ÖREBRO UNIVERSITET
Institutionen för Ekonomi,
Statistik och Informatik

The Capital Asset Pricing Model

Test of the model on the Warsaw Stock Exchange

C –Thesis

Author: Bartosz Czekierda

Writing tutor: Håkan Persson

Lucy: *"I've just come up with the perfect theory. It's my theory that Beethoven would have written even better music if he had been married"*

Schroeder: *"What's so perfect about that theory?"*

Lucy: *"It can't be proven one way or the other"*

- ***Charles Schulz, Peanuts, 1976***

Abstract

Since 1994 when the Warsaw Stock Exchange has been acknowledged as a full member of World Federation of Exchanges and became one of the fastest developing security markets in the region, it has been hard to find any studies relating to the assets price performance on this exchange. That is why I decided to write this paper in which the Nobel price winning theory namely the Capital Asset Pricing Model has been tested.

The Capital Asset Pricing Model (or CAPM) is an equilibrium model which relates asset's risk measured by *beta* to its returns. It states that in a competitive market the expected rate of return on an asset varies in direct proportion to its beta.

In this paper the performance of 100 stocks traded continuously on the main market in the years 2002-2006 has been tested. I have performed three independent tests of the CAPM based on different methods and techniques to better check the validity of the theory and then compared the results.

As in the case of many other studies of the Capital Asset Pricing Model, this one didn't find a complete support for the model but couldn't reject some of its features either.

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1. Introduction

…When the first primitive man decided to use a bone for a club instead of eating its marrow, that was investment.

-Anonymous

1.1 Concept of the stock exchange[1]

The main idea of the stock exchange is to provide firms with capital and equity. They do so by issuing common stocks which can be purchased and traded on the market. Price of such a stock is usually defined as a net present value of company's future cash flows. If a person owns a share he's entitled to a fraction of the firm's profit and essentially owns a part of the firm. Stock exchanges are usually organized to separate new stock issues from daily trading. If a company wishes to raise additional funds for new capital by issuing new shares it does this on the primary market while existing shares are traded on the secondary market. There are two main types of exchanges: auction markets and dealer markets. On the auction market, which is definitely the most popular type, an auctioneer works as an intermediary and matches potential buyers and sellers. The dealer market is characterized by the presence of dealer groups which trade with the investors directly. Dealer markets are not particularly popular for stock trading but other financial instruments such as bonds are usually traded that way.

1.2 Purpose of the study

The main objective of this paper is to check the validity of the Capital Asset Pricing Model using the assets traded on the Warsaw Stock Exchange. The Capital Asset Pricing model or in short the CAPM is equilibrium model that relates stocks risk measured by beta to their returns. Its main massage is that stocks returns are increasing proportionally to their betas and that this relationship is positive and linear. It is expressed by so called Security Market Line. A complete derivation and logic behind the model will be described in Chapter 2. The testing procedure will be concentrated on properties of this Security Market Line using the ordinary least squares and multiple regressions as main analytical tool. In this paper three independent tests of the model will be performed based on previous studies of the researchers such as Black, Jensen, Scholes, Fama and MacBeth[2]. Chapter 3 will describe their studies in more detail. I will use the monthly returns on the stocks in the years 2002-2006. Due to this relatively short testing period the original tests must be modified to accommodate the available data. This process will be described in Chapter 4 followed by the empirical analysis in Chapter 5 and the conclusions in Chapter 6.

[1] Brealey, Myers, Allen [2006] p.60-61
[2] Haugen Robert A. [2001] p.238-139

1.3 The Warsaw Stock Exchange[3]

The origins of Polish financial markets date back to the 19th century. On May 12, 1817 the first stock exchange known as the Mercantile Exchange was founded in Warsaw. Financial instruments traded in that time were primarily bonds and bills of exchange. Assets similar to stocks developed during the second half of the 19th century. The Warsaw exchange was not the only market operating in Poland at that time. Similar exchanges were founded in Katowice, Krakow, Lvov, Lodz, Poznan and Vilnius. By 1939 there were 130 securities traded on the exchange including municipal, corporate and government bonds as well as shares.

Unfortunately further development of the financial sector was interrupted by historical events. World War II and later the operation of the communistic system put a stop to trading for many years. After the fall of the regime a need for a well functioning financial system arose again. In 1990 Poland signed an intergovernmental agreement with France to create a new stock exchange in Warsaw. Not long afterwards in 1991 the Warsaw Stock Exchange (WSE) was officially opened. It took 3 more years however until WSE could be accepted as a full member of World Federation of Exchanges. Since then the market was developing rapidly. When the first session took place there were five companies listed on the exchange, today the corresponding number is 293. Last year's capitalization of domestic companies reached almost 160 billion USD. The number of companies listed on the exchange and the market's turnover are shown in the Diagrams 1 and 2.

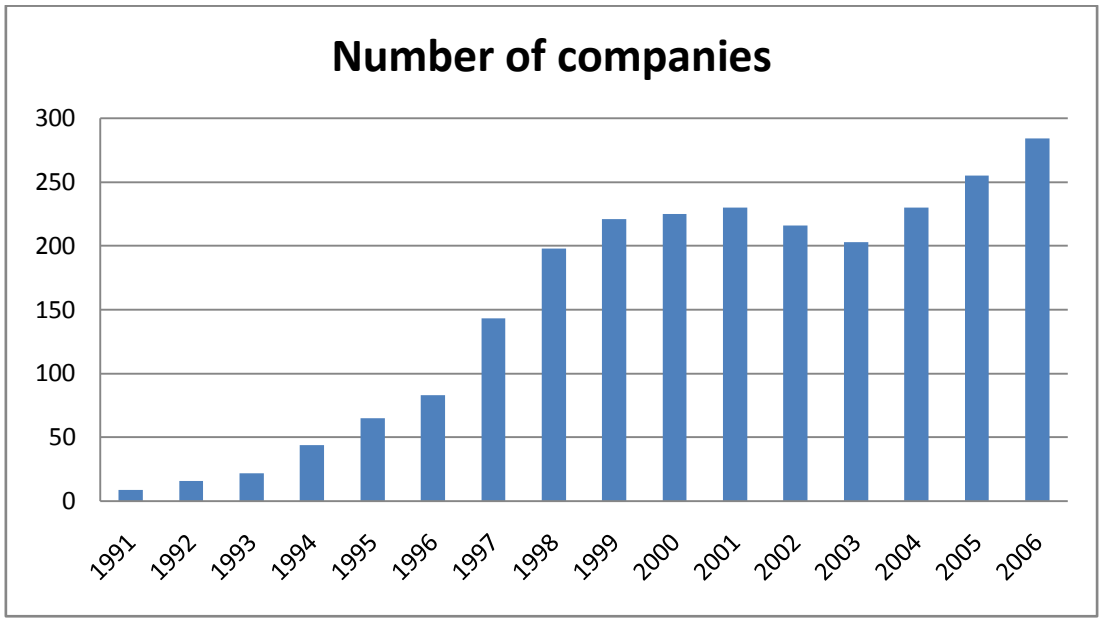

Diagram 1.Number of companies listed on the WSE.
Source: WSE official statistics

[3] 2006 Warsaw Stock Exchange Fact Book p.130-132

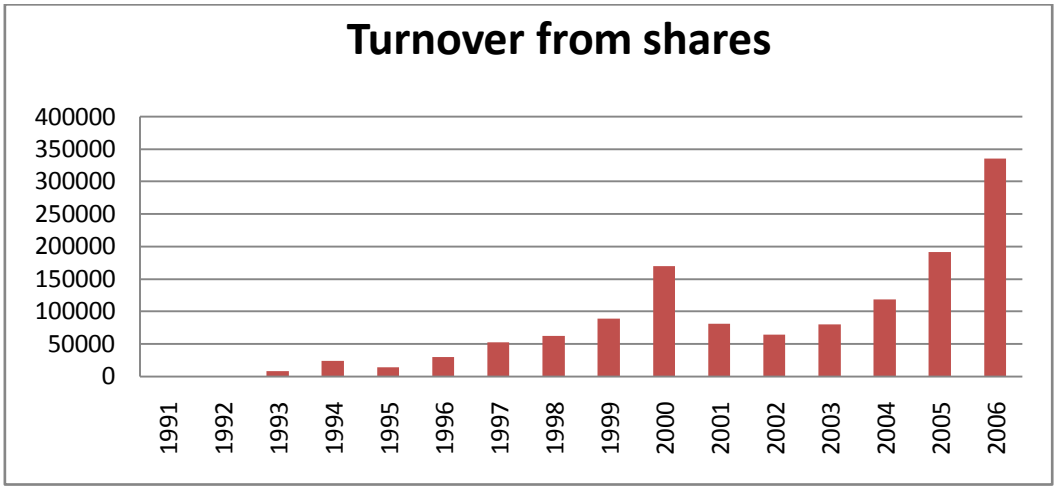

Diagram 2.Share turnover on WSE in mln PLN (1 USD ≅ 2,8 PLN)
Source: WSE official statistics

The Warsaw Stock exchange is a joint stock company with almost 60 000 shares outstanding. In 2005 it had 38 shareholders including brokerage houses, banks, and the State Treasury which holds 98, 81 % of all shares. The objectives of the WSE are stated in its mission and vision.

Mission of the WSE[4]

- To provide a transparent, effective and liquid market that concentrates trading in Polish financial instruments;
- To provide the highest quality of service to Polish market participants ;
- To provide a capital allocation and mechanism to finance the Polish economy;
- To foster capital markets' development in Poland.

The WSE's Vision[5]

- To achieve a 50% market capitalization/GDP ratio;
- To maintain the leading position on the domestic capital market;
- To become the largest exchange in the region and an important hub in the network of European exchanges.

Trading on WSE is organized into two main markets:

- Main market (official quotations)
- Parallel market

Assets traded on the main market belong to the companies with the largest liquidity which usually have a longer history while companies listed on the parallel market are smaller, younger and have less capital.

[4] 2006 Warsaw Stock Exchange Fact Book p.7-8
[5] 2006 Warsaw Stock Exchange Fact Book p.7-8

2. Theoretical background

In this section all the necessary theory of the stock valuation and portfolio management will be presented. I will start with the concept of asset valuation referred to as the fundamental share price. Next step will be to describe the modern portfolio theory created by Harry Markowitz and the theory of his followers Sharpe and Lintner known as Capital Asset Pricing Model (CAPM).Finally I will mention the theory of efficient capital markets.

2.1 Fundamental share price[6]

Fundamental share price is the most basic concept of the firm's valuation. It states that the market value of the share is the discounted value of all future expected cash flows from the company to its owners. The underlying assumption is that company desires to maximize the wealth of its stockholders which is equivalent to maximizing the value of the outstanding shares. Microeconomic theory assumes the profit maximization model of the company but fortunately the profit maximization and the shareholders' wealth maximization are goals very similar to each other.

Assume that shares price is P_t in period *t.* If a company pays out a dividend D_t^e and the expected value of the share in the period *t+1* is P_{t+1}^e then the stockholders expected gain from holding a share is $D_t^e + (P_{t+1}^e - P_t)$. If prevailing interest rates on risk-free asset is *r* and the risk-premium for normally risk-averse investors is *ε* then the equilibrium condition on the market reads:

$$(r+\varepsilon)P_t = D_t^e + P_{t+1}^e - P_t \tag{1}$$

Solving this equation for P_t gives the first expression for the stock price as a discounted value of the expected dividend and the expected price:

$$P_t = \frac{D_t^e + P_{t+1}^e}{1+r+\varepsilon} \tag{2}$$

Using this equation one can obviously express the stock price for any period of time: P_{t+1}^e, P_{t+2}^e,….P_{t+n}^e. Substituting expressions for future prices into equation 2 gives:

$$P_t = \frac{D_t^e}{1+r+\varepsilon} + \frac{D_{t+1}^e}{(1+r+\varepsilon)^2} + \frac{D_{t+2}^e}{(1+r+\varepsilon)^3} + \cdots + \frac{P_{t+n}^e}{(1+r+\varepsilon)^n} \tag{3}$$

If we assume that investors do not expect stock prices P_{t+n}^e to rise indefinitely at rate faster than $r+\varepsilon$ (if that was the case the price today would by infinitely high), then we conclude that $\lim_{n\to\infty} \frac{P_{t+n}^e}{(1+r+\varepsilon)^n} = 0$ and equation 3 can be rewritten as follows:

$$P_t = \frac{D_t^e}{1+r+\varepsilon} + \frac{D_{t+1}^e}{(1+r+\varepsilon)^2} + \frac{D_{t+2}^e}{(1+r+\varepsilon)^3} + \cdots = \sum_{t=1}^{\infty} \frac{D_t^e}{(1+r+\varepsilon)^t} \tag{4}$$

The expression above is known as the fundamental share price and as mentioned it is equal to the present value of expected cash flows i.e. dividends to the shareholders. In order to pay out dividends a company must earn a positive profit so the owners' wealth maximization means firms profit maximization.

[6] Sørensen Peter Birch, Whitta-Jacobsen Hans Jørgen [2005]" p. 337-339

2.2 Modern portfolio theory[7]

Modern portfolio theory is a set of concepts created by Harry Markowitz[8] in the early fifties. He introduced a measurement of assets risk and developed methods for combining them into risk-efficient portfolios, thus creating an important base for further evolution of financial theory.

The two most important values of any asset are its returns over time and the volatility of these returns. Measured over some fairly short interval of time, the rates of returns conform closely to normal distribution, while studying longer periods of time exhibits the distribution that could be described as lognormal i.e. skewed to the right[9] [10]. However it is commonly assumed that rates of returns are distributed normally. To describe such a distribution we need only two numbers: mean and standard deviation. Translating into financial definitions, mean describes expected return of the asset and standard deviation is a measurement of the risk. Risk and return are the only things that investors pay attention to while making their investment decisions.

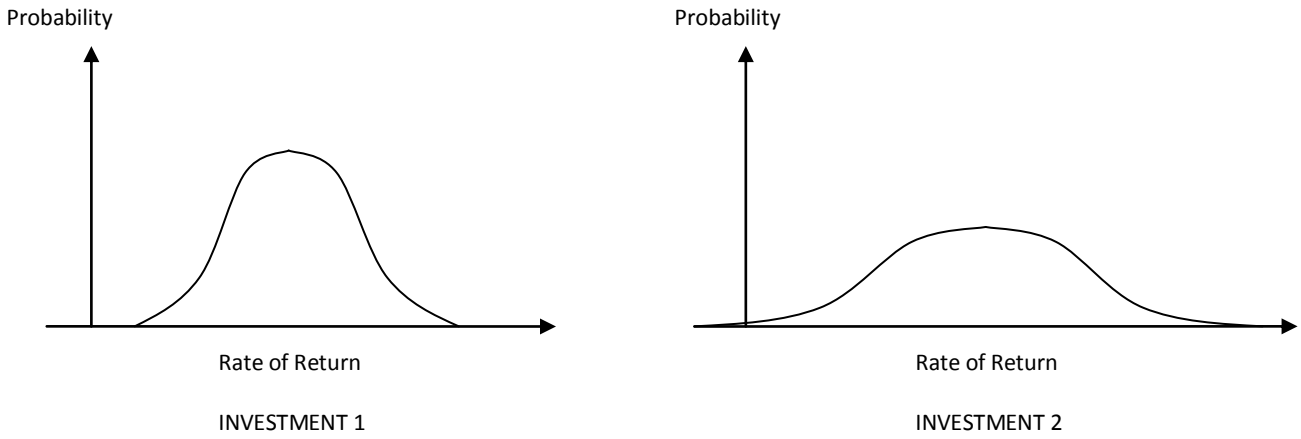

Figure 1 Probability distribution for two different investments with the same expected return.

The Figure 1 above shows two investments with the same average expected return but different risk. A rational investor should choose Investment 1 since its standard deviation of returns is much lower than that of Investment 2. A rational investor in this example is a risk-averse investor. This means that in risk-return framework he/she will always strive to achieve the highest possible return with lowest possible risk.

Most investors do not put their money into just one asset but combine many assets into portfolios. To measure the rate of return such a portfolio one simply takes the weighted average of returns on the individual assets:

$$E(r_p) = \sum x_i E(r_i) \qquad (5)$$

Where:
$E(r_p)$ –Expected return on the portfolio
x_i -Weight of stock *i* in the portfolio
$E(r_i)$ -Expected return on asset *i*

[7] This section relies heavily on Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] and Haugen Robert A. [2001]
[8] Markowitz[1952] p.77-91
[9] Returns greater then 100% can be observed while none -100% type returns should be encountered.
[10] Brealey, Myers, Allen [2006] p. 181 - 182

Calculating the risk of the portfolio is much trickier. Multiplying individual assets' standard deviations by their weights in the portfolio and summing them up could only work if all the securities in the portfolio were perfectly correlated with each other. This is rarely the case.

In his studies Markowitz[11] discovered that combining stocks into portfolios can substantially reduce the standard deviation of portfolio, thus introducing the concept known as diversification. Diversification is possible because prices of different stocks are not perfectly correlated with each other. In the Figure 2 below we can see how the increasing number of assets in the portfolio reduces its risk.

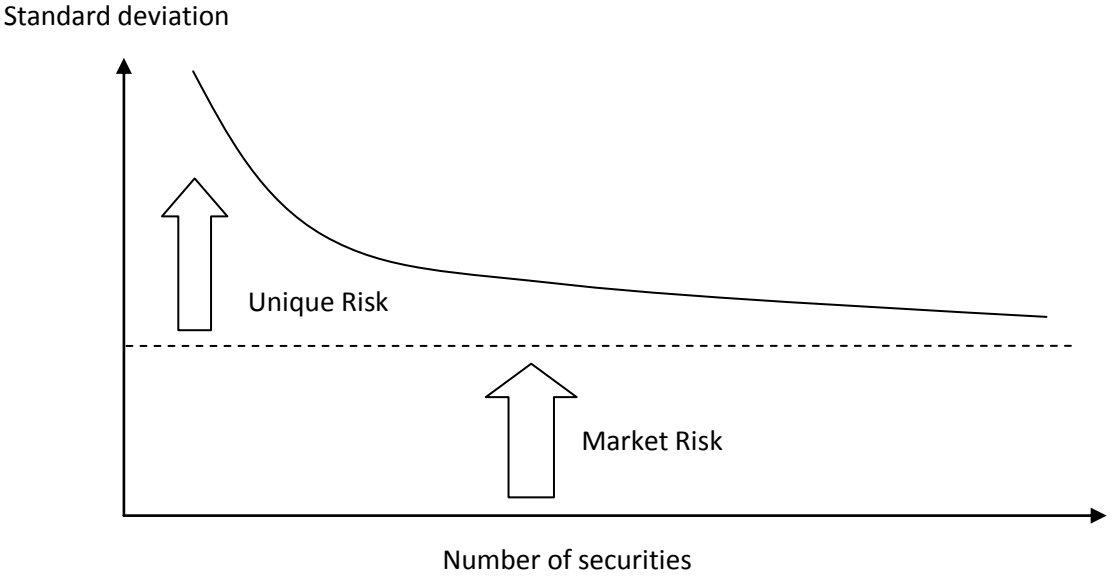

Figure 2 How diversification reduces risk.
Source: Brealey, Myers, Allen [2006]

We can see that as an investor increases number of assets in his portfolio the overall risk diminishes. It is also worth mentioning that the reduction of risk is most noticeable with only a few securities and as we put more stocks into portfolio reduction becomes smaller and smaller and ceases at some point. The risk that can be diversified is also called the unique risk while non avoidable risk is known as the market risk.

Knowing how the standard deviation of the portfolio changes with an increasing number of securities. It can by now shown how to calculate it. The simplest case is with just two assets and the formula looks like the one below:

$$\sigma(p) = \sqrt{x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2(x_1x_2\sigma_{12})} \quad (6)$$

Where:

$\sigma(p)$ -Portfolio standard deviation
σ_1^2 - Variance of stock
σ_1^2 - Variance of stock 1
x_2 -Weight of stock 2 in the portfolio
x_1 -Weight of stock 1 in the portfolio
σ_{12} -Covariance between stocks 1 and 2

[11] Markowitz[1952] p.77-91

Adding more stock into the portfolio involves putting more variables into the equation above, especially covariances. For instance portfolio with 3 securities involves 3 terms for weighted variances and 6 terms for weighted covariances[12].

The next question that arises is how many of each stock an investor should have in his/her portfolio to minimize the risk and maximize the expected return? To answer this question we must employ equations 5 and 6 to calculate the expected rates of return and the standard deviations for different weights of stocks. An example of such an analysis in a two-stock case can be seen in the Figure 3 below.

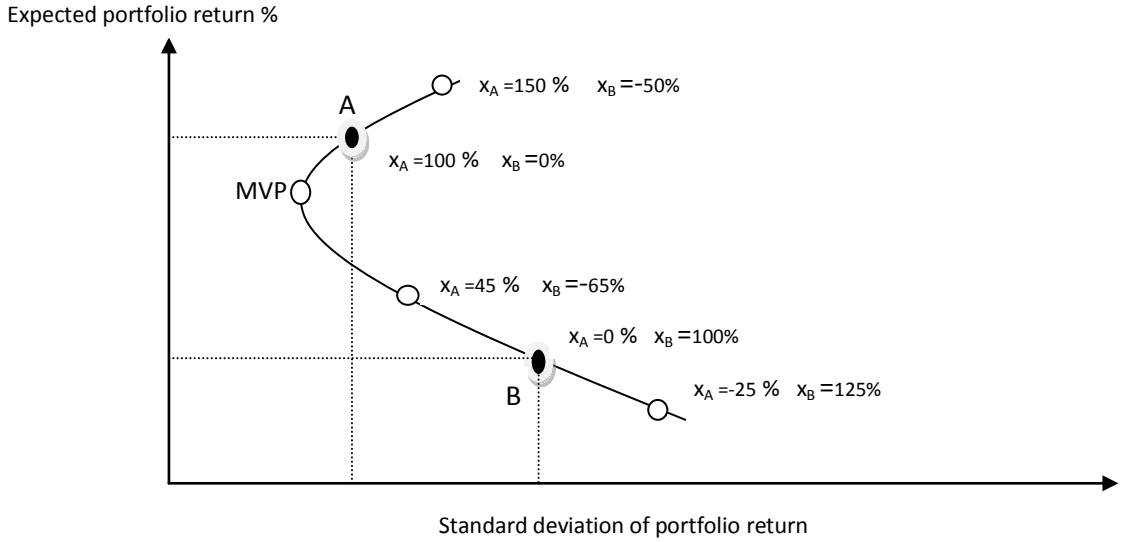

Figure 3 Combination line for securities A and B for the case of zero correlation
Source: Haugen Robert A. [2001]

Points A and B in the Figure 3 correspond to two different assets. Using equations 5 and 6 and trying different weights of these stocks in the portfolio (x_A, x_B) gives a so called combination line. The shape of the combination line depends on the degree of correlation between stocks. This bell-shaped curve is associated with a case when stocks A and B have no correlation with each other.

Figure 3 gives an investor important clues as to what combination of stocks should be chosen. One could guess that most investors would like to achieve highest possible expected return and lowest possible standard deviation and choose so called minimum variance portfolio (MVP). That is partially true, because it all depends on the investor's attitude to risk. The next question is therefore how to find such a portfolio?

The first step to answer this question is to draw a similar curve to that in Figure 3. To be more realistic much more stocks will be included. When analyzing many stocks the combination possibilities will be represented by an area in a risk-return framework rather than a combination line. Figure 4 illustrates this.

[12] $\sigma(p) = \sqrt{x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + x_3^2\sigma_3^2 + 2(x_1x_2\sigma_{12}) + 2(x_1x_3\sigma_{13}) + 2(x_2x_3\sigma_{23})}$

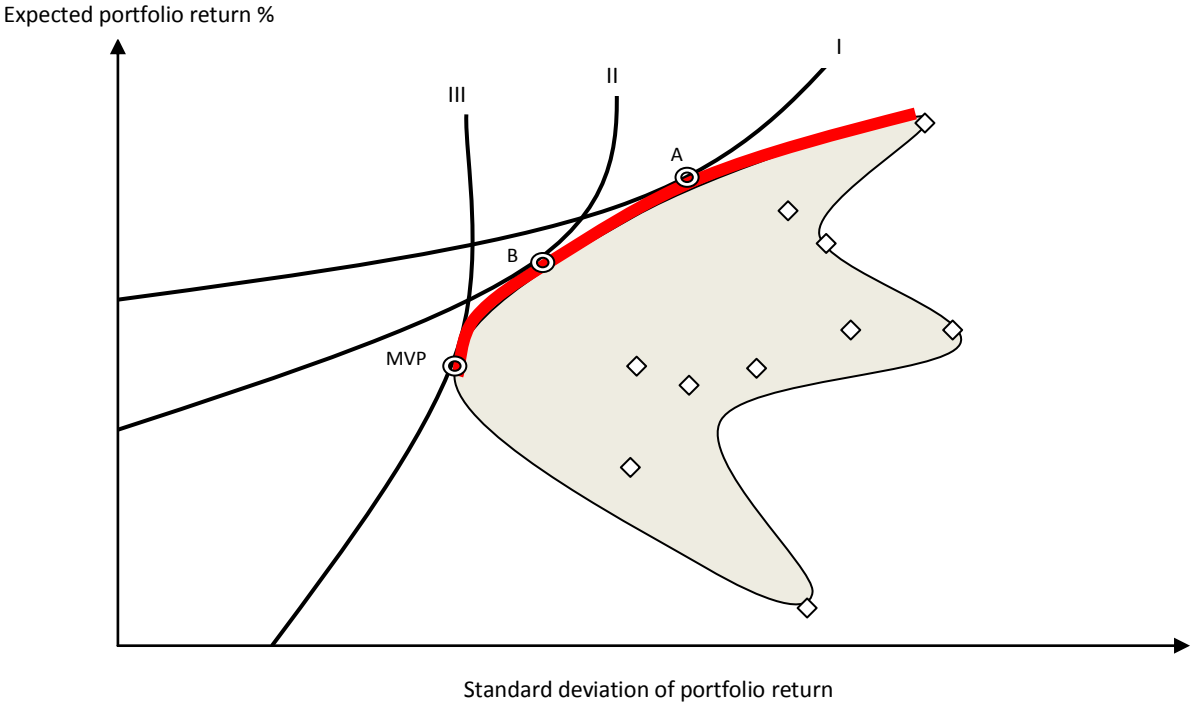

Figure 4 Optimal choices of investment portfolio
Source: Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005]

The diamond-like points in the figure above represent positions of single stocks in the risk-return framework. The shaded area represents so called the feasible set and it contains all the portfolios that can be constructed from these individual securities. When choosing a portfolio investors want to achieve the highest expected return possible according to their risk preferences. However no rational investor would invest in a portfolio below the minimum variance portfolio (MVP) since higher return can be achieved with the same risk. The part of the feasible set market with the red curve is called the efficient frontier because it contains portfolios defined by Markowitz as efficient portfolios. The main feature of these portfolios is that they offer the best possible expected return given a certain amount of risk.

Now it is possible for us to see which portfolios will be chosen. According to common practice in microeconomics the investors' preferences will be marked with utility functions represented by indifference curves I-III. An investor with indifference curve III is definitely a risk loving one since he chooses portfolio A with high return and high risk. An investor with indifference curve II can tolerate some risk thus chooses portfolio B while investor with utility function I is most the risk averse of them all and chooses minimum variance portfolio.

Knowing where the price of the stock comes from, how diversification reduces risk and how investors make their investment decisions by choosing efficient portfolios it is now possible to derive an extension of Markowitz's modern portfolio theory: *the capital asset pricing model*.

2.3 The Capital Asset Pricing Model (CAPM)[13]

The capital asset pricing model was created approximately 10 years after Markowitz's[14] famous article. The model was developed almost simultaneously by four researchers: Sharpe, Treynor, Mossin and Linter. In short the CAPM is a theory about how assets' price is related to their risk[15]. Before I can proceed and derive the model, a couple of assumptions must be made about investors and assets. I will use the same assumptions as Copeland, Weston and Shastri used in their handbook *"Financial Theory and Corporate Policy*":

- Assumption 1: Investors are risk-averse individuals who maximize the expected utility of their wealth
- Assumption 2: Investors are price-takers and have homogenous expectations about asset returns that have a joint normal distribution.
- Assumption 3: There exists a risk-free asset such that investors may borrow or lend unlimited amounts at the risk-free rate.
- Assumption 4: The quantities of assets are fixed. Also, all the assets are marketable and perfectly divisible.
- Assumption 5: Asset markets are frictionless, and information is costless and simultaneously available to all investors.
- Assumption 6: There are no market imperfections such as taxes, regulations, or restrictions on short selling.

One additional assumption should be made that all investors follow the Markowitz's portfolio selection theory and choose efficient portfolios.

Let's start the derivation of CAPM by incorporating the risk-free interest rate assumption. A risk-free interest rate r_f is defined as rate of return on investment with standard deviation equal to 0. In practical situations returns on assets such as government bonds are assumed to be risk-free

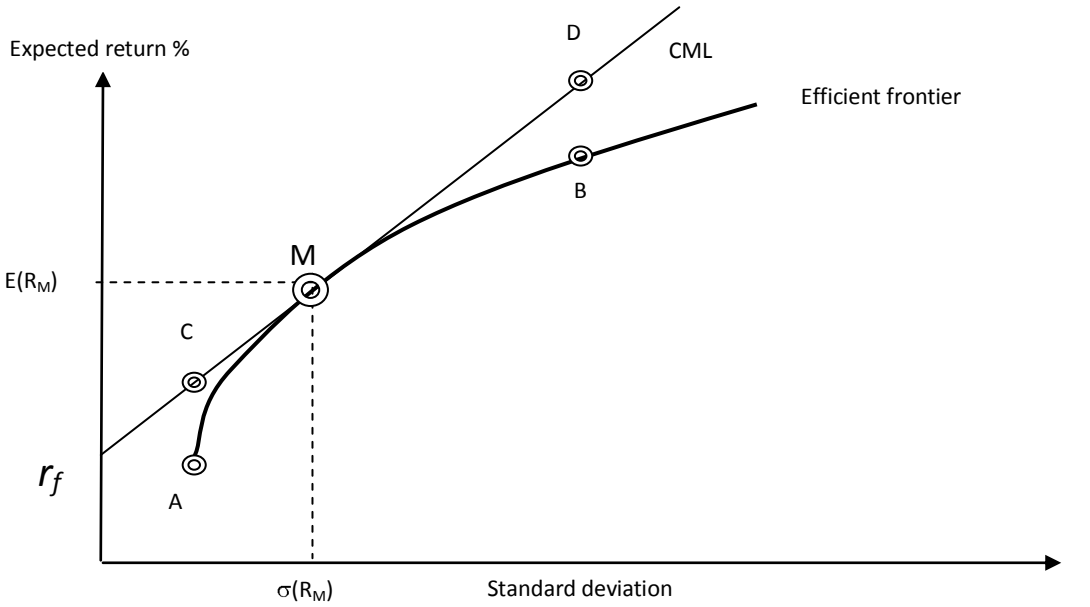

Figure 5 Derivation of Capital Market Line

[13] This section relies heavily on Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] and Haugen Robert A. [2001]

[14] Markowitz[1952] p.77-91

[15] Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005]

Consider Figure 5 above. It represents a well known risk-return framework. From the whole feasible set only the efficient frontier has been drawn. Assume now that this efficient frontier was derived from a set containing all the securities available on the market. With a presence of the risk-free asset the efficient frontier becomes linear and is called the Capital Market Line. The Capital Market Line (CML) can be written mathematically and its formula is:

$$E(r) = r_f + \frac{E(R_M) - r_f}{\sigma(R_M)}\sigma \tag{7}$$

Where:
$E(r)$- Expected return
$\mathrm{E(R_M)}$-Expected return on market portfolio
$\mathrm{r_f}$-Risk-free rate of return
$\mathrm{\sigma(R_M)}$-Risk of market portfolio
σ-Risk measured by standard deviation

Note that CML is tangent to the "old" efficient frontier in point M. Moving along the CML from point r_f up to point M an investor is lending some of his money and investing the rest in portfolio M, whereas moving from point M and to the right means that the investor is borrowing funds in order to invest his own money and the loan in portfolio M. Point M represents a market portfolio[16] and if investors are rational they will only choose a combination of risk-free asset and this portfolio, depending on their risk preferences. Consider point A for instance which is a minimum variance portfolio, an investor will be clearly better off by investing in portfolio C containing a mixture of risk-free and risky assets. The situation is the same in the case of point B where a better alternative is to borrow some money at r_f and invest more in the market portfolio achieving point D.

After introducing a risk-free interest rate into the portfolio creation process we know what combination of market portfolio and risk-free assets is appropriate for different investors. In the end all investors are concerned about is the final position of their investments in the risk-return framework. For this reason it is plausible to assume that investors will assess the risk of an individual security on the basis of its contribution to the risk of the portfolio[17]. A measurement of such a risk contribution is known as beta and it's defined as[18]:

$$\beta_i = \frac{Cov[r_i, r_m]}{Var[r_m]} \tag{8}$$

Where:
$Cov[r_i, r_m]$ - Covariance between the market portfolio and a single asset
$Var[r_m]$ - Variance of the market portfolio return

[16] As mentioned the efficient front was derived from a feasible set containing all securities available on the market.
[17] Haugen Robert A. [2001] p.209
[18] Beta can also be calculated from a linear regression by regressing return on the market as the independent variable and return on the asset as the dependent one. The result should be the same.

Beta can also be interpreted the other way around i.e. how sensitive an individual asset is to the market movements. By definition market portfolio (such as M in Fig.5) has a beta = 1. If a stock has a beta coefficient equal 0, 5 it means that it amplifies half of the market movements. We call such a stock a "defensive" one. If on the other hand stock's beta is greater then 1, it tends to react much stronger than the market. We call such a stock an "aggressive" one.

We now have a new definition of risk defined by beta so Figure 5 should be modified to represent this change. The risk-free asset will be unaffected since its risk is always 0. As mentioned market portfolio will have beta equal to one. Having these two points we can now draw a new figure with beta as a measure of risk.

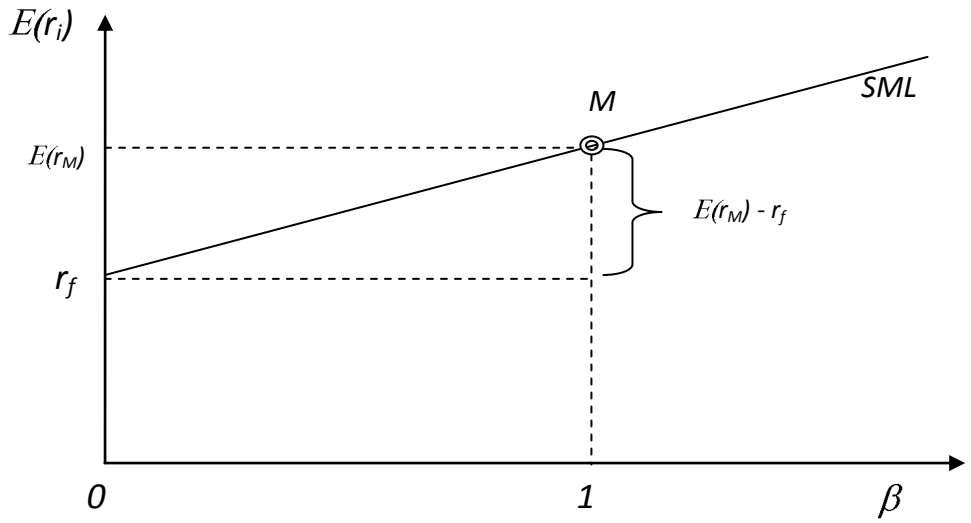

Figure 6 The Capital Asset Pricing Model
Source: Haugen Robert A. [2001]

Figure 6 presents the capital asset pricing model in a whole glance. Standard deviation has been replaced by beta and the line that was previously the capital market line is called security market line (SML) in this framework. Note that market portfolio M is exactly the same as in Figure 5. We can write the SML's equation now by taking values directly from the Figure 5 above:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f] \quad (9)$$

Where:
$E(r_i)$-Expected rate of return on an asset or a portfolio
r_f- Risk-free rate of return
$E(r_M)$-Expected return on market portfolio
β_i-Beta coefficient of an asset or a portfolio

We can rearrange it to express it in terms of an expected excess of returns on an asset or portfolio over the risk –free return:

$$E(z_i) = \beta_i E(z_m) \quad (10)$$

Where:

$$E(z_i) = E(r_i) - r_f$$
$$E(z_m) = E(r_M) - r_f$$

This excess is also defined as a risk premium which is demanded by investors for bearing additional risk. According to the model this premium should be proportional to the stock's beta so in equilibrium all the assets should lie on the SML[19]. If a stock was lying above the security market line it would offer greater return with the given beta than predicted in equilibrium. Investors would rush to buy it thus pushing up the price and lowering the return so the stock would eventually end up on the line. If the stock was below the SML the opposite would happen. There would be other assets offering greater return with the same risk so investors would sell out the asset undercutting the price thus increasing its return.

Assuming that CAPM is true it provides two important clues about the strategy of investing[20]:

- Diversify your portfolio of risky assets in proportion to market portfolio
- Mix your risky assets with risk-free securities to achieve the desired level of risk

2.4 Theory of the efficient capital market

Another very important contribution to the knowledge of financial markets is so called Efficient Market Hypothesis. A base for the theory was the discovery made by Maurice Kendall[21] in 1953 who studied prices of financial instruments and commodities. He found out that there is no pattern in behavior of these prices and described the phenomenon as the random walk[22]. It means that studying the past prices cannot help investors to predict what will happen in the future. In the late 1970: s Fama formed three types of market efficiency based on Kendall's discovery[23]:

- Weak-form efficiency: no extra profits can be made by studying historical prices. In other words present prices already reflect all the information that can be gained from past prices.
- Semi-strong-form efficiency: no extra profits can be made by interpreting publicly available information. The prices already reflect all published information.
- Strong-form efficiency: no extra profits can be made by using any information whether it is public or not because prices already reflect all possible information.

The idea that stock prices are unpredictable and move without any clear pattern will be used later in the paper in order to modify the Capital Asset Pricing Model so it can be tested using historical returns.

[19] Brealey, Myers, Allen [2006] p.189
[20] Bodie Ziv , Merton Robert C. [2000]
[21] Brealey, Myers, Allen [2006] p.189
[22] Brealey, Myers, Allen [2006] p.333-337
[23] Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] p.354-355

3. Previous empirical studies of the Capital Asset Pricing Model

Since the CAPM was established a number of empirical studies have been performed to test the model in reality. The results of these studies were very different: some tests supported the CAPM hypothesis; some of them rejected it completely.

The first supportive empirical study of the CAPM was published in 1972 by three researchers Black, Jensen and Scholes[24]. Their research concentrated on the properties of the security market line in the model and used the technique known as the cross-section test for the first time. As the population they chose all stocks listed on the New York Stock Exchange in years 1926 – 1965. First stock betas were estimated by regressing stocks' monthly returns during the first four years with monthly returns of the market index. In the next step they created 10 portfolios based on stocks' estimated betas[25] and computed monthly returns on these portfolios during the fifth year. This procedure was repeated until the end of the testing period. Finally they estimated portfolio betas and related them to their average returns, getting an approximation of the security market line. The results of their test were very promising and supportive for the CAPM. The relationship between portfolios betas and their average returns was linear with a positive and significant slope. Similar conclusion can be found in a later study of CAPM published by Fama and MacBeth[26] in 1974. They used a similar technique to Black, Jensen and Sholes with one major distinction: they tried to predict future rates of return based on estimates from previous periods. Nevertheless results were again supportive.

The capital asset pricing model has been criticized on several occasions. In the late 1970's Richard Roll[27] wrote several papers in which he criticizes the model and its assumptions. He argues that the model could only be tested by testing if the market portfolio is efficient and since it should contain all the financial instruments on the international market it is impossible to test it. Another study performed by Fama and French[28] in 1992 as an extension of the Fama and MacBeth experiment from 1974 showed a couple of anomalies that couldn't be explained by the CAPM. They looked beyond the returns and took company size under consideration. According to their study it would seem that on average small companies tend to have larger rates of return which is inconsistent with CAPM where only beta can influence the returns. Other studies have discovered that there are more factors that could also explain rates of return not predicted by the Capital Asset Pricing Model.

Reinganum in 1983 argued that in January risk premiums tend to be higher while French in 1980 stated that on Mondays same premiums are on average lower. Other studies showed that earnings/price ratio as well as book-to-market value has positive influence on risk premiums[29].

Despite all the critique the CAPM is widely used in the industry. It is used to help making capital budgeting decisions or measuring the performance of investment managers and is also a very useful benchmark.

[24] Haugen Robert A. [2001] p.238
[25] 10% of stocks with highest betas formed one portfolio, 10% of next highest betas formed next portfolio etc.
[26] Haugen Robert A. [2001] p.239
[27] Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] p.242
[28] Haugen Robert A. [2001] p.240
[29] Grigoris Michailidis, Stavros Tsopoglou, Demetrios Papanastasiou, Eleni Mariola [2006]

4. Methodology

In this section I will present the methods on which the empirical analysis will be based. First I will discuss the data source and data selection process. Next I will modify the model and make certain assumptions to make the results more reliable. Finally I will describe the statistical methods that will be used for testing the CAPM.

4.1 Data Selection

To test the Capital Asset Pricing Model data from official statistics of the Warsaw Stock Exchange will be used. The exchange has existed since 1994 but access to reliable data is provided from the year 2002. That is the main reason why this study will be conducted by analyzing monthly returns on common stocks from 2002 to 2006.

In this paper one hundred companies listed without any interruptions will be analyzed. I decided to divide the population in half and randomly choose 50 companies defined as big capitals and 50 companies defined as small capitals to cover the market as a whole. A NASDAQ definition of big capital states that it is a company with more than $5 billion in capitalization[30]. Since Polish companies cannot be compared to those in USA the definition has to be modified. After analyzing the data it seemed plausible to define a big capital on the Polish market as a company with a capitalization of more than PLN 585 million (around $1, 6 billion)[31]. The main reason why I decided to divide population by the size not by the branch is that it has been observed that size of company has certain influence on its stock returns. On the other hand it hasn't been proven that companies in certain industries have a tendency to over- or underperform the market.

As the representation of the market I choose market index WIG which contains 284 companies out of 293 listed on whole exchange. Other indexes available are WIG20 listing 20 biggest companies, mWIG40 containing 40 medium firms, sWIG80 with 80 small capitals. There are also a couple indexes strongly connected to certain branches. Out of all these indexes only WIG seems to be the best proxy of a market as a whole.

The last data set needed to perform the test is the interest rate on the risk-free asset. As a proxy of that rate I choose the rate of return on a 52 week government bond issued by the Polish Central Bank. This rate has been converted into monthly rate by simply dividing it by 12 each month. The development of the risk-free interest rate over the testing period can be seen in the Figure 8 below.

[30] http://www.investorwords.com/2722/large_cap.html

[31] The whole population was sorted by companies' capitalization rate and then divided into two groups. The border value was used to define large and small capital.

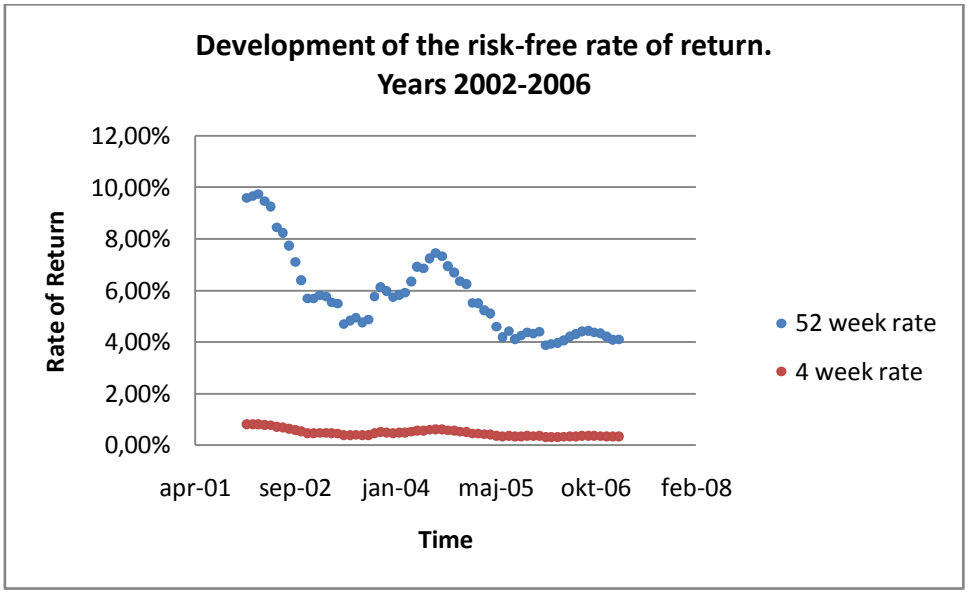

Figure 7 Development of the risk-free rate of return
Source: Polish Central Bank: www.nbp.pl

4.2 Testable version of the CAPM

In section 2.3 the CAPM was derived in two versions which will be rewritten here for convenience. The most common version of CAPM is:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f] \tag{11}$$

$$\beta_i = \frac{Cov[r_i, r_m]}{Var[r_m]} \tag{12}$$

The second version of CAPM expresses the returns in terms of their excess over the risk-free rate and it can be written as follows[32]:

$$E(z_i) = \beta_i E(z_m) \tag{13}$$

$$\beta_i = \frac{Cov[z_i, z_m]}{Var[z_m]} \tag{14}$$

The problem might arise because betas are not calculated from the same values in these two versions, thus they can differ. However if the risk-free rate is non-stochastic equations 12 and 14 are equivalent[33]. Proxies of the risk-free rates in the real world might happen to be stochastic. The distribution of the risk-free rate used in this study can be seen in Figure 7. Regardless if the risk-free rate is stochastic or not most of the empirical work on CAPM employs excess returns version[34], thus this paper will also employ the CAPM based on equations 13 and 14.

[32] Remember: $E(z_i) = E(r_i) - r_f$, $E(z_m) = E(r_M) - r_f$
[33] Campbell John Y., Lo Andrwe W., MacKinlay Craig A. [1997] p.182
[34] Campbell John Y., Lo Andrwe W., MacKinlay Craig A. [1997] p.182

The next important step to prepare the CAPM for empirical testing is to transform it from expectations form (*ex ante*) into *ex post* form which uses the actual observed data. To do so an employment of efficient market hypothesis will be used, known as a fair-game model. A fair game model states that on average, studying a large number of samples, the expected return on an asset equals its actual return[35]. Mathematically it can be expressed as follows:

$$\varepsilon_{i,t+1} = r_{i,t+1} - E(r_{i,t+1}) \tag{15}$$

$$E(\varepsilon_{i,t+1}) = E[r_{i,t+1} - E(r_{i,t+1})] = 0 \tag{16}$$

Where:
$\varepsilon_{i,t+1}$ – The difference between actual and expected returns
$r_{i,t+1}$ - Actual return
$E(r_{i,t+1})$- Expected return

Equation 15 is quite straightforward while equation 16 states that the expected value of the difference between the actual and expected returns is 0. We are simply assuming that probability distributions of returns do no change significantly over time[36].

Removing expectations terms from the equation 13 reveals the CAPM that will be tested in this paper:

$$z_i = \beta_i z_m \tag{17}$$

4.3 Statistical framework for testing the CAPM

I decided to run three independent tests of the CAPM using different techniques and then compare the results with each other. The first test is based on one of the earliest attempts to check the validity of the theory which uses so a called two-pass regression technique. The second test will be based on Black, Jensen, and Sholes[37] (BJS) research from 1972 and will employ a cross-sectional analysis of the assets. Finally I will use combined ideas of BJS studies and Fama-MacBeth[38] research from 1974 that also uses a cross-sectional technique.

4.3.1 The two-pass regression test

The first step in testing the CAPM using this method is to use the monthly excess returns on 100 chosen assets over the testing period 2002-2006 to estimate their betas. To do it a time series OSL regression will be run for every single asset (First-pass regression). The regression equation will be:

$$z_{ti} = \alpha_i + \beta_i z_{Mt} + \varepsilon_{ti} \tag{18}$$

[35] Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] p.367
[36] Haugen Robert A. [2001] p.236
[37] Haugen Robert A. [2001] p.238
[38] Haugen Robert A. [2001] p.239

Where:

z_{ti} - Excess of an asset's returns over the risk free rate at time *t*
α_i -Regressions intercept
β_i- Estimated beta of asset *i*
z_{Mt}- Excess of the market returns over the risk free rate at time *t*
ε_{ti}- Random disturbance term at time *t*

In total 100 time-series regressions will be performed on this stage of analysis. According to CAPM the intercept of the regression described by equation 18 should be 0, whereas there are no restrictions on the value of beta. After estimating betas I will attempt to estimate the security market line for the testing period. To do so a second-pass regression will be run according to the equation:

$$\overline{z}_i = \gamma_0 + \gamma_1 \beta_i + \varepsilon_i \quad (19)$$

Where:
$\overline{z}_i$ - Average excess of returns on asset *i* over the testing period
γ_0 - Regression intercept
γ_1- Regression coefficient
β_i- Estimated beta of the asset *i*
ε_i- Random disturbance term.

This regression will be run across all one hundred assets resulting in an estimation of SML. If CAPM holds the results should be as follows:

$$\boldsymbol{\gamma_0 = 0}$$

$$\boldsymbol{\gamma_1 = avarage\ excess\ of\ market\ returns\ over\ the\ risk\ free\ rate}$$

The next step will be to perform so called non-linearity test. As mentioned in the theoretical section CAPM predicts that assets' returns are linearly related to their betas. In order to test this hypothesis an additional term will be added to equation 19:

$$\overline{z}_i = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \beta_i^2 + \varepsilon_i \quad (20)$$

Term β_i^2 is simply a second power of our estimated beta. If the model indeed holds and the linear relationship between beta and returns is strong then adding the beta square term shouldn't influence the previous results. Thus if CAPM is true then:

$$\boldsymbol{\gamma_2 = 0}$$

The last check of the theory that can be performed is a test for non systematic risk. The CAPM says that the only risk that matters to investors, which is reflected in returns, is measured by beta. Any other factors simply don't matter. To account for non systematic risk yet another parameter will be added to the regression equation:

$$\overline{z}_i = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \beta_i^2 + \gamma_3 RV_i + \varepsilon_i \quad (21)$$

The RV_i term stands for the variance of residuals of an asset *i.* We obtain the value of this term from the first-pass regression that has been used to estimate stocks betas. Residual variance in this case will be the measure of the risk not accounted by beta. If CAPM holds then:

$$\gamma_3 = 0$$

4.3.2 Black, Jensen and Scholes Test

The second test of the CAPM that I will perform is based on the Black, Jensen and Scholes test from 1972 which is described in more detail in section 3. Due to a much shorter testing period their technique must be modified to accommodate available data. The BJS test studies the performance of the CAPM on the portfolios rather than single stocks. By creating portfolios, a certain amount of company-specific risk will be diversified in accordance with Markowitz's modern portfolio theory. The testing procedure will be performed in following steps:

1. Stocks' betas will be estimated using equation 18 based on monthly returns in the years 2002-2003.
2. Stocks will be ranked by their estimated betas and 10 portfolios will be created based on stocks' betas; 10 % of the stocks with the lowest betas create the first portfolio and so on, until 10 portfolios are created.
3. The monthly returns on these portfolios will be computed in the year 2004. A monthly return on a portfolio is simply an arithmetic average of the monthly returns on the stocks in the portfolio.
4. Stocks' betas will be re-estimated using equation 18 based on monthly returns in years 2003-2004.
5. The portfolios will be reconstructed using the same method described in step 2 and betas from step 4. The monthly returns on the portfolios in year 2005 will be computed.
6. Stocks' beta will be estimated one more time using equation 18 based on the monthly returns in the years 2004-2005.
7. The portfolios will be reconstructed again and their returns will be computed for the year 2006.
8. The portfolios betas will be estimated by regressing returns computed in steps 3, 5 and 7 to the market index. The regression equation is:

$$z_{tp} = \alpha_p + \beta_p z_{Mt} + \varepsilon_{tp} \quad (22)$$

Where:

z_{tp} - Excess of the portfolio returns over the risk free rate at time *t*

α_p -Regressions intercept

β_p- Estimated beta of the portfolio *p*

z_{Mt}- Excess of the market returns over the risk free rate at time *t*

ε_{tp}- Random disturbance term at time *t*

9. The cross-sectional regression will be performed to estimate SML by regressing portfolios' average excess of returns over the risk-free rate in 2004-2006 to their betas estimated in the step 8. The regression equation is:

$$\overline{z}_p = \gamma_0 + \gamma_1 \beta_p + \varepsilon_p \quad (23)$$

Where:
$\overline{z}_p$ - Average excess of returns on portfolio *p* over the testing period
β_p- Estimated beta of the portfolio *p*
ε_p- Random disturbance term.

10. The non-linearity and non-systematic risk tests will be performed according to the equations:

$$\overline{z}_p = \gamma_0 + \gamma_1 \beta_p + \gamma_2 \beta_p^2 + \varepsilon_p \quad (24)$$

$$\overline{z}_p = \gamma_0 + \gamma_1 \beta_2 + \gamma_2 \beta_p^2 + \gamma_3 RV_p + \varepsilon_p \quad (25)$$

The logic behind equations 24 and 25 is exactly the same as in the first test using a two-pass regression technique.

If the Capital Asset Pricing Model is true the values of regressions' coefficients should equal to:

$$\boldsymbol{\gamma_0 = 0}$$
$$\boldsymbol{\gamma_1 = avarage\ excess\ of\ market\ returns\ over\ the\ risk\ free\ rate}$$
$$\boldsymbol{\gamma_2 = 0}$$
$$\boldsymbol{\gamma_3 = 0}$$

4.3.3 Black, Jensen and Scholes, Fama and MacBeth Test.

The last empirical test of the CAPM will be very similar to the BJS analysis performed earlier. However this time I will incorporate some ideas used by Fama and MacBeth in their study from 1974. Again portfolios are used to test the model, however this time the performance of 20 portfolios will be tested. Moreover the portfolios will be constructed only once so they will have the same content during the whole testing period. The testing procedure will be performed in the following steps:

1. Stocks' betas will be estimated using equation 18 based on monthly excess of returns in the years 2002-2003.
2. Stocks will be ranked by their estimated betas and 20 portfolios will be created based on stocks' betas; 5 % of stocks with the lowest betas will create the first portfolio and so on until 20 portfolios are created.
3. The monthly excess returns on these portfolios will be computed in the years 2003-2005 as the arithmetic average of monthly excess returns on the stocks in the portfolio.
4. Portfolios' betas will be estimated using equation 22 by regressing their monthly excess returns in the years 2003-2005 against the market index.

5. The cross-sectional regression will be performed according to equation 23 to estimate SML by regressing portfolios' average excess of returns in the year 2006 to their betas estimated in step 4.
6. Non-linearity and the non-systematic risk test will be performed utilizing equations 24 and 25.

If the CAPM holds the cross-sectional regression results should be:

$$\gamma_0 = 0$$
$$\gamma_1 = avarage\ excess\ of\ market\ returns\ over\ the\ risk\ free\ rate$$
$$\gamma_2 = 0$$
$$\gamma_3 = 0$$

4.4 Evaluating the regressions results

To evaluate the results obtained by performing the regressions I will use the *t*- test and *p*-value criterion. During the empirical analysis the *t*-value statistic will be given for every important estimate. The critical values for the *t*-statistic are -1, 96 and 1, 96 which means that if the *t*-value is greater than 1, 96 or smaller than -1, 96 the results are statistically significant with 95% confidence i.e. the probability of receiving a certain result is 95 %. When analyzing final Security Market Line Estimations, the *p*-value will be given for every parameter. The critical value of p-statistic is 0,05 which mean that if the *p*-value is as small as or smaller than 0,05 then the results are significant.

5. Empirical Analysis

In this section the empirical tests of the Capital Asset Pricing Model will be performed. Testing procedure will follow precisely all steps that have been described earlier.

5.1 The two-pass regression test

The first step in testing the CAPM will be to estimate the beta values of all 100 assets involved in the study during the testing period 2002-2006. One hundred time-series regressions have been performed according to equation 18 and the results are summarized in the Table 1 below. (For more detailed results of the regressions please see Table A in Appendix A)

Stock Name	Beta	*t*-value	Stock Name	Beta	*t*-value	Stock Name	Beta	*t*-value
Optimus	0,59	2,61	**MIESZKO**	0,30	1,16	**MENNICA**	0,06	0,25
Prokom	1,35	8,34	**EFEKT**	0,83	2,52	**KETY**	0,75	5,18
TPSA	1,07	9,08	**CERSANIT**	1,19	3,97	**Kruszwica**	1,42	4,40
AGORA	0,81	4,72	**RELPOL**	0,74	3,85	**Ferrum**	1,25	2,37
KredytBank	0,65	3,89	**05VICT**	0,24	0,62	**INSTALKRK**	0,83	2,33
PROSPER	1,22	5,01	**01NFI**	0,01	0,03	**04PRO**	0,58	1,21
STRZELEC	0,94	3,12	**INGBSK**	0,51	4,02	**DEBICA**	0,38	2,11
COMPLAND	0,55	3,32	**Groclin**	0,84	3,81	**POLNORD**	1,40	2,51
WILBO	1,05	5,06	**BUDIMEX**	1,04	5,24	**GETIN**	1,64	4,83
SWARZEDZ	1,88	4,83	**FARMACOL**	0,75	4,00	**ELBUDOWA**	0,92	4,37
IRENA	0,38	2,32	**MostalZab**	1,00	1,92	**Jutrzenka**	0,70	3,25
MNI	1,53	3,92	**Millennium**	1,07	5,70	**IMPEXMET**	1,50	4,83
AMICA	0,64	2,57	**NORDEABP**	0,38	1,48	**MOSTALWAR**	0,46	1,28
ABG	0,36	1,34	**WANDALEX**	0,94	3,06	**06MAGNA**	-0,07	-0,50
PEKAO	1,02	11,42	**PGF**	0,55	4,05	**FORTE**	0,75	4,06
KOGENERA	0,84	3,18	**08OCTAVA**	0,60	1,31	**Sanok**	0,72	3,09
PPWK	1,19	2,70	**ORBIS**	1,32	7,44	**02NFI**	0,50	0,94
Netia	1,27	3,39	**DZPOLSKA**	0,56	1,28	**VISTULA**	0,78	2,05
MUZA	0,58	1,41	**BZWBK**	1,14	9,25	**ELDORADO**	0,16	0,66
POLLENAE	1,23	4,44	**BEDZIN**	0,78	2,38	**ECHO**	0,97	4,90
BOS	0,42	3,00	**NOVITA**	0,67	1,67	**POLIMEXMS**	1,42	4,52
Handlowy	0,53	4,42	**KGHM**	1,42	7,85	**SWIECIE**	0,00	-0,02
13FORTUNA	0,17	0,53	**MOSTALPLC**	0,86	3,35	**Kopex**	1,08	2,60
KROSNO	0,51	2,48	**COMARCH**	1,02	5,56	**FORTISPL**	0,19	0,84
TALEX	0,93	3,55	**WISTIL**	0,99	2,41	**TUEUROPA**	-0,10	-0,31
PKNORLEN	1,01	8,62	**Zywiec**	0,42	3,96	**LPP**	0,87	3,63
STALEXP	1,32	3,90	**Interia.pl**	1,74	5,17	**GRAJEWO**	0,59	2,91
CSS	0,60	2,77	**LENTEX**	0,76	2,33	**PROCHEM**	0,61	2,59
MostalExp	1,78	4,08	**INDYKPOL**	0,21	0,62	**BORYSZEW**	1,00	2,45
BRE	1,28	7,80	**KABLE**	0,95	1,22	**TIM**	1,13	3,70
ENERGOPN	0,57	1,31	**UNIMIL**	0,43	1,84	**WAWEL**	0,40	2,17
Jupiter	0,48	1,41	**MCI**	1,32	3,10	**STALPROD**	0,77	2,39
ELEKTRIM	1,03	1,47	**PROVIMROL**	1,11	5,39			
BANKBPH	1,26	11,83	**APATOR**	0,44	1,81			

Table 1 The results of first-pass regression. Estimated betas and their t- values.

The range of estimated betas is from -0, 1 to 1, 88. The results are quite promising, 73 % of all estimated betas are significant with 95 % confidence. As mentioned earlier according to CAPM the intercepts of estimated regression lines should be 0. Considering that matter the results of first-pass regression are also quite good: only 14 % of estimations exhibited an intercept significantly different from zero.

5.1.1 SML Estimation

The next step is to perform second pass regression according to equation 19 were average excesses of all assets' returns over the appropriate risk-free interest rate will be regressed against their estimated betas. Here I will present only the results of this regression; however regression inputs are summarized in the Table B in Appendix A.

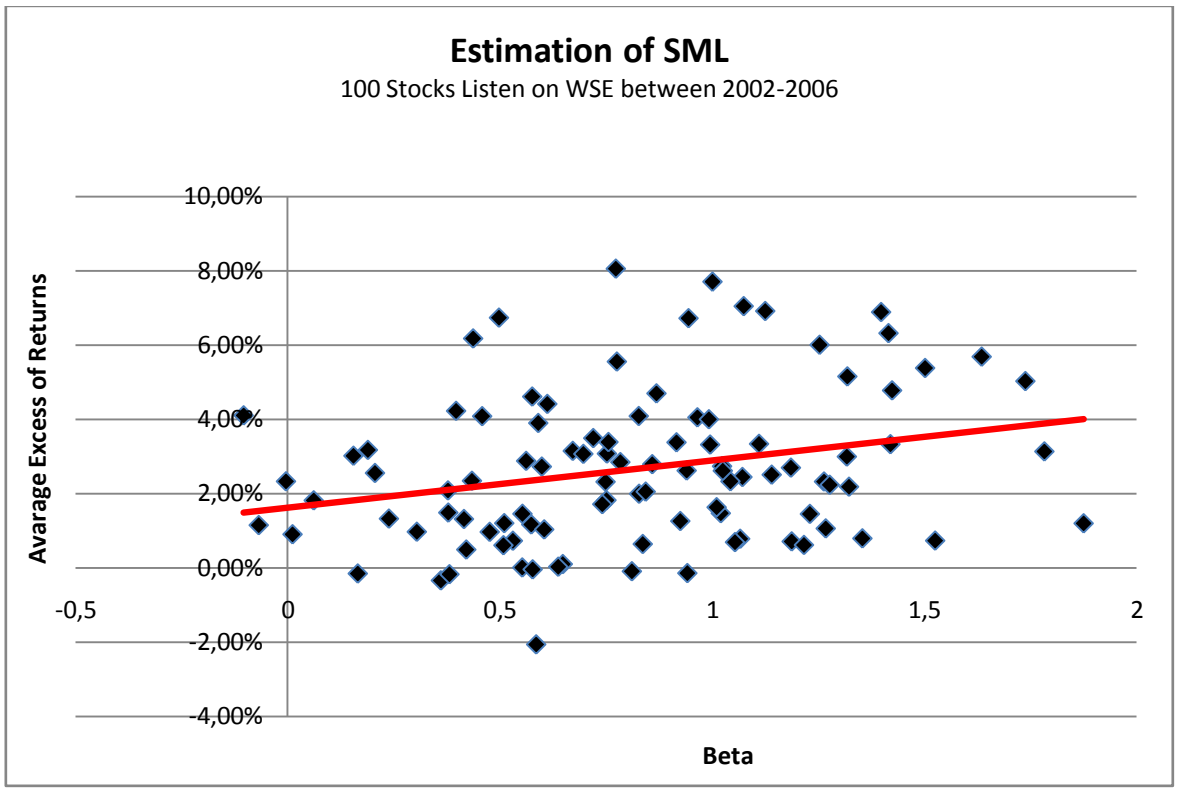

Figure 8 Estimation of the Security Market Line on Warsaw Stock Exchange. Testing period 2002-2006

Figure 8 above shows the graphical representation of the estimated Security Market Line on Warsaw Stock Exchange. Lines intercept is definitely not zero but the SML is upward sloping which supports the idea of CAPM that expected returns are positively and proportionally related to beta. However to draw any constructive conclusions we must examine regression results which are summarized in the Table 2 below.

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,016154	3,732683	0,000318	0
γ_1	0,012724	2,710598	0,00793	0,01704
R-square	6,97 %			
Standard Error	0,01996			

Table 2 Second-pass regression results and CAPM predicted values.

As we can see from Table 2 the estimated SML doesn't support the CAPM theory. The estimated value of γ_0 which should be equal to 0 according to the Capital Asset Pricing Model is significantly different from 0. Analysis shows that the slope γ_1 of the estimated SML is positive and significant which is consistent with the model. This slope however, which should equal to the markets average risk premium, is somewhat lower than this predicted by the CAPM. Finally the R-square value is extremely low suggesting that only a small portion of variation in stocks' returns can be explained by the beta.

5.1.2 Non-linearity Test

The non-linearity test has been performed according to equation 20. The results of this regression are presented in the Table 3 below.

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,010854	2,562462	0,011931	0
γ_1	0,009521	2,144871	0,034461	0,01704
γ_2	0,364057	4,027795	0,000112	0
R-square	20,30%			
Standard Error	0,01857			

Table 3 Second-pass regression results with non-linearity test.

The constant γ_0 is significantly different from 0 while the capital asset pricing model predicts value 0 of this coefficient. The slope of SML γ_1 is positive and statistically significant which is in accordance with the CAPM. Nevertheless CAPM prediction of SML slope i.e. markets risk premium is higher than the estimated one. Finally the estimated value of the coefficient γ_2 is significantly different from the CAPM prediction which implies no linear relationship between stocks' beta and return.

5.1.3Non-systematic risk Test.

To perform test for non-systematic risk I will utilize equation 21. The results of the regression are presented in the Table 4:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,010694	1,766897	0,080424	0
γ_1	0,010029	0,699723	0,485792	0,01704
γ_2	0,364115	4,007061	0,000121	0
γ_3	– 0,0003	– 0,03731	0,970318	0
R-square	20,30%			
Standard Error	0,018666			

Table 4 Second-pass regression results with non-linearity and non-systematic risk test.

Regressions intercept γ_0 is insignificantly different from 0 which is consistent with the CAPM prediction. The estimated average markets' risk-premium γ_1 is positive but insignificant and lower than the premium predicted by the model. Significant estimation of γ_2 implies no linear relationship between beta and return. Finally the estimated value of coefficient γ_3 is insignificantly different from 0 which is with accordance with the CAPM. It implies that all the risk is captured by beta and non-systematic risk has no influence on stocks' returns.

5.2 Black, Jensen and Scholes Test

I will start the test with summarizing all the testing sub-periods for convenience:

	Sub-period 1	**Sub-period 2**	**Sub-period 2**
Stocks' beta estimation	2002-2003	2003-2004	2004-2005
Portfolio creation date	31-12-2003	31-12-2004	31-12-2005
Portfolio returns computation	2004	2005	2006

Table 5 Testing sub-periods in the BJS test

The stocks' betas have been calculated according to equation 18 in each of the 3 sub-periods. The complete results of these regressions are presented in Tables A-C in Appendix B. In years 2002-2003 40 % of estimated betas are significant while 91 % of estimated intercepts are insignificantly different from 0. Estimates in the next sub-period are somewhat better: 61 % significant betas and 96 % intercepts insignificantly different from 0. In the last sub-period the corresponding percentages are 30 % for betas and 89 % for intercepts.

After estimating the betas 10 portfolios have been constructed based on these betas. The content of each portfolio in corresponding sub-period is presented in the Table 6.

PORTFOLIO 1

2003	Beta	t-value	2004	Beta	t-value	2005	Beta3	t-value
06MAGNA	-0,36	-2,36	SWIECIE	-0,56	-1,60	TUEUROPA	-1,47	-1,36
SWIECIE	-0,21	-0,87	MIESZKO	-0,22	-0,35	05VICT	-1,28	-1,35
INDYKPOL	-0,11	-0,44	13FORTUNA	-0,15	-0,35	MENNICA	-0,95	-1,26
ABG	-0,09	-0,25	DZPOLSKA	-0,08	-0,19	WISTIL	-0,73	-1,24
MOSTALWAR	-0,01	-0,02	06MAGNA	-0,08	-0,62	Jupiter	-0,71	-1,12
13FORTUNA	0,02	0,10	01NFI	-0,07	-0,16	PPWK	-0,47	-0,54
08OCTAVA	0,03	0,05	05VICT	-0,07	-0,16	MUZA	-0,33	-0,50
MIESZKO	0,04	0,22	08OCTAVA	-0,01	-0,01	KROSNO	-0,28	-0,60
05VICT	0,05	0,24	TUEUROPA	0,09	0,11	01NFI	-0,27	-0,25
01NFI	0,10	0,70	MENNICA	0,10	0,18	06MAGNA	-0,23	-0,81

PORTFOLIO 2

2003	Beta	t-value	2004	Beta2	t-value	2005	Beta	t-value
04PRO	0,11	0,61	MOSTALWAR	0,12	0,24	Kruszwica	-0,18	-0,40
FORTISPL	0,12	0,33	ABG	0,16	0,26	DEBICA	-0,17	-0,60
UNIMIL	0,12	0,36	Jupiter	0,18	0,50	IRENA	-0,15	-0,50
APATOR	0,14	0,38	UNIMIL	0,21	0,49	08OCTAVA	-0,04	-0,09
02NFI	0,15	0,56	04PRO	0,26	0,69	Sanok	-0,03	-0,08
Jupiter	0,17	0,85	APATOR	0,29	0,66	WAWEL	-0,03	-0,06
TUEUROPA	0,20	0,76	INDYKPOL	0,29	0,39	RELPOL	-0,01	-0,03
MUZA	0,24	0,51	BOS	0,33	1,93	Zywiec	0,01	0,09
ENERGOPN	0,27	0,33	ENERGOPN	0,34	0,35	SWIECIE	0,02	0,07
INGBSK	0,33	1,68	MUZA	0,37	0,65	LPP	0,06	0,16

PORTFOLIO 3

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
MENNICA	0,39	1,66	FORTISPL	0,41	1,15	DZPOLSKA	0,06	0,09
KredytBank	0,40	1,87	INGBSK	0,42	1,58	MIESZKO	0,08	0,09
BOS	0,41	2,01	COMPLAND	0,48	1,59	ELDORADO	0,09	0,29
IRENA	0,41	1,86	02NFI	0,48	1,32	02NFI	0,13	0,26
MostalZab	0,44	0,71	Millennium	0,57	2,01	MOSTALPLC	0,14	0,19
AMICA	0,49	1,51	WAWEL	0,57	2,09	TALEX	0,17	0,27
NORDEABP	0,49	1,23	Zywiec	0,57	3,05	POLIMEXMS	0,17	0,21
Optimus	0,51	1,56	FARMACOL	0,58	1,29	KABLE	0,18	0,15
WAWEL	0,55	2,76	DEBICA	0,60	2,35	BUDIMEX	0,24	0,53
STRZELEC	0,57	1,67	MOSTALPLC	0,63	1,50	POLLENAE	0,25	0,49

PORTFOLIO 4

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
ELDORADO	0,58	2,73	IRENA	0,67	2,49	GRAJEWO	0,26	0,71
Handlowy	0,58	3,75	MostalZab	0,68	0,92	STALPROD	0,30	0,44
POLNORD	0,59	1,89	TALEX	0,69	1,54	04PRO	0,31	0,56
GRAJEWO	0,60	1,66	CSS	0,70	4,08	PGF	0,38	1,37
PROCHEM	0,61	2,73	Optimus	0,71	2,14	KOGENERA	0,38	0,56
NOVITA	0,61	1,21	AMICA	0,73	1,54	NOVITA	0,42	0,55
CSS	0,63	2,00	Groclin	0,76	2,91	IMPEXMET	0,43	0,76
MOSTALPLC	0,63	4,34	VISTULA	0,76	0,94	Groclin	0,47	1,05
Zywiec	0,64	3,70	KredytBank	0,77	2,91	Handlowy	0,47	1,68
Kopex	0,69	1,10	PKNORLEN	0,78	6,27	NORDEABP	0,49	0,91

PORTFOLIO 5

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
PGF	0,70	3,87	ELEKTRIM	0,81	1,26	PROCHEM	0,49	0,65
COMPLAND	0,70	3,00	WANDALEX	0,82	1,29	COMARCH	0,50	1,66
DZPOLSKA	0,71	1,80	Handlowy	0,86	4,09	AGORA	0,52	1,48
ELBUDOWA	0,72	3,11	PGF	0,87	4,27	KETY	0,55	1,74
DEBICA	0,73	4,44	LENTEX	0,88	2,57	ECHO	0,55	1,50
INSTALKRK	0,73	1,40	MostalExp	0,88	2,05	TIM	0,55	0,64
KROSNO	0,74	2,67	TPSA	0,90	4,76	ORBIS	0,56	1,77
EFEKT	0,75	1,76	PROCHEM	0,91	1,70	Jutrzenka	0,58	0,92
FORTE	0,78	2,82	KROSNO	0,92	2,44	BOS	0,58	1,74
FARMACOL	0,79	2,31	ELBUDOWA	0,92	2,18	WANDALEX	0,59	0,86

PORTFOLIO 6

2003	Beta	t-value	2004	Beta2	t-value	2005	Beta	t-value
ECHO	0,83	3,46	BZWBK	0,94	7,44	LENTEX	0,62	1,27
KETY	0,84	4,43	KOGENERA	0,94	2,31	ELEKTRIM	0,65	0,69
STALPROD	0,84	2,35	Kopex	0,95	1,29	VISTULA	0,65	0,88
PKNORLEN	0,86	5,62	MNI	0,96	1,36	AMICA	0,65	1,23
Millennium	0,87	3,68	LPP	0,96	2,49	FARMACOL	0,66	2,34
VISTULA	0,90	1,44	PEKAO	1,00	7,61	BORYSZEW	0,71	0,94
PEKAO	0,91	7,29	POLNORD	1,00	2,13	COMPLAND	0,72	2,01
WANDALEX	0,92	2,12	NORDEABP	1,01	2,11	INGBSK	0,74	2,93
BZWBK	0,92	6,41	INSTALKRK	1,01	1,80	CERSANIT	0,77	3,45
CERSANIT	0,93	1,77	GRAJEWO	1,02	2,32	Netia	0,79	2,60

PORTFOLIO 7

2003	Beta	t-value	2004	Beta2	t-value	2005	Beta	t-value
Groclin	0,93	3,49	CERSANIT	1,03	6,72	STALEXP	0,79	1,21
LPP	0,94	2,69	ELDORADO	1,03	4,97	BEDZIN	0,80	1,72
BEDZIN	0,94	1,66	Jutrzenka	1,03	3,73	13FORTUNA	0,83	0,92
AGORA	0,95	4,50	KETY	1,06	4,14	EFEKT	0,84	1,43
RELPOL	0,96	3,94	AGORA	1,09	4,41	Optimus	0,86	1,78
KOGENERA	0,97	2,68	STRZELEC	1,09	2,20	POLNORD	0,86	1,15
LENTEX	0,99	3,60	Netia	1,10	4,73	FORTISPL	0,87	2,18
TPSA	1,04	6,07	COMARCH	1,11	4,60	CSS	0,89	3,16
Sanok	1,07	3,06	BUDIMEX	1,14	4,38	BRE	0,96	3,77
Jutrzenka	1,08	5,50	EFEKT	1,15	2,90	GETIN	0,97	1,45

PORTFOLIO 8

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
TALEX	1,10	3,13	TIM	1,17	1,88	PROSPER	1,01	2,80
WILBO	1,13	4,97	BANKBPH	1,20	6,47	FORTE	1,01	3,06
BUDIMEX	1,14	6,56	PPWK	1,20	2,32	MNI	1,01	1,90
ELEKTRIM	1,19	2,52	Prokom	1,28	4,92	INDYKPOL	1,07	0,96
Ferrum	1,20	1,60	FORTE	1,28	4,18	ABG	1,10	1,73
COMARCH	1,24	5,79	WILBO	1,29	3,75	UNIMIL	1,18	2,55
PPWK	1,26	2,36	BRE	1,31	4,62	Ferrum	1,20	1,31
BANKBPH	1,29	7,23	RELPOL	1,31	5,19	KredytBank	1,20	4,34
PROVIMROL	1,32	4,84	KGHM	1,35	4,93	WILBO	1,23	2,44
KGHM	1,33	6,36	NOVITA	1,40	2,21	BANKBPH	1,24	6,25

PORTFOLIO 9

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
Prokom	1,34	6,11	GETIN	1,46	2,29	ENERGOPN	1,26	2,04
BRE	1,35	4,97	STALEXP	1,47	2,73	PKNORLEN	1,29	5,72
TIM	1,37	3,65	STALPROD	1,49	3,03	Kopex	1,30	3,16
MostalExp	1,40	2,81	BEDZIN	1,49	2,53	MOSTALWAR	1,36	1,75
MCI	1,44	3,51	ECHO	1,49	7,40	PEKAO	1,36	7,21
PROSPER	1,53	4,03	ORBIS	1,58	5,85	APATOR	1,37	3,09
BORYSZEW	1,54	2,46	Sanok	1,66	3,74	MostalZab	1,42	1,40
POLLENAE	1,61	4,08	PROSPER	1,68	4,08	MostalExp	1,46	3,04
STALEXP	1,62	4,21	IMPEXMET	1,68	3,33	INSTALKRK	1,46	2,78
ORBIS	1,64	6,90	MCI	1,69	1,78	ELBUDOWA	1,48	2,62

PORTFOLIO 10

2003	Beta	t-value	2004	Beta	t-value	2005	Beta	t-value
MNI	1,71	2,49	Ferrum	1,82	1,91	TPSA	1,49	5,96
SWARZEDZ	1,76	3,67	PROVIMROL	1,98	6,60	BZWBK	1,50	7,33
Interia.pl	1,77	4,31	SWARZEDZ	2,00	2,36	Millennium	1,50	4,47
WISTIL	1,77	2,64	Interia.pl	2,20	3,78	KGHM	1,52	3,64
IMPEXMET	1,91	4,29	POLLENAE	2,29	4,69	Prokom	1,55	4,18
Netia	1,94	2,76	POLIMEXMS	2,38	3,42	MCI	1,76	1,36
POLIMEXMS	2,00	4,89	BORYSZEW	2,42	2,97	PROVIMROL	1,79	4,50
GETIN	2,06	3,51	KABLE	2,58	2,80	Interia.pl	2,03	2,45
Kruszwica	2,25	4,65	Kruszwica	3,09	5,24	STRZELEC	2,29	4,30
KABLE	2,27	3,93	WISTIL	3,18	4,34	SWARZEDZ	3,40	3,03

Table 6 Portfolios content in various sub-periods

The next step is to estimate portfolios betas by regressing their monthly returns from years 2004-2006 against the market index in the same period according to equation 22. The complete regression results can be found in Table D in Appendix B. All of the estimates of portfolios betas showed to be significant however the intercept is in 4 cases significantly different from 0.

Having portfolios' betas the data set to cross-sectional regression must be prepared. In cross-sectional regression the average portfolios' risk premiums calculated from years 2004-2006 will be related to their betas resulting in estimation of the security market line. Table 7 presents the regression inputs:

Portfolio	Average Risk Premium	Beta	Beta Square	Variance of Residuals
p1	1,85 %	0,567484	0,322037819	0,004462515
p2	3,38 %	0,628821	0,395415687	0,0017224
p3	4,21 %	0,563046	0,317020736	0,00538096
p4	2,68 %	0,731949	0,535749812	0,003807878
p5	2,22 %	0,799905	0,639847671	0,001581915
p6	4,53 %	0,649953	0,422438742	0,003208911
p7	2,65 %	0,806912	0,651107636	0,004784368
p8	3,09 %	0,834141	0,695790425	0,002898525
p9	4,54 %	1,010285	1,020675408	0,003969413
p10	2,59 %	0,864074	0,746623489	0,003849638

Table 7 Cross-sectional regression inputs

5.2.1 SML Estimation

Based on data from Table 7 and using equation 23 the security market line has been estimated. Its graphical representation can be found in the Figure 9 below.

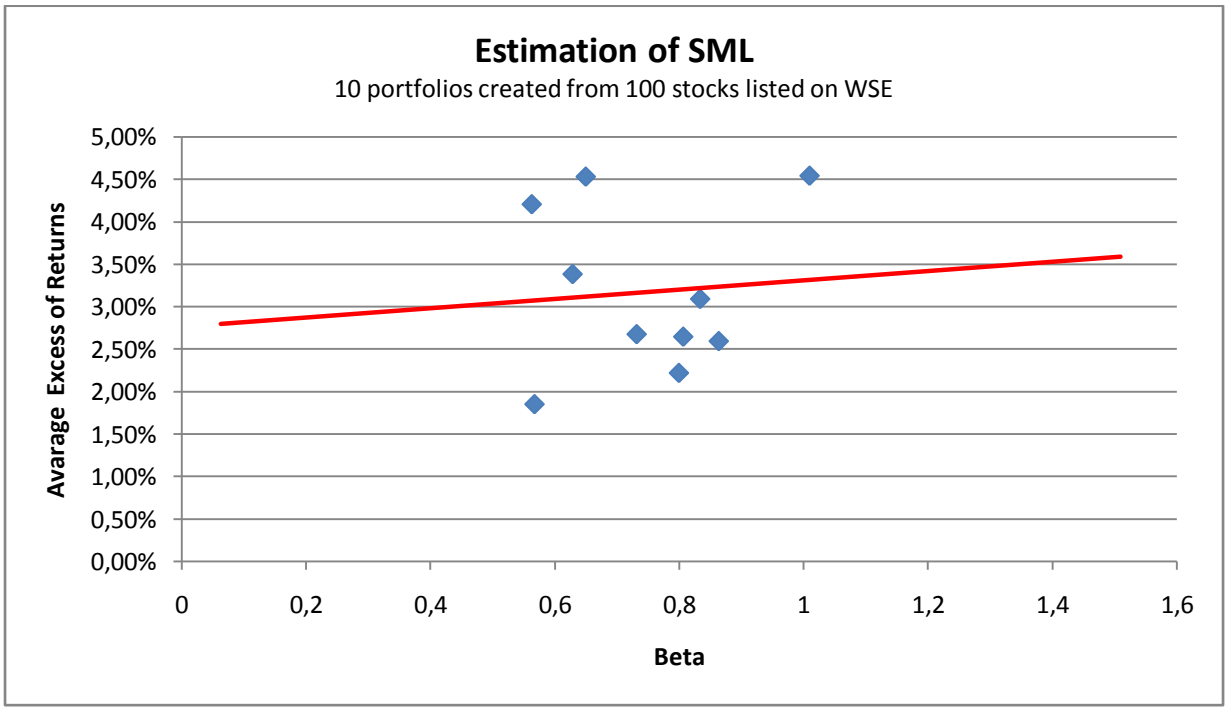

Figure 9 Estimation of the Security Market Line on Warsaw Stock Exchange. Testing period 2004-2006

Table 8 summarizes the regression results:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,027696	1,550413	0,159639	0
γ_1	0,005433	0,230544	0,823455	0,02012
R-square	0,66 %			
Standard Error	0,010181			

Table 8 Cross-sectional regression results

According to cross-sectional regression the estimated SML has an intercept insignificantly different from 0 which supports the CAPM hypothesis. The estimated slope γ_1 is positive but insignificant and much lower than the predicted by the model. Furthermore the R-square value is extremely low implying almost no relation between portfolios' returns and their betas.

5.2.2 Non-linearity test

The non-linearity test's results performed according to equation 24 can be seen in Table 9 below:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,154867	1,744899	0,124516	0
γ_1	– 0,33843	– 1,42968	0,195884	0,02012
γ_2	0,224875	1,458979	0,187937	0
R-square	0,238242			
Standard Error	0,009531			

Table 9 Cross-sectional regression results with non-linearity test

After performing the non-linearity test we can see that estimated intercept of SML γ_0 is still in accordance with CAPM: insignificantly different from 0. The slope however is negative and insignificant this time. Coefficient γ_2 which should be 0 if there is a linear relationship between beta and excess returns is insignificantly different from 0. In that matter the CAPM is supported.

5.2.2 Non-systematic risk test

The last step is to perform non-systematic risk test using equation 25. Its results are summarized in the Table 10:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,164679	1,488764	0,187122	0
γ_1	– 0,35918	– 1,27893	0,248155	0,02012
γ_2	0,238078	1,307171	0,239012	0
γ_3	– 0,53913	– 0,17644	0,865753	0
R-square	0,242174			
Standard Error	0,010268			

Table 10 Cross-sectional regression results with non-linearity and non-systematic risk tests.

The values of estimated coefficients $\gamma_0, \gamma_1, \gamma_2$ are approximately the same as in the previous cross-sectional regression. Intercept in insignificantly different from 0, slope is negative and insignificant and the SML exhibits linearity between beta and excess returns. Coefficient γ_3 is insignificantly different from 0 which means that non-systematic risk has no influence on portfolios returns. This result supports the Capital Asset Pricing Model.

5.3 Black, Jensen and Scholes, Fama and MacBeth Test

The last test performed in this thesis will be based on BJS and Fama and MacBeth research. Again I will summarize the testing procedures in the Table 11 for convenience:

	Time Period
Stocks' beta estimation	2002-2003
Portfolio creation date	31-12-2003
Portfolio returns computation	2004-2005
SML estimation	2006

Table 11 Testing steps in various years.

The analysis will start as usual with the estimation of beta coefficients of all one hounded stocks using equation 18. Estimations resulted in obtaining 60 % significant betas and 92 % intercepts insignificantly different from 0. For the complete results of these regressions please see Table A in Appendix C. After estimating stocks' betas, 20 portfolios have been created based on these estimates. The content of each portfolio is presented in Table 12.

Stocks in Portfolio 1	Beta	t-value	Stocks in Portfolio 2	Beta	t-value	Stocks in Portfolio 3	Beta	t-value	Stocks in Portfolio 4	Beta	t-value	Stocks in Portfolio 5	Beta	t-value
06MAGNA	-0,36	-2,36	13FORTUNA	0,02	0,10	04PRO	0,11	0,61	Jupiter	0,17	0,85	MENNICA	0,39	1,66
SWIECIE	-0,21	-0,87	08OCTAVA	0,03	0,05	FORTISPL	0,12	0,33	TUEUROPA	0,20	0,76	KredytBank	0,40	1,87
INDYKPOL	-0,11	-0,44	MIESZKO	0,04	0,22	UNIMIL	0,12	0,36	MUZA	0,24	0,51	BOS	0,41	2,01
ABG	-0,09	-0,25	05VICT	0,05	0,24	APATOR	0,14	0,38	ENERGOPN	0,27	0,33	IRENA	0,41	1,86
MOSTALWAR	-0,01	-0,02	01NFI	0,10	0,70	02NFI	0,15	0,56	INGBSK	0,33	1,68	MostalZab	0,44	0,71

Stocks in Portfolio 6	Beta	t-value	Stocks in Portfolio 7	Beta	t-value	Stocks in Portfolio 8	Beta	t-value	Stocks in Portfolio 9	Beta	t-value	Stocks in Portfolio 10	Beta	t-value
AMICA	0,49	1,51	ELDORADO	0,58	2,73	NOVITA	0,61	1,21	PGF	0,70	3,87	INSTALKRK	0,73	1,40
NORDEABP	0,49	1,23	Handlowy	0,58	3,75	CSS	0,63	2,00	COMPLAND	0,70	3,00	KROSNO	0,74	2,67
Optimus	0,51	1,56	POLNORD	0,59	1,89	MOSTALPLC	0,63	4,34	DZPOLSKA	0,71	1,80	EFEKT	0,75	1,76
WAWEL	0,55	2,76	GRAJEWO	0,60	1,66	Zywiec	0,64	3,70	ELBUDOWA	0,72	3,11	FORTE	0,78	2,82
STRZELEC	0,57	1,67	PROCHEM	0,61	2,73	Kopex	0,69	1,10	DEBICA	0,73	4,44	FARMACOL	0,79	2,31

Stocks in Portfolio 11	Beta	t-value	Stocks in Portfolio 12	Beta	t-value	Stocks in Portfolio 13	Beta	t-value	Stocks in Portfolio 14	Beta	t-value	Stocks in Portfolio 15	Beta	t-value
ECHO	0,83	3,46	VISTULA	0,90	1,44	Groclin	0,93	3,49	KOGENERA	0,97	2,68	TALEX	1,10	3,13
KETY	0,84	4,43	PEKAO	0,91	7,29	LPP	0,94	2,69	LENTEX	0,99	3,60	WILBO	1,13	4,97
STALPROD	0,84	2,35	WANDALEX	0,92	2,12	BEDZIN	0,94	1,66	TPSA	1,04	6,07	BUDIMEX	1,14	6,56
PKNORLEN	0,86	5,62	BZWBK	0,92	6,41	AGORA	0,95	4,50	Sanok	1,07	3,06	ELEKTRIM	1,19	2,52
Millennium	0,87	3,68	CERSANIT	0,93	1,77	RELPOL	0,96	3,94	Jutrzenka	1,08	5,50	Ferrum	1,20	1,60

Stocks in Portfolio 16	Beta	t-value	Stocks in Portfolio 17	Beta	t-value	Stocks in Portfolio 18	Beta	t-value	Stocks in Portfolio 19	Beta	t-value	Stocks in Portfolio 20	Beta	t-value
COMARCH	1,24	5,79	Prokom	1,34	6,11	PROSPER	1,53	4,03	MNI	1,71	2,49	Netia	1,94	2,76
PPWK	1,26	2,36	BRE	1,35	4,97	BORYSZEW	1,54	2,46	SWARZEDZ	1,76	3,67	POLIMEXMS	2,00	4,89
BANKBPH	1,29	7,23	TIM	1,37	3,65	POLLENAE	1,61	4,08	Interia.pl	1,77	4,31	GETIN	2,06	3,51
PROVIMROL	1,32	4,84	MostalExp	1,40	2,81	STALEXP	1,62	4,21	WISTIL	1,77	2,64	Kruszwica	2,25	4,65
KGHM	1,33	6,36	MCI	1,44	3,51	ORBIS	1,64	6,90	IMPEXMET	1,91	4,29	KABLE	2,27	3,93

Table 12 Content of the portfolios

Afterwards the portfolios' excess returns have been computed for years 2004-2005 by simply calculating the mean of excess returns on stocks in the portfolio. The next step is to estimate betas of these portfolios by regressing the portfolios' excess returns to the market index in the same time period using equation 23. For results of these regressions please see Table B in Appendix C. Eleven of these portfolios have significant estimated betas and only two have intercepts significantly different from 0.

Now everything is ready to perform the cross-section regression and estimate the security market line in the year 2006. The regression inputs are presented in Table 13:

Portfolio	Average Excess returns in 2006	Beta	Beta Square	Variance of residuals
p1	6,18%	0,662537	0,438956	0,010414
p2	0,79%	-0,13477	0,018162	0,014431
p3	6,95%	0,770993	0,59443	0,013204
p4	6,16%	-0,10452	0,010924	0,028409
p5	3,98%	0,420572	0,176881	0,016108
p6	2,33%	0,852132	0,726129	0,014699
p7	10,54%	0,431808	0,186458	0,009582
p8	8,75%	0,552562	0,305325	0,022143
p9	5,65%	0,492158	0,242219	0,008926
p10	4,13%	0,738256	0,545021	0,020009
p11	6,49%	0,838578	0,703212	0,008299
p12	6,40%	0,973739	0,948168	0,024395
p13	0,75%	0,366502	0,134324	0,016944
p14	5,19%	0,607397	0,368931	0,010931
p15	9,82%	0,697025	0,485845	0,027274
p16	6,00%	0,915004	0,837232	0,012939
p17	6,18%	1,253952	1,572396	0,018736
p18	5,51%	0,664625	0,441726	0,024692
p19	6,25%	1,226472	1,504234	0,041869
p20	8,64%	0,386471	0,149359	0,043445

Table 13 Inputs to cross-section regression

5.3.1 SML Estimation

Using the data from Table 13 and equation 23 the security market line has been estimated. It is presented in the Figure 10 below:

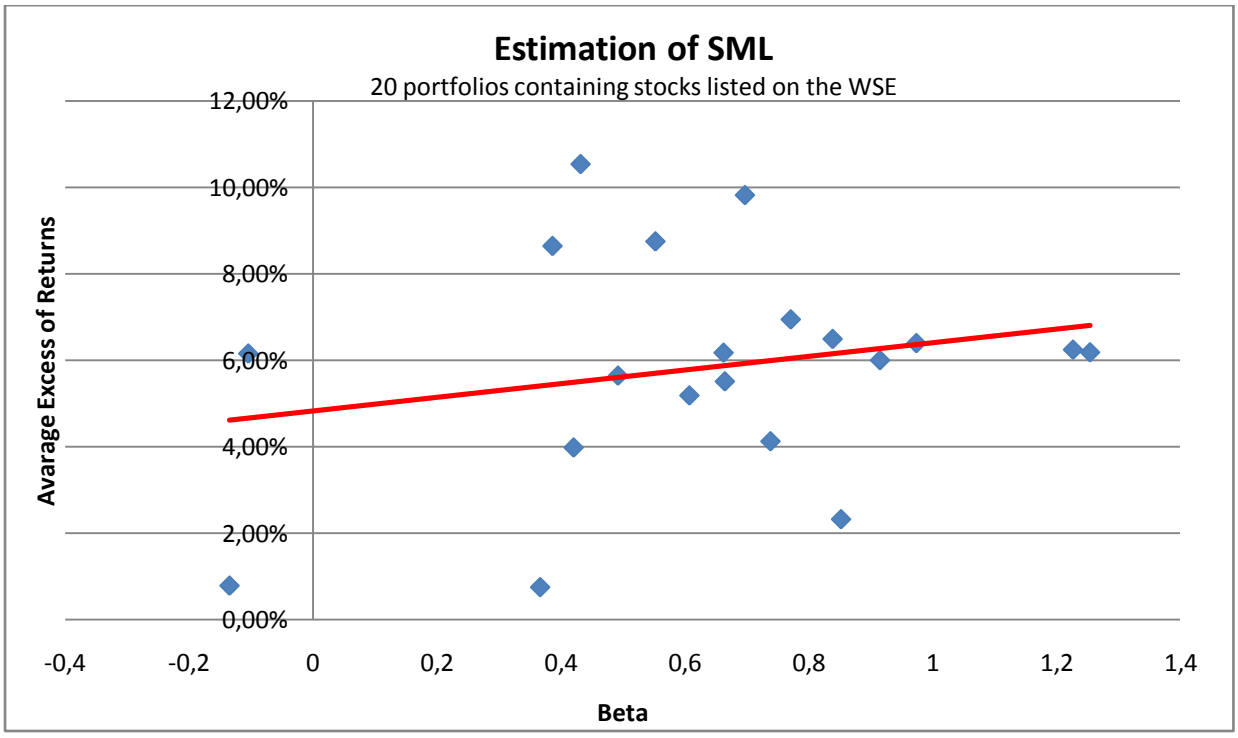

Figure 10 Estimation of the Security Market Line on Warsaw Stock Exchange. Testing year 2006

The regression results are summarized in the table 13:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,048382	4,036697	0,000774	0
γ_1	0,015794	0,949783	0,354802	0,02307
R-square	4,8 %			
Standard Error	0,025962			

Table 13 Results of the cross-section regression

The estimated vale of the intercept γ_0 is inconsistent with the CAPM theory since it is significantly different from 0. The estimated slope of the security market line isn't consistent with the theory either. It is positive but much lower than predicted by the model and insignificant. One cannot dismiss the fact that R-square is again very low implying no clear relationship between excess returns and beta.

5.3.2 Non-linearity test

The results of the regression after the non-linearity test (equation 24) are summarized in Table 14:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,04213	3,131407	0,006081	0
γ_1	0,053802	1,317447	0,20517	0,02307
γ_2	– 0,0341	– 1,01879	0,322581	0
R-square	10,25%			
Standard Error	0,025934			

Table 14 Results of the cross-section regression with non-linearity test

After performing the non-linearity test the value of estimated intercept is approximately unchanged and still inconsistent with the CAPM. The slope of SML is positive, however higher than predicted by the model this time and insignificant. The test for non-linearity itself has been passed. The value of γ_2 is insignificantly different from 0 implying a linear relationship between beta and excess returns.

5.3.3 Non-systematic risk test

The results of the regression after the non-systematic risk test (equation 25) are summarized in Table 15:

	Regression Results	*t*-value	*p*-value	CAPM predicted values
γ_0	0,023828	1,300421	0,211877	0
γ_1	0,068512	1,671935	0,113976	0,02307
γ_2	– 0,04893	-1,4338	0,170884	0
γ_3	0,863724	1,424534	0,173505	0
R-square	20,35%			
Standard Error	0,025183			

Table 15 Results of the cross-section regression with non-linearity and non-systematic risk.

The results suggest that the intercept of the estimated SML, which is insignificantly different from 0, is in accordance with CAPM. The slope however is even higher than in previous test and still insignificant. Non-linearity test has been passed again. It would also seem that non-systematic risk has no influence on the portfolios' risk premiums since γ_3 is insignificantly different from 0, thus consistent with the theory of CAMP.

6. Summary and Conclusions

6.1 Summary

The results of all three tests are summarized in the Table 15:

	Two-Pass Technique	Black, Jensen and Scholes	BJS and Fama, MacBeth
Intercept = 0	Failed	Passed	Failed
Slope = average risk premium	Significantly positive but too low	Positive but too low and insignificant	Positive but too low and insignificant
Non-linearity	Failed	Passed	Passed
Non-systematic risk	Passed	Passed	Passed

Table 16 Summary of the CAPM tests

According to the first test based on the two-pass regression technique, the Capital Asset Pricing Model hasn't been fully supported by the empirical data. The estimated security market line exhibited some properties not consistent with the theory. The intercept appeared to by significantly different from 0, slope of the SML was lower than model's predicted one[39] and no clear linear relationship between beta and excess returns could be noticed. The only thing in accordance with the CAPM is the fact that the non-systematic risk i.e. the one not captured by beta has no influence on demanded risk premiums.

Changing the method and instead of studying individual assets but rather portfolios resulted in somewhat better results. The intercept of the estimated SML seems to support the CAPM theory. Also the SML exhibits a linear relationship between beta and excess returns. Moreover the non-systematic risk seems to have no reflection in returns. The results have shown however that the slope of the estimated SML is to low and most importantly insignificant which says against the Capital Asset Pricing Model.

The last test, very similar to the Black, Jensen and Scholes one also failed to support the theory. The estimated intercept and slope of SML are different than those predicted by the model. Despite clear linearity and no non-systematic risk importance the CAPM couldn't be fully accepted.

6.2 Conclusions and ideas for future studies

After performing the empirical analysis on the Warsaw Stock Exchange in order to test the performance of the Capital Asset Model the main conclusion is that the model has not been supported by the data. While it cannot be supported completely some of the implications of the model seem to be true: beta as a valid measure of risk, linearity and partially a positive relationship between beta and returns.

Comparing those results with the results of original tests of Black, Jensen and Scholes and Fama and MacBeth described in Section 3 one can conclude that they do differ. While their studies found strong support for the CAPM this analysis did not. The results of this thesis are however in

[39] The results considering intercept and slope of the security market line are evaluated based on the first estimation of SML in every test (equation 19 in two-pass test and equation 23 in Black, Jensen and Scholes and BJS, Fama and MacBeth test) since adding the non-linearity and non-systematic risk test results in changes of these parameters.

accordance with studies performed after 1965 like Fench 1980 or Fama and French 1992 which rejected the model. These studies however allowed more variables than just beta to influence stocks' expected return so one should be careful in comparing the results of these studies.

One must bear in mind that the version of the CAPM tested in this model is the most basic one and it is based on quite strong assumptions. Remember that we assumed for instance no market imperfections (taxes, transaction costs) or same access to information for all investors. Perhaps by modifying or reliving some of the assumptions the results would be better. There are also some versions of the CAPM putting the restrictions on the risk-free asset such as the Black versions which assumes lack of such an asset on the market or the CAPM when lending at risk-free rate is possible but not borrowing. Maybe these versions could find a support of empirical data. At this point it is also important to remember that the index WIG was used as a proxy of the market and the market portfolio. One must bear in mind that this index contains only common stocks but theory assumes that market portfolio contains all tradeable assets including not only stocks, bonds, options, futures but even real estate and human capital. In that case the proxy of the market used in this paper is hardly a realistic one.

A good idea for future study of assets traded on the Warsaw Stock Exchange could be to test a theory developed after the CAPM namely the Arbitrage Pricing Theory, which allows more factors than just beta to influence securities' rate of returns.

7. References

Bodie Ziv , Merton Robert C. [2000] *"Finance"* International Edition Prentice Hall, New Jersey

Brealey, Myers, Allen [2006] *"Corporate Finance"* 8th Edition McGraw-Hill, New York

Campbell John Y., Lo Andrwe W., MacKinlay Craig A. [1997] *"The Econometrics of Financial Markets"* 2nd Edition Princeton University Press, New Jersey

Copeland Thomas E., Weston Fred J. Shastri Kuldeep [2005] *"Financial Theory and Corporate Policy"* 4th Edition Pearson Education

Haugen Robert A. [2001] *"Modern Investment Theory"* 5th Edition Prentice-Hall, New Jersey

Grigoris Michailidis, Stavros Tsopoglou, Demetrios Papanastasiou, Eleni Mariola [2006] "Testing the Capital Asset Pricing Model (CAPM): The Case of the Emerging Greek Securities Market" *International Research Journal of Finance and Economics* Issue 4,

Markowitz Harry [1952] "Portfolio Selection" *Journal of Finance* Vol. VII, No.1

Sørensen Peter Birch, Whitta-Jacobsen Hans Jørgen [2005] *"Introducing Advanced Macroeconomics: Growth & Business Cycles"* McGraw-Hill Berkshire

"Fact Book 2006" Official publication of the Warsaw Stock Exchange

Warsaw Stock Exchange Official Quotations *http://www.gpw.com.pl/gpw.asp?cel=informacje_gieldowe&k=15&i=/statystyki/miesieczne&sky=1*

Official Statistics of the Polish Central Bank *www.nbp.pl*

Appendix A

Table A.

Results of the first-pass regressions

Stock	Constant	t-value constant	Estimated Beta	t-value Beta	R Square	Regression standard error	Variance of residuals
TUEUROPA	0,0428	2,055	– 0,10	– 0,31	0,16 %	0,1576	0,0249
06MAGNA	0,0126	1,476	– 0,07	– 0,50	0,41 %	0,0647	0,0042
SWIECIE	0,0233	1,992	0,00	– 0,02	0,00 %	0,0887	0,0079
01NFI	0,0088	0,394	0,01	0,03	0,00 %	0,1692	0,0286
MENNICA	0,0171	1,129	0,06	0,25	0,11 %	0,1145	0,0131
ELDORADO	0,0275	1,859	0,16	0,66	0,72 %	0,1120	0,0125
13FORTUNA	– 0,0044	– 0,225	0,17	0,53	0,46 %	0,1484	0,0220
FORTISPL	0,0285	2,027	0,19	0,84	1,17 %	0,1064	0,0113
INDYKPOL	0,0220	1,054	0,21	0,62	0,63 %	0,1579	0,0249
05VICT	0,0091	0,380	0,24	0,62	0,64 %	0,1818	0,0330
MIESZKO	0,0045	0,271	0,30	1,16	2,18 %	0,1249	0,0156
ABG	– 0,0096	– 0,569	0,36	1,34	2,92 %	0,1276	0,0163
DEBICA	0,0143	1,279	0,38	2,11	6,91 %	0,0850	0,0072
NORDEABP	0,0084	0,522	0,38	1,48	3,52 %	0,1215	0,0148
IRENA	– 0,0083	– 0,805	0,38	2,32	8,26 %	0,0779	0,0061
WAWEL	0,0354	3,086	0,40	2,17	7,25 %	0,0870	0,0076
Zywiec	0,0060	0,915	0,42	3,96	20,75%	0,0498	0,0025
BOS	– 0,0023	– 0,262	0,42	3,00	13,02%	0,0667	0,0044
UNIMIL	0,0160	1,083	0,43	1,84	5,36 %	0,1119	0,0125
APATOR	0,0543	3,584	0,44	1,81	5,17 %	0,1147	0,0132
MOSTALWAR	0,0330	1,464	0,46	1,28	2,64 %	0,1706	0,0291
Jupiter	0,0015	0,072	0,48	1,41	3,22 %	0,1600	0,0256
02NFI	0,0588	1,769	0,50	0,94	1,45 %	0,2519	0,0635
KROSNO	– 0,0026	– 0,205	0,51	2,48	9,30 %	0,0973	0,0095
INGBSK	0,0033	0,412	0,51	4,02	21,21%	0,0603	0,0036
Handlowy	– 0,0018	– 0,240	0,53	4,42	24,55%	0,0570	0,0033
COMPLAND	– 0,0094	– 0,898	0,55	3,32	15,49%	0,0791	0,0063
PGF	0,0051	0,591	0,55	4,05	21,45%	0,0649	0,0042
DZPOLSKA	0,0192	0,695	0,56	1,28	2,64 %	0,2090	0,0437
ENERGOPN	0,0018	0,067	0,57	1,31	2,77 %	0,2083	0,0434
04PRO	0,0362	1,210	0,58	1,21	2,37 %	0,2269	0,0515
MUZA	– 0,0103	– 0,403	0,58	1,41	3,22 %	0,1939	0,0376
Optimus	– 0,0306	– 2,179	0,59	2,61	10,19%	0,1065	0,0114
GRAJEWO	0,0289	2,268	0,59	2,91	12,34%	0,0965	0,0093
08OCTAVA	0,0170	0,593	0,60	1,31	2,77 %	0,2173	0,0472
CSS	0,0000	– 0,001	0,60	2,77	11,37%	0,1035	0,0107
PROCHEM	0,0336	2,272	0,61	2,59	10,05%	0,1122	0,0126
AMICA	– 0,0106	– 0,684	0,64	2,57	9,91 %	0,1178	0,0139

KredytBank	– 0,0101	– 0,966	0,65	3,89	20,14%	0,0791	0,0063
NOVITA	0,0200	0,794	0,67	1,67	4,45 %	0,1907	0,0364
Jutrzenka	0,0188	1,395	0,70	3,25	14,95%	0,1019	0,0104
Sank	0,0226	1,548	0,72	3,09	13,72%	0,1107	0,0122
RELPOL	0,0045	0,369	0,74	3,85	19,79%	0,0915	0,0084
KETY	0,0104	1,142	0,75	5,18	30,86%	0,0687	0,0047
FARMACOL	0,0054	0,456	0,75	4,00	21,02%	0,0892	0,0080
FORTE	0,0179	1,540	0,75	4,06	21,54%	0,0880	0,0077
LENTEX	0,0209	1,031	0,76	2,33	8,31 %	0,1539	0,0237
STALPROD	0,0673	3,326	0,77	2,39	8,72 %	0,1534	0,0235
VISTULA	0,0423	1,786	0,78	2,05	6,57 %	0,1792	0,0321
BEDZIN	0,0150	0,729	0,78	2,38	8,62 %	0,1564	0,0245
AGORA	– 0,0148	– 1,374	0,81	4,72	27,07%	0,0816	0,0067
INSTALKRK	0,0267	1,199	0,83	2,33	8,27 %	0,1689	0,0285
EFEKT	0,0058	0,280	0,83	2,52	9,57 %	0,1560	0,0243
KOGENERA	– 0,0079	– 0,480	0,84	3,18	14,46%	0,1247	0,0156
Groclin	0,0061	0,438	0,84	3,81	19,44%	0,1053	0,0111
MOSTALPLC	0,0132	0,821	0,86	3,35	15,72%	0,1219	0,0149
LPP	0,0321	2,138	0,87	3,63	17,98%	0,1138	0,0129
ELBUDOWA	0,0181	1,381	0,92	4,37	24,18%	0,0994	0,0099
TALEX	– 0,0032	– 0,198	0,93	3,55	17,37%	0,1237	0,0153
WANDALEX	0,0101	0,525	0,94	3,06	13,49%	0,1459	0,0213
STRZELEC	– 0,0175	– 0,926	0,94	3,12	13,93%	0,1434	0,0206
KABLE	0,0511	1,056	0,95	1,22	2,44 %	0,3663	0,1342
ECHO	0,0240	1,946	0,97	4,90	28,62%	0,0934	0,0087
WISTIL	0,0230	0,892	0,99	2,41	8,82 %	0,1956	0,0383
MostalZab	0,0162	0,498	1,00	1,92	5,80 %	0,2459	0,0604
BORYSZEW	0,0599	2,343	1,00	2,45	9,11 %	0,1938	0,0376
PKNORLEN	– 0,0010	– 0,131	1,01	8,62	55,33%	0,0557	0,0031
PEKAO	– 0,0027	– 0,490	1,02	11,42	68,49%	0,0424	0,0018
COMARCH	0,0099	0,855	1,02	5,56	33,98%	0,0874	0,0076
ELEKTRIM	0,0086	0,198	1,03	1,47	3,49 %	0,3305	0,1092
BUDIMEX	0,0055	0,438	1,04	5,24	31,42%	0,0945	0,0089
WILBO	– 0,0111	– 0,850	1,05	5,06	29,88%	0,0990	0,0098
TPSA	– 0,0104	– 1,415	1,07	9,08	57,88%	0,0557	0,0031
Millennium	0,0061	0,521	1,07	5,70	35,17%	0,0892	0,0080
Kopex	0,0521	2,013	1,08	2,60	10,14%	0,1960	0,0384
PROVIMROL	0,0144	1,116	1,11	5,39	32,66%	0,0977	0,0096
TIM	0,0499	2,619	1,13	3,70	18,57%	0,1444	0,0209
BZWBK	0,0056	0,722	1,14	9,25	58,76%	0,0586	0,0034
CERSANIT	0,0067	0,358	1,19	3,97	20,79%	0,1419	0,0201
PPWK	– 0,0132	– 0,478	1,19	2,70	10,82%	0,2090	0,0437
PROSPER	– 0,0146	– 0,962	1,22	5,01	29,50%	0,1152	0,0133
POLLENAE	– 0,0065	– 0,375	1,23	4,44	24,76%	0,1315	0,0173
Ferrum	0,0386	1,164	1,25	2,37	8,53 %	0,2515	0,0633
BANKBPH	0,0016	0,244	1,26	11,83	70,01%	0,0507	0,0026

Netia	– 0,0111	– 0,472	1,27	3,39	16,06%	0,1776	0,0316
BRE	0,0005	0,051	1,28	7,80	50,33%	0,0778	0,0060
ORBIS	0,0074	0,670	1,32	7,44	47,98%	0,0841	0,0071
MCI	0,0290	1,089	1,32	3,10	13,82%	0,2018	0,0407
STALEXP	– 0,0008	– 0,036	1,32	3,90	20,21%	0,1611	0,0259
Prokom	– 0,0152	– 1,495	1,35	8,34	53,69%	0,0771	0,0059
POLNORD	0,0450	1,288	1,40	2,51	9,49 %	0,2647	0,0701
POLIMEXMS	0,0390	1,987	1,42	4,52	25,40%	0,1487	0,0221
KGHM	0,0090	0,796	1,42	7,85	50,66%	0,0859	0,0074
Kruszwica	0,0234	1,156	1,42	4,40	24,40%	0,1536	0,0236
IMPEXMET	0,0281	1,443	1,50	4,83	27,96%	0,1478	0,0218
MNI	– 0,0187	– 0,768	1,53	3,92	20,39%	0,1847	0,0341
GETIN	0,0289	1,363	1,64	4,83	27,98%	0,1608	0,0259
Interia.pl	0,0206	0,978	1,74	5,17	30,83%	0,1596	0,0255
MostalExp	0,0009	0,033	1,78	4,08	21,73%	0,2074	0,0430
SWARZEDZ	– 0,0200	– 0,823	1,88	4,83	27,97%	0,1844	0,0340

Table B.

Inputs to the second-pass regression

Stock Name	Average excess of stock returns over the risk-free rate	Beta	Beta Square	Variance of Residuals
TPSA	0,78 %	1,066807116	1,138077423	0,003107163
PEKAO	1,47 %	1,021137032	1,042720838	0,001800021
PKNORLEN	1,63 %	1,01125127	1,022629131	0,00309755
BANKBPH	2,32 %	1,26443722	1,598801483	0,002570154
Millennium	2,44 %	1,072056236	1,149304574	0,007950945
Handlowy	0,72 %	0,531000223	0,281961237	0,003250813
INGBSK	1,20 %	0,510635664	0,260748781	0,003635023
BZWBK	2,50 %	1,141132349	1,302183037	0,003429049
AGORA	– 0,10 %	0,811487527	0,658512007	0,006656011
KGHM	3,32 %	1,420998295	2,019236156	0,007380285
Zywiec	1,31 %	0,415682445	0,172791895	0,002475855
BRE	2,23 %	1,277873	1,632959405	0,006047184
KredytBank	0,10 %	0,648691936	0,420801228	0,006259787
Prokom	0,79 %	1,354882092	1,835705483	0,005940725
SWIECIE	2,32 %	– 0,003873008	1,50002E-05	0,007859338
ORBIS	2,99 %	1,318215613	1,737692404	0,007070561
Netia	1,06 %	1,268493744	1,609076379	0,031556345
COMPLAND	0,00 %	0,553062208	0,305877806	0,006263208
BUDIMEX	2,33 %	1,043833139	1,089587623	0,008925945
BOS	0,49 %	0,421131457	0,177351704	0,004444385
MostalZab	3,31 %	0,995950926	0,991918247	0,060445642
DEBICA	2,08 %	0,377998878	0,142883151	0,007224706

KOGENERA	0,64 %	0,837176474	0,700864448	0,015555417
Sanok	3,49 %	0,720446975	0,519043844	0,01224712
KETY	2,31 %	0,74941932	0,561629317	0,004721339
ABG	– 0,34 %	0,361225227	0,130483665	0,016290017
PGF	1,45 %	0,55356673	0,306436124	0,004211217
CERSANIT	2,69 %	1,186421654	1,40759634	0,02012688
COMARCH	2,73 %	1,024103129	1,048787218	0,007645621
FORTISPL	3,17 %	0,189180828	0,035789386	0,011319153
NORDEABP	1,48 %	0,378674979	0,14339474	0,014750256
GRAJEWO	3,89 %	0,590782735	0,34902424	0,009307164
ECHO	4,05 %	0,965975129	0,93310795	0,008732657
FARMACOL	1,82 %	0,751599296	0,564901502	0,007965352
IMPEXMET	5,38 %	1,502678309	2,258042099	0,021830869
DZPOLSKA	2,87 %	0,562187522	0,316054809	0,043679077
LPP	4,69 %	0,869427733	0,755904582	0,012943033
TUEUROPA	4,10 %	– 0,103722644	0,010758387	0,024851066
MOSTALWAR	4,08 %	0,45857926	0,210294938	0,029102653
ELDORADO	3,01 %	0,155161395	0,024075059	0,01254268
Kruszwica	4,77 %	1,424884466	2,030295742	0,023602485
STALPROD	8,05 %	0,77362817	0,598500546	0,023519786
POLIMEXMS	6,31 %	1,416408992	2,006214432	0,022110076
PROVIMROL	3,33 %	1,111219093	1,234807872	0,009552708
BORYSZEW	7,70 %	1,001523265	1,003048851	0,037566491
APATOR	6,17 %	0,437300583	0,1912318	0,013158758
STALEXP	2,18 %	1,323322078	1,751181321	0,025937827
VISTULA	5,55 %	0,776071566	0,602287076	0,032127245
GETIN	5,68 %	1,636092893	2,676799954	0,025850796
POLNORD	6,88 %	1,39901483	1,957242495	0,070054506
PROCHEM	4,41 %	0,612136344	0,374710904	0,012591064
POLLENAE	1,45 %	1,23111287	1,515638899	0,017280565
SWARZEDZ	1,19 %	1,876412897	3,520925361	0,034015819
MOSTALPLC	2,79 %	0,859547484	0,738821877	0,014864136
WANDALEX	2,61 %	0,940611137	0,88474931	0,021287739
EFEKT	1,99 %	0,828456282	0,68633981	0,024332603
UNIMIL	2,34 %	0,434538797	0,188823966	0,012514777
TIM	6,91 %	1,125850667	1,267539724	0,020853944
WISTIL	4,00 %	0,993103789	0,986255135	0,03826316
BEDZIN	2,84 %	0,784331226	0,615175472	0,02445774
WAWEL	4,22 %	0,397119144	0,157703615	0,007573186
PPWK	0,71 %	1,188209309	1,411841362	0,043671279
KABLE	6,72 %	0,945000446	0,893025843	0,134163117
MUZA	– 0,05 %	0,577571535	0,333588878	0,037584031
Interia.pl	5,02 %	1,739078934	3,02439554	0,0254669
RELPOL	1,71 %	0,741762539	0,550211664	0,008368978
MIESZKO	0,97 %	0,304536288	0,092742351	0,015603079
STRZELEC	– 0,15 %	0,942279266	0,887890215	0,020577008

FORTE	3,07 %	0,752639725	0,566466555	0,00774035
MCI	5,15 %	1,319427117	1,740887916	0,040721302
TALEX	1,25 %	0,925658941	0,856844475	0,01529289
INSTALKRK	4,08 %	0,827644172	0,684994876	0,028526117
WILBO	0,69 %	1,054598717	1,112178453	0,009791592
NOVITA	3,14 %	0,672170098	0,45181264	0,036375696
02NFI	6,73 %	0,498174455	0,248177788	0,063450886
INDYKPOL	2,55 %	0,205921622	0,042403715	0,02493301
ENERGOPN	1,16 %	0,574329307	0,329854153	0,043387629
05VICT	1,32 %	0,238751214	0,057002142	0,033048559
IRENA	– 0,18 %	0,381453857	0,145507045	0,006061136
CSS	1,03 %	0,604844799	0,365837231	0,010703522
01NFI	0,90 %	0,011552421	0,000133458	0,028628641
ELBUDOWA	3,37 %	0,916669582	0,840283123	0,009887256
Jutrzenka	3,06 %	0,697115195	0,485969595	0,010375949
06MAGNA	1,15 %	– 0,068122115	0,004640623	0,004189967
MENNICA	1,81 %	0,061495394	0,003781683	0,013117214
KROSNO	0,60 %	0,508699285	0,258774962	0,009467132
PROSPER	0,61 %	1,217144967	1,481441871	0,013282007
Jupiter	0,96 %	0,47634136	0,226901091	0,025614713
AMICA	0,02 %	0,637841035	0,406841186	0,013872019
04PRO	4,61 %	0,576576128	0,332440031	0,051491185
13FORTUNA	– 0,16 %	0,165319397	0,027330503	0,02201328
08OCTAVA	2,72 %	0,599224278	0,359069735	0,047229474
Ferrum	6,00 %	1,254018696	1,57256289	0,063250725
Groclin	2,05 %	0,844079717	0,712470569	0,011079267
LENTEX	3,38 %	0,756242411	0,571902585	0,023690011
MNI	0,73 %	1,52640372	2,329908316	0,034125807
Kopex	7,04 %	1,075099334	1,155838579	0,038421597
MostalExp	3,13 %	1,783902067	3,182306584	0,043003683
ELEKTRIM	2,61 %	1,025835969	1,052339436	0,109198017
Optimus	– 2,07 %	0,585893436	0,343271119	0,011351378

Appendix B

Table A.

Estimated stocks' betas in years 2002-2003

Stock Name	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
06MAGNA	0,00557532	0,477773581	-0,35713	-2,359383028	20,19%	0,056209535
SWIECIE	0,04837366	2,56376462	-0,21238	-0,867746282	3,31%	0,090885183
INDYKPOL	-0,0083785	-0,427014147	-0,11145	-0,437891964	0,86%	0,094512092
ABG	0,01760185	0,615374952	-0,09412	-0,253671164	0,29%	0,137778261
MOSTALWAR	0,02239953	0,956180025	-0,00674	-0,022194203	0,00%	0,112839591
13FORTUNA	-0,0120073	-0,997880264	0,016271	0,104246494	0,05%	0,057960347
08OCTAVA	0,03896732	0,802853307	0,032892	0,052245243	0,01%	0,233790349
MIESZKO	0,00271491	0,200938542	0,038992	0,2224827	0,22%	0,065080986
05VICT	0,00446355	0,25954491	0,053908	0,241658392	0,26%	0,08283804
01NFI	0,0009608	0,083960296	0,104489	0,703925698	2,20%	0,05512181
04PRO	-0,0107487	-0,788572372	0,107535	0,608210489	1,65%	0,065656236
FORTISPL	0,04618648	1,707217426	0,115111	0,328026125	0,49%	0,130313158
UNIMIL	0,04425335	1,727327356	0,119246	0,358831033	0,58%	0,123405278
APATOR	0,07564299	2,563602377	0,14488	0,378535039	0,65%	0,142128209
02NFI	0,01050399	0,52467696	0,145875	0,561741711	1,41%	0,096432774
Jupiter	-0,0310636	-2,006195714	0,171432	0,853551781	3,21%	0,07458319
TUEUROPA	0,00671589	0,33125144	0,198972	0,756594938	2,54%	0,097658025
MUZA	-0,0326303	-0,889272935	0,244348	0,513380464	1,18%	0,176745693
ENERGOPN	-0,0256893	-0,411421987	0,266323	0,328822084	0,49%	0,300764413
INGBSK	-0,0035632	-0,236906876	0,328487	1,683741858	11,42%	0,072447183
MENNICA	-0,0133148	-0,72948797	0,393807	1,663352356	11,17%	0,087918078
KredytBank	-0,0420972	-2,580045749	0,396111	1,871580292	13,74%	0,078593714
BOS	-0,0101984	-0,650011956	0,409238	2,010866646	15,53%	0,075574022
IRENA	-0,0054757	-0,321340765	0,411179	1,860272489	13,59%	0,082079244
MostalZab	-0,0480682	-0,994660593	0,444439	0,708999862	2,23%	0,232779973
AMICA	-0,009203	-0,366751451	0,492555	1,513263593	9,43%	0,120870392
NORDEABP	0,01486785	0,480672549	0,493443	1,229859342	6,43%	0,148991373
Optimus	-0,0330435	-1,298098341	0,513813	1,556122796	9,92%	0,122614231
WAWEL	0,01825942	1,178317457	0,554506	2,758664411	25,70%	0,074642632
STRZELEC	-0,0168426	-0,639780464	0,570652	1,671133764	11,26%	0,126805802
ELDORADO	0,01974307	1,212638738	0,576416	2,729417916	25,30%	0,078423386
Handlowy	-0,0134269	-1,122066542	0,58258	3,753318239	39,04%	0,057639455
POLNORD	-0,0155881	-0,654779314	0,585155	1,894914562	14,03%	0,114672895
GRAJEWO	0,04381201	1,557831411	0,604115	1,656014731	11,08%	0,135467463
PROCHEM	0,00786554	0,454904112	0,612163	2,729454919	25,30%	0,083285773
NOVITA	-0,0268547	-0,688834272	0,613008	1,212210739	6,26%	0,187787748
CSS	-0,0181948	-0,751013092	0,62831	1,999363351	15,38%	0,11669755
MOSTALPLC	-0,0135991	-1,213042443	0,630397	4,335070789	46,07%	0,054000404
Zywiec	0,01754328	1,327349144	0,635086	3,704454263	38,41%	0,063663127

Kopex	0,07046021	1,448979325	0,694345	1,100806464	5,22%	0,23423081
PGF	0,00052356	0,037756644	0,695767	3,868188586	40,48%	0,066793735
COMPLAND	-0,0160206	-0,886681142	0,70395	3,003631125	29,08%	0,087031145
DZPOLSKA	-0,0228277	-0,749421414	0,7105	1,798233342	12,81%	0,146722802
ELBUDOWA	-0,0145036	-0,814857276	0,718448	3,111842473	30,56%	0,085734809
DEBICA	0,0501957	3,966818669	0,72798	4,435194421	47,21%	0,060951788
INSTALKRK	-0,0155296	-0,385394162	0,72919	1,39508839	8,13%	0,194096721
KROSNO	0,0173813	0,817015927	0,735526	2,665405211	24,41%	0,102474067
EFEKT	-0,0397053	-1,205158061	0,750577	1,756337983	12,30%	0,158696258
FORTE	0,05114381	2,394636755	0,782058	2,822946682	26,59%	0,102876382
FARMACOL	0,01624264	0,616556919	0,789847	2,311408672	19,54%	0,12689536
ECHO	0,01498965	0,81431305	0,825627	3,457807868	35,21%	0,088667062
KETY	0,03405852	2,333996076	0,838511	4,429965666	47,15%	0,070289085
STALPROD	0,03110743	1,124880148	0,843924	2,352678574	20,10%	0,133204864
PKNORLEN	0,00554079	0,470743604	0,857556	5,6168453	58,92%	0,056695597
Millennium	-0,0157355	-0,86172866	0,872324	3,682868995	38,14%	0,087957139
VISTULA	-0,0038037	-0,079222541	0,899844	1,444862982	8,67%	0,231270311
PEKAO	-0,0087108	-0,904751672	0,911019	7,294841777	70,75%	0,046375735
WANDALEX	-0,0046676	-0,140118717	0,916837	2,121839105	16,99%	0,16045716
BZWBK	0,00323209	0,290774148	0,923973	6,408394582	65,12%	0,053541372
CERSANIT	-0,0181795	-0,450845127	0,926575	1,771509234	12,48%	0,194230134
Groclin	0,06523062	3,181623874	0,927042	3,485889738	35,58%	0,098756322
LPP	0,08288062	3,083925225	0,937118	2,68820513	24,73%	0,129452792
BEDZIN	0,06035558	1,386868133	0,937418	1,66061213	11,14%	0,209625682
AGORA	-0,0063962	-0,39226719	0,950881	4,495771266	47,88%	0,07854189
RELPOL	0,01016489	0,544033474	0,955428	3,942191652	41,40%	0,08999938
KOGENERA	-0,03392	-1,218274482	0,967392	2,678608709	24,59%	0,134113484
LENTEX	0,00756476	0,35858497	0,986262	3,604181407	37,13%	0,101616702
TPSA	-0,0114564	-0,870692717	1,035187	6,065323239	62,58%	0,063378814
Sanok	0,05045679	1,862876523	1,073967	3,056838016	29,81%	0,130466147
Jutrzenka	0,00898665	0,594372168	1,077771	5,495458029	57,85%	0,072828577
TALEX	0,01889623	0,698333382	1,099022	3,131203635	30,83%	0,130339062
WILBO	-0,0149071	-0,852542478	1,126524	4,966857061	52,86%	0,084224428
BUDIMEX	-0,0003591	-0,026710222	1,143863	6,558534094	66,16%	0,064765904
ELEKTRIM	-0,0454936	-1,251935919	1,186031	2,516198326	22,35%	0,175037296
Ferrum	0,02052366	0,355216814	1,196658	1,596709847	10,39%	0,278306574
COMARCH	-0,0071511	-0,433811056	1,238731	5,793209134	60,40%	0,07940307
PPWK	-0,0531767	-1,297815692	1,25537	2,362001978	20,23%	0,197365271
BANKBPH	0,00137457	0,099766499	1,291887	7,228702294	70,37%	0,066365707
PROVIMROL	0,04300335	2,052298455	1,315758	4,840958513	51,58%	0,100930867
KGHM	0,01954785	1,212122621	1,331276	6,364038561	64,80%	0,077680982
Prokom	0,00444901	0,262483053	1,344235	6,114069475	62,95%	0,081643981
BRE	-0,0210396	-1,008358316	1,346387	4,974676659	52,94%	0,100504237
TIM	0,01850671	0,638634917	1,372733	3,651965024	37,74%	0,139585033
MostalExp	-0,0373688	-0,974535258	1,399442	2,813590041	26,46%	0,184702771
MCI	-0,0156977	-0,495193571	1,44359	3,510742593	35,91%	0,152694805

PROSPER	-0,0097629	-0,334172494	1,52825	4,032770974	42,50%	0,140724698
BORYSZEW	0,11805953	2,44632209	1,537917	2,456759907	21,53%	0,232460772
POLLENAE	-0,0102319	-0,337492818	1,60607	4,084039741	43,12%	0,146034003
STALEXP	-0,0254055	-0,853897985	1,624344	4,208953202	44,61%	0,143312278
ORBIS	0,00246263	0,134697806	1,636691	6,901521391	68,40%	0,088064575
MNI	-0,0851334	-1,607756085	1,71336	2,494512688	22,05%	0,255059901
SWARZEDZ	-0,0296098	-0,800689875	1,760399	3,669924346	37,97%	0,178128479
Interia.pl	0,00638962	0,202436448	1,766368	4,314313074	45,83%	0,152036847
WISTIL	0,09238486	1,785445987	1,772635	2,641084612	24,07%	0,249239182
IMPEXMET	0,02657942	0,774512592	1,909953	4,290648467	45,56%	0,165302422
Netia	-0,0091304	-0,168531945	1,936732	2,756007853	25,66%	0,260956692
POLIMEXMS	0,00705509	0,223106946	2,003782	4,885151662	52,03%	0,152318204
GETIN	0,01846817	0,408285712	2,060134	3,51117895	35,91%	0,217882249
Kruszwica	0,05311032	1,419785422	2,254531	4,646405654	49,53%	0,180184912
KABLE	-0,0023689	-0,05321078	2,26787	3,927287322	41,21%	0,214439542

Table B.

Estimated stocks' betas in years 2003-2004

Stock Name	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
TPSA	-0,00334187	-0,28427001	0,895181	4,758102369	50,72%	0,053668499
PEKAO	-0,00593836	-0,726365967	0,995014	7,605012971	72,44%	0,037322546
PKNORLEN	0,01225198	1,567111903	0,784437	6,269508325	64,11%	0,035691667
BANKBPH	-0,00191009	-0,164668703	1,201688	6,47335845	65,57%	0,052954694
Millennium	-0,01299491	-0,738365661	0,565912	2,009224408	15,50%	0,080345647
Handlowy	-0,021303	-1,624478352	0,858544	4,090888159	43,20%	0,059866979
INGBSK	-0,01045501	-0,633320752	0,418615	1,584512662	10,24%	0,075363532
BZWBK	-0,01018581	-1,285100433	0,943437	7,437658567	71,55%	0,036184191
AGORA	-0,01943466	-1,255303032	1,092265	4,408401919	46,90%	0,070678778
KGHM	0,01245547	0,727210014	1,350756	4,927859036	52,47%	0,078191729
Zywiec	-0,00581457	-0,494268531	0,574164	3,049741834	29,71%	0,053705079
BRE	-0,01754422	-0,9929321	1,30663	4,620828307	49,25%	0,080663119
KredytBank	-0,03945158	-2,392483802	0,767684	2,909035092	27,78%	0,075279362
Prokom	-0,02254681	-1,386702251	1,279174	4,915972886	52,35%	0,074227107
SWIECIE	0,04051878	1,83620426	-0,56356	-1,595831845	10,37%	0,100738606
ORBIS	-0,01685891	-1,002030147	1,575994	5,853123052	60,90%	0,076808476
Netia	-0,01041311	-0,717260533	1,098666	4,728721718	50,41%	0,066277222
COMPLAND	-0,00317264	-0,169833501	0,475452	1,590343037	10,31%	0,085282103
BUDIMEX	-0,01209066	-0,742108985	1,143258	4,384739297	46,64%	0,074377703
BOS	-0,01315534	-1,236708034	0,3282	1,927902038	14,45%	0,048561865
MostalZab	-0,0192085	-0,418939719	0,676089	0,921390876	3,72%	0,209315974
DEBICA	0,02005032	1,248902292	0,604018	2,350924377	20,08%	0,073291483
KOGENERA	0,02913282	1,142143339	0,944086	2,312763581	19,56%	0,116445433
Sanok	0,03439219	1,242648119	1,656818	3,740630851	38,88%	0,126349111
KETY	0,01715928	1,072529593	1,060551	4,142126611	43,82%	0,073038246

ABG	-0,00453459	-0,121461404	0,155724	0,260637703	0,31%	0,170435525
PGF	0,01187079	0,937774254	0,865582	4,272762228	45,35%	0,057788558
CERSANIT	0,0166099	1,734889693	1,029645	6,720074389	67,24%	0,043707471
COMARCH	0,01716069	1,135043903	1,113791	4,603237122	49,06%	0,069021206
FORTISPL	0,03023027	1,364816088	0,408604	1,152699862	5,70%	0,101118
NORDEABP	0,0009145	0,030679992	1,008856	2,114854716	16,90%	0,136078957
GRAJEWO	0,04207938	1,537140556	1,018125	2,323951082	19,71%	0,124973049
ECHO	0,00134987	0,107095357	1,493264	7,402836437	71,35%	0,057541453
FARMACOL	0,01857239	0,661986013	0,580989	1,2939887	7,07%	0,128079461
IMPEXMET	0,0547986	1,734540679	1,683002	3,328751607	33,50%	0,144226663
DZPOLSKA	-0,00443791	-0,162610825	-0,08304	-0,19012729	0,16%	0,124591766
LPP	0,02419395	1,00441171	0,961607	2,494505883	22,05%	0,109965258
TUEUROPA	0,04147611	0,873844265	0,087137	0,114714977	0,06%	0,216682828
MOSTALWAR	-0,00421088	-0,129513706	0,122955	0,236304452	0,25%	0,148428661
ELDORADO	0,0189709	1,463195622	1,030262	4,965281715	52,84%	0,059189706
Kruszwica	0,02929921	0,795228131	3,089048	5,238925083	55,51%	0,16819952
STALPROD	0,05251235	1,709676688	1,491611	3,034518533	29,51%	0,140219376
POLIMEXMS	0,04832486	1,10956944	2,38466	3,421306207	34,73%	0,198827619
PROVIMROL	0,01277994	0,682874066	1,975318	6,595241832	66,41%	0,085437518
BORYSZEW	0,11196461	2,201327889	2,418233	2,970870747	28,63%	0,232196998
APATOR	0,07450046	2,73858811	0,288243	0,662076861	1,95%	0,124191762
STALEXP	0,00603471	0,179193542	1,470407	2,728256972	25,28%	0,153742681
VISTULA	0,11902179	2,351547159	0,761507	0,940119053	3,86%	0,231064566
GETIN	0,05194245	1,305056709	1,456096	2,28601281	19,19%	0,181699465
POLNORD	-0,02002534	-0,685013754	0,995175	2,127160872	17,06%	0,133456956
PROCHEM	0,03910985	1,16349633	0,912015	1,695362333	11,56%	0,153455225
POLLENAE	0,00713114	0,233848293	2,28774	4,687740137	49,97%	0,13921482
SWARZEDZ	0,02452178	0,462689668	2,000322	2,358410362	20,18%	0,241948416
MOSTALPLC	0,01395676	0,529576901	0,632039	1,498546491	9,26%	0,120314001
WANDALEX	0,02772858	0,700808497	0,816715	1,289805185	7,03%	0,180629561
EFEKT	0,01204844	0,485439102	1,151826	2,899829173	27,65%	0,113307006
UNIMIL	0,00580493	0,215971566	0,210482	0,489323463	1,08%	0,122704685
TIM	0,11559058	2,96996886	1,173861	1,884637975	13,90%	0,177676963
WISTIL	0,03938937	0,860839468	3,17881	4,340995805	46,14%	0,208889873
BEDZIN	0,04486702	1,214762525	1,492508	2,52500595	22,47%	0,168615085
WAWEL	0,05330277	3,140313934	0,568988	2,094633568	16,63%	0,077488508
PPWK	0,0116447	0,359556784	1,20272	2,320519553	19,66%	0,147850074
KABLE	0,05603673	0,974873856	2,576796	2,801156084	26,29%	0,26241275
MUZA	0,00302215	0,084188414	0,371835	0,647244639	1,87%	0,163879111
Interia.pl	0,01379732	0,379339741	2,1977	3,775579035	39,32%	0,166045472
RELPOL	0,01807594	1,14557224	1,31052	5,189755681	55,04%	0,072034225
MIESZKO	0,02512372	0,647041578	-0,21529	-0,346465639	0,54%	0,177260628
STRZELEC	-0,03593349	-1,156454391	1,094051	2,200130133	18,03%	0,141850677
FORTE	0,02763113	1,444168634	1,280515	4,182015753	44,29%	0,087345647
MCI	0,0581785	0,979079245	1,691976	1,779226328	12,58%	0,271272185
TALEX	0,00467348	0,166055385	0,692324	1,537104705	9,70%	0,128483673

INSTALKRK	0,02132924	0,607791374	1,008942	1,796498812	12,79%	0,160206939
WILBO	-0,0152632	-0,707658195	1,294234	3,74949082	38,99%	0,098465177
NOVITA	-0,00448294	-0,113568758	1,395827	2,209575748	18,16%	0,180204244
02NFI	0,03421448	1,496473207	0,484659	1,324575146	7,39%	0,104376219
INDYKPOL	0,05163745	1,096638701	0,293228	0,389122235	0,68%	0,214962048
ENERGOPN	0,03170855	0,518398856	0,341556	0,348924151	0,55%	0,279236976
05VICT	0,06830928	2,556235123	-0,06725	-0,1572479	0,11%	0,121994285
IRENA	-0,00890995	-0,529993955	0,670272	2,491312836	22,00%	0,07674763
CSS	-4,0516E-05	-0,003774193	0,701763	4,084743104	43,13%	0,049008141
01NFI	0,05387784	1,911177696	-0,07211	-0,15983473	0,12%	0,12869736
ELBUDOWA	0,01272171	0,483136166	0,918109	2,178711539	17,75%	0,120208874
Jutrzenka	0,01504774	0,869645489	1,032387	3,72816376	38,72%	0,078993199
06MAGNA	0,01278813	1,534722069	-0,08286	-0,621350207	1,72%	0,038039778
MENNICA	0,05706625	1,613968955	0,103378	0,182695381	0,15%	0,161415314
KROSNO	0,03129317	1,334836338	0,916795	2,443611721	21,35%	0,107024213
PROSPER	0,00476667	0,184993837	1,682573	4,080351567	43,08%	0,117630114
Jupiter	-0,00093946	-0,041221118	0,180827	0,495774543	1,10%	0,104044849
AMICA	-0,01337441	-0,449051499	0,734872	1,541753823	9,75%	0,135968712
04PRO	0,02744566	1,172970788	0,259414	0,692769878	2,13%	0,106818647
13FORTUNA	0,03094769	1,125388825	-0,15239	-0,346263328	0,54%	0,12554116
08OCTAVA	0,02956697	0,561170941	-0,00877	-0,010402793	0,00%	0,240531669
Ferrum	0,08949351	1,498303296	1,821445	1,90548673	14,17%	0,272679417
Groclin	0,00409295	0,251054777	0,760206	2,913703416	27,84%	0,074426619
LENTEX	0,00670479	0,31335325	0,880257	2,570635371	23,10%	0,097681263
MNI	0,04292678	0,977095098	0,95725	1,361493042	7,77%	0,200563589
Kopex	0,05222206	1,138777319	0,949339	1,293563759	7,07%	0,209351352
MostalExp	-0,01224054	-0,45349808	0,883359	2,045002712	15,97%	0,123221289
ELEKTRIM	0,04022567	1,000713289	0,807654	1,255490285	6,69%	0,183507636
Optimus	0,00066385	0,032103348	0,707452	2,137761136	17,20%	0,094401807

Table C.

Estimated stocks' betas in years 2004-2005

Stock Name	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
TPSA	-0,0102075	-0,912340514	1,489877	5,959140371	61,75%	0,049831313
PEKAO	-0,0041213	-0,488708798	1,357816	7,205338512	70,24%	0,037559716
PKNORLEN	0,01520069	1,510973728	1,286884	5,724356988	59,83%	0,044807255
BANKBPH	0,00738026	0,829024764	1,24333	6,249946517	63,97%	0,039650245
Millennium	0,00528098	0,350499525	1,503912	4,466724798	47,56%	0,067107148
Handlowy	0,0067192	0,536155871	0,469856	1,677767813	11,34%	0,055817234
INGBSK	0,0036159	0,319608442	0,741448	2,932763877	28,11%	0,050389442
BZWBK	-0,0025889	-0,281875049	1,503638	7,326119665	70,93%	0,040907694
AGORA	0,00099003	0,063185901	0,517924	1,479219111	9,05%	0,069786111
KGHM	-0,0031455	-0,168085293	1,520087	3,6350084	37,52%	0,08334866

Zywiec	0,00421609	0,628865336	0,013937	0,093029355	0,04%	0,02986027
BRE	0,00546251	0,482304638	0,955364	3,774782309	39,31%	0,050444375
KredytBank	-0,0026807	-0,215985317	1,204505	4,342902383	46,16%	0,055279511
Prokom	-0,0383682	-2,320245064	1,545452	4,182266284	44,29%	0,07365116
SWIECIE	-0,0197872	-1,530992594	0,020819	0,072084598	0,02%	0,057564194
ORBIS	-0,004788	-0,3365445	0,564144	1,774469425	12,52%	0,063366124
Netia	0,00234148	0,173138058	0,785237	2,598345012	23,48%	0,060233719
COMPLAND	-0,0144481	-0,908409038	0,715818	2,01403541	15,57%	0,070838796
BUDIMEX	-0,0035722	-0,177279444	0,237326	0,527065135	1,25%	0,089746407
BOS	-3,254E-06	-0,000216908	0,582399	1,737260965	12,06%	0,066817649
MostalZab	0,00729509	0,161226825	1,415962	1,400398978	8,18%	0,201527969
DEBICA	-0,0221741	-1,721652204	-0,17305	-0,601247069	1,62%	0,057364507
KOGENERA	0,02609041	0,855901881	0,382866	0,562061328	1,42%	0,13576845
Sanok	0,00856561	0,448983926	-0,03388	-0,079475077	0,03%	0,084970789
KETY	-0,01351	-0,953569814	0,551461	1,741829546	12,12%	0,063102232
ABG	-0,0437031	-1,540229767	1,098174	1,731962073	12,00%	0,126377168
PGF	0,0085248	0,6953241	0,375208	1,369523404	7,86%	0,054605781
CERSANIT	0,00786171	0,78617711	0,770737	3,44908196	35,10%	0,044538803
COMARCH	-0,002868	-0,214669392	0,496893	1,664344292	11,18%	0,059505303
FORTISPL	0,01596836	0,894613751	0,867858	2,175793795	17,71%	0,079499889
NORDEABP	-0,0058064	-0,243787992	0,486878	0,914788967	3,66%	0,106080377
GRAJEWO	0,02099942	1,30521091	0,255841	0,711603199	2,25%	0,071658633
ECHO	0,02306485	1,400915549	0,551916	1,500126652	9,28%	0,073329827
FARMACOL	0,00679678	0,537114717	0,662436	2,342615701	19,96%	0,056360939
IMPEXMET	0,02077546	0,830345831	0,426594	0,76298673	2,58%	0,111438055
DZPOLSKA	-0,0011622	-0,040168916	0,05883	0,090988593	0,04%	0,128868524
LPP	0,01111206	0,674831907	0,057526	0,156335983	0,11%	0,073340011
TUEUROPA	0,09718778	2,003436853	-1,47353	-1,359303271	7,75%	0,216061761
MOSTALWAR	-0,0245643	-0,706598429	1,356995	1,746788928	12,18%	0,154836565
ELDORADO	-0,0031215	-0,228181593	0,087942	0,287681773	0,37%	0,060928321
Kruszwica	-0,0001299	-0,006642652	-0,17542	-0,401286408	0,73%	0,087127074
STALPROD	0,04740871	1,569423816	0,298716	0,442521238	0,88%	0,134542591
POLIMEXMS	0,0784675	2,098704651	0,174183	0,208478076	0,20%	0,166525371
PROVIMROL	-0,0229635	-1,290921225	1,789447	4,501667018	47,95%	0,079228437
BORYSZEW	0,04602622	1,352900011	0,71496	0,940450886	3,86%	0,151524024
APATOR	0,04080896	2,05758587	1,368267	3,087217348	30,23%	0,08833635
STALEXP	-0,0159632	-0,548246876	0,785935	1,20791611	6,22%	0,129683709
VISTULA	0,07888854	2,380053818	0,650805	0,87865282	3,39%	0,147628112
GETIN	0,04364144	1,460835902	0,968121	1,450192183	8,73%	0,133057557
POLNORD	-0,0070226	-0,209796125	0,858431	1,147616931	5,65%	0,149088549
PROCHEM	0,05190024	1,541970876	0,48697	0,647444758	1,87%	0,149911559
POLLENAE	-0,0045963	-0,201413328	0,252034	0,494235343	1,10%	0,101638979
SWARZEDZ	-0,0348761	-0,69508096	3,399282	3,031714971	29,47%	0,223477839
MOSTALPLC	0,04284307	1,282846175	0,141266	0,189289558	0,16%	0,148746897
WANDALEX	0,00835192	0,274916116	0,585698	0,862743382	3,27%	0,135309435
EFEKT	0,01047602	0,39859894	0,840618	1,431306146	8,52%	0,117058224

UNIMIL	-0,0337471	-1,62863489	1,18124	2,551050609	22,83%	0,092289983
TIM	0,08336138	2,156686048	0,553891	0,641268615	1,83%	0,172155093
WISTIL	-0,0036424	-0,13774904	-0,73144	-1,237858487	6,51%	0,117772372
BEDZIN	-0,0310747	-1,491654371	0,798627	1,715531488	11,80%	0,092785737
WAWEL	0,05522293	2,879041884	-0,02667	-0,0622288	0,02%	0,085430584
PPWK	0,04532344	1,155102377	-0,47474	-0,54143276	1,31%	0,174760915
KABLE	0,02440859	0,463188959	0,180229	0,153050585	0,11%	0,234707186
MUZA	-0,0048775	-0,163410364	-0,33205	-0,497832426	1,11%	0,132940148
Interia.pl	0,00561603	0,151299775	2,029212	2,446412498	21,39%	0,165323022
RELPOL	-0,0079747	-0,488322094	-0,00936	-0,025646367	0,00%	0,072736436
MIESZKO	0,01646029	0,401244896	0,081319	0,088707439	0,04%	0,182713225
STRZELEC	-0,0704774	-2,961827336	2,289097	4,304946706	45,72%	0,105982014
FORTE	-0,0012281	-0,083254858	1,008072	3,058072872	29,83%	0,065702152
MCI	0,02292415	0,397232716	1,760044	1,364799829	7,81%	0,257033731
TALEX	-0,0094474	-0,34510768	0,168029	0,274676782	0,34%	0,121926487
INSTALKRK	-0,0067834	-0,287695504	1,462654	2,775994935	25,94%	0,10501672
WILBO	-0,0381645	-1,69342127	1,228228	2,438812926	21,28%	0,100377489
NOVITA	0,00111791	0,032865572	0,417162	0,548822935	1,35%	0,151498419
02NFI	0,05556575	2,482796469	0,129318	0,258574768	0,30%	0,099679994
INDYKPOL	0,0363811	0,73006957	1,069282	0,960228336	4,02%	0,221949167
ENERGOPN	-0,0016685	-0,060572802	1,255273	2,039295345	15,90%	0,122685635
05VICT	0,08597334	2,029522872	-1,27646	-1,348436518	7,63%	0,188673863
IRENA	-0,0144675	-1,07675117	-0,1506	-0,501581883	1,13%	0,05984374
CSS	-0,0215737	-1,720311665	0,885766	3,160782754	31,23%	0,055854727
01NFI	0,02714514	0,545724364	-0,2729	-0,245513994	0,27%	0,221544319
ELBUDOWA	0,01065248	0,419742577	1,483978	2,616698068	23,74%	0,113034108
Jutrzenka	0,03318948	1,176966425	0,578765	0,918458429	3,69%	0,1255967
06MAGNA	0,01576881	1,226797136	-0,23258	-0,80974428	2,89%	0,057249005
MENNICA	0,06216976	1,84180358	-0,94941	-1,258662798	6,72%	0,150341123
KROSNO	0,00674077	0,319378632	-0,2825	-0,598977644	1,60%	0,094003895
PROSPER	-0,0383572	-2,38357467	1,006052	2,797671532	26,24%	0,071673657
Jupiter	0,02315263	0,809587658	-0,71374	-1,116850041	5,37%	0,127373278
AMICA	-0,0225956	-0,948343412	0,654428	1,229125751	6,43%	0,106120907
04PRO	0,05573042	2,277918553	0,308282	0,563881848	1,42%	0,108967261
13FORTUNA	0,00503047	0,124125246	0,830989	0,917572878	3,69%	0,180505512
08OCTAVA	-0,0014219	-0,074200556	-0,03679	-0,085907867	0,03%	0,085349862
Ferrum	0,02748947	0,667975495	1,202082	1,307139139	7,21%	0,183293812
Groclin	-0,027909	-1,397535033	0,467792	1,048250156	4,76%	0,088945425
LENTEX	-0,0319421	-1,458923933	0,61936	1,265920371	6,79%	0,097515289
MNI	0,02278866	0,958185777	1,008713	1,897983023	14,07%	0,105928054
Kopex	-0,0163809	-0,887679986	1,304678	3,163842315	31,27%	0,082191001
MostalExp	-0,0118077	-0,551569689	1,45501	3,041561194	29,60%	0,095346589
ELEKTRIM	-0,0018781	-0,044462994	0,649462	0,688062032	2,11%	0,188131647
Optimus	-0,0228697	-1,060672231	0,85693	1,778528347	12,57%	0,096032948

Table D

Estimated portfolios' betas

Portfolio	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
1	0,00711128	0,586059139	0,567484	2,366031708	14,14%	0,066802062
2	0,02119043	2,810924083	0,628821	4,219971712	34,37%	0,041502513
3	0,03073911	2,306986866	0,563046	2,137818999	11,85%	0,073355029
4	0,01204183	1,074322935	0,731949	3,303668679	24,30%	0,061708006
5	0,0061135	0,846217867	0,799905	5,601491311	47,99%	0,039773299
6	0,03223986	3,13327202	0,649953	3,195656202	23,10%	0,056647247
7	0,01023921	0,814962804	0,806912	3,249159847	23,69%	0,069169129
8	0,01413547	1,44545781	0,834141	4,315267428	35,39%	0,053837948
9	0,02509914	2,193205355	1,010285	4,466194711	36,98%	0,06300328
10	0,00856639	0,760101037	0,864074	3,878804099	30,68%	0,062045454

Appendix C

Table A

Estimated stocks' betas in years 2002-2003

Stock Name	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
06MAGNA	0,00557532	0,477773581	-0,35713	-2,359383028	20,19%	0,056209535
SWIECIE	0,04837366	2,56376462	-0,21238	-0,867746282	3,31%	0,090885183
INDYKPOL	-0,0083785	-0,427014147	-0,11145	-0,437891964	0,86%	0,094512092
ABG	0,01760185	0,615374952	-0,09412	-0,253671164	0,29%	0,137778261
MOSTALWAR	0,02239953	0,956180025	-0,00674	-0,022194203	0,00%	0,112839591
Jupiter	-0,0120073	-0,997880264	0,016271	0,104246494	0,05%	0,057960347
13FORTUNA	-0,0120073	-0,997880264	0,016271	0,104246494	0,05%	0,057960347
AMICA	0,03896732	0,802853307	0,032892	0,052245243	0,01%	0,233790349
08OCTAVA	0,03896732	0,802853307	0,032892	0,052245243	0,01%	0,233790349
MIESZKO	0,00271491	0,200938542	0,038992	0,2224827	0,22%	0,065080986
05VICT	0,00446355	0,25954491	0,053908	0,241658392	0,26%	0,08283804
01NFI	0,0009608	0,083960296	0,104489	0,703925698	2,20%	0,05512181
04PRO	-0,0107487	-0,788572372	0,107535	0,608210489	1,65%	0,065656236
FORTISPL	0,04618648	1,707217426	0,115111	0,328026125	0,49%	0,130313158
UNIMIL	0,04425335	1,727327356	0,119246	0,358831033	0,58%	0,123405278
APATOR	0,07564299	2,563602377	0,14488	0,378535039	0,65%	0,142128209
02NFI	0,01050399	0,52467696	0,145875	0,561741711	1,41%	0,096432774
TUEUROPA	0,00671589	0,33125144	0,198972	0,756594938	2,54%	0,097658025
MUZA	-0,0326303	-0,889272935	0,244348	0,513380464	1,18%	0,176745693
ENERGOPN	-0,0256893	-0,411421987	0,266323	0,328822084	0,49%	0,300764413
INGBSK	-0,0035632	-0,236906876	0,328487	1,683741858	11,42%	0,072447183
MENNICA	-0,0133148	-0,72948797	0,393807	1,663352356	11,17%	0,087918078
KredytBank	-0,0420972	-2,580045749	0,396111	1,871580292	13,74%	0,078593714
BOS	-0,0101984	-0,650011956	0,409238	2,010866646	15,53%	0,075574022
IRENA	-0,0054757	-0,321340765	0,411179	1,860272489	13,59%	0,082079244
MostalZab	-0,0480682	-0,994660593	0,444439	0,708999862	2,23%	0,232779973
NORDEABP	0,01486785	0,480672549	0,493443	1,229859342	6,43%	0,148991373
Optimus	-0,0330435	-1,298098341	0,513813	1,556122796	9,92%	0,122614231
WAWEL	0,01825942	1,178317457	0,554506	2,758664411	25,70%	0,074642632
STRZELEC	-0,0168426	-0,639780464	0,570652	1,671133764	11,26%	0,126805802
ELDORADO	0,01974307	1,212638738	0,576416	2,729417916	25,30%	0,078423386
Handlowy	-0,0134269	-1,122066542	0,58258	3,753318239	39,04%	0,057639455
POLNORD	-0,0155881	-0,654779314	0,585155	1,894914562	14,03%	0,114672895
GRAJEWO	0,04381201	1,557831411	0,604115	1,656014731	11,08%	0,135467463
PROCHEM	0,00786554	0,454904112	0,612163	2,729454919	25,30%	0,083285773
NOVITA	-0,0268547	-0,688834272	0,613008	1,212210739	6,26%	0,187787748
CSS	-0,0181948	-0,751013092	0,62831	1,999363351	15,38%	0,11669755
MOSTALPLC	-0,0135991	-1,213042443	0,630397	4,335070789	46,07%	0,054000404
Zywiec	0,01754328	1,327349144	0,635086	3,704454263	38,41%	0,063663127

Kopex	0,07046021	1,448979325	0,694345	1,100806464	5,22%	0,23423081
PGF	0,00052356	0,037756644	0,695767	3,868188586	40,48%	0,066793735
COMPLAND	-0,0160206	-0,886681142	0,70395	3,003631125	29,08%	0,087031145
DZPOLSKA	-0,0228277	-0,749421414	0,7105	1,798233342	12,81%	0,146722802
ELBUDOWA	-0,0145036	-0,814857276	0,718448	3,111842473	30,56%	0,085734809
DEBICA	0,0501957	3,966818669	0,72798	4,435194421	47,21%	0,060951788
INSTALKRK	-0,0155296	-0,385394162	0,72919	1,39508839	8,13%	0,194096721
KROSNO	0,0173813	0,817015927	0,735526	2,665405211	24,41%	0,102474067
EFEKT	-0,0397053	-1,205158061	0,750577	1,756337983	12,30%	0,158696258
FORTE	0,05114381	2,394636755	0,782058	2,822946682	26,59%	0,102876382
FARMACOL	0,01624264	0,616556919	0,789847	2,311408672	19,54%	0,12689536
ECHO	0,01498965	0,81431305	0,825627	3,457807868	35,21%	0,088667062
KETY	0,03405852	2,333996076	0,838511	4,429965666	47,15%	0,070289085
STALPROD	0,03110743	1,124880148	0,843924	2,352678574	20,10%	0,133204864
PKNORLEN	0,00554079	0,470743604	0,857556	5,6168453	58,92%	0,056695597
Millennium	-0,0157355	-0,86172866	0,872324	3,682868995	38,14%	0,087957139
VISTULA	-0,0038037	-0,079222541	0,899844	1,444862982	8,67%	0,231270311
PEKAO	-0,0087108	-0,904751672	0,911019	7,294841777	70,75%	0,046375735
WANDALEX	-0,0046676	-0,140118717	0,916837	2,121839105	16,99%	0,16045716
BZWBK	0,00323209	0,290774148	0,923973	6,408394582	65,12%	0,053541372
CERSANIT	-0,0181795	-0,450845127	0,926575	1,771509234	12,48%	0,194230134
Groclin	0,06523062	3,181623874	0,927042	3,485889738	35,58%	0,098756322
LPP	0,08288062	3,083925225	0,937118	2,68820513	24,73%	0,129452792
BEDZIN	0,06035558	1,386868133	0,937418	1,66061213	11,14%	0,209625682
AGORA	-0,0063962	-0,39226719	0,950881	4,495771266	47,88%	0,07854189
RELPOL	0,01016489	0,544033474	0,955428	3,942191652	41,40%	0,08999938
KOGENERA	-0,03392	-1,218274482	0,967392	2,678608709	24,59%	0,134113484
LENTEX	0,00756476	0,35858497	0,986262	3,604181407	37,13%	0,101616702
TPSA	-0,0114564	-0,870692717	1,035187	6,065323239	62,58%	0,063378814
Sanok	0,05045679	1,862876523	1,073967	3,056838016	29,81%	0,130466147
Jutrzenka	0,00898665	0,594372168	1,077771	5,495458029	57,85%	0,072828577
TALEX	0,01889623	0,698333382	1,099022	3,131203635	30,83%	0,130339062
WILBO	-0,0149071	-0,852542478	1,126524	4,966857061	52,86%	0,084224428
BUDIMEX	-0,0003591	-0,026710222	1,143863	6,558534094	66,16%	0,064765904
ELEKTRIM	-0,0454936	-1,251935919	1,186031	2,516198326	22,35%	0,175037296
Ferrum	0,02052366	0,355216814	1,196658	1,596709847	10,39%	0,278306574
COMARCH	-0,0071511	-0,433811056	1,238731	5,793209134	60,40%	0,07940307
PPWK	-0,0531767	-1,297815692	1,25537	2,362001978	20,23%	0,197365271
BANKBPH	0,00137457	0,099766499	1,291887	7,228702294	70,37%	0,066365707
PROVIMROL	0,04300335	2,052298455	1,315758	4,840958513	51,58%	0,100930867
KGHM	0,01954785	1,212122621	1,331276	6,364038561	64,80%	0,077680982
Prokom	0,00444901	0,262483053	1,344235	6,114069475	62,95%	0,081643981
BRE	-0,0210396	-1,008358316	1,346387	4,974676659	52,94%	0,100504237
TIM	0,01850671	0,638634917	1,372733	3,651965024	37,74%	0,139585033
MostalExp	-0,0373688	-0,974535258	1,399442	2,813590041	26,46%	0,184702771
MCI	-0,0156977	-0,495193571	1,44359	3,510742593	35,91%	0,152694805

PROSPER	-0,0097629	-0,334172494	1,52825	4,032770974	42,50%	0,140724698
BORYSZEW	0,11805953	2,44632209	1,537917	2,456759907	21,53%	0,232460772
POLLENAE	-0,0102319	-0,337492818	1,60607	4,084039741	43,12%	0,146034003
STALEXP	-0,0254055	-0,853897985	1,624344	4,208953202	44,61%	0,143312278
ORBIS	0,00246263	0,134697806	1,636691	6,901521391	68,40%	0,088064575
MNI	-0,0851334	-1,607756085	1,71336	2,494512688	22,05%	0,255059901
SWARZEDZ	-0,0296098	-0,800689875	1,760399	3,669924346	37,97%	0,178128479
Interia.pl	0,00638962	0,202436448	1,766368	4,314313074	45,83%	0,152036847
WISTIL	0,09238486	1,785445987	1,772635	2,641084612	24,07%	0,249239182
IMPEXMET	0,02657942	0,774512592	1,909953	4,290648467	45,56%	0,165302422
Netia	-0,0091304	-0,168531945	1,936732	2,756007853	25,66%	0,260956692
POLIMEXMS	0,00705509	0,223106946	2,003782	4,885151662	52,03%	0,152318204
GETIN	0,01846817	0,408285712	2,060134	3,51117895	35,91%	0,217882249
Kruszwica	0,05311032	1,419785422	2,254531	4,646405654	49,53%	0,180184912
KABLE	-0,0023689	-0,05321078	2,26787	3,927287322	41,21%	0,214439542

Table B

Portfolios' estimated betas

Portfolio	Intercept	t-value Intercept	Beta	t-value Beta	R-Square	Regressions Standard Error
1	-0,0071809	-0,45623182	0,662537	1,883688044	13,89%	0,07010307
2	0,02663747	1,383898411	-0,13477	-0,313320587	0,44%	0,085729571
3	0,02686528	2,075498819	0,770993	2,665479336	24,41%	0,057651521
4	0,02348207	1,783977304	-0,10452	-0,355337145	0,57%	0,058625814
5	0,01046269	0,939069176	0,420572	1,689228555	11,48%	0,049623535
6	-0,0133052	-1,146325573	0,852132	3,28538441	32,91%	0,051695935
7	0,01389495	1,163174599	0,431808	1,617604327	10,63%	0,053205203
8	0,00204448	0,164194534	0,552562	1,985868166	15,20%	0,055458258
9	-0,0037214	-0,385349194	0,492158	2,280559496	19,12%	0,043012883
10	0,0032004	0,379413123	0,738256	3,916594415	41,08%	0,037569364
11	0,01548905	1,938017988	0,838578	4,695373645	50,05%	0,035596622
12	0,0176784	1,641182898	0,973739	4,045297198	42,66%	0,047976415
13	-0,0109713	-1,31626553	0,366502	1,967688488	14,97%	0,037124079
14	0,00513919	0,44218482	0,607397	2,338706416	19,91%	0,051764588
15	-0,0051145	-0,245646493	0,697025	1,498121537	9,26%	0,092733632
16	0,00474533	0,482955006	0,915004	4,167322246	44,12%	0,043762445
17	0,01231443	0,737941041	1,253952	3,362652078	33,95%	0,074324968
18	-0,0035357	-0,283565333	0,664625	2,385335104	20,55%	0,055534513
19	0,00213233	0,117082388	1,226472	3,013626231	29,22%	0,08111552
20	0,02974581	1,658822757	0,386471	0,964460181	4,06%	0,079867074