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WHO DRIVES THE RUSSIAN FINANCIAL MARKETS?

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By employing the EGARCH model using monthly data from September 1995 to March 2003, we found that financial indicators from Germany rather than the United States are the main drivers of Russian financial markets. In a one-step prediction, the fluctuations of asset returns are well predicted that the prediction errors fall within the prescribed range of the confidence bands. However, EGARCH does not necessarily dominate the benchmark prediction of the random walk model, because with Russia's financial markets constantly in transition and adjusting to frequent changes in the financial system, the usefulness of past data is diminished.

Keywords: EGARCH; Russian financial markets; Spillovers from the United States and Germany; Prediction

I. INTRODUCTION

RECENT rapid financial deregulation throughout the world has promoted a great deal of trading in financial assets that has attracted international investors. A large increase in portfolios and direct investment from advanced countries into emerging economies took place between 1980 and 2000. As a result, advanced countries now hold substantial emerging market assets, enabling them to exert great influence on these markets. Glick and Hutchison (1990), Bekaert and Harvey (1997), Baks and Kramer (1999), Conover, Jensen, and Johnson (1999), and Jensen, Mercer, and Johnson (1996) have shown that the monetary and real markets of the United States drive emerging stock markets more powerfully than

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regional market effects.[1] On the other hand, in analyzing developing countries in Asia, Ng (2000) and Miyakoshi (2003) argue that the regional effect should not be ignored. These findings suggest that emerging country governments and international investors benefit by using signals from the United States and regional markets. Most previous researchers have focused on the spillover effects from monetary shocks (stock returns, money supply) and from real shocks (GDP) in advanced countries on the emerging markets. They concluded that these shocks are useful signals for the governments of states with emerging markets to take necessary steps to promote relevant economic policy and for investors to obtain some profits.

It is worth mentioning that there are some corresponding features between Eastern European markets and markets in Asian developing countries. However, as the history of capitalism is shorter in the former, the data for analyses are not available for longer periods. Nevertheless, the Russian market provides data series for a relatively long period, and so can represent the other Eastern European markets.

The Russian financial market is the largest emerging market in Eastern Europe in terms of market capitalization (Table I), and was also larger than the Asian emerging markets in 1997. In 2001, despite the Russian crisis of August 1998, it was still larger than the Indonesian and Thai markets, while smaller than the Korean and Malaysian markets that lead the Asian emerging markets. On the other hand, domestic credit extended by Russian banks is relatively small compared with those of the other countries in Table I, while Russia's external debt was much the largest in both 1996 and 2000. However, Russia's external debt service ratio and short-term debt as a proportion of total debt are both relatively low, suggesting effective debt management and that the Russian market should be attractive to foreign investors. It may therefore be surprising, given such favorable conditions, that the Russian crisis eventuated. Despite its short duration, this crisis did not shed a favorable light on the Russian market. However, the 2000 and 2001 recovery show that, with its large potential, the Russian market will attract foreign monetary authorities and other international investors, subject to appropriate research.

It is interesting to investigate the impact of a regional market on Eastern European emerging markets by looking at the German market and the Russian market, respectively. The German market was chosen as a regional market because, in comparison with other Western European countries, Germany has closer relations in trade and investment with Russia, as shown below. Moreover, the German market is the biggest regional market in Europe: its export-import volume is 1.5 times larger than that of France and the United Kingdom, and, based on data from 1990 to 1999, the trading volume of the German stock market, measured in U.S. dollars, is also larger than that of France and the United Kingdom.

[1] The spillover effects from the United States on advanced countries have already been investigated in many papers over the past fifteen years since Eun and Shim (1989).

TABLE I

FINANCIAL ASSET TRADING DATA AND MANAGEMENT

	Bond Markets				Stock Markets				External Debt Management			
	External Debt (U.S.$ million)		Domestic Credit from Banks (% GDP)		Trading Volume (% GNP, GDP)		Market Capitalization (U.S.$ million)		Debt-Export Goods-and-Services Ratio (%)		Short-Term Debt (% Total)	
	1996	2000	1996	2000	1996 (GNP)	2001 (GDP)	1997	2001	1996	2000	1996	2000
Russia	124,785	160,300	24.8	24.0	0.7	8.1	128,207	76,198	6.6	10.1	9.5	9.7
Czech	20,094	21,299	78.6	57.3	15.4	13.0	12,786	9,331	8.3	12.7	29.6	42.3
Estonia	46	3,280	20.1	40.0	—	6.6	—	1,483	1.3	8.7	26.4	28.8
Hungary	26,958	29,415	49.1	53.9	3.7	26.6	14,975	10,367	41.0	24.4	12.5	14.1
Latvia	472	3,379	13.0	24.2	0.3	3.2	148	697	2.3	15.8	9.4	37.6
Lithuania	1,286	4,855	11.5	14.4	0.6	1.8	900	1,199	2.9	17.1	12.2	22.9
Bulgaria	9,819	10,026	150.6	18.3	0.0	0.5	7	505	20.5	16.2	9.2	4.2
Poland	40,895	63,561	35.4	37.8	4.1	9.3	12,135	26,017	6.4	20.9	0.2	11.2
Slovakia	7,704	9,462	60.1	59.9	12.2	4.7	1,826	665	11.9	18.0	38.3	12.2
Slovenia	4,031	—	36.0	47.1	2.2	2.6	663	2,839	8.7	—	1.4	—
Ukraine	9,335	12,166	15.0	23.4	—	0.9	—	1,365	6.1	18.6	4.8	3.7
Romania	8,291	10,224	4.2	14.1	0.0	0.6	61	2,124	12.6	18.8	9.8	3.5
Korea	—	134,417	74.5	104.0	36.6	121.3	41,881	220,046	—	10.9	—	30.1
Malaysia	39,777	41,797	131.9	43.4	174.9	65.2	93,608	120,007	8.2	5.3	27.8	11.1
Indonesia	129,033	141,803	54.6	66.2	14.2	9.3	29,105	23,006	36.8	25.3	25.0	16.0
Thai	90,824	79,675	98.8	121.7	24.0	19.0	23,538	36,340	11.5	16.3	41.4	18.7

Source: World Bank, *World Development Indicators, 2002* (Washington, D.C.: World Bank, 2003).
Note: — denotes missing data.

There has been little research into Russian financial markets. Rockinger and Urga (2000), Hall and Urga (2002), and Abrosimova and Linowski (2002) have investigated the weak-form efficiency model for stock markets. While they draw no strong conclusions, they do find evidence for a tendency towards becoming efficient. Peresetsky, Turmuhambetova, and Urga (2001), and Fedorov and Sarkissian (2000) have analyzed the risk premium of the government short-term bond markets and the integration variation across industry or market capitalization groups. Hayo and Kutan (2002) have examined the spillover effects on Russian stocks and bonds solely from U.S. financial markets, providing strong support for the spillover effects. However, the spillover effects from a Western European regional market and from a real sector market have not previously been investigated.

We investigate what signals drive the Russian stock markets and show how Russian stock returns are predicted by using such signals. We pick up the United States as a world market and Germany as a regional market for Russia and examine the signals (stock returns and industrial production indices) from both countries by employing the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model using monthly data from September 1995 to March 2003, and evaluate the EGARCH model with such signals in a one-step prediction.

A major finding of our research is that the spillover effects from Germany have stronger impacts on Russian stock returns, call rates, lending rates, and exchange rate than those of the United States. In addition, the German production index cannot be ignored. The estimation results suggest that the Russian monetary authorities and international investors have to monitor such German signals to maximize their profits. We also evaluated EGARCH with such signals in a one-step prediction. The fluctuations of such returns were well predicted in the sense that the prediction errors fall in the prescribed range of the confidence bands. However, EGARCH does not necessarily dominate the benchmark prediction of the random walk model in terms of the root mean squared error. In this sense, the one-step prediction based on this EGARCH with such signals is not useful. In practice, with their adaptation to frequent changes in the financial system and consequent deletion of useful information from the past, the Russian markets are in a transitional phase.

The organization of the paper is as follows. We explain the EGARCH model in Section II, describe the Russian financial markets and the data set in Section III, discuss the estimation results in Section IV, examine the one-step prediction based on EGARCH in Section V, investigate previous research on the effects of oil and gas prices on returns in Section VI, and draw our conclusions in Section VII.

II. AN EGARCH MODEL

This paper uses the exponential GARCH model for overcoming the drawbacks in a standard GARCH model for computing the effects of past variance on the present

(Nelson 1991).[2] We restrict our attention to an EGARCH (1,1) since it has been shown to be a parsimonious representation of conditional variance that adequately fits many financial time series. However, this EGARCH includes the foreign controlling variables. This specification can be expressed as:

$$R_t = c + \sum_{j=1}^{k}\alpha_j R_{t-j} + \sum_{j=1}^{k}\beta_j^G GR_{t-j} + \sum_{j=1}^{k}\beta_j^U UR_{t-j}$$

$$+ \sum_{j=1}^{k}\gamma_j^G GP_{t-j} + \sum_{j=1}^{k}\gamma_j^U UP_{t-j} + \varepsilon_t, \tag{1}$$

$$\varepsilon_t \,|\, (\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots) \sim N(0, \sigma_t^2), \tag{2}$$

$$\log\sigma_t^2 = \delta_0 + \delta_1 z_{t-1} + \delta_2 [|z_{t-1}| - E(|z_{t-1}|)] + \delta_3 \log\sigma_{t-1}^2, \tag{3}$$

$$\varepsilon_t \equiv \sigma_t z_t: \; z_t \sim N(0, 1), \; t = 1, 2, \ldots, T, \tag{4}$$

where R_t is the Russian asset return ($\log Q_t - \log Q_{t-1}$; Q_t is an asset price), c is the constant, GR_{t-j} and UR_{t-j} are the German and the U.S. asset returns with jth lag (G and U are symbols for Germany and the United States), and GP_{t-j} and UP_{t-j} are the German and U.S. industrial production index growth ($\log P_t - \log P_{t-1}$; P_t is an index) with jth lag. The first three terms (excluding a constant term) in the right hand of equation (1) express the monetary (i.e., returns) effects among the Russian, German, and U.S. markets. The second two terms are real spillover effects from Germany and the United States (in the sense of Granger causality). The ε_t represents an error term conditional on past information set. The σ_t^2 are the variances for error term ε_t. The β_j^G and β_j^U measure the impact of German and U.S. returns on Russian returns. The production index impacts are represented by the coefficients γ_j^G and γ_j^U, respectively.[3] We do not consider Russia's industrial production indices because of data unavailability.

We can write the log likelihood function $\log L$ and can determine the parameter θ (c, α_j, β_j, γ_j, δ_0, δ_1, δ_2, δ_3) to maximize it. It should follow that the maximum likelihood estimate $\hat{\theta}$ for θ will be asymptotically normal and consistent with a

[2] Nelson pointed out three main drawbacks. First, the volatility of the standard model does not respond asymmetrically to positive and negative residuals. Second, the nonnegativity constraints on the coefficients are imposed to ensure that variance remains nonnegative for all t with probability one. Third, only the magnitude (and not the positivity or negativity of unexpected excess returns) determines variance.

[3] In the EGARCH model, the persistence of variance is measured by the magnitude of δ_3: the more the magnitude approaches unity, the greater is the persistence of shocks to volatility. The positivity or negativity of unanticipated excess returns determines future variance, which is measured by δ_1 and δ_2. The δ_2 represents a magnitude effect. For $\delta_2 > 0$, the innovation in $\log \sigma^2$ is then positive (negative) when the magnitude of Z_{t-1} is larger (smaller) than its expected value. The δ_1 represents a sign effect. For $\delta_1 < 0$, the innovation in conditional variance is positive (negative) when returns innovations are negative (positive).

covariance matrix equal to the inverse of Fisher's information matrix. Following Nelson (1991), we assume this asymptotic normality and the consistency of estimate $\hat{\theta}$ and hence traditional inference procedures are available.

III. RUSSIAN FINANCIAL MARKETS AND DATA

The Russian stock, bond, and exchange markets were liberalized from the beginning of the 1990s. The Russian Trading System (hereinafter RTS), an electronic trading system, was established in September 1995 in order to combine regionally separated stock markets, most of which were established in the early 1990s, into an organized stock market. After its establishment, the RTS set up its own index called the Russian Trading System Index, which began providing daily calculations from September 1, 1995. At present, the RTS Index covers the most liquid shares of the 59 largest Russian companies. The list of constituents of the index is set every three months. For computation of the RTS Index, the fraction includes the total market capitalization of the index component stocks as of current date as numerator and the total market capitalization of the same stocks as of initial date as denominator. This fraction is then multiplied by 100.

The official foreign exchange market in Russia consists of the Moscow Interbank Currency Exchange (MICEX) and some other exchanges (no more than ten) in the regions. The Central Bank of the Russian Federation sets the official exchange rate for the ruble based on MICEX trades. We use this official exchange rate. The MICEX system of electronic lot trading (SELT) is used to hold interregional trades in currency within the framework of the unified trading session of interbank exchanges as well as regular trades in foreign currencies. About five hundred lending institutions are members of the MICEX Currency Market Section.[4]

Government securities, corporate bonds, and sub-federal and municipal bonds are traded on the MICEX, which includes eight major financial centers. All types of transactions involving government securities (GKO, OFZ)[5] are included, from primary distribution and secondary trades to redeeming issues and bonds paying coupon yields. At present, about three hundred dealers trade on the government securities market. In 2002 the total volume of transactions reached 256 billion rubles (about U.S.$8.2 billion), including REPO deals. For corporate bonds the MICEX is Russia's first and major trading floor where trades are held in the corporate bonds of over 80 Russian companies and banks. In 1999–2002 the corporate bonds of over 80 issuers to the total sum of 110 billion rubles (about U.S.$3.5 billion) were placed on the MICEX.

[4] For details, see the Central Bank of Russian Federation (www.cbr.ru) and MICEX (www.micex.com).

[5] GKO denotes government short-term couponless bonds, and OFZ is for federal loan bonds (which is a government coupon bond with a maturity greater than one year).

Monthly data for the RTS Index are calculated as monthly averages of the closing value (measured in U.S. dollars) of daily data for each month from the RTS database, which has open access and is free of charge.[6] This monthly average of the closing value is again measured in rubles by multiplying the ratio of exchange rates against the U.S. dollar in September 1995, and for each month. All data for the other variables are compiled from the International Monetary Fund's *International Financial Statistics* (*IFS*), CD-ROM (August 2003). The data run from September 1995 to March 2003 depending on availability. We use real terms (subtracting inflation rate [line 64] from nominal values) of stock returns (share prices: line 62), call rates (line 60b), lending rates (line 60p), and exchange rate returns (line rf). In the database the industrial production indices P are the seasonally adjusted series (1990 = 100, line 66), and share prices Q are measured in local currency for Germany (GM) and the United States (US).[7]

The data shown in Figure 1 are: the Russian, the German, and the U.S. real stock returns, real call rates, real lending rates, and the real exchange rate returns (all returns are measured in percentages), and the growth rates of the German and the U.S. industrial production indices (measured in absolute levels). There is no abnormal data except for the period of the Russian crisis in September 1998. We have omitted several data observations around this month for all computations. On the other hand, we include the dummy variable in a constant term in equation (1) of the EGARCH model with exchange rate returns from December 1998, when the exchange rate is denominated, and also before September 1996, when the call and lending markets are being made for EGARCH with lending rates or call rates.

Finally, we consider the effects of gas and oil prices on Russian asset returns. As Hayo and Kutan (2002) and others have pointed out, these energy export prices play a crucial role for the Russian economy, since it is heavily dependent on the energy industry. We use the prices of Russian Federation natural gas (line 92276NGZZF) and of average crude oil (line 00176AAZZF) which is converted from U.S. dollars to Russian rubles by the monthly ruble rate (line rf); their growth rates are used and measured in percentages.

The Russian rate of return (measured in percentages) generated only by AR in equation (1) has the following features. Table II reports the standard deviation of error term ε_t in this AR, the Kendall-Stuart skewness, the excess kurtosis, and their tests; the mean of the error term is estimated to be always zero. The Ljung-Box Q-statistic $Q^2(1)$ and $Q^2(5)$ are reported under the null hypothesis of non-serial correlation tests in daily squared error. At the significance level of 5 percent, the null

[6] See ftp://ftp.rtsnet.ru.

[7] As do Karolyi (1995) and others, we measure the market returns in local currency. Note that when market returns are denominated in U.S. dollars, international investors are assumed to be unhedged against foreign exchange risk. Thus, we now assume that the investors are hedged against it. For details, see Miyakoshi (2003).

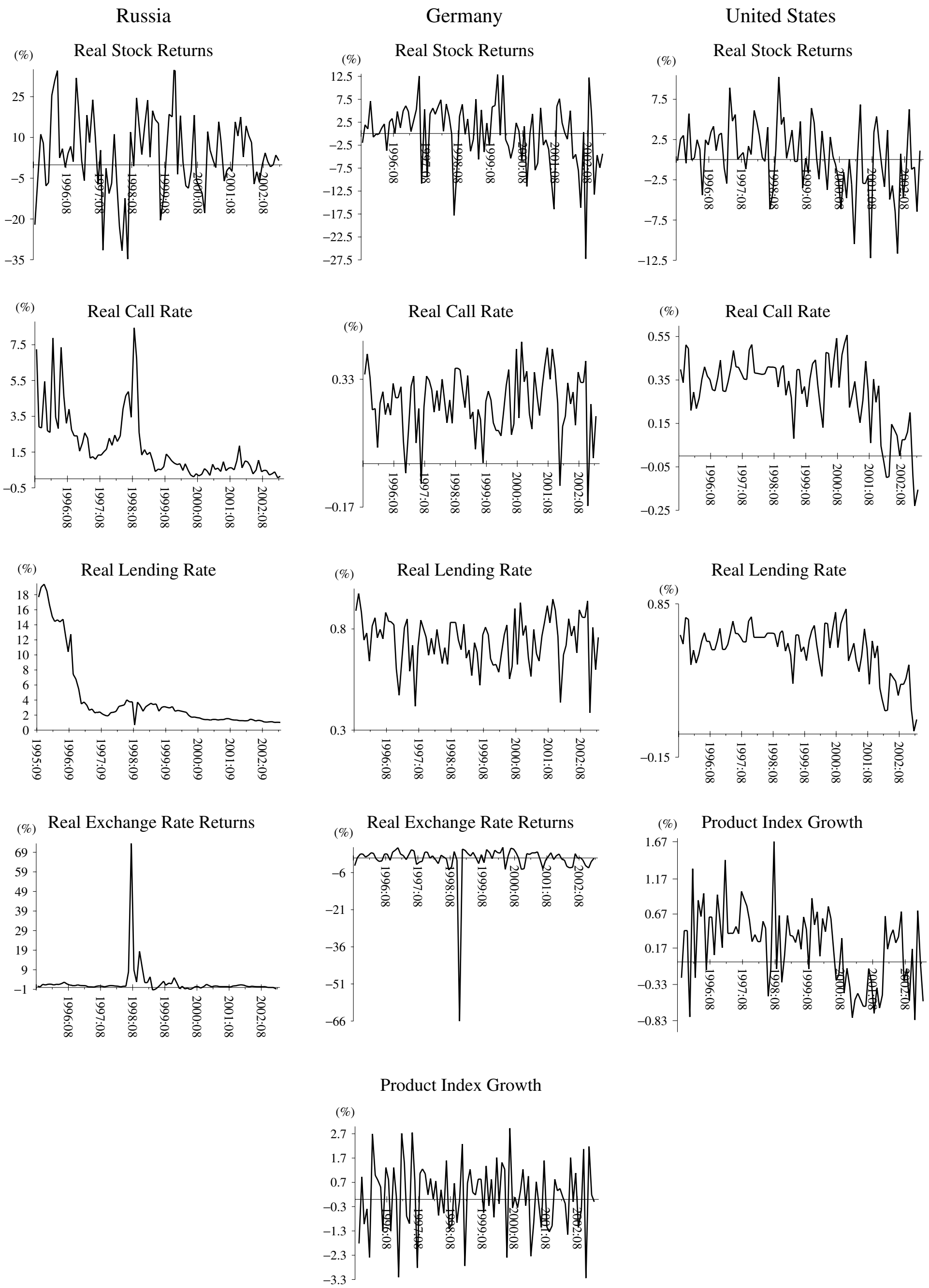


Fig. 1. Graphs of the Observed Data

TABLE II

SUMMARY STATISTICS OF ε_t

	Mean	t-value (Mean = 0)	Standard Deviation	Skewness	Excess Kurtosis	Q (1)	$Q^2(1)$	Q(5)	$Q^2(5)$	Optimal Lag Length: SBIC
Stock returns only	0.00	0.00	12.6110	–0.1603	0.071	0.0659	0.0043	1.8589	3.2594	1
		(1.00)		(0.56)	(0.90)	(0.80)	(0.95)	(0.87)	(0.66)	
Call rate	0.00	0.00	0.9436	1.3880	4.3964	0.5875	4.7273	33.6738	46.4528	1
		(1.00)		(0.00)	(0.00)	(0.44)	(0.03)	(0.00)	(0.00)	
Lending rate	0.00	0.0000	0.7200	–0.2673	13.3352	11.8116	28.0780	26.1089	33.5605	1
		(1.00)		(0.33)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Exchange rate returns	0.00	0.00	1.2272	2.5483	13.7419	0.0149	0.3079	1.9668	0.6888	1
		(1.00)		(0.00)	(0.00)	(0.90)	(0.58)	(0.85)	(0.98)	
Stock returns with gas and petrol	0.00	0.00	12.5589	–0.1597	0.1432	0.0496	0.1350	1.8218	3.6243	1
		(1.00)		(0.56)	(0.80)	(0.82)	(0.71)	(0.87)	(0.61)	

Note: All returns are measured in percentages. We examine the ε_t estimated by using only the AR presented in equation (1), not by using the variance equation in equation (3). The Q for ε_t and the Q^2 for ε_t^2 are distributed as χ^2 (1 or 5) under the null hypothesis of non-serial correlation with lags up to 1 or 5. The significance levels appear in parentheses.

hypotheses (skewness = 0 or excess kurtosis = 0) are generally rejected except for stock returns, but non-serial correlations for error terms are not rejected except for call rates. Thus, the time series have the typical features of stock returns like fat tail and spiked peak, but not the persistence of variance.[8] That is, as we use monthly data, the persistence of variance disappears within a month. Otherwise, the estimated squared error is only a proxy for the variance and does not express the variance correctly. However, in Table III, the significant coefficient δ_3 in the variance equation supports the variance persistence. Thus, as a result, an ARCH-type model seems to be appropriate for analyzing these series.

We use Schwarz's Bayesian Information Criterion (SBIC) to determine the optimal lag length for AR in equation (1) out of three lags. From now on, we use the EGARCH with the same lag length (one lag) as that of the AR. Table II shows the summary statistics for ε_t in the AR with one lag as an optimal lag.

IV. ESTIMATION RESULTS AND DISCUSSIONS

Table III presents the estimation results of the Russian (α), the German (β^G), and the U.S. (β^U) return effects, and the production index growth effects of γ^G and γ^U, respectively.[9] The estimated coefficients show that in significant cases, except for the lending rate,

$$|\beta^G| > |\beta^U|, \tag{5}$$

for stock returns, call rates, lending rates, and the exchange rate, indicating that the Russian market returns are influenced only by the regional factor of the German market (in the sense of Granger causality), not by the world factor of the U.S. market: Russian stock returns increase when German stock returns increase; likewise the Russian exchange rate return declines in line with the decline in the German rate. The arbitrage between German and Russian assets prices decreases Russian stock prices and then increases the Russian stock returns. Optimistic expectations also increase Russian returns. However, the call rates move in the opposite direction.

This result differs from those of Ng (2000), Miyakoshi (2003), and others dealing with emerging markets, which support stronger impacts from the United States. Like these previous studies, we do not test hypothetically which absolute values of coefficients are larger. Our result cannot be attributed to the time difference of opening and closing hours between the Russian and German exchanges, since we use monthly

[8] All computations in this paper have been performed with the computer package WinRATS-32 Version 5.0.

[9] The BFGS algorithm for the Maximum Likelihood is sensitive to the choice of initial estimates. The combination of SIMPLEX and BFGS works better than BFGS alone. For simplicity, we set 11 more than parameter plus one as the iteration number in the SIMPLEX for all countries.

TABLE III

PARAMETER ESTIMATIONS

	Return Equation							Variance Equation		
	Own Effects	Foreign Monetary Effects		Foreign Real Effects		Oil-Gas Price				
	Russian: α	GM: β^G	US: β^U	GM: γ^G	US: γ^U	Oil	Gas	δ_1	δ_2	δ_3
Stock returns only	0.4503***	0.6863***	−0.6028	0.2539	0.1320	—	—	0.1643	−0.2435	−0.8058***
	(4.70)	(2.68)	(−1.38)	(0.25)	(0.05)			(1.23)	(−1.42)	(−5.09)
Call rate	0.7505***	−0.4332*	0.3152	−0.0091	0.0267	—	—	0.1922	0.9252***	0.8546***
	(7.87)	(−1.61)	(1.07)	(−0.33)	(0.31)			(1.18)	(2.97)	(10.25)
Lending rate	1.0764***	0.0959***	−0.1921***	0.0160*	−0.0387*	—	—	0.5218**	−0.0733	1.0185**
	(109.69)	(3.69)	(−3.92)	(1.90)	(−1.75)			(5.31)	(−1.09)	(78.15)
Exchange rate returns	0.6670***	0.0479***	—	0.0384***	0.1810***	—	—	2.6131***	−1.0146***	0.4349***
	(47.08)	(23.90)		(12.67)	(9.96)			(9.67)	(−4.16)	(15.00)
Stock returns with gas and petrol	0.4511***	0.7068***	−0.6520*	0.2418	−0.1685	0.1339	−0.1670	0.1383	−0.2918*	−0.8024***
	(5.42)	(2.84)	(−1.63)	(0.25)	(−0.07)	(0.97)	(−0.81)	(0.98)	(−1.88)	(−112.98)

Notes: 1. Asymptotic *t*-statistics for the estimated parameters appear in parentheses.
2. We include dummy variables and omit the sample for each EGARCH; omitted from September 1998 to January 1999 for all EGARCHs; included a dummy variable in a constant term from January 1999 for EGARCH with exchange rates returns and from September 1996 for EGARCH with call and lending rates.

***, **, and * indicate respectively statistical significance at 1 percent, 5 percent, and 10 percent assuming conditional normality.

data. Thus, regional market power, and not world market power, has a stronger impact on the Russian market.

On the other hand, Russian market returns are influenced by foreign production growth with significant γ^G and γ^U for lending rates and exchange rate returns, and here U.S. production growth has a stronger impact than the German,

$$|\gamma^G| < |\gamma^U|. \tag{6}$$

These coefficients represent real impacts but, in general, the real impact will not appear until after a few months. Thus, the coefficient reflects the expectation for future development of the economy. As a result, the world impact of the United States will be stronger, but the signs for both coefficients are negative except for exchange rate return. Rising U.S. production growth raises U.S. bond prices (together with stock prices) and revalues the U.S. dollar, which leads the counterpart revaluation or devaluation of the Russian variables.

We now give statistical and economic justifications for the results described in equations (5) and (6). The right-hand column of Table III shows the estimation results in a variance equation in equation (3). The δ_1 are not negative significant for all returns opposed to the standard results in the research field of advanced financial markets. However, the $|\delta_3|$ for all returns are approximately one, which enhances the persistence of variance. This will not be consistent with the test result of Table II. As explained above, the estimated squared error is only a proxy for a variance, which does not lead to a correct test result. A more detailed explanation will be considered in future research. However, the δ_2 is significant except for lending rate. These results support our use of the EGARCH model.

We did not consider Russia's industrial production indices because of data unavailability. However, we have to confirm that omitting this data is not a serious drawback on the analytical results. In general, the industrial production indices display behavior similar to the GDP, while the monthly data is available only for the industrial production indices. Therefore, we investigate whether or not the U.S. and German quarterly GDP affect the Russian one in a sense of Granger causality. If they affect the latter, the U.S. and German industrial production indices also cause the Russian production index. This causality suggests a support for omitting this variable in the analysis. We use the quarterly GDP (line 99BPZF for Russia, 99BVRZF for the United States, 99BRYF for Germany) from 1995:Q4 to 2003:Q1 in the *International Financial Statistics* (June 2004). The results of the causality test for *RGDPG* (Russian GDP growth) are shown.

$$\begin{aligned} RGDPG_t = &- \underset{(-2.12)}{0.075} + \underset{(3.04)}{0.513}RGDPG_{t-1} + \underset{(2.22)}{4.512}UGDPG_{t-1} \\ &- \underset{(-0.68)}{1.348}GGDP_{t-1}, \end{aligned} \tag{7}$$

where the numbers in parentheses are t-values, the adjusted R-squared is 0.727, and the DW is 1.92. The regression shows a good fitness.[10] The coefficient of *UGDPG* (U.S. GDP growth) is significant, supporting the causality from the United States to Russia. Also, though the coefficient of *GGDPG* (German GDP growth) is not significant, the joint null hypothesis of both GDP growths having no effect is rejected at the 0.1 significance level by using an F-test. In addition, the eight times larger coefficient of the United States than that of Russia suggests that omitting this data does not have a serious drawback on the analytical results.

Next, by using other data, we have to interpret the result that, while the spillovers from the German market returns to the Russian are stronger than those of the United States, the spillovers from the production growth of both Germany and the United States are significant. We have to examine at least two channels for these spillovers. The first is from the German real sector to the Russian market returns through the Russian real sector, and the other is directly from the German financial sector to the Russian returns.[11] For the first channel, as seen in Table IV-A, Germany is the top trading partner in exports to and imports from Russia, and from 1995 to 2002 the United States was the second top partner. In 2002, for example, exports to Germany were U.S.$8,289 million against imports of U.S.$6,966 million, while exports to and imports from the United States were U.S.$6,888 million and U.S.$2,820 million respectively. Russia's imports from Germany were twice as large as from the United States, and the gap between imports from German and from other countries has recently grown. Thus, Germany's close relation with the Russian real sector will influence the Russian returns through its real sector. For the second channel, since the data on financial assets are relatively scarce from 1999 to 2001, we cannot confirm the predominance of Germany against the United States. However, the cumulative data to 2003 in Table IV-B indicate similar magnitudes of portfolio and direct investment from the United States, Germany, Netherlands, Cyprus, and the United Kingdom.

V. PREDICTION BASED ON EGARCH WITH SIGNALS FROM GERMANY AND THE UNITED STATES

We make use of the signals from the United States and Germany for predicting the returns. The EGARCH with signals gives the predictor of R_τ conditional on information $I_{\tau-1}$ as:

[10] Seasonal dummies are included but the result is not shown. Those dummies are mostly significant.

[11] Here we consider the external- and internal-relations between the real and financial sectors in both countries. There are other channels, for example, one of which is from the German financial sector to the Russian returns through the German real sector. However, we will consider these channels in future research.

TABLE IV

A. Main Trade Partners for Russia, Excluding CIS Members, by Trading Volumes

(U.S.$ million)

	1995		1996		1997		1998		1999		2000		2001		2002	
	Ex	Im	Ex	Im	Ex	Im	Ex	Im	Ex	Im	Ex	Im	Ex	Im	Ex	Im
Germany	6,079	6,537	6,734	5,158	6,531	6,640	5,697	5,404	6,178	4,195	9,231	3,896	8,178	5,716	8,289	6,966
US	5,092	2,651	6,411	2,896	4,951	4,061	5,995	4,052	6,433	2,387	7,972	2,703	5,944	3,199	6,888	2,820
Italy	3,292	1,851	2,808	2,316	3,564	2,651	3,203	1,787	3,690	1,157	7,258	1,211	6,844	1,341	7,246	2,732
China	3,377	865	4,684	996	3,982	1,261	3,144	1,146	3,476	889	5,233	948	4,021	1,611	6,015	2,250
Netherlands	3,183	1,646	3,317	1,006	4,554	1,206	3,930	905	3,520	688	4,340	738	3,870	840	6,236	1,579

Source: International Monetary Fund, *Direction of Trade Statistics, June 2003* (Washington, D.C., 2003).
Note: CIS is Commonwealth of Independent States which is an organization of former republics of the Soviet Union. Ex and Im denote exports and imports, respectively.

B. List of the Main Russian Economy Investors by Trading Volumes

(U.S.$ million)

	1999		2000		2001		Accumulated by Jan. 1, 2003	
	Direct	Portfolio	Direct	Portfolio	Direct	Portfolio	Direct	Portfolio
US	2,104	0.4	1,241	0.5	1,084	4	4,220	68
Germany	330	0.1	341	2	495	0.2	1,714	384
Netherlands	516	2	610	—	575	4	2,398	21
Cyprus	370	11	678	86	512	153	3,927	305
United Kingdom	178	0.1	262	21	336	163	2,190	128

Source: Federal State Statistics Service, *Handbook "RUSSIA"* (Moscow), various years.
Note: Direct and Portfolio denote the direct and portfolio investment, respectively.

$$E(R_\tau|I_{\tau-1}) = c + \sum_{j=1}^{k}\alpha_j R_{t-j} + \sum_{j=1}^{k}\beta_j^G GR_{t-j} + \sum_{j=1}^{k}\beta_j^U UR_{t-j}$$
$$+ \sum_{j=1}^{k}\gamma_j^G GP_{t-j} + \sum_{j=1}^{k}\gamma_j^U UP_{t-j}, \tag{8}$$

where $I_{\tau-1}$ is the information set available at time $\tau - 1$. We examine the behavior of one-step predictions based on the EGARCH:

$$\hat{R}_\tau = \hat{c}(\tau - 1) + \sum_{j=1}^{k}\hat{\alpha}_j(\tau - 1)R_{\tau-j} + \sum_{j=1}^{k}\hat{\beta}_j^G(\tau - 1)GR_{\tau-j}$$
$$+ \sum_{j=1}^{k}\hat{\beta}_j^U(\tau - 1)UR_{\tau-j} + \sum_{j=1}^{k}\hat{\gamma}_j^G(\tau - 1)GP_{\tau-j} + \sum_{j=1}^{k}\hat{\gamma}_j^U(\tau - 1)UP_{\tau-j}, \tag{9}$$
$$\tau = T_0 + 1, \ldots, T,$$

where the ML estimates are calculated from the data up to $\tau - 1$. The 95 percent confidence limit of the limits of the one-step predictions are approximated by

$$\hat{R}_\tau \pm 1.96\hat{\sigma}(\tau - 1), \tag{10}$$

where $\hat{\sigma}$ $(\tau - 1)$ is the estimated standard error.

Figure 2 illustrates the behaviors of one-step predictions for returns. The predictions cover the 12 periods from April 2002 to March 2003. For example, the predicted value of the real stock return in September of 2002 based on the data from March 1996 up to August 2002 is −1.20 percent, the upper (lower) confidence limits are 22.33 (−24.73), and the actual value is 0.15 percent. The actual values of the real stock return may lie outside the confidence bands. Such outliers exist for October 2002, while the others lie within these bands. For the real call rate and the real exchange rate return, most actual values lie within the confidence bands. In this sense, the model used in this paper satisfactorily predicts the values of the returns one month ahead.

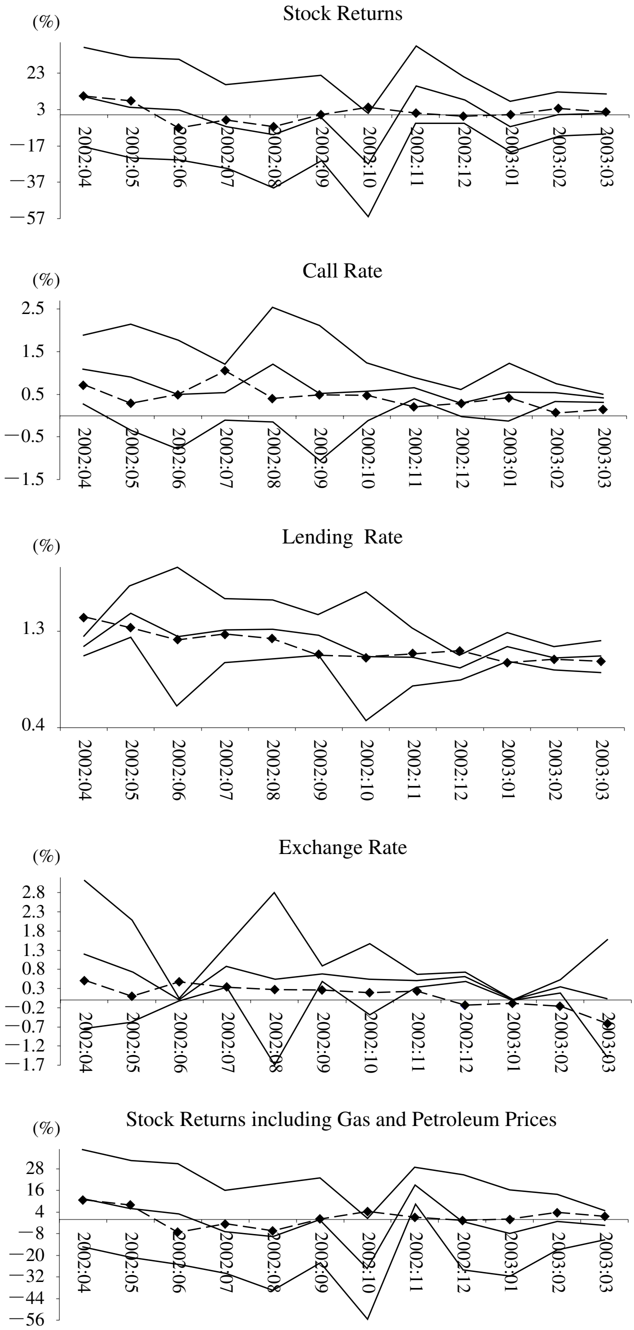
We will now investigate whether predictions using EGARCH are more accurate than predictions using the martingale process. If the Russian market is weakly efficient in the sense of Fama (1970), the returns follow a martingale process:

$$E(R_\tau|I_{\tau-1}) = R_{\tau-1}. \tag{11}$$

The efficient market hypothesis implies that the best predictor of R_τ conditional on information $I_{\tau-1}$ is given by $E(R_\tau|I_{\tau-1}) = R_{\tau-1}$. We compare the root mean squared error (RMSE):

$$RMSE = \sqrt{\frac{1}{T}\sum_{\tau=1}^{T}(\hat{R}_\tau|I_{\tau-1} - R_\tau)^2}, \tag{12}$$

Fig. 2. Returns for the One-Step Prediction by the EGARCH Model



where $\hat{R}_\tau | I_{\tau-1}$ denotes either the EGARCH or benchmark predictor. We use the RMSE by the martingale process as the benchmark statistic.

Table V presents the RMSEs of a martingale process and of the EGARCH. The RMSEs of the EGARCH for all returns are larger than that of the benchmark prediction. The results show that the EGARCH is not useful for predicting the out-of-sample behaviors of all returns, since the predictors are not superior to the benchmark predictor.

Examining the prediction performance for the four predictors in detail, Table VI sets forth the value of prediction error at each period during 12 months. For 6 months (April, June, July, and September 2002; February and March 2003), the EGARCH predictor for stock returns is superior (which means that the absolute value of prediction error is smaller), but it shows very poor performance for October 2002. Such a bad outcome would have emerged even from the EGARCH predictor for April 2002 with better performance for other months, because the predictor is produced based on the many changes in the financial system during the period from August 1996 to March 2002 when the returns data fluctuate dramatically compared with the German and U.S. data (as shown in Figure 1). Note that the measurement unit for Russia in Figure 1 is different from that for Germany and the United States. Thus, such an EGARCH predictor shows the high–low values. Moreover, since we consider the annual value of recent years when the financial system did not change much, the actual value behaves like the previous one. Accordingly, the random walk prediction is superior. However, the superiority is not due to the efficiency of the Russia market. Rather, it comes from the fact that the Russian economy is in a transition process with many drastic changes.

We can confirm this conjecture by showing the chronology for the changes in Russia's financial system in Table VII. For example, foreign exchange controls were liberalized in January 1997; government controls over operations conducted by nonresidents at the organized securities markets were expanded in January 2000; and the discount rate was cut to 28 percent from 55 percent within six months during 2000.

TABLE V

The RMSE of the EGARCH Compared with the Benchmark Prediction

	Benchmark (a)	EGARCH (b)	(b) / (a)
Stock returns only	5.5701	11.3167	2.0317
Call rate	0.3225	0.4058	1.2583
Lending rate	0.0934	0.1257	1.3458
Exchange rate returns	0.2757	0.5078	1.8419
Stock returns with gas and petrol	5.5701	11.4606	2.0575

TABLE VI

DETAIL PREDICTION ERROR

	Stock Returns Alone			Call Rate			Lending Rate			Exchange Rate		
	Actual Value	Bench-mark Error	EGARCH Error	Actual Value	Bench-mark Error	EGARCH Error	Actual Value	Bench-mark Error	EGARCH Error	Actual Value	Bench-mark Error	EGARCH Error
2002:04	10.5378	3.5900	–0.6408	0.7133	0.2492	0.3795	1.4300	–0.2008	–0.2712	0.5093	0.4822	0.6723
2002:05	7.9669	2.5709	–3.8629	0.2925	0.4208	0.6157	1.3342	0.0958	0.1454	0.1024	0.4070	0.6491
2002:06	–7.1257	15.0926	9.9126	0.4875	–0.1950	0.0220	1.2208	0.1133	0.0246	0.4717	–0.3693	–0.4516
2002:07	–2.7749	–4.3508	–3.3564	1.0558	–0.5683	–0.5084	1.2725	–0.0517	0.0376	0.3443	0.1274	0.5363
2002:08	–6.5078	3.7328	–3.8855	0.4008	0.6550	0.8115	1.2342	0.0383	0.0852	0.2699	0.0744	0.2860
2002:09	0.1549	–6.6627	–1.3518	0.4783	–0.0775	0.0466	1.0867	0.1475	0.1814	0.2595	0.0104	0.4369
2002:10	4.2492	–4.0943	–31.8069	0.4758	0.0025	0.0935	1.0508	0.0358	0.0198	0.1944	0.0652	0.3552
2002:11	1.0722	3.1770	15.8085	0.2075	0.2683	0.4517	1.0908	–0.0400	–0.0299	0.2302	–0.0359	0.2728
2002:12	–0.7685	1.8407	9.2159	0.2925	–0.0850	0.0073	1.1175	–0.0267	–0.1625	–0.1377	0.3680	0.7493
2003:01	–0.0041	–0.7644	–6.3210	0.4083	–0.1158	0.1481	1.0083	0.1092	0.1506	–0.0772	–0.0606	0.0779
2003:02	3.5684	–3.5725	–2.7969	0.0700	0.3383	0.4805	1.0367	–0.0283	0.0174	–0.1623	0.0852	0.5235
2003:03	1.5212	2.0472	–0.8587	0.1450	–0.0750	0.2597	1.0200	0.0167	0.0460	–0.6135	0.4512	0.6442

TABLE VII

TIMETABLE OF FINANCIAL SYSTEM CHANGES

Date	Event and Explanation
Jan. 1997	Residents of the Russian Federation were granted the right to purchase foreign currency to conduct foreign exchange operations connected with capital flow
Apr. 1998	Tightened controls over banking capital taken out of the country
Oct. 1999	A requirement was imposed that obligations between residents and nonresidents to repay loans should be fulfilled in the currency in which these loans were extended
Jan. 2000	The Bank of Russia expanded the sphere of control over export operations by extending customs banking controls to ruble export operations between Russian residents and their foreign counterparts
Jan. 2000	To improve the system of supervision over operations conducted by nonresidents in the organized securities market, control over the amount of funds deposited with the MICEX Clearing House was transferred from settlement centers to authorized banks
Jan.–July 2000	Discount rate was cut from 55% to 28%
Sept. 2001	The Bank of Russia expanded the range of foreign exchange operations connected with the movement of capital and conducted without any restrictions
June 2002	The next crisis (to Brazil) in Latin America stipulated for a fall in the RTS to April's level
Oct. 2002	Positive macroeconomic indicators for the Russian economy and high oil price

Sources: Bank of the Russian Federation, *Annual Reports* (Moscow), 1997–99 editions; *Bulletins* (Institute for the Economy in Transition), various issues.

VI. EFFECTS OF OIL AND GAS PRICES INCLUDED IN THE EGARCH WITH STOCK RETURNS

We will finish by investigating the effects of including oil and gas prices in the EGARCH with stock returns. Hayo and Kutan (2002) and others have pointed out that these energy export prices play a crucial role in the Russian economy, since it depends heavily on the energy industry. They showed that the Russian daily stock returns (in percentages) are Granger-caused by the growth of the daily oil price (in percentages). We have shown at the bottom of Table III that the Russian monthly stock returns (in percentages) are not Granger-caused by the monthly oil and gas price growth (in percentages). That is, the coefficients of both oil and gas price growth are not significant. Thus, the effects of oil and gas prices on Russian stock returns do not appear in the monthly periods, as opposed to the results in daily periods.

One of the possible causes for the different result was pointed out by Nagayasu (2001, pp. 531–41). By using an impulse response function with developing country data, he found that a shock to the stock price indices lasts for only a very short time, which seems attributable to difficulties in obtaining a strong relationship between these financial time-series using low-frequency data. Following his finding, we will interpret that daily returns with a high frequency tend to react to expectations by investors based on daily oil and gas prices, but the shock lasts for only a very short time.[12] Thereafter, the monthly return and oil and gas prices with lower frequency will not obtain a strong relationship. However, the annual return with much lower frequency will react to those annual prices as macroeconomic fundamentals, which is a subject for further research.

The results of stock returns *alone* at the top of the columns in Table III are very similar to those of stock returns with gas and petrol. The Russian real stock returns are Granger-caused by the spillover effects from the German stock returns, which are stronger than those of the United States: $|\beta^G| > |\beta^U|$. These similarities are also shown in Table II which indicates the summary statistics of the error term from AR with the stock returns. Moreover, as seen in Table V, the RMSE of the prediction error from this model is similar.

VII. CONCLUDING REMARKS

We investigated what drove pricing in the Russian stock markets and showed how Russian stock returns were predicted by using the following signals. Taking the United States as a world market and Germany as a regional market for Russia, we examined the spillover signals (stock returns and industrial production indices) from both countries by employing the EGARCH model with monthly data from September 1995 to March 2003, and evaluated the EGARCH model with such signals in a one-step prediction.

Our major finding is that the spillover effects from the German market returns have stronger impacts on Russian stock returns, call rates, and exchange rate returns than those from the United States. In addition, the German production index cannot be ignored. These estimation results imply that Russia as a local market has a stronger relationship with Germany as a regional market than with the United States as a world market. This fact was supported by the large amount of real and financial trading between the two countries. The estimation results suggest that the Russian monetary authorities and international investors have to monitor the signals from Germany to maximize their own returns.

We also evaluated the EGARCH with such signals in a one-step prediction. The fluctuations of such returns were well predicted in the sense that the prediction errors fall in the prescribed range of the confidence bands. However, the EGARCH does not necessarily dominate the benchmark prediction of the random walk model in terms of the root mean squared error. In this sense, the one-step prediction based

[12] Note that the analysis of Hayo and Kutan (2002) did not use impulse response.

on the EGARCH in this study with such signals is not useful. The Russian economy is in a transition process such that the markets are experiencing frequent changes in the financial system in a manner that destroys the usefulness of previous information. However, signals from Germany will be helpful for predicting trends in Russian financial markets after the transition process has been worked through.

Finally, oil and gas exports play a crucial role for the Russian stock exchange, as pointed out by Hayo and Kuttan (2002) and others. However, we find that the oil and gas prices have no significant effects on the Russian stock returns over monthly periods as opposed to the positive results for daily periods.

These findings should be seen in the context of the drastic transition processes that are taking place in Russia's financial markets.

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