of this paper is as follows. Section 2 describes the data sources for the analysis and methodological issues. Section 3 is a presentation of the

empirical results. The last section summarizes the conclusions of this paper.

2. Data and Methodology

This study applies a vector autoregressive (VAR) model with Russian data from January 5, 1998 through December 31, 2008. Daily data of stock prices and exchange rates are used in the analysis because investors make operations in stock and currency markets on the basis of daily information, and daily data might reflect clearer transactions than weekly or monthly data. As an indicator of stock prices, the log of RTS Index denominated in Russian ruble is used.[1] The log of the Russian ruble exchange rate per U.S. dollar is used as an indicator of exchange rates.

Moreover, two exogenous variables are included in the estimation. The first is the interest rate spread between the Moscow Interbank Bid Rate (MIBID) and Federal Fund rates (this indicator is referred to as *SPREAD*), which could cause the inflows and outflows of funds, and the fluctuations of exchange rates.[2] The second is world crude oil prices, which contributed to Russian economic growth and the increase of Russian export revenues.[3] The log of futures prices of New York Mercantile Exchange light sweet crude oil is used as an indicator of world oil prices (this indicator is referred to as *OIL*).[4]

Russia's foreign exchange system has been changed depending on Russia's macroeconomic conditions. The short history of the currency exchange scheme is as follows. Although the ruble exchange rate had been depreciating following the Russian transition to a market economy, the exchange rate began to stabilize and accordingly, the Russian government and the Central Bank of Russia introduced a fixed exchange rate of 4.3-4.9 ruble per U.S. dollar on July 6, 1995. Although the authorities introduced a crawling band from the second half of 1996, the fixed exchange rate band was adopted again after January 1, 1998, and was set within 5.25-7.15 ruble per U.S. dollar (for details, see OECD, 1998).

Although macroeconomic indicators showed favorable values in 1997, the

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1) The data is available at the website of the stock exchange RTS (http://www.rts.ru/). Although stock prices of RTS Standard are denominated in U.S. dollars, payments are made in Russian rubles.

2) The data on the MIBID are available after the beginning of 1998 in the Bulletin of Banking Statistics issued by the Central Bank of Russia. This paper does not use data on the Moscow Interbank Offered Rate because the data are not available for about a month after the Russian government's default. The data on Federal Fund rates were derived from the Federal Reserve Economic Data website (http://research.stlouisfed.org/fred2/).

3) Oil price increases enabled Russia to achieve rapid economic growth. On the other hand, it has often been indicated that Russia is suffering from Dutch Disease because of the increase of oil prices (see, e.g., World Bank, 2005; Ollus and Barisitz, 2007) while Oomes and Kalcheva (2007) claim that although they find evidence of Dutch Disease, that is, real appreciation, a declining manufacturing sector, an expanding service sector, and rapid real wage growth, more research is needed to determine that these symptoms are not caused by other factors.

4) The data are available at the Energy Information Administration (official energy statistics from the U.S. government).

crisis was near at hand. During the first half of 1998, about 50 percent of federal tax revenue was needed for servicing the debt, and just before the crisis all federal tax revenue was so used (Sutela, 1999). Government bond prices began to plummet in early August 1998, and many banks sought to sell their government bond portfolios in order to meet their current obligations on foreign loans and protect themselves from exchange rate risk, which caused a further increase of interest rates and the depreciation of the Russian ruble. On August 17, 1998, the Russian authorities announced a series of measures, including a new exchange rate band of 6-9.5 ruble per U.S. dollar, and Russia moved to a freely floating exchange rate regime on September 2, 1998 (for details, see OECD, 2000).[5)]

Figure 1 shows the changes of the Russian ruble exchange rate per U.S. dollar from January 5, 1998 through December 31, 2008. This paper divides the period researched here into five sub-periods. The first sub-period is from January 5, 1998 to August 14, 1998, when the ruble-U.S. dollar exchange rate was relatively stable before the Russian government's default. The second sub-period is from August 17, 1998 to April 8, 1999, in which the ruble exchange rate largely depreciated. The third sub-period is from April 9, 1999 to January 9, 2003, when industrial production began to increase in May, 1999 while the ruble depreciated slowly. The fourth sub-period is from January 10, 2003 to July 16, 2008, when the Russian ruble began to appreciate against U.S. dollar under the circumstances of oil price increases. The fifth sub-period is from July 17 to December 31, 2008, in which the ruble exchange rate depreciated in the context of the global financial market turmoil and the sharp decline of

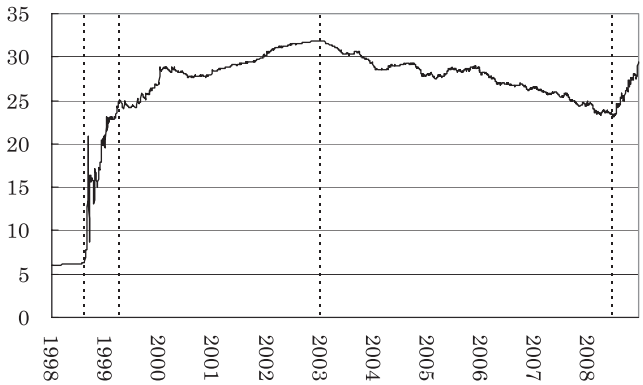

Figure 1 . Russian ruble exchange rates per U.S. dollar.

(Source) Central Bank of Russia, *Bulletin of Banking Statistics*.

5) It is significant to note that Russian exporters had been required to convert a certain share of export earnings into the Russian ruble in accordance with the currency market regulations of the Central Bank of Russia. The share of the mandatory sale of export revenues was lifted from 50 percent to 75 percent at the beginning of 1999. It was gradually decreased, and the regulations were abolished on May 7, 2006 (*Vedomosti*, March 28, 2006; *Kommersant*, May 31, 2006). Furthermore, the deposit requirements for foreign investors by the Central Bank of Russia were eliminated on July 1, 2006, leading to the liberalization of capital movement (*Kommersant*, May 31, 2006).

crude oil prices.

As indicated above, a VAR model is applied to evaluate the relations between exchange rates and stock prices. The VAR model of order p can be written as:

$$\mathbf{y}_t = \boldsymbol{\mu} + \sum_{j=1}^{p} \mathbf{A}_j \mathbf{y}_{t-j} + \mathbf{B}\mathbf{u}_t + \mathbf{C}\mathbf{v}_t + \boldsymbol{\varepsilon}_t \tag{1}$$

where $\mathbf{y}_t$ is a 2×1 vector of jointly determined variables, t is a linear time trend, $\boldsymbol{\mu}$ is a 2×1 vector of constants, $\mathbf{A}_j$ is a 2×2 matrix of coefficients to be estimated, $\mathbf{u}_t$ is a 2×1 vector of the interest rate spread between MIBID and Federal Fund rates (*SPREAD*), $\mathbf{v}_t$ is a 2×1 vector of world crude oil prices (*OIL*), $\mathbf{B}$ and $\mathbf{C}$ are 2×2 coefficient matrixes of coefficients to be estimated, and $\boldsymbol{\varepsilon}_t$ is a 2×1 vector of white noise error terms.

3. Empirical Results

3.1. Preliminary Research

This paper begins the analysis with testing the order of integration of the variables, using the Augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979) and the Phillips-Perron unit root test (Phillips and Perron, 1988). Table 1 reports the results of the Augmented Dickey-Fuller unit root test, showing that all variables except for *FX* in the second sub-period cannot reject the null hypothesis of the existence of a unit root and are integrated of order 1 in their levels while they are stationary in their first differences. The results of the Phillips-Perron unit root test in Table 2 also indicate the same conclusion as those of Table 1.

Because the above-mentioned unit root tests suggest that each indicator except for *FX* in the second sub-period has stochastic trends in log levels, whether these variables have common stochastic trends is investigated by the procedures suggested in Johansen (1991). Table 3 reports the trace and eigen-

Table 1. Augmented Dickey-Fuller unit root test results

		Constant		Constant & trend	
Periods	Variables	Log level	1st log difference	Log level	1st log difference
1/05/98-	*FX*	-1.70(1)	-8.26(0)***	-3.68(1)**	-8.37(0)***
8/14/98	*SP*	-0.06(1)	-10.40(0)***	-1.38(0)	-10.38(0)***
8/17/98-	*FX*	-3.46(4)**	-7.77(3)***	-4.79(1)***	-7.96(3)***
4/08/99	*SP*	-1.87(1)	-8.52(0)***	-5.00(1)***	-8.49(0)***
4/09/99-	*FX*	-1.09(1)	-23.39(0)***	-2.09(1)	-23.38(0)***
1/09/03	*SP*	-2.02(1)	-27.33(0)***	-2.70(1)	-27.35(0)***
1/10/03-	*FX*	0.32(0)	-34.85(0)***	-1.23(0)	-34.85(0)***
7/16/08	*SP*	-1.28(0)	-34.55(0)***	-1.81(0)	-34.55(0)***
7/17/08-	*FX*	-0.27(0)	-10.06(0)***	-3.04(0)	-10.03(0)***
12/31/08	*SP*	-1.43(0)	-9.98(0)***	-1.71(0)	-9.99(0)***

(Note) Figures in parentheses indicate lag length. Superscripts*** and ** denote rejection of the null hypothesis of the existence of a unit root at the 1% and 5% levels of significance, respectively.

Table 2. Phillips-Perron unit root test results

		Constant		Constant & trend	
Periods	Variables	Log level	1st log difference	Log level	1st log difference
1/05/98–	*FX*	−1.89	−8.26***	−3.82**	−8.38***
8/14/98	*SP*	−0.27	−10.39***	−1.67	−10.37***
8/17/98–	*FX*	−3.45**	−6.63***	−3.47**	−6.70***
4/08/99	*SP*	−1.41	−7.94***	−4.05***	−7.90***
4/09/99–	*FX*	−1.01	−22.70***	−1.82	−22.69***
1/09/03	*SP*	−2.08	−27.28***	−2.70	−27.29***
1/10/03–	*FX*	0.32	−34.88***	−1.36	−34.88***
7/16/08	*SP*	−1.28	−34.55***	−2.04	−34.55***
7/17/08–	*FX*	−0.29	−10.05***	−3.33*	−10.02***
12/31/08	*SP*	−1.43	−9.96***	−1.86	−9.98***

(Note) Superscripts ***, ** and * denote rejection of the null hypothesis of the existence of a unit root at the 1%, 5% and 10% levels of significance, respectively.

value statistics in Johansen's cointegration tests. The null hypothesis of being no cointegration is not rejected for all cases tested, showing there are no long run relations between these two variables. These results are consistent with most cases in Bahmani-Oskooee and Shorabian (1992), Nieh and Lee (2001) and Pan et al. (2007).

3.2. Granger Causality Test Results

The results of Granger causality tests are shown in Table 4. In the first sub-period, stock prices led exchange rates with statistical significance at the 5 percent level. The Russian ruble depreciated slowly, while stock prices had a tendency to decrease throughout the first sub-period. Therefore, the causal relations can be explained by the portfolio balance theory because the fall of Russian stock prices could prompt investors to exchange their funds for hard currency, which led to the depreciation of the ruble exchange rate. The findings also indicate that crude oil futures have a statistically significant positive correlation with stock prices and a significant slightly negative correlation with exchange rates. The correlation of falling oil price futures with decreasing

Table 3. Johansen cointegration test results

Periods	Variables (Lags)	Maximum eigenvalue statistic	Trace statistic	Hypothesis
1/05/98–	*FX, STOCK* (7)	6.44	6.78	None
8/14/98		0.34	0.34	At least one
4/09/99–	*FX, STOCK* (3)	12.21	12.87	None
1/09/03		0.66	0.66	At least one
1/10/03–	*FX, STOCK* (3)	7.18	10.27	None
7/16/08		3.09*	3.09*	At least one
7/17/08–	*FX, STOCK* (2)	2.67	4.85	None
12/31/08		2.18	2.18	At least one

(Note) Lag lengths were selected using Akaike Information Criteria (up to 10). Superscript * denotes significance at the 10% level.

Table 4 . Granger causality test results

	Dependent variable	Independent variable	Chi-squared	$SPREAD(*10^{-3})$	$OIL(*10^{-3})$
1/05/98-	ΔST	ΔFX	6.62	0.47^{***}	102.56^{**}
8/14/98	ΔFX	ΔST	16.66^{**}	-0.00^{**}	-0.06^{***}
8/17/98-	ΔST	FX	33.03^{***}	-2.09^{***}	-47.89
4/08/99	FX	ΔST	0.26	-2.02^{***}	-30.89
4/09/99-	ΔST	ΔFX	8.91^{**}	0.24	-0.79
1/09/03	ΔFX	ΔST	13.64^{***}	-0.00	-0.08
1/10/03-	ΔST	ΔFX	0.70	-0.02	-0.06
7/16/08	ΔFX	ΔST	51.18^{***}	-0.00	-0.04
7/17/08-	ΔST	ΔFX	0.52	0.65	1.33
12/31/08	ΔFX	ΔST	18.40^{***}	-0.07	-0.38

(Note) Superscripts *** and ** denote significance at the 1% and 5% levels, respectively.

stock prices and with the depreciating Russian ruble reflect stumbling economic conditions in Russia, or in one of the major oil exporters in the world. On the other hand, the interest rate spread between Russia and the U.S. has a statistically significant positive correlation with stock prices and a significant negative correlation with exchange rates, contrary to expectations. The interest rate spread fluctuated considerably before the Russian government's default with sharp soars and falls. This situation might cause a statistically significant correlation of the interest rate spread with falling stock prices and depreciating ruble.

Exchange rates led stock prices in the second sub-period, when the ruble exchange rate had plummeted under the Russian government's default. The plunge of exchange rates and stock prices in the crisis period cannot be explained by the goods market theory because the ruble depreciation is supposed to exert a favorable influence on both export-oriented industries and companies related to import substitution. Kaminsky and Schmukler (1999) claim that some of market jitters cannot be explained by any apparent substantial news, but seem to be driven by herd instincts of the market itself. The Russian government's failure to finance its budget deficit properly stimulated investors to exert downward pressures on ruble and stock market prices, leading to herding behavior, which resulted in the Russian authorities being unable to maintain the exchange rate band.

The interest rate spread between Russia and the U.S. is negatively correlated with stock prices as well as exchange rates with statistical significance at the 1 % level. Whereas right before and after the Russian government's default the MIBID soared because of a liquidity shortage, and the interest rate spread between Russia and the U.S. widened, as time passed the spread began to narrow. Although ruble-denominated stock prices continued to fall for a while after the default, the trend soon changed and they began to rise. Exchange rates sharply fell with a brief period of rebound, followed by further depreciation. Therefore these situations are consistent with the statistical implications. On the other hand, international oil prices do not show a statistical significant correlation with stock prices and exchange rates.

In the third sub-period, stock prices and exchange rates had bidirectional causality. The Russian ruble tended to depreciate slowly while stock prices had a rising trend. According to the goods market theory, the depreciation of ruble was favorable for export companies and domestic companies related to import substitution, which could contribute to the rise of stock prices. At the same time, according to the portfolio balance theory, the upward trend of stock prices attracted funds from abroad, which could exert an appreciating effect on the Russian ruble. Therefore, the ruble depreciation effects could be partly offset by the ruble appreciation effects.

In the fourth sub-period, stock prices led exchange rates. Whereas stock prices displayed an upward trend, exchange rates tended to appreciate. The fluctuations of stock prices and exchange rates in this sub-period can be explained by the portfolio balance theory, that is, the rise of stock prices attracted funds from abroad, which in turn led to the Russian ruble appreciation.

In the fifth sub-period, the statistical analysis indicates that stock prices led exchange rates. Because exchange rates tended to depreciate and stock prices were on a downward trend since mid-2008, statistical results imply that investors sold shares and exchanged the realized funds for hard currency. Although the global financial turmoil, especially after mid-2008, led to the plunge of Russian stock prices and the depreciation of the Russian ruble, the causality between stock prices and exchange rates is different from that of the second sub-period.

As mentioned above, the relations between stock prices and exchange rates in the first, fourth and fifth sub-periods are explained by the portfolio balance theory, which is consistent with the cases of Sweden in Hatemi-J and Irandoust (2002), and Hong Kong, Korea and Singapore before the Asian financial crisis in Pan et al. (2007).

On the other hand, the causality between stock prices and exchange rates is bidirectional in the third sub-period, when ruble depreciated while stock price increased. Therefore, the situations in the third sub-period are explained by the goods market theory, although the increasing stock prices could partly attenuate the ruble depreciation by attracting funds from abroad. The goods market theory implies stronger causal relations from exchange rates to stock prices in periods and countries with a higher foreign trade-GDP ratio. It was 38.7 percent for the first quarter of 1998 in Russia while it jumped up to 74.9 percent for the third quarter of 1998 because of the ruble depreciation. It tended to decrease and has fluctuated between about 40 and 50 percent since 2001.[6] Therefore, the results of this study are not consistent with this prediction.

The causality from exchange rates to stock prices in the second sub-period is explained by investors' herding behavior as in Pan et al. (2007), which also indicate the causality from exchange rates to stock prices during the Asian financial crisis in 1997 in the cases of Hong Kong, Korea, Singapore,

[6] These figures are calculated on the basis of data from the website of the Central Bank of Russia.

Taiwan and Thailand.

3.3. Impulse Responses

This section assesses impulse responses of some variable toward another for 20 periods ahead. The results are shown in Figures 2 through 11. The order of the variables to which a one standard deviation shock is given as follows: stock prices and exchange rates.[7] Figures also show 95% confidence bounds around each impulse response.

Figure 2 shows impulse responses of exchange rates to stock prices in the first sub-period. Exchange rates demonstrated a statistically significant negative response to stock prices on the third day. On the other hand, stock prices exhibited positive and negative responses repeatedly and statistical significant responses were not observed (Figure 3).

In the second sub-period, exchange rates responded negatively to stock prices at first although these responses were not statistically significant (Figure 4). Stock prices showed statistically significant positive responses to exchange rates for the first three days, whereas they turned negative from the fourth day, and later became negligible (Figure 5).

In the third sub-period, exchange rates exhibited a statistical significant negative response to stock prices on the third day, while stock prices showed

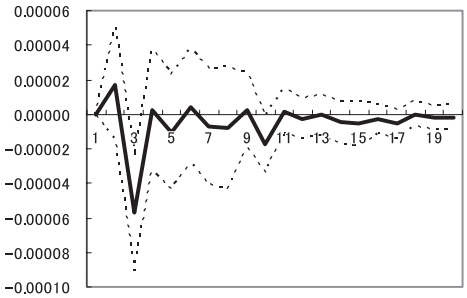

Figure 2 . Response of *FX* to *ST* (sub-period 1)

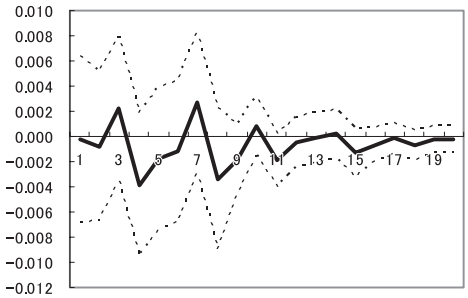

Figure 3 . Response of *ST* to *FX* (sub-period 1)

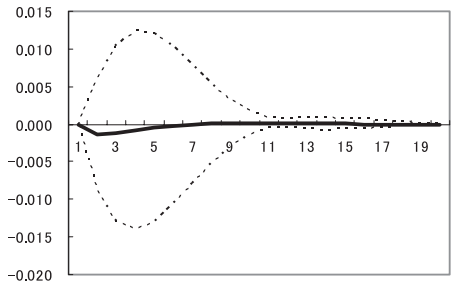

Figure 4 . Response of *FX* to *ST* (sub-period 2)

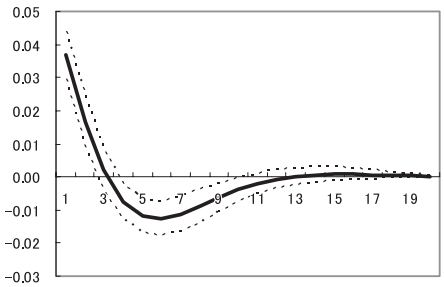

Figure 5 . Response of *ST* to *FX* (sub-period 2)

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7) The results could be different by the order of the variable to which a shock is given. In this paper, however, results with almost no difference were obtained.

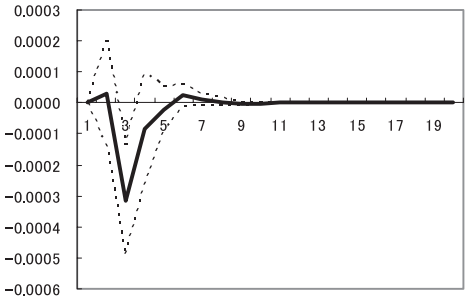

Figure 6 . Response of *FX* to *ST* (sub-period 3)

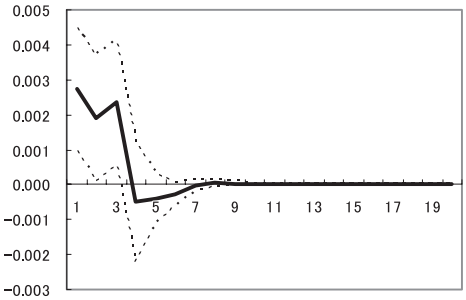

Figure 7 . Response of *ST* to *FX* (sub-period 3)

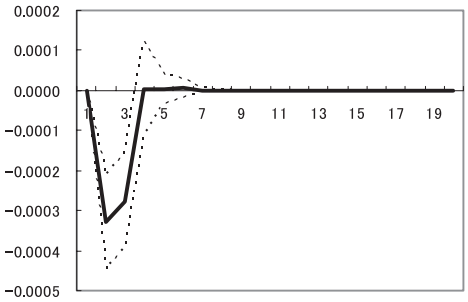

Figure 8 . Response of *FX* to *ST* (sub-period 4)

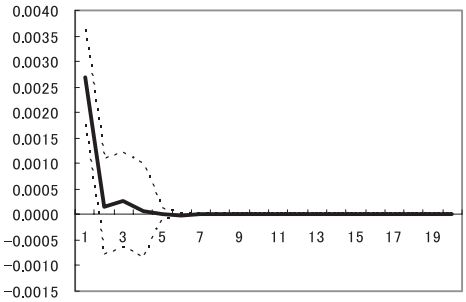

Figure 9 . Response of *ST* to *FX* (sub-period 4)

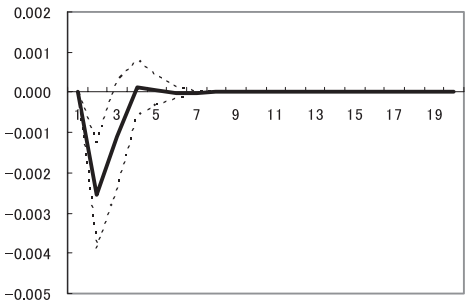

Figure10. Response of *FX* to *ST* (sub-period 5)

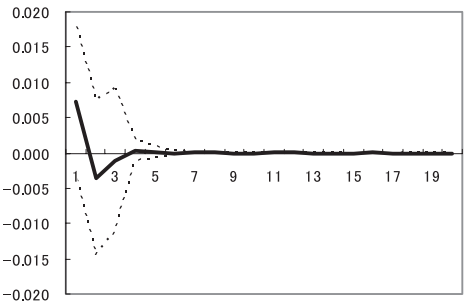

Figure11. Response of *ST* to *FX* (sub-period 5)

statistical significant positive responses to exchange rates in the first three days. In the earlier periods responses of *ST* to *FX* are larger than those of *FX* to *ST* (Figures 6 and 7).

In the fourth sub-period, responses of exchange rates to stock prices were negative with statistical significance on the second and third days, whereas stock prices positively responded to foreign exchange on the first day with statistical significance (Figures 8 and 9).

Finally, in the fifth sub-period exchange rates demonstrated a statistical significant negative response to stock prices on the second day (Figure 10). On the other hand, stock prices did not show statistical significant responses to exchange rates (Figure 11).

3.4. Variance Decomposition

Table 5 presents variance decomposition for the bi-variate vector autoregressive model specified in Equation (1). Figures in the table indicate the percentage explained by exchange rates and stock prices among the unanticipated changes of exchange rates or stock prices over a 20-day horizon. In the first sub-period the error variances of FX and ST are mainly explained by their own innovations.

However, in the second sub-period, more than 50 percent of the error variance of ST is explained by FX. Furthermore, the contribution of stock prices to the volatility in exchange rates is less than 0.03 percent.

In the third and fourth sub-periods the error variances of FX and ST are mainly explained by their own innovations. In the fifth sub-period, stock prices contributed to about 98 percent of volatility in stock prices, whereas stock prices accounted for more than 14 percent of exchange rate variation.

4. Conclusions

This paper examined the relations between stock prices and exchange rates in Russia on the basis of daily data from 1998 through 2008. The cointegration test indicated that there was no long-run equilibrium relationship between these two variables. The Granger causality test showed that exchange

Table 5. Variance decomposition (percentage)

		Exchange rates explained by		Stock prices explained by	
Sub-period	Horizon	FX	ST	FX	ST
1	5	90.974	9.026	1.348	98.652
	10	91.326	8.674	2.616	97.384
	15	91.570	8.430	2.898	97.102
	20	91.584	8.416	2.955	97.045
2	5	99.972	0.028	54.100	45.900
	10	99.973	0.027	59.147	40.853
	15	99.973	0.027	59.207	40.793
	20	99.973	0.027	59.221	40.779
3	5	98.646	1.354	2.176	97.824
	10	98.637	1.363	2.187	97.813
	15	98.637	1.363	2.187	97.813
	20	98.637	1.363	2.187	97.813
4	5	96.233	3.767	2.402	97.598
	10	96.232	3.768	2.402	97.598
	15	96.232	3.768	2.402	97.598
	20	96.232	3.768	2.402	97.598
5	5	85.608	14.392	1.887	98.113
	10	85.607	14.393	1.887	98.113
	15	85.607	14.393	1.887	98.113
	20	85.607	14.393	1.887	98.113

rates led stock prices in the second sub-period, while stock prices led exchange rates in the other sub-periods except the third sub-period, when the causality was bidirectional.

The analysis of this paper indicates that the results of the third sub-period are consistent with the goods market theory, whereas the portfolio balance theory can explain the situations of the first, fourth and fifth sub-periods. The second sub-period could be explained by the herding behavior of investors. Therefore, the characteristics of exchange rate and stock price fluctuations in the fifth sub-period are different from those of the second sub-period.

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