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TESTS OF THE ARBITRAGE PRICING THEORY USING MACROECONOMIC VARIABLES IN THE RUSSIAN EQUITY MARKET

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1 INTRODUCTION

Asset prices are commonly believed to react sensitively to economic news. Daily experience seems to support the view that individual asset prices are influenced by a wide variety of unanticipated events and that some events have a more pervasive effect on asset prices than do others. (Chen et al., 1986) Thus, various asset pricing models can be used to determine equity returns. The one-factor CAPM is the dominant asset pricing model in the literature but a few multi-factor asset pricing models have also been derived.

An important body of research in financial economics has been the behaviour of asset returns and especially the forces that determine the prices of risky assets. There are also a number of competing theories of asset pricing. These include the original capital asset pricing models (hereafter CAPM) of Sharpe (1964), Lintner (1965) and Black (1972), the intertemporal models of Merton (1973), Long (1974), Rubinstein (1976), Breeden (1979), and Cox et al. (1985), and the arbitrage pricing theory (hereafter APT) of Ross (1976).

Probably the most famous multi-factor model is the Ross's APT which was developed in the year 1976. The capital asset pricing theory begins with an analysis of how investors construct efficient portfolios and the theory has its basis in mean-variance analysis. The APT comes from an entirely different family. It does not ask which portfolios are efficient. Instead, it starts by assuming that each equity's return depends partly on pervasive macroeconomic influences or factors and partly on noise (Brealey et al., 2006). The APT has been widely discussed in literature (e.g., Chen (1983); Connor & Korajczyk (1986); Berry et al. (1988); Groenewold & Fraser (1997); Sharpe (1982)).

The APT has been empirically studied in several markets, e.g., Antoniou et al (1998) implemented it to London Stock Exchange, Dhankar & Esq (2005) to Indian stock market, Berry et al. (1988) to S&P 500 and Chen et al. (1986) to New York Stock Exchange, Azeez & Yonezawa (2003) to Japanese stock market and finally Anatolyev (2005) to Russian stock markets.

However, even though Anatolyev (2005) investigated Russian equity markets, he did not try to implement the APT to individual equities. To the best of our knowledge, this is the first study that tests the APT in Russian equity market. This paper provides a test of the APT for Russian equity markets and also tries to find the relevant factors priced in Russian stock markets' largest equities. In this study the 20 largest and most traded stocks are investigated by the APT.

The purpose of this thesis is to investigate following issues: First, what kind of factors affects Russian equity market returns and second, how well the APT can explain Russian equities' returns. We will try to find out, is the market risk the most powerful risk factor or are there some other factors priced. We will choose a few factors which are found appropriate according to theory. After that, we will choose 20 of the biggest corporations in Russian equity market in 2005 and then we will run ordinary least-squares regressions to test the APT.

First we will try to use a few of the same macroeconomic variables that Chen et al. (1986) used in their study of U.S. equity returns. Second, we will try to seek some other macroeconomic variables that could have an effect on the Russian equity markets. It is well known that, e.g., oil profits have boosted the Russian economy. Finally we will provide the results of these factors and decide whether or not they are statistically significant for Russian equities.

This study is performed from the European investor's point of view so that the currency used in this study is euro and also risk-free rate is one-month Euribor. We will exclude the statistical methods (factor and principal component analysis) and we will select the macroeconomic variables *a priori*. However, we will use factor analysis to give us guidance for the amount of factors priced in our sample of equities. We will not use sophisticated (e.g., GARCH, Kalman-filter) methods in generation of our unanticipated macroeconomic variables – we will use the "rate of change" method. The data used in this study is gathered from Datastream and especially MSCI (Morgan Stanley Capital International) indices are used. The study comprises years from the beginning of 1999 to the end of March 2006.

The thesis is structured as follows. The next chapter introduces the theoretical background; the APT is presented in great detail and also the biggest debate issue in earlier studies, the determination of factors, is represented. We will also represent the benefits of the APT over the single-factor CAPM. The third chapter describes the data, especially the features of Russian equity markets and the 20 largest equities, and also the research methodology. In this chapter we will also go through the linear regression model that will be the methodology we will use in our quantitative analysis. The fourth chapter reports the empirical results and findings. The final chapter is for conclusions and suggestions for further research.

2 THEORETICAL BACKGROUND

A fundamental principle in finance is the trade-off between risk and return. This means that one portfolio can be expected to outperform another portfolio only if the former is riskier in some appropriate sense. Currently, the best two theories that provide a rigorous foundation for computing trade-off between risk and return are the CAPM[1] and the APT. In this section we will discuss these theories and our focus is on the APT and especially on the factors affecting returns.

2.1 The arbitrage pricing theory

The APT relates the expected rate of return on a sequence of primitive securities to their factor sensitivities, suggesting that factor risk is of critical importance in asset pricing (Gilles & Leroy, 1990). The APT is a new and different approach to determining asset prices. It tries to capture some of the non-market influences that cause securities to move together. It is based on the law of one price: two items that are the same can not sell at different prices. One advance is that the strong assumptions made about utility theory in using the CAPM are not necessary. (Elton et al., 2003) Unlike the CAPM, which requires strong restrictions on return distributions and preferences, the APT gives a characterization of expected returns on assets based only on the weak assumptions that there are no arbitrage opportunities, returns follow a factor structure and there are homogeneous expectations (Gilles & LeRoy, 1990).

The APT formulated by Ross (1976) rests on the hypothesis that the equity price is influenced by limited and non-correlated common factors and by a specific factor totally independent from the other factors. By using this arbitrage reasoning it can be shown that in an efficient market, the expected return is linear combination of each factor's beta. (Morel, 2001) The risk associated with holding a particular security

[1] Although empirical tests have documented many shortcomings to this theoretical model, in particular the anomalous effect of the market value and book-to-market ratio influences on equity returns. Yet, the CAPM still receives 2-3 times the coverage in standard finance texts compared to the APT. (Groenewold & Fraser, 1997)

comes from two sources. The first source of risk is the macroeconomic factors that affect all securities. Their influence pervades the whole asset market and can not be diversified away. The second source of risk is the idiosyncratic element. This element is unique to each security and, according to the APT, in a broadly diversified portfolio it can be diversified away. Thus, an efficient market will only reward the risks associated with the systematic (macroeconomic) factors. (Watsham & Parramore, 1997)

The APT assumes that arbitrage profit opportunities are quickly eliminated through competitive forces – this means, that an investor can not earn a positive expected rate of return on any combination of assets without incurring some risk and without making some net investment (Berry et al., 1988). Broadly speaking, the APT implies that the return of an asset can be broken down into an expected return and an unexpected or surprise component. Thus, the APT predicts that "general news" will affect the rate of return on all stocks but by different amounts. In this way the APT is more general than the CAPM, because it allows larger number of factors to affect the rate of return. (Cuthbertson, 2004)

The model assumes that the return to the *i*th security, R_{it} , is generated by a multi-index model:

$$R_{it} = a_i + b_{i1}F_{1t} + ... + b_{iJ}F_{Jt} + \varepsilon_{it} \qquad i = 1,2,...,N \, , \tag{1}$$

where the F_{jt} are factors $(j = 1,2,...,J)$; the b_{ij} are factor loadings or sensitivities and e_i is a random variable with $E(e_i) = 0$, $E(e_i^2) = \sigma_i^2$, $E(e_i e_k) = 0$, $i \neq k$, and $\mathrm{cov}(e_i, F_j) = 0$ for all i and j. There are N assets. (Groenewold & Fraser, 1997)

The focus of the APT is on the expected rate of return $E(r_i)$. Assuming that: a) there are no arbitrage possibilities, and b) the law of large numbers,[2] the model implies the following relationship between the expected return to asset and the factor sensitivities:

$$E(R_{it}) = \lambda_0 + \lambda_1 b_{i1} + ... + \lambda_J b_{iJ} + \varepsilon_{it} \, , \tag{2}$$

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[2] In a statistical context, the law of large numbers implies that the average of a random sample from a large population is likely to be close to the mean of the whole population.

where λ_0 usually equals the risk-free rate of return and λ_J has the interpretation of the expected return to a portfolio (price of risk) with unit sensitivity to factor j and zero sensitivity to all other factors. (Cheng, 1996)

It can be seen from equation (1) that each security i has a unique sensitivity to each F_{jt} but that any F_{jt} has a value that is the same for all securities. Any F_{jt} affects more than one security. Finally, from equation (2) we see that λ_J is the extra expected return required because of a security's sensitivity to the j th attribute of the security. The problem here is that, whereas for the CAPM the correct F_{jt} is defined, for the multifactor model and the APT the set of F_{jt}'s is not defined by the theory.[3] (Elton et al., 2003)

Stock prices can be written as expected discounted dividends:

$$P_0 = \sum_{t=1}^{\infty} \frac{E(D_t)}{(1+r)^t}, \qquad (3)$$

where P_0 is stock price, E is the expectations operator, r is the discount rate and D_t is the dividend paid at the end of period t. It follows that systematic forces (factors) that influence equities' returns are those that change discount factors or expected cash flows $E(D_t)$ or both. (Chen et al., 1986) Any economic announcements will affect equity price movements if the new information revealed by announcements affects those components (Morel, 2001).

[3] The CAPM can be thought simply as a special case of the APT where $J=1$ and $F_1 = (R_m - R_f)$. (Groenewold & Fraser, 1997)

2.2 The factors of the APT

The main problem in testing the APT is that the APT has been silent about which events and factors are likely to influence all assets. There is a rather embarrassing gap between theoretically exclusive importance of systematic "state variables" and our complete ignorance of their identity. The co-movements of asset prices suggest the presence of underlying exogenous influences, but no one has yet determined which economic variables, if any, are responsible. (Chen et al., 1986) Thus, there is no formal theoretical guidance in choosing the appropriate group of economic factors to be included in the APT model (Azeez & Yonoezawa, 2003).

This is both its strength and its weakness. It is strength in empirical work since it permits the researcher to select whatever factors provide the best explanation for the particular sample at hand; it is weakness in practical applications because, in contrast to the CAPM, it can not explain variation in asset returns in terms of limited and easily identifiable factors, such as equity's beta. (Groenewold & Fraser, 1997)

Berry et al. (1988) give good and simple instructions what kind of variables qualify as legitimate risk factors in the APT framework. They state that legitimate risk factors must possess three important properties:

1) At the beginning of every period, the factor must be completely unpredictable to the market.
2) Each APT factor must have a pervasive influence on stock returns.
3) Relevant factors must influence expected return; i.e. they must have non-zero prices.

The first property is very important to the APT and has been widely discussed in literature.[4] Every researcher who tries to test the APT must select factors that can not be forecasted either from its own past value or from any other publicly available in-

[4] See, e.g., Roll & Ross (1980), Lehmann & Modest (1988)

formation.[5] Thus, at the start of every time period, the expected value of the factor is zero. The second property means that firm-specific events do not constitute as legitimate APT factors. An investor might earn excess returns if he or she is able to identify firms with favourable firm-specific events, but this fact is not relevant for APT-based portfolio management strategies, because firm-specific (non-systematic) risks can be diversified away. The third property is purely an empirical issue, because if the factors are zero, they have no influence on returns.

Since the nature and number of the priced factors are unspecified by the APT, two approaches have been used to empirically implement the theory.[6] The most widely used approach, originally proposed by Gehr (1978) and subsequently extended by Roll and Ross (1980), relies on factor analysis techniques to simultaneously estimate the common factors and factor loadings of security returns. The second approach is in contrast to the factor analysis approach. Chen et al. (1986) attempt to use macroeconomic variables to explain asset returns in the APT context. The macroeconomic variables are treated as factors in the APT return generating process.

2.2.1 Selecting factors through a multivariate statistic models

The most common test of the APT is a two-step test; the first step involves the use of time-series data to estimate a set of factor loadings for each asset; the second step then regresses the (sample) mean returns on the factor loadings in a cross-section regression. The tests are not straightforward, however, for the model gives no guidance as to the number neither of factors nor to the identity of factors. Most empirical work is based on the use of factor analysis or principal components analysis to both identify the factors and provide estimates of the factor loadings. The estimated factor

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[5] Priestley (1996) tested three alternative methods to create unanticipated components i.e. "factors that cannot be forecasted either from its own past value or from any other publicly available information". He concluded that Kalman-filter innovations method performs best compared to rate-of-change and autoregressive components methods.
[6] Connor (1995) tested three methods' explanatory power for U.S. equity returns. These methods were macroeconomic, fundamental and statistical factor analysis. He concluded that although statistical and fundamental methods outperformed macroeconomic model in terms of explanatory power, by other important criteria such as intuitive appeal and theoretical consistency, using a macroeconomic factor model is probably the strongest of the three approaches.

loadings are then used in a cross-section regression to explain mean asset returns. (van Rensburg, 1999) Factor and principal components analysis are based on a notion that observations on real, observable, economic or other variables can be viewed as being a weighted sum of unobservable variables called "principal components" or "factors". (Herbst, 2002) Principal component analysis is somewhat analogous to factor analysis[7] - the goal is to determine a specific set of F_j's and b_{ij}'s such that the covariance of residual returns is as small as possible (Elton et al., 2003).

The first test of the APT is conducted by Gehr (1978) who applies factor analysis to U.S. stock returns. This approach is further developed by Roll and Ross (1980) who report a five-factor structure of which two are priced after cross-sectional testing. There have also been a lot of tests in different economies[8], but the main criticism of Dhrymes et al. (1984) made about factor analysis approach still holds fast: significance tests of individual risk premium in the context of factor analysis with orthogonal rotation are not valid and in addition, the number of significant factors increases as the number of assets is increased in the sample. In their samples the number of significant factors increased from 3 for groups of 15 securities to 7 for groups of 60 securities.

In general, the number of factors that influence equity returns extracted from factor analysis has been a source of much contention.[9] For example, Trzinka (1986) finds five dominant factors within returns for a sample of US firms. Cho (1984) uses inter-battery factor analysis on a range of US industries and documents that the number of factors ranges from between two and five. Cho et al. (1986) perform a similar analysis at the international level for eleven industrial economies and report between one and five factors. Groenewold & Fraser (1997) found three factors for Australian share market. Cheng (1996) examined the UK market and found out, that "the market factor alone appears to incorporate most of the information contained in the underlying multiple factors". The number of factors ranges from zero to almost ten in our papers ex-

[7] These methods are not represented in this thesis, because we will choose the APT's factors a priori. However, Elton et al. (2003, 370–381) give an excellent description of these models.
[8] See, e.g., Roll & Ross (1980), Chen (1983), Chamberlain & Rothschild (1983), Lehmann & Modest (1988), Kryzanowwski et al. (1994).
[9] The advantages and disadvantages of using factor analysis to identify the influences are well documented in the literature; see, e.g., Brown & Weinstein (1983) and Gibbons (1982).

amined and because of this lack of guidance in choosing the factors to the APT from factor or principal component analysis, we will continue to the theory that selects factors *a priori*.

2.2.2 Selecting factors through a macroeconomic variable model

An alternative to the use of artificially structured factors and their corresponding sensitivities is to identify factors *a priori*. In most empirical work, factors are artificially generated using factor analysis or principal components analysis and therefore have no "real-world" interpretation at all. From this perspective, the work initiated by Chen et al. (1986) is worth attention for they seek to identify the factors in the APT with macroeconomic variables they feel ought to influence asset returns.

Their tests imitate the two-step procedure used by Fama & MacBeth (1973) to investigate the CAPM where portfolios' exposures to pricing factors (betas) are estimated from regressions based on time-series data for the r_i and F_J in equation (1). In the second step cross-sectional regressions estimates the market prices for the beta values obtained from the fist set of regressions and as a result, the estimated premiums are generated for each risk factor. (Löflund, 1992)

"The primary advantages of using macroeconomic factors are: (1) the factors and their APT prices in principle can be given economic interpretations, while with a factor analysis approach it is unknown what factors are being priced and (2) rather than only using asset-prices to explain asset-prices, observed macroeconomic factors introduce additional information, linking asset-price behaviour to macroeconomic events." (Azeez & Yonezawa, 2003)

While there is no formal guidance choosing the right macroeconomic variables to the APT model, Chen et al. (1986) suggest a discounted cash flow approach (equation (3)) for their selection. They also argue that because current beliefs about these variables are incorporated in price, it is only innovations or unexpected changes that can affect returns. On this basis they select five variables for their study: (1) the unanticipated change inflation rate; (2) the change in expected inflation; (3) the unanticipated change in term structure; (4) the unanticipated change in risk premium; and (5) the unanticipated change in the growth rate of industrial production. They found out that variables (1), (4) and (5) are significant determinants of U.S. equity returns. Almost all published studies of testing the APT through selected macroeconomic variables have used these macroeconomic variables, or else very close related to these (Chen et al., 1997). Papers that have implemented this macro-economic APT for other countries find that the same types of variables as those used by Chen et al. (1986) are priced as well as other more country-specific variables.[10]

According to Berry et al. (1988) the choice of choosing the "right" macroeconomic variables can be made on empirical grounds: the factors should adequately explain asset returns; they should pass the statistical tests necessary to qualify as legitimate APT factors; the actual asset returns should exhibit plausible sensitivities to the realizations of these factors; and the factors should have non-zero APT prices.

There have been a lot of tests of the APT.[11] It is well known that the macroeconomic variables chosen by Chen et al. (1986) have been the foundation of the APT. It's worth pointing out, why these variables could affect equities' returns:

1) *Inflation.* Inflation impacts both the level of the discount rate and the size of the future cash flows.
2) *The term structure of interest rates.* Differences between the rate on bonds with a long maturity and a short maturity affect the value of payments far in the future relative to near-term payments.
3) *Risk premium.* Differences between the return on safe bonds (AAA) and more risky bonds (BAA) are used to measure the market's reaction to risk.

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[10] E.g., the growth rate of money supply, oil and gold prices, and exchange rates with various countries. See van Rensburg (1999) for South Africa, Groenewold & Fraser (1997) for Australia and Antoniou et al. (1998) for the United Kingdom. Sadorsky (1999) studied the relationship of oil prices changes and stock return for the U.S. and found out that oil price changes and oil price volatility play important roles in affecting equity returns.

[11] Probably the most widely known: see, e.g., Chen et al. (1986), Burmeister & McElroy (1988) for the United States, Beenstock & Chan (1988), Poon & Taylor (1991), and Clare & Thomas (1994) for the United Kingdom.

4) *Industrial production.* Changes in industrial production affect the opportunities facing investors and the real values of cash flows. (Elton et al., 2003)

Exploring each variant in turn that are commonly used in tests of the APT, Monetary Portfolio Theory suggests that changes in money supply alters the equilibrium position of money, thereby altering the composition and price of assets in an investor's portfolio. In addition, changes in money supply may impact on real economic variables, thereby having a lagged influence on stock returns. Both of these mechanisms suggest a positive relationship between changes in money supply and equity returns. Common stock is also traditionally viewed as a hedge against inflation. However, empirical tests have found a negative relationship to exist between inflation and nominal stock returns.[12] It is also widely accepted that current stock levels are positively related to future levels of real activity, as measured by industrial production. Under perfect purchasing power parity conditions, exchange rates will adjust to reflect relative inflation levels, and the law of one price will be upheld. However, in the short-to-medium term, deviations from purchasing power parity will be priced to the extent that they represent exchange rate risk that must be borne by investors. (Bilson et al., 2000)

However, these are only examples how macroeconomic variables can be chosen. As we said, the APT does not give guidance what factors should be used. Thus, a researcher should decide the right factors for his specific purposes (e.g., what are the unique features of the country that's examined).[13]

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[12] See, e.g., Gultekin (1983).

[13] A detailed description of selecting macroeconomic variables for emerging equity market returns can be found in Bilson et al. (2000). They also give a good theoretical foundation why these macroeconomic factors affect equity returns.

2.3 The comparison between the APT and the CAPM

Many textbooks and articles repeat two common complaints about the CAPM:

1) Evidence that it takes more than one factor to explain the shared, or systematic, risk in securities discredits the CAPM.
2) In demonstrating that the risk premium on an asset depends only on its systematic factor loadings, the APT provides investors with a result of great practical value that the CAPM does not provide. (Treynor, 1993)

The APT is commonly put forward as a superior alternative to the criticized but widely-used CAPM. The alleged weakness of the CAPM, its baggage of “unrealistic assumptions” and its empirical shortcoming, are well known. Test of the CAPM typically display poor explanatory power as well as overestimating the risk-free rate and underestimating the market risk premium. The main criticism is particularly the use of betas to predict an asset’s return – returns on high-beta stocks will tend to be overestimated and vice versa for low-beta stocks. (Groenewold & Fraser, 1997)

The advances of the APT over the CAPM are widely discussed in the literature and we will sum up a few of the main notes that have been discussed. First, in favour of the APT is that the APT makes no assumptions about the empirical distribution of asset returns. Second, the strong assumptions made about utility theory in deriving the CAPM are not necessary. The APT also admits several risk sources and therefore can be more operational and has a better forecasting ability than the CAPM. There is no special role for the market portfolio in the APT, whereas the CAPM requires that the market portfolio is efficient. The APT is also easily extended to a multiperiod framework. (Elton et al., 2003; Morel, 2001)

There has to be made several rigorous assumptions when deriving the CAPM. When deriving the APT there has to be made only three assumptions:

1) There are no market frictions, e.g., short selling is unrestricted, investors can borrow and lend at risk-free rate and there are no taxes
2) There are numerous securities so that idiosyncratic risk can be diversified away
3) Investors are risk-averse and seek to maximize their wealth. (Lofthouse, 2001)

Studies comparing the APT and the CAPM have used both factor or principal component analysis and selecting macroeconomic variables *a priori*. Connor & Korajczyk (1986) used principal components analysis and found five factors that could explain the size and January effect better than the CAPM. Berry et al. (1988) conclude that the APT model is better explaining equities returns than the CAPM and that at the 0.01 significance level the CAPM model can be rejected in favour of the APT model. Josev et al. (2001) conclude for Australian industry equity portfolios that “the results show that there is strong evidence in favour of the APT model”. In a recent study for Indian stock markets Dhankar & Esq (2005) conclude that “APT with multiple factors provides a better indication of asset risk and estimates of required rate of return than the CAPM which uses beta as the single market of risk.” Elton et al. (2003) state that the APT remains the newest and most promising explanation of relative returns. The APT promises to supply as with a more complete description of returns than the CAPM.

2.4 General disagreements and contradictions of the APT

However, it can be argued that the APT naturally out-performs the CAPM in a statistical sense for two reasons: the APT permits more than a single factor and the APT constructs the factors to best fit data whereas the CAPM uses a single factor clearly defined by the theory. If a researcher includes another variable to explain returns, R^2 can never be smaller with the added variable. (Groenewold & Fraser, 1997)

The most disappointing feature of the APT is that it does not identify the common factors (nor even their number). It is not also supported by the theoretical foundations of the CAPM that describes the investors' behaviour (Morel, 2001). Gilles & LeRoy (1990) state that the APT contains no useful information about prices, because they think that the APT does not include any clear restrictions and it can be thought as a too general asset pricing model. They also state that many economists have all along been sceptical about the content of the APT, because they believe that the APT should depend on the validity of assumed restrictions on preferences and technology. One of the main weaknesses of the factor analysis of the APT is that the number of relevant factors in empirical APT models increases with the number of securities being factor analyzed (Dhrymes et al., 1984).

Furthermore, the tendency of factors to increase can not be explained by "priced" and "non-priced" risk factors. This problem arises because the theory in itself does not identify relevant factors. The major assumption of the APT model is that asset returns are linearly related to a set of unspecified common factors and that there are no arbitrage opportunities. This generality of the theoretical APT has turned out to be a major weakness for the empirical APT. (Koutmos et al., 1993) There is also a great deal of scepticism about the test methods of the APT. Cheng (1996) states that the method of Chen et al. (1986) is very sensitive to the number of independent variables included in the regression. Cheng (1996) also notes that when a researcher is testing the APT, a factor may be significant in one multivariate analysis and then will not be significant when testing in a univariate model. The multicollinearity among economic variables presents another drawback of this approach.

3 DATA AND METHODOLOGY

After the collapse of communist and social regimes at the beginning of 1990s, a number of Central and Eastern Europe (CEE) countries started their journey into capitalism and privatisation. Generally CEE equity markets and especially Russian equity markets have attracted interest of academics due to a number of reasons. First, these markets provide a great possibility to test existing asset pricing models and pricing anomalies in special conditions of evolving markets. Second, in the light of growing interdependencies between world equity markets due to enhanced capital movements, it is interesting to test the extent of which emerging markets are integrated with global markets. Third, since the early 1990s, Russian policy makers have implemented major economic and financial reforms, resulting in the growing number of new financial instruments. A related question in this respect is whether investors in this market react to news or unexpected changes in economy in a similar fashion as those in advanced market economies. Fourth, because Russia is rich in energy resources, oil price shocks may have destabilizing effects on domestic financial markets. Fifth, the Russian equity market has attracted additional attention due to the crisis of 1998. (Lucey & Voronkova, 2004) Although Russian equity market has gained so much interest from foreign investors, there have not been so many quality analyses of Russian equity markets and only few studies examine financial market issues in Russia (Anatolyev, 2005)

The data for this study is collected from the DataStream system. The description of 20 biggest equities of the year 2005 in Russia can be found in Appendix 1. These are the equities that we will use in our quantitative analysis. All time-series of equities and indices are total-return. [14] The empirical study is based on logarithmic excess returns. However, the macroeconomic factors are in raw form i.e. we have not taken away the risk-free rate; except for oil price and MSCI Russia. In addition, all returns of equities are measured in euros. Euribor interest rate is calculated from the one

[14] Total Return Indices measure the market performance, including price performance and income from dividend payments.

month annual interest rates and transformed to monthly continuously compounded interest rates with formula from Vaihekoski (2002):

$$\ln i_{1month}^{monthly} = \ln\left(1 + i_{1month}^{pa} \times \frac{30}{360}\right), \quad (4)$$

where i is 1 month risk-free rate.

The observation period is from January 1999 to March 2006. All return data are calculated on a monthly interval. It could be better from statistical point of view to use a longer period of data, but the stock markets of Russia were founded in the middle of 20th century, so there is not much research data available to us. In addition, Brealey et al. (2006) state that “five years of data is the recommended length of data to use in most financial analysis”. The crisis in Russian financial markets of 1997–1998 is usually divided into three periods: October 1997 – January 1998, March – May 1998 and July – August 1998 (Lucey & Voronkova, 2004). We are more interested of the *positive* effects of the macroeconomic variables to the Russian equity market. We will try to find, what is behind of the emerging of Russian equity markets. In addition, euro became the European Unions official currency in the beginning of the year 1999.

All the economic variables examined are measured by rate of change rather than absolute values. There are three reasons for taking logarithmic returns. First, this procedure facilitates comparison with equity returns. Second, the process is applied to render the series stationary. Third, since only the innovations or unanticipated changes in the economic indicators are of interest, it is not so much the absolute change in an economic indicator that is important, but how it compares to market expectations. Economically, if macroeconomic variables are random walks, the logarithmic returns are equivalent to unexpected values which are the unanticipated innovations in the economic variables. (Cheng, 1996)

3.1 Russian equity market

Russian equity market has had many ups and downs since its foundation. Since the dissolution of the Soviet Union in December 1991, Russia has had many crises due to various problems in their economy. In January 1992, Russia started the long and difficult path of transition towards a market economy. Nowadays Russia is one the biggest emerging markets. (Hayo & Kutan, 2004)

The market value of all stocks in Russian equity market has changed dramatically, but it is clearly smaller than in other emerging markets where it is usually close to GDP. It is generally considered that the equities are undervalued. This indicates problems in Russia's politics, and risks that are included in companies and macroeconomics. Despite of these risks, Russia has also made a strong progress in development of its economy and that has on the other hand raised equity prises. For example in the year 2004 the equity prises almost doubled. (Korhonen, 2004)

There are a number of stock exchanges in Russia. In terms of value most of equity trading takes place through MICEX (Moscow Interbank Currency Exchange) or trough RTS (Russian Trading System). RTS, where trading is in US dollars, is dominated by international investors while Russian traders are concentrating in MICEX. (Lucey & Voronkova, 2004) Although regional stock exchanges in Russia existed from as early as 1993, the two largest exchanges, RTS and MICEX, were launched in the mid-1995 and mid-1997, respectively. In addition to the RTS and MICEX indexes, there are several other indexes in the Russian equity market composed by various information agencies (e.g., AK&M, RBC, S&P-RUX). The most comprehensive index presumably is the Morgan Stanley Capital International Inc. (MSCI) Emerging markets (EM) index for Russia (expressed in USD). (Anatolyev, 2005)

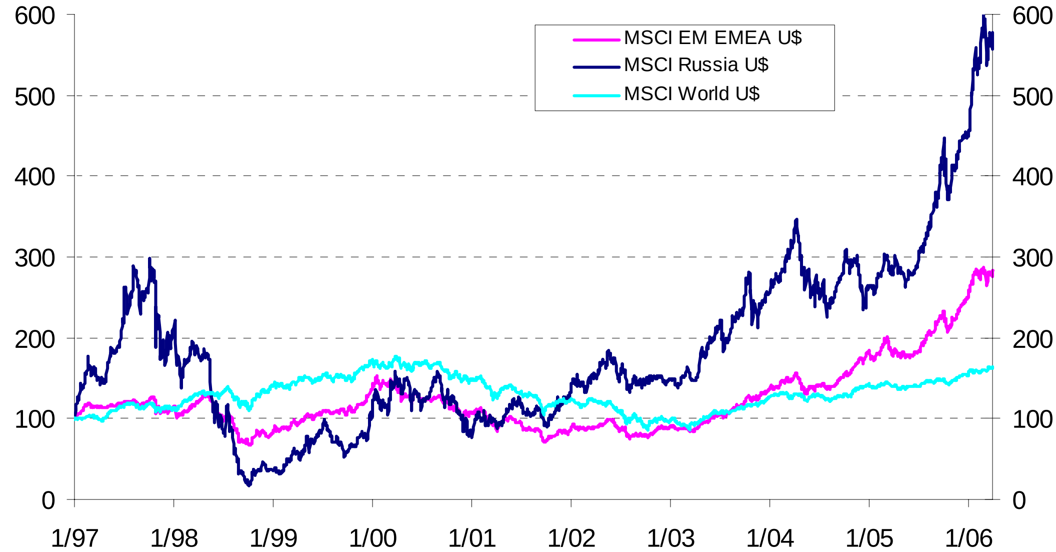

Figure 1. MSCI RUSSIA U$ index against MSCI EM EMEA U$ and MSCI World U$ indices. The indices have been scaled to start from 100.

During 2001-2005 the Russian market has grown, which can be seen in Figure 1. Figure 1 also shows the performance of MSCI Russia compared to other emerging markets and to MSCI World index. During 2001-2003 Russian market performed well contrast to the slowdown in the US and EU economies and financial and political risks of instability in Latin American emerging markets. In 2002 RTS grew by one third. In 2003 the political risks of investing in Russian market became important again against the background of the conflict between Yukos and government. The market decreased by 25 % during October 2003. However, the overall results for the year 2003 were positive due to remarkable increase of the “blue chips”, stimulated by high oil prices.[15] Growth of some companies exceeded 100 %. (Lucey & Voronkova, 2004) A clear problem of Russian equity markets is that nowadays 98% of the organized stock market is dealing with the shares of 10 “blue chips” and only 2 % is left for the other companies (Anatolyev, 2005).

[15] E.g., in 2003, shares of six companies RAO UES (United Energy System), LUKoil, Surgutneftegaz, Yukos and Taftnet) accounted for 72 % of RTS turnover - this means, that in the short term, dynamics of the RTS index is determined by the market leaders (Lucey & Voronkova, 2004)

3.2 Test assets and risk factors

Emerging stock markets have been identified as being at least partially segmented from global capital markets. As a consequence, it has been argued that local macro-economic factors rather than world risk factors are the primary source of equity return variation in these markets. The extant literature suggests that a wide range of factors may be relevant. Such variables include goods prices, money supply, real activity, exchange rates, interest rates, political risk, oil prices, the trade sector, and regional stock market indices. However, in emerging markets, there is argument that not all of these variables are either relevant or appropriate.[16] (Bilson et al., 2000)

Test assets are the 20 biggest companies of Russian equity markets. This information is provided by RA Expert (retrieved 29.03.2006). We have to exclude some of the biggest companies in Russia, because they are listed neither in RTS nor MICEX.

The risk factors are selected *a priori* according to the unique features of Russian economy. The Russian economy has rich energy sources. Exports make up about 33 percent of GPD, and about 50 percent of export revenues come from the energy sector, especially oil. As an important source of global risk, changes in the world oil prices are therefore expected to significantly affect economic growth in Russia and may disturb the financial market activity.[17] (Hayo & Kutan, 2004)

The crisis of 1998 had considerable effect on the international investor confidence in Russia. The inflow of foreign capital went down to $19.5 billion in 1998, $10 billion in 1999 and 11$ billion in 2000. Other consequences of crisis was the depreciation of rouble which made the imports more expensive and thus causing substantial increases in inflation during the post crisis period. (Jithendranathan & Kravchenko, 2002)

In Russian equity markets it is a widely accepted fact that market prices of traded equities do not reflect their underlying fundamental values and price fluctuations may

[16] E.g., Chen et al. (1986) found out that it is not the interest rate itself that is relevant but the yield and default spred are more likely to influence equity returns.

[17] Hayo & Kutan (2004) also note that Russian equity market is sensitive to oil price changes and they suggested that oil price movements may significantly destabilize Russian markets.

reflect more the dynamics of overall economic and political factors[18] than the changes in fundamental values. (Anatolyev, 2005) Given these changes and dynamics of the Russian economy, we would expect that the equity market prices reflect risks generated by such underlying macro factors. The macroeconomic variables we use are unanticipated shocks to money supply, unanticipated inflation, unanticipated change in oil price, unanticipated changes to the exchange rate and unanticipated shocks to industrial production. We also use the market as a one risk factor, because we want to test the performance of the CAPM compared to the APT. The graphs of these macroeconomic variables can be found in Appendix 2. We use the rate of change technique to estimate the unexpected components of macroeconomic factors. Under this, from the economic variables are taken logarithmic returns and this data then enters as unanticipated component to the APT model.[19]

3.3 Test methodology

In this study we use simplified version of the test methodology of Fama-Macbeth (1973). The procedure contains three important stages. In the first stage the sample is chosen. We have done that by choosing 20 of the largest stocks of Russian equity markets. After that we have taken the logarithmic excess returns. In the second stage the assets' exposure to the economic state variables is estimated by regressing their returns on the unanticipated changes in the economic variables over the seven years. In the third stage the resulting estimates of exposure (betas) are used as the independent variables in cross-sectional regression, with asset returns mean return being the dependent variable. Each coefficient from a cross-sectional regression provides an estimate of the sum of the risk premium, if any, associated with the state variable and the unanticipated movement in the state variable.

3.3.1 Multiple regression

[18] Anatolyev (2005) constructed a specified political risk factor, which is a proxy of political and economic risk. This factor explains well the investors' interest to invest in Russian equity markets.
[19] We hypothesize that the change in these macroeconomic variables is an unanticipated component. This is the assumption of the rate of change method.

A regression model that includes several independent variables is known as a multiple regression. The true relationship between the independent variable Y and the various independent variables, the X_i s, is given by:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon \,, \qquad (5)$$

In our study we switch the X_i s with macroeconomic variables. The regression equation is:

$$R_{it} = \beta_{1i} MS_t + \beta_{2i} INF_t + \beta_{3i} OIL_t + \beta_{4i} FX_t + \beta_{5i} IP_t + \beta_{6i} R_{mt} + \varepsilon_t \,, \qquad (6)$$

where: R_{it} is the logarithmic excess return on asset i for month t; MS_t is the logarithmic return of money supply (M2); INF_t is the logarithmic return of inflation; OIL_t is the logarithmic excess return of oil price; FX_t is the logarithmic return of RUB/EURO exchange rate; IP_t is the logarithmic return of industrial production and R_{mt} is the logarithmic excess return of MSCI EM Russia index. This first-pass time series regression will yield estimates for the β_{i1}, β_{i2}, etc. to β_{i6}. This will be repeated for $i = 1$, 2, 3… 20 securities so that we have 20 values for each of the betas.

In the second step, we use cross-sectional regression. This regression equation is:

$$\overline{R}_i = \lambda_0 + \lambda_1 \beta_{1i} + \lambda_2 \beta_{2i} + \lambda_3 \beta_{3i} + \lambda_4 \beta_{4i} + \lambda_5 \beta_{5i} + \lambda_6 \beta_{6i} + \varepsilon_i \,, \qquad (7)$$

where $\overline{R}_i$ is the mean logarithmic excess return for asset i, β_{1i} to β_{6i} represent the sensitivity of a security's return to factor j and is a measure of the risks inherent in the security under study. λ's represent the reward for bearing these risks (price risk). Hence, in equation (6) the β_{ij} are the variables which are different across the 20 securities. The λ_{ij} are the same for all securities and hence these can be estimated from the cross-section regression equation (7).

3.3.2 Problems with regression

The assumptions underlying the linear regression model are assumptions about the disturbance term (residual). The assumptions are:

1) The residual terms have a zero mean
2) The variance of the errors is constant and finite over all values
3) The errors are statistically independent of one another
4) There is no relationship between the error and corresponding x value
5) The error terms are normally distributed

If these assumption hold then the estimates for coefficients α and β, have a few properties that are desirable: First, the estimators $\hat{\alpha}$ and $\hat{\beta}$ are the true values of α and β. Second, $\hat{\alpha}$ and $\hat{\beta}$ are linear estimators. Third, the actual values $\hat{\alpha}$ and $\hat{\beta}$ will be on average their true values. (Brooks, 2002)

However, if these assumptions are violated, we are facing problems with the methodology. The first assumption is that the error terms have on average zero mean. This assumption will never be violated if there is a constant term included in the function. (Brooks, 2002)

The second assumption is that the variance of the error terms is constant. If the residuals have a constant variance they are said to be homoscedastic, but if they are not constant they are said to be heteroscedastic. The effects of heteroscedasticity are that the regression coefficients are no longer the best or minimum variance estimates, thus they are no longer the most efficient coefficients. The consequence is that if the variances are biased then the standard errors of those coefficients will also be biased. If this bias is negative, the estimated standard errors will be smaller than they should be and the test statistic will be larger than it is in reality. (Watsham & Parramore, 1997) White (1980) has derived a heteroskedasticity consistent covariance matrix estimator which provides correct estimates of the coefficient covariances in the presence of heteroskedasticity of unknown form. The White covariance matrix is given by:

$$\hat{\Sigma}_W = \frac{T}{T-k}\left(X'X\right)^{-1}\left(\sum_{t=1}^{T} u_t^2 x_t x_t'\right)\left(X'X\right)^{-1}, \tag{8}$$

where T is the number of observations, k is the number of regressors, and u_t is the least squares residual. (Eviews 5 user's guide, 2004) We will use this estimator in Eviews 5.0 when we are running our multiple regressions.

The third assumption is that the errors are statistically independent of one another i.e. they are not correlated with each other over time. Autocorrelation occurs when the residuals are not independent of each other because current values of variables are influenced by past values. The OLS regression model is a minimum variance, unbiased estimator only when the residuals are independent of each other. If auto-correlation exists in the residuals, the regression coefficients are unbiased but the standard errors will be underestimated and the tests of regression coefficients will be unreliable. To test for the first-order autocorrelation, the Durbin-Watson statistic must be calculated. The formula for Durbin-Watson statistic is:

$$DW = \frac{\sum\left(e_t - e_{t-1}\right)^2}{\sum e_t^2}, \tag{9}$$

As a rule of thumb, if Durbin-Watson is two there is no positive autocorrelation, if it is zero there is perfect positive autocorrelation, and if it is four there is perfect negative autocorrelation. However, the Durbin-Watson statistic has a sampling distribution that has two critical values d_L and d_U. (Watsham & Parramore, 1997). Durbin-Watson has its null and alternative hypothesis: $H_0 =$ no autocorrelation if $d_U \le d \le 4 - d_U$ and $H_1 =$ positive autocorrelation if $d < d_L$, negative autocorrelation if $d > 4 - d_L$. As a rule of thumb, with 50 or more observations and only a few independent variables, a

D-W statistic below about 1.5 is a strong indication of positive first order serial correlation. (Brooks, 2002)

When some or all of the independent variables in a multiple regression are highly correlated, the regression model has difficulty untangling their separate explanatory effects on dependent value. In effect, the model has problems in isolating their separate influences. (Watsham & Parramore, 1997) Thus, we will also test the independent variables for multicollinearity, because the macroeconomic factors could have high correlations with each other. This analysis is done by examining the correlation matrix.

The fifth assumption is that the disturbance terms are normally distributed. This can be tested with the Bera-Jargue test of normality. There is no direct answer what should be done if the disturbances are not normally distributed. (Greene, 2003)

Purpose of the Bera-Jarque is to test whether the data is normally distributed or not. Formula for Bera-Jarque is:

$$Bera - Jarque = \frac{N}{6}\left[Skewness\right]^2 + \frac{N}{24}\left[Kurtosis\right]^2, \quad (10)$$

where *N* is the number of observations. The result is compared to Chi-Square. H_0 is normal distribution.

4 EMPIRICAL RESULTS

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for monthly data consisting the period of years 1999–2006. Every equity has a positive mean excess return – some of them have a close to ten percent per month. Per annum this is over 100 percent. However, the riskiness of Russian equity markets is shown in large standard deviations and these are very large compared to mean returns. E.g., Magnitogorskii Metallurgical Combine has standard deviation of 253.4 % p.a, because its equity price has ranged between 0.7–287.2 US$ in our sample period. Almost every equity has a positive skewness and some of them are very skewed. This implies that equities have had many large positive returns, because the mean is larger than median or mode, and distribution's tail is long to right. Many of the excess equity returns exhibit a very high degree of kurtosis.[20]

Bera-Jarque test shows that only 4 of our 20 stocks are normally distributed, since the Chi-Square at 0.05 significance level with 2 degrees of freedom is 5.991. We test the normality also with Kolmogorov-Smirnov test and the amount of normally distributed equities grows from 4 to 14.

[20] This analysis is done by SPSS program that automatically deducts 3 from original values. In Tables 1 and 2 value 0 represents normal kurtosis.

Table 1. Descriptive statistics 1999-2006. All returns are excess returns. In the table are shown mean, standard deviation, skewness, excess kurtosis and series' normality for 20 largest companies of Russian equity markets. Mean and standard deviation are on a monthly interval. ** indicates statistical significance at 0.01 and * at 0.05 level.

Company	N	Mean	Std. Dev.	Skewness	Kurtosis	Bera-Jarque	Kolmogorov-Smirnov
Gazprom	70	4.35%	13.46%	2.44	11.71	469.13**	0.11
Lukoil	85	3.49%	14.10%	0.36	1.34	8.23*	0.81
RAO UES	85	3.56%	18.13%	0.16	0.84	2.88	0.43
Yukos	85	4,84%	31.61%	-0.70	8.12	240.62**	0.08
Surgutneftegaz	85	3.32%	15.02%	0.45	1.42	10.00*	0.71
Sibneft	85	5.44%	21.67%	2.09	11.16	503.16**	0.01**
Sperbank	85	6.12%	18.77%	0.53	1.64	13.62**	0.12
Norilsk Nickel	57	2.68%	11.35%	0.04	-0.42	0.44	0.75
Severstal	85	6.29%	18.69%	2.07	7.51	260.93**	0.06
Slavneft	85	6.50%	24.32%	0.52	3.42	45.43**	0.11
Sistema	85	3.21%	23.46%	4.13	22.74	2073.80**	0.00**
Avtovaz	85	5.56%	19.34%	1.23	3.49	64.72**	0.03*
Tatneft	85	4.84%	16.26%	0.43	0.18	2.73	0.77
Transneft	43	3.99%	10.81%	0.51	0.36	2.09	0.84
Magnitogorskii Metallurgical Combine	85	2.50%	73.57%	-6.68	55.59	11577.07**	0.00**
Novolipetsk Metallurgical Combine	49	10.31%	24.88%	2.24	6.29	121.88**	0.08
Rosneft	85	2.35%	29.89%	4.15	37.40	5199.06**	0.00**
Mechel	21	15.66%	49.18%	2.61	8.42	85.94**	0.16
Aeroflot	85	3.79%	15.49%	0.72	1.63	16.86**	0.53
Vimpelkom	67	2.24%	12.95%	2.28	10.74	380.56**	0.01**

Also in Table 2 each macroeconomic variable has a positive mean return. This can also be seen in Appendix 2, where are the graphs for these factors. Standard deviations are close to mean returns, but oil price and MSCI Russia have been more volatile than other factors.

Table 2. Descriptive statistics for macroeconomic factors 1999-2006. Only "Oil price" and "MSCI Russia" are excess returns. In the table are shown mean, standard deviation, skewness, excess kurtosis and series' normality for the macroeconomic variables and for MSCI Russia index. Mean and standard deviation are on a monthly interval.

Factor	N	Mean	Std. Dev.	Skewness	Kurtosis	Bera-Jarque	Kolmogorov-Smirnov
Money Supply	85	3.01%	3.23%	0.04	1.65	9.69*	0.22
Inflation	84	1.28%	0.79%	0.82	1.06	13.35**	0.19
Oil price	85	1.69%	11.63%	-0.29	0.89	4.00	0.62
RUB/€	85	0.29%	2.63%	0.52	0.66	5.41	0.76
Industrial production	84	0.47%	3.27%	-0.57	1.10	8.73*	0.95
MSCI Russia	85	3.10%	13.57%	0.29	1.46	8.75*	0.91

The factors are also quite normally distributed, which can be seen from skewness and kurtosis values. However, again Bera-Jarque value indicates that oil price and the exchange rate for RUB/€ is not normally distributed. Thus, we test normality with Kolmogorov-Smirnov test that indicates every factor is normally distributed.

4.2 Factor analysis

We run the factor analysis to find out, how well we have interpreted the theory of the APT in selection of our variables and especially the number of factors. The results from factor analysis can be seen in Table 3. We know that there is a lot of noise in our sample, but this factor analysis gives guidance to how many factors should be used. Surprisingly, the number of factors that SPSS calculates is six, which accounts for over 80 % of variance – the same amount of factors that in our tests of the APT.

Table 3. The results from factor analysis. This Table 3 explains the number of factors needed to satisfactorily explain the variance in our sample. In this factor analysis we have used our 20 equity sample and the method of factor analysis is Principal component analysis.

Total Variance Explained			
Component	Total	% of variance	Cumulative %
1	7.349	37.197	37.197
2	2.346	11.732	48.929
3	1.973	9.863	58.791
4	1.717	8.583	67.374
5	1.467	7.335	74.709
6	1.269	6.343	81.052
7	0.997		
8	0.669		

Although our factor analysis is significant (sig. <0.001), the Kaiser-Meyer-Olikin measure of sampling,[21] which detects the partial correlation of the examined variables, is 0.125. This value is unacceptable and therefore we can not make any robust conclusions of this factor analysis.

4.3 Regression results

Table 4 contains the results from fitting the model as described in equation (6) to each of the 20 equities. A least squares procedure is used, with the coefficients being adjusted for heteroskedasticity, as proposed by White (1980). The main conclusion is that these macroeconomic variables in the first-pass regression do relatively poorly in explaining the equities logarithmic excess returns. However, when we have examined other studies, this kind of result is very common.

[21] The Kaiser-Meyer-Olikin measure of sampling is smaller the greater are the partial correlations. Usually, the measure over 0.6 is thought to be sufficient. (Greene, 2003)

Table 4. Results from the first regressions. In this table is also a comparison between the APT and the CAPM. ** indicates statistical significance at 0.01 and * at 0.05 level.

		APT									CAPM				
Company	**N**	β_{1MS}	β_{2CPI}	β_{3Oil}	β_{4FX}	β_{5IP}	$\beta_{6Market}$	**Adjusted R^2**	**D-W**	**F-test**	α	β_{rm}	**Adjusted R^2**	**D-W**	**F-test**
Gazprom	70	0.220	1.750	-0.009	-0.193	-0.005	0.338	-0.033	2.131	1.125	0.039*	0.328	0.061	2.216	5.451*
		(0.340)	(1.260)	(-0.768)	(-0.401)	(-0.013)	(1.890)			0.359	(2.329)	(1.969)			0.023
Lukoil	85	0.216	-0.271	0.032	0.026	0.030	0.969**	0.868	2.021	90.666**	0.005	0.970**	0.871	2.124	569.149**
		(1.284)	(-0.050)	(0.610)	(0.133)	(0.209)	(20.238)			<0.001	(0.873)	(22.202)			<0.001
RAO UES	85	0.111	0.111	-0.123	-0.543	-0.217	1.100**	0.727	1.794	35.26**	0.001	1.131**	0.712	1.718	208.744**
		(0.459)	(0.149)	(-1.391)	(-0.911)	(-0.686)	(15.787)			<0.001	(0.053)	(15.849)			<0.001
Yukos	85	-0.877	3.302	0.057	0.072	-0.120	1.031**	0.166	1.547	3.583**	0.016	1.049**	0.193	1.576	21.131
		(-1.024)	(1.509)	(0.223)	(0.077)	(-0.134)	(4.279)			0.003	(0.461)	(4.421)			<0.001**
Surgutneftegaz	85	0.028	-0.320	0.045	0.531	0.233	1.032**	0.836	2.168	70.544**	0.002	1.011**	0.833	2.139	420.099
		(0.145)	(-0.521)	(0.802)	(1.831)	(1.251)	(18.291)			0.001	(0.263)	(18.231)			<0.001**
Sibneft	85	-0.140	1.784	0.522	1.224	-1.253*	0.954**	0.398	2.257	9.807**	0.027	0.901**	0.310	2.270	38.976
		(-0.217)	(0.786)	(1.940)	(1.474)	(-2.385)	(4.732)			<0.001	(1.564)	(4.193)			<0.001**
Sperbank	85	-0.167	2.971	0.053	-0.920	-0.524	0.938**	0.515	2.227	15.281**	0.030*	0.991**	0.508	2.130	87.582
		(-0.364)	(1.701)	(0.403)	(-1.786)	(-1.360)	(7.288)			<0.001	(2.370)	(7.165)			<0.001**
Norilsk Nickel	57	-0.630	3.119	-0.078	0.081	0.110	0.636**	0.215	1.860	3.208*	0.015	0.625**	0.239	1.938	18.546
		(-1.136)	(1.500)	(-0.499)	(0.121)	(0.299)	(3.873)			0.01	(1.067)	(4.171)			<0.001**
Severstal	85	0.371	1.649	0.069	-0.493	0.122	0.630**	0.188	1.680	4.284**	0.042*	0.672**	0.229	1.735	25.916
		(0.467)	(0.697)	(0.452)	(-0.812)	(0.310)	(4.408)			<0.001	(2.462)	(4.747)			<0.001**
Slavneft	85	1.506	-0.992	-0.071	-0.341	0.223	0.440	0.019	2.129	1.513	0.051*	0.452	0.052	2.037	5.625
		(1.235)	(-0.223)	(-0.258)	(-0.318)	(0.362)	(1.648)			0.185	(2.318)	(1.490)			0.020**
Sistema	85	0.859	0.648	0.110	0.015	-0.328	0.178	-0.021	2.102	0.614	0.026	0.213	0.003	2.097	1.276
		(1.103)	(0.310)	(0.652)	(0.017)	(-0.727)	(1.080)			0.718	(0.984)	(1.195)			0.262**
Avtovaz	85	-1.377	6.187	-0.085	-0.998	0.525	0.153	0.037	1.866	1.941	0.048*	0.227	0.014	1.885	2.153
		(-1.271)	(1.777)	(-0.550)	(-1.633)	(1.120)	(0.980)			0.085	(2.129)	(1.501)			0.146
Tatneft	85	0.539	-0.284	0.328**	0.580	0.255	0.891**	0.627	2.307	21.254**	0.021	0.898**	0.557	2.263	106.784**
		(1.473)	(-0.763)	(3.701)	(1.397)	(0.940)	(11.547)			<0.001	(1.760)	(9.731)			<0.001
Transneft	43	0.262	0.051	0.002	0.310	-0.397	0.914**	0.329	1.973	6.940**	0.018	0.837**	0.389	1.995	27.710**
		(0.564)	(0.030)	(0.012)	(0.689)	(-0.812)	(5.107)			<0.001	(1.464)	(5.485)			<0.001
Magnitogorskii Metal-lurgical Combine	85	0.195	6.701	-0.097	-8.537	-3.907	-0.454	0.055	2.044	1.607	0.026	-0.039	-.0.012	2.179	0.004
		(0.115)	(1.129)	(-0.145)	(-1.171)	(-1.443)	(-0.826)			0.156	(0.351)	(-0.144)			0.947
Novolipetsk Metallur-gical Combine	49	1.562	4.683	-0.195	-1.407	0.055	0.514	-0.011	1.700	0.941	0.092*	0.544	0.016	1.825	1.779
		(1.358)	(1.041)	(-0.449)	(-0.732)	(0.050)	(1.853)			0.777	(2.623)	(1.625)			0.189
Rosneft	85	-0.490	1.973	-0.406	1.523	1.770	-0.016	0.008	2.137	0.991	0.026	-0.077	-0.011	2.065	0.101
		(-0.850)	(0.773)	(-1.277)	(0.991)	(1.497)	(-0.112)			0.438	(0.741)	(-0.523)			0.752
Mechel	21	-0.851	17.155	0.084	10.976	1.909	0.768	0.061	1.317	0.140	0.149	0.213	-0.051	1.292	0.022
		(-0.336)	(0.984)	(0.060)	(1.596)	(0.810)	(0.891)			0.988	(1.112)	(0.239)			0.884
Aeroflot	85	0.345	0.829	-0.062	-0.290	-0.499	0.491**	0.155	1.697	3.411**	0.022	0.5039**	0.185	1.689	20.073**
		(0.516)	(0.376)	(-0.435)	(-0.457)	(-1.410)	(2.758)			0.005	(1.423)	(3.203)			<0.001
Vimpelkom	67	0.091	0.785	0.131	-0.362	-0.624	0.427**	0.105	2.152	2.642	0.015	0.448	0.130	2.166	10.856**
		(0.272)	(0.609)	(0.819)	(-0.559)	(-1.476)	(2.800)			0.24	(1.107)	(3.158)			<0.001

As it is clearly evident from the Table 4 above, there is no support for the APT. The oil price is significant for only one equity – the other factors are not significant at all. Only the market beta is significant in twelve cases. In nine of the twenty cases we can not reject the null hypothesis that the betas are different from zero. When examining the adjusted R^2, the CAPM with single factor, the market return, has a better explanation power in eleven equities. Thus, the including of five macroeconomic variables does not give us better explanation of equities' returns. In fifteen cases the market return factor is different from zero, when using the CAPM. However, the R^2's differ greatly between the equities. In some equities the R^2 is negative, but with some equities we get close to 90 %. The majority of R^2's are between 20–90%, so this result is quite promising.

To test the first-order autocorrelation, we use the Durbin-Watson statistics. We detect autocorrelation only for Yukos. Thus, the autocorrelation is not a problem in our study. We also perform a multicollinearity check, where we examine the correlation matrix between macroeconomic variables. The correlations are relatively weak and not significant. Thus, the multicollinearity between variables does not seem to be a problem either. This correlation matrix can be found in Appendix 3.

From the analysis above, the using of the APT in pricing the assets in Russian equity markets seems to be a difficult task. Given that our macroeconomic factors do poorly in explaining the excess returns of our equities, it appears that there is something wrong with our model. This might be due to several reasons. First, our proxies may be poor. Second, we have not taken account the information lags in our sample. This might be the most significant factor, because maybe the information is not priced so quickly, in a month, as we presume. The International Monetary Fund (IMF) Data Dissemination Standards gives us guidance to this issue. Their guidance recommends that, e.g., money supply and inflation should be lagged one month and industrial production two months. Third, the model may be miss-specified and we have almost certainly left some macroeconomic variables un-examined. We could use some other factors also and then eliminate these factors one-by-one in reverse order of their t-ratios. Also our procedure almost certainly suffers from "errors-in-variables"[22] problem. However, these issues are left for further research

When we perform the cross-section regression, we obtain the following equation:

$$\overline{R}_i = \underset{(2.309)}{0.011} + \underset{(8.075)}{0.024}\beta_{MS} + \underset{(15.179)}{0.009}\beta_{CPI} + \underset{(2.678)}{0.041}\beta_{Oil} - \underset{(-2.562)}{0.004}\beta_{FX} + \underset{(4.117)}{0.016}\beta_{IP} + \underset{(4.967)}{0.026}\beta_{Market}$$

with adjusted R^2 0.916 and Durbin-Watson 2.603. The results show that the APT specification with six priced factors provides a remarkably good description of the behaviour of the cross-section of average security returns with expected returns predicted by the APT explaining over 90 % of the cross-sectional variation in average excess returns. This finding is interesting for it suggests that the APT specification of our model is quite capable of explaining cross-sectional variation in observed security returns in Russian equity market.

As defined by our theory, the prices of bearing risks for money supply, inflation, oil price, industrial production and the market beta are positive and for the exchange rate negative – although the values are very low. According to null hypothesis, the constant should be zero. However, in our regression the constant is statistically significant and positive. This might be due to pricing error of the equity or the lack of risk factors that should be in our model. In addition, because of the problems in the first-pass regression and the relatively short period of data for some equities, we have to be careful in making any conclusions.

However, these results give us some guidance, how we should determine the expected returns for our equities. For example, with Taftnet we found out that its b value for oil price fluctuations is statistically significant and its value is 0.328. If an investor thinks that the oil price will increase, the investor could buy Taftnet's equities more to his or her portfolio. This increase in oil price would lead to a $0.328 \times 0.041 = 0.013$% contribution in *expected excess return* of Taftnet, which might be just sufficient to reward the investor for the additional risk.

[22] See, e.g., Blume & Friend (1973).

5 CONCLUSIONS

In this study we examined the APT and its efficiency in Russian equity markets. This study has explored a set of macroeconomic variables as systematic influences on equity market returns in Russia and has examined their influence on asset pricing. The theory of the APT was presented in great detail and also the biggest debate amongst researchers, the determination of factors, was presented. The most used tests are statistical models: principal component analysis and factor analysis. There also exists a theory that selects these factors, from the basis of modern finance, *a priori*. However, we did not find any rigorous proof for only using statistical models and in fact, some of the authors concluded that there is no formal guidance, which model should be used. In our empirical research we used five macroeconomic factors that were selected *a priori*.

In addition, from the several studies examined, we conclude that the APT is a superior asset pricing model compared to the CAPM. However, one of the main weaknesses of the APT is that it does not give any guidance, which factors should be used and what is the correct amount of them. In addition, the statistical methods have been criticized because the amount of factors increases when more equities are added to the sample.

The empirical aim of this study was to find out, how well the APT explains the Russian 20 biggest equities, and in addition, what kind of factors are priced in those equities. We found out, that the macroeconomic variables we used – unanticipated shocks to money supply, unanticipated inflation, unanticipated change in oil price, unanticipated changes to the exchange rate and unanticipated shocks to industrial production – did poorly explaining the excess returns of our sample of equities and were not priced in equity prices. The only factor that was found significant – and for only one equity – was the unanticipated change in oil price. The market beta was clearly the most significant factor and this result is in favour of the CAPM. Our other tests, F-test and the explanatory power measure adjusted R square, also supports this result. However, when we run our cross-sectional regression, the results were promising – the adjusted R square was over ninety percent and each of the prices or risk were very significant.

However, we can not conclude that the APT does not work as an asset pricing model in Russia. These shortcomings are represented in the thesis, but the most distracting issue was that the macroeconomic variables were not lagged, so we might not even be able to capture the effect of these variables. In addition, we examined 20 largest companies and not the whole market, so the results might not be robust in that sense for the whole Russian equity market. The bottom-line conclusion of this study is that while security returns in Russia might be influenced by a number of systematic economic forces, the market return remains the most dominant factor and plays a major role in the APT for the Russian equity market. The market factor alone appears to incorporate most of the information.

There are several suggestions for further research. First, statistical methods should be used and after that these results could be compared to the macroeconomic variable model and to the CAPM. Second, the macroeconomic variables should be lagged. This study could be performed by examining the lead lag effects of different variables. Third, the risk exposures should be allowed to vary over time, as done in Fama & Macbeth (1973). Fourth, some other factors could also be used. For example these could be: measures of market-based financial measures such as P/E and P/B; measures of political and legal environment; measures of corporate governance and other information risks. Fifth, the unanticipated components included in the APT model could be generated with more sophisticated methods, e.g., GARCH or Kalman-filter.

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APPENDICES

Appendix 1. The sample of 20 biggest equities in the Russian equity market in 2005. This information is provided by RA Expert. (In Russian) (retrieved 29.03.2006)

Rank 2005	Rank 2004	Company	Revenues mUSD	Profits mUSD	Capitali-zation mUSD	Industry
1	1	Gazprom	33892.3	7136.8	90200.8	Oil and gas
2	3	Lukoil	28810.0	4248.0	41557.8	Oil and gas
3	4	RAO UES	23582.8	1108.5	14003.4	Energy
5	5	Yukos	22100.0	n.a.	1334.6	Oil and gas
7	7	Surgutneftegaz	10690.9	2415.0	34429.1	Oil and gas
8	9	Sibneft	8022.9	2045.6	16621.1	Oil and gas
9	8	Sperbank	7537.3	669.2	17090.5	Banks
10	10	Norilsk Nickel	6742.0	1832.0	15294.6	Metals
12	19	Severstal	6268.8	1401.2	4529.4	Metals
13	-	Slavneft	6124.0	1219.0	3244.7	Oil and gas
15	15	Sistema	5711.3	411.2	9684.0	Financial-industrial
16	13	Avtovaz	5570.3	158.7	662.4	Motor vehicles
18	14	Tatneft	5232.2	854.5	5405.3	Oil and gas
19	16	Transneft	5220.2	1428.0	n.a.	Transportation
20	18	Magnitokorsk Metallurgical Combine	4829.0	1217.0	n.a.	Metals
21	20	Novolipetsk Metallurgical Combine	4538.7	1772.5	6973.1	Metals
22	17	Rosneft	4515.1	837.3	2969.3	Oil and gas
24	-	Mechel	3636.0	1342.7	4058.6	Metals
29	24	Aeroflot	2158.8	172.1	1617.7	Transportation
30	28	Vimpelkom	2146.6	350.4	n.a.	Telecommunications

[a] These equities are listed in this order according to revenues. However, there are also larger corporations in Russia, but they are not listed companies.

Appendix 2. The performance of macroeconomic variables used in our study. (Source: Datastream)

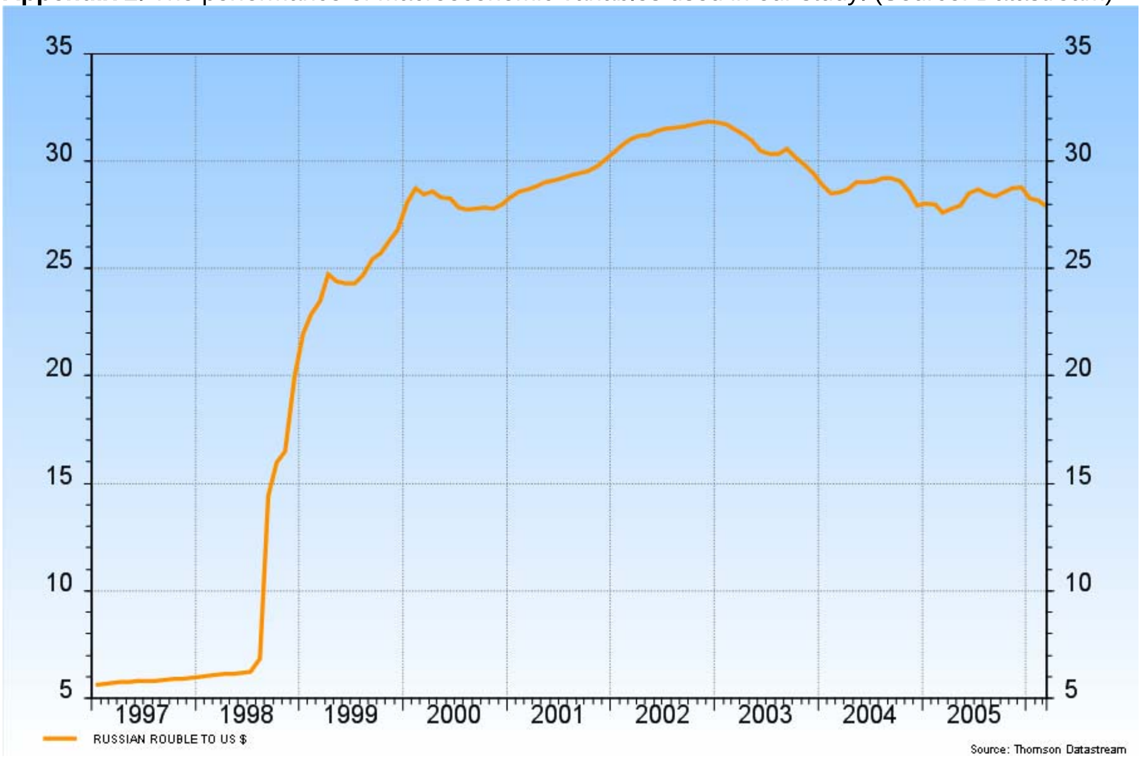

Figure 2. Russian rouble to US$.

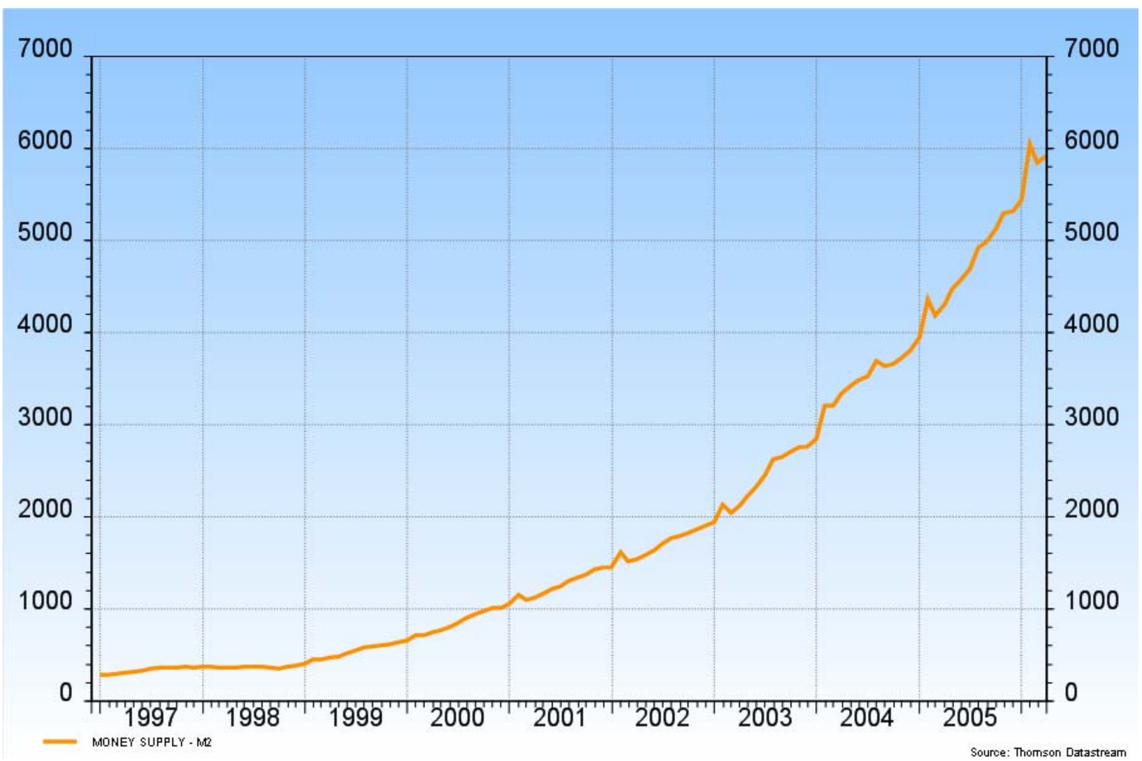

Figure 3. Money supply – M2 in Russian economy .

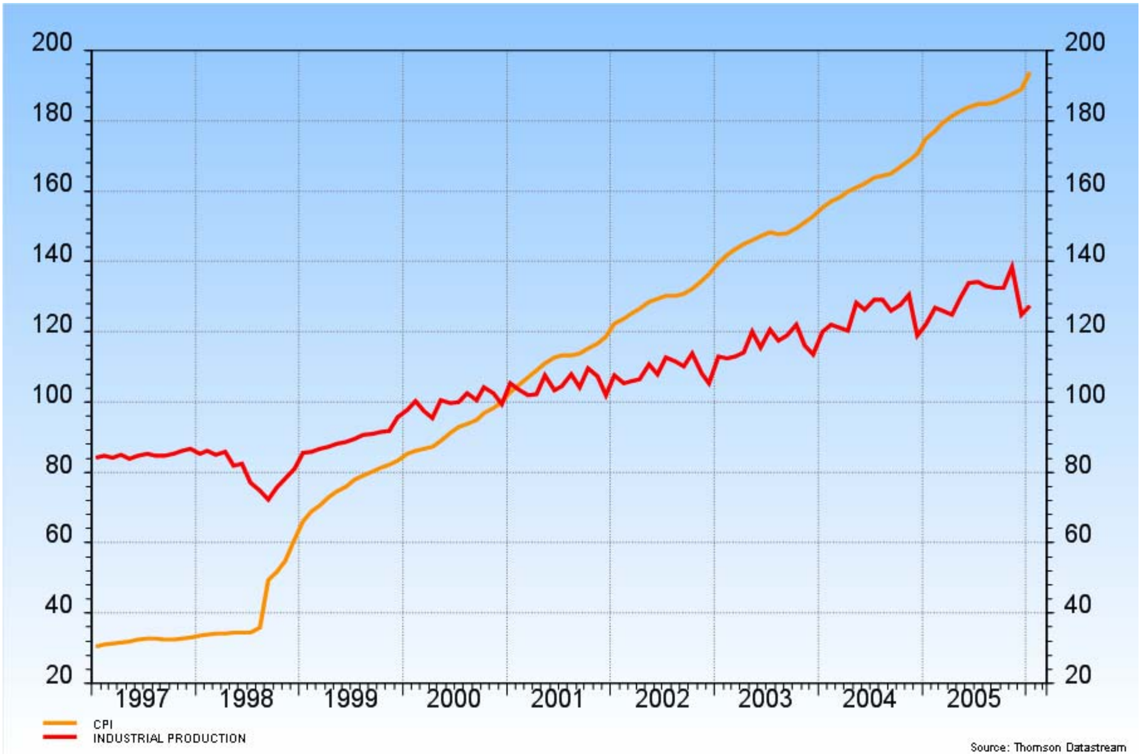

Figure 4. Consumer Price Index (inflation) and Industrial production in Russian economy.

Figure 5. The Crude Oil-Brent US$ world price for a barrel of oil.

Appendix 3

This table represents the Pearson correlation coefficients between the macroeconomic variables. The test is 1-tailed and * represents statistical significance at the 0.05 level.

	Money supply	Inflation	Oil price	RUB/€	Industrial production	MSCI Russia
Money supply	1.000					
Inflation	0.298*	1.000				
Oil price	0.087	0.126	1.000			
RUB/€	-0.045	-0.070	-0.088	1.000		
Industrial production	0.337*	0.187*	0.186	-0.062	1.000	
MSCI Russia	0.088	0.150	0.082	-0.294*	0.120	1.000