TESTING FOR ONGOING EFFICIENCY IN THE RUSSIAN STOCK MARKET [1]

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This version: 14 May 2002

ABSTRACT:

In this paper we discuss a test of changing market efficiency based on a time varying parameter model with generalised autoregressive conditional heteroscedasticity in mean (GARCH-M) structure of the residuals. We apply this procedure to the returns from the two main indexes of the Russian stock market, running from September 1995 to the end of March 2000. When we consider the Russian Trading System (RTS) index of the most liquid stocks, the market is initially inefficient and that it takes around two and a half years to become efficient. The story from the Skate Press Agency General Index (ASPGEN), comprising a wider number of stocks, is that the overall performance of the market had remained predictable for most of the time and only in the last period there is sign of ongoing efficiency. We then apply the technique to a sample of individual liquid shares and find mixed evidence over the period but with a tendency however towards becoming efficient.

Keywords: **Kalman Filter, Stock Markets Efficiency, Transition Economies.**

JEL Classification: **C22, G14,G15.**

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[1]We acknowledge J. Hatgioannides, S. Lazarova, M. Nuti, and P. Temple for valuable comments and discussions. Special thanks go to Lorenzo Campori for extracting the data set from REUTERS and BLOOMBERG terminals, and Helen Kozlova of Skate Agency in Moscow in providing us with general information concerning the markets and shares investigated in this study. Nevertheless, the usual disclaimer applies.
Financial support from PHARE-ACE Project N. T97-8118-R is gratefully acknowledged.

1. INTRODUCTION

A central part of the transformation process of a centrally planned economy to a market based one is the establishment of a set of financial markets, which works reasonably efficiently. These markets play a number of roles in the transformation process. Not only do they act as a channel of investment funds through the economy but during the economic restructuring, they also play a central role in the allocation of wealth from the privatisation process.

There are many decisions that must be made in the creation of new financial markets. The type of trading system must be chosen; the structure of regulation and the form of trading are examples of these choices. When the market is established and working efficiently there may be little clear distinction to make between the various options. However, in the early days of a new market, it is obvious that market participants are unlikely to act in accord with the efficient market paradigm (Cornelius, 1994). While these markets are new, trading is still very thin, disclosure practices of firms are very limited, and there are institutional barriers to trade. Therefore, market efficiency may not have yet occurred.

As a first step to understanding these problems, a direct measure of the level of (in)efficiency may be used to model the process of learning that we expect to be taking place in those markets. There is an extensive literature on testing the efficient market hypothesis (see Fama,1970, Baillie, 1989, Fama, 1991, Campbell, Lo and MacKinley, 1997, Fama (1998)). Moreover, a number of recent studies analyse the behaviour of emerging equity markets. (See for instance Bekaert and Harvey 1995 and 1997, Claessens, Dasgupta, Glen,1995, Campbell, 1996, Harvey, 1995 and finally, the recent contribution by Jochum, Kirchgassner and Platek, 1999). However, we take the view that the testing procedures used in most of these studies is not be a fruitful approach to apply to evaluate the evolving efficiency in the transition economies. Instead we use a time varying parameter model which can move from an indicator of inefficiency to efficiency (and vice versa) as the parameters change, in line with recent contributions by Rockinger and Urga (2000, 2001) and Zalewska-Mitura and Hall (1999). In fact, it is not unrealistic to suppose that these markets start from an inefficient status, but move towards an efficient behaviour. The approach adopt in this paper provides an indicator of the degree of market inefficiency and the timing and speed of the movement towards efficiency.

The plan of the paper is as follows: Section 2 outlines the efficiency hypotheses, presents the evolving efficiency model, and gives a brief overview of the Russian trading system. Although our model is applicable to any of the transition (and emerging) markets, in this paper we study the Russian case, the most important amongst the transition countries. In Section 3 we describe the data used and we then apply the evolving efficiency procedure. Section 4 concludes.

2. TESTING MARKET EFFICIENCY IN TRANSITION ECONOMIES

2.1 Market Efficiency Hypotheses

The main objective of this paper is to test whether the Russian market, the most important amongst the so-called transition economies markets, has evolved towards some degree of efficiency since its foundation.

We consider a model in which the predictability of returns, measured by autocorrelation, evolves through time. Since the predictability of an asset's price suggests that there is a possibility of realising easy profits, many studies have investigated the possibility of recurrent patterns in asset prices. Taylor (1986), Keim (1987), Fama (1991), and Fama (1998) are surveys of this literature. Fama (1970) considers a market to be efficient if prices reflect all available information. Roberts (1967) distinguishes various forms of efficiency depending on the information considered. However, Malkiel (1992) and Fama (1991) insist on a slightly different notion of efficiency; they define a market as efficient if no economic profits can be made. On the other hand, predictability of returns can be obtained in a general equilibrium framework or as a result of a non-trading bias. In neither situation can abnormal returns be made. Nonetheless, predictability as a reward for risk taking may be more of a long run issue than a short-term consideration

We define a financial market as efficient if all publicly available information is fully exploited so that there are no abnormal profits. In the financial economics literature, there are two aspects of the efficiency of financial markets, namely the *operational efficiency* and the *allocational efficiency*. The former requires that the participants supplying and demanding funds are able to carry out transactions cheaply, while the latter requires that the prices of securities are such that they equalise the risk-adjusted rates of return across all securities (i.e. securities with the same level of risk will offer the same expected return). In an allocationally efficient market savings are allocated to productive investment in an optimal way and all participants in the market benefit.

These two types of efficiency are strongly linked. Operational efficiency can be directly measured fairly easily in the form of bid-ask spread and commission rates. We therefore concentrate on the question of measuring the extent of allocational efficiency. This notion of efficiency is often redefined in terms of various types of efficiency as follows. A market is *weak efficient* if security prices fully reflect the information contained in past price movements. That is, they do not follow patterns which repeat and it is not possible to trade profitably purely on the basis of historical price information. A market is *semistrong efficient* if security prices fully reflect all publicly available information. That is market participants cannot make superior returns by 'searching out' information from publicly available sources, since the information is already incorporated into security prices. A market *strong efficient* if security prices fully reflect all relevant information whether it is publicly available or not. In such case, no investor could ever earn consistently superior returns (even an insider with his inside knowledge).

As a failure of weak form efficiency implies a failure of semi-strong and strong form efficiency, we confine our analysis to this most basic notion of efficiency as it may be the case that the Russian markets have not even met this condition yet.

2.2 Modelling Market Efficiency in Transition Economies

The weak form efficiency hypothesis requires that there should be no profit opportunities based on the past movement in asset prices. This means that an efficient market should be an unpredictable one. This has often been tested by carrying out simple regressions of the form:

$$r_t = \beta_0 + \sum_{i=1}^{p} \beta_i r_{t-i} + e_t$$

where r is the rate of return on an asset and weak form efficiency implies that $\beta_i = 0, \quad i > 0$. This is often tested by estimating such equations, either using OLS or GMM and simply testing this hypothesis. In the case of the Russian markets (as indeed for other emerging markets too) this is not a sensible approach because it would effectively be testing efficiency over the whole period of their existence and it is hardly credible that they came into being as fully efficient markets. The early inefficiency would therefore bias the results of the estimation and test and we could conclude that there are profit opportunities simply because of past inefficiencies (Laurence, 1986).

We need to find a way to allow the estimation procedure to model this changing structure. We will then have a measure or test of current market efficiency so that we can assess the possibility of present profit opportunities. We will also have a measure of the timing of the move (if it has occurred) towards full efficiency, so that we will be able to say something about how quickly markets become efficient. This can be achieved only by developing a version of the above test equation that explicitly allows for the changing parameters which may be present. This can be done initially be reformulating that equation as,

$$r_t = \beta_{0t} + \sum_{i=1}^{p} \beta_{it} r_{t-i} + e_t$$

so that the parameters now have time subscripts and can vary over time (see also Emerson, Hall, and Zalewska-Mitura (1997), Zalewska-Mitura and Hall (1999) and Rockinger and Urga (2000, 2001)).

A second element of conventional financial models is that the error process will often not have a full set of normally independently identically distributed (NIID) properties. If in particular the variance of the error process is changing over time in a systematic way this will cause problems for the testing procedure and it may also affect the required rate of return. If this changing variance structure is omitted and also has a serial correlation property then again we may find spurious correlation and incorrectly reject market efficiency. This can be dealt with by combining the time varying parameter model with a standard generalised autoregressive conditional heteroscedasticity in mean (GARCH-M) model.

Based on this, the state space model that we may estimate using the Kalman Filter is the following:

$$r_t = \beta_{0t} + \beta_{1t} r_{t-1} + \beta_2 h_t + e_t \quad e_t \sim N(0, h_t) \tag{1}$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 \tag{2}$$

$$\beta_{i,t} = \beta_{i,t-1} + \eta_{i,t}; \qquad \eta_{1,t} \sim N(0, v_1^2); \quad i = 0,1 \tag{3}$$

This is an autoregressive of order one (AR(1)) model with time changing intercept and slope, β_{0t} and $\beta_{1,t}$ respectively. β_2 represents the risk-premium parameter in the conditional model. v_i is a measure of the variability of the parameters $\beta_{i,t}$. α_0 represents the constant in the volatility equation, α_1 is the contribution of shocks on volatility, and α_2 measures the persistence of a given shock. This model is quite general because it encompasses as special case one in which either or both coefficients β_{0t} and $\beta_{1,t}$ are not time varying such that $\beta_{0t} = \beta_0$ and/or $\beta_{1,t} = \beta_1$.

Robustness of the procedure: some Monte Carlo evidence

Although the above procedure is a maximum likelihood estimation procedure there is a question as to how effectively the time-varying coefficient captures the changing learning process. This is because although the fixed parameters of the state space system have conventional maximum likelihood consistency properties the time varying coefficient does not. Indeed it is not clear conceptually what consistency means for a coefficient which can have a different value at each point in time. A series of Monte Carlo experiments (see also Zalewska-Mitura and Hall (1999)) demonstrate the properties and the abilities of this model to capture the changing correlation structure in the data. The time varying parameter model captures the movements in the true parameter remarkably effectively. The Monte Carlo experiment establishes two important properties of the technique. First, the time path of the estimated β does not depend on σ^2, the variance of the daily returns. In other words, the variability of returns can be very large (it is used the value 0.05, corresponding to the case of the crises in Asia in 1997 and in Russia in 1998), or relatively low (0.0004 and 0.0005, corresponding to the average values of Warsaw Stock Exchange and Budapest Stock Exchange respectively), anyway the returns follow the same pattern of autoregression that the procedure is able to detect. Second, the probability of this detection does not change with changes in values of σ^2.

2.3 The Russian Trading System

Having presented the theoretical model that may be applied, in this section we briefly introduce the main characteristics of the Russian markets. Russia has two main stock exchanges located in Moscow, the Moscow Central Stock Exchange and the Moscow International Stock Exchange as well as a number of regional exchanges.

The Moscow Central Stock Exchange (MCSE) was founded and registered on November 21st 1990, even before any legislative acts were issued by the Russian Government. Regular trading sessions on the MCSE started in August 1991. The Moscow International Stock Exchange (MISE) was established in 1990 and started regular trading sessions on October 30th 1991. In July 1994 a Central Depository Clearing House was created and the Russian Federation Commission on Securities and the Capital Market (FCSM) was created by decree in November 1994. On July 1st 1994 the voucher privatisation scheme ended.

During 1995 several attempts were made to set up a regulatory system for the markets and a number of decrees appeared trying to protect shareholders rights and create the institutions necessary to operate the market. A presidential decree on July 10th 1995 exempted securities transaction from taxation in the Russian Federation. On December 26th 1995 the Law on Joint-Stock Companies was passed, providing a regulatory framework for operations in the securities markets and protecting the rights of shareholders. On April 16th 1996, the signing of the Law on the Securities Market, established the role of the FCSM as the principal regulator and further protects the rights of shareholders. It sets the foundation of the legal infrastructure for the capital markets. This period also saw a dispute between the FCSM and the Central Bank for the role as principal regulator. An electronic trading system was established in the form of the Russian Trading System (RTS) in October 1995 to consolidate regional securities markets into an organised security industry. In January 2000, RTS acquired a stock exchange license and became one of the largest stock exchanges in Russia.

RTS offers the users a choice of one or several sites. Its participants can announce quotes, get information on the stock market, strike deals and conclude the trade in an on-line system. RTS also provides for the possibility of the unification between the Depository, Registrar and Depository-Clearing Companies. In the future this will lead to electronic payment and re-registration after the conclusion of a deal. The system expenses are relatively low because the system is oriented on the joined connection of users to the network.

By the end of 1997 the Russian Trading Systems listed 208 (73 in 1996) companies with a market capitalisation of 128.8 billion of US dollars compared to 37.23 billion of US dollars in 1996. After the excessive exuberance for Russian equities in 1996-97, the Russian markets experienced a collapse in the middle of 1998 and a subsequent recovery in 1999. The August 1998 crisis in Russia reflected the generalised shift in investor sentiment away from emerging markets in the wake of the financial crisis in East Asia in the Fall 1997 and the political instability of the country. At the end of 1998 the market is practically dead, despite an official figure of 237 listed companies but with a capitalisation of 20.60 billion US dollars. Its low value is also due to the huge devaluation of the rouble. In 1999, following the patterns of other transition economies, stock returns in Russia recovered strongly. Russia recorded significant gains of about 244%. At the end of 1999 the number of companies listed was 207 with a market capitalisation of 72.21 US$bn (see EBRD, 1999), IFC Factbook (1999, 2000) and Emerging Markets Investors Fact Book (2000)). Currently, around 400 stocks and bonds are admitted to trading in the RTS.

3. EMPIRICAL RESULTS

As already stressed earlier, the aim of this paper is to evaluate empirically whether the Russian equities market has become less autocorrelated, which we like to interpret as a condition of increasing weak form of efficiency of the market. In addition, our model allows us to test whether the market has been affected by macro and qualitative factors, and finally if there is any presence of risk premium. We use both two general stock indexes and a few heavily traded individual shares. We begin by considering the stock indexes.

3.1 Russian Stock Indexes

3.1.1 Data Description

Multiple indexes are available for the Russian stock market. However in this study we use the two main indexes available at daily frequency, spanning from September 1, 1995 until March 30, 2000.

The RTS index. The daily RTS index is an official indicator of the Exchange calculated from September 1, 1995; it is the basic indicator for the Russian stock market development. Its listing includes 21 stocks of the largest and most liquid Russian companies and is calculated every 30 minutes during the trading hours on the basis of data on trades concluded in the RTS for those most liquid shares. The RTS index is published on-line on the RTS web server at www.rts.ru, where a detailed description of the methodology of the index calculation can be found.

In contrast with an unweighted (speculative) index, the RTS index is much more stable with respect to sharp oscillations of a single stock price, since companies with large capitalization make the main contribution to the index. As a rule, the stocks of such companies are extremely tolerant to the momentary behavior of individual players.

Moreover, in the last two years, the RTS index is de-facto the most important factor of the entire Russian stock market for the majority of participants in the market. It is related to the large turnover in the RTS and to a large number of bonds listed in the RTS. Information on the RTS index regularly appears in mass media (newspapers, tv, bulletin) and on the RTS web page.

The index is graphed in Figure 1.

[Insert Figure 1 somewhere here]

The other main index is the **ASP General Index.** Since 1992, the Skate Press agency has created a set of stock indexes including the ASP-General Index which has been made available since June 20, 1994. This index is capitalisation-weighted, rouble denominated, covering 100 stocks (the list is revised each quarter). Skate Press uses data provided by the Russian Trading System and quotations reported by market makers included in the list approved by Skate Press. The ASP index is published on-line on the SKATE web server at www.skatefn.com and the graph of the index is shown in Figure 1.

3.1.2 Empirical Results: Testing for Efficiency.

In Table 1 we report the results by estimating Equations (1)-(3) using the two indexes. Our model allows us to measure the impact of macro factors and the presence of autocorrelation via the time varying parameters $\beta_{i,t} = \beta_{i,t-1} + \eta_{i,t}$ where $\eta_{i,t} \sim N(0, v_i^2)$ with $i = 0,1$. It is worth noting that to test $v_i = 0$ involves non-standard statistics and, thus, the associated standard errors are meaningless (see Harvey, 1989, p. 236). For this reason we do not report them in the paper. In addition, if $v_i = 0$ then clearly the associated parameter is constant and the standard t-test can be used to evaluate if the β_i is statistically different from zero. If $v_i \neq 0$, then the associated coefficient varies over time and it is possible to evaluate its significance in each time period. A graph can report the time profile of the coefficients and the 95% confidence interval.

[Insert Table 1 somewhere here]

We start by focusing on the coefficient $\beta_{0,t}$. In our experiments there is evidence that $\beta_{0,t} = \beta_0$ being its variance (v_0) equal to zero. Thus, we can conclude that it is constant over time and its significance depends on the value of the standard error. Table 1 tells us that there is no impact from β_0 when the RTS index is considered but on the other hand the coefficient is very close to be significant at the conventional 5%

level in the case of ASPGEN. In our model this parameter picks up macro effects and non measurable factors (such as political events, external shocks). Thus there is a clear evidence that those factors do not affect the equity markets when the RTS index of the most liquid assets is considered, but they become important when the broader ASPGEN rouble denominated index is used.

In our model the parameter β_2, representing the risk-premium parameter in the conditional model, is by construction not time-varying, and thus its estimates and standard error can be evaluated in the standard way. The coefficient appears statistically significant at conventional 5% level for the ASPGEN index but insignificant for the RTS. Thus, there is thus evidence of a positive risk-premium for the former index. Further, GARCH-M effects are very significant.

Let us now consider the AR(1) coefficient, i.e. the time changing slope $\beta_{1,t}$. Its variance for both RTS and ASPGEN indexes are different from zero, being 0.89 and 0.008 respectively. The first conclusion then is that the coefficients are time-varying. Thus our comments have to be based on the graphs reported in Figures 2 and 3 where we can see the evolution of the time-varying coefficients measuring the time-varying correlation in the two indexes and the 95% confidence interval. Both coefficients tell us very interesting stories. The coefficient in Figure 2 for the RTS index begins with a high value (though not significantly different from zero) that remains effectively steadily and significantly non zero up to October 1997. In November 1997 it increases to remain substantially stable, though statistically insignificant, up to the August 1998 crisis. This behaviour well summarises the history of the Russian capital markets over that period. The first crisis came when the Asian crisis triggered a global "flight to quality" from markets with uncertain macroeconomic conditions. The investors continued to withdraw from the Russian market in January 1998 (EBRD, 1999), but the strong intervention from the Central Bank (CB), in the light of the pressure on the rouble, prevented a currency crisis and helped the equity market to recover in February and March 1998. Later in March 1998, political instability (the Prime Minister was dismissed) and the fall of the oil price, with the obvious impact on the State budget, (negatively) affected the equity market. At the beginning of the second quarter of the year, pressure from the exchange rate forced the CB to increase interest rates to more than 100%. Moreover, bubbling yields, speculations over the IMF loans, hurrying issuing of Eurobonds, undermined confidence in existing foreign debt and the market sentiment. Thus the crisis in August 1998 indeed did not come as a surprise. The financial system of the country was effectively paralysed (moratorium on debt payments, devaluation of the currency of more than 50%, a halt in foreign exchange trading on MICEX). The stock market crash brought the RTS to its lowest level in the four year of history (see Figure 1).

A significant increase of the value of $\beta_{1,t}$ is evident in the aftermath of this crisis. After a flat September (the daily value traded on the RTS at the end of September dropped to about $300,000), the market rose in mid-October and November 1998 when it attracted few brave investors willing to risk in effectively undervalued equities. (The daily turnover peack of this period was $6 million compared to the $100 million peack in August 1997.) Having the Russian market been the worst performer in 1998 as compared with other countries, the following year began with the same lingering mood. Further, all emerging markets, Russia included, were affected by the currency devaluation in Brazil. In addition, Russia faced a period of hyperinflation, weak rouble, major decline in production, and a depressed domestic market. This period of deep crisis, with a market far from any level of efficiency, ends at the end of the first quarter of 1999. In fact, $\beta_{1,t}$ in Figure 2 is statistically significant up to the drop in the first quarter of 1999, corresponding to the beginning of the strong recovery: by the end of the year the market had recovered the huge losses from both the Asian and August 1998 crises. Several factors may explain this unexpected rise: first, the debt restructuring, then the dramatic rise of oil prices, the April 1999 agreement between the Government and the IMF to repay old loans with new ones, the restructuring of the GKO (Treasury bills) in June. The shape decline in July and August may be explained by anxiety about a possible U.S. rate hike which would weaken the dollar and political turmoil with the dismissal of the Prime Minister Stephasin replaced by Putin. The wave of bombing in September and the unfolding Bank of New York scandal took foreign investors away from the market for a while. But in October good news (from the expanding trade surplus, positive industrial production) caused a strong recovery of the Russian shares helping the return of both foreign and domestic investors. Soaring oil prices, the recovering of the manufacturing sector benefiting from increasing domestic demand, and the surprising stability of the political scene (both for Putin and his allies at the parliamentary election) plus the resignation of Yeltsin on December 31, 1999 (the market registered an increase of 19.9% that day) completed the unexpectedly strong recovery of the Russian equity market, and the year ended with gains at around 250%. And the story of the first quarter of the year 2000, covered in our sample period, is very much the same the last part of 1999.

The coefficient on ASPGEN (Figure 3) follows a slightly different pattern only in that it better stresses the ups and downs of the market, but substantially reinforced the story sketched in discussing the results from the RTS index. $\beta_{1,t}$ is substantially different from zero over the whole period with the exception being the period between the 1998 Spring and the crisis in August, the first quarter of 1999 and from the Fall of 1999 onwards, with a clear tendency in the last period of our sample (the first three months of 2000) to remain in an efficient pattern with a slightly raised level so that it does actually fall to zero as the RTS.

[Insert Figures 2 and 3 somewhere here]

In summary, when we consider the RTS index of the most liquid stocks there is evidence that the market took some 2-3 years to become reasonably efficient. This change happened in a fairly steady way since the fall of 1997 and in particular from the end of 1998. The story from the 100 stocks ASPGEN tells us that the overall performance of the market remains predictable over most of the period but the in this case too there are signs of ongoing efficiency over the last period.

3.2 A Sample of Russian Stock Prices

This last section applies our model to a set of frequently traded stocks to see whether there is a confirmation of the finding from the two stock indexes.

3.2.1 Data Description

We choose a sample of the largest companies which had been trading for a fairly long period and which had a relatively high transaction level. Some large companies were excluded either because they had only been traded for a relatively short period or because the volume of trade was very low. The selected companies belong to the leading (gas and) oil sector and are the follows:

LUKoil (LKOH)- This is the largest oil holding in Russia. It was set up in 1991 from the three best oil-and-gas producing enterprises in Western Siberia - Langepasneftegaz, Uraineftegaz and Kogalymneftegaz - from which the name LUKOIL comes. Since LUKOIL absorbed other oil-producing, oil-refining, sales, petrochemical, transport and other oil business enterprises. LUKOIL today operates in 40 regions of Russia and 25 countries; it is the biggest proven reserve of oil in the world owned by a private oil company. It employs over 120,000 employees working in Russia and abroad, it produces the 24% of all oil produced in Russia and the 12% of all the oil products produced in Russia. It owns more than 1,100 filling stations on the territory of Russia, of the other former USSR republics and other countries.

Purneftegaz (PFGS) – PFGS is Russia’s sixth largest oil producer. It extracts oil and gas, drills oil-wells and produces combustible and lubricant materials. It employs 11,569 employees located mainly in the Yamal-Nenetsk Autonomous Region in northern Russia. The company was previously part of the SIDANCO holding but a government decree issued in January 1995 transferred the company to Rosneft’s control. However an agreement was settled in the Arbitration Court on October, 7 1997 leaving SIDANCO 38% stake in the company. PFGS currently accounts for about 60% of Rosneft’s total crude oil output and has three oil-extraction divisions

Yuganskneftegaz (YFGA) – The company is a subsidiary of YUKOS oil holding and it was registered in 1993. It ranks first amongst Russia’s oil producers in terms of ABC-1 reserves and second in terms of production volume. It employs 11,982 employees. In 2000 YFGA has increased oil output to 28 million tons. The company plans to put 150 new wells into operation and carry out repair on its pipelines and wells, with an estimated cost for these projects exceeding 1999 financing levels, totaling over 5 billion of Roubles.

3.2.2 Empirical Results: Testing for Efficiency.

For these stocks we have daily data on the (average) share price of each of these companies and we applied our time varying learning model on each of them in turn. Table 2 reports the estimated parameters of model (1)-(3) with GARCH process for each of the companies.

[Insert Table 2 somewhere here]

The GARCH effects are highly significant but in other respects these parameters are unsurprising.

The β_0 coefficients for these stocks too are not time-varying with a statistically significant effects for YFGA only. There is evidence of strong positive risk-premium effects (β_2) for the LKOH company only while in the other two cases it is negative though statistical insignificant.

Interesting stories come by looking at the evolution of the $\beta_{1,t}$. First, all of them are time-varying being v_1 (variance) different from zero. Thus, the results may be evaluated using the graphs of the coefficients. Figure 4 reports the estimates of $\beta_{1,t}$ representing the evolution of the autocorrelation factor for LKOH. We find a very clear and surprising pattern showing strong and significant signs of inefficiency at the beginning of the period, in the aftermath of the October 1997 and August 1998 crisis with a tendency for this inefficiency to disappear from the middle of 1999 onwards. The main stylised facts associated with these ups and downs are linked to the fall and rise of international oil prices. In fact in March 1998 the fall of world oil prices (with its consequence on the State budget deeply depending on the oil export revenues) caused heavy losses in the oil company shares, a large part of the Russian market. The strong recovery in 1999 is linked to the dramatic rise in international oil prices, and indeed the oil (and gas) sector led the rally of the Russian equities market from March and April 1999 onwards.

Finally, Yuganskneftegaz and Purneftegaz present evolving $\beta_{1,t}$ coefficients (we do not report these graphs) showing some variation but remaining insignificant throughout.

[Insert Figure 4 somewhere here]

4. CONCLUSION

In this paper we discuss a test of changing market efficiency based on a time varying parameter model with GARCH in mean effects. The model is quite effective at capturing both the level and the speed of change of time varying correlation structure in a series of returns.

We apply this procedure to the returns from two indexes of the Russian stock market and demonstrate that when we consider the RTS index of the most liquid stocks the market was initially inefficient and that it took something of the order of two and a half years to become efficient. The story from ASPGEN index, comprising a wider number of stocks, is that the overall performance of the market remains predictable. However, from both indexes there is evidence of a tendency towards being efficient

We then apply the technique to a sample of individual high liquid shares and found that in this case too there is a mixed evidence over the period in particular when we consider the stock for the largest oil holding in Russia, LUKOIL, with a tendency however towards being efficient.

We discussed various explanations for this finding linked to both domestic and international events.

REFERENCES

Baillie, R. T., 1989. Econometric tests of rationality and market efficiency. Econometric Reviews 8, 151-186.

Bekaert, G., Harvey, C.L., 1995. Time-varying world market integration. Journal of Finance 50, 403-444.

Bekaert, G., Harvey, C.L., 1997. Emerging equity market volatility. Journal of Financial Economics 43, 29-77.

Campbell, J.Y., 1996. Consumption and the stock market : interpreting the international experience. NBER Working Paper 5610.

Campbell, J.Y., Lo, A.W., MacKinley, A.C., 1997. The econometrics of financial markets (Princeton University Press, Princeton).

Claessens, S., Dasgupta, S., Glen, J., 1995. Return behaviour in emerging stock markets. The World Bank Economic Review 9, 131-151.

Cornelius, P.K., 1994. A Note on the informational efficiency of emerging stock markets. Weltwirtschaftliches Archiv 24, 820-828.

Emerson R., Hall, S.G., Zalewska-Mitura, A., 1997. Evolving market efficiency with an application to some Bulgarian shares. Economics of Planning 30, 75-90.

Emerging Markets Investors, 2000. Fact book 2000 (Risk Publication, London)

European Bank for Reconstruction and Development, 1999. Transition report (EBRD, London).

European Bank for Reconstruction and Development, 2000. Transition report update (EBRD, London).

Fama, E., 1970. Efficient capital markets I: review of theory and empirical work. The Journal of Finance 11, 318-417.

Fama, E., 1991. Efficient capital markets II. Journal of Finance 46, 1575-1617.

Fama, E., 1998. Market efficiency, long-term returns, and behavioral finance. Journal of Financial Economics 49, 283-306.

Harvey, A. C., 1989. Forecasting structural time series models and the Kalman filter (Cambridge University Press, Cambridge).

Harvey, C.R., 1995. Predictable risk and returns in emerging markets. The Review of Financial Studies 8, 773-816.

International Finance Corporation, 1999. Emerging stock markets factbooks 1999 (Standard & Poor's, McGraw Hill, New York).

International Finance Corporation, 2000. Emerging stock markets factbooks 2000 (Standard & Poor's, McGraw Hill, New York).

Jochum, C., Kirchgassner, G., Platek, M., 1999. A long-run relationship between Eastern European stock markets? Cointegration and the 1997/98 crisis in Emerging markets. Weltwirtschaftliches Archiv 135, 454-479.

Keim, D.B., 1988. Stock market regularities: a synthesis of the evidence and explanations, in E. Dimson (Ed.), Stock Market Anomalies (Cambridge University Press, Cambridge)

Laurence, M., 1986. Weak form efficiency in the Kuala Lumpur and Singapore stock markets. Journal of Banking and Finance 10, 431-445.

Malkiel, B.,1992. Efficient market hypothesis, in P. Newman, M. Milgate, and Eatwell,J. (eds.), New Palgrave Dictionary of Money and Finance, (Macmillan, London).

Roberts, H. V., 1967. Statistical versus clinical prediction of the stock market. Unpublished manuscript, CRSP, University of Chicago, Chicago.

Rockinger, M., Urga, G., 2000. The evolution of stock markets in transition economies. Journal of Comparative Economics 28, 456-472.

Rockinger, M., Urga, G., 2001. A time varying parameter model to test for predictability and integration in stock markets of transition economies. Journal of Business of Economics and Statistics (*in press*).

Taylor, S., 1986. Modelling financial time series (John Wiley & Sons, Chichester).

Zalewska-Mitura, A., Hall, S.G., 1999. Examining the first stages of market performance. A test for evolving market efficiency. Economics Letters 64, 1-12.

Table 1: Estimates for AR(1) with time varying coefficients and GARCH effects .

	RTS ($)	ASPGEN (Rouble)
β_0	0.0004	0.0013
	(0.3)	(1.9)
β_2	0.043	1.03
	(0.08)	(2.1)
v_1	0.89	0.008
α_0	0.00002	0.28
	(0.06)	*(3.0)*
α_1	0.08	0.56
	(2.7)	*(3.3)*
α_2	0.17	0.43
	(0.06)	*(2.8)*
NOBS	1116	1109
LL	3123	3385

Notes: *We report the parameter estimates of model (1)-(3) in the text, with time changing* β_1*, but constant* β_0 *and risk premium term* β_2*. We calculate the returns using the RTS and ASP indexes. The parameter* v_1 *measures the variability of the time varying parameter* β_{1t}*. It is expressed relative to the variance of the measurement equation* h_t*, which has been normalised to unity. We also report the results of the estimates of a GARCH model where* α_0 *represents the constant in the volatility equation;* α_1 *is the contribution of shocks on volatility, and* α_2 *measures the persistence of a given shock.*

The coefficients in parentheses are asymptotic t-statistics. We do not report the t-statistic for v_1 *given that its standard errors follow nonstandard distributions and are thus meaningless (Harvey, 1989, p.236). NOBS represents the number of observations while LL is the maximum of the log-likelihood.*

Table 2: Estimates for AR(1) with time varying coefficients and GARCH effects .

	LKOH	YFGA	PFGS
β_0	-0.0005	-0.004	0.0016
	(0.3)	(2.9)	(1.0)
β_2	1.15	-0.72	-0.29
	(4.7)	(1.5)	(1.7)
v_1	0.17	0.02	0.5
α_0	0.17	0.34	0.65
	(3.3)	*(4.0)*	*(5.1)*
α_1	0.0002	0.51	0.47
	(5.2)	*(5.1)*	*(4.8)*
α_2	0.0002	0.51	0.48
	(4.6)	*(15.4)*	*(15.0)*
NOBS	1116	555	611
LL	2681	1383	1356

Notes: See Table 1.

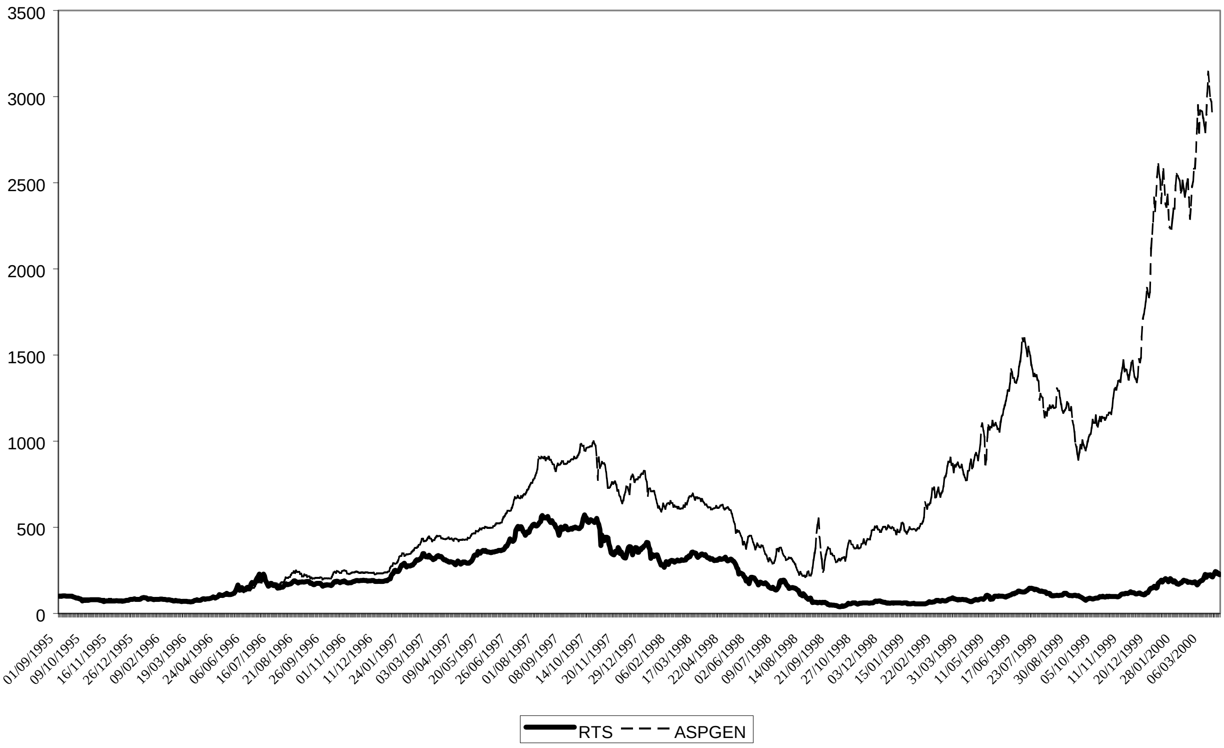

Figure 1: Plot of the RTS U.S. dollar-denominated index and ASPGEN rouble-denominated index.

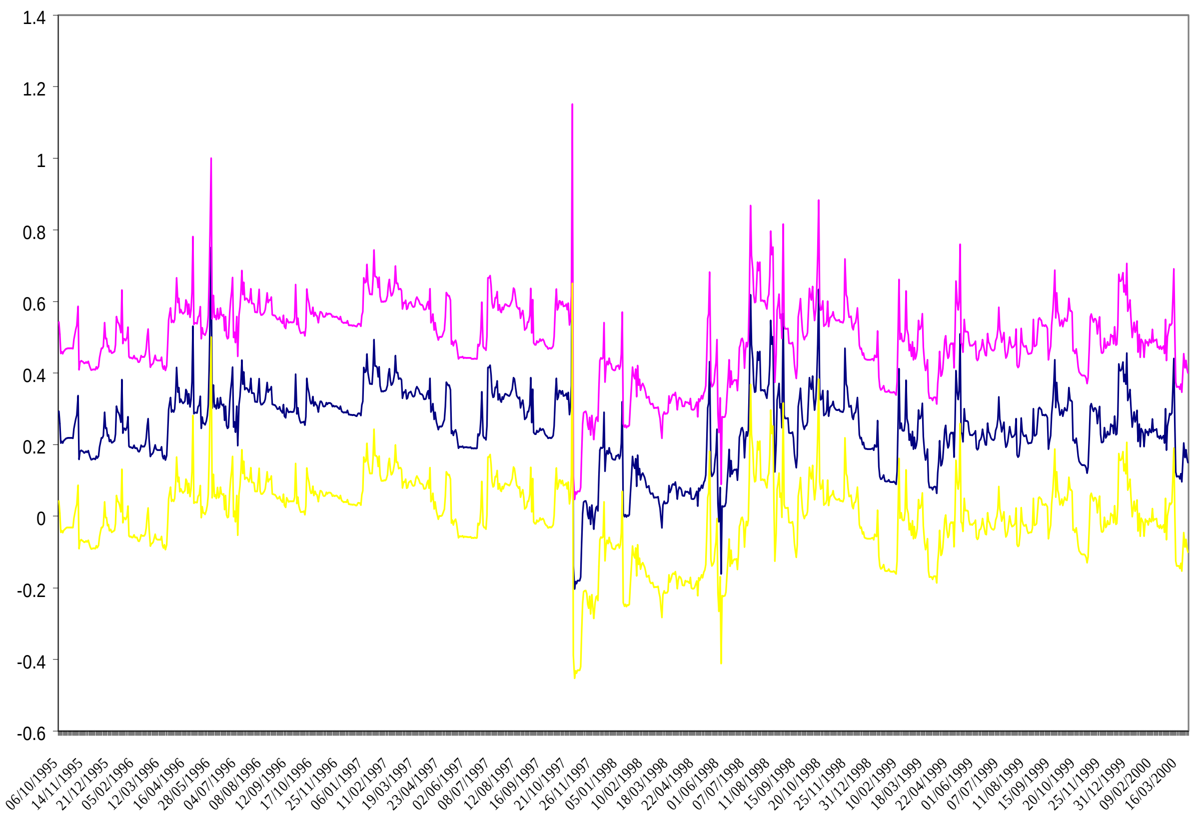

Figure 2: Estimates of $\beta_{1,t}$ representing time-varying predictability for the RTS dollar-denominated index and 95% confidence interval.

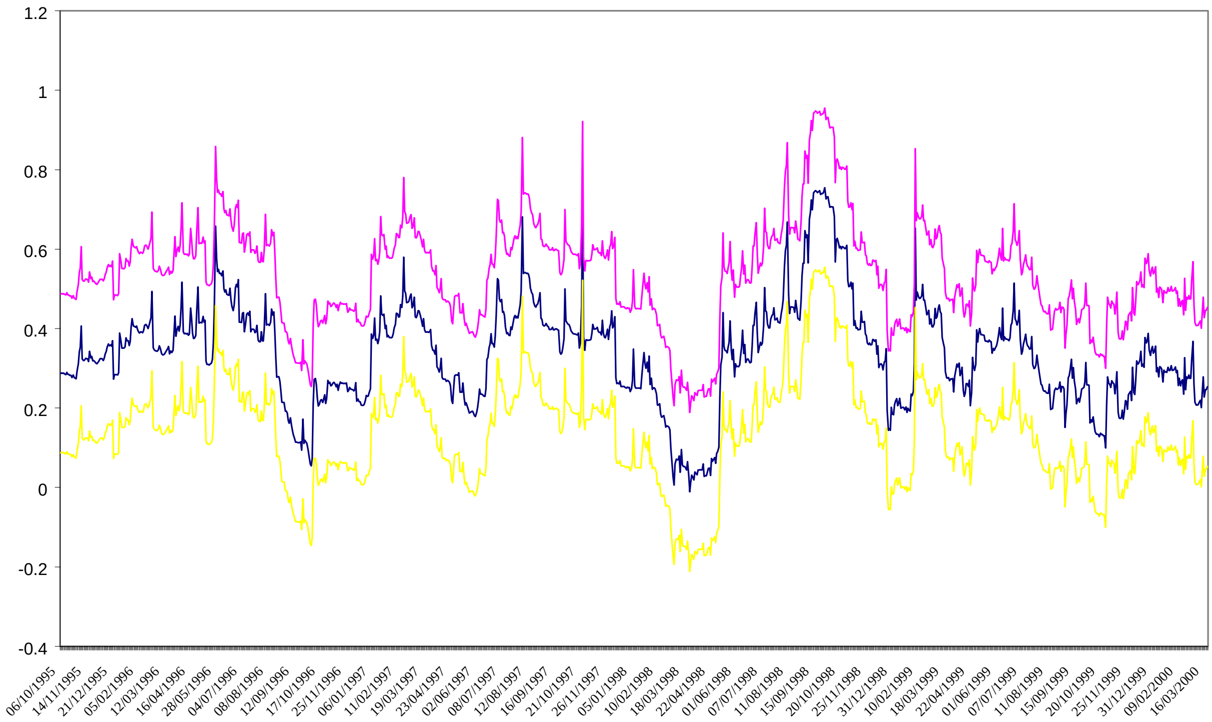

Figure 3: Estimates of $\beta_{1,t}$ representing time-varying predictability for the ASPGEN rouble-denominated index and 95% confidence interval.

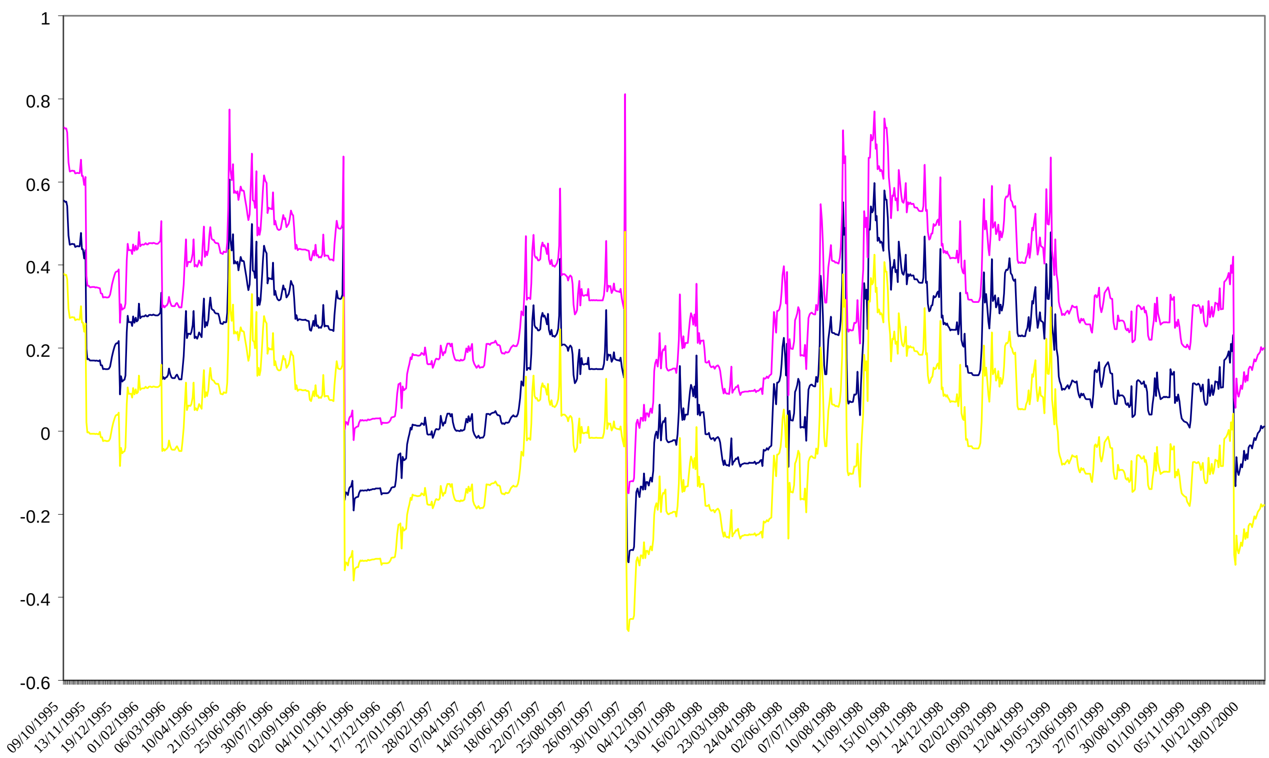

Figure 4: Estimates of $\beta_{1,t}$ representing time-varying predictability for LKOH and 95% confidence interval.