Empirical analyses of financial markets

INFORMATION EFFICIENCY IN CENTRAL EUROPEAN EQUITY MARKETS[1]

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Abstract

The paper focuses on testing a weak form of market efficiency as regards capital markets in the Czech Republic, the Slovak Republic, Hungary, Poland and the United States. We have used a variance ratio test as a research method. Informational efficiency was tested using weekly and monthly values of relevant market indices in a period from 1993 until August 2004. We concluded that the US market reports the weak form of efficiency. Furthermore, the main results of our research concerning Central European markets show: (i) the weak form of the efficient market hypothesis could not be rejected for Central European capital markets, (ii) an improvement of market efficiency was observed over time on all the observed markets one can observe an improvement of market efficiency in these markets over time and (iii) the Central European capital markets converged to the U.S. capital market (in terms of the weak form of market efficiency.

Keywords: *market efficiency; hypothesis testing; market index; variance ratio test;PX-50;*

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1. Introduction

The aim of the paper is to follow previous research (Hanousek [6], Vošvrda [13]) and to test a weak form of market efficiency of capital markets in the Czech Republic, the Slovak Republic, Hungary, Poland and in the United States. When using standard statistical methods, we want to answer following questions:

1. Can we observe any information efficiency in Central European capital markets?
2. Can we observe an improvement of information efficiency in these markets during time?
3. What gap is among Central European capital markets and the US (mature) capital market?

Based on our results we also want to address an issue if one can see any consolidation within Central European equity markets or any convergence to the U.S. market.

2. Informational efficiency of the capital market

Let us start with few definitions. An efficient capital market theory focuses on ability of a market to absorb new information and to react on it. A capital market is said to be efficient it fully and correctly reflects all relevant information in determining security prices. In other words, nobody can benefit from the information relevant to the stock prices that are not known to the other market participants.

Formally, the market is said to be efficient with respect to some information set if revealing that information does not affect security prices (Campbell [3]). Moreover, one cannot make economic profits by trading on the basis of that information set. Economists often define three levels of market efficiency, which are distinguished by the degree of information reflected in security prices.

A market would be described as being **weak-form efficient** if the security price reflects all information contained in the record of its past prices. In other words, this form of efficiency implies that relative changes of prices follow the random walk hypothesis and therefore price changes are unforecastable. Strategies used by technical analysts are failing in such a market.

Semi-strong efficiency of a market means that the information set includes both the history of prices and all publicly available information. Since publicly known information is incorporated in security prices, buying or selling recommendations from fundamental analysts are useless.

Finally, if market prices reflect all available information (both public and private), a market is said to be **strong-efficient**. In such a market, there is no such special information based on which an investor can make abnormal profits. In other words, insider information is valueless and therefore insiders do not post better trading results than other market participants (Filer [4]).

Formally, we can describe afore-mentioned definitions as follows:

$$E_t(P_{t+1} \mid \Phi_t) = P_t \tag{1}$$

Where:

E_t = expected value operator

P_{t+1} = price of security at time t+1

P_t = price of security at time t

Φ_t = the set of information available to investors at time t

It follows from equation 1 that the best estimate for the future price of security is the current price of security.

3. Models of testing efficiency

Basic models, which are used by most methods mainly for testing the weak-form of efficiency, are based on various types of the random walk hypothesis including its generalization.

3.1 The Random Walk – type 1 (RW1)

The simplest version of the random walk hypothesis assumes independent and identically distributed (IID) increments and is given by the following equation:

$$p_t = \mu + p_{t-1} + \varepsilon_t, \varepsilon_t \approx IID \tag{2}$$

Where:

P_t = price of security at time t, P_{t-1} = price of security at time t-1

$p_t = \ln P_t$, $p_{t-1} = \ln P_{t-1}$

μ = the expected price change (drift)

ε_t = independently and identically distributed value.

If we consider normality of ε_t (i.e. with the mean value 0 and variance σ^2), we are talking about a Brownian motion. Such a distributional assumption implies that continuously compounded returns are IID varieties with mean μ and variance σ^2.

3.2 *Random Walk – type 2 (RW2)*

However, the assumption of identically distributed increments of security prices is not fulfilled in the long-term run. The shift in the economic, social, technological, institutional, and regulatory environment affect security prices in the capital markets and therefore it changes the parameters of distribution of price increments over the long-term.

For reasons outlined above we relax the assumption of RW1 to include processes with independent but not identically distributed (IID) increments and we shall refer it to as the Random walk 2 (RW2). Clearly, RW1 is a special case of RW2. RW2 also allows modeling of more general price processes in the capital markets. For instance, the models with the time-variation volatility that assumes heteroscedasticity in the time series $\{\varepsilon_t\}$ are the case.

3.3 *The Random Walk – type 3 (RW3)*

An even more general type of the random walk hypothesis is the one that relaxes the independence assumption of RW2 to include processes with dependent but uncorrelated increments. We shall call such a type the Random Walk model (RW3). It is clear that RW3 contains RW1 and RW2 as special cases.

For example, the following process satisfies assumptions of RW3 but not of RW1 or RW2 is any process for which:

$$Cov[\varepsilon_t, \varepsilon_{t-k}] = 0, \forall k \neq 0 \tag{3}$$

but where

$$\exists k \neq 0, Cov[\varepsilon_t{}^2, \varepsilon_{t-k}{}^2] \neq 0 \tag{4}$$

Such a process has uncorrelated increments, but is clearly not independent since its squared increments are correlated (Campbell [3]).

4. Methods of testing market efficiency

4.1 The break event point test

The Break event point test ranks to one of the most used nonparametric tests of the random walk hypothesis, i.e. of the tests being independent on particular distribution of increments. For more details see Campbell [3].

4.2 The runs test

The runs test is another test of RW1. This test investigates the number of sequences of consecutive positive and negative returns called *runs* in a particular sequence. More information about the runs test could be found in Levene [9] or Anděl [1]. Let us mention that the break event point test and the runs test are fully equivalent and differ only in a definition of a test statistic.

4.3 The variance ratio test

The variance ratio test (Ayadi [2] or Urrutia [12]) could be applied to all three types of the random walk hypothesis (if properly modified). The test follows the idea that if a time series of the natural logarithm of prices fulfills the random walk hypothesis, then variance of *q-th* derivations has to increase directly as a degree *q* of derivation increases. The variance ratio is defined as follows:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)} \tag{5}$$

where σ^2 (q) is variance of *q-th* derivations divided by q and σ^2 (1) is variance of the first derivations (for more details see Lo[10]):

$$\sigma^2(q) = \frac{1}{m}\sum_{t=q}^{nq}(\ln P_t - \ln P_{t-q} - q\hat{\mu})^2 \tag{6}$$

$$\sigma^2(1) = \frac{1}{(nq-1)}\sum_{t=1}^{nq}(\ln P_t - \ln P_{t-1} - \hat{\mu})^2 \tag{7}$$

whereas

$$m = q(nq - q + 1)(1 - \frac{q}{nq})$$

$$\hat{\mu} = \frac{1}{nq}(\ln P_{nq} - \ln P_0)$$

and P_0 , P_{nq} are the first and last values in times series of prices.

If the random walk hypothesis holds, the variance ratio VR(q) shall converge to 1. Then two test statistics z(q) and z'(q) could be derived in dependence on the fact if we assume for ε_t from equation (2) homoscedasticity (constant variance), which corresponds with RW1, or heteroscedasticity (variable variance), which corresponds with RW2 or RW3.

The formulas of the test statistics z(q) a z'(q), which under RW1 shall converge to the standard normal distribution N(0,1), are as follows:

$$z(q) = \frac{VR(q) - 1}{\sqrt{\Phi(q)}} \approx N(0,1) \qquad (8)$$

where

$$\Phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)}$$

$$z'(q) = \frac{VR(q) - 1}{\sqrt{\Phi'(q)}} \approx N(0,1) \qquad (9)$$

where

$$\Phi'(q) = \sum_{j=1}^{q-1} [\frac{2(q-j)}{q}]^2 \hat{\delta}(j)$$

and

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{nq} (\ln P_t - \ln P_{t-1} - \hat{\mu})^2 (\ln P_{t-j} - \ln P_{t-j-1} - \hat{\mu})^2}{\sum_{t=1}^{nq} [(\ln P_t - \ln P_{t-1} - \hat{\mu})^2]^2}$$

Technically, if we reject the hypothesis for the reason that the variance ratio equals 1 (for any time lag), it is enough for rejection of the random walk hypothesis. Nevertheless, we can consider all time lags together and only one confidential interval (Stolin [11]) that can influence testing results. When using the test statistics z(q), one shall not neglect that it is derived for RW1 and therefore it shall be tested if natural logarithms of price increments ε_t are IID. On the contrary, when using the test statistics z´(q) one shall test only independence or even the uncorrelation between the increments.

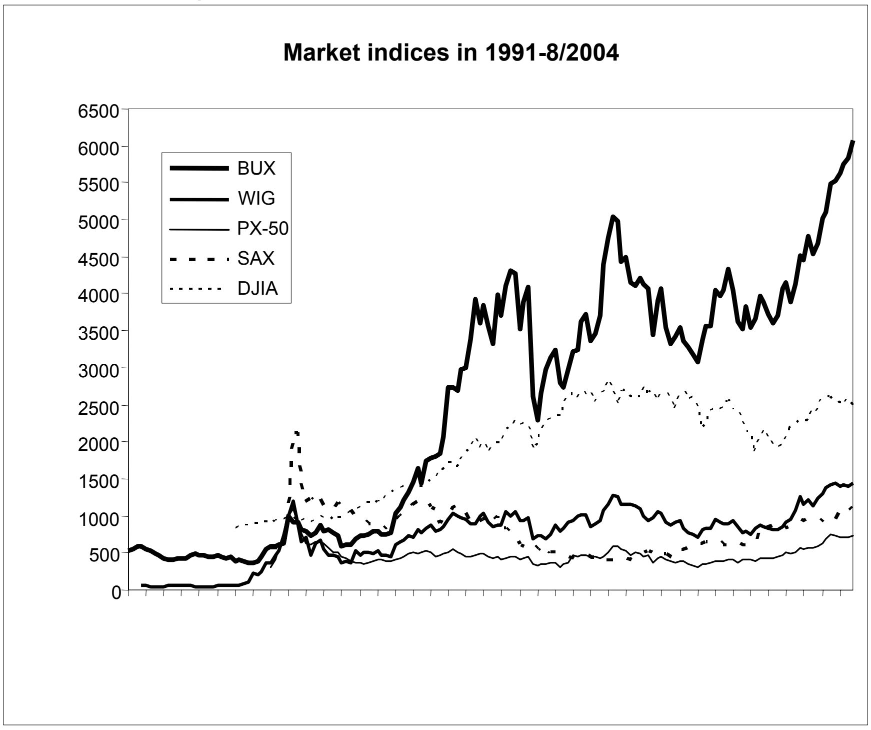
5. The results of testing market efficiency

Regarding the scope of the paper and strength of the used tests we present only results of the variance ratio test, which has the highest predicative power.

5.1 Data used

When testing the market efficiency, we have used weekly and monthly data as regards capital markets in the Czech Republic, Poland, Hungary, Slovakia and in the United States. The US market is usually considered as highly effective and as a benchmark for other capital markets. This fact we have tried to prove or falsify. We have used the market indices of the particular markets as representatives of these market: PX 50 for the Czech Republic, the Warsaw Stock Exchange Index (WIG) for Poland, the Budapest Stock Index (BUX) for Hungary, the Slovak Share Index for Slovakia and Dow-Jones-Industrial-Average (DJIA) for the US (see Figure 1):

Figure 1 Development of stock market indices in the period from 1991 until August 2000



Source: Own calculations based on data of the stock exchanges

Note: All indices were recalculated to the closing value of 1,000 as

Apart from the closing monthly and weekly values of market indices, end-of-month values recalculated to dollars were used. This fact can play an important role in the view of foreign investors that want to invest monies in the analyzed capital markets. Such obtained results can variegate the conducted research of market efficiency (under the assumption of no transaction costs occurred in relation to terms of trade).

5.2 The variance ratio test

In contrast to the break event point test and the runs test used by some authors (Ayadi [2] or Urrutia [12]), the variance ratio test considers drift μ in the test statistics. One the other hand, a pitfall of the variance ratio test is its dependence on the parameters of data distribution respectively on data normality (at least in case of testing RW1).

Considering every lag being independent and homoscedasticity of the time series ε_t (see formula (2)), we concluded relatively clear results for the weekly values in the period from September 1993 until August 2004 with the lags of 1, 2, 3 and 6 months (more precisely 4, 8, 13 a 26 weeks). While we reject the hypothesis in Central European markets, the US market seems to be effective under RW1. Technically, if we reject the hypothesis for the reason that the variance ratio equals 1 (for any time lag), it is sufficient for rejection of the random walk hypothesis. When thinking about a) all lags from the interval from 2 to 26 weeks together and b) the unique confidentiality interval of the maximum value of the test statistics for all time lags, we concluded the same result as mentioned above (i.e. we reject the hypothesis in Central European markets, but we do not disaffirm for the US market) – see Table 1.

Although we have found some statistical support for the weak-form efficiency in the US market, one shall investigate why RW1 was rejected in Central European markets. One of the reasons could be heteroscedasticity in the time series ε_t (from formula (2)) being explained by increasing market capitalization, a rise in trading activities and by nonsystematic interference in Central European markets (e.g. privatization deals - a direct sale of state-owned companies to an investor etc.). All these factors could lead to various-frequented stock price movements in the capital market per time unit and therefore a variable variance of ε_t (or heteroscedasticity) in time series could occur.

For reasons outlined above one shall study also the second test statistic z'(q), which is resistant to heteroscedasticity in data and denoted in Table 1 in square brackets. As it follows from table 1, we do not reject RW1 in any analyzed market.

Table 1: The variance ratio test (weekly data, local currencies, long period)

Weekly returns September 1993 - August 2004 *(z –homoscedasticity assumption)* *[z' – resistance against heteroscedasticity]*					
Lag	*Hungary*	*Poland*	CR	*SR*	USA
q=4	1,33 (4,76)* [0,40]	1,28 (3,89)* [0,21]	1,62 (7,92)* [0,71]	1,71 (9,13)* [0,77]	0,94 (-0,85) [-0,07]
q=8	1,57 (5,14)* [0,46]	1,44 (3,95)* [0,23]	2,08 (8,74)* [0,87]	2,11 (8,95)* [0,87]	0,85 (-1,21) [-0,10]
q=13	1,59 (4,00)* [0,37]	1,70 (4,73)* [0,29]	2,18 (7,18)* [0,77]	2,26 (7,65)* [0,85]	0,80 (-1,29) [-0,11]
q=26	1,65 (3,05)* [0,30]	2,10 (5,06)* [0,33]	1,82 (3,43)* [0,39]	1,54 (2,25)* [0,29]	0,75 (-1,07) [-0,10]
max z(q=2..26) ***max z'(q=2..26)***	(5,30)* [0,48]	(5,06)* [0,33]	(8,76)* [0,87]	(9,13)* [0,91]	(-1,87) [-0,14]

* *The variance ratio significantly differs from 1 on 5% significance level and therefore we reject RW1.*

If we do similar calculations for weekly returns in local currencies in the shorter period from January 1998 until August 2004, we reject RW1 under homoscedasticity assumption only for the Czech market. If we suppose data heteroscedasticity, we do not reject RW1 in all markets.

Table 2: The variance ratio test (weekly data, local currencies, short period)

(Weekly returns January 1993 - August 2004 *(z –homoscedasticity assumption)* *[z' – resistance against heteroscedasticity]*					
Lag	*Hungary*	*Poland*	C R	*SR*	USA
q=4	*1,15 (1,51) [0,18]*	*1,14 (1,35) [0,10]*	*1,33 (3,32)* [0,38]*	*1,01 (0,06) [0,01]*	*0,95 (-0,53) [-0,06]*
q=8	*1,31 (1,93) [0,24]*	*1,22 (1,41) [0,12]*	*1,47 (2,96)* [0,38]*	*1,05 (0,32) [0,04]*	*0,87 (-0,82) [-0,09]*
q=13	*1,15 (0,72) [0,10]*	*1,27 (1,29) [0,11]*	*1,42 (2,03)* [0,28]*	*1,12 (0,59) [0,08]*	*0,77 (-1,10) [-0,13]*
q=26	*0,98 (-0,05) [-0,01]*	*1,24 (0,78) [0,07]*	*1,43 (1,41) [0,21]*	*1,26 (0,85) [0,14]*	*0,67 (-1,07) [-0,13]*
max z(q=2..26) max z'(q=2..26)	*(2,10) [0,26]*	*(1,41) [0,12]*	*(3,32) [0,40]*	*(0,85) [0,14]*	*(-1,36) [-0,14]*

**The variance ratio significantly differs from 1 on 5% significance level and therefore we reject RW1.*

The table 3 shows results of testing RW1 assuming foreign investments (monthly dollar market returns) in the period from September 1993 until August 2004.

Table 3: The variance ratio test (monthly data, dollars, long period)

Monthly returns September 1993 - August 2004 *(z –homoscedasticity assumption)* *[z' – resistance against heteroscedasticity]*					
Lag	*Hungary*	*Poland*	CR	*SR*	USA
q=3	*0,93 (-0,51) [-0,13]*	*1,05 (0,35) [0,06]*	*1,27 (2,01)* [0,35]*	*1,43 (3,28)* [0,50]*	*0,92 (-0,67) [-0,11]*
q=6	*0,89 (-0,53) [-0,13]*	*0,95 (-0,22) [-0,03]*	*0,96 (-0,16) [-0,03]*	*0,92 (-0,39) [-0,07]*	*0,85 (-0,73) [-0,12]*
q=9	*0,97 (-0,11) [-0,03]*	*0,71 (-1,06) [-0,16]*	*1,00 (0,01) [0,00]*	*0,93 (-0,26) [-0,05]*	*0,88 (-0,44) [-0,07]*
q=12	*1,07 (0,22) [0,05]*	*0,64 (-1,10) [-0,17]*	*1,11 (0,34) [0,06]*	*1,04 (0,12) [0,03]*	*0,99 (-0,04) [-0,01]*
max z(q=3..12) max z'(q=3..12)	*(-0,78) [-0,19]*	*(-1,10) [-0,17]*	*(2,01) [0,35]*	*(3,28) [0,50]*	*(-0,76) [-0,12]*

**The variance ratio significantly differs from 1 on 5% significance level and therefore we reject RW1.*

When comparing results in the Table 3 (monthly dollars returns) with the results for the same period for local currencies returns (this table is not concluded in the paper), we can see a movement in the Polish market, where we do not refuse under heteroscedasticity assumption, other changes did not occur. Assuming heteroscedasticity, we do not reject RW1 in any market in both periods.

However, the main pitfall of the variance ratio test is its sensitivity to normality of the time series ε_t (see formula (2)). In practice, this assumption is equivalent to normality of market returns and is to be tested. The table 4 shows the results of such testing on dollars market returns.

Table 4: The data normality test (monthly data, dollars, both periods)

Distribution of dollar returns on capital markets										
	Hungary		Poland		CR		SR		US	
Period	7/93 - 8/04	**1/98 - 8/04**	7/93 - 8/04	**1/98 - 8/04**	10/93 - 8/04	**1/98 - 8/04**	11/93 - 8/04	**1/98 - 8/04**	1/93 - 8/04	**1/98 - 8/04**
Average	1,4%	**0,7%**	0,9%	**0,6%**	0,8%	**1,1%**	0,5%	**0,4%**	0,8%	**0,3%**
Standard deviation	10,4%	**9,9%**	12,5 %	**9,9%**	9,8%	**8,6%**	11,0%	**6,6%**	4,4%	**5,0%**
Skewness	-0,40	**-1,75***	-0,34	**-1,17***	0,48*	**-1,00***	2,85*	**0,23**	-0,75*	**-0,60***
Kurtosis	4,92*	**6,57***	2,39*	**4,04***	4,03*	**3,23***	20,18*	**0,72**	1,49*	**1,03**
Max. return	43,2	**20,5**	35,2	**20,6**	45,1	**20,7**	76,5	**21,9**	10,1	**10,1**
Min. return	-48,2	**-48,2**	-43,7	**-43,7**	-34,4	**-34,4**	-36,8	**-14,9**	-16,4	**-16,4**
Student spread	8,8**	**6,9****	6,3**	**6,5****	8,1**	**6,4****	10,3**	**5,5**	6,0	**5,3**
Number of observations	134	**79**	134	**79**	131	**79**	130	**79**	139	**79**

Notes:
returns=100*ln(P_t/P_{t-1})
standard error (S.E.) skewness = $[6/N]^{1/2}$
standard error (S.E) curtosis = $[24/N]^{1/2}$
N=number of observations
Student spread = (Max return – Min retunr)/ relative variance
*It significantly differs from 1 on 5% significance level
** If Student spread is grater than 6, we reject data normality on 5% significance level.

It follows from the Student spread results that monthly dollar returns in the period from September 1993 until August 2004 do not satisfy the normality assumption except for the US market, which therefore confirms its property of a benchmark of the capital market. We can see from the Table 4 an improvement of the vast majority of the test statistics for the shorter period from January 1998 until August 2004. As a result, the tests assuming heteroscedasticity reflect reality more precisely than the other ones. Such tests are not so sensitive to data normality and provide us relatively good statistical evidence for non-rejection of RW2 and RW3. Furthermore, the tests imply that not only the US market but also the Czech, Slovak, Polish and Hungarian ones post the weak-form of market efficiency.

5.3 The results of testing

1. Can we observe any information efficiency in Central European capital markets?

   We could not reject the weak form hypothesis of Central European capital markets – see the results in tables 1-3 (especially the results concerning heteroscedasticity).

2. Can we observe an improvement of information efficiency in these markets during time?

   Yes, we do not reject RW1 in all markets in the shorter of period from January 1998 until August 2004 – compare results in tables 1 and 2 or with previous research (Hanousek [6], Vošvrda [13]).

3. What gap is among Central European capital markets and the US (mature) capital market?

   Central European capital markets converge to the US one also through distribution characteristics (see Table 4).

6. Conclusion

The methods, calculations and obtained result proof the general statement that the U.S. market is mature and effective. We concluded that the US market reports the weak form of efficiency. On the other hand, we are aware of simplifications we made when using the U.S. market index (DJIA) as a representative of the market (the same simplification was made for other capital markets as well).

Despite the restrictive assumptions of some used test (e.g. data normality), we could not unambiguously reject the weak form of efficiency in any researched market. Concerning the results of the relatively robust variance ratio rests, we share the opinion that current stock prices in the analyzed markets reflect the past price movements. Therefore strategies used by technical analysts are useless and could not help investors to make abnormal returns. The same holds when assuming foreign portfolio investments. In other words, the examined markets effectively incorporate information about exchange rates movements of the local currencies against the world ones (in our case against the US dollar).

When analyzing the shorter period commencing in January 1998, one can see an improvement in the test statistics. For this reason, we claim that stabilization (or an improvement in market efficiency) of Central European has been happening. The U.S. market still seems to be more effective compared to Central Europe, but the gap is getting smaller. The fact behind it could be an implementation of standard bourse rules, IT development, Internet and other manners that make informational flows quicker and more accurate.

In conclusion, our analysis answered three questions to be asked at the beginning of the paper. On the other hand, we know that our research is not comprehensive. Other topics are to be addresses to do our work more precise. These topics include using more robust tests as GARCH models, testing the semi-strong form of efficiency of Central European markets, testing efficiency not only on market indices but also on particular stocks and finally focus on intra-day stock trading etc.

References

[1] ANDĚL, J. (1985): Matematická statistika. Praha, SNTL/ALFA, 1985

[2] AYADI, O.F.– PYUN, C.S. (1994): An Application of Variance Ratio Test to the Korean Securities Market. Journal of Banking and Finance, vol. 18, 1994, pp. 643-658.

[3] CAMPBELL, J.Y.– LO, A.W.– MACKINLAY, A.C. (1997): The Econometrics of Financial Markets. New Jersey, Princeton University Press, 1997

[4] FAMA, E. (1970): Efficient Capital Markets: A Review of Theory and Empirical Work. Journal of Finance, vol. 25, 1970, pp. 383-417.

[5] FILER, R.K.– HANOUSEK, J.(1996): The Extent of Efficiency in Central European Equity Markets. Prague, CERGE-EI, Working Paper, 1996, no.104.

[6] HANOUSEK, J.– FILER, R.K.(1996): Informational Efficiency in Central European Equity Markets: The Effect of Macroeconomic Variables on Stock Prices. Prague, CERGE-EI Working Paper, 1996, no. 108.

[7] JANDA, K. (1994): Modelování rizika akciového portfolia, Finance a úvěr, vol. 44, no. 9, p. 463 - 472

[8] JONES, C.P.(1991): Investments: Analysis and Management.. New York, John Wiley & Sons, Inc, 1991.

[9] LEVENE, H.(1952): On the Power Function of Tests of Randomness Based on Runs Up and Down. Annals of Mathematical Statistics, vol. 23, 1952, pp. 34-56.
[10] LO, A.W.– MACKINLAY, A.C. (1989): The Size and Power of the Variance Ratio Test in Finite Samples: A Monte Carlo Investigation. Journal of Econometrics, vol. 40, 1989, pp. 203-238.
[11] STOLIN, M.R.– URY, H.K. (1979): Tables of the Studentized Maximum Modulus Distribution and an Application to Multiple Comparisons Among Means. Technometrics, vol. 1, 1979, pp. 87-93.
[12] URRUTIA, J.L.(1995): Tests of Random Walk and Market Efficiency for Latin American Emerging Equity Markets. The Journal of Financial Research, vol. 3, 1995, pp. 299-309.
[13] VOŠVRDA, M.– FILÁČEK, J.– KAPIČKA, M.(1998): The Efficient Market Hypothesis Testing on the Prague Stock Exchange. Bulletin of the Czech Econometric Society, vol. 5, 1998, pp. 55-67.

A TEST OF MARKET EFFICIENCY: EVIDENCE FROM THE ICELANDIC STOCK MARKET

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Abstract

This extensive study examines the relationship between the price-to-earnings (P/E) ratio, the market-to-book (M/B) ratio, dividend yields, size, past returns, and current returns of Icelandic stocks. The study uses monthly return data on stocks from the Iceland Stock Exchange from January 1993 to June 2003. The model, which uses multiple regression analysis with dummy variables, is based on the classical Capital Asset Pricing Model, so the beta coefficient is the sole measure of risk. The findings are that the returns of stocks with a low P/E ratio are much higher than returns of other stocks, and that these returns are statistically significantly higher when differences in systematic risk are accounted for. The returns of small stocks and stocks with a low M/B ratio are higher than that of other stocks but the difference is not statistically significant. However, there is no relationship between current returns and historical returns, or between returns and dividend yields.

Keywords: *Market efficiency, Icelandic stock market, P/E ratio*

1. Introduction

An efficient capital market is one in which stock prices fully reflect available information. The notion that stocks already reflect all available information is referred to as the efficient market hypothesis (EMH). A precondition for the strong version of the hypothesis is that information and trading costs, the costs of getting prices to reflect information, are always zero (Grossman and Stiglitz, 1980). A weaker and economically more sensible version of the efficiency hypothesis states that security prices reflect information to the point where the marginal benefits of acting on information, i.e., the profits to be made, do not exceed the marginal costs (Jensen, 1968). Therefore, according to the EMH, stock prices change in response to new and unpredictable information and they follow a random walk—that is, they are random and unpredictable.

It is common to distinguish between three versions of the EMH: the weak, the semistrong, and the strong forms. The weak form of the hypothesis asserts that stock prices already reflect all information that can be derived by examining market trading data. The semistrong form of the hypothesis states that all publicly available information regarding the prospects of a firm must already be reflected in the stock price. Finally, the strong version of the EMH states that stock prices reflect all information relevant to the firm, even information available only to company insiders.

Testing capital markets for signs of inefficiency is difficult because ambiguity about information and trading costs causes problems. The joint-hypothesis problem is even more serious. It states that we can only test whether information is properly reflected in prices in the context of a pricing model that defines the meaning of "properly". Consequently, when we find anomalous evidence on the behavior of returns, we cannot be sure whether it is clear evidence of market inefficiency or if the model we use is ambiguous. Therefore, market efficiency *per se* is not testable (Fama, 1991).

Despite these problems, a great deal of research has been done on capital market efficiency. Most of the research supports the EMH, but some studies have found signs of capital market inefficiency. The most important signs are:

- Size. Small stocks, i.e., stocks with small market capitalization, have outperformed stocks with large market capitalization over long periods. The general belief is that small stocks give superior returns, even when accounting for risk (Fama and French, 1992).
- Temporal anomalies. Studies indicate that average stock returns have been higher in January than in other months. Across the days of the

week, average stock returns have been found to be lowest on Mondays (Berument and Kiymaz, 2001).

- Value vs. glamour. A number of studies have shown that stocks with low price-to-book ratios and/or low price-to-earnings (P/E) ratios, generally called value stocks, outperform stocks with high ratios, called glamour stocks (Fama and French, 1992).
- Reversals. Several studies have found that stocks that perform poorly in one time period have a strong tendency to experience sizeable reversals over the subsequent period. Likewise, the best performing stocks in a given period tend to perform poorly in the following period (De Bondt and Thaler, 1985).

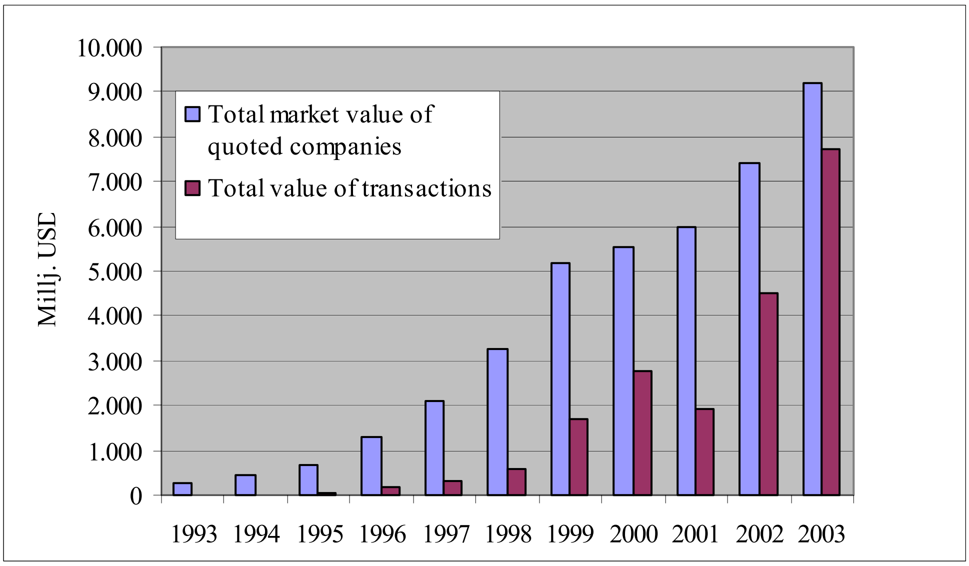
In this paper, empirical tests are undertaken to determine whether the Icelandic stock market shows signs of market inefficiency. The results of these tests are discussed in relation to the EMH and alternative theories that might explain the findings. The empirical tests search for the appearance of the abovementioned important signs of market inefficiency, which have been found on other capital markets. Therefore, the relationships between the P/E ratio, the market-to-book (M/B) ratio, size, historical returns, dividend yields, and returns on the Icelandic stock market are examined.

2. The Icelandic Stock Market

2.1 Size and Activity

The total market value of quoted companies on the Icelandic stock market at the end of 2003 was approximately 9,200 million USD, or 82% of GDP. By contrast, in 1993, the total market value was only 270 million USD, which was then 4% of GDP. Figure 1 shows the total value of transactions of stocks on the Icelandic Stock Exchange (ICEX) and the total market value of quoted companies from 1993 to 2003. As the figure shows, the size of the market and its turnover has increased exponentially. In 1993, the total volume of stock trading on the ICEX was only 13 million USD but by 2003, it had grown to 7,750 million USD.

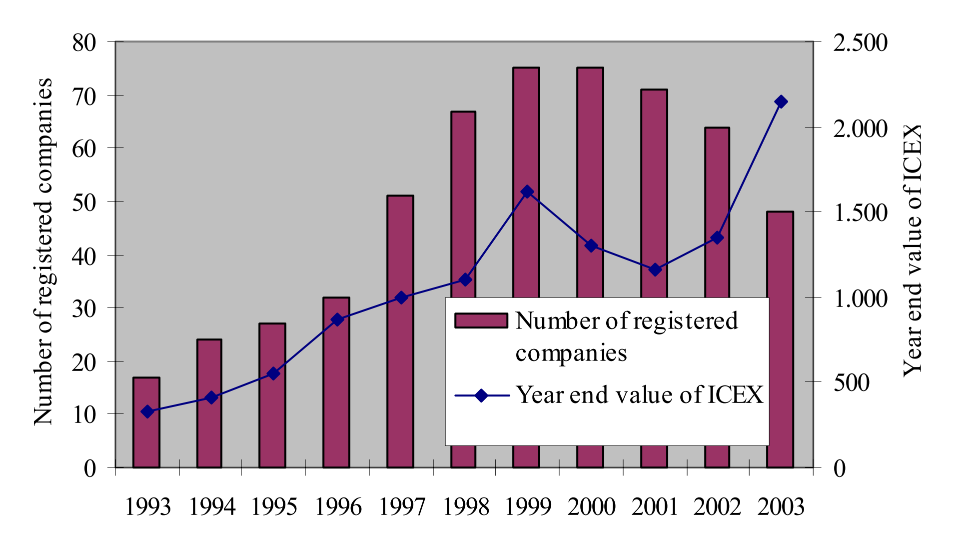
Figure 1. Total market value of stocks and the total value of transactions, 1993–2003



Source: The Icelandic Stock Exchange.

The number of registered companies reached a peak in 1999–2000, when 75 companies were trading on the exchange. Since then, the number has declined steadily, mainly because of mergers and acquisitions. Figure 2 shows the number of registered companies on ICEX and the year-end value of the ICEX-15 index. The ICEX-15 index is an index consisting of the 15 largest stocks quoted on the ICEX weighted by market capitalization. The figure shows clearly that the Icelandic stock market has been an excellent place in which to invest. The geometric mean annual return of the ICEX-15 index was 17.1% from the beginning of 1993 to the end of 2003. The return of the market was negative only in 2000 and 2001.

Figure 2. Number of registered companies on ICEX and the year-end value of the ICEX-15.



Source: The Icelandic Stock Exchange.

3. Data

This study uses monthly return data of ICEX stocks from January 1993 to June 2003. The data used to calculate monthly returns was obtained from the ICEX price database. End of the month prices were used to calculate monthly returns for every stock. Returns were adjusted for stock splits and dividends; i.e., dividends were included in returns. Data on earnings, dividends, stockholders' equity, and the total number of shares outstanding were obtained by examining each firm's financial reports for the period observed. To avoid the look-ahead bias, the previous years' figures were not used until they were made available to investors

The stocks used in this research were randomly selected. There are 20 stocks in the sample for 1993, with five in each portfolio during that year. For 1994, there are 24 stocks, with six in each portfolio, and for 1995 to June 30, 2003, there are 28 stocks in the sample, with seven in each portfolio.

4. Methodology

Finding a suitable methodology for this study was a problem. The limited number of stocks quoted and the short period of trading on the Icelandic stock market reduce the scope for a suitable methodology. The methodology used is almost identical to that used by Jahnke, Klaffke, and Oppenheimer (1987) to analyze the performance of low and high P/E portfolios. The main difference is that they constructed a portfolio and held it for the entire period. In this paper, new portfolios are constructed each month because new information regarding earnings, yield, etc., is published for some of the stocks almost every month. Therefore, by regrouping the portfolios every month, the new information is incorporated into the research sooner. In addition, the denominator of most of these factors changes every month because the prices of the stocks change.

The main fault in this methodology is that some of the variables examined here may be related. For example, it is likely that the size of firms may be related to their P/E ratios, i.e., the price per share divided by earnings per share. To overcome this problem, it would have been necessary to split the available sample into a number of portfolios that combine attributes in a controlled manner. Because of the limited number of stocks observed, this was impossible. The reader should bear these limitations in mind when interpreting the results.

This methodology is based on grouping procedures and the construction of portfolios. For every month from January 1993 to June 2003, four portfolios were constructed based on the value of the variable examined. The stocks were equally weighted in the portfolios; i.e., the return of the portfolio equals the average return of the stocks. Then the returns of the stocks were measured and compared, and the returns of the extreme portfolios were tested to determine whether they were statistically different when accounting for systematic risk.

Markowitz (1959) laid the groundwork for the Capital Asset Pricing Model (CAPM). In his seminal research, he cast the investor's portfolio selection problem in terms of expected return and variance of return. He argued that investors would optimally hold a mean–variance-efficient portfolio—that is, a portfolio with the highest expected return for a given level of variance. Sharpe (1964) and Lintner (1965) built on Markowitz's work to develop economy-wide implications. They showed that if investors have homogeneous expectations and optimally hold mean–variance-efficient portfolios, then, in the absence of market friction, the portfolio of all invested wealth, or the market portfolio, is itself a mean–variance-efficient portfolio.

The Sharpe and Lintner derivations of the CAPM assume the existence of lending and borrowing at a risk-free rate of interest. Using this version of the CAPM, for the expected return of asset *i* we have:

$$E[R_i] = R_f + \beta_{im}(E[R_m] - R_f) \quad (1)$$

$$\beta_{im} = \frac{Cov[R_i, R_m]}{Var[R_m]}, \quad (2)$$

where $E[R_i]$ is the expected return of a security, R_f is the risk-free return, and $E[R_m]$ is the return of a market index. An approach known as Jensen's alpha is one of many performance measures that are based on the classical CAPM. It is easily computed by finding the intercept, α_p, in the regression:

$$R_p - R_f = \alpha_p + \beta_p(R_m - R_f) + u_p. \quad (3)$$

This method was introduced by Jensen (1968). The procedure allows the efficient estimation of α_p, a measure of the monthly excess return after adjustment for portfolio risk. Assuming the CAPM holds, the alphas on passively managed portfolios are expected to be zero because all securities are expected to lie on the security market line. Therefore, a significantly positive alpha of a portfolio indicates an excess return.

The goal of this study is to compare the performance of portfolios by applying the methodology of Jahnke et al. (1987). Rather than estimating the previous equation for two extreme portfolios, the required performance is estimated by using ordinary least squares (OLS) on the following regression:

$$R_{pt} - R_{ft} = \alpha_p + d_L D_{pt} + \beta_p(R_{mt} - R_{ft}) + s_L S_{pt} + u_{pt}, \quad (4)$$

where: R_{pt}, is the return in month *t* (*t* = 1,..,126) earned by a portfolio purchased at the beginning of the month; α_p is the intercept, which equals the monthly abnormal performance of the portfolio that is not represented by a dummy variable, i.e., α_H; R_{ft} is the risk-free rate, i.e., the return of one-month Treasury bills in month *t*; β_p is the slope, which equals the systematic risk of the portfolio β_H, which is not represented by a dummy; R_{mt} is the rate of return on the ICEX-15 index in month *t*; D_{pt} is equal to zero for observations of the portfolio that are not represented by a dummy and one for all observations of the portfolio that are represented by a dummy variable; and u_{pt} is an error term assumed to have an expected value of zero and to be serially uncorrelated. $S_{pt} = D_{pt}(R_{mt} - R_{ft})$ for all observations. The coefficient α_p in the equation equals α_H, i.e., the measure of monthly abnormal performance for the portfolio that is not represented by a dummy variable, which means that D_{pt} = 0 for that portfolio. The coefficient d_L is a key parameter in this regression. It measures the difference between the excess returns of the portfolio that is not represented by a dummy variable and the portfolio that is represented by a dummy variable. It should be noted that $\alpha_p + d_L$ is equal to the alpha of the portfolio, which is represented by a dummy variable. Thus, we may use a t-test to determine if d_L is significantly different from zero. If d_L is significant, then the returns of the portfolios are significantly different when differences in systematic risk are taken into account. β_p equals β_H, i.e., the systematic risk (beta) of the portfolio, which is not represented by a dummy variable. Finally, s_L provides an estimate of the difference in systematic risk between the portfolio that is represented by a dummy variable and the one that is not, with $\beta_p + s_L$ being the systematic risk of the portfolio that is represented by a dummy variable, β_L.

5. Performance According to Firm Size

5.1 Previous Research

The size of a company is normally measured by the market value of its ordinary shares. Over long periods, and in many countries—for example, Australia, Belgium, Canada, Finland, France, Japan, the Netherlands, the UK, the US, and former West Germany—small firms have produced higher returns than large firms (Lofthouse, 1994). In an extensive study, Fama and French (1992) analyzed data from the American stock market from 1963 to 1990. They constructed portfolios based on betas and the size of firms. They found that small firms outperformed large firms for both low- and high-beta stocks. Reinganum (1992) analyzed the returns of New York Stock Exchange (NYSE) stocks ranked by size from 1926 to 1989. He found that small firms gave returns with a higher average arithmetic mean for that period. The returns of the small firms were superior even when accounting for risk. In a study of UK market data from April 1961 to March 1985, Levis (1989) found that small firms outperformed larger firms in that they gave excess returns when adjusted for risk.

The reason that small stocks outperform large stocks has been related to the higher cost of trading. The bid/ask spread is generally much higher for small stocks, making the cost of trading much higher. Another suggested reason is that smaller firms have different sector or industry distributions than do larger firms.

5.2 Study and Results

For every month covered by this study, four portfolios were constructed according to the market capitalization of common stocks. The returns of the portfolios were measured and the performance of the extreme portfolios (the smallest and largest stocks) was measured by using standard OLS to estimate the parameters in equation 4.
Figure 3 shows the geometric mean returns of the portfolios. The portfolio with the smallest stocks has the highest returns, whereas the portfolio with the largest stocks has the lowest returns.

Figure 3. Returns of portfolios constructed according to firm size

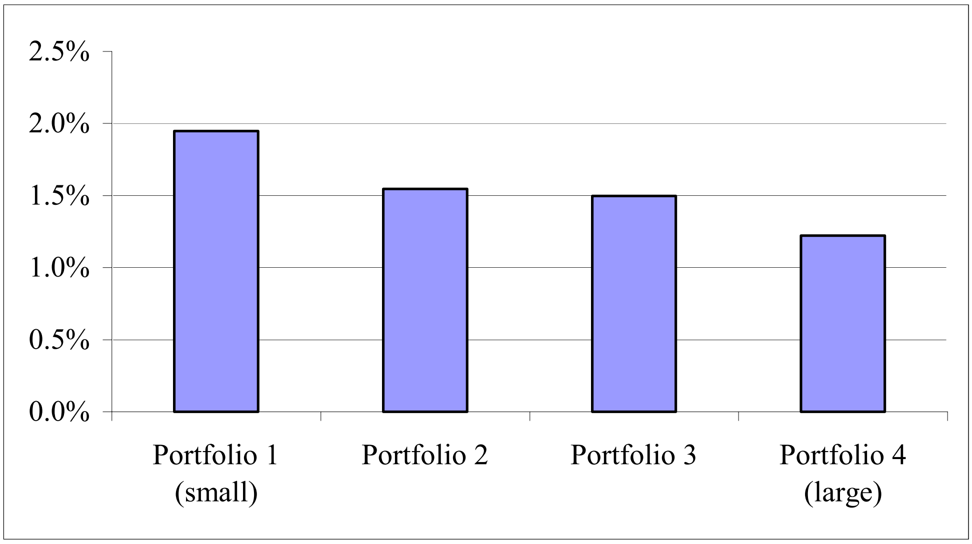


Table 1 gives the most important results of the regression when applying equation 4. The systematic risk (beta) is estimated to be 0.97 (βp equals β_H) and 0.76 ($\beta p + s_L$) for the highest and lowest market capitalization portfolios, respectively. The difference in systematic risk is statistically significant as the t-statistic of –2.13 for (s_L) indicates. The alphas of the higher and lower market capitalization portfolios are estimated to be 0.15% (α_p equals α_H) and 1.04% (α_p + d_L), respectively. The difference is not statistically significant as the t-statistic of 1.93 for (d_L) indicates. Therefore, the returns of portfolios 1 and 4 are not statistically different even when the lower systematic risk of portfolio 1 is taken into account. The Durbin–Watson coefficient of 1.90 indicates that there is not a significant first-order autocorrelation.

Table 1. Results of the regression of portfolios constructed according to firm size

	α_p	d_L	βp	s_L	R^2
Coefficient	0.0015	0.0089	0.97	–0.21	0.56
t-statistics	(0.45)	(1.93)	(*14.03)	(*–2.13)	
p-statistics	0.65	0.054	<0.0001	0.034	
Durbin W.	1.90				

* Significant at the 5% level.

6 Performance According to dividend yield

6.1 Previous Research

Dividend yield is defined as dividends per share divided by the market value of the share. There has been some debate as to whether high-yield stocks offer superior returns. There are many reasons for different findings. For instance, in many countries, income, including dividends, is taxed at a higher rate than are capital gains. Another reason may be that some clients prefer income and will buy high-yield stocks, whereas other investors may prefer capital gains.

Litzenberger and Ramaswamy (1979) examined the effects of taxes and dividend yields on returns. They used NYSE data from January 1936 to December 1997. They found that high returns and high yields went together and that high-yield stocks offered excess returns. In his investigation of the UK market, Levis (1989), studying data from April 1961 to March 1985, found that high-yield stocks gave excess returns. Levis tested many variables and found that yields affected returns for most of the variables tested. In a study analyzing NYSE data from January 1927 to December 1976, Elton, Gruber and Rentzler (1983) examined the effects of dividend yields on returns. They found that there was a persistent relationship between dividend yields and excess returns. In particular, except for those stocks that had previously paid zero dividends, the higher the dividend yield was, the higher was the excess return.

6.2 Study and Results

For every month covered by this study, we constructed four portfolios according to the dividend yield of common stocks. Figure 4 shows the geometric mean returns of the portfolios. Portfolio 1, the portfolio with the lowest dividend yield, had the highest monthly return. The portfolio with the highest dividend yield had the second highest average return.

Figure 4. Returns of portfolios constructed according to the dividend yields of firms

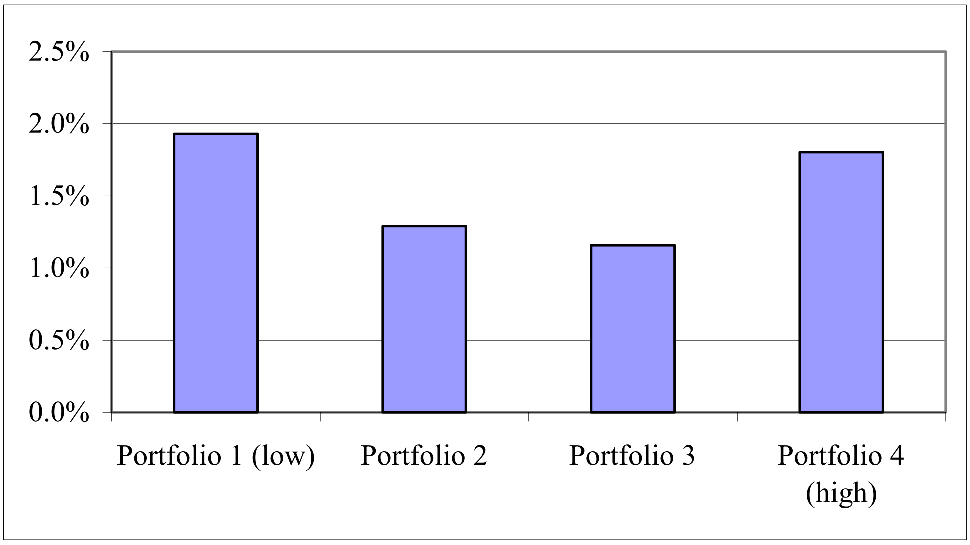


Table 2 shows that there is no statistically significant difference between the returns of portfolios 1 and 4 because the coefficient d_L is not statistically significant. Therefore, it is safe to conclude that there has not been a relationship between returns and dividend yields for Icelandic stocks.

Table 2. Results of the regression of portfolios constructed according to dividend yields

	α_p	d_L	βp	s_L	R^2
Coefficient	0.0083	0.0015	0.79	0.14	0.46
t-statistics	(2.09)	(0.26)	(*9.37)	(1.19)	

p-statistics	0.037	0.79	<0.0001	0.23	
Durbin W.	1.84				

* Significant at the 5% level.

7 Performance According to P/E ratios

7.1 Previous Research

The performance of stocks based on P/E ratios is one of the most widely analyzed issues in relation to capital markets. Many US studies have shown that low P/E-ratio stocks outperform high P/E-ratio stocks over long periods. Studies of other markets have come to similar conclusions (Lofthouse, 1994). In an extensive study on the US, German, French, English, and Japanese equity markets, Haugen and Baker (1996) studied data from 1985 to 1993. They found that the ratio of earnings to price, that is, the reciprocal of the P/E ratio, affected returns in all these markets. In all countries studied, low P/E stocks gave excess returns during the period. The effect of the P/E ratio was highest in the US and France. Basu (1977) attempted to determine empirically whether the investment performance of stocks was related to their P/E ratio. He analyzed data from the NYSE between September 1956 and August 1971 and found that a low P/E portfolio gave, on average, a 13.5% return per year, whereas a high P/E portfolio gave a 9.5% return. This higher return was not associated with higher levels of systematic risk. Indeed, the systematic risk of the low P/E portfolio was lower than that of the high P/E portfolio. In an extensive study on the UK stock market from 1961 to 1985, Levis (1989) found that low P/E stocks gave excess returns during that period.

The reason for low P/E ratio stocks outperforming high P/E ratio stocks has been related to the tendency of investors to overestimate growth for high-growth companies and to underestimate growth for low-growth companies. High-growth companies normally sell at high P/E ratios, whereas low-growth companies sell at low P/E ratios, with the result that the stocks with low P/E ratios outperform the others.

7.2 Study and Results

In this study, earnings are defined as profits after tax plus exceptional and extraordinary items. To rank the stocks into portfolios and compare the performance of high and low P/E portfolios, we used the E/P ratio (i.e., earnings divided by price) because companies with negative earnings are automatically ranked as having the lowest E/P ratio. For every month under study, we constructed four portfolios based on E/P ratios. The performance of the extreme portfolios, portfolios 1 and 4, was measured by estimating parameters in equation 4 using OLS.

Figure 5. Returns of portfolios constructed according to the P/E ratios of stocks

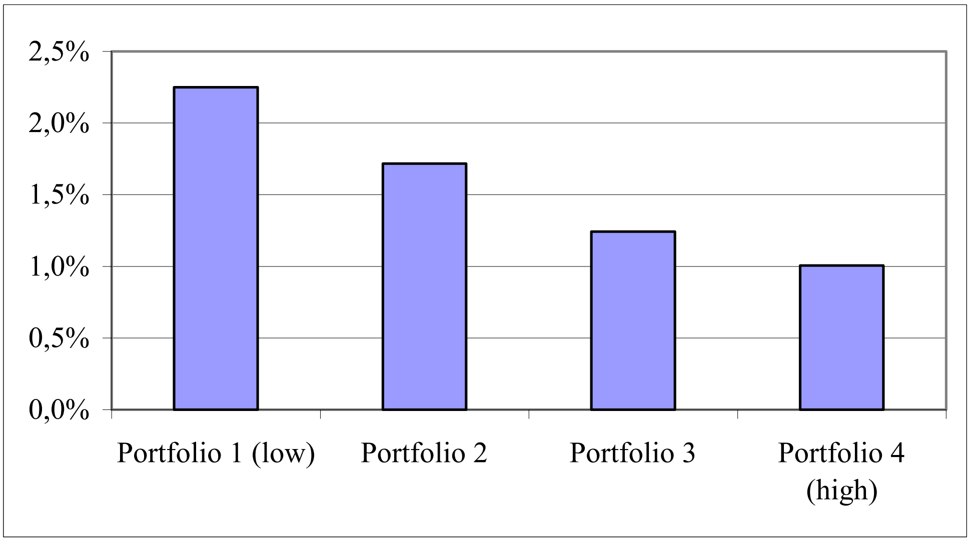


Figure 5 shows the average returns of the four portfolios. The returns of portfolio 1, which contained the stock with the lowest P/E ratios, were much higher than the returns of other portfolios. Portfolio 4's returns were the lowest. The figure indicates that a relationship between returns and P/E ratios might have existed.

Table 3 shows the results of the regression. The systematic risk (beta) is estimated to be 0.89 and 0.74 ($\beta p + s_L$) for the low and high P/E ratio portfolios, respectively. The alphas of the low and high P/E ratio portfolios are estimated to be 1.3% and 0.1% ($\alpha_p + d_L$), respectively. The difference is statistically significant as the t-statistic of –2.06 for (d_L) indicates.

Table 3. Results of the regression of the portfolios constructed according to P/E ratios

	α_p	d_L	βp	s_L	R^2
Coefficient	0.013	–0.012	0.89	–0.15	0.43
t-statistics	(*3.16)	(*–2.06)	(*10.03)	(–1.23)	
p-statistics	0.0018	0.041	<0.0001	0.22	
Durbin W.	1.82				

* Significant at the 5% level.

Forming portfolios based on low P/E-ratio stocks provides considerably higher returns than portfolios based on high P/E-ratio stocks. Moreover, the difference in returns is statistically significant.

8 Performance According to M/B ratios

8.1 Previous Research

M/B ratios, also referred to as price-to-book ratios, express the market value of common stocks divided by the book value of ordinary shareholders' funds. Many studies have found that buying stocks with low M/B ratios has resulted in excess returns. Rosenberg, Reid and Lanstein (1985) analyzed the performance of a strategy of purchasing stocks with low price-to-book ratios using data from January 1973 to March 1980 from the COMPUSTAT database. The stocks analyzed were mainly NYSE stocks. The study was constructed as a hedge study, which means that stocks with low price-to-book ratios were bought and stocks with high price-to-book ratios were sold short. The study showed that this strategy gave excess returns; i.e., it resulted in a positive return of 0.32% per month. In their extensive study, Haugen and Baker (1996) analyzed data for five countries from 1985 to 1993. They found that stocks with low price-to-book ratios gave excess returns in the US, Germany, France, the UK, and Japan. The excess return was statistically highly significant in all of these countries. Capula, Rowley, and Sharpe (1993) analyzed the performance of stocks with low price-to-book ratios (called value stocks) and stocks with high price-to-book ratios (called growth stocks) from January 1981 to June 1992 in France, Germany, Switzerland, the UK, Japan, and the US. They found that the value stocks outperformed the growth stocks in all countries studied, as they gave higher average returns when adjusted for risk during the period under study.

8.2 Study and Results

For every month of the study, we constructed four portfolios according to the M/B ratios of the stocks in the sample. Figure 6 shows that portfolio 1, which consisted of the stocks with the lowest M/B ratios, had the highest average returns, whereas portfolio 4 provided the lowest average returns.

Figure 6. Returns of portfolios constructed according to firms' M/B ratios

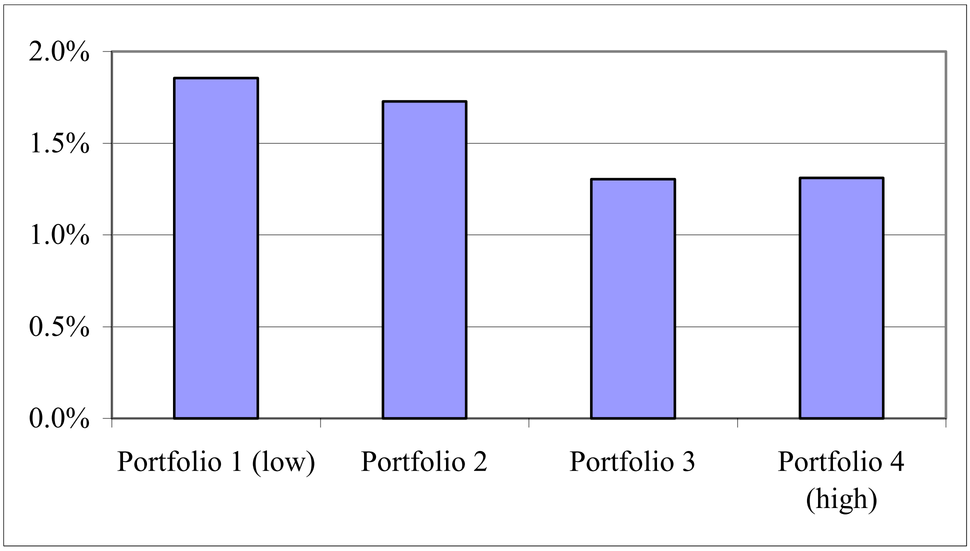


Table 4 shows that the systematic risk (beta) is 1.04 and 0.71 for the highest and lowest M/B portfolios, respectively. The difference in systematic risk between the portfolios is statistically significant as the t-statistic of –2.76 for s_L indicates. The alpha is estimated to be 0.29% and 0.94% for the highest and lowest M/B portfolios, respectively. The difference between the alphas of the portfolios is not statistically significant. Therefore, there is not a statistically significant difference in returns between the two portfolios when accounting for risk.

Table 4. Results of the regression of portfolios constructed according to M/B ratios

	α_p	d_L	βp	s_L	R^2
Coefficient	0.0029	0.00653	1.04	–0.33	0.47
t-statistics	(0.73)	(1.17)	(*12.22)	(*–2.76)	
p-statistics	0.46	0.245	<0.0001	0.006	
Durbin W.	2.07				

* Significant at the 5% level.

A portfolio based on stocks with low M/B ratios provides a considerably higher return than does a portfolio with high M/B stocks. The risk (beta) of the low M/B portfolio is significantly lower than that of the high M/B portfolio. However, the different in risk-adjusted returns between the portfolios is not statistically significant.

9 Performance According to Previous Returns

9.1 Previous Research

De Bondt and Thaler (1985) studied market behavior by analyzing monthly return data for NYSE common stocks from January 1936 to December 1982. They found that the market did overreact. They formed portfolios based on winners—i.e., stocks that had provided positive abnormal returns—and losers—i.e., stocks that had given negative risk-adjusted returns over the previous three years. Then they held the portfolios for 36 months. They found that, over this time, the portfolios of the 35 loser stocks outperformed the market by 19.6%, on average. In contrast, the winner portfolios performed about 5.0% below the market average. Thus, the difference in the cumulative average residual between the extreme portfolios equaled 24.6%. Jagadeesh (1990) studied the behavior of security returns using NYSE data for the period 1934 to 1987. He found that there was a negative first-order serial correlation in monthly stock returns and that it was statistically highly significant. This meant that high returns were followed by low returns. In addition, Jagadeesh found that there was significant positive serial correlation of longer lags, with the 12-month serial correlation being particularly strong. He found that the overreaction was most notable in January. Jagadeesh concluded that his research reliably rejected the hypotheses that stock prices follow a random walk. Haugen and Baker (1996) studied data from the US, Germany, France, the UK, and Japan from 1985 to 1993. They found that, in all of these countries, stocks that had given excess returns relative to an index in the previous month underperformed the following month.

The reason for the overreaction of markets has been related to the overreaction of investors to new information. Investors observe each other and the market as a whole, and some investors chase trends. This makes the market excessively volatile, as trends persist for overly long periods and then reverse.

9.2 Study and Results

To compare the performance of winners and losers and to analyze the difference, we formed four portfolios for each month of the study according to the previous month's return.

Figure 7. Returns of portfolios constructed according to previous returns

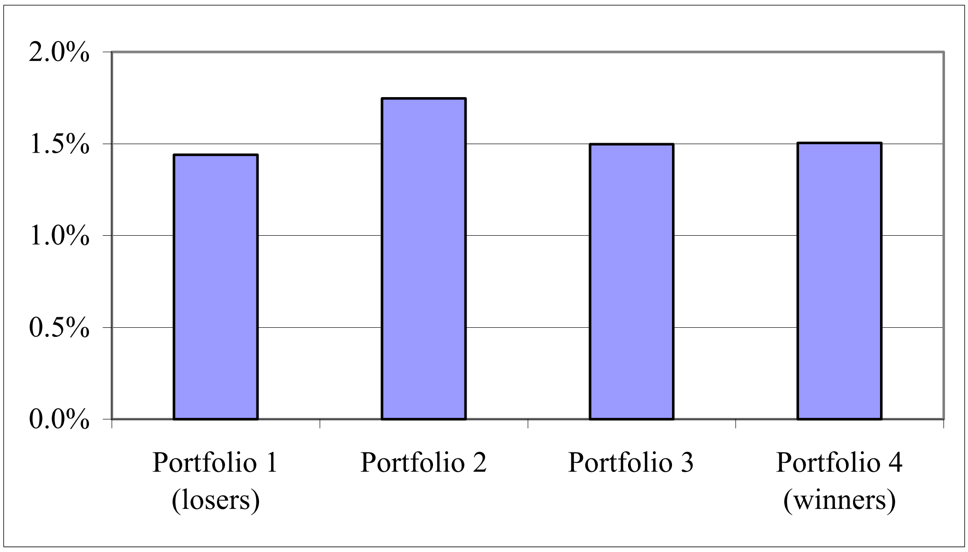


Table 5 shows the results of the regression, and figure 7 shows the returns of the portfolios. The average monthly returns are similar for all the portfolios: there is no statistically significant difference in returns. Therefore, there was no apparent relationship between the returns of Icelandic stocks and the previous returns.

Table 5. Results of the regression of portfolios based on losers and winners

	α_p	d_L	βp	s_L	R^2
Coefficient	0.0051	–0.00001	0.87	–0.18	0.47
t-statistics	(1.45)	(–0.02)	(*11.56)	(–1,48)	
p-statistics	0.15	0.99	<0.0001	0.14	
Durbin W.	2.07				

* Significant at the 5% level.

10 Conclusion

In this paper, empirical tests were performed to determine whether the Icelandic stock market showed clear signs of market inefficiency, which have appeared on other capital markets.

The performance of portfolios was measured and compared both in absolute terms and when accounting for systematic risk. The model applied in this research, which used multiple regression analysis with dummy variables, was based on the classical Capital Asset Pricing Model, so the beta coefficient was the sole measure of risk. The findings were that returns of stocks with low P/E ratios were much higher than returns of other stocks, and that the returns were statistically significantly higher than those of other stocks when accounting for differences in systematic risk. The returns of small stocks and stocks with low M/B ratios were higher than that of other stocks, but the difference was not statistically significant. However, there was no relationship between current returns and historical returns, or between returns and dividend yields.

The finding that stocks with low P/E and M/B ratios provide high returns on the Icelandic stock market is consistent with findings on other stock markets. It is interesting that the small and underdeveloped Icelandic stock market shares the same signs of inefficiency that appear in larger and more developed stock markets.

References

[1.] Basu, S. (1977). The relationship between earnings, yield, market value and return for NYSE common stocks—further evidence. Journal of Finance, (32), 663–681.

[2.] Berument, H. and Kiymaz, H. (2001). The day of the week effect on stock market volatility. Journal of Economics and Finance, (25), 181–193.
[3.] Capula, C., Rowley, I. and Sharpe, W.F. (1993). International value and growth stock returns. Financial Analysts Journal, (49), 27–36.
[4.] De Bondt, W. and Thaler, R. (1985). Does the stock market overreact?. Journal of Finance, (40), 793–808.
[5.] Elton, E., Gruber, M. and Rentzler, J. (1983). A simple examination of the empirical relationship between dividend yields and deviations from the CAPM. Journal of Banking and Finance, (7), 135–146.
[6.] Fama, E.J. (1991). Efficient capital markets: II. Journal of Finance, (46), 1575–1615.
[7.] Fama, E. and French, K. (1992). The cross-section of expected stock returns. Journal of Finance, (47), 427–465.
[8.] Grossman, S. and Stiglitz, J. (1980). On the impossibility of informationally efficient markets. American Economic Review, (70), 393–408.
[9.] Jensen, M. (1968). The performance of mutual funds in the period 1945–1964. Journal of Finance, (23), 389–416.
[10.] Haugen, R.A. and Baker, N.L. (1996). Commonality in the determinants of expected stock returns. Journal of Financial Economics, (41), 401–439.
[11.] Jagadeesh, N. (1990). Evidence of predictable behavior of security returns. Journal of Finance, (45), 881–898.
[12.] Jahnke, G., Klaffke, S.J. and Oppenheimer, H.R. (1987). Price–earnings ratios and security performance. Journal of Portfolio Management, (14), 39–46.
[13.] Jensen, M. (1968). The performance of mutual funds in the period 1945–1964. Journal of Finance, (23), 389–416.
[14.] Levis, M. (1989). Stock market anomalies: a reassessment based on UK evidence. Journal of Banking and Finance, (13), 675–696.
[15.] Lintner, J. (1965). The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. Review of Economics and Statistics, (47), 13–37.
[16.] Litzenberger, R.H. and Ramaswamy, K. (1979). The effect of personal taxes and dividends on capital asset prices: theory and empirical evidence. Journal of Financial Economics, (7), 163–195.
[17.] Lofthouse, S. (1994). Equity investment management—how to select stocks and markets. New York: John Wiley.
[18.] Markowitz, H. (1959). Portfolio selection: efficient diversification of investments. New York: John Wiley.

[19.] Reinganum, M.R. (1992). A revival of the small firm effect. Journal of Portfolio Management, (18), 55–62.
[20.] Rosenberg, B., Reid, K. and Lanstein, R. (1985). Persuasive evidence of market inefficiency. Journal of Portfolio Management, (11), 9–16.
[21.] Sharpe, W. (1964). Capital asset prices: a theory of market equilibrium under conditions of risk. Journal of Finance, (19), 425–442.
[22.] The Icelandic Stock Exchange. Data 1993-2003.

THE LONG AND SHORT RUN INTERDEPENDENCES BETWEEN THE ROMANIAN EQUITY MARKET AND OTHER EUROPEAN EQUITY MARKETS

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Abstract

The present paper examines the short and long run dynamics between the Romanian equity market and different stock markets from the European Union. By using the Johansen's cointegration test we find evidence to support cointegration between the nine European markets chosen. Our short run investigation is done within a VECM framework. We examine the impact of shocks to external equity markets on the Romanian market by using the Impulse Response and Variance Decomposition analyses. No evidence is found to support short run integration of the Romanian market with other stock markets from EU. We reveal that the most important Romanian index, BET, responds mostly to its own shocks. Our findings are consistent with the fact that foreign investors still choose to diversify their portfolios by buying stocks at the Bucharest Stock Exchange, which offers them the possibility to obtain very large speculative profits.

Keywords: *cointegration, VECM, stock market indices, interdependences*

1. Introduction

The last decades of the world history can be characterized by the process of globalization. As time goes by, the effects of this process are more widely and faster spread. Moreover, they penetrate a wide range of domains (the economic one, as well as the social, political and cultural ones).

In the economic field, the globalization process implies that cash flows between different national economies are bigger, faster and more and more frequent. This phenomenon has caused –over time- an increasing integration of national economies, especially of national capital markets. The integration of world capital markets has increased also due to a process of relaxation of restrictions on capital flows and exchange controls in many countries.

There is a lot of research regarding the integration of world capital markets. This interest of researchers towards this subject can be explained first of all by considering the impact of this phenomenon on portfolio international diversification, as well as on the arbitrage possibilities between different national stock exchanges. In addition, the fast propagation of the crises settled on different capital markets to other capital markets was another factor that gave a strong impulse to the research in this field.

This article investigates the cointegration between the Romanian Stock Exchange and other stock exchanges from the European Union. The selection criterion of the European stock exchanges regards the level of the economic relationships with Romania. We chose stock exchange indices from Austria, Belgium, France, Germany, Holland, Hungary, Italy and United Kingdom. We work with blue-chip indices: BET for Romania, ATX for Austria, BFX (BEL 20) for Belgium, CAC 40 for France, DAX for Germany, AEX for Holland, BUX for Hungary, MIB 30 for Italy and FTSE 100 for England. The analysis covers the period from the 1st of January, 2000 to the 22nd of June, 2005.

In section 2 we review the literature written in this field of research. Section 3 describes briefly the Romania's transition to a market economy after 1989, as well as the appearance and the development of a capital market. In Section 4 we present the data and the methodology we consider. We use the Johansen's cointegration test, as well as a VECM aproach for the short-run analysis. Section 5 is a presentation of our results, while in section 6 we draw the conclusions.

2. Literature Review

Over time, researchers have had a strong interest in the linkages among international stock markets. The first studies in this area were done by Levy and Sarnat (1970), Ripley (1973), Lessard (1976) and Hillard (1979). They found low correlations between national stock markets.

Identifying the co movements of various stock markets became a constant preoccupation of specialists after the 1987 international market crash. Eun and Shim (1989) find evidence sustaining the existence of a co-movement between the US stock market and other world equity markets by using the VAR approach. Malliaris and Urrutia (1992) analyze "lead-lag relationships for six major stock market indexes" (from New-York, Tokyo, London, Hong Kong, Singapore ans Australia) before, during and after the 1987 crisis. By using Granger causality methodology, they find no important causality relationships before and after the crisis. However, they detect uni-/ bi-directional causalities for the month of the crash. Furstenberg and Jeon (1990), Lee and Kim (1994) find that the linkages between stock markets became stronger after the October 1987 crash.

Kasa (1992), Blackman et al. (1994), Jochum et al.(1999) examine the existence of a long run equilibrium for different mature as well as emerging equity markets and find evidence to sustain the cointegration of these markets. On the contrary, Richards (1999) finds no cointegration by using the small sample critical values proposed by Cheung and Lai (1993).

As during the last decade of the 20^{th} century a wide range of emerging stock markets appeared and started to develop, a lot of research was done on the integration between these markets or between them and mature equity markets.

Studies like Gelos and Sahay (2000), Scheicher (2001), Gilmore and McManus (2002) investigate the extent to which the equity markets from Central Eastern Europe are integrated with the global markets and whether they are subject to global shocks. Linne (1998) tries to find whether the emerging Eastern European markets (Russia, Poland, Hungary, the Czech Republic and Slovak Republic) are cointegrated between themselves, as well as with mature markets (Germany, UK, France, Italy, Switzerland, US and Japan). The results show that among the emerging markets, Poland displays a common trend with the world portfolio proxied by MSCI-World Index. Russia doesn't display any linkages with any of the analyzed markets, while the Slovakian stock market is cointegrated with all mature stock markets.

Gelos and Sahay (2000), Hernandez and Valdes (2001), Dungey et al. (2003) investigate the repercussions of the Russian currency and debt crisis on other world stock markets.

Numerous studies aim to reflect the integration of emerging markets from South Asia, South Africa, South America or Middle East. Ratanapakorn and Sharma (2002) use the cointegration analysis and Granger causality test to analyze the short run and long run relationships between stock indices from the Middle East, US, Europe, Latin America and Eastern Europe. They find no long run relationship between the Middle East indices and the rest of the stock markets. Maysami et al. (2000) examines interactions between the Singapore equity market and the stock markets of the US and Japan, by using unit root tests and the VAR methodology. The same methodology is used by Phylaktis (1999) to determine the influence of the US and Japan markets on the markets from the Pacific Basin countries.

All the studies mentioned above represent only a small part of the vast literature written in this area. The Romanian stock market was not part of any research concerning the other emerging markets from CEE. This is probably due to the slow development of the capital market in Romania during the last decade of the 20th century, mostly as a result of the severe recessions that characterized the Romanian economy during that period.

3. The Romanian Capital Market –a mirror of the Romanian economy in transition

The Romanian transition to a market economy after the collapse of the socialism has been more difficult than the transition of other former socialist countries, being characterized by a range of severe economic periods of recessions. The recession of the first years of transition was due mostly to more objective causes such as: the whole Romanian economy before 1989 was completely nationalized and centralized; its management was irrational and refused to take into account any signals from the real economy; there was no competition on any market of the national economy; after 1989, the politicians, but also the managers and entrepreneurs had no experience at all. Unlike this first period of recession, the severe depression between 1997 and 1999 was caused by the lack of continuity in the macroeconomic policies. This period was characterized by a fall of 12% in the GDP, high external deficits and a very high inflation rate. All these led to the "edge" of the crisis in 1999, when Romania was close to bankruptcy (cessation of payments).

Starting from 2000, several measures were adopted in order to stop the economic fall and achieve stabilization. The GDP grew in 2000 with

2.1% and this trend was continued afterwards. The last three years were characterized by deflation, due to the prudent monetary policy led by the National Bank, but also to the austerity Government policy concerning public expenditures. The foreign direct investments, as well as the Romanian exports increased.

The Romanian capital market followed the same trends as the national economy. The legal basis of the capital market was put in 1994. In 1995, after almost 50 years of interruption, the Bucharest Stock Exchange was refounded1. During 1995 and the 1st trimester of 1997 the stock exchange was characterized by a slow growth and lack of liquidity. During the second and the third trimesters of 1997, a boom in the transactions volume took place. This boom was mostly due to massive foreign investments, while only 5% of the transactions were done by residents. The cause of this phenomenon was the increasing trust in the Romanian economy, as a result of the politic shift in 1996 (from left wing to right wing) and the promising policies of the new government.

The Romanians didn't choose to invest at the stock exchange for several reasons:

- ✓ they lacked the education and the trust in such kind of investment;
- ✓ in this period, the state bonds offered very high interest rates (in general, higher than any other investment)
- ✓ the level of income in Romania was continuously depreciating.

However, the legislative hesitations of the new government, the slow rhythm of privatization, the high level of political instability, the resignation of the government in 1998 led to diminishing foreign investments at Bucharest Stock Exchange. Certainly, the period of economic recession between 1997 and 1999 left marks on the stock exchange activity.

However, the economic growth achieved beginning with 2000 was reflected in the stock exchange activity as well. The main stock exchange index, BET, grew from 814.85 points on the 5th of January 2000 to more than 5000 points in March 2005. The liquidity has improved and the transactions volumes has increased. The ratio between residents transactions and nonresidents transactions also grew. Nowadays, about 80% (in average per month) of the transactions are done by residents.

Apart from the Bucharest Stock Exchange, several other organized capital markets were founded:

1 On the 23rd of June 1995 the Association of the Stock Exchange was founded.

- ✓ On the 1st of November 1996, the RASDAQ market (Romanian Association of Securities Dealers Automated Quotations) was founded. This is an OTC market where the companies that do not fulfill the requirements to be traded at BSE are negotiated.
- ✓ In 1994, The Sibiu Merchandise Stock Exchange was founded. In 1997, this institution became The Monetary – Financial and Merchandise Stock Exchange, and derivates started to be negotiated (especially futures on currencies and indices).
- ✓ In November 1998, following the model of the stock exchange mentioned above, The Romanian Merchandise Exchange was founded. Futures on currencies, interest rates, as well as options on currency futures are traded here.

At the Bucharest Stock Exchange (BSE), the variations in stock prices are mostly reflected by three important indices.

The first one, BET, a blue chips index, was launched in September 1997. It measures the price variations of the top ten companies in terms of liquidity and market capitalization. It is a Laspeyres index, weighted with the market capitalization of the stocks.

BET-C (1998) reflects the global evolution of the market, while the third index, BET FI is a sectorial one. It measures the price variation of the five close investment funds listed at the Bucharest Stock Exchange.

4. Data and Methodology

We use the natural logarithms of weekly indices for the period from the 1st of January 2000 to the 22nd of June 2005. We chose to collect Wednesday prices in order to avoid any "day of the week" effects on data. All the indices are based on prices denominated in Euros. Adjustments were made for those indices denominated in other currencies.

Concerning our methodology, first of all, we determine the number of unit roots of each index series by using the Augmented Dickey Fuller Test and the Philips Perron Test.

Then, cointegration is tested by using Johansen's cointegration test.

Finally, if the cointegration hypothesis is confirmed, we proceed to a short-run analysis, by using the VECM methodology, impulse response functions, as well as variance decomposition.

The data processing was made by using software packages like: Microsoft Excel, Fox Prow, EViews 3 and Stata 9.

4.1 Unit Root Tests

i. Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF)

The starting point in testing the presence of unit roots is an AR(1) model with one of the next three forms:

$$\Delta y_t = \gamma y_{t-1} + \varepsilon_t \qquad (1)$$

or $\Delta y_t = \mu + \gamma y_{t-1} + \varepsilon_t$ - a drift term is added (2)

or $\Delta y_t = \mu + \beta t + \gamma y_{t-1} + \varepsilon_t$ - both a drift term and a linear time trend are added. (3)

In the above equations, ε_t is a white noise.

In all equations, we test whether the parameter $\gamma=0$, which is equivalent with testing the presence of a unit root.

The test described above is only valid when the series is an AR(1) process. In the case of higher order serial correlation, in order for ε_t to be a white noise, a correction must be made. The Augmented Dickey-Fuller method of solution to this problem was based on assuming that the *y* series follows an AR(p) process and adding lagged difference terms of the dependent variable *y* to the right-hand side of the regression:

$$\boldsymbol{\Delta y_t = \mu + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \ldots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t} \qquad (4)$$

The null hypothesis is the same as in Dickey Fuller test: $\mathbf{H_0}$: $\gamma=0$, while the alternutive is: $\mathbf{H_1}$: $\gamma<0$.

The t-statistic under the null hypothesis of a unit root does not have the conventional t-distribution. The critical values for the t-test were first simulated by Dickey and Fuller (1979) and more recently by MacKinnon (1991).

4.1.1 The Philips Perron Test (PP test)

The test regression for the PP test is the same as the one for the DF test. But, Philips and Perron (1988) propose a non-parametric correction for higher order correlation. An estimate of the spectrum of ε at frequency zero that is robust to heteroskedasticity and autocorrelation of unknown form is used. The Newey-West heteroskedasticity autocorrelation consistent estimate is:

$$\omega^2 = \gamma_0 + 2\sum_{j=1}^{q}(1 - \frac{j}{q+1})\gamma_j \,, \qquad (5)$$

$$\gamma_j = \frac{1}{T}\sum_{t=j+1}^{T}\tilde{\varepsilon}_t\tilde{\varepsilon}_{t-j} \,, \qquad (6)$$

where q is the truncation lag.

The PP t statistics is:

$$t_{PP} = \frac{\gamma_0^{1/2} t_\gamma}{\omega} - \frac{(\omega^2 - \gamma_0) T S_\gamma}{2\omega\tilde{\sigma}}, \qquad (7)$$

where t_γ and S_γ are the t-statistic and standard error of γ and $\tilde{\sigma}$ is the standard error of the test regression.

The PP statistics has the same asymptotic distribution as the DF or ADF statistics.

4.1.2 The Johansen's cointegration test

The starting point for this test is a VAR(p) process:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t, \qquad (8)$$

This can also be written:

$$\Delta y_t = \sum_1^{p-1} \Pi_i \Delta y_i + \Pi y_{t-p} + Bx_t + \varepsilon_t, \qquad (9)$$

where y_t is a *k*-vector of non-stationary I(1) variables, x_t is a *d* vector of deterministic variables, and ε_t is a vector of innovations. Also, $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Pi_i = -\sum_{j=i+1}^{p} A_j$.

If the series are cointegrated, Π has reduced rank $r \le k-1$ and can be factorized into $\Pi = \alpha\beta'$, where α and β are two (k x r) matrices. α represents the speed of adjustment to disequilibrium and β is a matrix of long run coefficients, such that $\beta' y_{t-p}$ represents up to *k-1* cointegration relationships in the multivariate model.

Johansen (1988) obtains estimates of α and β using the procedure known as reduced rank regression. He estimates the Π matrix without imposing any VECM restrictions, by calculating k eigenvalues[2]($\lambda_1, \ldots, \lambda_k$). The r eigenvectors - $\hat{V} = (\hat{v}_1, \ldots, \hat{v}_r)$ - corresponding to the first r eigenvalues contain, in fact, the estimations of the elements of the β matrix. The combinations $\hat{v}_i' y_t$, i=1...r, are all stationary. The other k-r combinations obtained with the last k-r eigenvectors are nonstationary. In order for the series to be cointegrated (this implies that $\beta' y_t$ is stationary), the last k-r

2 For more information, see Harris and Sollis (2003)

eigenvalues must be very small (zero). Therefore, Johansen proposes to test the null:

$$H_0 : \lambda_i = 0, \quad \text{i=r+1,…, n} \qquad (10)$$

In order to test the null above, the so-called trace statistic is used:

$$\lambda_{trace} = -T \sum_{i=r+1}^{k} \log(1 - \hat{\lambda}_i), \text{ r=0, 1, 2, …, k-1.} \qquad (11)$$

Asymptotic critical values for the trace statistics were provided by Johansen and Juselius (1990), Osterwald-Lenum (1992), Pesaran et al. (2000) and Doornik (1999)3. EViews 3, the statistical sofware we use, tabulates the critical values for the reduced rank test as given by Osterwald-Lenum (1992).

Johansen considered the following five possibilities of conducting the test4:

1. Series *y* have no deterministic trends and the cointegrating equations do not have intercepts;

2. Series *y* have no deterministic trends and the cointegrating equations have intercepts;

3. Series *y* have linear trends but the cointegrating equations have only intercepts;

4. Both series *y* and the cointegrating equations have linear trends;

5. Series *y* have quadratic trends and the cointegrating equations have linear trends.

4.2 The short-run analysis

If the index series are proved to be cointegrated, the short-run analysis must be done within a VECM framework. Therefore, after establishing the number of cointegration relationships, we need to estimate the short-run vector autoregression (VAR) in error-correction form with the cointegration relationships explicitly included:

$$\Delta y_t = \sum_1^{p-1} \Pi_i \Delta y_i + \Pi y_{t-p} + Bx_t + \varepsilon_t \qquad (12)$$

3 See Harris and Sollis (2003), pg 122

4 see Johansen, 1995, p. 80–84 for details

Considering that all the components of the VECM are stationary *I(0)* variables, standard OLS regression and inference can be used in estimating the coefficients.

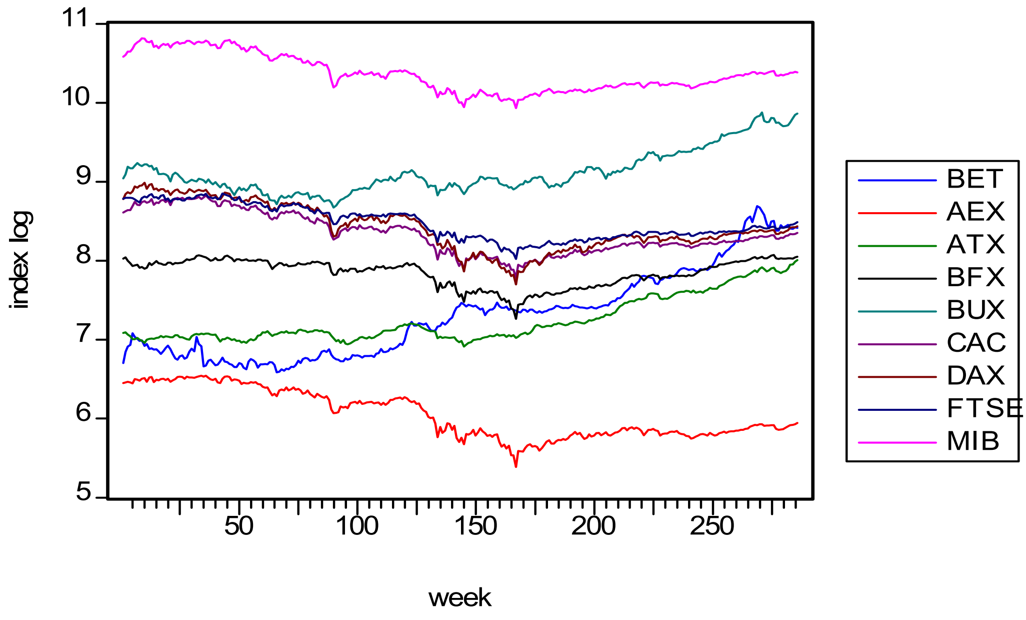
Our short-run aproach also concerns the analysis of impulse-response functions and variance decomposition, which are estimated within a VECM framework as well. The impulse-response functions are meant to trace the impact of one standard deviation shock in the innovations on the endogenuos variables of the VECM. Briefly, the impulse-response analysis involves that the errors are orthogonalized by a Cholesky decomposition so that the covariance matrix of the resulting innovations is diagonal.

The variance decomposition decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR. Such an analysis provides information on the relative importance of each random innovation to the variables in the VAR.

5. Results

Before running any tests, a chart was made, representing the variations of the logs of the nine series:

Figure 1 The Variations of the Logs of the Index Series



Source: Author's calculation

By analyzing the chart, we can observe that the line graphs representing the variations in the indices of most of the mature markets (MIB, DAX, FTSE, AEX, BFX, CAC) are quite parallel, suggesting a common trend. The line graphs of BET (the Romanian index) and BUX (the Hungarian index) seem to be parallel as well.

5.1 Unit Root Tests

We conducted the Augmented Dickey Fuller Test with a number of four lagged differences on the right hand of each equation tested. For the Philips Perron Test, we chose a truncation lag equal to five. This truncation lag was determined using the Newey-West method:

$$q = floor(4(T/100)^{2/9}),$$

where T is the total number of observations.

The results of the Augmented Dickey Fuller and Philips Perron tests can be summarized in the following tables:

1.1.1. Table 1 The ADF and PP statistics for the nine index series

	ADF STATISTIC	*PP STATISTIC*
AEX	-0.972028	-1.111446
ATX	-0.421773	-0.732197
BET	-2.95374	-1.806125
BFX	-0.605546	-0.873784
BUX	-1.532198	-1.048656
CAC	-0.682541	-0.80589
DAX	-0.819667	-0.902629
FTSE	-0.346169	-0.588957
MIB	-0.77107	-0.972134

Source: Author's calculation

Table 2 MacKinnon critical values for rejection of hypothesis of a unit root.

for the ADF test	1% Critical Value	-3.9941
	5% Critical Value	-3.4272
	10% Critical Value	-3.1366
for the PP test	1% Critical Value	-3.9937
	5% Critical Value	-3.427
	10% Critical Value	-3.1365

Comparing the test statistics in Table 1 with the critical values in the Table 2, we can conclude that in all the cases the null hypothesis of one unit root is accepted for all the significance levels considered (1%, 5%, 10%).

5.2 Johansen's Cointegration Test

In conducting Johansen's cointegration test, we encountered two kinds of problems.

The first one concerns the number of lags of the first differenced terms included in the right hand side of equation (1). In solving this problem, we used all information criteria available: the Hannan Quinn Information Criterion (HQ)5, the Akaike Information Criterion (AIC), the Schwarz criterion (SC). According to these criteria, we chose to perform the test with 1 lag in levels.

The second problem was selecting one of the five possibilities proposed by Johansen to run the test. We eliminated the first model (no deterministic components in the data or in the cointegration equations), especially because the intercept is needed to account for the units of measurement of the variables y_t 6. In order to choose one of the models 2 to 5, we applied the so-called Pantula principle suggested by Johansen in an article written in 19927. According to this principle, all models are estimated and the results are presented from the most restrictive model (2) to the least restrictive (5). "The test procedure is then to move from the most to the least restrictive model and at each stage to compare the trace statistic to its critical value and only stop the first time the null is not rejected."8 Following this procedure for 1 lag in the differenced terms, the first time the null was not rejected was for the third model (series *y* have linear trends but the cointegrating equations have only intercepts) and for a rank *r=1*.

We didn't include in the test regression any other exogenous variables, such as dummies.

Table 3 presents the results of the Johansen's test performed in its third form and for 1 lag in levels:

5 Johansen et al (2000) recommend using the HQ criterion in establishing the lag length of a VAR.
6 The series means differ from zero. Therefore intercepts are needed in the cointegrating equations.
7 For more information, see Harris and Sollis (2003), pages 134, 135
8 Harris and Sollis (2003), page 134

Table 3 The results of Johansen's cointegration test				
Eigenvalue	*Likelihood Ratio*	*5 Percent Critical Value*	*1 Percent Critical Value*	*Hypothesized No. of CE(s)*
0.1748	205.7967	192.89	205.95	None *
0.1359	151.0397	156	168.36	At most 1
0.1049	109.3944	124.24	133.57	At most 2
0.0874	77.8050	94.15	103.18	At most 3
0.0631	51.7547	68.52	76.07	At most 4
0.0453	33.1803	47.21	54.46	At most 5
0.0428	19.9756	29.68	35.65	At most 6
0.0222	7.5017	15.41	20.04	At most 7
0.0039	1.1118	3.76	6.65	At most 8

Source: Author's calculation

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.

In the table above, L.R. test indicates one cointegration relationship at 5% significance level. The normalized coefficients of this cointegration

relationships are presented in the following table (Table 4):

Table 4 Normalized Cointegrating Coefficients: 1 Cointegrating Equation									
BET	*AEX*	*ATX*	*BFX*	*BUX*	*CAC*	*DAX*	*FTSE*	*MIB*	*Intercept*
1	22.96	-3.18	5.24	2.71	52.32	-13.96	-58.62	-18.75	183.37

Source: Author's calculation

The cointegration analysis suggests that the Romanian stock market is integrated in the long-run with other European stock markets. This is not in contradiction with the fact that at the Bucharest Stock Exchange, nonresidents are still able to obtain very large profits, performing every year about 20%9 of the transactions. Such transactions are mainly speculative and capital flows have a transitory nature. There are large foreign capital flows during winter and spring, when the returns at BSE are very high. Such capitals are withdrawn in a few months. Therefore, while displaying a long-run equilibrium with EU stock markets, the Romanian market offers the possibility of large profits in the short run.

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9 In average, 24.96% in the first seven months of 2005 and 18.28% in 2004 (Source: www.bvb.ro).

5.3 The short-run analysis

As described in section 4, in the case of cointegration, the VECM methodology is required in the short-run analysis. Therefore, we estimated a restricted VAR containing one cointegrating relationship and 1 lag in levels. The results of our estimation can be seen in Table 5:

Table 5 The VECM estimation output

	Coef.	***Std. Err.***	***t***	***P>|t|***	***R-sq***
D_bet					
Coint Eq	-0.0027	0.0019	-1.41	0.158	0.026
Constant	0.0061*	0.0025	2.38	0.018	
D_aex					
Coint Eq	-0.0067*	0.0016	-4.15	0	0.0594
Constant	-0.0016	0.0022	-0.75	0.451	
D_atx					
Coint Eq	-0.0002	0.0009	-0.19	0.849	0.0256
Constant	0.0032*	0.0012	2.72	0.007	
D_bfx					
Coint Eq	-0.0031*	0.0013	-2.32	0.02	0.0187
Constant	0.0001	0.0018	0.08	0.937	
D_bux					
Coint Eq	-0.0032*	0.0014	-2.25	0.024	0.0249
Constant	0.0029	0.0020	1.5	0.133	
D_cac					
Coint Eq	-0.0064*	0.0015	-4.33	0	0.0628
Constant	-0.0008	0.0020	-0.4	0.689	
D_dax					
Coint Eq	-0.0057*	0.0016	-3.44	0.001	0.041
Constant	-0.0011	0.0022	-0.49	0.622	
D_ftse					
Coint Eq	-0.0018	0.0012	-1.53	0.127	0.0096
Constant	-0.0010	0.0016	-0.63	0.531	
D_mib					
Coint Eq	-0.0036*	0.0013	-2.8	0.005	0.0275
Constant	-0.0006	0.0017	-0.36	0.717	

Source: Author's calculation

In the above table, all the 5% statistically significant coefficients are marked with *. The coefficients of the cointegration relationship denote the speed of adjustment to disequilibrium. Within these coefficients, only some of them are statistical significant: the ones for the AEX, BFX, BUX, CAC40, DAX and MIB30 equations. For all the VECM equations, the R^2 coefficients are very low, indicating a reduced degree of statistical significance of the models. Although the Romanian market represents for foreign investors an opportunity for obtaining speculative profits, it does not display short-run interdependences with other EU markets. We also believe that in the short-run, an analysis based on daily data would be more appropriate.

5.3.1 Impulse-Response functions

As described in Section 4, the impulse response functions provide information on the expected response of each market to shocks affecting that market, as well as to shocks on other stock markets considered. The response of BET to one standard deviation shock in BET, AEX, ATX, BFX, BUX, CAC40, DAX, FTSE100 or MIB30 are presented within the figure in Annex 1. As expected, shocks on itself display a high and constant impact on BET. Shocks to ATX, BFX and BUX have an insignificant effect on the Romanian index, while shocks to AEX, DAX and MIB30 exert a small, but constant influence on BET. AEX has a negative impact on BET, while the German and the Italian indices have a positive influence. From all the EU stock indices, CAC40 and FTSE100 exhibit the largest, increasing in time effects on the Romanian index. The French index has a negative impact, while the British one displays a positive effect on BET.

5.3.2 Variance decomposition

To further assess the relative importance of shocks in prices, we decompose the forecast error variance of BET into parts attributable to shocks to BET, as well as to the other indices considered. The variance decomposition of BET is graphed in Annex 2. Shocks from the Romanian market explain most of its own forecast uncertainty (about 98%). Within the possible external shocks, the ones from FTSE100 account for only 1% -2% of the forecast error variance of BET, as the forecast horizon increases.

Although the Romanian market displays a long-run equilibrium with the equity markets from the EU, in the short-run it does not react promptly to shocks emanating from EU markets. Both the impulse-response and the variance decomposition analyses show that the Romanian index, BET, responds, most of all, to its own shocks.

6. Conclusions

This paper investigates to what extent the Bucharest Stock Exchange is integrated with eight European stock markets (Austria, Belgium, England, France, Germany, Holland, Hungary, Italy). First, we determine the order of integration for each index series, by using unit root tests (ADF and PP). We find that every index series displays one unit root. Then, in order to identify a long run relationship between the nine markets, we apply Johansen's cointegration test. We find one cointegrating relationship between the nine equity markets. We can say that in the long run the Romanian stock exchange is integrated with the other European equity markets.

Our investigation in the short run implies the estimation of the VECM, as well as impulse-response functions and variance decomposition analyses. We find that responses of the Romanian stock market to external shocks are neither significant nor prompt. About 98% of the forecast error variance of the Romanian index, BET, is due to shocks of itself. Our findings are consistent with the fact that foreign investors still obtain very large speculative profits at the Bucharest Stock Exchange. We cannot speak of a short-run integration of the BSE with other stock markets from EU.

References

[1] BRESSON, G., PIROTTE, A. Econometrie des series temporelles. Paris : Press Universitaire de France, 1995.

[2] CHEUNG, Y., LAI, K. A Fractional Cointegration Analysis of Purchasing Power Parity. Journal of Business and Economic Statistics, 1993, Vol 11, 103-112.

[3] CHEUNG, Y., NG, L. K. Stock Price Dynamics and Firm Size: An Empirical Investigation. The Journal of Finance, 1992, vol 47, 1985-1997.

[4] DUNGEY, M., FRY, R., GONZALES-HERMOSILLO B., MARTIN, V. Unanticipated shocks and systemic influences: the impact of contagion in global equity markets in 1998. IMF Working Paper WP/03/84, 2003.

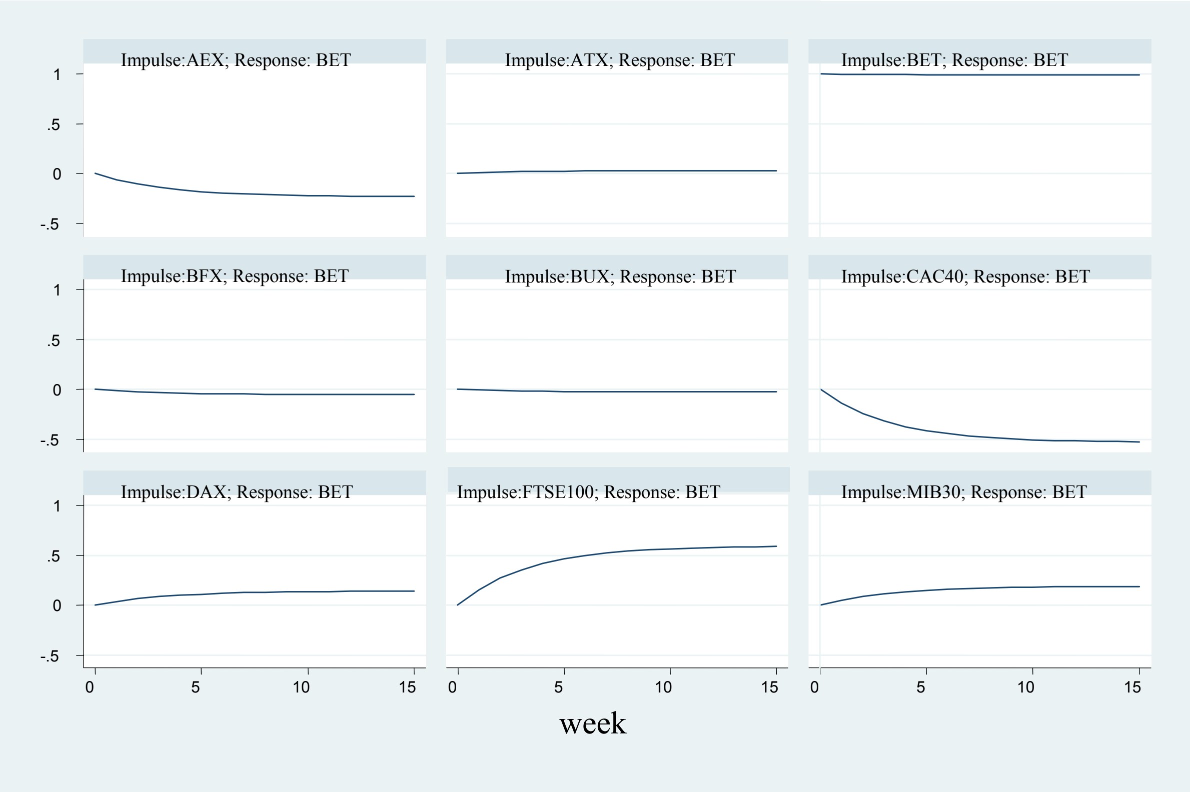
[5] ELFAKHANI, S. M., ARAYSSI, M., SMAHTA, H. A. Globalization and Investment Opportunities: a Cointegration Study of Arab, US and Emerging Stock Markets, 2004.

[6] EUN, C. S., SHIM, S. International Transmissions of Stock Market Movements. Journal of Financial and Qualitative Analysis, 1989, vol 24, pp 41-56.
[7] GELOS, G., SAHAY, R. Financial Market Spillovers in Transition Economies. IMF Working Paper WP/00/71, 2000.
[8] GILMORE, C. G., MCMANUS, G. M. International Portfolio Diversification: US and Central European Equity Markets. Emerging Markets Review, 2002, no 3, pp 69-83.
[9] HARRIS, R., SOLLIS, R. Applied Time Series Modelling and Forecasting. Chichester: John Wiley & Sons Ltd, 2003.
[10] HERNANDEZ, L. F., VALDES, R. O. What Drives Contagion: Trade, Neighbourhood, or Financial Links?. International Review of Financial Analysis, 2001, no 10, 203-218.
[11] HILLIARD, J. The Relationship between Equity Indices on World Exchanges", Journal of Finance, 1979, 103-114.
[12] JOHANSEN, S. Statistical Analysis of Cointegration Vectors. Journal of Economic Dynamics and Control, 1988, Vol 12, No 2-3, 231-254.
[13] JOHNSTON, J., DINARDO, J. Econometric Methods. The McGraw-Hill Companies, Inc, 1997.
[14] KASA, K. Common Stochastic Trends in International Stock Markets. Journal of Monetary Economics, 1992, vol 29, no. 1, 95-124.
[15] LEE, S.B., KIM, K.J. Does the October 1987 Crash Strengthen the Co-movement in Stock Price Indices?. Quarterly Review of Economics and Business, 1994, vol 3, no 1-2, 89-102.
[16] LESSARD, D. R. World, Country and Industry Factors in Equity Returns: Implications for Risk Reductions through International Diversification. Financial Analysis Journal, 1976, Vol 32, 32-38.
[17] MASIH, A. M. M., MASIH, R. Dynamic Linkages and The Propagation Mechanic Driving Major International Markets: An Analysis of The Pre- and Post- Crash Eras. The Quarterly Review of Economics and Finance, 1997, 37(4), pp 859-885.
[18] MALLIARIS, A. G., URRUTIA, J. L. The International Crash of October 1987: Causality Tests. The Journal of Financial and Quantitative Analysis, 1992, vol 27, no 3, pp 353-364.
[19] MILLS, T. C. The Econometric Modelling of Financial Time Series. Cambridge University Press, 1999.
[20] PHYLAKTIS, K. Capital Market Integration in the Pacific-Basin Region: An Impulse Response Analysis. Journal of International Money and Finance, 1999, no18, pp 267-287.
[21] RATANAPAKORN, O., SHARMA, S.C. Interrelationships among Regional Stock Indices. Review of Financial Economics, 2002, no 11(2), pp 91-108.

[22] RIPLEY, D. M. Systematic Elements in The Linkage of National Stock Market Indices. Review of Economics and Statistics, 1973, vol 55, no 3, pp 356-361.
[23] TULAI, H. Capital Investments. Cluj-Napoca: Casa Cartii de Stiinta, 2003, pp 113-122.
[24] VORONKOVA, S., LUCY, B. M. Linkages and Relationships between Emerging European and Developed Stock Markets Before and After the Russian Crisis of 1997- 1998. IIIS Discussion Paper, no 54, 2005.
[25] WONG, W. K., AGARWAL, A., DU, J. Financial Integration for India Stock Market, a Fractional Cointegration Aproach. 2005. Access from: <http://nt2.fas.nus.edu.sg/ecs/pub/wp/wp0501.pdf >

Annex1:

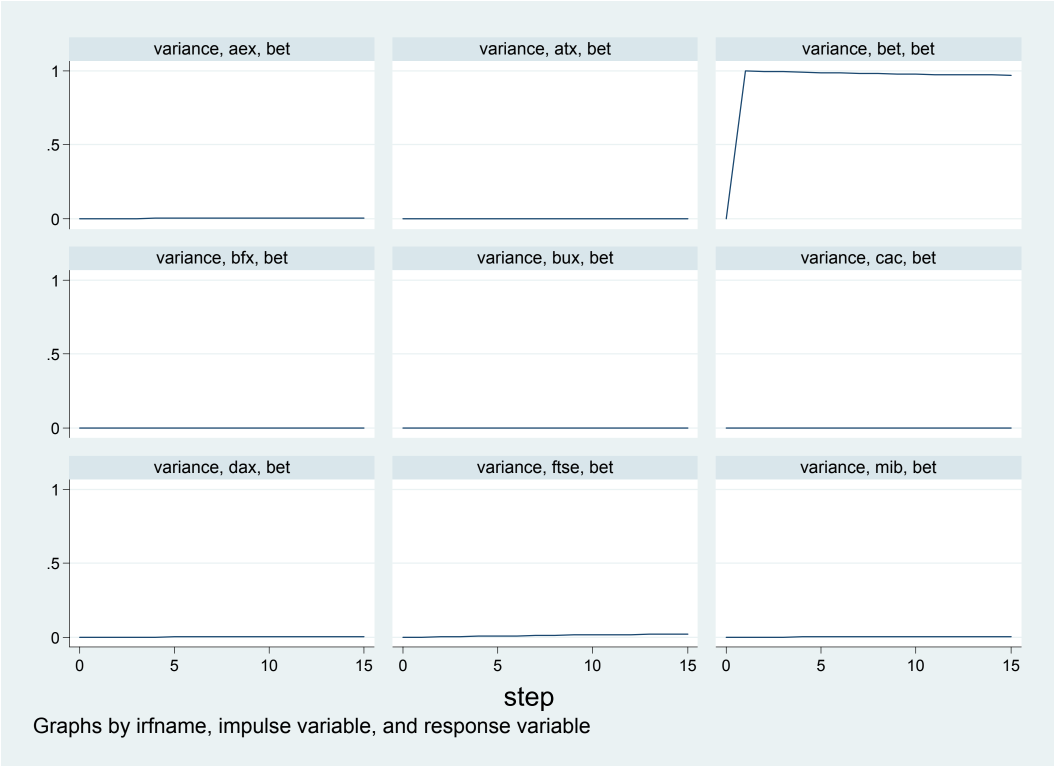
Figure 2 Impulse-Response of BET to One Standard Deviation Innovation in AEX, ATX, BET, BFX, BUX, CAC40, DAX, FTSE100 and MIB30



Source: Author's calculation

Annex 2:

Figure 3 Forecast Error Variance Decomposition for BET



Source: Author's calculation

THE CROSS-SECTION OF EXPECTED STOCK RETURNS FOR THE ATHENS STOCK EXCHANGE

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Abstract

Two easily measured variables, size and book-to-market equity, combine to capture the cross-sectional variation in average stock returns associated with market β, size, book-to-market equity, and earnings-price ratios for the Athens stock exchange for the period from 1997 to 2003. Creating portfolios on the basis of beta values produces no reliable relation between betas and average returns. Moreover, when portfolios are formed on size alone there is no relation between size and average return. When portfolios are formed on E/P alone there seems to be no evidence about any relation between E/P and average returns while when portfolios are formed on their estimated book-to market-equity no relation between average return and book-to-market equity can be derived. Variables like size, E/P and book-to-market equity are all scaled versions of a firm's stock price. They can be regarded as different ways of extracting information from stock prices about the cross-section of expected stock returns. Since all these variables are scaled versions of price, it is reasonable to expect that some of them are redundant for explaining average returns.

Keywords: *Athens Stock Exchange, portfolio returns, beta, risk free rate, stocks*

1. Introduction

Investors and financial researchers have paid considerable attention during the last few years to the new equity markets that have emerged around the world. This new interest has undoubtedly been spurred by the large, and in some cases extraordinary, returns offered by these markets. Practitioners all over the world use a plethora of models in their portfolio selection process and in their attempt to assess the risk exposure to different assets.

One of the most important developments in modern capital theory is the capital asset pricing model (CAPM). The capital asset pricing model (CAPM) of William Sharpe [1964], John Lintner [1965] and Fischer Black [1972] marks the birth of asset pricing theory. Four decades later, the CAPM is still widely used in applications, such as estimating the cost of capital for firms and evaluating the performance of managed portfolios. The attraction of the CAPM is that it offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Unfortunately, the empirical record of the model is poor – poor enough to invalidate the way it is used in applications.

The efficiency of the market portfolio implies that a) expected returns on securities are a positive linear function of their market βs (the slope in the regression of a security's return on the market's return), and b) market βs suffice to describe the cross section of expected returns.

There are several empirical contradictions of the Sharpe-Lintner – Black (SLB) model. The most important is the size effect of Banz [1981].He finds that market equity, ME (a stock's price times shares outstanding), adds to the explanation of the cross section of average returns provided by market βs. Average returns on small (low ME) stocks are too high given their β estimates, and average returns on large stocks are too low.

Another contradiction of the SLB model is the positive relation between leverage and average return documented by Bhandari [1988]. It is plausible that leverage is associated with risk and expected return, but in the SLB model leverage should be captured by market β.

Stattman [1980] and Rosenberg, Reid, and Lanstein [1985] find that average returns on U.S stocks are positively related to the ratio of a firm's book value of common equity, BE, to its market value, ME. Chan, Hamao and Lakonishok [1991] find that book to market equity, BE/ME, also has a strong role in explaining the cross section of average returns on Japanese stocks.

Finally, Basu [1983] shows that earnings-price ratios (E/P) help to explain the cross section of average returns on U.S stocks in tests that also include size and market β. Ball [1978] argues that E/P is a proxy for factors in expected returns. E/P is likely to be higher for stocks with higher risks and expected returns.

All the above variables can be regarded as different ways to scale stock prices, to extract information in prices about risk and expected returns. Moreover, since E/P, ME, leverage and BE/ME are all scaled versions of price, it is reasonable to expect that some of them are redundant for describing average returns. Initial goal of this paper is to evaluate the joint roles of market β size, E/P, and book-to-market equity in the cross section of average returns on the stocks of the Athens Stock Exchange.

Tests are conducted for a period of seven years (1997-2003), which is characterized by intense return volatility (covering historically high returns for the Greek Stock market as well as significant decrease in asset returns over the examined period). These market return characteristics make it possible to have an empirical investigation of the pricing model on differing financial conditions thus obtaining conclusions under varying stock return volatility.

Existing financial literature on the Athens stock exchange is rather scanty and it is the purpose of this study to widen the theoretical analysis of this market by using modern finance theory and to provide useful insights for future analysis of this market.

2. Empirical Appraisal of the model

2.1 Empirical Tests

The theory itself has been criticized for more than 30 years and has created a great academic debate about its usefulness and validity. Tests of the CAPM are based on three implications of the relation between expected return and market beta implied by the model (Fama & French, [2003]). First, expected returns on all assets are linearly related to their betas, and no other variable has marginal explanatory power. Second, the beta premium is positive, meaning that the expected return on the market portfolio exceeds the expected return on assets whose returns are uncorrelated with the market return. Third, assets uncorrelated with the market have expected returns equal to the risk free interest rate, and the beta premium is the expected market return minus the risk free rate. Most tests of these predictions use either cross-section or time-series regressions.

2.2 Tests on Risk Premiums

The early cross-section regression tests focus on the model's predictions about the intercept and slope in the relation between expected return and market beta. The approach is to regress a cross-section of average asset returns on estimates of asset betas. The model predicts that the intercept in these regressions is the risk free interest rate, R_f, and the coefficient on beta is the expected return on the market in excess of the risk free rate, $\mathrm{E}(R_{\mathrm{M}})$-$R_f$.

Two problems in these tests quickly became apparent. First, estimates of beta for individual assets are imprecise, creating a measurement error problem when they are used to explain average returns. Second, the regression residuals have common sources of variation, such as industry effects in average returns. To improve the precision of estimated betas, researchers such as Blume [1970], Friend and Blume [1970], and Black, Jensen, and Scholes [1972] work with portfolios, rather than individual securities. Since expected returns and market betas combine in the same way in portfolios, if the CAPM explains security returns it also explains portfolio returns. Estimates of beta for diversified portfolios are more precise than estimates for individual securities. Thus, using portfolios in cross-section regressions of average returns on betas reduces the critical errors in variables problem. Grouping, however, shrinks the range of betas and reduces statistical power. To mitigate this problem, researchers sort securities on beta when forming portfolios; the first portfolio contains securities with the lowest betas, and so on, up to the last portfolio with the highest beta assets. This sorting procedure is now standard in empirical tests.

The model's relation between expected return and market beta also implies a time-series regression test. CAPM says that the average value of an asset's excess return (the asset's return minus the risk free interest rate, $R_{it} - R_{ft}$) is completely explained by its average realized CAPM risk premium (its beta times the average value of $(R_{\mathrm{M}}$ - R_f)).

Many tests reject the basic assumption of the CAPM model. There is a positive relation between beta and average return, but it is too "flat". The evidence that the relation between beta and average return is too flat is confirmed in time series tests, such as Friend and Blume [1970], Black, Jensen, and Scholes [1972], and Stambaugh [1982]. The returns on the low beta portfolios are too high and the returns on the high beta portfolios are too low.

The model predicts that the intercept is the risk free rate and the coefficient on beta is the expected market return in excess of the risk free rate, $(\mathrm{E}(R_{\mathrm{M}}) - R_f)$-Rf. The regressions consistently find that the intercept is greater than the average risk free rate (typically proxied as the return on a one or three month Treasury bill), and the coefficient on beta is less than the average excess market return (proxied as the average return on a portfolio of stocks minus the Treasury bill rate). This is true in the early tests, such as Douglas [1968], Black, Jensen and Scholes [1972], Miller and Scholes [1972], Blume and Friend [1973], and Fama and MacBeth [1973], as well as in more recent cross-section regression tests, like Fama and French [1992].

2.3 Testing Whether Market Betas Explain Expected Returns

The model predicts that the market portfolio is mean-variance-efficient. This implies that differences in expected returns across securities and portfolios are entirely explained by differences in market beta; other variables should add nothing to the explanation of expected returns

This prediction plays a prominent role in tests of the CAPM. In the early work, the weapon of choice is cross-section regressions. One simply adds pre-determined explanatory variables to the cross-section regressions of returns on beta. If all differences in expected return are explained by beta, the average slopes on the additional variables should not be reliably different from zero. For example, in Fama and MacBeth [1973] the additional variables are squared market betas (to test the prediction that the relation between expected return and beta is linear), and residual variances from regressions of returns on the market return (to test the prediction that market beta is the only measure of risk needed to explain expected returns). These variables do not add to the explanation of average returns provided by beta.

2.4 Recent Tests

Starting in the late 1970s, empirical work appears to challenge CAPM. Specifically, evidence mounts that much of the variation in expected return is unrelated to market beta.

The first contradiction is Basu's [1977] evidence that when common stocks are sorted on earnings-price ratios, future returns on high E/P stocks are higher than predicted by the CAPM. Banz [1981] documents a size effect; when stocks are sorted on market capitalization (price times shares outstanding), average returns on small stocks are higher than predicted by the CAPM. Bhandari [1988] finds that high debt-equity ratios (book value of debt over the market value of equity, a measure of leverage) are associated with returns that are too high relative to their market betas. Finally, Statman [1980] and Rosenberg, Reid, and Lanstein [1985] document that stocks with high book-to-market equity ratios (BE/ME, the ratio of the book value of a common stock to its market value) have high average returns that are not captured by their betas.

There is a theme in the contradictions of the CAPM summarized above. Ratios involving stock prices have information about expected returns missed by market betas. Fama and French [1992] update and synthesize the evidence on the empirical failures of the CAPM. Using the cross-section regression approach, they confirm that size, earnings-price, debt-equity, and book-to-market ratios add to the explanation of expected stock returns provided by market beta. Fama and French [1996] reach the same conclusion using the time-series regression approach applied to portfolios of stocks sorted on price ratios. They also find that different price ratios have much the same information about expected returns.

Kothari, Shanken, and Sloan [1995] try to save the CAPM by arguing that the weak relation between average return and beta is just a chance result. But the strong evidence that other variables capture variation in expected return missed by beta possibly makes this argument irrelevant.

2.5 Explanations on the model's failures

The evidence on the empirical problems of the CAPM provided by Fama and French [1992] serves as a catalyst, implying that the CAPM may have fatal problems. Research then turns to explanations.

One possibility is that the CAPM's problems are not authentic, meaning that researchers use data and discover contradictions that occur in specific samples as a result of chance. A standard response to this concern is to test for similar findings in other samples. Chan, Hamao, and Lakonishok [1991] find a strong relation between book-to-market equity (BE/ME) and average return for Japanese stocks. Capaul, Rowley, and Sharpe [1993] observe a similar BE/ME effect in four European stock markets and in Japan. Fama and French [1998] find that the price ratios that produce problems for the CAPM in U.S. data show up in the same way in the stock returns of twelve non-U.S. major markets, and they are present in emerging market returns. This evidence suggests that the contradictions of the CAPM associated with price ratios are not sample specific.

Among those who conclude that the empirical failures of the CAPM are fatal, two views emerge. The firsts view is based on evidence that stocks with high ratios of book value to price are typically firms that have fallen on bad times, while low BE/ME is associated with growth firms (Lakonishok, Shleifer and Vishny, [1994]; Fama and French, [1995]). They argue that sorting firms on book-to-market ratios exposes investor overreaction to good and bad times. Investors over-extrapolate past performance, resulting in stock prices that are too high for growth (low BE/ME) firms and too low for distressed (high BE/ME, so-called value) firms. When the overreaction is eventually corrected, the result is high returns for value stocks and low returns for growth stocks. Proponents of this view include DeBondt and Thaler [1987], Lakonishok, Shleifer, and Vishny [1994], and Haugen [1995].

The second view for the empirical contradictions of the CAPM is based on the need for a more complicated asset pricing model. The CAPM is based on many unrealistic assumptions. For example, the assumption that investors care only about the mean and variance of distributions of one-period portfolio returns is extreme. It is reasonable that investors also care about how their portfolio return covaries with labor income and future investment opportunities, so a portfolio's return variance misses important dimensions of risk. If so, market beta is not a complete description of an asset's risk, and we should not be surprised to find that differences in expected return are not completely explained by differences in beta. In this view, the search should turn to asset pricing models that do a better job explaining average return

3. Sample Selection and Data

3.1 The sample securities

The study covers the period from January 1997 to December 2003. This time period was chosen because it is characterized by intense return volatility with historically high and low returns for the Greek stock market incorporating changes in fundamental variables of the enterprises, giving us the opportunity to test the model on differing financial conditions thus obtaining conclusions under varying stock return volatility.

The selected sample consists of the majority of the stocks that were trading on the Athens Stock Exchange over the examination period. We excluded financial firms because the high leverage that is normal for these firms probably does not have the same meaning as for non financial firms, where high leverage more likely indicates distress. The sample companies account for a major portion of market capitalization as well as average trading volume for the Greek stock market. Shares not included in the sample are either thinly traded or do not have accounting and financial information on a continuous basis.

The share data has been obtained form the Metastock and the Athens stock exchange, financial databases widely used in Greece by practitioners and researchers. The price data has been adjusted for capitalization changes such as bonus rights and stock splits. All the selected securities are traded on the ASE on a continuous basis throughout the full Athens stock exchange trading day, and are chosen according to prespecified liquidity criteria set by the ASE Advisory Committee.1 The selection was made on the basis of the trading volume and excludes stocks that were traded irregularly or had small trading volumes.

All the selected stocks are included in the formation of the FTSE/ASE 20, FTSE/ASE Mid 40 and FTSE/ASE Small Cap index. These indices are designed to provide real-time measures of the Athens Stock Exchange (ASE).

The above indices are formed subject to the following criteria:

(i) The FTSE/ASE 20 index is the large cap index, containing the 20 largest blue chip companies listed in the ASE.
(ii) The FTSE/ASE Mid 40 index is the mid cap index and captures the performance of the next 40 companies in size.
(iii) The FTSE/ASE Small Cap index is the small cap index and captures the performance of the next 80 companies.

3.2 Data

The study uses weekly stock returns for the selected companies listed on the Athens stock exchange for the period of January 1997 to December 2003. The data are obtained from MetaStock (Greek) Data Base.

Most firms in Greece have their fiscal year ends on December. So tests did not have to deal with matching the accounting data for all fiscal year ends in every calendar year. We use a firm's market equity at the end of December of each year to compute its book to market, leverage and earnings price ratios and we use its market equity of June of each year to compute its size. The accounting information combined with share price data has been used to construct measures of size and value employed in the study, as discussed in the next section.

1 www.ase.gr

Additionally annual profit information measured as Profit before Depreciation and Taxes (PBDT) has been collected for the sample companies from 1997 to 2003. The choice of profit figure has been guided by the fact that PBDT figures are seldom negative, making them appropriate for growth rate calculations.

In order to obtain better estimates of the value of the beta coefficient, the study utilizes weekly stock returns. Returns calculated using a longer time period (e.g. monthly) might result in changes of beta over the examined period introducing biases in beta estimates. On the other hand, high frequency data such as daily observations covering a relatively short and stable time span can result in the use of very noisy data and thus yield inefficient estimates.

All stock returns used in the study are adjusted for dividends as required by the CAPM. The ASE Composite Share index is used as a proxy for the market portfolio. This index is a market value weighted index, is comprised of the 60 most highly capitalized shares of the main market, and reflects general trends of the Greek stock market.

The 3-month Greek Treasury Bill is used as the proxy for the risk-free asset. The yields were obtained from the Treasury Bonds and Bill Department of the National Bank of Greece. The yield on the 3-month Treasury-bill is specifically chosen as the benchmark that better reflects the short-term changes in the Greek financial markets.

4. Methodology

The asset pricing model of Sharpe (1964), Lintner (1965), and Black (1972) is related to the way that academics and practitioners think about average returns and risk. The main argument of the model implies that the expected returns on securities are a positive linear function of their market betas (the slope in the regression of a security's return on the market's return), and the market’s beta suffice to describe the cross-section of expected returns.

There are several empirical contradictions of the Sharpe-Lintner-Black (SLB) model as previously presented such as the size effect of Banz [1981], the positive relation between leverage and average return documented by Bhandari [1988], the positive relation of the ratio of a firm’s book value of equity, BE, to its market value, ME and the E/P effect presented by Ball [1978].

The purpose in this part of the paper is to evaluate the joint roles of market’s β, size, E/P and book to market equity in the cross section of average stock returns on the Athens stock exchange (ASE). The relations between β and average return, the expanded relations between average return, size, E/P, and book-to-market equity will also be tested in order to investigate the sources of dimensions of risk in the SLB model. If assets are priced rationally, then stock risks should be multidimensional. One dimension of risk is proxied by size, ME. Another dimension of risk is proxied by BE/ME, the ratio of the book value of common equity to its market value. Ball [1978] argues that E/P is a proxy for the unnamed factors in the expected returns. This argument for E/P might also apply to size (ME), and book to market equity. All these variables can be regarded as different ways to scale stock prices, to extract information in prices about risk and returns.

In order to accomplish the above tests a significant number of stocks were selected from the ASE covering the period from January 1997 to December 2003. The number of stocks varies from year-to-year based on the criterion of their market capitalisation and their average trading volume. Most firms in Greece have their fiscal year ends on December. So tests did not have to deal with matching the accounting data for all fiscal year ends in every calendar year. We use a firm's market equity at the end of December of each year to compute its book to market, earnings price ratios and we use its market equity of June of each year to compute its size. Then, beta was estimated by regressing each stock's weekly return against the market index according to the following equation:

$$R_{it} - R_{ft} = \alpha + \beta_t (R_{mt} - R_{ft}) + e_t \qquad (1)$$

where, R_{it} is the return on stock i, R_{ft} is the rate of return on a risk-free asset, R_{mt} is the rate of return on the market index, β_i is the estimate of beta for the stock i, and e_{it} is the corresponding random disturbance term in the regression equation.

4.1 Decile Estimates-Two Dimension Sorting

In June of each year stocks are sorted by size (ME). After estimating the size of stocks, data were allocated to three deciles according to their size, 30% low size, 40% medium and 30% high size deciles. We split the data on deciles based on the evidence of Chan and Chen [1998] that size produces a wide spread of average returns and betas. To allow for variation in beta that is unrelated to size we subdivide each of the three size deciles into portfolios comprised of eight stocks each, on the basis of their individual beta estimates from the highest to lowest. Thus, a two dimension sorting is conducted firstly by the fundamental variable criterion, ME, and then by the beta estimate. Having created portfolios the average portfolio return is calculated from the individual stock returns.

The same methodology as described above is followed in constructing portfolios based on individual beta estimates where the criterion for forming deciles in this case, is not the size (ME) of stocks but their beta estimates.

The study continues by constructing portfolios using the criterion of book to market equity and earnings price ratio by allowing variation in beta. Three deciles are constructed 30% low, 40% medium and 30% high deciles using the initial sorting of stocks on the above two criterion. Moreover the data on deciles are categorized based on their individual beta estimates and portfolios of eight stocks in each one are created. In this way a two dimensional sort is also achieved and the intersection of these variables can be examined in scaling stock prices and extracting information about risk and returns.

4.2 Decile Estimates-One Dimension Sorting

In order to examine the main prediction of the SLB model that average return is positively related to market beta, portfolios are formed on size and beta alone. Moreover, book to market equity and E/P is also used in order to examine if these variables are good proxies for beta.

The same methodology as previously described is followed by creating three deciles 30% low, 40% medium and 30% high according to the above criteria (size, beta, BE/ME and E/P) but in this case no further sorting is being made, as in the above case where a second pass sort based on beta estimates was conducted.

4.3 Cross-section examination

The cross-sectional variation in average stocks returns associated with market *β,* size, book to market equity and earnings-price ratios is examined by using the time series regression. Tests are conducted on two dimension criterion sorting for each year separately from 1997 to 2003.

The importance of size and book to market equity in explaining the cross section in average stock returns is examined by using the following equation:

$$R_{pt} = \alpha + b_{2t} \cdot \ln(ME_{pt}) + b_{3t} \cdot \ln(BE_{pt} / ME_{pt}) + e_t \quad (2)$$

where R_{pt} , is the return of the portfolios, ME_t is the market equity of the constructed portfolios and finally BE_{pt} over ME_{pt} is the book equity to market equity of portfolios.

The inclusion of beta provides an interesting insight into the relation between size and book to market and average return. It is examined by the following equation.

$$R_{pt} = \alpha + b_{1t} \cdot \beta_{pt} + b_{2t} \cdot \ln(ME_{pt}) + b_{3t} \cdot \ln(BE_{pt} / ME_{pt}) + e_t \quad (3)$$

The final step is to examine all calculated variables by including in the regression analysis the estimated value of E/P of the portfolios. It is examined the earnings price ratio as a proxy for the omitted sources of risk that the previous variables may have not identified.

$$R_{pt} = \alpha + b_{1t} \cdot \beta_{pt} + b_{2t} \cdot \ln(ME_{pt}) + b_{3t} \cdot \ln(BE_{pt} / ME_{pt}) + b_{4t} \cdot (E_{pt} / P_{pt}) + e_t \quad (4)$$

5 Estimates

5.1 Beta estimation

Table 1a shows that forming portfolios on size alone, rather than on size and beta magnifies the range of beta for the examined period. In 1997 for instance in the first case (form portfolios on size alone) the lowest value of beta is -0.1979 and the highest is 0.4857 with estimated range between the two of them -1.0558. While in the second case (form portfolios on size and then sort them according to their beta estimates) the lowest value of beta is -0.2385 with highest value 0.4857 and range -0.6836. A different pattern of results are observed in years 2000, 2001 and 2002 where the Greek stock market suffered from a sharp decrease in stock prices returns. In these years the market was highly volatile, stock prices returns became rather unstable with severely fluctuating values of beta.

One important fact about βs is important. The beta sort is not a refined size sort. The deciles firstly are created by the size criterion and then within these deciles, stocks are sorted according to their individual beta estimates. Thus the beta sort achieves its goal to produce a variation in beta that is unrelated to size. This is important in allowing our tests to distinguish between beta and size effects in returns and any other variable that will be used later in the study.

5.2 β and Size

Table 2 shows average returns from 1997 to 2003 for portfolios formed from one-dimensional sort of stocks on size or beta. The portfolios are formed at the end of each year and their returns are calculated from the average returns of stocks that are included in the formation of these portfolios. Portfolios created on December because all firms that have been used in the study have their fiscal year ends on December, so we did not have to deal with matching the accounting data.

The Table shows that when portfolios are formed on size alone, we observe no relation between size and average return and no relation between average return and beta. These contradictory results are met in every year of the study where low beta portfolios provide higher returns than high beta portfolios. Thus, a simple size sort seems not to support the SLB prediction of a positive relation between beta and average return. For the estimation of ME, the study uses natural logs because logs are a good functional form of capturing effects in averaging returns. Using logs also leads to a simple interpretation of the relation between the values of these factors in averaging returns.

When portfolios formed on the basis of the ranked market betas of stocks a wider range of beta is produced than from portfolios formed on size. In the year of 2003 for example when portfolios are formed on betas the lowest value in beta is -0.1065 and the highest value is 2.6445 while the same values when forming portfolios on size alone are 0.7254 and 1.8626 respectively. As in the previous case in the size portfolios the beta sorted portfolios do not support the SLB model.

There is big spread in average returns across the beta portfolios, and there is no obvious relation between beta and average returns. For example, in year 2000 the high beta portfolio produces negative returns while the lowest beta portfolios produces positive returns. The widespread in returns, from 0.0249 in the year 2000 for the low beta portfolio to -1.8336 for the highest beta portfolio is an additional point that comes in contrast to the SLB model prediction.

The portfolios formed on size and then on betas in Table 1b clarify the contradictory evidence to the SLB model on the relation between beta and average return produced by portfolios formed on size or beta alone. Specifically, the two-pass sort gives a clearer picture of the separate roles of size and beta in average returns. Contrary to the central prediction of the SLB model, the second-pass beta sort produces less variation in average returns rather than on sorting portfolios on beta alone. Although the ranking in betas in Table 1b-panel B increase strongly in each size decile, average returns are flat or show a tendency to decline. In Table 1b-panel C, within the columns of the average return and betas, average returns and betas in some cases decrease with increasing size although a clear pattern cannot be inferred.

The two-pass sort on size and beta in Table 1b says that there might be a variation in beta that is related to size and related to average return, but variation in beta unrelated to size is not compensated in the average returns. The proper inference seems to be that there is a slight relation between size and average return, but controlling for size, there is no relation between beta and average return.

One possibility for the poor results in beta is that other explanatory variables are correlated with beta, and this creates problems for the relation between average returns and measured betas. However, this point cannot explain why beta has no power even when is used alone to create portfolios to explain average returns. Another hypothesis is that, as the SLB model assumes there is a positive relation between beta and average return, but the relation might become problematic by noise in the beta estimates.

5.3 Book-to-Market Equity and E/P

Table 3 shows average returns from 1997 to 2003 for portfolios formed on ranked values of book-to-market equity (BE /ME) or earnings-price ratio (E/P). The BE/ME and E/P portfolios in Table 3 are formed in the same general way (one-dimensional yearly sorts) as the size and beta portfolios in Table 2.

When portfolios are formed on E/P alone there seems to be no evidence about any relation between E/P and average returns. There are cases where portfolios E/P's increase in line with average returns but especially in years from 2000 to 2002, a period of high volatility for the market, no reliable relation between E/P and stock returns can be inferred.

Ball (1978) argues that the earnings-price ratio captures all omitted risk factors in expected returns. If current earnings are a proxy for expected future earnings then high-risk stocks with high expected returns will have low prices relative to their earnings. Thus, E/P should be related to the expected returns capturing the omitted sources of risk. However, this argument only makes sense, for firms with positive earnings. When current earnings are negative, like in our study for the period from 2000 to 2002-a period of recession for the Greek economy, they are not a proxy for the earnings forecasts embedded in the stock price, and E/P is not a proxy for expected returns.

In the next case when portfolios are formed on their estimated book-to market-equity no relation between average return and book-to-market equity can be derived. Average returns sometimes move in line with the increasing values of BE/ME portfolios but in most times returns do not behave in accordance to the BE/ME increase. It should be noted that the absence of any relation between average returns and betas, as previously presented, could be explained by the majority of firms with negative book equity.

We can report, however, that average returns for negative BE firms are high, like the average returns of high BE/ME firms. Different stock returns behavior, with a significant spread in values between negative BE firms and high BE/ME firms, is met in years from 2000 to 2002 , a period of extreme high volatility for the Greek stock market where most stocks lost much of their values. Negative book equity which results from persistently negative earnings is a signal of poor earnings prospects.

5.4 The interaction of Size, Beta, Book-to Market-Equity and Earnings Price Ratios in explaining average returns

Table 4 shows time-series regressions of the portfolios created each year based on the criterion of two pass sort. The purpose is to evaluate the joint roles of market beta, size, E/P and book-to market-equity.

5.4.1 Size Regressions

In order to explain the role of size in explaining average returns a two dimensional variation has been used, by creating deciles based on their size and then creating portfolios according to their beta estimates within these deciles, as previously described.

Like average returns in Table 1b, the results from the regressions about the intersection of returns between size and book-to-market equity indicate that there is no relation. The R^2 values are low in all years of the model; their slopes are negative with negative values of t-statistics and standard errors close to zero. The inclusion of beta in explaining the intersection of these variables with average returns does not seem to give different results. Although the R^2 values increase, the values of t-statistics persist to be negative with standard errors close to zero.

Adding E/P to the regression equation provides some useful thoughts. The slopes of the variables increase, R^2 values become significant and standard errors move from zero. The results indicate that by the inclusion of E/P the model works better and all variables together explain average returns. There is a positive relation between E/P and average returns which is due to the positive relation between E/P and ln(BE/ME) .Firms with high E/P tend to have high book-to-market-equity ratios.

5.4.2 Beta Regressions

The study examines now the interaction of size, beta, book-to market-equity and earnings price ratios in explaining average returns when forming portfolios based on the beta estimates of individual stocks. The results support the idea that when beta, size and book-to-market equity are combined together the model explains the variation in average returns. There is a positive relation between beta and these variables. R^2 values are high enough to support this idea with standard errors not close to zero and in addition acceptable values of t-statistics. The inclusion of all variables in the model does not provide supportive evidence in explaining average returns.

5.4.3 BE/ME and E/P Regressions

Creating portfolios according to their book-to-market equity and examining the cross-sectional variation in average stocks returns associated with market *β,* size, book to market equity and earnings-price ratios seems to give better results in explaining average returns than in the previous two cases. All statistical criteria have acceptable values to support the model and to provide adequate evidence in explaining the behaviour of stock returns. We should not, however, exaggerate with these results due to the fact that small ME stocks are more likely to have high book-to-market ratios, and high BE/ME stocks tend to be small (they tend to have low ME).

In the two dimensional sorting case based on E/P the model does not provide any positive relation in explaining average returns. The statistical criteria support the absence of relation and no conclusions can be extracted.

6 An extended variable model for explaining average returns

6.1 The multidimensional results

The conclusions from creating portfolios either on one or two pass-sort are summarized:

(1) When we form portfolios on the basis of beta values of stocks there is no reliable relation between betas and average returns.

(2) There is no relation between size and average return and no relation between average return and beta when portfolios are formed on size alone.

(3) Forming portfolios on size alone, rather than on size and beta magnifies the range of beta for the examined period.

(4) Contrary to the central prediction of the SLB model, the second-pass beta sort produces less variation in average returns rather than on sorting portfolios on beta alone. Although the ranking in betas increase strongly in each size deciles, average returns are flat or show a tendency to decline.

(5) The two-pass sort on size says that there might be a variation in beta that is related to size and average return, but variation in beta unrelated to size is not compensated in the average returns. There is a slight relation between size and average return, but controlling for size, there is no relation between beta and average return.

(6) When portfolios are formed on E/P alone there seems to be no evidence about any relation between E/P and average returns.

(7) When portfolios are formed on their estimated book-to market-equity no relation between average return and book-to-market equity can be derived. Average returns sometimes move in line with the increasing values of BE/ME portfolios but in most times returns do not behave in accordance to the BE/ME increase.

6.2 The intersection between Size, Beta, Book-to-Market Equity and E/P

The evaluation of joint roles of market beta, size, E/P and book-to market-equity in explaining stock returns in general do not give any supportive evidence. The combination of the above variables when portfolios are formed on size, indicate no power of interpreting average returns. The inclusion of E/P to the regression equation indicates that the model works better and that the intersection of all variables explains average returns. The explanation of the positive relation between E/P and average returns might be due to the positive relation between E/P and ln (BE/ME) .Firms with high E/P tend to have high book-to-market-equity ratios

The intersection of the variables with the beta sorting criterion for creating portfolios supports the idea that when beta, size and book-to-market equity are combined together the model explains the variation in average returns. The more reliable results are provided when portfolios are created on the basis of stocks book-to-market equity. But we should not exaggerate with these results due to the fact that small ME stocks are more likely to have high book-to-market ratios, and high BE/ME stocks tend to be small (they tend to have low ME). Finally, in the two dimensional sorting case based on E/P the model does not provide any positive relation in explaining average returns and conclusions can be extracted.

The purpose of the study is to examine the joint roles of market's β, size, E/P and book to market equity in the cross section of average stock returns on the Athens stock exchange covering the period from 1997 to 2003. We emphasize on different methods to approach the Sharpe-Lintner-Black model. In short, our tests do not support the central prediction of the SLB model, that average stock returns are positively related to market beta. One reason for these contradicting results is that some years of the examined period refer to an unstable and highly volatile period for the Greek stock market where stock prices increased significantly and suddenly lost most of their gains. So, is possible that the SLB model cannot incorporate these value fluctuations. Moreover, the tests here are restricted to stocks. It is possible that including other assets will change the inferences about the average premiums for beta, size, and book-to-market equity.

Variables like size, E/P and book-to-market equity are all scaled versions of a firm's stock price. They can be regarded as different ways of extracting information from stock prices about the cross-section of expected stock returns. Since all these variables are scaled versions of price, it is reasonable to expect that some of them are redundant for explaining average returns.

The relations between returns and economic variables that measure variation in business conditions are affected from the general economic situation and might help expose the nature of the economic risks captured by firm's fundamental variables like size, book-to-market equity and E/P.

References

[1] Bailey J.W, Alexander J.G, Sharpe W.1998. Investments. 6th edition, London: Prentice-Hall.

[2] Banz, Rolf W. 1981. "The Relationship Between Return and Market Value of Common Stocks."Journal of Financial Economics. 9:1, pp. 3-18.

[3] Basu, Sanjay. 1977. "Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis." Journal of Finance. 12:3,pp. 129-56.

[4] Bekaert, G., Harvey, C. 1997. Emerging equity market volatility. Journal of Financial Economics 43: 29-78.

[5] Bhandari, Laxmi Chand. 1988. "Debt/Equity Ratio and Expected Common Stock Returns:Empirical Evidence." Journal of Finance. 43:2, pp. 507-28.

[6] Black, Fischer, Michael C. Jensen and Myron Scholes. 1972. "The Capital Asset Pricing Model:Some Empirical Tests," in Studies in the Theory of Capital Markets. Michael C. Jensen,ed. New York: Praeger, pp. 79-121.

[7] Black, Fischer. 1972. "Capital Market Equilibrium with Restricted Borrowing." Journal of Business. 45:3, pp. 444-454.

[8] Blume, Marshall and Irwin Friend. 1973. "A New Look at the Capital Asset Pricing Model."Journal of Finance. 28:1, pp. 19-33.

[9] Blume, Marshall. 1970. "Portfolio Theory: A Step Towards Its Practical Application." Journal of Business. 43:2, pp. 152-174.

[10] Bodie, Z., Kane, A. and Marcus, A. J. 1999. Investments. 4^{th} edition, New York New York: McGraw- Hill.

[11] Brealey, R.A., and S.C. Meyers. 2002. Principles of Corporate Finance. New York: McGraw-Hill.

[12] Campbell, J. Y., Lo, A. W. and MacKinlay, A. C. 1997. The Econometrics of Financial Markets. Princeton, N. J.: Princeton University Press.

[13] Capaul, Carlo, Ian Rowley, and William F. Sharpe, 1993, "International Value and Growth Stock Returns." Financial Analysts Journal. January/February, pp. 27-36.
[14] Carhart, Mark M. 1997. "On Persistence in Mutual Fund Performance." Journal of Finance. 52:1, pp. 57-82.
[15] Chan, Louis K.C., Yasushi Hamao and Josef Lakonishok. 1991. "Fundamentals and Stock Returns in Japan." Journal of Finance. 46:5, pp. 1739-1789.
[16] Chen, N., R. Roll, and S. A. Ross 1986. Economic forces and the stock market. Journal of Business 59: 383-403.
[17] Cochrane, J. H. 1991. Volatility tests and efficient markets: A Review Essay. Journal of Monetary Economics 127: 463-485.
[18] Cochrane, John H. 2001. Asset Pricing. Princeton, N. J.: Princeton University Press. :Conditions of Risk". Journal of Finance. 19:3, pp. 425-442.
[19] DeBondt, Werner F.M. and Richard H. Thaler, 1985, Does the stock market overreact?, Journal of Finance 40, 793-805.
[20] Douglas, George W. 1968. Risk in the Equity Markets: An Empirical Appraisal of MarketEfficiency. Ann Arbor, Michigan: University Microfilms, Inc.
[21] Elton, E. J. and Gruber, M. J. 1995. Modern Portfolio Theory and Investment Analysis. 5th edition, New York: John: Wiley & Sons, Inc.
[22] Fama, Eugene F. 1996. "Multifactor Portfolio Efficiency and Multifactor Asset Pricing." Journal of Financial and Quantitative Analysis. 31:4, pp. 441-465.
[23] Fama, Eugene F. and James D. MacBeth. 1973. "Risk, Return, and Equilibrium: Empirical Tests." Journal of Political Economy. 81:3, pp. 607-636.
[24] Fama, Eugene F. and Kenneth R. French. 1992. "The Cross-Section of Expected Stock Returns."Journal of Finance. 47:2, pp. 427-465.
[25] Fama, Eugene F. and Kenneth R. French. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." Journal of Financial Economics. 33:1, pp. 3-56.
[26] Fama, Eugene F. and Kenneth R. French. 1995. "Size and Book-to-Market Factors in Earnings and Returns." Journal of Finance. 50:1, pp. 131-155.
[27] Fama, Eugene F. and Kenneth R. French. 1996. "Multifactor Explanations of Asset Pricing Anomalies." Journal of Finance. 51:1, pp. 55-84.
[28] Fama, Eugene F. and Kenneth R. French. 1997. "Industry Costs of Equity." Journal of FinancialEconomics. 43:2 pp. 153-193.

[29] Fama, Eugene F. and Kenneth R. French. 1998. "Value Versus Growth: The International Evidence." Journal of Finance. 53:6, pp. 1975-1999.
[30] Friend, Irwin and Marshall Blume. 1970. "Measurement of Portfolio Performance under Uncertainty." American Economic Review. 60:4, pp. 607-636.
[31] Gibbons, M. R., S. A. Ross, and J. Shanken. 1989. A test of the efficiency of a given portfolio. Econometrica 57: 1121-1152.
[32] Hamilton, James D. 1994. Time Series Analysis. Princeton University Press, Princeton
[33] Haugen, Robert. 1995. The New Finance: The Case against Efficient Markets. Englewood Cliffs, New Jersey: Prentice Hall.
[34] Jagannathan, R. and McGratten, E. R. 1995. The CAPM Debate. Quarterly Review of the Federal Reserve Bank of Minneapolis 19: 2-17.
[35] Jagannathan, R. and Wang, Z. 1996. The conditional CAPM and the cross-section of expected returns. Journal of Finance 51: 3-53.
[36] Jegadeesh, Narasimhan and Sheridan Titman. 1993. "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency." Journal of Finance. 48:1, pp. 65-91.
[37] Jensen, Michael C. 1968. "The Performance of Mutual Funds in the Period 1945-1964." Journal of Finance. 23:2, pp. 389-416.
[38] Kothari, S. P., Jay Shanken, and Richard G. Sloan. 1995. "Another Look at the Cross-Section of Expected Stock Returns." Journal of Finance. 50:1, pp. 185-224.
[39] Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny. 1994. "Contrarian Investment, Extrapolation, and Risk." Journal of Finance. 49:5, pp. 1541-1578.
[40] Lintner, John. 1965. "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." Review of Economics and Statistics. 47:1, 13-37.
[41] Loughran, Tim and Jay. R. Ritter. 1995. "The New Issues Puzzle." Journal of Finance. 50:1, pp.23-51.
[42] Loughran T., 1997, Book-to-market across firm size, exchange, and seasonality: is there an effect? Journal of Financial and Quantitative Analysis, Vol.30, 1997, 607-618.
[43] Markowitz, Harry. 1952. "Portfolio Selection." Journal of Finance. 7:1, pp. 77-99.
[44] Markowitz, Harry. 1959. Portfolio Selection: Efficient Diversification of Investments. Cowles Foundation Monograph No. 16. New York: John Wiley & Sons, Inc.
[45] Merton, Robert C. 1973. "An Intertemporal Capital Asset Pricing Model." Econometrica. 41:5, pp. 867-887.
[46] Michael C.Jensen, ed. New York: Praeger, pp. 47-78.

[47] Miller, Merton, and Myron Scholes. 1972. "Rate of Return in Relation to Risk: A Reexamination of Some Recent Findings," in Studies in the Theory of Capital Markets.
[48] Mitchell, Mark L. and Erik Stafford. 2000. "Managerial Decisions and Long-Term Stock Price Performance." Journal of Business. 73:3, pp. 287-329.
[49] Mossin, J. 1966. Equilibrium in a capital asset market. Econometrica 34: 768-783. Overreaction and Stock Market Seasonality." Journal of Finance. 42:3, pp. 557-81.
[50] Reinganum, Marc R. 1981. "A New Empirical Perspective on the CAPM." Journal of Financialand Quantitative Analysis. 16:4, pp. 439-462.
[51] Rosenberg, Barr, Kenneth Reid, and Ronald Lanstein. 1985. "Persuasive Evidence of Market Inefficiency." Journal of Portfolio Management. 11, pp. 9-17.
[52] Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium under
[53] Stambaugh, Robert F. 1982. "On The Exclusion of Assets from Tests of the Two-Parameter Model: A Sensitivity Analysis." Journal of Financial Economics. 10:3, pp. 237-268.
[54] Stattman, Dennis. 1980. "Book Values and Stock Returns." The Chicago MBA: A Journal of Selected Papers. 4, pp.25-45.
[55] Stein, Jeremy. 1996. "Rational Capital Budgeting in an Irrational World." Journal of Business. 69:4, pp. 429-455.
[56] Tobin, James. 1958. "Liquidity Preference as Behavior Toward Risk." Review of EconomicStudies. 25:2, pp. 65-86.

RANDOM AND NON-RANDOM WALKS IN THE ROMANIAN STOCK MARKET

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Abstract

Linear and nonlinear dependencies found in the Romanian stock market clearly reject the random walk hypothesis. Still, it is possible that these dependencies to be present just in certain periods of time, while in others the random walk null hypothesis could be accepted. In this situation, the rejection of the random walk hypothesis can be determined by some powerful dependencies in a few sub periods, thing that could provide a better starting point when it comes to debate about the forecasting power in the Romanian stock market. Using the Hinich & Patterson (1995) "windowed" methodology we discovered that, like on other markets, long periods of random walk alternates with short periods of linear/nonlinear correlation while the last ones are more frequent when compared with the Asian markets. Moreover, we developed a methodology for isolating maximum length period with significant linear/nonlinear dependencies and we reached the conclusion that returns are higher in random walk periods rather than in periods exhibiting linear/nonlinear dependencies.

Keywords: *linear/nonlinear dependencies; random walk; windowed methodology.*

1. Introduction

Financial economics literature has been dominated in the last decades by the linear concept diffused especially through the linear modeling of financial data time series. The fact that linear dependencies are not found within a time series does not mean that the series observations are random as this series might exhibit other more complex forms of dependencies. As possible factors that might induce significant non-linearity in stock market, Antoniou et al. (1997) enumerates: difficulties in executing arbitrage transactions, market imperfections, irrational investors' behavior, diversity in agents' beliefs and heterogeneity in investors' objectives. Thus, the linear concept, insufficiently sophisticated to capture these complex patterns, is challenged in recent years as a significant number of studies suggest that non-linearity is a universal phenomenon, at least for time series data of stock prices.

The linear and nonlinear dependencies found in the Romanian financial market rejected clearly the random walk hypothesis. However, it is possible that these dependencies to be present just in some sub periods of time while in others we could accept the null hypothesis. In this case, rejecting the random walk hypothesis on the whole sample could be the effect of some strong dependencies existing in certain sub periods. In this context, the main goal of this study is the analysis of the episodic transient behavior of non-linear dependencies in the case of Bucharest Stock Exchange. Bearing this in mind, this study conclusion could lead to a more delicate debate about the degree of predictability in the Romanian stock market.

The first ones to emphasis on the existence of such behavior were Schahter et al. (1985) and Hood et al. (1985). Hinich and Patterson (1995) developed testing methodology of the linear and non-linear dependencies by dividing the whole sample in "windows" and using the portmanteau correlation and bicorrelation test. Using this methodology a great number of studies, such are the one of Brooks and Hinich (1998), Brooks et al. (2000), Ammermann and Patterson (2003) and Lim and Hinich (2005), emphasis the existence of a different stock price behavior on sub periods of time, respectively the existence of long random-walk sub periods alternated with short sub periods characterized by strong linear or nonlinear correlation. Using a different methodology, Ramsey and Zang (1997) discover similar results.

A study that we have in progress proved that the rejection of the random walk hypothesis in the Romanian stock market is due both to a linear correlation determined by the low trading frequency and especially to some additive and multiplicative non-linear dependencies. Developing profitable forecasting linear and nonlinear models is possible only if these dependencies can be found during the whole sample period. Thus, it's becoming interesting to see how the return behavior of Romanian stocks has the same characteristics with the one from other markets, respectively the alternation of long periods of random-walk with short periods characterized by strong linear and nonlinear dependencies.

In this study we will use the "windowed" methodology developed by Hinich and Patterson (1995) which implies the division of the observations sample in sub samples or "windows" and running linear and nonlinear dependencies identification tests. More than that, the study will propose an improved version of the methodology for delimiting, as accurate as possible, the random walk periods from those exhibiting linear and nonlinear correlation.

2. Methodology

The methodology followed in this study is the "windowed" methodology developed by Hinich and Patterson in 1995. The following lines will expose a short description of this procedure. More details regarding the fundamentals and properties of tests in small samples can be found in Hinich and Patterson (1995) or Hinich (1996).

2.1 Hinich & Patterson methodology

Let the sequence **{R(t)}** be the realization of a stochastic process, respectively the return sample, where t is the time unit which is a whole number. The procedure implies the division of the sample in no overlapped sub samples of volume **n**, named "windows". Thus, the k window is the following sequence $\{R(t_k),R(t_k+1),\ldots,R(t_k+n-1)\}$ while the k+1 window is $\{R(t_{k+1}),R(t_{k+1}+1),\ldots,R(t_{k+1}+n-1)\}$ where $t_{k+1}= t_k + n$.

In each window, the null hypothesis is that R(t) are the realizations of a "white noise" process with null correlations and bi-correlations phenomenon described by the following formulas: $C_{EE}(r)=E[R(t)R(t+r)]$ and $C_{EEE}(r, s)=E[R(t)R(t+r)R(t+s)]$, where **r** and **s** are whole numbers satisfying the relation $0<r<s<L$, L being the number of lags. The identification of linear correlation will be made using the portmanteau C test (similar to the Box-Pierce test) while in the case of the nonlinear correlations we will use the H portmanteau test.

We define Z(t) as the standardized observations series, that is a centered and reduced series:

$$Z(t) = \frac{R(t) - m_R}{\sigma_R} \qquad (1)$$

where **t** takes values from 1
to n and $\mathbf{m_k}$, $\boldsymbol{\sigma_k}$ being the mean and the standard deviation within each window. The correlation between these standardized returns within each window will be:

$$C_{RR}(r) = (n-r)^{-1/2} \sum_{t=1}^{n-r} Z(t)Z(t+r) \qquad (2)$$

While the bi-correlation is computed as follows:

$$(r,s) = (n-s)^{-1} \sum_{t=1}^{n-s} Z(t)Z(t+r)Z(t+s) \qquad 0 \le r \le s \qquad (3)$$

The C and H statistics, used to detect linear (C) and nonlinear (H) dependencies in each window are distributed according to a χ^2 law of probability with L respectively (L-1)(L/2) degrees of freedom and they have the following expressions:

$$C = \sum_{r=1}^{L} \left[C_{RR}(r)\right]^2 \qquad (4)$$

$$H = \sum_{s=2}^{L} \sum_{r=1}^{s-1} G^2(r,s) \qquad (5)$$

Where $G(r,s) = (n-s)^{1/2} C_{RRR}(r,s)$ (6)

The number of lags, L, is specified as L= n^b, with 0< b <0.5. Using Monte-Carlo simulations, Hinich and Patterson (1995) recommends the usage of b=0.4 in order to maximize the power of the test assuring in the same time a good asymptotical approximation. Another parameter to be choused, the window length, must be long enough to offer a robust statistically power and yet short enough for the test to be able to identify the arrival and disappearance of transient dependencies, as changes in the variables behavior. Brooks and Hinich recommended a window length of 35 observations corresponding to an approximate 7 weeks trading period, volume that we will also use in our study.

The rejection of the null hypothesis by the C and H tests is done with a determined risk level, for which we will consider two values 0.05 and 0.01 corresponding to probabilities of 95% and 99%. This means that at a 0.05 risk level, the possibility of a false rejection of the null hypothesis exists in 5 of 100 windows.

2.2 Modified "windowed" methodology

The procedure of dividing the studied sample in no overlapped windows, proposed by Hinich and Patterson (1995), does not allow a correct identification of the sub periods exhibiting linear and nonlinear dependencies because the test results depends on how the first day of the sample is determined. For example, in a window, the random walk hypothesis can be accepted just because the linear/nonlinear dependencies exist just in a small time fraction of the windowed sub period. Thus, choosing the first day from the whole sample will significantly influence the results of the test.

This disadvantage can be eliminated by running the Hinich and Patterson methodology (1995) in a successive way, considering the first day of the sample each of the first 34 day of the first window. We developed this particular methodology in order to identify all sub periods, of different length, exhibiting linear and nonlinear correlations, from the ones in which the random walk hypothesis is accepted.

The problem to be solved can be schematizing as following: We have a sequence of returns and we want to isolate maximum length sub periods exhibiting linear and/or nonlinear dependencies. To carry out this task we have built a two step algorithm, which firstly isolates the fix length windows exhibiting linear/nonlinear dependencies and secondly join consecutive, both no overlapped (but strictly consecutive) and overlapped windows which rejects the random walk hypothesis. With this methodology we can determine local maximum length sub periods rejecting the random walk null hypothesis.

2.3 Todea-Zoicaş algorithm for isolating maximum length sub periods exhibiting linear and/or nonlinear dependencies

Variables:

L=length of a window (integer);

N=total number of observations within the sample period (integer);

NW= number of delimitated windows within the sample period (integer);

i,j,r,s= integer variables;

C, H, Lin_dep, Non_lin_dep = matrix of integers.

C*, H*= table values for the χ^2 distribution (degrees of freedom, risk level)

We define a window as a function f: {1, 2,…, NW} $\rightarrow N^* \times N^*$, characterized by two interval extremities, the beginning and the end of the windowed period: W (j):= (t_1,t_2) .

- *Isolating fix length windows exhibiting linear/nonlinear dependencies*

```
For i: =1 to L-1 do
        NW: = trunc ((N+1-i)/L);
    For j: = 1 to NW do
        W (i, j): = ((j-1)*L+i, j*L+i-1)
        C (i, j): = sum_{r=1}^{L} [C_RR(r)]^2  (for C_EE(r) see formula no. 2)
        H (i, j): = sum_{s=2}^{L} sum_{r=1}^{s-1} G^2(r,s)  (for G(r, s) and C_EEE (r, s)
see formula 6 and 3)
For i: =1 to L-1 do
    For j: = 1 to NW do
        If C (i, j) > C* then
            Lin_dep (i, j): = 1
        Else
            Lin_dep (i, j): = 0
        If H (i, j) > H* then
            Non_lin_dep (i, j): = 1
        Else
            Non_lin_dep (i, j): = 0
```

where C (i, j): = $\sum_{r=1}^{L}\left[C_{RR}(r)\right]^2$ (for $C_{EE}(r)$ see formula no. 2) and H (i, j): = $\sum_{s=2}^{L}\sum_{r=1}^{s-1} G^2(r,s)$ (for G(r, s) and C_{EEE} (r, s) see formula 6 and 3)

- *Joining consecutive both no overlapped (but strictly consecutive) and overlapped windows exhibiting linear/nonlinear dependencies*

The windows exhibiting linear and nonlinear dependencies are delimited from all windows within the *Lin_dep* and *Non_lin_dep* matrixes. These matrixes contain all the possible windows that can be delimited from the sample period running the modified H&P methodology; a value of 1 is associated with the windows exhibiting dependencies and 0 for the random walk windows.

For example, suppose that the *Lin_dep* matrix looks like the following one:

$$Lin\_dep = \begin{pmatrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 1 & 0 & 1 \end{pmatrix} \qquad (7)$$

First we isolate horizontally in case of all the matrix lines, maximum length arrays containing "1" and then we join vertically the overlapping and strictly consecutive arrays found above. Thus, we obtain maximum length windows exhibiting linear dependencies. In a similar way we proceed with the Non_lin_dep matrix. Finally, we join in the above described manner the maximum length windows exhibiting both linear and nonlinear dependencies obtaining maximum length windows rejecting the random walk hypothesis.

3. The data

The data consists of daily closing prices for the top traded stocks in Bucharest Stock exchange (BSE) and BSE main index, BET. All stocks prices and the index values are denominated in the local currency (RON), the period throughout we conducted the study is from 05.01.2000 to 19.12.2003, with a number of 980 observations. From these closing prices we obtained a series of logarithmic returns using the following formula: $r_t = \ln(p_t/p_{t-1})$ where p_t and p_{t-1} are successive closing prices.

4. Empirical results

The main objective of the Hinich-Patterson methodology (1995) is to see in what way the stocks prices follow a random walk during the whole sample interval. Choosing a 35 day window, we delimited a number of 28 windows in which we run the C and H tests with 0.05 and 0.01 risk levels.

From table 1 we can observe the higher frequency of windows exhibiting nonlinear dependencies compared to the linear ones. A particular case is the one of ATB (Antibiotics Iasi) where the linear correlation found in previous autocorrelation studies can be met in the great number of C significant windows also.

Table 1 Number of windows exhibiting linear/nonlinear dependencies

Index/ Stock	Risk level: 0,05		Risk level: 0,01	
	No. of windows with C significant	No. of windows with H significant	No. of windows with C significant	No. of windows with H significant
BET	1 (3,57%)	2 (7,14%)	0 (0%)	1 (3,57%)
ATB	7 (25%)	3 (10,71%)	4 (14,29%)	3 (10,71%)
AZO	2 (7,14%)	5 (17,86%)	2 (7,14%)	3 (10,71%)
CMP	3 (10,71%)	0 (0%)	1 (3,57%)	0 (0%)
IMP	2 (7,14%)	7 (25%)	0 (0%)	2 (7,14%)
SIF1	3 (10,71%)	2 (7,14%)	1 (3,57%)	1 (3,57%)
SIF2	0 (0%)	6 (21,43%)	0 (0%)	4 (14,29%)
SIF3	3 (10,71%)	7 (25%)	0 (0%)	5 (17,86%)
SIF4	1 (3,57%)	2 (7,14%)	1 (3,57%)	2 (7,14%)
SIF5	2 (7,14%)	5 (17,86%)	0 (0%)	2 (7,14%)
TLV	3 (10,71%)	5 (17,86%)	3 (10,71%)	3 (10,71%)

The results obtained are similar to those found by Lim and Hinich (2005) on 13 stock markets from Asia, namely that long periods of random walk alternates with short periods of linear and nonlinear correlation. However, the percentage of C and H significant windows is higher in the Romanian stock market compared with the Asian markets where the percentage is below the 7% level. As a conclusion, we can say that the Romanian market has a higher forecasting potential, respectively a lower degree of market efficiency in the weak form.

Modeling returns becomes difficult when the variables of the return's stochastic process change their behavior in time. Lim and Hinich (2005) consider this alternate random walk – linear/nonlinear dependencies the main cause of the relative low performance of nonlinear forecast models. A first step in improving these models should be the exact delimitation of the sub periods rejecting the random walk hypothesis. Once these sup periods are being identified, the next step is a comparative analysis of the returns probabilities distributions.

In the case of the Bucharest Stock Exchange index (BET), running the Hinich & Patterson (1995) methodology leaded to the delimitation of just three windows in which the random walk hypothesis is rejected with a guarantying probability of 95%. Running our proposed methodology (i.e. applying in a successive way the H&P methodology) changes substantially the results. As we can see in table no.2, in this case there are a number of 6 windows exhibiting linear correlation and 7 windows exhibiting nonlinear correlation, the risk level being 0.05. More than that, these windows have different length, obtaining by summing them a total period of 291 trading days (30%) in the case of linear correlation and 404 days (40%) for the nonlinear correlation.

Table 2 Windows exhibiting linear and nonlinear correlation - the modified methodology (BET index)

	Significant C	**Insignificant C**	**Significant H**	**Insignificant H**
No. of windows	6	7	7	8
Windows	06/06/00 07/08/00	06/01/00 05//06/00	06/06/00 11/10/00	06/01/00 05/06/00
	14/08/00 11/10/00	08/08/00 13/08/00	26/10/00 19/12//00	12/10/00 25/10/00
	20/03/02 14/05/02	12/10/00 19/03/02	15/02/01 02/07/01	20/12/00 14/12/01
	13/09/02 13/12/02	15/05/02 12/09/02	01/03/02 29/04/02	03/07/01 28/02/02
	08/04/03 08/07/03	14/12//02 07/04/03	15/10/02 04/12/02	30/04/02 14/10/02
	11/09/03 10/11/03	09/07/03 10/09/03	06/02/03 07/04/03	05/12//02 05/02/03
		11/11/03 19/12/03	15/04/03 11/09/03	08/04/03 14/04/03
				12/09/03 19/12/03
No. of days from the sample (percentage)	291 from 985 (29.54%)	694 from 985 (75.46%)	404 from 985 (41.01%)	581 from 985 (58.99%)

In order to completely identify the sub periods exhibiting linear and nonlinear correlations from the random walks ones, we will join the consecutives windows belonging to the same of these two categories in order to obtain the complete sub period in which the null hypothesis is rejected with a probability of 95%. More than that, in order to check if our methodology allows a better delimitation of the two categories sub periods we will determinate both C and H statistic on the longer now, homogenous sub periods.

Table 3 Acceptance/rejection of the random walk hypothesis - the modified methodology

Windows	C - statistic (Prob.)	H -statistic (Prob.)
Significant C and H windows – rejection of the random walk hypothesis		
06/06/00 11/10/00	9,59 (0,14)	62,61 (0,000)
15/02/01 02/07/01	4 (0,67)	53,37 (0,000)
01/03/02 14/05/02	14,2 (0,039)	6,75 (0,34)
13/09/02 13/12/02	17,55 (0,002)	19,98 (0,029)
06/02/03 10/11/03	11,89 (0,156)	98,89 (0,000)
Insignificant C and H windows – acceptance of random walk hypothesis		
06/01/00 05/06/00	9,94 (0,127)	12,55 (0,727)
20/12/00 14/02/01	0,36 (0,986)	1,79 (0,938)
03/0701 01/03/02	6,08 (0,64)	4,006 (0,005)
15/05/02 12/09/02	3,89 (0,67)	17,91 (0,06)
16/12/02 05/02/03	1,09 (0,835)	2,48 (0,857)
11/11/03 19/12/03	4,45 (0,41)	2,48 (0,608)

The C and H statistics with the probabilities associated to the acceptance of the random walk null hypothesis, presented in table no.3 prove that the new methodology allows a correct identification of the random walk periods. Another important result is that the long random walk periods are followed by long periods exhibiting linear and nonlinear dependencies. More exactly, from the whole sample the number of trading days in which the random walk hypothesis is rejected is 493 representing approximately 50% from the whole sample.

Table 4 Statistics of BET index return distribution

Statistics	Whole sample	Sub periods rejecting the random walk hypothesis	Sub periods accepting the random walk hypothesis
Average	0,00157	0,00135	0,00198
Standard deviation	0,0162	0,0183	0,0153
Skewness	0,223	-0,045	0,634
Kurtosis	10,14	10,76	6,29
Jarque-Bera	2102,07	1120,08	232,22

The statistics from the above table shows that the daily average return in periods accepting the random walk hypothesis is superior to those in which is rejected. On the other hand, the volatility is more powerful in the sub periods rejecting the random walk hypothesis, signaling the existence of a greater number of extreme variations. The presence of these extreme variations in sub periods rejecting the random walk hypothesis can be noticed also from skewness and kurtosis coefficients values. The returns distribution in these sub periods is more distanced from the Gaussian probability law compared to the distribution of random walk returns.

5. Conclusions

The results obtained in this study are similar to those found by Lim and Hinich (2005) on 13 stock markets from Asia, namely that long periods of random walk alternates with short periods of linear and nonlinear correlation. However, the percentage of C and H significant windows is higher in the Romanian stock market compared with the Asian markets where the percentage is below the 7% level. As a conclusion, we can say that the Romanian market has a higher forecasting potential, respectively a lower degree of market efficiency in the weak form.

The findings throw some interesting light on the ongoing debate of stock market predictability. Though the BET index returns series follow a random walk pattern for long periods of time, there were time when it does not, suggesting the potential for profitability for technical trading rules. In particular, during those periods when the market moves in a significantly non-random and dependent pattern, it is possible for investors to use a certain trading rule to exploit those detected linear and nonlinear dependencies in order to earn abnormal rates of returns.

References

[1] AMMERMANN, A.H. and D.M. PATTERSON, *The cross-sectional and cross-temporal universality of nonlinear serial dependencies: evidence from world stock indices and the Taiwan Stock Exchange*, Pacific-Basin Finance Journal, 2003, 11, pp. 175 - 195.

[2] ANTONIOU, A., N. ERGUL and P. HOLMES, *Market efficiency, thin trading and non-linear behavior: evidence from an emerging market,* European Financial Management, 1997, 32, pp. 175 - 190.

[3] BROOKS, C. and M.J. HINICH, *Bicorrelation and cross-bicorrelation as tests for nonlinearity and as forecasting tools*, Journal of Forecasting, 2001, 20, pp. 181 - 196.

[4] HINICH, M.J. and D.M. PATTERSON, *Evidence of nonlinearity in daily stock returns*, Journal of Business and Economic Statistics, 1985, 3, pp. 69 - 77.

[5] HINICH, M.J. and PATTERSON, D.M., *Detecting epochs of transient dependence in white noise*. Mimeo. University of Texas at Austin, 1995.

[6] HOOD, D.C., ANDREASSEN, P. and SCHACHTER, S., *Random and non-random walks on the New York Stock Exchange,* Journal of Economic Behavior and Organization, 1985, 6, pp. 331 - 338.

[7] HSIEH, D.A., *Testing for non-linearity in daily foreign exchange rate changes,* Journal of Business, 1989, 62, pp. 339 - 368.

[8] LIM, K.P. and LIEW, V.K.S., *Nonlinearity favors nonlinear TA techniques, The Technical Analyst*, 2004, May issue, pp. 38 - 40.

[9] LIM., K.P. and M.J. HINICH, *Cross-temporal universality of non-linear dependencies in Asian stock markets*, Economics Bulletin, 2005, Vol. 7, No. 1, pp. 1 - 6.
[10] LIM., K.P., M.J. HINICH and V.K.S. LIEW, *Episodic non-linearity and non-stationarity in ASEAN exchange rates returns series*, Labuan Bulletin of international Business and Finance, 2003, 1(2), pp. 79 - 93.
[11] SARANTIS, N., *Nonlinearities, cyclical behavior and predictability in stock markets: international evidence*, International Journal of Forecasting, 2001, 17, pp. 459 - 329.
[12] SCHEINKMAN, J. and B. LEBARON, *Nonlinear dynamics and stock returns, Journal of Business*, 1989, 62, pp. 311 - 337.

THE AUSTRALIAN DOLLAR'S LONG TERM FLUCTUATIONS AND TREND: THE COMMODITY PRICES CUM ECONOMIC CYCLES HYPOTHESIS

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Abstract

The Australian dollar's exchange rate (mainly in relation to the American dollar) has received a considerable attention in research and several models have been proposed to explain its trend and fluctuations. Thus, as a conclusion of this research we can say that this commodity currency very much depends on the terms of trade which in turn depend on commodity prices. The present paper is based on this conclusion and hence proposes the possibility that the Australian dollar's behavior is overwhelmingly explained by a handful of cycles of mainly harmonic frequencies. Using the principles of Fourier analysis, a simple regression provides considerable evidence about the existence of these cycles. In addition, and as important, a search into the commodity realm demonstrates that these cycles are for example related to various cycles of mining and producing minerals. If the proposition of the present paper is true, we have a very simple yet substantial explanation of the long term trend and fluctuations of the Australian dollar exchange rate and probably of exchange rates of many other commodity currencies.

Key words*: Australian dollar, Fourier, cycles, minerals.*

1. Background

There are many factors as mentioned by many researchers that affect or could affect exchange rates in general. De Grauwe and Grimaldi [10] have pertinently summarized some of the main issues and explained why the fundamentals of exchange rates do not seem to work properly. Overall, there is some sort of puzzle in the determination of these rates. For example there is the puzzle of excess volatility according to which the volatility of the exchange rate by far exceeds the volatility of the underlying economic variables. Also, although the purchasing power parity (PPP) hypothesis was strongly suggested as explaining the behavior of exchange rates, recent research dismisses this hypothesis as being true at least for the Australian dollar [14]; or at least it qualifies it: "our estimate of the longrun elasticity of the exchange rate with respect to commodity prices is 0.939 and statistically not different from unity, which strongly supports the commodity-currency hypothesis" [13 p. 83].

However, these latter authors also remark: "although we fail to reject PPP and UIP1, so long as commodity prices are included in the cointegrating relations, note that the PPP relation is inherently difficult to capture in a study of this type, for domestic price developments will not be uninfluenced by substantial shifts in domestic monetary and fiscal policies, and these are not explicitly accounted for in our model" [13, p. 96). Masih and Masih [20] have produced some interesting results that probably support our own results indirectly. They showed that the PPP hypothesis is still valid for the Australian dollar because they used fractional cointegration2, and hence low frequency dynamics.

Thus, the Australian dollar is one of these commodity currencies (see for example [8]) that are heavily influenced by commodity prices. Usually these currencies are those of small economically defined countries (hence not being able to influence the world economy and to a considerable extent commodity prices). Consequently "the A$ appreciates (depreciates) in both nominal and real terms when the prices of certain commodities exported by Australia, e.g. coal, metals, and other primary industrial materials, rise (fall) in international markets' [13, p. 82].

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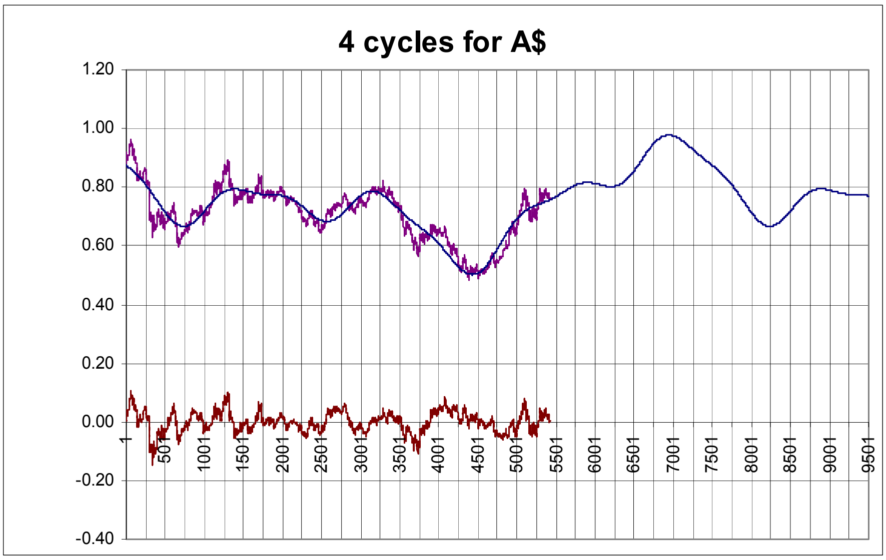
1 UIP stands for uncovered interest parity.

2 However, as these authors admit, cointegration is only a necessary condition for long-run PPP but not a sufficient one.

2. Commodity prices cycle and economic cycles

Following this brief background, it is logical to further investigate the relationship between the exchange rate fluctuations and the commodity prices fluctuations3. In this paper we will take an indirect approach: we must first see what sort of fluctuations and trends exist in determining commodity prices. Then we must investigate some of the reasons for these fluctuations and trends. Perhaps there are some hidden cycles inside the fluctuations term of commodity prices. If our suspicions are correct then we can examine the Australian dollar series to see whether these cycles constitute a very important component of its long term fluctuations. The quantitative method to be used for this examination is the Fourier analysis of time series.

Figure 1 Upper diagram: raw data and fitted line; lower diagram: residuals of the fitted model.



Source: graph constructed by the author, based on data of RBA official internet site [25]. The A$ is expressed in terms of US$. Note: for the fitted line and residuals see text further below.

A visual examination of the commodity price and exchange rate series4 (see Figures 1 and 2) show that there seem to be some noticeable

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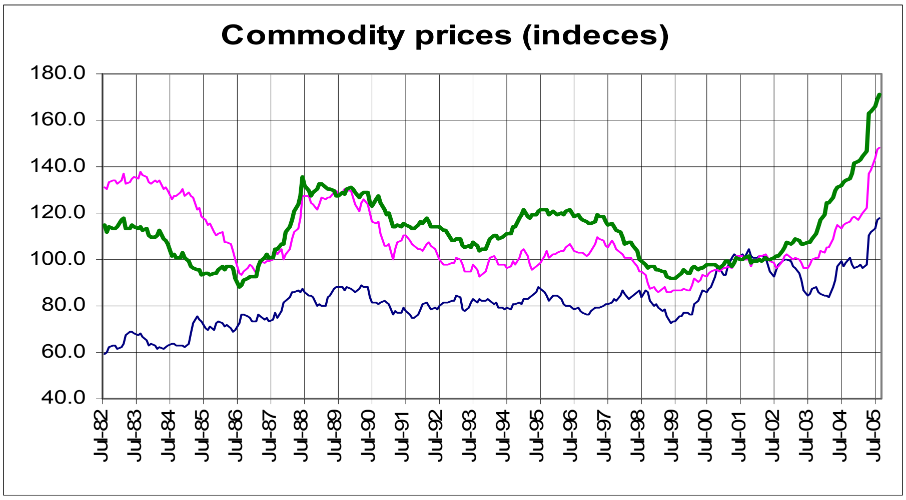
3 When we refer to commodity prices we mean rural and mineral commodities primarily. However, industrial commodity prices should not and cannot be absent in a more comprehensive analysis. This is even more pertinent if we remark that recently in the last 40 years or so the peaks (in 1955, 1965, 1973, 1979, 1988, and 1995) and troughs of industrial commodity prices seem to coincide with the prices of all other commodity prices [5].

4 The Australian dollar started floating in December 12, 1983. Before that from November 1976 to December 1983 it was set in terms of the trade weighted index (TWI) under a

peaks and troughs approximately during the same years for both series. Cashin *et al* [4] have shown that the Australian currency (as well as 18 other currencies) is clearly cointegrated with commodity prices and that the PPP model is subsequently a weak model for countries like Australia5. Karfakis and Phipps [16, p. 272] have similarly concluded that "movements in the terms of trade account for much of the long-run variation in the exchange rate" of the Australian dollar (thus having already considered changes in relative price levels and interest rate differentials).

Figure 2 Commodity prices



Source of data: RBA internet site [25]. Note: the upper graph is in terms of US dollars, the middle graph in terms of SDRs and the lower graph in terms of Australian dollars.

If our hypothesis of some predetermined cycles is correct then we must search for the reasons of this predetermination. Here in this paper we suggest that these reasons are related to the mining and production cycles of minerals and perhaps other commodities that Australia exports (such as sugar and wool). An indication of how important is the Australian component of minerals in the world production we can cite Humphreys [15, p. 5]: "Australia has managed to increase its share of world iron ore production to 20% from 13%, its share of nickel mine production to 17% from 8%, its share of copper mine production to 7% from 4%, and its share of zinc mine production to 17% from 13%". Overall, exports of rural and non-rural commodities as a percentage of total exports has been about 60% (RBA site). The main commodities having the largest percentage in the construction of

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crawling peg system. Up to November 1971 it was fixed to sterling, then to the US dollar up to September 1974, and then to the TWI (see [23].

5 These authors examine the two series in real terms.

the commodity price index in Australia are: gold (16.3%), coking coal (13.8%), beef and veal (9.4%), steaming coal (9.3%), iron ore (9.3%), wool (8.6%), aluminium (8.6%), and so on [24].

A report by Western Mining Corporation (WMC) [26, p.31] finds that the average delay between discovery and time startup for Australian (also for Canadian and American) gold firms is 5.4 years, whereas it is 8.3 years for other countries. For copper, Graedel *et al* [12, p. 17] report all the principal uses of copper as percentage of total and the corresponding residence time in each use. Hence the weighted average of this time is about 35 years (author's calculations). Cortazar and Casassus [9] have shown that the optimal timing of a mine expansion is intrinsically related to changes in copper prices via the investment process. Achireko and Ansong [1] have demonstrated that gold prices are required in mine valuations. The relationship between supply and demand as well as inventories in mineral production has been well evidenced (e.g. [17]).

Following the above discussion we can hypothesize that the cycles we need to consider are those of commodity prices *per se* (average period length about 7-8 years) and those of economic business cycles: an average period length of about 3-4, 15-16 and 30-32 years. Cashin *et al* [6, pp. 282-3] have found that most commodities have cycles of an average duration of between 6 and 8 years. In addition, it is important to stress that most commodities are cointegrated thus generating a common cycle for themselves [21, 22]. The so-called business cycle of duration 3-4 years is primarily related to production, inventories, and employment. The "Kuznets" cycles of about 15-16 years and 29-30 years are more linked with the investment process (cf. for example a good paper on all these cycles by Forrester, [11]). In our context these three economic cycles are intrinsically related with the commodity prices cycle of about 7-8 years, since also these prices are a consequence of or a reason for the existence of these economic cycles6. All four cycles are generating each other through the "mysterious" properties of harmonics7.

As we can see in figure 3 the 4 harmonics (see below for these results) produce consecutive waves with varying height (amplitude) and phase. The sequence from 1988 to 2013 of these waves is as follows (in

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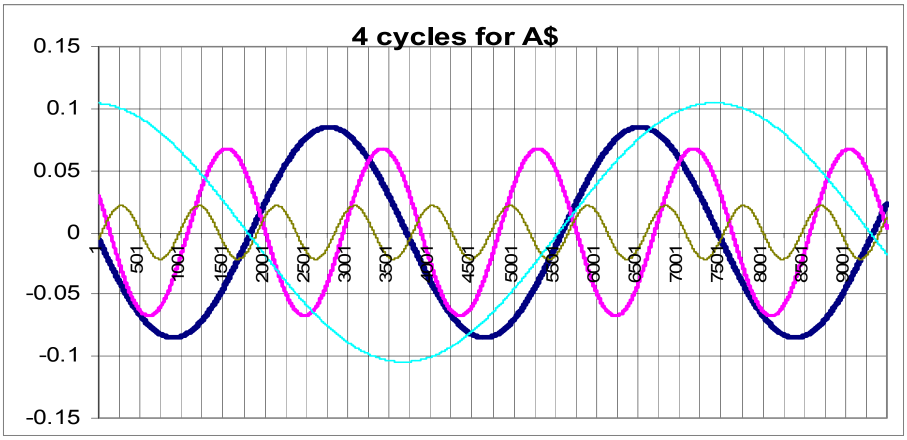
6 However, as Cashin *et al* [6, p. 292] have remarked, "cycles in economic activity alone do not drive the evolution of commodity prices, and that other factors, particularly supply conditions in individual commodity markets, are likely to be a key determinant of cycles in commodity prices".

7 A detailed analysis of all these issues is of course out of the scope of this paper which primarily sets the basis via some propositions for more research.

parenthesis is the corresponding period of the cycle): 9/88 (3.75); 1/90 (7.5); 6/92 (3.75); 11/94 (15); 2/96 (3.75); 6/97 (7.5); 10/99 (3.75); 7/03 (3.75); 11/04 (7.5); 5/07 (3.75); 11/09 (15); 2/11 (3.75); 5/12 (7.5); 6/13 (30). This succession of waves of various strength and length is the reason for 85% of fluctuations in the floating exchange rate of Australian dollar (as quantitatively determined below). It is also interesting to note that in 2001 all cycles were found to be at their respective troughs and hence we had a substantial depreciation of the currency.

In addition it is important to stress that our model predicts quite accurately the peaks of economic cycles as analyzed by other scholars. For example, Bajada [2] suggested that significant peaks took place in 1989/908 and 1994/95; these dates coincide with our peaks of the 7.5 year and 15 year waves (see above). Finally, it might be possible to construct a new theory as the mechanics of the links between all four harmonic cycles: thus, 2 consecutive peaks of the 3.75 year business cycle in 11/84 and 9/88 generated the commodity prices cycle (of 7.5 years period) peak of 1/90; the latter in conjunction with another business cycle peak in 6/92 generated the longer investment-caused cycle (of 15 years period) peak in 11/94, and so on.

Figure 3 The 4 cycles determined by the OLS regression



Notes: the higher the amplitude the higher the period of the cycle. Thus, the first peak of the 15 year cycle occurs on the 1510th day approximately or 1/1990. Every 250 days constitute on year on the x-axis. Thus the 5000th datum is in July 2003.

8 Layton [18] supports this date of 1989/90 with his analysis.

3. Econometric evidence

Fourier analysis is useful in many ways. In this paper this analysis will be used for 2 purposes. First, it will indicate econometrically how good is the assumption that the A$ can be overwhelmingly approximated by 4 cycles harmonic to each other. And second, it will indicate whether the cycles suggested in the discussion above can be confirmed through the calculation of spectra.

A few important points can summarize the Fourier analysis (see [7]; [3]) as used here. A time series f (t) can be fully represented by the sum of sinusoidal functions for all harmonic frequencies. Thus it becomes significant for our paper that if we can isolate only a few such sinusoidal functions that mostly explain the initial series f (t) (for example a high R^2 will indicate how important these cycles are) then we can provide evidence that our preliminary theoretical discussion contains some grains of truth. More precisely mathematically we can summarize the salient points of Fourier functions as follows:

$$f(t) = A + C\cos(\omega_0 t + \vartheta) = A + B_1\cos(\omega_0 t) + B_2\sin(\omega_0 t) \qquad (1)$$

where C is the amplitude, ω_0 is the angular frequency (related to frequency f as in cycles per time by $\omega_0 = 2\pi f$; and $f = 1/T$, where T is the period of the cycle); and θ is the phase shift. When equation (1) is expressed as a function of both cosine and sine, and estimated in an ordinary least squares (OLS) regression the amplitude and phase shift, if needed, can be indirectly calculated as a function of B_1 and B_2. If we want to include more than one angular frequency, as in harmonics we can have multiples of ω_0 as in $2\omega_0$ or $3\omega_0$, etc. and run a multiple regression with as many independent variables as the number of harmonics plus the fundamental frequency ω_0.

The suggested best fit (see below the criteria of choosing the "best" fit) Fourier approximation of the Australian dollar by 4 harmonics is the one that uses as fundamental frequency 3.75 years (or 250 active days per year), hence the harmonics being 7.5 years, 15 years and 30 years. Figure 1 shows the raw data, the fitted 4-cycle sinusoidal fitted curve and predictions for the next 16 years9.

9 It is well known that what we can do on the frequency domain we can also do on the time domain. Using the 140 quarters of real exchange rate from 1970 to 2005, similar results are obtained; the best fit is the regression that has as independent lagged variables those with 16, 31, 32, 64, and 128 quarters as significant lags (thus corresponding to 4, 8, 16, and 32 years of periods). To correct such a model for serial correlation, it was re-run by using the

The criteria for choosing the above fitted curve are the following:

A] The *a priori* justification on economic and econometric grounds (the commodity prices cycle; the commodity production cycles; the general economic cycles; the "mysterious" connections of harmonics).

B] The R^2 of Fourier regressions as shown in equation (1). See Table 1 below.

Table 1 Comparative data for 4 similar periods to 16 years

Period of cycle	**14**	**15**	**16**	**17**	**18**
R^2	0.78	0.86	0.88	0.83	0.80
Constant	0.725	0.751	0.790	0.862	0.966
When the 4 cycles cancel each other	0.83	0.74	0.67	0.51	0.34
Predictions (June, July, August, September 2005)	Under-estimating	Minimal error (almost 0% to 1% on average each month)	Over-estimating	Over-estimating even more	Over-estimating even more
Maximum peak at about 2010-2013	0.9 (in 2010)	0.98	1.1	1.3	1.6 (in 2013)

Note: the average of the whole sample from December 12, 1983 to May 26, 2005 is 0.707.

C] The out of sample performance of the model, both short run and long run. The short run is also a comparison of actual data with predicted data during the period June to September 2005. The results of this comparison are shown in Table 1. In the long run, it is expected that the Australian dollar will only approach the absolute equality of 1A$ to 1US$ but will not surpass it[10].

D] The value of the constant in the regression, again shown in Table 1. It is expected that this constant should not be too far away from the average over the whole set of data which is 0.707.

E] The significance of the phase between the 4 harmonic cycles (a hint on the differences of phase and some interpretation was given above).

F] The behavior of the residuals of regressions. The standard diagnostic tests of serial correlation, functional form, normality, and heteroscedasticity for the ordinary least squares (OLS) regression are as expected not good because the used model of the four sinusoidal independent variables of long cycles has ignored the very short influence of daily and weekly cycles. This

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Cochrane-Orcutt method (as autoregressive of order 1); the coefficients remained approximately the same with no serial correlation and the R^2 remained high at about 0.90.

10 This is of course a "gut feeling".

can easily be fixed with the re-estimation of the model according to the Cochrane-Orcutt procedure. Effectively lags up to 3-6 days11 completely eliminated the serial correlation and other related problems. In addition, some of the errors (when the daily and weekly cycles are not included in the original OLS model this becomes even more apparent) seem to well coincide with some ad hoc situations and events, and policy measures. For example, according to Makin [19, p. 336], "intervention was highest in July 1986 to prevent further depreciation by buying Australian dollars, but was also high in February 1989 to stem appreciation". These two interventions agree with the magnitude and sign of the residuals of our model (negative during 1986 and positive during 1989). A detailed analysis of the residuals is nonetheless out of the scope of this paper.

G] The suggestion of cycles according to spectra. As already mentioned spectral analysis (based on Fourier analysis) can also be used to detect cycles of a time series. In order to have a longer span of time than the 22 years of daily floating Australian dollar, its real exchange rate12 is used instead for which data are available on a quarterly basis from June 1970 to June 2005 (N=140). The results are quite clear: significant peaks of the spectrum of this series are found for periods of about 30 and 15 quarters allowing for a reasonable window and according to all three approximations ("Bartlett", "Tukey", and "Parzen"). Peaks of periods of 60 and 120 quarters are also detected but these periods are only found if a larger window of the spectrum is used and hence their significance is less strong given the limited number of observations.

4. Conclusions

The review of the relevant literature has shown that most standard theories of the determination of exchange rates have failed to explain most issues concerning these rates. It seems that there is a now a relative consensus that some sort of non-linear inherent tendency could be the main force of driving trends and fluctuation of exchange rates. In particular the currencies

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11 The original daily data were recalculated as 2-day averages thus reducing the original number of data from 5422 to 2711. The ensuing regressions with 2711 data produced as expected similar results and the lags in the autoregressive Cochrane-Orcutt scheme needed lags up to three 2-day data to eliminate serial correlation and related problems.

12 Thus the use of real exchange rates provides similar results to those found for nominal exchange rates. This is not a surprising outcome for a commodity currency like the Australian dollar which depends on world trade for its determination (the real exchange rate is based on a real trade weighted index). It is also worth noting that since the real exchange rate goes further back from December 1983 (the date of floating the A$)-thus we have the period June 1970 to June 2005- and since the same cycles exist for this more extended period of time, it is possible to assert that the PPP hypothesis might be to some extent valid.

that are now called commodity currencies, such as the Australian and Canadian dollars are heavily influenced by commodity prices. All this has led the author to investigate the possibility that the Australian dollar is primarily determined by a handful of harmonic cycles which in turn are based on the commodity prices cycles, commodity production cycles and in general on economic cycles that are suspected to be influenced by the commodity world.

Hence the proper econometric approach to this investigation was judged to be the well-known Fourier analysis according to which any time series can be represented by the sum of sinusoidal functions. The application of such analysis to the trend and fluctuations of this currency has produced some very interesting results. The four harmonic cycles used in this respect (3.75, 7.5, 15, and 30 years) explain 85% of the everyday changes of this commodity currency, the remaining being attributed to *ad hoc* situations, policy measures, and so on. These conclusions if true (many people would be very skeptical of such amazing results) have far reaching implications at least for commodity currencies.

First, more investigations should concentrate on the underlying cycles of commodity prices, commodity production cycles (e.g. mining ones) in order to shed more light on the alleged relationship between all aspects of commodities and national currencies. In addition, economic cycles in general which have been neglected in the last 30 years or so should be further reconsidered. Second, we have to reassess what we mean by trend and stationarity in time series; for in our case the remaining 15% of unexplained variance seems to fluctuate around the 4-cycle "trend" as determined in this paper. Third, and as a consequence of the second implication, economic policy is rather powerless in strongly influencing the exchange rate in its floating state.

Fourth, theories such as the PPP version does not hold true at least in its traditional way of integer cointegration. Both this paper and [20] seem to support the idea that once we include low frequency dynamics and hence long period cycles the Australian dollar reverts back to its "mean". Fifth and probably most important for many speculators, it is possible to predict quite accurately the long run behavior of the Australian dollar. Thus, it is recommended that for the time being let us hold our Australian dollars until about 2012 (the highest peak of the A$ appreciation); in that year we must start buying American dollars again.

References

[1] ACHIREKO, P.K., ANSONG, G. Stochastic model of mineral prices incorporating neural network and regression analysis. *Transactions, Institution of Mining and Metallurgy (Section A: Mineral technology)*. (2000), vol. 109, January-April, pp. A49-A54.

[2] BAJADA, C. Business Cycle properties of the legitimate and underground economy in Australia. *Economic Record*. 2003, vol. 79, no. 247, Dec, pp. 397-411.

[3] BLOOMFIELD, P. *Fourier Analysis of Time Series: an Introduction*. New York: John Wiley & Sons, 1976. ISBN 0-471-08256-2.

[4] CASHIN, P., CESPEDES, L.F., SAHAY, R. Commodity currencies and the real exchange rate. *Journal of Development Economics*. 2004, vol. 75, no. 1, pp. 239-268.

[5] CASHIN, P., McDERMOTT, C.J. The long-run behavior of commodity prices: small trends and big variability. *IMF staff Papers*. 2002, vol. 49, no. 2, pp. 175-199.

[6] CASHIN, P., McDERMOTT, C.J., SCOTT, A. Booms and slumps in world commodity prices. *Journal of Development Economics*. 2002, vol. 69, no. 1, pp. 277-296.

[7] CHAPRA, S.C., CANALE, R.P. *Numerical Methods for Engineers*. Boston: WCB/McGraw-Hill, 1998. ISBN 0-070-10938-9.

[8] CHEN, Y.C., ROGOFF, K. Commodity currencies. *Journal of International Economics*. 2003, vol. 60, no. 1, pp. 133-160.

[9] CORTAZAR, G., CASASSUS, J. Optimal Timing of a mine expansion: implementing a real options model. *The Quarterly Review of Economics and Finance*. 1998, vol. 38, Special Issue, pp. 755-769.

[10] DE GRAUWE, P., GRIMALDI, M. The Exchange rate and its fundamentals in a complex world. *Review of International Economics*. 2005, vol. 13, no. 3, pp. 549-575.

[11] FORRESTER, J.W. Business structure, economic cycles, and national policy. *Futures*. 1976, June, pp. 195-214.

[12] GRAEDEL, T.E., BERTRAM, M., FUSE, K., GORDON, R.B., LIFSET, R., RECHBERGER, H., SPATARI, S. The contemporary European copper cycle: the characterization of technological copper cycles. *Ecological Economics*. 2002, vol. 42, no. 1-2, pp. 9-26.

[13] HATZINIKOLAOU, D., POLASEK, M. The commodity-currency view of the Australian dollar: a multivariate cointegration approach. *Journal of Applied Economics*. 2005, vol. 8, no. 1, pp. 81-99.

[14] HENRY, O.T., OLEKALNS, N. Does the Australian dollar real exchange rate display mean reversion? *Journal of International Money and Finance*. 2002, vol. 21, no. 5, pp. 651-666.

[15] HUMPHREYS, D. Global industrial production and what it means for mining. *The Northern miner*. 2003, vol. 89, no. 16, pp.4-6.

[16] KARFAKIS, C., PHIPPS, A. Modeling the Australian dollar-US dollar exchange rate using cointegration techniques. *Review of International Economics*. 1999, vol. 7, no. 2, pp. 265-279.
[17] LABYS, W.C., AFRASIABI, A. Cyclical disequilibrium in the US copper market. *Applied Economics*. 1983, vol. 15, no. 4, pp. 437-449.
[18] LAYTON, A.P. A new approach to dating and predicting Australian business cycle phase changes. *Applied Economics*. 1997, vol. 29, no. 7, pp. 861-868.
[19] MAKIN, T. The main determinants of Australia's Exchange rate. *The Australian Economic Review*. 1997, vol. 30, no. 3, pp. 329-339.
[20] MASIH, A.M.M., MASIH, R. Fractional cointegration, low frequency dynamics and long-run purchasing power parity: an analysis of the Australian dollar over its recent float. *Applied Economics*. 2004, vol. 36, no. 6, pp. 593-605.
[21] NGUYEN, V.N. Common trends in metal futures curves and inventories: evidence from the London Metal Exchange. *Derivatives use, Trading & Regulation*. 2004, vol. 10, no. 2, pp. 114-130.
[22] PYNNONEN, S., VATAJA, J. Bootstrap testing for cointegration of international commodity prices. *Applied Economics*. 2002, vol. 34, no. 5, pp. 637-647.
[23] RANKIN, B. The exchange rate and the Reserve Bank's role in the foreign exchange market. Canberra: Reserve Bank of Australia (RBA), May 1998. Access from:
<http://www.rba.gov.au/education/exchange_rate.html>
[24] Reserve Bank of Australia (RBA) Bulletin. *Modifications to the reserve Bank of Australia's Commodity price Index*. 1998, September.
[25] Reserve Bank of Australia (RBA): Access from:
<http://www.rba.gov.au/Statistics/AlphaListing/alpha_listing_e.html >
[26] Western Mining Corporation (WMC). Access from:
Originally in http://www.wmc.com/acrobat/pacrim20040922.pdf ; and then in general from: <http://www.wmc.com/bb/search/home.jsp>

CAN DAY OF THE WEEK EFFECT BE EXPLAINED BY INTERBANK RATES: AN EVIDENCE FROM AN EMERGING MARKET

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Abstract

This paper reports the results of various tests of the day of the week effects using daily observations on the National 30 Index for Turkish stock exchange and interbank rates for the period January 3, 1997 and July 23, 2001. It is also searched whether day of the week effect be explained by interbank rates or not. While significant evidence of day of the week effect is reported and tried to explain its reasons in literature, there is no significant explanation about it. The paper reports a significant day of the week effects for both market and investors can beat the markets and earn excess returns by using an active trading strategy than a simple buy and hold strategy. It's also could be said day of the week effect can be explained by interbank rates for an emerging market, namely Turkey.

Keywords: *Day of the Week Effects, Market Anomalies, Turkish Stock Market, Interbank Market, Kruskal Wallis.*

1. Introduction

Efficient Market Hypothesis (EMH) says that in an efficient market no one can beat the market systematically because security prices fully reflect all avaible information1. This means, in inefficient market investors can use a strategy to beat the market. Hence, Day of the Week Effect anomaly has an important implication in finance. According to day of the week researchers, holding period returns are lower on Monday than on other days of the week23.

Vast number of studies provides evidence for day of the week effect and seasonal anomalies in the literature. Defusco4 have examined returns for U.S. firms in the five-day interval surrounding a board meeting date and found that a firm's Monday return in that interval is more likely to be negative than other Monday returns. Cornell5 has investigated whether cash and futures markets have some seasonal pattern or not for S&P500 Index. He has reported that weekly pattern of returns was observed in the cash market but no similar pattern for the S&P500 futures. Ayadi6 has reported that there is no seasonality in the distribution of monthly stock returns in Nigeria, Zimbabwe and Ghananian market. Kato7 has reported low Tuesday and high Wednesday returns for the Japanese stock returns. Gibbons and Hess8 have reported strong and persistent negative mean returns on Mondays for the S&P500 and the value-and-equal weighted portfolios. Athanassakos and

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1 Fama, E.F. *Efficient Capital Markets*, Journal of Finance, December 1991, Vol: 46, pp.1575-1617.

2 Sias, R.W. and Starks L.T., *The Day of the Week Anomaly: The Role of Institutional Investors*, Financial Analysts Journal, 1995, Vol:51, pp.58-67.

3 Clare A.D., M.S.B. Ibrahim and S.H. Thomas, *The Impact of Settlement Procedures on Day of the Week Effect: Evidence form the Kuala Lumpur Stock Exchange*, Journal of Busines Finance&Accounting, 1998, Vol:25 (3), pp. 401-418.

4 Defusco, R.A. *Day of the Week Effect: A Test of the Information Timing Hypothesis*, Journal of Busines Finance&Accounting, 1993, Vol:20(6), pp.835-842.

5 Cornell, Bradford, *The Weekly Pattern in Stock Returns: Cash Versus Futures: A Note*, The Journal of Finance, 1985, Vol:XL, pp.583-588.

6 Ayadi, O. Felix, *Stock Return Seasonalities in Low-Income African Emerging Markets*, Managerial Finance, 1998, Vol:24, pp.22-33.

7 Kato, Kiyoshi, *Weekly Patterns in Japanese Stock Returns*, Management Science, 1990, 36, pp. 1031-1043.

8 Gibbons, R.G. and Hess P. Day *of the Week Effect and Asset Returns*, Journal of Busines, 1981, Vol:54, pp.579-596.

Robinson9 have tested day of the week effect for Toronto Stock Exchange and they have reported that they found evidence for a strong and statistically significiant negative Tuesday effect. Balaban10 has investigated daily anomalies for Turkish Stock Market and reported that significiant day of the week effect for the Turkish market. Metin and et all.11 have examined the weak form efficiency of Istanbul Stock Exchange (ISE) by using random walk test and the day of the week effect. They have used data January 4, 1988 to December 27, 1996. They have reported Friday and Monday effect but Monday effect was not statistical significiant. Bildik12 has investigated the day of the week effect in overnight interest rates in interbank market, overnight interest rates in interest rates of the Istanbul Stock Exchange (ISE) and daily closing values of the Istanbul Stock Exchange's Composite Index. The researcher has reported that there is no significiant difference between the repo rates occurred in the ISE repo Market and interest rates in Interbank Market. He also reported overnight interest rates decrease on Wednesdays and increase on Mondays relative to previous days. In stock market, he has found pattern of low or negative returns over the first part of the week (Monday through Tuesday) and high and positive returns over the second part of the week (Wednesday through Friday).

This study's main aim is to provide further international evidence for the presence of the day of the week effect in Turkish stock exchange and interbank rates market. Second, we try to find whether the day of the week effect be explained by interbank rates or not.

The remainder of the paper is structured as follows: Section I introduces some evidence for day of the effect anomaly. Section II explains data structure and methodology which is followed. In section III we gave the empirical results where Section IV concludes.

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9 Athanassakos, G. and Robinson M. J. *The Day of the Week Anomaly: The Toronto Stock Exchange Experience*, Journal of Busines Finance&Accounting, 1994, Vol:21(6), pp. 833-856.

10 Balaban, Ercan, *Day of the Week Effect: New Evidence from an Emerging Stock Market*, Applied Economics Letters, 1995, Vol: 2, pp.139-143.

11 Metin, Kıvılcım, Muradoglu G. and Yazıcı B., *İstanbul Menkul Kıymetler Borsası'nda Gün Etkilerinin İncelenmesi,* IMKB Dergisi, 1997, Vol:4, pp.15-25.

12 Bildik, Recep, *Day of the Week Effect in Turkish Stock and Money Markets,* Annual Meeting of European Financial Management Association, Paris, 1999, pp. 1-49.

2. Data and methodology

This study is conducted using data from the Central Bank of Turkey database. The first one of these data sets includes daily average values of the overnight interest rates, which are determined in the Interbank Money Market of the Central Bank of Turkey. The second data set consists of daily closing values of the Istanbul Stock Exchange's National 30 Index.

Daily observations of the ISE National 30 Index are employed to investigate the day of the week effect. ISE National 30 Index includes Turkish blue-chip shares. ISE National 30 Index is composed of National Market companies except investment trusts and will also be used for trading in the Derivatives Market that will start trading soon. The constituent 30 companies are selected on the basis of pre-determined criteria directed for the companies to be included in the indices. The data includes daily closing prices and ranges between January 3, 1997 and July 23, 2001. Daily returns on the ISE National 30 Index that amount to 1113 observations are used. We have excluded extreme four daily interest rate returns (similar to Bildik's paper) and observations for 20-23 February 2001, which have been effected by a severe economic crisis where daily interest rates return jumped to 4018.58.

We have used overnight interest rates instead of ISE repo market variables which have no significiant differencies between them[13]. Data set consists of the daily return of the overnight interest rates which are determined in the Interbank Market of the Central Bank of Turkey (IMM) for the period January 3, 1997 to July 23, 2001. Data has provided from the Central Bank of Turkey database. Daily returns of the overnight interest rates that amount to 1.138 observations are calculated as follows:

$$R_{t1}= V_t/365 \qquad (1)$$

Where V_t, and R_{t1} denote the overnight interest rate on t and overnight interest rate return, respectively.

ISE National 30 Index return observations are calculated as follows:

$$R_{t1}= (V_t-V_{t-1})/V_{t-1} \qquad (2)$$

Where V_t, V_{t-1} and R_{t1} denote the daily closed ISE National 30 Index variables on t and t-1, and daily return on t1, respectively.

13 Bildik, 1999.

If we have reason to believe that the returns are not normally distributed, we can use a non-parametric test to evaluate the result. To avoid the strong assumption of a normal distribution, we have used Kruskal-Wallis Test (KW)[14] which is a non-parametric test. The Kruskal-Wallis Test is a rank-sum test that serves to test the assumption that k independent random samples come from identical populations and in particular that the null hypothesis $\mu_1=\mu_2..........=\mu_k$, against the alternative that these means are not all equal, Kruskall Wallis Test has the following assumptions: (1) The variable of interest is continuous (not discrete). The measurement scale is at least ordinal, (2) The probability distributions of the populations are identical, except for location. Hence, we still require that the population variances are equal, (3) The groups are independent, (4) All groups are simple random samples from their respective populations. Each individual in the population has an equal probability of being selected in the sample.

3. Empirical Results

If we consider Table 1 we can clearly see the existence of day of the week effect anomaly in ISE National 30 Index. In full period, Monday has the lowest mean (-0.0019) and the highest mean is observed on Friday (0.0072). The daily average return for the whole period is 0.003118. In a normal distribution the average mean and the average median are not very far apart each other and the average skewness of the distribution is close to zero[15].

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14 Freund J., and Simon G.A. *Modern Elementary Statistics,* Prentice-Hall International Inc. 1997, 9. Edition, pp.570.

15 Kritzman, M.P. *About Higher Moments,* Financial Analysts Journal*,* Sep.-Oct. 1994, pp.10-17.

Table 1. Descriptive Statistics for ISE National 30 Index

	Average Return	MONDAY Return	TUESDAY Return	WEDNESDAY Return	THURSDAY Return	FRIDAY Return
Number of observations	1113	223	225	222	223	220
Mean (Return)	.003118	-.0019	.0018	.0029	.0056	.0072
Median	.0011	-.0044	-.0005	.0018	.0048	.0037
Std. Deviation	.039	.0435	.0373	.0393	.0392	.0364
Skewness	.262*	.417	.919	-.0194	-.318	.0756
Kurtosis	2.687	1.564	3.911	4.447	1.239	3.585
Jargua-Bera	341.87* 0.00					

Notes: * Sinificiant at α= 1%, 5%, 10%

Sources: Central Bank of Turkey database.

The normal distribution is symetric around the mean; hence the median and the mode are both equal to the mean. The median (because of observing more than one mode, it is not being given mode value) value is 0.0011 and not equal to the mean (0.003118) in full period and all days of the week. Therefore we observe significiant skewness. Standard deviation as a measure of risk is 0.039 for whole period. The lowest standard deviation value is on Friday (0.0364) while the highest value on Monday (0.0435). Kurtosis value is less than 3 in most periods and distribution is kurtic. Series is also skewed for all periods which the values are different from 0. If we consider Jargua-Bera test statistics (341.87 and p: 0.00) we can say that return series have a non-normal distribution for full period and days of the week.

Table 2. T Test Results for ISE 30 Index

INTEREST		N	Mean	Std. Deviation
MONDAY	**>= .00**	96	.0352	.0328
	< .00	127	-.0299	.0260
TUESDAY	**>= .00**	109	.0297	.0299
	< .00	116	-.0244	.0209
WEDNESDAY	**>= .00**	114	.0308	.0259
	< .00	108	-.0266	.0278
THURSDAY	**>= .00**	126	.0313	.025
	< .00	97	-.0277	.0275
FRIDAY	**>= .00**	126	0.029	.0298
	< .00	94	-.0218	.0210

Sources: Central Bank of Turkey database.

If we compare positive and negative returns (mean) of the days, we observed Mondays and Tuesdays number of negative returns are larger than theirs positive returns where other days number of positive returns larger than theirs number of negative returns. Hovewer, absolute values of negative and positive returns of Mondays are larger than absolute values of negative and positive returns of other days. This result also supports Table 1 results that returns and standard deviations of Mondays are larger than other days.

Table 3. Kruskal-Wallis Test for ISE 30 Index

Group	N	Ave. Rank	Chi-Square	Asymp. Sig
1	223	501.31	12.380	.015
2	225	538.89		
3	222	564.09		
4	223	591.33		
5	220	590.01		
Overall	1113	501.31		

Sources: Central Bank of Turkey database.

As illustrated in Table 3. KW test statistic value is (12.380) and has p value (0.015). We have failed to accept the null hypothesis so, those five days returns are all equal. Kruskall Wallis Test conforms to the descriptive statistics that there is a significiant day of the week effect.

After we determined that there are differences between days of the week returns, we applied Mann-Whitney U test to determine which day returns have differences.

Table 4. Mann Whitney U Test for ISE 30 Index

Groups	N	Mean Rank	Mann-Whitney U	Z	P*
Monday-Wednesday	223 222	210.63 235.42	21995.00	-2.033	.042
Monday-Thursday	223 223	206.37 240.63	21044.00	-2.807	.005
Monday-Friday	223 220	204.04 240.20	20526.00	-2.972	.003

Source: Central Bank of Turkey database.

*: $p \leq 0.05$, There is significiant difference.

$p \leq 0.01$, There is important significiant difference

As could be seen in Table 4, we found significiant differences between Monday and Wednesday and Thursday returns. There are no significiant differences between other days of the week.

The descriptive statistics results are given in Table 5 and Table 6 and results indicate that series is not a normal distribution and leptokurtic.

Table 5. Descriptives Statistics for Interbank Rates

	Average Return	MONDAY Return	TUESDAY Return	WEDNESDA YReturn	THURSDA YReturn	FRIDAY Return
Number of observations	1138	229	228	227	227	227
Mean (Return)	.1855492	.1890	.1842	.1827	.1824	.1893
Mode	.172	.1726	.172	.172	.172	.172
Median	.196	.1968	.1963	.1968	.1949	.1962
Std. deviation	.1378	.1378	.3678	.054	.0668	.1539
Skewness	12.573	12.573	14.265	.685	4.488	13.028
Kurtosis	179.275	179.275	210.718	6.492	47.745	187.298
Jargua-Bera	3644014* 0.00					

Notes: * Significiant at α= 1%, 5%, 10%

Source: Central Bank of Turkey database.

In full period, as could be seen in Table 5 all days of the returns (mean) are almost equall. So, there could be no significiant difference between them. The daily average return (mean) of the whole period is 0.1855. The median and the mode values are 0.196 and 0.172, respectively and not equal to the mean (0.1855) in full period and all days of the week. Standard deviation as a measure of risk is 0.1378 for whole period. The lowest standard deviation value is in Wednesday (0.054) while the highest value in Tuesday (0.3678).

The average skewness of the distribution is not equal to zero (12.573) and kurtosis value is larger than 3 (179.275) and distribution is leptokurtic for most daysof the week. We can say that series has not a normal distribution as indicated by the J-B test statistics (3644014, p=0).

Table 7. T Test Results for Interbank Rates

INTEREST		N	Mean	Std. Deviation
RETURN	**>=,18554929**	710	.2187	.1184
	< ,18554929	428	.1305	.0376
MONDAY	**>=,18554929**	146	.2229	.1609
	< ,18554929	83	.1294	.037
TUESDAY	**>=,18554929**	142	.2164	.072
	< ,18554929	86	.1311	.037
WEDNESDAY	**>=,18554929**	144	.2134	.035
	< ,18554929	83	.1293	.038
THURSDAY	**>=,18554929**	139	.2151	.059
	< ,18554929	88	.1308	.039
FRIDAY	**>=,18554929**	139	.2258	.185
	< ,18554929	88	.1318	.037

Sources: Central Bank of Turkey database.

As it could be seen in Table 7, when for the research period as whole returns which are larger than average are more frequent than returns which are lower than average.

Table 8. Kruskal-Wallis Test for Interbank Rates

Group	N	Mean. Rank	Chi-Square	p
1	229	576.39	.532	.970
2	228	561.11		
3	227	573.34		
4	227	559.89		
5	227	571.80		
Overall	1138	576.39		

Sources: Central Bank of Turkey database.

KW test statistic is (0.532) and has p value (0.970) so; we accepted the null hypothesis, which says returns are equal for all days.

Table 9. Returns for ISE 30 and Interbank Returns

	Monday	Tuesday	Wednesday	Thursday	Friday
ISE 30 Index Returns	-.0019	.0018	.0029	.0056	.0072
Interbank Returns	.1890	.1842	.1827	.1824	.1893

As could be seen in Table 9, Friday has the highest return for both ISE National 30 Index and Interbank rates. So, investors should be indifference between interest and stock exchange. Because of this we could not explain the day of the week effect of the ISE National 30 Index with using interest rates but we can implement an investment strategy with using this anomaly.

We would sell ISE National 30 Index on Fridays. Because of T+2 pay system we get money on Mondays. Then we invest our money to repo (Interbank) for two days and also give a buy order ISE National 30 Index. Wednesday mornings we get our money from repo and pay to ISE National 30 Index. Then wait till Friday and sell ISE National 30 Index again.

Table 10. Some Trading Strategies

Strategy 1 (%)	Strategy 2 (%)	Strategy 3 (%)
0.042	2.04	6.12

Strategy 1: Buy and hold for ISE National 30 Index
Strategy 2: Buy on Monday and sell on Friday satrategy for ISE National 30 Index
Strategy 3: Sell ISE National 30 Index on Fridays. On Mondays get money from ISE National 30 Index and invest in repo during Monday and Tuesdays where give a buy order at the same time (Monday) to ISE National 30 Index. On Wednesdays get money from repo and pay to ISE National 30 Index. Then wait till Friday and sell ISE National 30 Index again.

4. Conclusion

This paper presents evidence for the existince of the day of the week effect for Turkish stock returns namely ISE National 30 Index. A daily pattern in stock market returns is observed for ISE National 30 Index.

Our results support to the previous literature[16;17] Mondays have the lowest return for ISE National 30 Index and Fridays has the highest return. Low and negative returns are observed on Mondays and getting increase through Friday. Our study also supports to Bildik's (1999) results who stresses low or negative returns over the first part of the week (Monday

16 Muradoglu and Humayun, 2002.
17 Bildik, 1999.

through Tuesday) and high and positive returns over the second part of the week (Wednesday through Friday). In our results the lowest standard deviation value is on Friday (0.0364) while the highest value on Monday (0.0435) which is also support Bildik's results.

In our paper, in interbank market there is no significiant differences between days return where Bildik reports Wednesdays and Mondays, respectively. So we can not claim that there is a pattern in interbank market. The lowest standard deviation value is in Wednesday (0.054) while the highest value in Tuesday (0.3678) where in Bildik's (1999) results are Wednesday and, Friday respectively.

So, the weak form of the efficient market hypothesis does not hold for ISE National 30 Index. Because of the existence of the day of the week effect for ISE National 30 Index, investors could implement an active trading strategy which is based on this anomaly, and they could earn 6.12% return. This strategy is more good than satrategy 1 and 2.

References

[1] ATHANASSAKOS, G. and ROBINSON M. J. The Day of the Week Anomaly: The Toronto Stock Exchange Experience, *Journal of Busines Finance&Accounting*, 1994, Vol:21(6).

[2] AYADI, O. FELIX Stock Return Seasonalities in Low-Income African Emerging Markets, *Managerial Finance,* 1998, Vol:24.

[3] BALABAN, ERCAN Day of the Week Effect: New Evidence from an Emerging Stock Market, *Applied Economics Letters,* 1995, Vol: 2.

[4] BILDIK, RECEP Day of the Week Effect in Turkish Stock and Money Markets, *Annual Meeting of European Financial Management Association,* Paris, 1999.

[5] CLARE A.D., M.S.B. IBRAHIM and S.H. THOMAS The Impact of Settlement Procedures on Day of the Week Effect: Evidence form the Kuala Lumpur Stock Exchange, *Journal of Busines Finance&Accounting,* 1998, Vol:25 (3).

[6] CORNELL, BRADFORD The Weekly Pattern in Stock Returns: Cash Versus Futures: A Note, *The Journal of Finance,* 1985, Vol:XL.

[7] DEFUSCO, R.A. Day of the Week Effect: A Test of the Information Timing Hypothesis, *Journal of Busines Finance&Accounting,* 1993, Vol:20(6).
[8] FREUND, J., and SIMON G.A. *Modern Elementary Statistics,* Prentice-Hall International Inc. 1997, 9. Edition.
[9] GIBBONS, R.G. and HESS P. Day of the Week Effect and Asset Returns, *Journal of Busines,* 1981, Vol:54.
[10] KATO, KIYOSHI Weekly Patterns in Japanese Stock Returns, *Management Science,* 1990, 36.
[11] KRITZMAN, M.P. About Higher Moments, *Financial Analysts Journal,* Sep.-Oct. 1994.
[12] METIN, KIVILCIM., MURADOGLU G. and YAZICI B., İstanbul Menkul Kıymetler Borsası'nda Gün Etkilerinin İncelenmesi, *IMKB Dergisi,* 1997, Vol:4.
[13] MURADOGLU G. AND HUMAYUN A. Calendar Anomalies in Emerging Markets, Working paper, 2002, Hess Business School.
[14] SIAS, R.W.AND STARKS L.T. The Day of the Week Anomaly: The Role of Institutional Investors, *Financial Analysts Journal,* 1995, Vol:51.
[15] www.imkb.gov.tr

ALTERNATIVE MODELS FOR MEASURING SERVICE QUALITY, AND RELATING SERVICE QUALITY TO BEHAVIORAL INTENTIONS: MODERATING INFLUENCES

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Abstract

This paper studies the service quality and relating service quality to satisfaction and subsequent behavior after purchase. There are three stages of model testing in this paper. The first stage was to test the service quality models for its relationship with satisfaction. The second stage was to examine the relationship between satisfaction and word-of-mouth referrals and also re-purchase intentions. The third stage was to look at the moderating effect of warrantee on satisfaction and word-of-mouth referrals and also re-purchase intentions. This research lingers on the perceptions of Malaysians toward the banking institutions in Malaysia using a data sample collected from all the 15 states of Malaysia. Building on a synthesis of the extant literature on service quality measurement, this article identifies the underlying reason why dissatisfied customers would still patronage an organization.

Keywords: *Service quality, satisfaction, word-of-mouth referrals, re-purchases intentions, and warrantee*

1. Introduction

Service quality measurement has been discussed over the past few decades but there is no conclusion among researchers and academicians as to which measurement is the best to measure service quality. Every measurement scales seem to have their own strengths and weaknesses. In this paper, I will re-visit the SERVQUAL model that has been developed by Parasuraman et al. (1988) and the SERVPERF model that was developed by Cronin et al. (1992) to see its applicability in a developing country, such as Malaysia. All the models (SERVQUAL, weighted SERVQUAL, SERVPERF and weighted SERVPERF) will be compared by looking at the perceptions of Malaysians toward the service quality rendered by the banking institutions. It will also look at the moderating effect such as warrantee that might be the main contributor towards the unresolved issue why dissatisfied customers still remain with their current banks.

2. Quality Standard

Many academicians give different definition to quality. Kotler et al. (1969) note that customer satisfaction can be related to value and prices whereas service quality generally does not depend on prices (Anderson et al., 1994). Quality should be accordance to the needs and expectations of the customers. Customers' expectations are the true standard for judging service quality and not the policy of the bank or the management of the bank (Berry et al., 1991). Parasuraman et al. (1994) point out that customers expect service companies to do what they are supposed to do (fundamentals), not fanciness; performance and not empty promises. Defining customer needs in the service industries is more complex compared to the manufacturing because the customers are involved in the production process. The same concept applies to some other researchers.

Quality is how the offer of the bank gains uniqueness and value in the eyes of the customers and it is both the act of making the offer different and its evaluation by customers (Christopher et al., 1994). According to Berry et al. (1988), only the customers know that competing organizations that provide the same types of services do not provide the same quality of service. Quality can be used to operationalise utility, that is satisfaction (Brady & Cronin, 2001; Perreault et al., 1976). According to Dabholkar, Shepherd & Thorpe (2000), quality leads to satisfaction which in turn influences purchasing behavior (Johnson & Gustafsson, 2000). Satisfaction also has a direct influence on customer loyalty (Mittal & Lassar, 1998) and repurchases intentions/behaviors (Kumar, 2002, Mittal & Kamakura, 2001).

One of the most dominant model is service quality is the SERVQUAL model which has been developed by Parasuraman et al. (1988). This model served as the best measurement for service quality till 1992 where Cronin et al. (1992) developed the performance measurement scale (SERVPERF) which becomes great threat to SERVQUAL. There are many followers to both the models and till today, there are no consensus as to which model serves as the best model to measure service quality.

This research will consider what Joseph et al. (1992) has argued. Hence SERVQUAL will be examined as well as SERVPERF since SERVPERF uses the importance measurement to look at the attributes to see how it differs in Malaysia. It will also consider whether the SERVQUAL and the SERVPERF model is only a theory of the west or can be applied throughout the whole world since most of the researches on SERVQUAL and SERVPERF are done in the European countries or America.

3. Word-of-mouth Referrals

Word-of-mouth marketing tends to work very slowly and it is limited by geographical area but it is a very effective marketing mean. The value in word-of-mouth marketing is immense because of its impartiality and its credibility.

Word-of-mouth referrals are important in determining the success of a bank. Word-of-mouth marketing is the cheapest method for a bank to market itself. It needs no additional costs for advertising in local newspapers or in any media. This would lead to higher profit to the bank concerned because they can save a lot of money in attracting customers in this way.

In many situations, customers seek the opinions of others before selecting a service firm. When customers depends on someone else for information (company advertisement or literature), as opposed to customer's experiences, the beliefs they hold about what the product will do (expectations) may be important in forming satisfaction (Goode et al., 1996). Customers' referrals are better prospects since there is the screening process that has taken place in the recommender's mind compared to the advertisement.

Happy and satisfied customers are said to be willing to tell their friends or acquaintances (Zeithaml, 2000, Anderson & Mittal 2000, Johnson, Barksdale & Boles, 2003, Kennedy, Ferrell, & LeChair, 2001) about the particular bank and word-of-mouth marketing is more effective compared to advertisement because of its first hand experiences. Terry (1996) acknowledges that American research indicates that a contented customer will talk about his or her banker to five more individuals while a discontented customer will talk to fifteen other individuals expressing his or her dissatisfaction. Therefore, how a banker deals with its customers is important because it will have great impact on the perceptions on how potential customers perceive the bank. The effect will be seen in geometrical order whether it is a positive impact or negative impact. Should it be seen as negative impact, it will have great bearings on the amount of potential customers' loss to the bank.

In the study by Tan et al. (1986) in Singapore, they found that friends' advice, neighbors and family members have great impact on the decision to patronage a certain financial institution. These findings are consistent with the Eastern culture that emphasis on the social and family ties (Sudin Haron et al., 1994).

4. Warrantee

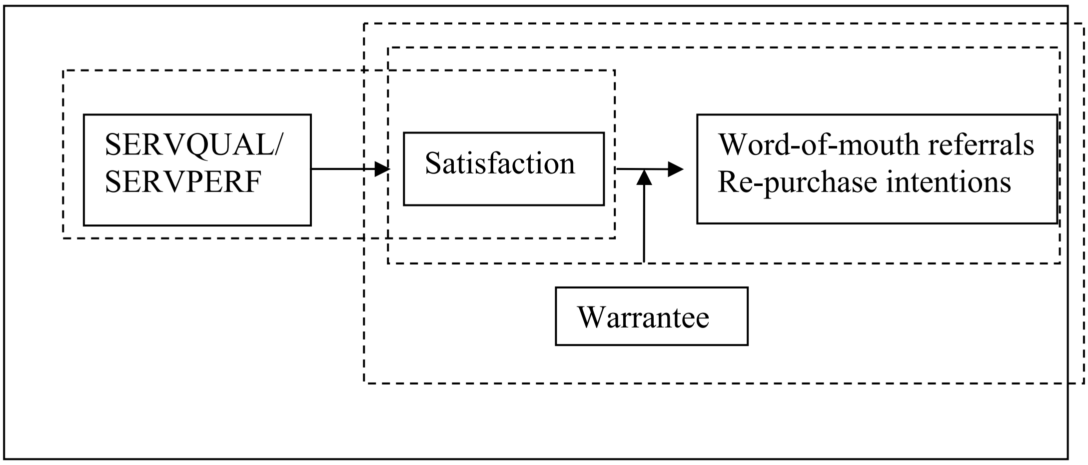
In a long-term relationship, Ravald et al. (1996) states that safety, credibility, security, continuity and etc. together will increase the trust for the supplier and these will thereby support and encourage customer loyalty. This measurement is also supported by Zeithaml et al. (1990) where they suggested a few dimensions for service quality and one of the dimensions is security, that is free from risks and doubts. While according to Avkiran (1994), the credibility factors include the ability of staff to solve problems, security and informing customers. Whereas according to Christopher et al. (1994), the most important element in the banking sectors is the security issues.

In this study, I will use the warrantee by the Malaysian government as the moderator. This is because the government warrants not all banks in Malaysia but only few selected banks. In case of anything happened, those customers at the warranted banks are guaranteed their fund from the government.

5. Testing the Framework

Figure 1 below shows the relationship used in this study. There are three parts to this study. The first is the relationship between service quality (SERVQUAL/SERVPERF) model and satisfaction, the second part is the relationship between satisfaction and word-of-mouth referrals/re-purchase intentions, and the third part is how word-of-mouth referrals or re-purchase intentions are being moderated by warrantee.

Figure 1: Relationship of the Variables under Study



5.1 Research Models and Hypothesis

There are still no concluding statements on whether SERVQUAL or SERVPERF model is a better measurement for satisfaction. Hence, in this paper, I will look into the applicability of SERVQUAL and SERVPERF in Malaysia, a developing country since most of the studies are done in developed countries.

These first two hypotheses provide the basis for this investigation:

Hypothesis 1: SERVQUAL, weighted SERVQUAL, SERVPERF and weighted

SERVPERF do not have generic dimensions

Hypothesis 2: Service quality dimensions are positively related to satisfaction

As for the main objectives of this study, another three hypotheses would identify the questions addressed in this part of the study.

Hypothesis 3: Satisfaction is positively related to word-of-mouth referrals

Hypothesis 4: Satisfaction is positively related to re-purchase intentions

Hypothesis 5: Warrantee would moderate the relationship between the perceptions of

satisfaction and the re-purchase intentions

Hypothesis 6: Warrantee would moderates the relationship between the perceptions of

satisfaction and the word-of-mouth referrals.

With these six hypotheses, the analyses are done so that these research questions could be answered.

6. Sample

The data for this study were gathered from questionnaires sent to all the 15 states in Malaysia. A total of 1025 usable questionnaires were received. Respondents were from all walks of lives ranging from age 18 years old to 60 years old. This age range has been chosen because this category falls into the most frequent users of the banking facilities. From the normality tests using the Kolmogorov-Smirnov Test for normality, all the respondents were distributed normally at $p < .05$ level.

6.1 Measurements

The measurements needed for the study are expectations and perceptions of service quality to measure customer satisfaction and the consequence behaviors after services are being rendered. The 22 expectations and performance items were taken directly from the SERVQUAL scale (Parasuraman, Zeithaml and Berry, 1988). The direct measure of service quality was based on a 7-point likert scale. As for the satisfaction item, the question is being adapted directly from Cronin et al. (1992), "overall, my satisfaction level towards XYZ is…" The measurements for warrantee re-purchase intentions and word-of-mouth referrals were constructed by the researcher after taking into consideration previous researches (refer to appendix).

Brown et al. (1993) and Carman (1990) argue that the use of disconfirmation approach as in SERVQUAL (Parasuraman et al., 1988) is not an appropriate measurement and stress that it should be changed from "strongly disagree" and "strongly agree" to "Worse than I expected" and "Better than I expected" to measure performance. Brown et al. (1993) acknowledge that this approach is a better measurement since it gives a better psychometric value and is more efficient compared to the disconfirmation paradigm.

7. General Model of Study

The following equation gives the general model of the study1.

Model 1

$Y_1 = \beta_1 + \beta_i X_i + \varepsilon$

where:

Y_1 = satisfaction

β_i = parameters

X_i = service quality dimensions

ε = error term

8. Results

Using the Varimax Rotation Method, two dimensions were extracted (with eigenvalue greater than 1) as can be seen from table 1. Cross-loadings were also checked to see whether there are any items that have high correlation with other factors. As according to Hair, Anderson, Tatham and Black (1998) and Kline (1991), if an item has loadings of greater than 0.5 in one dimension and more than 0.35 in another dimension, then that particular item must be dropped from further analysis (since there exist the cross-loadings problem). Those values in italic show the existence of cross-loadings, hence, they were dropped from further analysis.

1 Note: Service quality can be either SERVQUAL, weighted SERVQUAL, SERVPERF or weighted SERVPERF

Table 1: Dimensions Extracted from the Service Quality Measurements

	SERVQUAL		Weighted SERVQUAL		SERVPERF		Weighted SERVPERF	
	Service Quality	Tangibles	Service Quality	Tangibles	Service Quality	Tangibles	Service Quality	Tangibles
V1	0.308	**0.716**	0.319	**0.717**	0.318	**0.756**	0.101	**0.777**
V2	0.180	**0.832**	0.189	**0.816**	0.229	**0.823**	0.216	**0.725**
V3	0.367	**0.709**	0.342	**0.719**	0.291	**0.775**	0.142	**0.757**
V4	0.273	**0.687**	0.257	**0.696**	0.292	**0.717**	0.326	**0.621**
V5	**0.613**	0.258	**0.607**	0.224	*0.529*	*0.536*	*0.522*	*0.419*
V6	**0.723**	0.233	**0.712**	0.217	*0.645*	*0.446*	*0.586*	*0.403*
V7	**0.574**	0.208	**0.577**	0.22	*0.462*	*0.501*	*0.429*	*0.463*
V8	**0.720**	0.246	**0.707**	0.256	*0.633*	*0.518*	*0.619*	*0.417*
V9	**0.642**	0.269	**0.606**	0.308	*0.458*	*0.569*	*0.389*	*0.519*
V10	**0.713**	0.188	**0.701**	0.206	*0.673*	*0.404*	*0.559*	*0.375*
V11	**0.749**	0.174	**0.725**	0.178	*0.751*	*0.36*	0.68	0.301
V12	**0.769**	0.221	**0.748**	0.202	*0.754*	*0.389*	**0.717**	0.216
V13	**0.546**	0.265	**0.541**	0.248	**0.702**	0.326	**0.624**	0.327
V14	**0.679**	0.230	**0.676**	0.231	**0.636**	0.278	**0.662**	0.252
V15	**0.639**	0.235	**0.628**	0.251	*0.602*	*0.472*	**0.607**	0.34
V16	**0.718**	0.159	**0.702**	0.158	**0.754**	0.343	**0.762**	0.141
V17	**0.675**	0.198	**0.655**	0.213	*0.703*	*0.386*	**0.694**	0.242
V18	**0.596**	0.150	**0.590**	0.133	**0.767**	0.287	**0.666**	0.239
V19	**0.557**	0.212	**0.546**	0.211	*0.723*	*0.352*	**0.673**	0.205
V20	**0.616**	0.130	**0.615**	0.109	**0.827**	0.247	**0.727**	0.168
V21	**0.615**	0.148	**0.578**	0.081	**0.784**	0.263	**0.693**	0.141
V22	**0.576**	0.156	**0.562**	0.142	**0.758**	0.261	**0.677**	0.193
Cronbach Alpha	0.935	0.826	0.93	0.823	0.925	0.866	0.925	0.823
R^2		0.267		0.258		0.246		0.243

* those in italics have been omitted due to cross loadings

The factor analysis results as extracted only showed two dimensions for service quality. This result is not surprising since as mentioned by Carman

(1990), though SERVQUAL establishes stability, but its five dimensions are not always generic. Hence, the second hypothesis is being supported. The Cronbach Alpha (> 0.8) demonstrates that all the measures are reliable. From the analysis between the Perceptions minus Expectations (P – E), the result also shows that most of the respondents asked were not satisfied with the services rendered by the banking institution.

From the factor analysis, there are two dimensions extracted. Hence model 1 will be utilized to test the relationship between service quality and satisfaction. The following model was done for the SERVQUAL model. The R^2 for other alternative models are reported in table 1. Since the R^2 is highest for SERVQUAL model, only SERVQUAL model would be used as a base to answer hypothesis 2.

Table 2: Regression results between service quality and satisfaction

	B	R^2	Adjusted R^2
Service Quality	0.678**		
Tangibles	0.568**	0.267	0.266

** is significant at $\rho < 0.01$

From table 2, the findings show that there is a positive relationship between dimensions of service quality and satisfaction. Hence, hypothesis 2 is being supported.

8.1 Moderating Models

The second model is to test the second, that is there is a positive relationship between satisfaction and word-of-mouth referrals or re-purchase intentions. On top of that, the moderating variable was also included in the model.

Model 2

$$Y_1 = \beta_1 + \beta_2 X_1 + \beta_3 Z_1 + \varepsilon$$

where:

Y_1 = Word-of-mouth referrals/Re-purchase Intentions

β_i = Parameters

X_1 = Satisfaction

Z_1 = Warrantee Program

ε = Error term

In order to capture the moderating effects, model 3 is built. The model incorporates the warranty as the moderator.

Model 3

$$Y_1 = \beta_1 + \beta_2 X_1 + \beta_3 Z_1 + \beta_4 X_1 Z_1 + \varepsilon$$

where:

Y_1 = Word-of-mouth referrals/Re-purchase Intentions

β_i = Parameters

X_1 = Satisfaction

Z_1 = Warranty

ε = Error term

In order to proceed with the analysis, factor analysis is run again on the moderators and subsequent behavior after purchase. Table 3 shows the results of the extraction.

Table 3: Factor Analysis for Moderator and Subsequent Behavior after Purchase

Items	Warrantee	Word-of-Mouth Referrals	Re-purchase Intentions
I1	**0.766**	0.325	0.234
I2	**0.717**	0.216	0.234
W1	0.250	**0.750**	0.345
W2	0.341	**0.777**	0.317
W3	0.223	**0.767**	0.298
L1	0.312	0.253	**0.758**
L2	0.130	0.294	**0.790**
L3	0.234	0.189	**0.870**
Cronbach Alpha	0.927	0.876	0.825

For table 3, out of eight items on moderators and subsequent behavior after purchase, there are three dimensions extracted. All the dimensions show internal consistency (from the cronbach alpha reading). Thus, further analyses were run using model 2 and model 3 and the subsequent tables provide the output of the analyses.

Table 4: Warrantee as Moderator for Satisfaction and Word-of-mouth referrals

	Standard B Step 1	Standard B Step 2	Standard B Step 3
Dependent Variable			
Word-of-mouth referrals			
Independent variable			
Satisfaction	0.761**	0.289**	0.310**
Moderating Variable			
Warrantee		0.617**	0.342**
Interaction Effect			
Satisfaction* Warrantee			0.094**
R^2	0.278	0.384	0.459
Adjusted R^2	0.277	0.382	0.458
R^2 Change	0.277	0.106	0.075
Significant F change	0.000	0.000	0.001

Note: The value in the bracket is the t-statistics
* is significant at $\rho < 0.05$
** is significant at $\rho < 0.01$

Table 5: Warrantee as Moderator for Satisfaction and Re-Purchase Intentions

	Standard B Step 1	Standard B Step 2	Standard B Step 3
Dependent Variable			
Re-purchase Intentions			
Independent variable			
Satisfaction	0.333*	0.255**	0.468*
Moderating Variable			
Warrantee		0.405**	0.533**
Interaction Effect			
Satisfaction* Warrantee			0.045*
R^2	0.281	0.324	0.446
Adjusted R^2	0.280	0.323	0.445
R^2 Change	0.281	0.043	0.122
Significant F change	0.000	0.000	0.000

Note: The value in the bracket is the t-statistics

* is significant at $\rho < 0.05$

** is significant at $\rho < 0.01$

From table 4 and 5, the results show there are positive relationships between satisfaction and word-of-mouth referrals and re-purchase intentions. Therefore, hypotheses 4 and 5 are being supported. The analyses also show that there is moderating effect (warrantee) between satisfaction and word-of-mouth referrals and re-purchase intentions, hence, hypotheses 5 and 6 also being supported.

9. Limitations

In this study, the limitations lie on the sampling methods. From the random samples gathered, the respondents were not screened for whether they have been using the banking services lately or not. This is because there are some customers who have not been using the banking facilities for sometime, yet they might be one of the respondents.

10. Discussions and Managerial Implications

From the findings, there are few points that can be pondered upon. The first is the impact of service quality on satisfaction level. In general, service quality would definitely lead to satisfaction. But how service quality level is being justified is very vague. It depends on individuals and past experiences. In other words, individuals from different background would perceive service quality differently. Therefore, though the service quality level is good, but still there are customers who are dissatisfied and vice versa. Hence, there must be another form or ties that are able to bind the customers to the banking institutions. One of them is through warrantee.

Managers and researchers should put more emphasis on the moderating effect that will moderate the relationship between the service quality, the re-purchase intentions and word-of-mouth referrals. While there are still many customers who are dissatisfied with the current level of services, but due to these moderating effects, they will still remain with the bank and be their ambassador through the word-of-mouth referrals to others.

This is because while there are warrantees, it binds the customers strongly to that particular bank. The customers would feel safe in their transaction with the bank and would not worry in case of any mishaps that might befall. Hence, customers who put great weighs on the security will certainly patronize the same bank.

Therefore, it is suggested that bank institutions should try to seek ways to implement warrantee into their banking environment. What can be done is creating a sense of security in the eyes of customers in terms of strong financial assets if the banks are not warranted by the government. Hence, those banks that have yet to merge should seek alternatives to create strong financial assets in order to create an attractive environment for customers.

11. Direction for Future Research

Future research should look at other possible moderators that might moderate the relationship and bind the customers to a particular bank. Emphasis should also be made on the customers' demography to see how these different demographic categories differ in their perception towards warrantee.

12. Conclusion

As can be seen from the analysis, though there are customers who are not satisfied with their current bank, there still exist ties that bind them to their current bank. These ties are in the form of warrantee. From this research, it can be concluded that service quality alone does not play a very important role in determining the patronization of customers. In other words, there are other aspects that should be taken into consideration other than service quality in the process of attracting customers to certain banks.

References

[1] Anderson, E. & Sullivan, M. W. Strengthening the Satisfaction-Profit Chain. *Journal of Service Research*. 2000, vol. 3 (Nov), pp. 107 – 120.

[2] Avkiran, N.K. Developing an Instrument to Measure Customer Service Quality in Branch Banking. *International Journal of Bank Marketing.* 1994, vol. 12 (November), pp. 10-18.

[3] Berry, L.L. & Parasuraman, A. *Marketing Services: Competing Through Quality*. New York, NY: The Free Press, 1991.

[4] Berry, L.L., Parasuraman, A. and Zeithaml, V.A. The Service Quality Puzzle. *Business Horizon.* 1988, vol. 60 (September-October), pp. 35-43

[5] Brady, M. K. & Cronin, J. J. Some New Thoughts on Conceptualizing perceived Service Quality: A Hierarchical Approach. *Journal of Marketing.* 2001, 65 (3), 34 – 49.

[6] Carman, James M. Consumer Perceptions of Service Quality: An Assessment of the SERVQUAL Dimensions. *Journal of Retailing. 1990,* vol. 66 (Spring), pp. 33-55.

[7] Christopher, M., Payne, A. & Ballantyne D. *Relationship Marketing-Bringing Quality, Customer Service, and Marketing Together*. Butterworth Heinemann, 1994.

[8] Cronin, J. J. & Taylor, S. A. Measuring Service Quality: A Re-examination and Extension, *Journal of Marketing*. 1992, vol. 56 (July), pp. 55-68.
[9] Dabholkar, P. A., Shepherd, C. D. & Thorpe, D. I. A Comprehensive Framework for Service Quality: AN Investigation of Critical Conceptual and Measurement issues Through a Longitudinal Study. *Journal of Retailing*. 2000, vol. 76, no. 2, pp. 139 – 173.
[10] Goode M. H., Moutinho, L.A. & Chien, C. Structural Equation Modelling of Overall Satisfaction and Full use of Services for ATMs. *International Journal of Bank Marketing.* 1996, vol. 7, pp. 4-11.
[11] Johnson, J. T., Barksdale, H. C. & Boles, J. S. Factors Associated with Customer Willingness to Refer Leads to Salespeople. *Journal of Business Research*. 2003, vol. 56, pp. 257 – 263.
[12] Johnson, M. D., Gustafsson, *A. Improving Customer Satisfaction, Loyalty and Profit: An Integrated Measurement and Management System*. San Francisco CA: Jossey-Bass, 2000.
[13] Joseph, M., McClure, C. and Joseph, B. Service Quality in the Banking Sector: The Impact of Technology on Service Delivery. *The International Journal of Bank Marketing*. 1999, vol. 17, no. 4, pp. 182-193.
[14] Kennedy, M. S., Ferrell, L. K. & LeChair, D. T. Consumers' Trust of Salesperson and Manufacturer: An Empirical Study. *Journal of Business Research*. 2001, vol. 51, pp. 73 – 86.
[15] Kline, P. An Easy Guide to Factor Analysis. Routledge, 1991.
[16] Kotler, P. & Levy, S.J. (1969). "Broadening the Concept of Marketing. *Journal of Marketing.* 1969, vol. 33, pp. 10-15.
[17] Mittal, B. & Kamakura, W. A. Satisfaction, Repurchase Intent, and Repurchase Behavior: Investigating the Moderating Effect of Customer Characteristics. Journal of Marketing Research. 2001, vol. XXXVIII, no. 1, pp. 131 – 142.
[18] Mittal, B. & Lassar, W. M. Why Do Customers Switch? The Dynamics of Satisfaction versus Loyalty. *The Journal of Services Marketing*, 1998, vol. 12, no. 3, pp. 177 – 194.
[19] Parasuraman, A, Zeithaml, V. & Berry, L.L. Alternative Scales for Measuring Service Quality: A Comparative Assessment Based on Psychometric and Diagnostic Criteria. *Journal of Retailing*. 1994, vol. 70, no. 3, pp. 201-229.
[20] Parasuraman, A., Zeithaml, V. A. & Berry, L. L. SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. *Journal of Retailing*. 1988, vol. 64, no. 1, pp. 12-40
[21] Perreault, W.D. & Russ, F.A. Physical Distribution Sservice in Industrial Purchase Decisions. *Journal of Marketing*. 1976, vol. 40

(April), pp. 3-10.
[22] Ravald, A. & Grönroos, C. The Value Concept and Relationship Marketing. *European Journal of Marketing*. 1996, vol. 30, no. 2, pp. 19-30.
[23] Sudin, Haron, Norafifah A. and Sandra, L.P. Bank Patronage Factors of Muslim and Non-Muslim Customers. *International Journal of Bank Marketing*. 1994, vol. 12, no. 1, 32-40.
[24] Tan, C.T. & Chua, C. Intentions, Attitude and Social Influence in Bank Selection: A Study in an Oriental Culture. *International Journal of Bank Marketing.* 1986, vol.4 (3), pp. 43-53.
[25] Terry, D. Private Banking: Effective Strategies for Building a New Customer Base. *The World of Banking*. 1996, vol. 15, no. 1, pp. 3-6, 25.
[26] Zeithaml, V. A. (2000). Service Quality, Profitability and the Economic Worth of Customers: What We Know and What We Don't Know. *Journal of Academy of Marketing Science*. 2000, vol. 28, no. 1, pp. 67 – 85.
[27] Zeithaml, V. A., Parasuraman, A. & Berry L. L. *Delivering Service Quality: Balancing Perecptions, and Expectations*. The Free Press, New York, NY, 1990.