TESTING FOR EVOLVING STOCK MARKET EFFICIENCY. WITH AN APPLICATION TO RUSSIAN STOCK PRICES[1]

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Discussion Paper No. DP 12-98

May 1998

[1] The data used in this paper have been extracted mainly from REUTERS terminals and AK&M data base. Other main providers were the Central Bank of Russia, Renaissance Capital Group and EXPERT Magazine. We wish to thank Edgar Lakalin for providing us with this data set.

Financial support from TACIS-ACE Project N. T95-4142-R is gratefully acknowledged.

In this paper we propose a test of changing market efficiency based on a time varying parameter model with GARCH in mean effects. We first perform a Monte Carlo experiment to show the power of our approach in capturing both the level and the speed of change of time varying correlation structure in a series of returns. We then applied this procedure to the returns from two indices of the Russian stock market and demonstrated that the market was initially inefficient and that it took something of the order of two and a half years to become efficient. We then applied the technique to a range of individual shares on the Russian market and found the surprising result that some of them seemed to be efficient while others were not. Further amongst the inefficient shares there seemed to be no tendency towards becoming efficient.

Keywords: Stock Markets, Learning, Efficiency, Transition Economies

JEL Classification: C5, G1

ISSN 0969-6598

CONTENTS

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 have to play a number of roles in the transformation process. Not only do they have to act in the normal way as a channel of investment funds through the economy but during the economic restructuring they will 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 a set 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 the establishment of a new market it is obvious that market participants are unlikely to act in accord with the efficient market paradigm (Cornelius, 1994). Different market micro structures may have an important influence on the learning process which takes place within a market as traders become efficient. An illustration of the problems that can be caused by an inefficient market is the recent real interest rates which have emerged in the Moscow markets. Real interest rates on these markets have been well in excess of 50% for a considerable period. This can lead to a serious miss-allocation of funds within the economy to the serious detriment of the investment in the real economy and the restructuring which needs to take place. It is also worth pointing out that the Russian market is so far from conventional notions of efficiency that these high real interest rates have been accompanied by a broadly stable nominal exchange rate which implies a gross violation of uncovered interest parity.

As a first stage towards understanding these problems we wish to develop a direct measure of the level of inefficiency and to model the process of learning which we expect to be taking place in the Russian markets. There has been a huge literature on testing the Efficient Market Hypothesis (see Campbell, Lo and MacKinley, 1997, Baillie, 1989, Fama,1970). We take the view that this would not be a fruitful procedure to apply to Russia as the markets are so far from efficient that the results would be obvious. Instead we wish to advance a time varying parameter model which can move from an indicator of inefficiency to efficiency as the parameters change. This will then give us 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: in Section 2 we outline the efficiency hypothesis, some issues in market micro structure, the evolving efficiency model and a brief Monte Carlo test of this model. In Section 3 we give a brief overview of the Russian stock market, we also present some of the high frequency data we will be using and then we apply the evolving efficiency procedure. Section 4 draws some general conclusions and makes some suggestions for further work.

2. MARKET EFFICIENT

2.1 Market Efficiency Hypotheses

A financial market is said to be efficient if all publicly available information is fully exploited so that there are no abnormal profit. There are two aspects of the efficiency of financial markets:

- *operational efficiency* - requires that the participants supplying and demanding funds are able to curry out transactions cheaply.

- *allocational efficiency* - requires the prices of securities to be 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 a market which is allocationally efficient, 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 is something which can largely be directly measured fairly easily in the form of bid-ask spread and commission rates generally. We will 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;

- *weak form efficiency* - if security prices fully reflect the information contained in past price movements, i.e. they do not follow patterns which repeat and it is not possible to trade profitably purely on the basis of historical price information;

- *semistrong form efficiency* - if security prices fully reflect all publicly available information i.e. market participants cannot make superior returns by 'searching out' information from publicly available sources, since the information will already be incorporated into security prices;

- *strong form efficiency* - 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 or strong form efficiency we will confine ourselves to this most basic notion of efficiency as it is fairly clear that the Russian markets have not even met this condition yet.

2.2 Emerging Stock Markets

The post communist transition economies have the opportunity to structure their financial markets in any way they choose. The first question is the choice of the type of financial system: *bank-based* or *market-based*? In the bank-based system, banks are both lenders to and big shareholders in large joint-stock corporations, which gives them a strong position in corporate governance. Financial markets tend to be smaller and less liquid, and transactions less transparent, at least to outsiders. Bank control over corporations need not be based on share holdings alone. Since banks can engage in brokerage, trust, or mutual fund business, they can exercise control by exercising voting rights on behalf of small investors. Alternatively, banks can write restrictive loan contracts or lend only short term to retain influence over management decisions. This bank-based system is introduced in most Western European countries (i.e. France, Germany) and Japan.

In contrast, in marked-based financial system such as in the United Kingdom and the USA, shares are widely held by the public either directly or indirectly through mutual funds, pension funds and insurance companies. Shares are actively traded and corporate governance is exercised by investors selling on poorly performing companies. Poorly managed firms may eventually become a target of a hostile take-over, which reflects the absence of insider control on a management.

There is also a choice to be made between “order-driven” market model (also called “auction market” model, i.e. a system in which market participants disclose their orders to buy or sell at specific prices), and “quote-driven” markets (also called “dealer markets” i.e. markets where market makers compete for orders by publishing bid (buy) prices and ask (sell) prices). The information processing in these two models is quite different and we might suspect that the market participants would learn to act efficiently at very different rates in the two systems.

Another aspect is the choice between a “call market” and a “continuous market”. In the call market buy and sell orders are accumulated over a specific period and executed simultaneously when a market-clearing price is established. In the continuous market, orders can be executed whenever the buy order price exceeds the sell order price. The main advantage of a call market is its simplicity of price discovery and the ease of disseminating information to investors. However there are no market makers to build up experience and to `guide’ the market in this system and so learning to become efficient may be slower and more erratic.

2.3 Modelling Market Efficiency in Transition Economies

The weak form efficiency hypothesis requires that there should be no profit opportunities which are 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 $\beta_i = 0, i > 0$, this will often be tested by estimating such equations, either using OLS or GMM and simply testing this hypothesis. In the case of the Russian markets this is not however a very sensible approach as it would effectively be testing efficiency over the whole period of there 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 therefore to find some way of allowing the estimation procedure to model this changing structure so as to achieve two aims. First we will then have a measure or test of current market efficiency so that we can assess the possibility of present profit opportunities. Second we will 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 learn to become efficient and to exploit the former profit opportunities. This can be achieved only by developing a version of the above test equation which 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 Zalewska-Mitura (1998) and Rockinger and Urga (1998)).

A second important element of conventional financial models is that the error process will often not prove to have a full set of 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's and incorrectly reject market efficiency. This can be dealt with by combining the time varying parameter model with a standard GARCH-M model in the following way (see Emerson, Hall and Zalewska-Mitura, 1997):

$$r_t = \beta_{0t} + \sum_{i=1}^{p} \beta_{it} r_{t-i} + \delta h_t + e_t \quad e_t \sim N(0, h_t)$$

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

This model which combines time varying parameters with a GARCH-M process may be estimated by setting up the following state space form.

Let the measurement equation be

$$r_t = \beta_{0t} + \sum_{i=1}^{p} \beta_{it} r_{t-i} + \delta h_t + e_t \qquad e_t \sim N(0, h_t)$$

and the state equations be,

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

$$\beta_{it} = \beta_{it-1} + v_{it} \quad i = 0 \ldots p \quad v_{it} \sim N(0, \sigma_i^2)$$

This is then a standard state space model which may be estimated by using the Kalman Filter as described in the Appendix.

2.4 Testing the validity of the varying coefficient approach: a Monte Carlo simulation

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. So we have undertaken a Monte Carlo experiment to demonstrate the properties and abilities of this procedure to capture the changing correlation structure in the data.

We generate a series of 1000 random returns from the following data generation process:

$$r_t = \beta_t r_{t-1} + \varepsilon_t \quad \textit{where} \quad \varepsilon_t \sim N(0, \sigma^2)$$

where the parameter β_t behaves as follows:

$$\beta_t = 0.8 - (0.8/500)(t-1) \qquad t = 1,....,500$$
$$\beta_t = 0 \qquad t = 500,...,1000$$

That is the coefficient declines linearly from 0.8 to 0 over the first 500 observations and then remains at zero. We perform the test for three values of the variance σ^2. First, we take σ^2 to be close to values observed across a series of stock markets in transition economies. The first value that we use is 0.0005 corresponding to the value of σ^2 for the Budapest Stock Exchange. The second chosen value of σ^2 is 0.004 to follow values from the Warsaw Stock Exchange. The third σ^2 equals 0.05. This last value for the variance is very high and we do not know of any stock exchange which is characterised by such a large variance.

We replicated this process and the time varying estimation 2000 times to generate the Monte Carlo distribution of the time varying parameter at each point over the 1000 observations. The time path of the mean and standard deviation for the case in which the value of $\sigma^2 = 0.0005$ is presented in Figure 1. (We only report this experiment because the outcome is the same for the cases of $\sigma^2 = 0.004$, and $\sigma^2 = 0.05$.) The continuous lines are the means $\{\tilde{\beta}_t\}$,the dotted lines are $\{\beta_t \pm 2\tilde{\sigma}_t\}$ and the dashed lines correspond to the true parameter from the data generating process (DGP). The figure demonstrates that the time varying parameter model captures the movements in the true parameter remarkably effectively. It is only at the beginning of the sample and the point at which the parameter ceases changing that there is any bias in the estimates and even at these two points the estimated parameter is not significantly different from the true one

The Monte Carlo experiment also establishes two important properties of the technique. First, the time path of β's estimated does not depend on σ^2 -the variance of the daily returns. In other words, the variability of returns can be very large (0.05), or relatively law (0.0005), but if the returns follow the same pattern of autoregression, i.e., $\{\{\beta_t^i\}_{i=1,...,2000}$ we should detect it. Second, the probability of this detection does not change with changes in values of σ^2.

3. EMPIRICAL RESULTS

3.1 The Russian Stock Market: an Overview

Russia has two main stock exchanges located in Moscow, the Moscow Central Stock Exchange and the Moscow International Stock Exchange and a number of regional exchanges.

The Moscow Central Stock Exchange (MCSE) was founded and registered on 21 November 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 it started regular trading sessions on 30 October 1991. In July 1994 a Central Depository Clearing House was created and the Russian Federation Commission on Securities and the Capital Market (FCSM) was also created by decree in November 1994. On 1 July 1994 the voucher privatisation scheme ended.

During 1995 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 10 July 1995 exempted securities transaction from taxation in the Russian Federation. 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 and this has now centralised most of the trading.

On 26 December 1995 the Law on Joint-Stock Companies was passed. This Law provides a regulatory framework for operations in the securities markets and protects the rights of shareholders. On 16 April 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 bases of the legal infrastructure for the capital markets.

By the end of 1997 there are approximately 150 companies listed in Moscow with a market capitalisation of 104.4 US$bn.

3.2 Russian Stock Indices

In this work we will examine both general stock indices and a range of the most heavily traded individual shares. We begin by considering the stock indices.

3.2.1 Data Description

For the Russian stock market various indices are available. In this study we make use of the two main indices at daily frequency[2].

1) **ROS Index** - provided by the CS First Boston investment bank (available since 01/08/94). This index is capitalisation-weighted, dollar denominated, and based on 30 stocks. The daily returns on this index are shown in Figure 2.

2) **ASP General Index** - published by the Skate Press agency (available since 20/07/94). This index is capitalisation-weighted, dollar denominated, covering 100 stocks (the list is revised each quarter). Skate Press is using data provided by the Russian Trading System and quotations reported by market makers included in the list approved by Skate Press. Daily returns on the ASP index are shown in Figure 4.

3.2.2 Testing Efficiency. The GARCH parameter values

The following equations give the estimated GARCH parameters for the models based on the two market indices

ASP $$\underset{}{h_t} = \underset{(0.0001)}{0.0001} + \underset{(0.027)}{0.307}h_{t-1} + \underset{(0.9)}{1.04}e^2{}_{t-1}$$

[2] The other main index which has a number of stocks between the two used in this study is the **AKM Composite Index -** published by the AK&M agency (available since 01/09/93). However, this index is capitalisation-weighted covering 50 stocks, but rouble denominated and not dollar denominated as the ones that we use.

ROS $h_t = 0.0005 + 0.38h_{t-1} + 0.00008e^2{}_{t-1}$

(0.0) (0.0) (0.0002)

Figures 3 and 5 report the two time varying coefficients which correspond to these two sets of results along with their confidence intervals. Both sets of coefficients tell much the same story: the coefficient in Figure 3 for the ROS index begins with quite a high (and significantly non zero) value which steadily falls over the period to a value close to zero by mid 1996. The coefficient on ASP (see Figure 5) follows much the same pattern but at a slightly raised level so that it does not actually fall to zero, although it does become close to be insignificantly different from zero by mid-1996.

So the picture from the indices is that the market took some 2-3 years to become reasonably efficient and that this change happened in a fairly steady way.

3.3 Stock Prices: Russian "Blue Chips"

3.3.1 Data Description

In what follows we briefly provide some description of the Russian «blue chips» used in our empirical exercise. Our criteria for selecting shares was a mixed one. We attempted to chose the largest companies which had been traded for a fairly long period and which had a relatively thick 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 finally selected companies, all belonging to the gas and oil sector, are the follows:

LUKoil (LKOH)- This is the largest oil holding in Russia. It took the third position in the list of Russian companies with respect to sales volume (4017.3 mln. US dollar in 1996) and the fourth position with respect to net profit volume (659 mln US dollar in 1996). LUKoil's capitalization was 16049.8 in 1996 (the third position amongst Russian holdings).

Komineft (KNFT) - It took the forty eighth position in the list of Russian companies with respect to sales volume (315 mln. US dollars in 1996) and nineteenth position with respect to capitalization (1046.3 mln. US dollars in 1996). At the same it had negligible profit (54.5 mln. US dollars) in 1996. The data related to net profit of Komineft are not available.

Kondpetrolium (KOND) - This company presents a capitalization of 131.5 mln US dollars, with an average price of stocks of 3.47 US $. The data on profit is not available.

Noyabrskneftegaz (NYGS) - It took the sixteenth position in the list of Russian companies with respect to sales volume (2110.5 mln. US dollars in 1996) and the twenty seventh position with respect to capitalization (811.9 mln. US dollars in 1996). At the same it had negligible net profit (18.1 mln. US dollars) in 1996.

Purneftegaz (PFGS) - It took the thirty fist position in the list of Russian companies with respect to sales volume (664.5 mln. US dollars in 1996) and the twenty second position with respect to capitalization (906.7 mln. US dollars in 1996). Net profit was 83.6 mln. US dollars in 1996.

Surgutneftegaz (SNGS)-The second company in the list of oil companies of Russia. It took the sixth position in the list of Russian companies with respect to sales volume (4589.1 mln. US dollar in 1996) and the third position with respect to net profit volume (705.7 mln. US dollar in 1996). Surgutneftegaz' capitalization was 6672.2 in 1996 (the seventh position amongst Russian companies).

Yuganskneftegaz (YFGA)-It took the fourteenth position in the list of Russian companies with respect to sales volume (2249.6 mln. US dollars in 1996) and the twenty first position with respect to capitalization (1016.8 mln. US dollars in 1996). It had negative profits (and net profits) (-51.3 mln. US dollars) in 1996.

We have daily data on the (average) share price of each of these companies and we now proceed to estimate our time varying learning model on each of them in turn. Table 1 gives the estimated parameters for the GARCH process for each of the companies. The GARCH effects are highly significant but in other respects these parameters are unsurprising.

Table 1 Testing for Efficiency, the GARCH parameters

	a_0	a_1	a_2
KOND	**0.0002** **(0.0)**	**0.71** **(0.032)**	**0.17** **(0.0)**
LKOH	**0.003** **(0.0)**	**0.196** **(0.08)**	**0.47** **(0.0)**
KNFT	**0.0** **(0.0)**	**0.96** **(0.009)**	**0.14** **(0.02)**
NYGS	**0.001** **(0.0)**	**0.685** **(0.05)**	**0.2** **(0.1)**
PFGS	**0.0** **(0.0)**	**0.8** **(0.025)**	**0.15** **(0.04)**
SNGS	**0.0002** **(0.0005)**	**0.5** **(0.05)**	**0.89** **(0.75)**
YFGA	**0.0001** **(0.0)**	**0.65** **(0.04)**	**0.3** **(0.025)**

Asymptotic standard errors in parenthesis

We now turn to the pattern of the time varying coefficients for each individual share. Here we find a very strong and surprising pattern which is that three of the seven shares show strong and significant signs of inefficiency but all three of them show no tendency for this inefficiency to be eliminated over time. In fact for each of the three cases where we found significant coefficients we found no tendency for variation in these parameters at all.

Of the seven shares, the three which are broadly efficient are following three: Komineft, which has a coefficient of almost exactly zero with no time variation; Kondpetroleum, which again has a constant coefficient which is highly insignificant throughout the whole period; finally Purneftegaz, which has a coefficient which shows some variation but which remains insignificant throughout.

The remain shares all show highly significant but not time varying coefficients. This is a somewhat remarkable finding as it implies that these market are inefficient in their trading, and also that they show no tendency to eliminate this inefficiency. It also presents us with a problem of reconciling the results for the indices with these results. Before considering this problem it is worth trying to verify this result and to check that it is not occurring for some spurious reason.

In order to do this, we took the share with the largest coefficient (Lukoil) and carried out a range of sub-sample estimates in order to check if the finding was not coming about either as a result of some single unusual observation or as a result of a small sub sample of observations. We estimated the model over five different sub samples and in each case we obtained a constant coefficient of almost the same order of magnitude. The total sample size was 547 observations and we derived our sub samples on the basis of excluding some of the unusual returns periods from each of the sub samples. In order to save space we will not present the figures for this exercise but the five samples and results were 1-180 (the value of the coefficient = 0.3), 1-150(coefficient=0.29), 50-180 (coefficient=0.32), 181-547 (coefficient=0.38), 200-547 (coeficient=0.35). So it is clear that this finding of a constant coefficient is a robust one.

We have considered how these results can be reconciled with the market index results and there are a number of possibilities which we have considered. One is that the single company results may not represent profit opportunities given the size of the bid-ask spreads, which exist on many Russian shares. In fact the spreads on some Russian shares are remarkably high, sometimes of the order of 30% of the average price, this is usually associated with the very thinly traded shares. However there is no positive relationship between a high bid-ask spread and our finding of inefficiency. In fact all the three shares which show inefficiency have very low spreads and are heavily traded shares.

Our main interpretation is that the three inefficient shares are widely traded by less skilled market participants being amongst the oldest and best known shares and these traders are not sufficiently involved in the market to learn about the profit opportunities which remain in the high frequency data. Other share trading is more dominated by professional traders who are more effective at removing the profit opportunities. As this type of trading has grown the market indices have been dominated by the more efficient trading. Of course it is not an entirely satisfactory explanation as it does not explain why the efficient traders do not exploit the opportunities which appear to remain in these shares.

4. CONCLUSION

In this paper we have proposed a test of changing market efficiency based on a time varying parameter model with GARCH in mean effects. We have demonstrated the effectiveness of this model via a Monte Carlo study, which shows that our approach is quite effective at capturing both the level and the speed of change of time varying correlation structure in a series of returns.

We then applied this procedure to the returns from two indices of the Russian stock market and demonstrated that the market was initially inefficient and that it took something of the order of two and a half years to become efficient. We then applied the technique to a range of individual shares on the market and found the surprising result that some of them seemed to be efficient while others were not. Further amongst the inefficient shares there seemed to be no tendency towards becoming efficient.

We discussed various explanations for this finding and concluded that the most likely explanation is a segmentation of the market into informed and uninformed traders, although this is not a completely satisfactory explanation.

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APPENDIX

Kalman Filter estimation of a univariate state space model

In this section a standard state space formulation of the time varying parameter model is presented, with the appropriate Kalman filter equations for the univariate case, following Harvey (1987).

Let

$$Y_t \;=\; d' z_t \;+\; e_t$$

be the measurement equation, where y_t is a measured variable, z_t is the state vector of unobserved variables, d is a vector of parameters and $e_t \sim NID(0,G_t)$. The state equation is then given as:

$$z_t \;=\; \Psi z_{t-1} \;+\; y$$

where Y are parameters and y~ $NID(0,Q_t)$, Q_t is sometimes referred to as the hyperparameters

The appropriate Kalman filter prediction equations are then given by defining z^*_t as the best estimate of z_t based on information up to t, and P_t as the covariance matrix of the estimate z^*_t, and stating:

$$z^*_{t|t-1} \;=\; \Psi z^*_{t-1}$$

and

$$P_{t|t-1} \;=\; \Psi P_{t-1} \Psi' \;+\; Q_t$$

Once the current observation on y_t becomes available, we can update these estimates using the following equations:

$$z^*_t \;=\; z^*_{t|t-1} \;+\; P_{t|t-1} d (Y_t - d' z^*_{t|t-1}) / (d' P_{t|t-1} d + \Gamma_t)$$

and

$$P_t \;=\; P_{t|t-1} \;-\; P_{t|t-1} d d' P_{t|t-1} / (d' P_{t|t-1} d + \Gamma_t)$$

These Equations then represent jointly the Kalman filter equations.

If we then define the one-step-ahead prediction errors as,

$$v_t \;=\; Y_t - d' z^*_{t|t-1}$$

then the concentrated log likelihood function can be shown to be proportional to

$$\log(l) = \sum_{t=k}^{T} \log(f_t) + N log(\sum_{t=k}^{T} v_t^2 / N f_t)$$

where $f_t = a'P_{t|t-1}a + G_t$ and N=T-k, where k is the number of periods needed to derive estimates of the state vector; that is, the likelihood function can be expressed as a function of the one-step-ahead prediction errors, suitably weighted.

Using these equations we may then estimate the state space form given above which involves both time varying parameters and the GARCH-M error process and the signal extraction problem of producing a continuos estimate of the asset price.

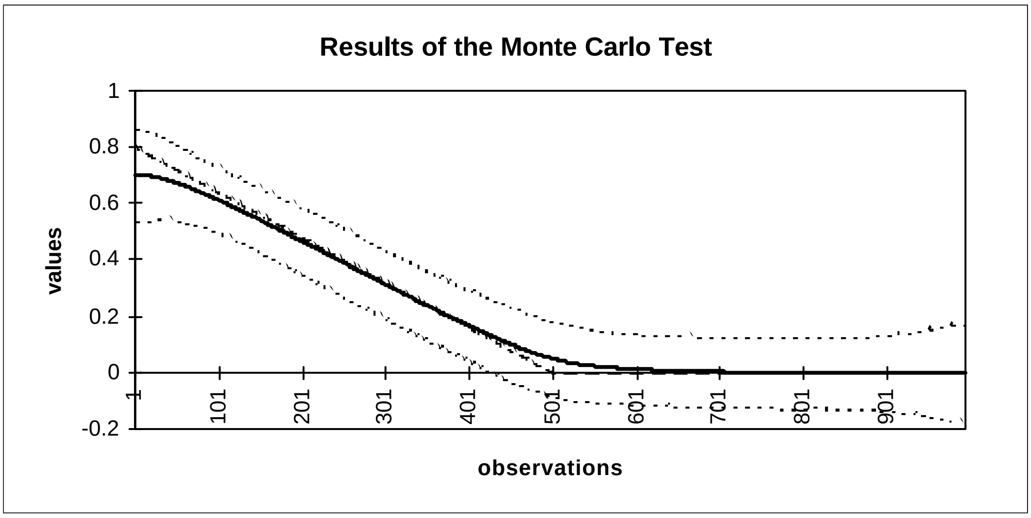


Figure 1

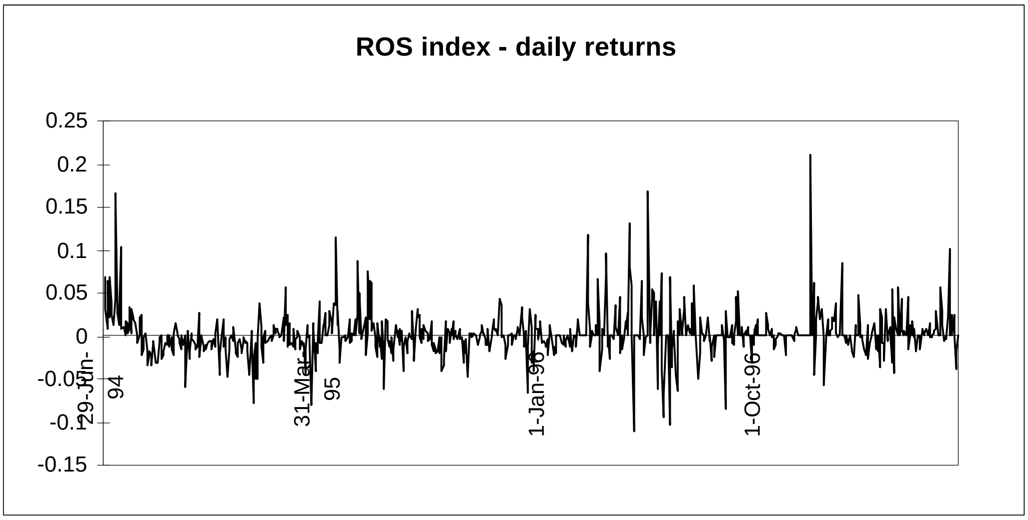


Figure 2

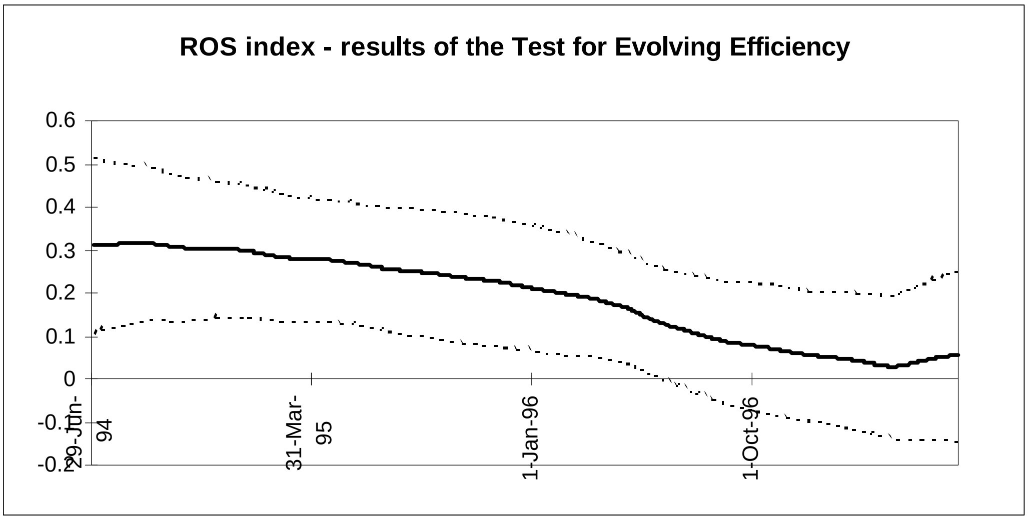


Figure 3

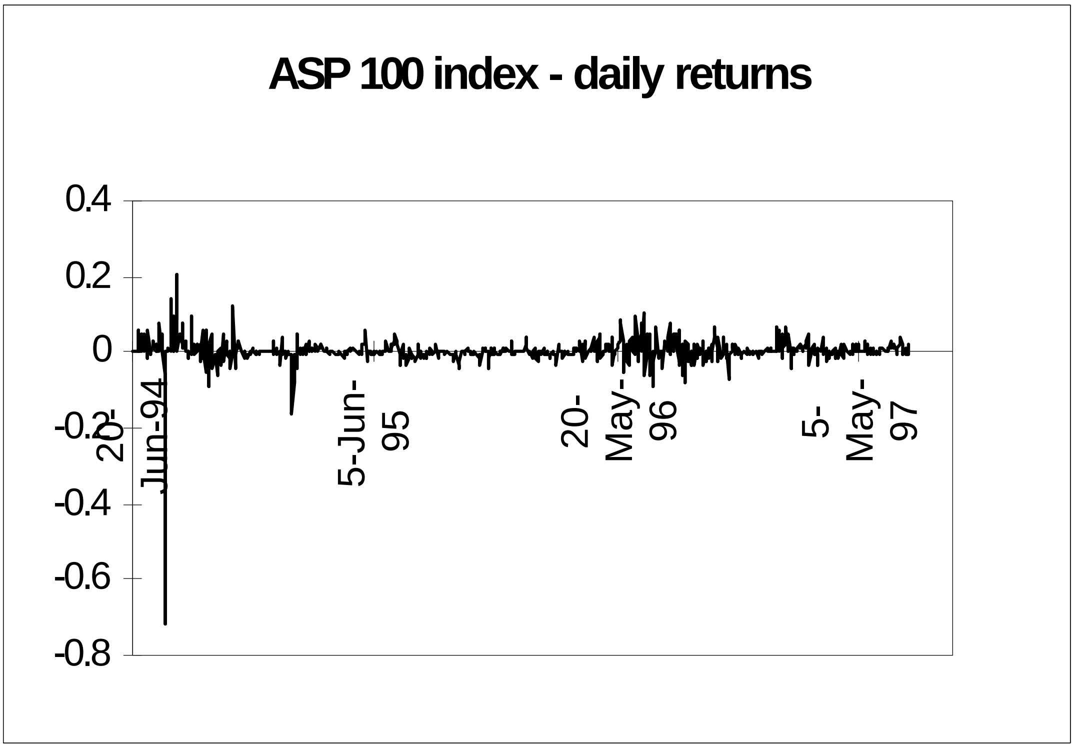


Figure 4

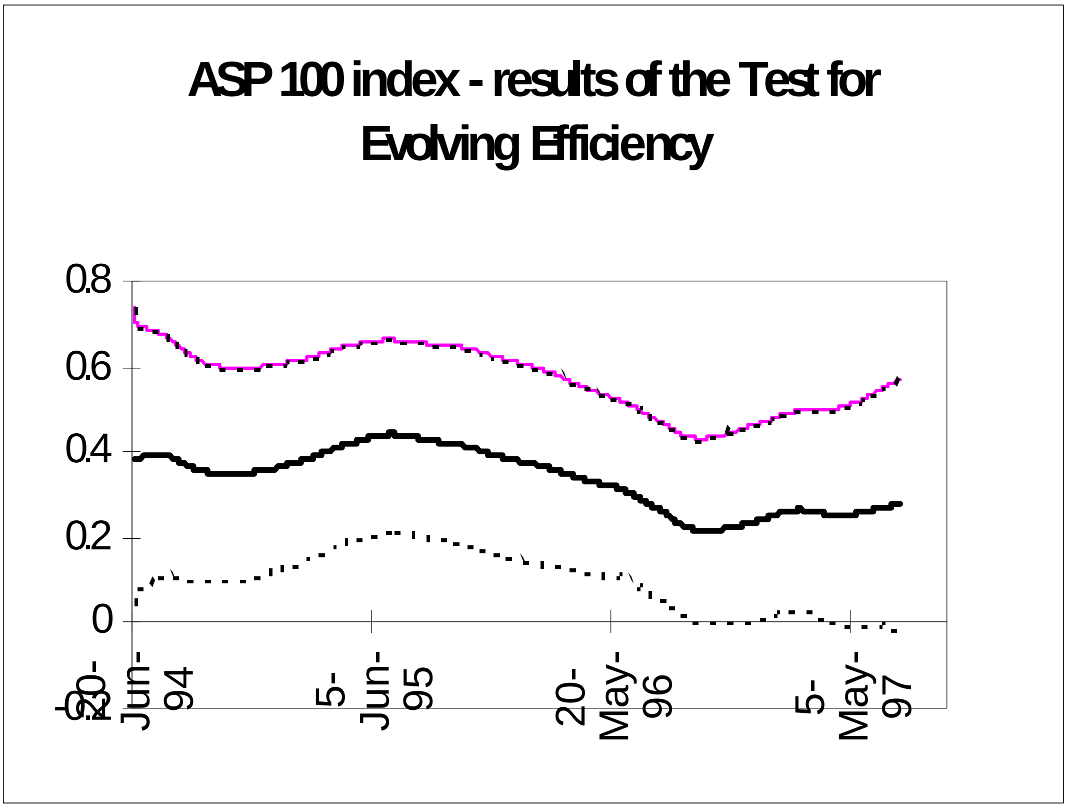


Figure 5

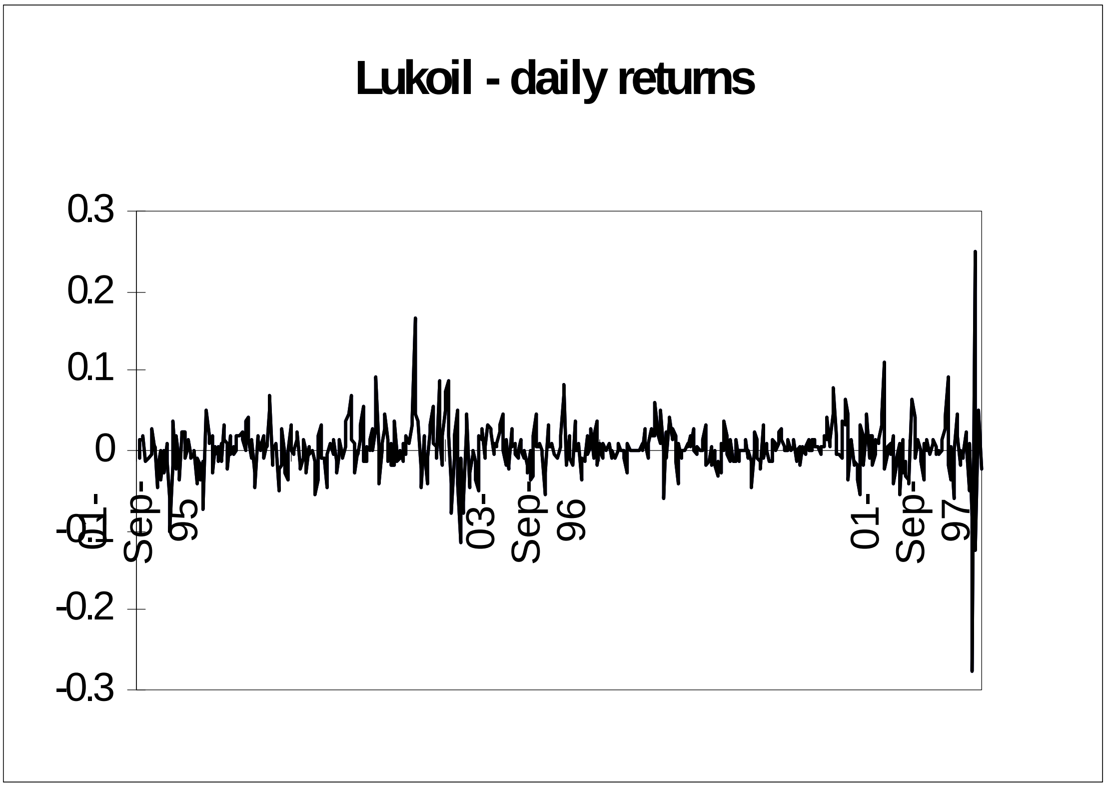


Figure 6

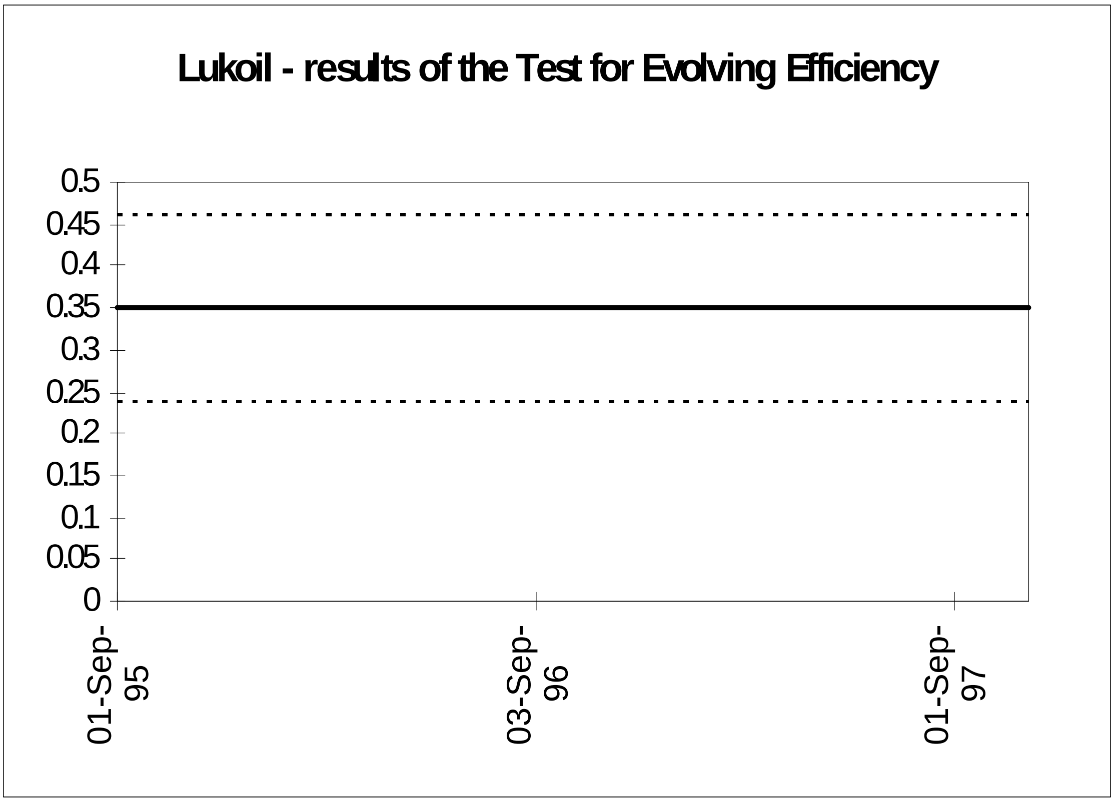


Figure 7

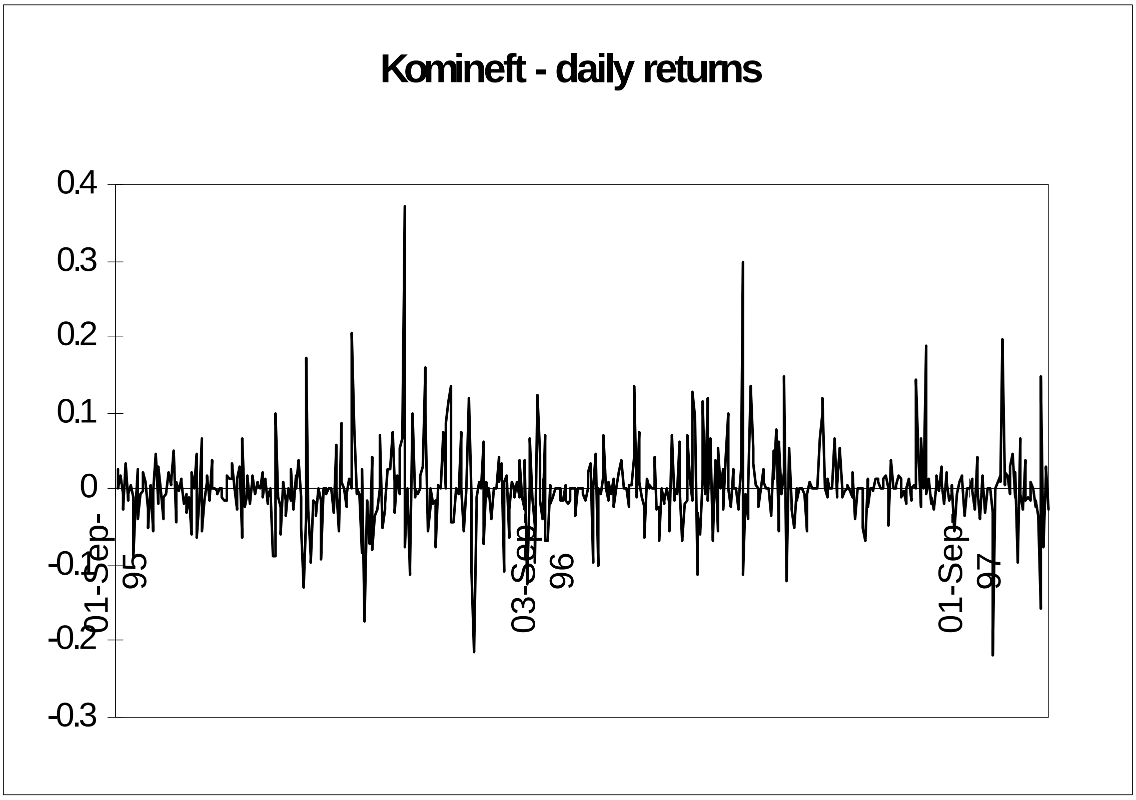


Figure 8

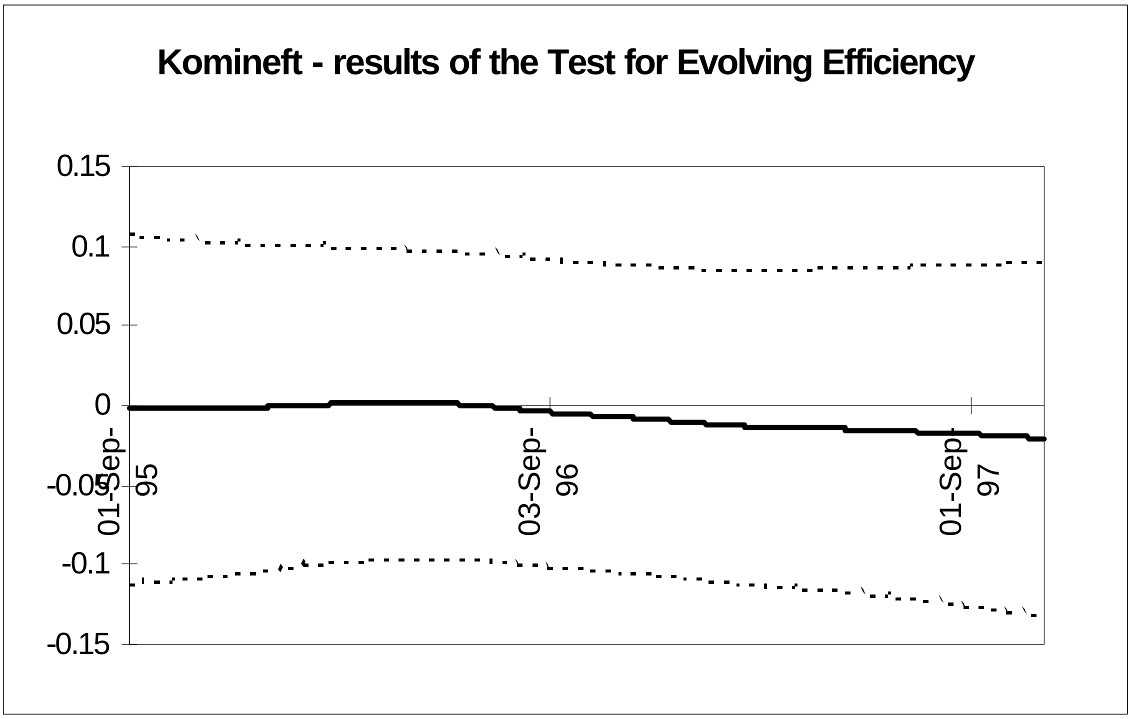


Figure 9

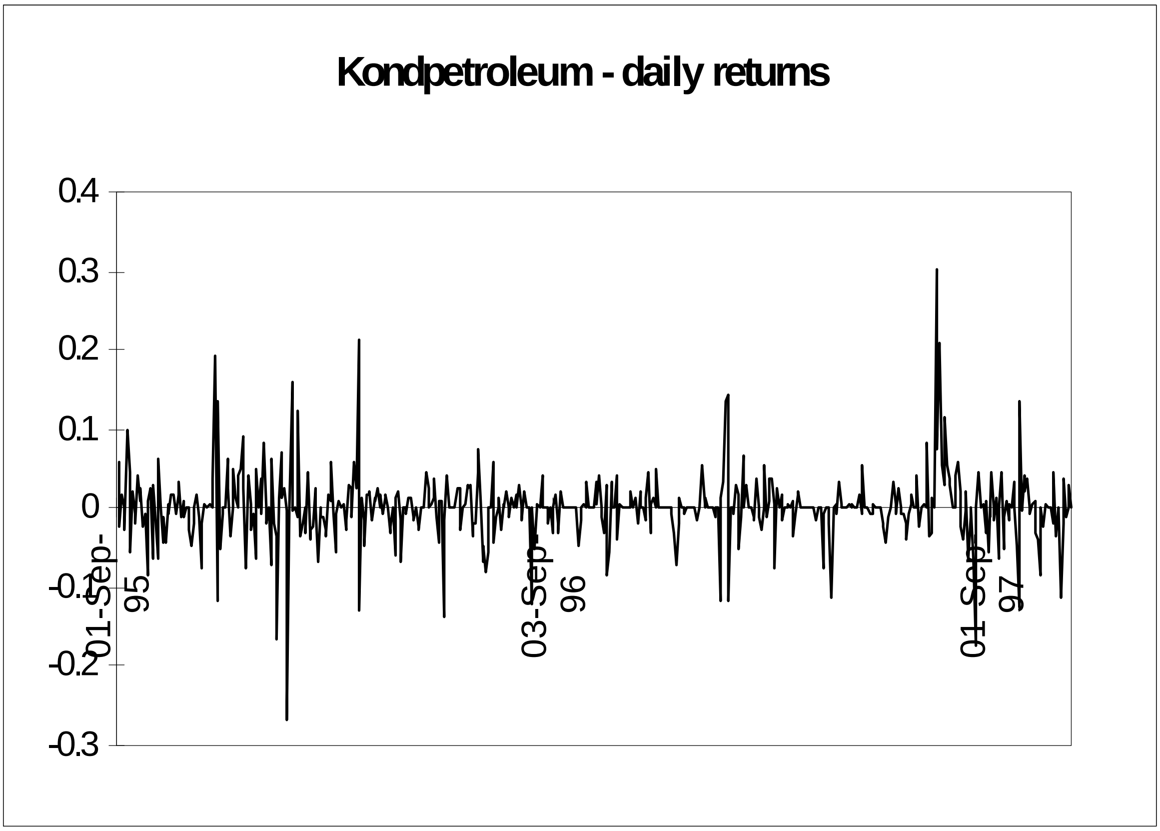


Figure 10

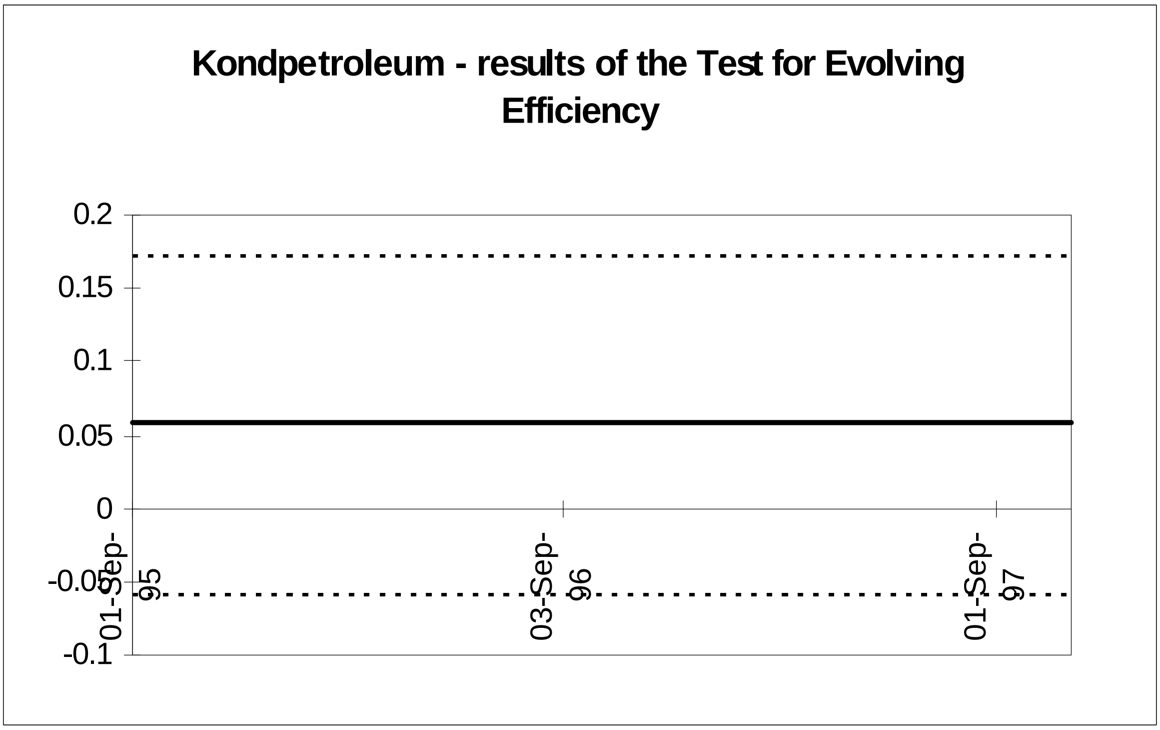


Figure 11

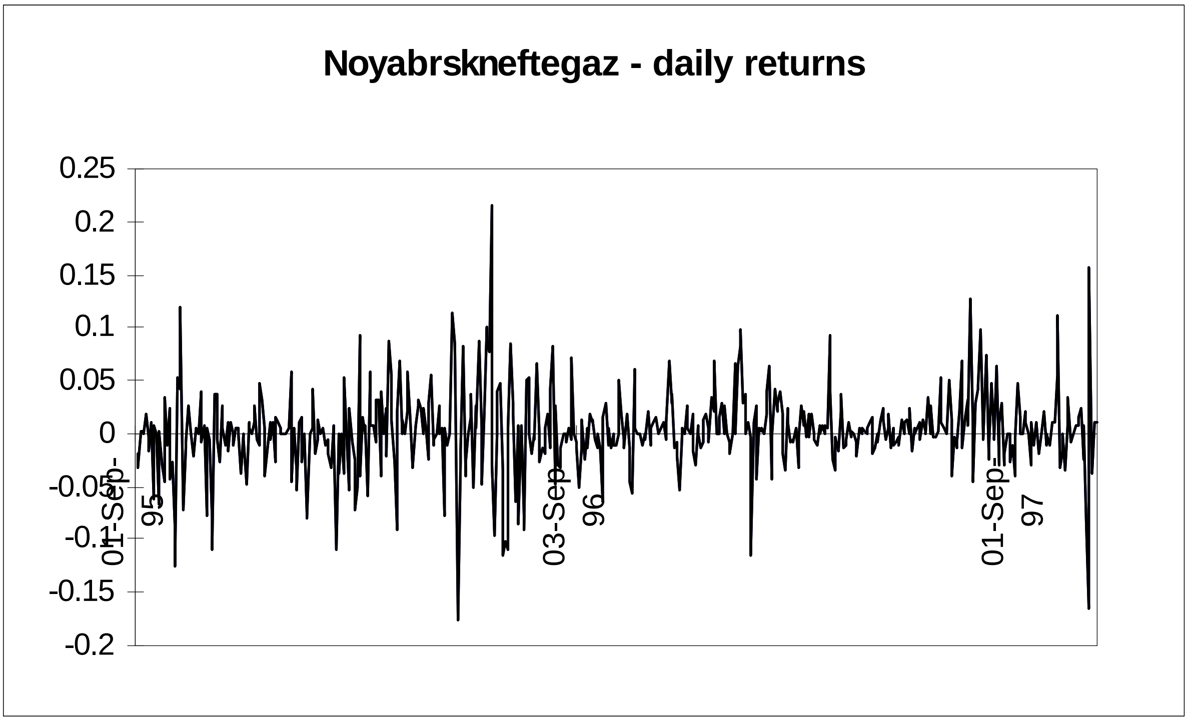


Figure 12

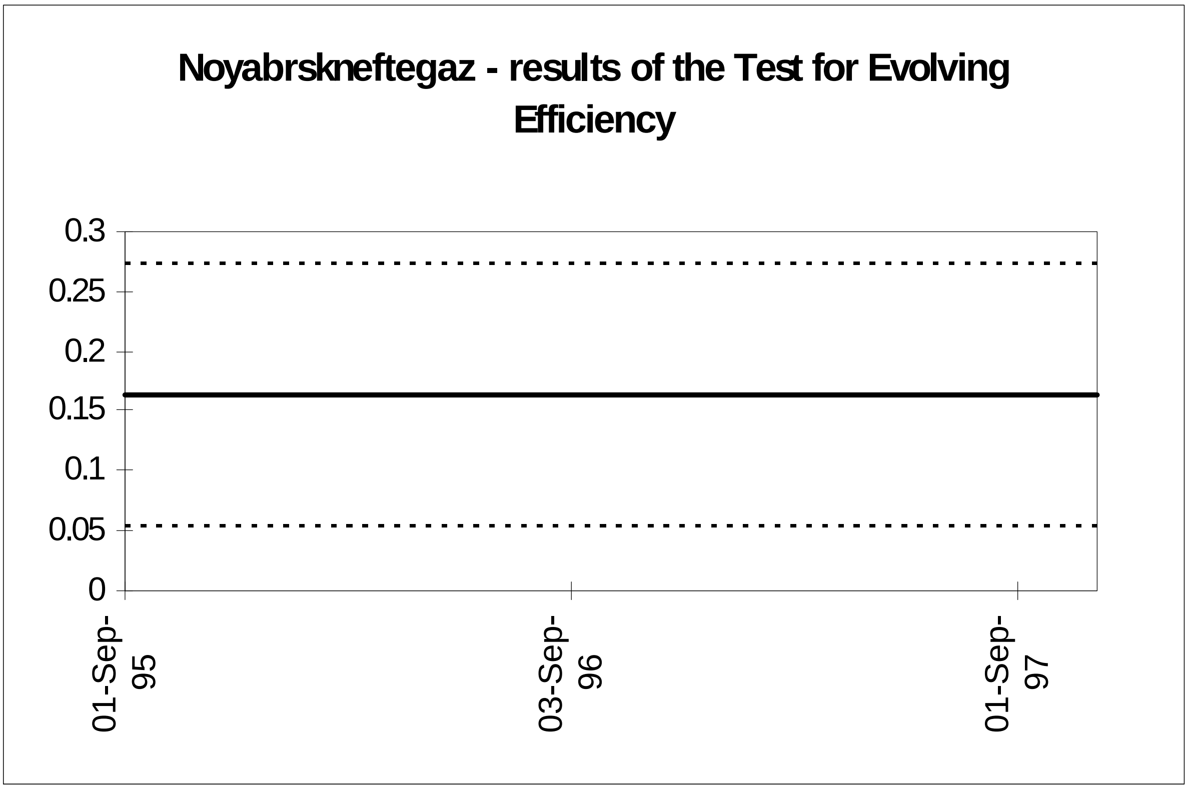


Figure 13

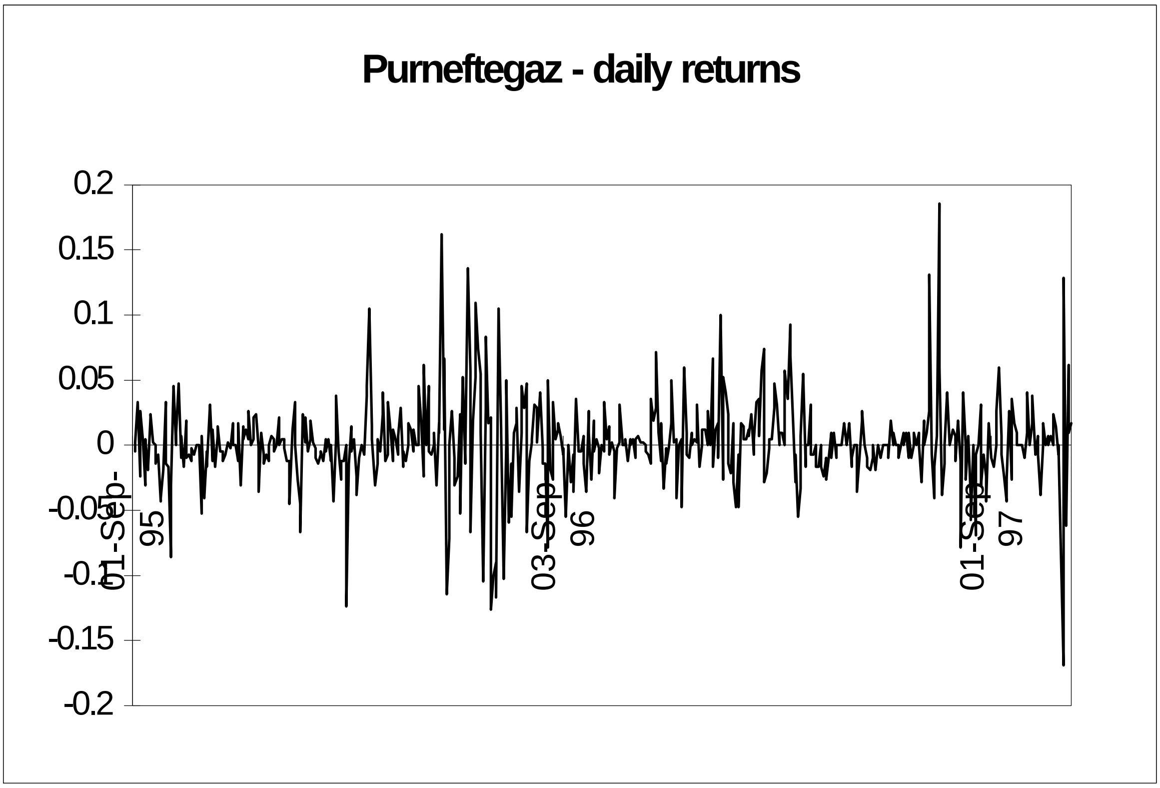


Figure 14

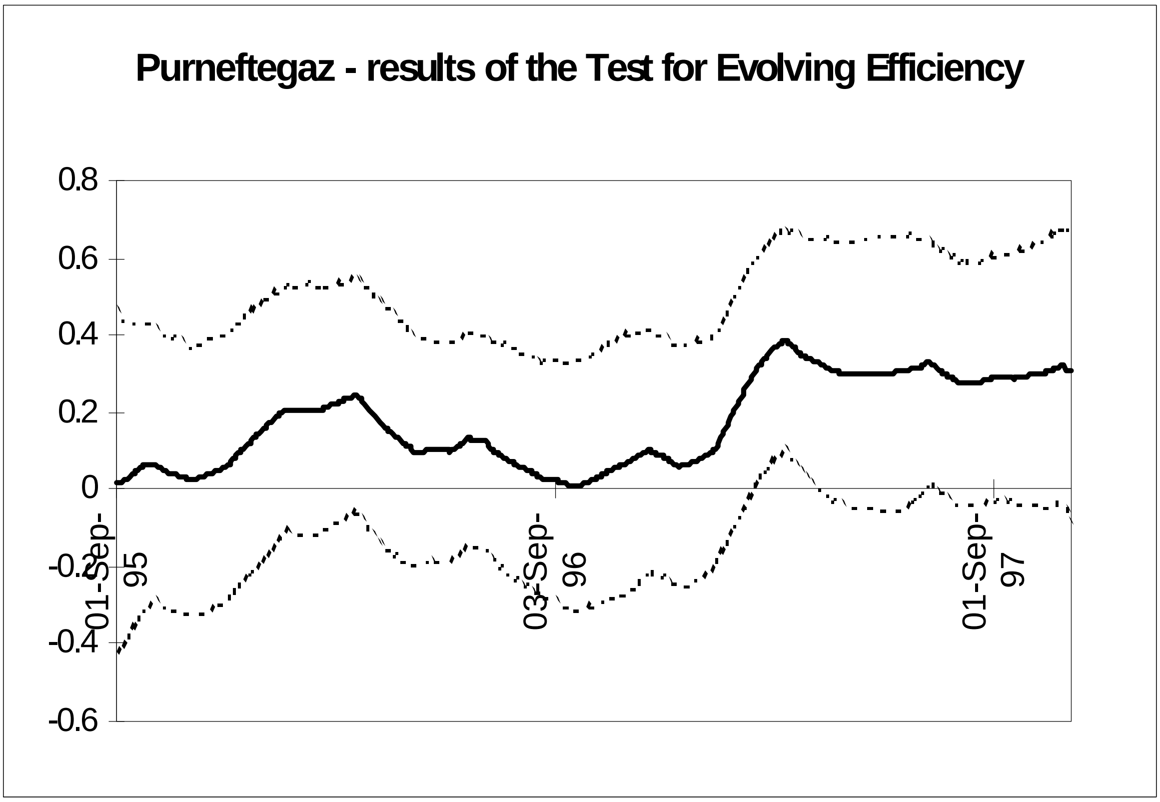


Figure 15

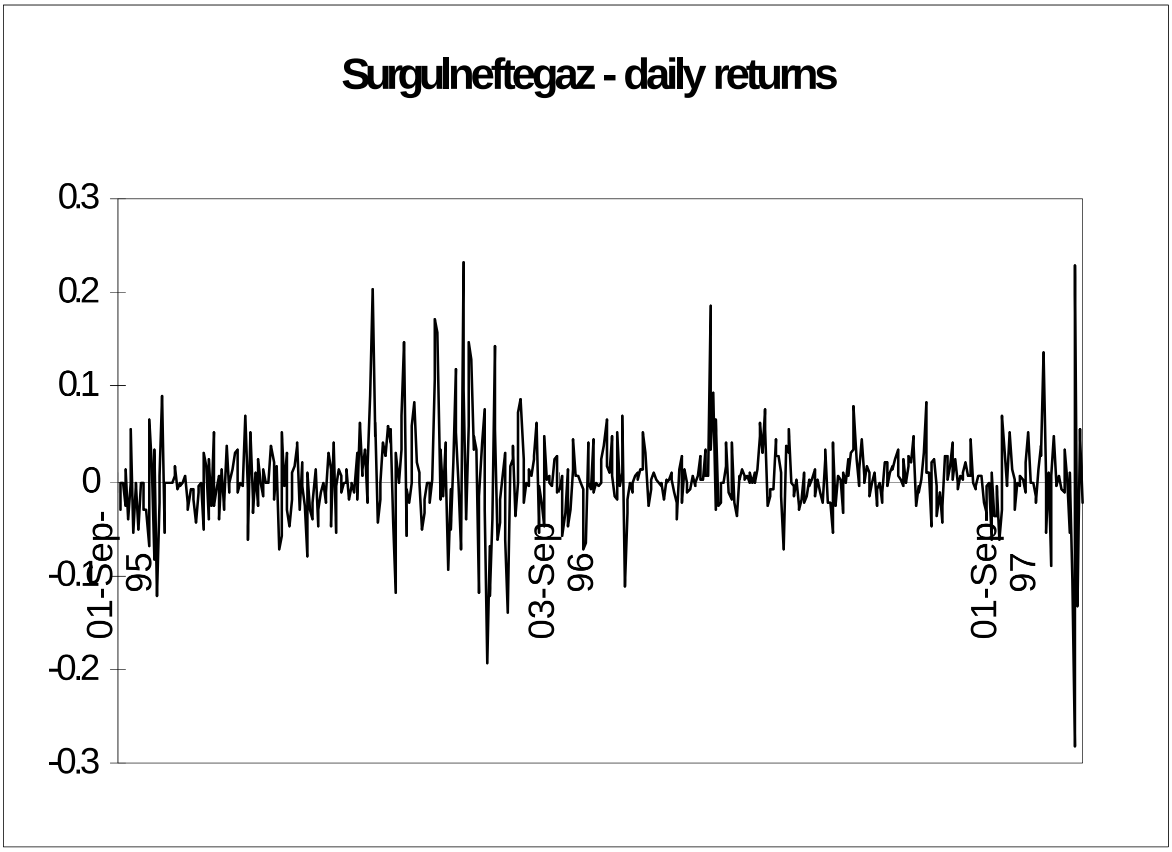


Figure 16

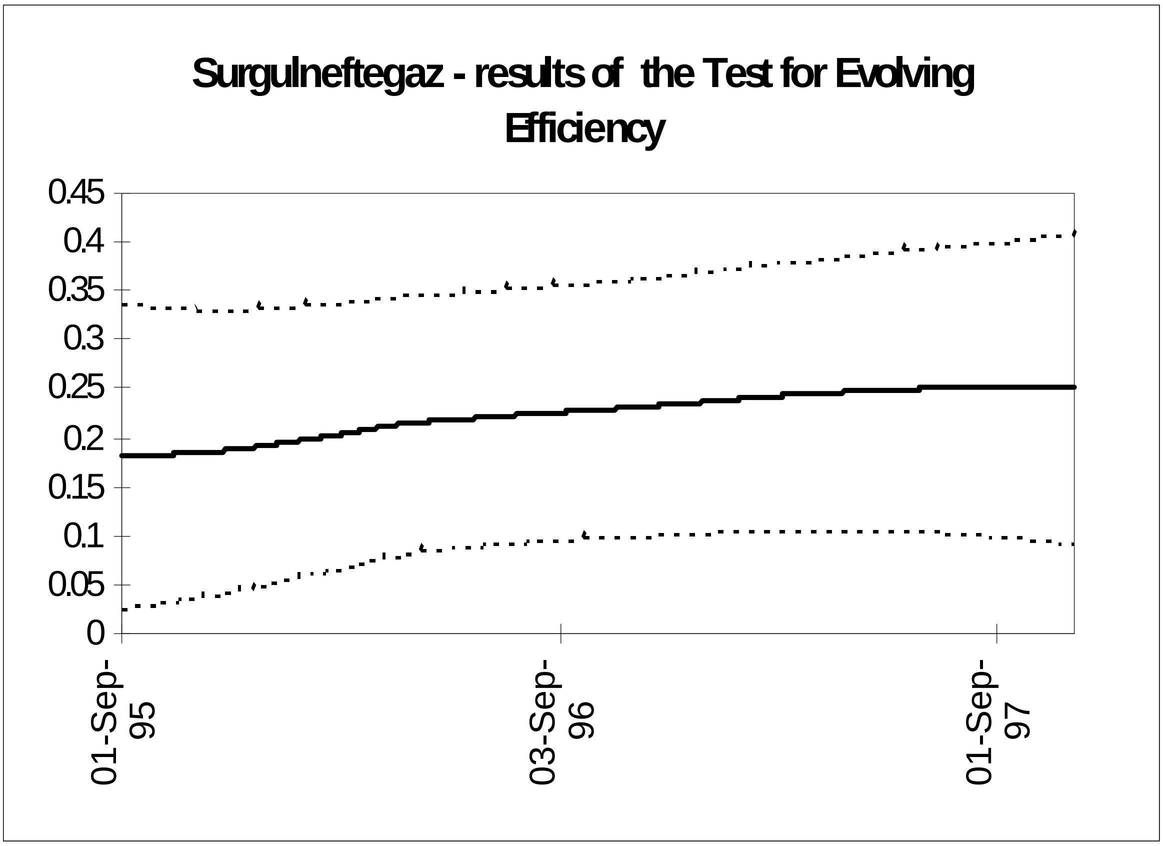
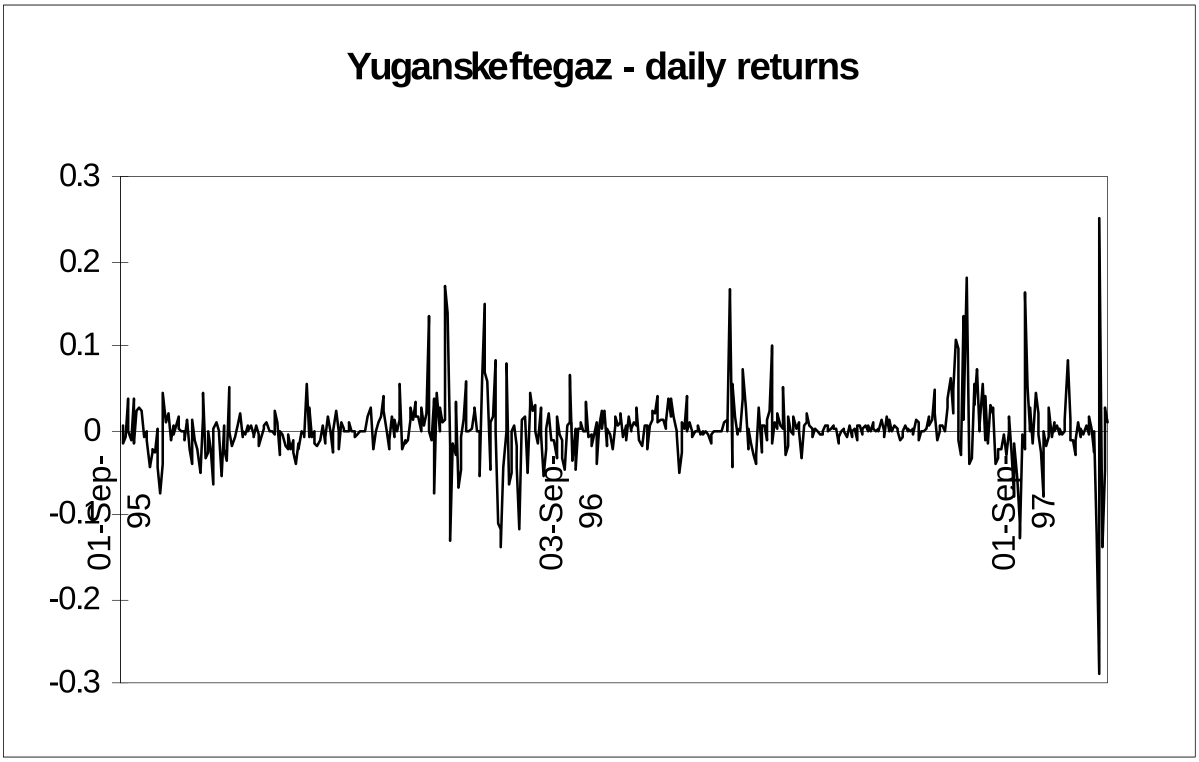


Figure 17


Yuganskeftegaz - daily returns
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
01-Sep-95
03-Sep-96
01-Sep-97

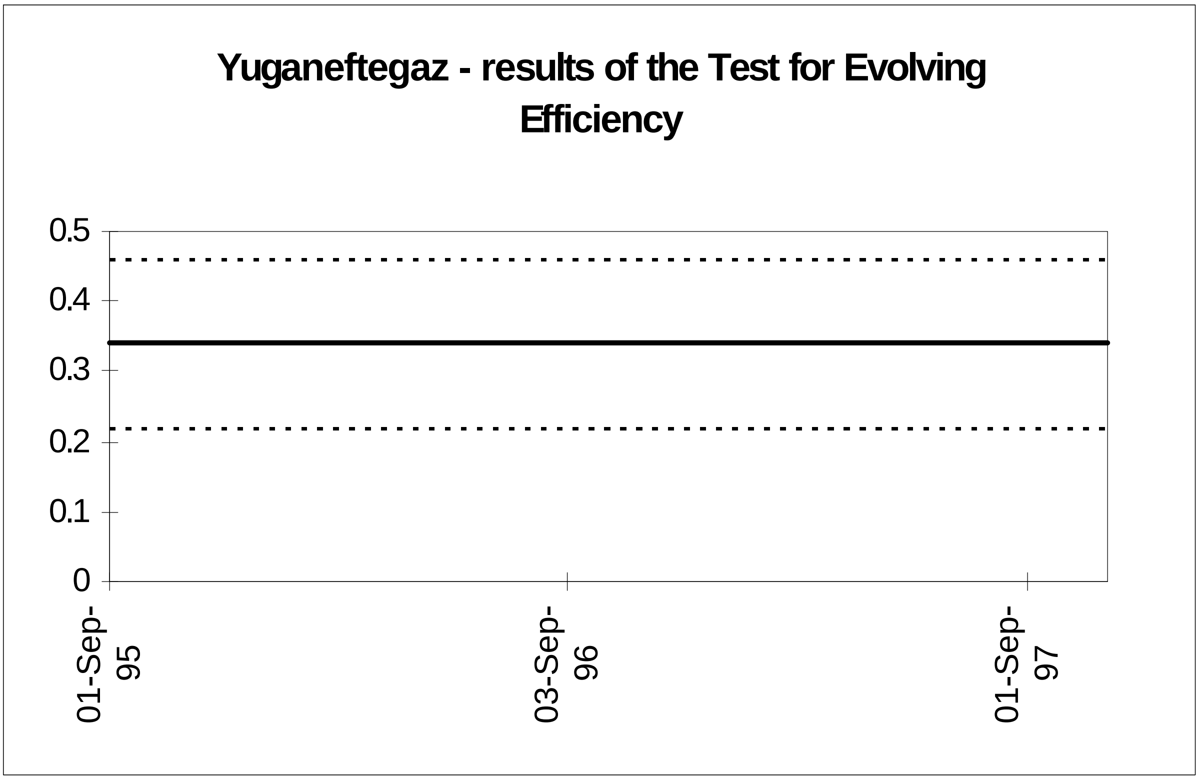

Yuganeftegaz - results of the Test for Evolving Efficiency
0.5
0.4
0.3
0.2
0.1
0
01-Sep-95
03-Sep-96
01-Sep-97

Figure 19