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Karol Hochschorner

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Univ.-Prof. Dipl.-Vw. Thomas Gehrig, PhD

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Abstract English:

This master thesis covers the arbitrage-free market theories and their inconsistencies with the real stock market. It shows the difference between theory and reality and states that the risk-free profit opportunities arise under specific circumstances. Further it describes the various types of stock market arbitrage opportunities and the reasons why they occur. The master thesis states that even though the law of one price might be violated it is not always risk-free to take advantage of it. Subsequently, the challenges and risk which every arbitrageur has to face are defined. In the final chapter, all empirically gathered information are applied into practice.

Abstract deutsch:

Diese Masterarbeit behandelt die arbitragefreien Markttheorien und ihre Unstimmigkeiten mit realen Aktienmärkten. Sie stellt den Unterschied zwischen Theorie und Realität dar und zeigt, dass risikolose Gewinnmöglichkeiten unter bestimmten Umständen auftreten. Außerdem beschreibt sie die verschiedenen Arten von Arbitragemöglichkeiten an Börsen und erörtert die Gründe, warum sie auftreten. Die Masterarbeit zeigt, dass die Vorteile, die aus der Verletzung des Gesetzes der Unterschiedslosigkeit der Preise resultieren, nicht immer risikolos sind. Die nächsten Kapitel definieren die Herausforderungen und Risiken, die jeder Arbitrageur nehmen muss. Am Ende sind alle empirisch gesammelten Informationen in der Praxis angewandt.

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List of abbreviations

AIG	American International Group
CAPM	Capital Asset Pricing Model
CDF	Credit default swap
CRSP	Center for Research in Security Prices
GDP	Gross domestic product
IPO	Initial Public Offering

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1. Introduction

The modern financial world is based on Efficient Market Theory. According to this theory markets are efficient, all securities are correctly priced, investors are rational, no mispricing of securities from their fair values can happen. If such price distortion occurs the market participants would immediately take advantage of it by buying the cheaper security or selling the more expensive one. They would do this with indefinite amount of capital until they drag the price back to its fair value since the profit is risk free (Fama (1965)). Contrary to the Efficient Market Theory there are signs that the prices do not always reflect the fair value. There are investors earning abnormal returns, hedge funds specializing on price discrepancies, famous stock market crashes and securities with the same risks and cash flows selling for different prices. The arbitrage opportunities arise because investors form different beliefs and they do not always act rationally but sometimes they follow the crowd. The final price of any security is the result of a battle between noise traders and rational investors (Campbell and Kyle (1988) and Daniel, Hirshleifer and Subrahmanyam (2001)). Benjamin Graham (2003) wrote that in the short run the prices can deviate from their fair value but in the long run they always equal the fundamental value. A rational investor should buy undervalued security and wait for the market to realize the true value.

Even though the prices might not equal the fair value, in the real world the rational investors cannot always take advantage of the discrepancy because of various costs and risks which do not exist in the ideal world of efficient markets (Shleifer and Vishny (1997)). Before any purchase all investors have to calculate with transaction and holding costs, with liquidity, execution and counterparty risk. All these variables make even a theoretical profitable trade a possible losing trade.

This paper is divided in 7 sections. The first section briefly describes the different market theories and the concept of arbitrage. The second section discusses the importance and possible benefits of arbitrage. The next four sections lay out the reasons for arbitrage, different types of arbitrage as well as the risks and costs connected to arbitrage. The last section describes the practical use of arbitrage strategy and shows that investors do not need to have special knowledge, abilities or better information than average market participants.

2. What is Arbitrage?

The term arbitrage was first defined by Mathieu de la Porte (1770) in his paper “La science des négocians et teneurs de livres”. He wrote about the most profitable places for issuing a bill in response to differences in exchange rates.

There are two main theories about the market efficiency. The first one represented for example by Friedman, Fama, Sharpe and Ross who believe that the markets are efficient and arbitrage is not possible because the investors would immediately recognize the risk free profit and they would drag the price back to its fundamental value. Fama (1970) described efficient market as markets in which prices in each point in time reflect all available information. Because all available information are already reflected in the prices no extra return or arbitrage is possible. There are three forms of market efficiency: Weak form efficiency, Semi-strong form efficiency and Strong form efficiency.

- Weak form efficiency assumes that the market reflects all historical price information in the security price. Fama (1965) showed on an empirical study that this form of efficiency holds.
- Semi-strong market efficiency assumes that the security price reflects all publicly available information. This includes also fundamental data and economic indicators.
- Strong market efficiency states that the security price reflects all public and also private information. This form is the strongest out of the three forms and under its conditions no investor can make additional profit.

The second theory is represented by Keynes (1936) who described the price of the asset as the final number of supply and demand, which are influenced by psychology of the masses.

According to Randal Billingsley (2005) arbitrage in stock market “*is the process of buying assets in one market and selling them in another to profit from unjustifiable price differences*”.¹ In this process there is no risk involved and the investor does not trade with his own money. He sells the more expensive security and buys the cheaper

¹ Billingsley (2005), pp. 2

security. The price difference is his profit which has to be higher than the risk-free rate of return. In his paper he described the Law of One Price as “*the same thing sells for the same price*”². Securities with the same risk and return have to have the same price otherwise the law of one price would be violated. In such case when the law of one price is violated the market participants would buy the cheaper security and sell the more expensive one. They will do this until the prices will equal. This theory holds when there are no transaction and holding costs or trading constraints because the investors can drag the price back to its non arbitrary level with no costs or barriers. In case there are additional cost connected with arbitrage Fama (1991) wrote that “*deviations from the extreme version of the efficiency hypothesis are within information and trading costs*”³. By having costs of trading the law of one price can be violated but because there are the additional costs no risk-free profit can be made and the efficient market hypothesis holds.

² Billingsley (2005), pp. 3

³ Fama (1991), pp. 1577

3. Importance of arbitrage

Arbitraders have a very important role in the financial markets. Peter L. Bernstein (1992) described arbitraders as “*Arbitraders keep the market honest. They bring perfection to imperfect markets as their hunger for free lunches prompts them to bid away the discrepancies that attract them to the lunch counter. In the process, they make certain that prices for the same assets in different markets will be identical*”⁴.

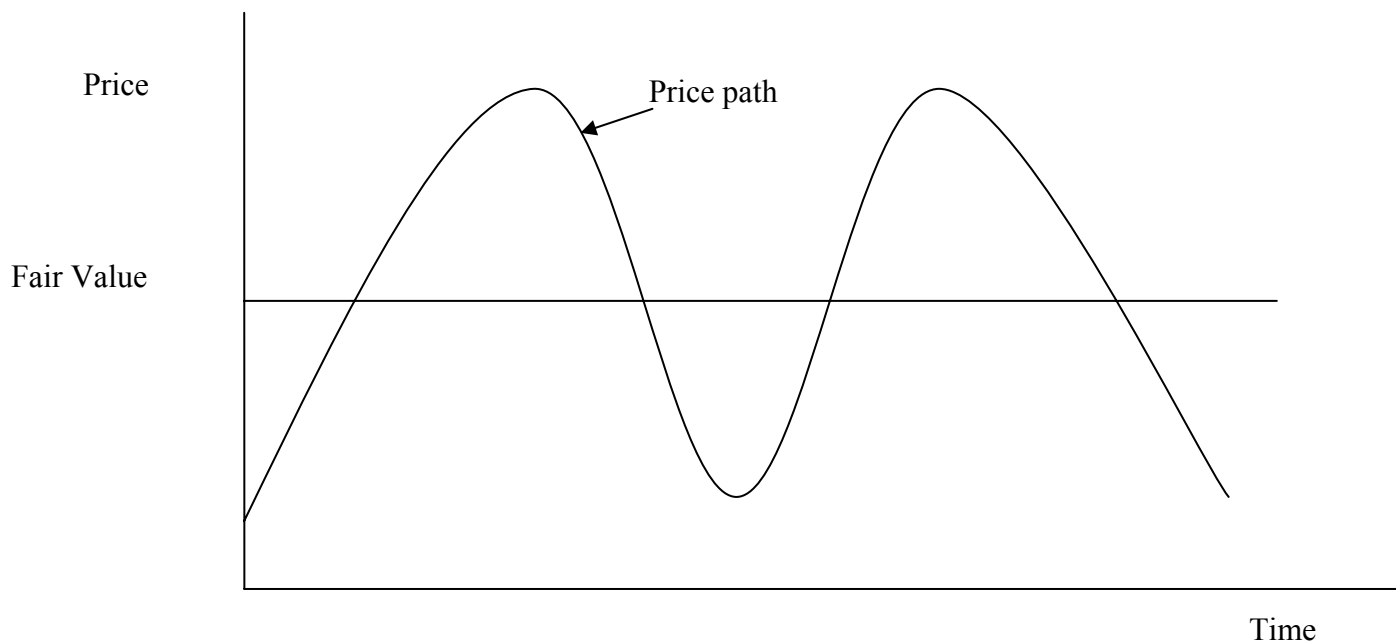


Figure I - Hypothetical mispricing process in the absence of arbitraders
(Source: Pontiff (2006))

This graph shows the hypothetical price path of a stock. The middle line is the fair value and the curve is the theoretical price path. In reality the fair value of securities are more or less constant but the noise traders push or pull the price above or under this price what creates opportunities for arbitraders. Arbitraders do not allow the price to deviate too much from the fair value. With the help of arbitraders the prices of securities usually move very close to their real value. This makes the markets much more efficient and an average market participant can trade securities without being worried that he is paying too much for the stock.

⁴ Bernstein (1992)

On the other hand arbitrage can be also harmful. Glen Weyl (2007) wrote about cases where the arbitrage benefits from the mis-beliefs of traders. In such cases the arbitrage represents the intermediary between buyer and seller. The arbitrage buys the security cheaply from the seller and sells it more expensive to the buyer. By doing this the arbitrage inefficiently allocates risk to the buying and selling party and causes harm to them because he creates additional risk.

One of the big advantages of arbitrage is that the returns are uncorrelated with the general market. The arbitrage makes profit even in market downturns when other investors are losing money.

4. Why does arbitrage happen

Fama's (1970) Capital Asset Pricing Model counts with investor's rationality. But Gilovich, Griffin and Kahneman (2002) pointed out that investors are not always rational and their decisions are sometimes biased by various factors.

4.1. Psychology

Markets are efficient if all investors are rational. But the rationality can be influenced by psychological bias. When the rational investor's judgment is influenced by psychology they can easily become irrational. Rational investor make smart and profit maximizing decisions opposite to irrational investors who base their decision on current needs and beliefs. There are five ways how people form their beliefs (Gilovich, Griffin and Kahneman (2002)).

➤ **Overconfidence:** Investors are usually too much confident and they believe their analysis much more than they should. At least the empirical studies show that there are times when they are wrong. Montier (2006) wrote about the overconfidence of professional money managers. Out of 300 money managers participating on the study almost 100% stated that their work performance was equal or above average. In reality this is of course not possible because not everybody can be above average. The overconfidence bias makes people believe that their judgment is better than the general public and when the price of the security moves against them they make irrational decisions.

➤ **Optimism and wishful thinking:** Traders sometimes believe in what they want to happen and not what is most likely to happen. They do not listen to rational opinions because it might have a bad outcome.

➤ **Representativeness:** This psychological bias arises when people base their decisions on past results. They believe that when something has happened in the past the same thing will happen in the future.

➤ **Conservatism:** Investors put more value on recent information even though the new information may not be as relevant as the old ones. Bondt and Thaler (1985)

described how investors overreact to new information. They are too pessimistic when bad information is announced and overoptimistic when good information is announced.

➤ Belief perseverance: After the investors form an opinion about some security they tend to hold to their belief. They do not change the opinion even when there is evidence or new information that they were wrong. This psychological bias reduces the investors profit because they hold the losing stocks too long.

4.2. Noise traders

One of the first people who divided market participants in two basic groups was Benjamin Graham (2003). According to him there are investors and speculators. Investors base their decisions on a deep research and on fundamental value of the underlying asset. Today they are called rational traders or arbitragers. On the other hand the speculators try to profit from the price moves without knowing the fundamental value of the underlying asset. They buy the securities for irrational reasons, they use techniques as technical analysis, they listen to advices from their brokers or other market predictors and they generally go with the crowd. Going with the crowd means buying when prices are going up and selling when prices go down. By doing this they believe that they are able to capture the potential upside profit and their downside risk is limited. The speculators are nowadays called noise traders.

Friedman (1953) and Fama (1965) argued that noise trader behavior is irrelevant because the influence of the irrational traders is offset by rational investors who drag the prices back to fundamental values. Friedman argued that the irrational traders on average lose money since they sell low and buy high. Losses would diminish them from the market in favor of rational investors. However there are economists who argue that noise traders have a great influence on price. They argued that the prices reflect together with fundamental value also the noise trader believes. The greater are the price moves the more they attract noise traders and the more money they invest in it. Even though the irrational traders mostly operate with small capital there is a big number of them. *“Noise in the sense of a large number of small events is often a causal factor much more powerful than a small number of large events can be”* (Black (1986))⁵. By putting

⁵ Black (1986), pp. 529

there too much money they can move the price very far from its fundamental value. The influence and amount of money they invest in a particular security is cumulative. The more the price of the security moves the more money are the noise traders willing to invest and the more widens the market price from its fundamental value. Flynn (2005) showed on an empirical study during 1985-2001 on close end funds the relationship between the close-end fund's discount/premium and the trading volume. The figure below shows on the x-axis the discount or premium in percentage and the y-axis shows the percentage trading volume of all shares outstanding. The evidence shows that the more were the prices divergent from net asset value the higher was the trading volume. It did not matter whether the close-end funds were selling for discount or premium. The price trend was the key factor which has attracted the noise trading investors.

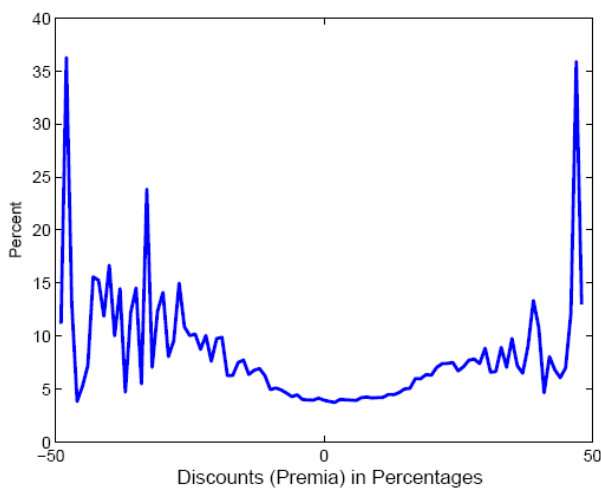


Figure II - Trading volume to discount/premium on close-end funds
(Source: Flynn (2005))

Because of the irrationality the noise trader's behavior is unpredictable and it is very difficult for rational investors to forecast the possible future scenarios. The level of their influence is also very difficult to calculate for economists and Black (1986) wrote that results of their various models are biased to unknown extend by noise traders.

Noise traders also might earn higher profit than rational investors (De Long, Shleifer, Summers and Waldmann (1990)). The higher return could be achieved by noise traders because they buy the securities at fundamental levels but drive the prices higher than their fair value. Every rational investor would expect the prices to fall back but the securities might be overpriced for a long period of time until the fair values catch up the market values. In such case the prices would not change and just the fair values would

increase. The noise trader would participate in all the uptrend but the rational investor would have to wait until the market price equals its fundamental value.

Even though noise traders may cause market inefficiencies they are very important for the overall functioning of stock exchanges. They are providers of liquidity because they invest under all possible conditions also in situations when it is more profitable not to trade.

4.3. Overreaction

Overreaction is the tendency of inappropriate and unreasonable reaction of investors on new information. When investors react excessively to new information they create price distortions from its fundamental value. Investors like companies with positive new information. They buy such shares regardless of the stock price and its fundamental value. On the other hand they do not want to hold companies with pessimistic future forecasts and bad new information. In both cases there is a market distortion and arbitrage opportunity arises. Bondt and Thaler (1985) demonstrated that investors act inappropriately to new information and that they want to hold the winners and sell the losers on an empirical study. The study was done during 1933-1980. At the end of each year they formed two portfolios. The first one, the winner portfolio, consisted out of 50 best performing stocks on the New York stock exchange and the second, the loser portfolio, consisted out of 50 worst performing stocks. The returns of both portfolios were tracked for next 35 months from their creation and then all portfolio returns were averaged for the final result. The results of the study are shown on the figure below. The left y-axis shows the cumulative average return and the x-axis shows number of month after the portfolio was created. The loser portfolio clearly outperformed the winner portfolio which supports the theory that investors overreact to new information. After 35 months after creation the loser portfolio outperformed the market by 19,6% and the winner portfolio underperformed the market by 5%. The total difference in returns between both portfolios was 24,6%. This also shows that the reaction on negative information is much more inappropriate and that there are more arbitrage opportunities from the loser portfolio stocks.

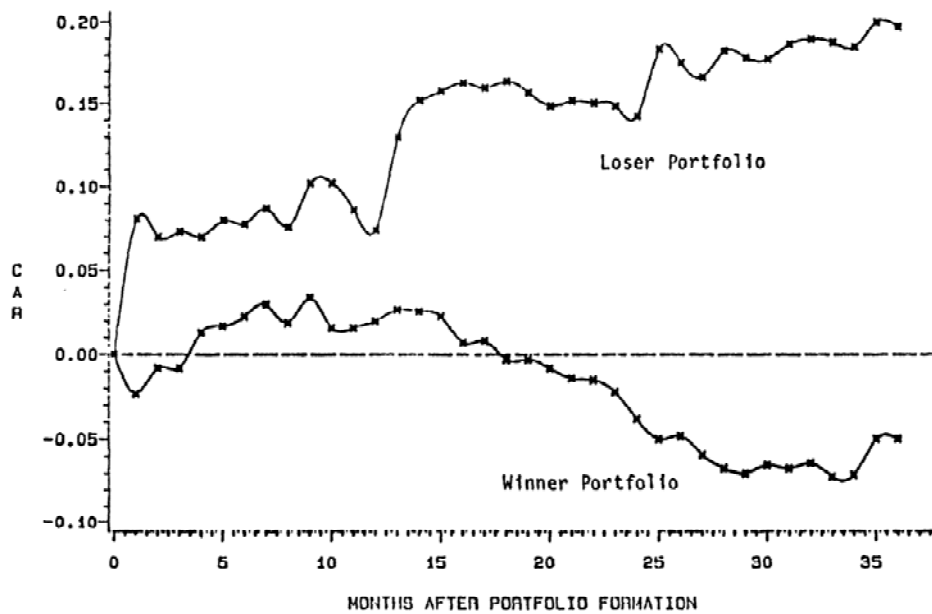


Figure III - Average return of Loser Portfolio vs. Winner Portfolio
 (Source: Bondt and Thaler (1985))

The excess return of loser portfolio can be also explained by higher beta and therefore the CAPM would hold (Chan (1986)). Since the stock values in the loser portfolio has decreased in theory they are much more leveraged and therefore should be more volatile than the other portfolio. But the evidence showed opposite result. Betas of the portfolios used in the study were 1,026 for the loser portfolio and 1,369 for the winner portfolio. By the CAPM the loser portfolio had higher return with lower risk compared to winner portfolio. Bondt and Thaler (1987) pointed out that the biggest gains of the loser portfolio were always in January every year. This may be because of the tax code and investors consolidation of taxes. They lock in capital gain tax by the winning portfolio and sell the losing because of deductible tax loss.

5. Types of arbitrage

There are different types of arbitrage based on the segment of the financial market and the way the securities are traded (Billingsley (2005)).

5.1. Merger arbitrage

Merger arbitrage arises when two or more companies announce a merger or acquisition. The arbitrageurs do not invest when there are just rumors that a merger might occur but instead when the offer is officially announced. Normally the price of the target company is lower than the price which the other company offers because of opportunity cost of money and the chance of failure. This spread between actual and offered price is the arbitrageur's potential profit. The profit is not sure because the merger might not occur or it might take longer time. On the other hand the profit might be even higher if more companies are interested in buying the target firm. In such case the buying companies compete against each other and try to give higher price than the other bidder. The dividends from the target company are also added to arbitrageur's profit.

In case the acquirer offers cash for the target company it is a cash merger and the arbitrageur buys the target company and waits until the price will equal the acquirer's price. The second option how a company can acquire another company is by offering its own shares. This type is called stock merger and there are two types of such merger. The first one is fixed exchange ratio stock merger and the second is floating exchange ratio stock merger. By fixed exchange ratio stock merger the acquiring company buys the target company for a pre defined fixed number of shares. If there is any arbitrage opportunity the arbitrageur would buy the target company's shares and sell the shares of the buying company by the right proportion. For short selling the big financial institutions typically receive risk free rate return which adds to their overall profit. By floating exchange ratio stock merger the acquiring company buys the target company for a pre defined value in its own shares. This means that the number of shares can change but the value stays. During the time when the two companies agree on the merger the share price of the target company is usually constant and near to the agreed

value. The arbitrageur buys shares of the target company and when the merger occurs he would receive unknown number of shares of the buying firm which he can sell and receive cash.

5.1.1. Risks connected to merger arbitrage

By merger arbitrage the arbitrageur has to consider two risks and both of them come out of the return formula. The return is calculated with a simple formula (Baker and Savasoglu (2002)).

$$r = \pi * r_s + (1 - \pi) * r_w$$

Where:

r = total return on arbitrage

r_s = return in case of successful merger

r_w = return in case the merger fails

π = probability of a successful merger

The return in case of successful merger is known because the investor knows for how much he is buying the shares and how much the acquiring firm has offered. The unknown variables are return in case the merger fails and the probability of successful merger. The return in case the merger fails can differ substantially and the failure mostly results in a loss for the arbitrageur.

➤ The price of the target company can come back to the level where it was before the offer of the acquiring company. In this case the arbitrageur would lose money on such trade because he bought it for the price adjusted to the offer.

➤ He would also lose money when the price would end up lower than the pre-offer price. Such scenario can occur when some new negative information come up about the company.

➤ In case the investors would be more optimistic or new positive information would be revealed the share price can end up higher than the pre-offer level. If the price stays higher than the pre-offer level but lower than the price for which the arbitrageur has bought it then he loses money. If the price stays on or about the level where the

arbitrager bought the shares then the arbitrager does not lose money even in case the merger is not realized.

The second unknown variable and the biggest risk for the arbitrager is the probability of the merger to succeed. There are many studies which calculated the probability based on the past result. One of the biggest samples was done by Bruno (2010). He examined 8137 merger deals between 1997-2009 around the world. The number of completed merger deals was 6 789 what is 83%. According to Koch and Sjöström (2003) there are variables which influence the probability of a successful merger.

- The bid premium which the acquiring company offers to the target company's shareholder. Owners of the target company are more willing to sell the company for higher premiums hence the higher is the premium the greater is the likelihood the merger will be successful.
- Reaction of the board has a huge impact on the ultimate result of the merger. The board can give recommendations to shareholders if the merger is in their interest or not. The reaction of the board is significantly correlated with the success of the merger.
- Shleifer and Vishny (1986) wrote about the significant effect of large shareholder in the target company. The large shareholder must be willing to make the merger and the larger is the biggest stockholder the greater is the possibility of the merger.
- On the other hand if the potential acquirer has any stake in the target company this does not increase the chances of a successful arbitrage even though the acquirer can influence to a certain extend decisions of the board.
- Hostile management can have a negative effect on the success of the merger (Jindra and Walkling (2004)). Management which wants to keep its job at any cost might baffle the merger even at the cost of shareholder who would be better off if the merger would occur.

The opportunity cost of money risk is not relevant for merger arbitrage because it can be easily calculated since the terms and date of the acquisition are mostly known. The investor knows the most important variables and he can conservatively guess the unknown variables based on historical data.

5.1.2. Return on merger arbitrage

After the investor has all the data he has to find merger opportunities which have spread between the actual and offered price wide enough. The historical data show that there are plenty of opportunities and the merger arbitrage strategy produces higher returns than the average market what is in a strong contrast to efficient market theory.

Year	Value-weighted Risk Arbitrage Return	Risk Arbitrage Index Manager Return	CRSP Value- weighted Average Return	Risk-free Rate of Return
1963	14,51 %	6,64 %	20,89 %	3,13 %
1964	10,27 %	4,44 %	16,30 %	3,48 %
1965	9,09 %	3,30 %	14,38 %	3,94 %
1966	11,46 %	-4,03 %	-8,68 %	4,69 %
1967	14,45 %	9,06 %	28,56 %	4,05 %
1968	-8,65 %	-2,88 %	14,17 %	4,75 %
1969	22,10 %	3,18 %	-10,84 %	6,49 %
1970	14,18 %	5,70 %	0,08 %	6,17 %
1971	19,93 %	5,79 %	16,20 %	4,15 %
1972	16,65 %	3,52 %	17,34 %	3,93 %
1973	20,38 %	-7,45 %	-18,77 %	7,17 %
1974	12,95 %	12,93 %	-27,86 %	7,97 %
1975	12,83 %	12,29 %	37,37 %	5,63 %
1976	19,93 %	19,20 %	26,77 %	4,91 %
1977	28,56 %	8,27 %	-2,98 %	5,25 %
1978	20,40 %	18,03 %	8,54 %	7,41 %
1979	17,15 %	13,85 %	24,40 %	10,42 %
1980	29,30 %	38,54 %	33,23 %	11,33 %
1981	38,44 %	35,15 %	-3,97 %	14,50 %
1982	38,41 %	31,99 %	20,42 %	10,38 %
1983	17,35 %	12,67 %	22,70 %	8,86 %
1984	21,45 %	8,13 %	3,28 %	9,62 %
1985	15,65 %	15,00 %	31,46 %	7,38 %
1986	13,32 %	20,61 %	15,60 %	5,93 %
1987	13,81 %	3,81 %	1,76 %	5,17 %
1988	27,23 %	27,63 %	17,62 %	6,50 %
1989	6,83 %	5,36 %	28,44 %	8,16 %
1990	6,69 %	4,38 %	-6,02 %	7,53 %
1991	18,19 %	12,13 %	33,59 %	5,32 %
1992	9,12 %	4,48 %	9,03 %	3,36 %
1993	14,16 %	12,31 %	11,49 %	2,90 %
1994	17,07 %	12,58 %	-0,62 %	3,98 %
1995	12,57 %	10,96 %	35,73 %	5,47 %
1996	11,32 %	15,39 %	21,26 %	5,16 %
1997	9,48 %	11,64 %	30,46 %	5,11 %
1998	12,64 %	4,09 %	22,49 %	4,70 %

Compound annual rate of return	16,05 %	10,64 %	12,24 %	6,22 %
Annual standard deviation of returns	9,29 %	7,74 %	15,08 %	0,73 %
Sharpe ratio	1,06	0,57	0,40	0

Table I - Annual Risk Arbitrage Return 1963-1998

(Source: Mitchell and Pulvino (2001))

The returns in the table above were calculated from 4750 merger opportunities in 35 years. The Value-weighted Risk Arbitrage Return represents return if the investor would invest his money in merger strategy based on the market value of each security. By this approach he cannot damage the results by his own wrong decisions and all arbitrageurs would get the same result. On the other hand this result is calculated without transaction costs which would slightly decrease the return. The third column Risk Arbitrage Index Manager Return shows return of a merger strategy where transactional costs are included and money is held in cash when there are no arbitrage opportunities. The periods when money is held in cash decrease the potential profit. The sample clearly shows that the merger arbitrage strategy outperformed CRSP Value-weighted Average Return, which represents a broad diversification and so called market return, in addition the merger arbitrage had a lower risk represented by lower standard deviation. The merger arbitrage strategy also outperformed the risk free rate of return by almost 10% in compound annual return. There are also other studies which came up with the same conclusion. Karolyi and Shannon (1998) analyzed the Canadian stock market and found that the merger arbitrage strategy had a 26% annual return compared to 14% return of the general market. Risk of the merger arbitrage was even lower than the market with portfolio beta 0,39.

5.2. Dual listed company's arbitrage

Jong, Rosenthal and Dijk (2005) described dual listed companies as companies which arise from a merger. The merging companies combine their cash flow and activities but each company keeps its own shareholder register and identities. There are two basic types of dual listed companies. The first one is when the companies have a combined entity structure. By this type the companies create one or more subsidiaries

which are proportionally owned by the two companies. In these subsidiaries the two companies combine all assets and liabilities and they just take out their portion of profit which is distributed to the final shareholders. The second type of dual listed companies is a separate entity structure. It arises when the two companies do not combine the assets and liabilities instead they keep the structure separate as it was before they decided to create dual listing company. The dividends to shareholders are divided proportionally according to their stakes in the joined company.

5.2.1. Price discrepancies by dual listed companies

The price of these two companies should in theory equal proportionally each other with the correlation coefficient 1 but in reality it is sometimes different. One of the best known examples is Royal Dutch Shell. This company was created by Shell and Royal Dutch. The shares of Shell were trading at 10 percent discount compared to Royal Dutch shares in 1997. The role of the arbitrageur is quite easy. He has to buy the cheaper one and sell the more expensive but there is a risk that the shares could stay at this price inequality for a long period of time or they could even more diverge.

Jong, Rosenthal and Dijk (2005) have examined all 13 cases of dual listed companies which have occurred. They found out great discrepancies in stock prices of the companies.

DLC	Mean	Stand. deviation	Min	Max
Royal Dutch/Shell	0,86	12,71	-36,22%	19,83%
Unilever	1,16	11,41	-39,07%	29,10%
ABB	-4,20	14,20	-48,77%	17,77%
Eurotunnel	-1,65	2,78	-10,87%	17,67%
Smithkline Beecham	7,94	4,09	-2,22%	15,97%
Fortis	-2,64	4,90	-17,10%	13,79%
Elsevier/Reed International	2,15	9,20	-14,73%	17,58%
Rio Tinto	1,90	4,76	-16,42%	11,31%
Dexia	-9,22	3,67	-17,66%	5,15%
Merita/Nordbanken	-7,01	3,19	-15,11%	2,03%
Zürich Allied	11,93	3,47	1,36%	21,00%
BHP Billiton	7,09	2,26	1,14%	18,45%
Brambles Industries	8,45	11,32	-18,62%	29,15%

Table II - Percentage price discrepancies

(Source: Jong, Rosenthal and Dijk (2003))

The Min and Max column shows to which extremes has the price gone by each individual dual listed company. By most companies there were situations where one part of the company was cheaper and later the same part was more expensive than the second part. By two companies, Zürich Allied and BHP Billiton, this situation never occurred and just one part of the company was more expensive. By this price discrepancy the arbitrage would never realize a profit since the prices never came back exactly to non arbitrary level. The biggest discrepancy has occurred by ABB in 1988 when it reached almost 50%. This means that an investor could buy the stock for half the price in Sweden than in Switzerland. Froot and Dabora (1999) have explained this price discrepancy by a stock price correlation with the domestic index. They found that stock have a significant correlation with the domestic index where they are traded.

5.2.2. Reasons for dual listed companies

Taxation: By mergers and acquisitions one of the parties has to pay capital gain tax from the recorded profit. On the other hand by dual listed company's structure both parties can avoid such tax. Furthermore the withholding tax from dividends for the domestic investors can be also avoided to a certain extend because the dividends are paid in each country separately.

National identity: This is not an economic reason but it can be very important for political purposes. It could be very difficult to defend when a strategic domestic company would be taken over by a foreign company because by ordinary merger or acquisition the acquired company loses its identity and would disappear. By dual listed companies both firms keep their national identity.

Share price stability: In case of a merger or takeover the company would have to pick the domiciled country. Institutional investors are in certain cases prohibited to buy foreign shares by regulation. Delisting the company from the stock exchange could result in shareholder fluctuation and that could result in share price fluctuation. The company could be also removed from the indexes and the index buying investors would be also forced to sell the shares. By creating dual listed company's structure all of these bad consequences are removed because the shares stay at the domestic stock exchange and also in the indexes.

Regulation: Every merger and acquisition requires approval by the government authorities because it can destroy the competitive environment on the particular market. On the other hand the dual listed company does not require any approval.

Access to capital: The well known companies might have better access to capital in their home markets under their own brand name.

Operational and corporate governance issues: By ordinary merger the existing option plan or convertible bonds may be complicated to solve. These securities would have to be terminated but by a dual listed company there is no such problem (Bedi, Richards and Tennant (2003)).

Growth informativeness: Foucault and Gehrig (2008) described the incentives of management to make stock cross-listing. They can gain valuable information about growth opportunities and therefore make better investment decisions. The incentive to make cross-listing is negatively correlated with the informativeness of the managers.

The structure of dual listed companies has also disadvantages. The structure becomes much more complex and more difficult to understand for ordinary investors. This can destroy the transparency of the company. The company would be obliged to follow the accounting rules of both states which would increase costs for double accounting. In addition easy operations under normal structure as stock splits, share repurchase and sale of assets become also much more complicated.

5.2.3. Companies listed on more stock exchanges

One of the greatest and widest price divergences occurred on the Chinese stock market. The Chinese stock market is much more complicated than other markets. In order to control the inflow and outflow of capital the government has created more types of shares which some companies have issued. There are nine types of shares which differ from each other based on the place where they are traded, currency in which they are traded and who is allowed to hold them. The two most important types are the A-shares and H-shares. Both of these shares have identical rights concerning dividend payments, and voting rights (Rogers (2008)).

A-shares: They are traded on Shanghai and Shenzhen stock market in Chinese domestic currency - Renminbi. Just the domestic Chinese investors are allowed to buy these shares and from 2002 also big international financial institutions which have at

least \$ 10 billion under management but their holding of one company is limited up to 10% of the outstanding shares. Ordinary investors outside China have no access to these shares.

H-shares: These shares are issued abroad mostly in Hong-Kong in the domestic currency of the stock exchange. International investors are allowed to buy such shares and sometimes they are willing to pay a premium for Chinese shares compared to Chinese investors. Because of the premium it is more valuable to issue the shares abroad and it also contributes to the company's prestige.

Peng, Miao and Chow (2007) have made an analysis of 39 out of 41 Chinese companies listed on two stock exchanges and found that the simple average premium of A-shares over H-shares during 2005-2007 was 77%. The highest premium was 262% by company Sinopec Yizheng Chemicals Fibre Co. Ltd. The law of one price was clearly violated but to take profit from this discrepancy was more difficult and not possible for ordinary investors. The reasons why these price discrepancies happened were trading restrictions. Because of the restriction the supply and demand of stocks was different in domestic and foreign stock exchange and the price reflected these differences. The best option how to increase the market efficiency is to cancel the trading restrictions.

5.3. Statistical arbitrage

According to Avellaneda and Lee (2010) statistical arbitrage is mainly used by hedge funds. The statistical arbitrage differs from other arbitrages because the traders do not care about the fundamental values of the assets. The arbitrageurs use complicated computer programs which allow them to make very short trades with a very small profit. The computer programs make hundreds or thousands of trades which usually do not take more than a few seconds and have statistically positive return. Because of the broad diversification the strategy has positive total return, low volatility and is not correlated with the stock market.

The traders design strategies which aim to profit from the market inefficiency. They used mathematical functions and statistical data to come up with the winning strategy. The strategy is then backtested on historical data. Backtesting is using the strategy on the historical data in order to see the theoretical return or loss. The author of the strategy can improve it based on the result from backtesting. The disadvantage of testing the

strategy on historical data is that the markets change and adjust to loopholes. The same situation with exact same conditions normally does not repeat. Even when the strategy is profitable based on historical data it might have negative result in real time market.

The winning strategy does not necessary mean a positive net trading result. The big thread to statistical arbitrage is he himself. By this type of investing psychology of the trader is very important. By statistical arbitrage the trader is not buying any value. He is only hoping that there is someone else who is willing to buy the security for more money from him. The buyer will come with certain probability but if the trader cannot stick to his strategy he will most likely end up with a loss. Traders do not always follow their strategy for example because of a losing streak. When an ordinary investor loses 50% from his portfolio he still has the security which is temporally trading 50% lower. On the other hand when a statistical arbitrage loses 50% from his portfolio he does not hold anything. He has to hope for a winning streak to make up for the loss.

There are many basic trading strategies which the trader can adopt.

Pairs trading: This strategy is very simple. The trader has to find two stocks with a very high degree of correlation or some other specific feature. The companies do not have to be from the same industry or do not have to have anything else than correlation in common. The other feature can be price to earnings ratio. It arises when there are two very similar companies which have dramatically different price to earnings ratio which cannot be fundamentally justified. When the correlation is broken and the stocks move more away from each other than is normal on the historical basis, the trader buys the cheaper stock and shorts the more expensive one. He believes that the correlation was broken just temporally and the prices will come back to historical trend price path. There are many risks connected with this strategy and broad diversification is crucial (Gatev, Goetzmann and Rouwenhorst (2006)).

Multifactor model: The basis of this arbitrage strategy was set by Ross (1976) and his Arbitrage Pricing Model. He pointed out that the stock price is affected by more factors. This opinion was contrary to the Capital Asset Pricing Model which stated that the stock price is influenced just by market risk. The drawback of Ross theory is that he did not describe precisely which factors affect the price. By multifactor arbitrage strategy the arbitrageurs try to find the factors which most influence the stock price and trade when there is some mispricing according to their strategy. Chen, Roll and Ross

(1986) described the main macro economics variables such as GDP and inflation and their effect on stock price path.

Mean Reversion: Arbitraders bet on situations when the price of the security divergent from its normal level. They short the security when it is above the normal level and buy it when it is below the level in believe that the prices will come back to the normal level (Liew and Roberts (2010)). One of such strategies is to sell growing outperforming stocks and buy the cheap underperforming ones.

Cointegration: It is very similar to pairs trading. By pairs trading the trader looks on correlation but Alexander, Giblin and Weddington (2002) wrote how correlation is not sufficient because it compares returns. Oppose to this cointegration measures co-movements in security prices. It comes out from the linear relationship between various factors. The arbitragers try to replicate the index with fewer stocks and also with different components. The final return and volatility should be similar to the replicated index and the arbitrage profits when the prices deviate. One of the big advantages of a cointegrated index is that it has lower transactions costs and it is much easier and cheaper to rebalance. This advantage is often used by hedging.

5.4. High frequency trading

With the development of computer this new type of arbitrage has occurred. High frequency trading strategy is based on the speed of trading. The traders try to execute the trades before other market participants and by this they are trying to capture the very small difference between actual price and the price the potential buyer is willing to pay. The profit from each trade is very small. It usually does not exceed few cents on each share, but the high frequency traders make thousands or millions of such traders. The trades take mostly just a very short period of time and at the end of the trading day all trades are closed. The length of the trades is measured in seconds and because of such an enormous number of trades which sometimes take millisecond the orders are executed with a help of very sophisticated and automated computer programs. The programs are designed by each trader himself according to his believes and preference based on statistical data. Even a small error in the computer program can destroy the

whole investing account. There are opinions that high frequency trading causes problems and price distortions (Riordan and Park (2012)). On the other hand Brogaard (2010) showed the evidence that high frequency trading contributes to the price efficiency, decreases market spreads, brings liquidity to the market and has no negative impact on volatility furthermore in some case decreases volatility.

By high frequency trading the trader tries to gain profit by placing the order before the other market participants. By doing this his order is executed first and he gains the very small difference between the price he paid for the particular security and the price which the next buyer paid. Since the high frequency trader can execute the orders before other market participants he can gain advantage also by public announcements. The trader can react sooner to the announcements and he can be in the market before other traders. Despite the advantages of high frequency trading the politicians and regulators want to regulate this trading strategy (Spicer and Lash (2009)). It is because the rapid growth of trading volume in the last five years and the potential threat to the financial system.

Executions risk: Every order especially the big ones are broken into smaller ones and executed separately. Between the separate executions there is a small spread which the investors have to pay. For an ordinary investor it represents a very small cost but for high frequent trader who makes thousands trades it can be a big thread. In addition there are situations where some orders are not executed. This is a big risk for traders who want to open two opposite positions. The broker might open just one of the positions and the other not. In such case the trader would be exposed also to other risks which are connected to a simple long or short position (Bartoli, Frino, Jarnecic and Johnstone (2006)).

Affecting the market: Bondarenko (2003) described the risk when there is too much cash invested following one strategy. In some cases when the traders operate with a lot of capital or when many market participants follow the same strategy they can affect the market and move the prices. In such situations the profit opportunities would be lost and the trader would have to adjust the trading strategy otherwise he would have a loss.

5.5. Subsidiary arbitrage

The next arbitrage opportunity arises when the parent company is cheaper than its subsidiary. This opportunity usually occurs when the parent company makes spin-off. Graham (2003) was among the first who wrote about an arbitrage where the market value of the parent company is less than its subsidiary. He did not write about it from an academic perspective but rather from an investment perspective. Graham is famous for buying companies for less than they are worth and he saw a great opportunity in buying parent companies for less money than their subsidiaries are worth.

Nanda (1991) wrote about the incentives of companies to do carve-outs. If management believes that the subsidiary value is lower than the general market believes they tend to spin off the subsidiary. They try to take advantage of the market optimism.

In order to find out if there is any arbitrage possible the investor has to calculate the market value of the parent company and the market value of the subsidiary. The difference in values of the parent company and its stake in the subsidiary is calculated with the following formula:

$$V = MV_p - C * MV_s$$

Where:

V = difference in values

MV_p = market value of the parent

MV_s = market value of the subsidiary

C = percentage stake of the parent company in the subsidiary

The negative result of the formula means that the parent company is cheaper than its subsidiary and an arbitrage is possible. The arbitrage would buy the shares of the cheaper parent company and sell the appropriate amount of shares of the more expensive subsidiary company. The drawback of the formula is that it considers the value of the parent company to be zero since it just compares the two options for how much the investor can buy the subsidiary. The first option is buying just the subsidiary and the second option is to buy the subsidiary by buying the parent company.

If the investor would buy the subsidiary by buying the parent company he would receive the subsidiary plus the parent company for free. A more precise formula would be also with the book value of the parent company.

$$V = MV_p - C * MV_s - (BV_p - BV_s)$$

Where:

BV_p = book value of the parent company

BV_s = book value of the subsidiary on the parent company's balance sheet

The problem is that the real value of the parent company does not have to equal the book value. The book value only represents the depreciated costs for which the company has acquired assets minus the liabilities. The actual price for which the company can sell the assets may be different. In addition there might be some off balance sheet liabilities which the company would have to account in future periods as depreciation of goodwill, loss from lawsuits and write off inventory. For this reasons it is safer to calculate the arbitrage opportunity with the first formula. It gives fewer arbitrage opportunities but the opportunities are much safer.

5.5.1. Reasons for subsidiary arbitrage

When the parent company is cheaper than its stake in the subsidiary company it looks like a clear and risk free arbitrage. Every informed and rational investor would take advantage of such situation or at least buy the cheaper parent company instead of the subsidiary. Cornell and Liu (2001) defined five reasons why the subsidiary arbitrage happens: Agency costs, Taxes, Liquidity, Noise trader demand and Share dilution.

Agency costs: These costs are caused by bad management of the parent company. When the management is incompetent it can affect the capital allocation and the shareholders might not get any money out of the company even when the company is profitable (Jensen (1986)). The management may pay out big bonuses, acquire other companies for big premiums and start investing in other non profitable products. Management cost more money than it generates by its abilities and the subsidiary profit is lost in the parent company and never gets to the shareholders. When the subsidiary

company is profitable and the parent is not it is sometimes better to own the subsidiary because the parent company may fund its not profitable business. By holding the subsidiary the shareholder is still dependent to a certain extent on decisions of the parent company's management because they usually own the majority. They decide who will run the company and if they will pay out any dividends.

The agency costs decrease with the management personal ownership of the company's shares. On the other hand if the management holds too big portion of the company they control the company. For the rest of the shareholders it is very difficult to change the current management and the managers can enforce such actions which will contribute just to their personal wealth (Morck, Shleifer and Vishny (1988)).

Taxes: There are two types of taxes which might influence the subsidiary arbitrage. The first one is the capital gain tax. This tax prevents the parent company from destroying shareholders value by selling the rest of the shares on the stock exchange with profit. If conditions of the Federal Tax Code are met then the parent company can avoid the capital gain tax by distributing the remaining shares to parent's shareholders. In case the parent company cannot avoid the capital gain tax then it would be obliged to big tax liabilities from selling the subsidiary at profit.

The second one is tax-timing options. They arise because the investors have the possibility to choose when to realize losses and postpone profits. By doing this the investors can adjust the short term tax rate. The value of tax-timing option increases with the increasing volatility of the subsidiary (Constantinides (1983)).

Liquidity: Part of the parent's company discount can be attributed to its illiquidity. More liquid assets tend to be more demanded and they sell for premium. In situations when the subsidiary operates in an industry which is very attractive and there is a very high demand for such companies it can happen that the subsidiary is more liquid than its parent company.

Noise trader demand: Majority of the subsidiary shares are held by the parent company and just a small fraction is publicly traded. Just a small change in the market sentiment can create big demand compared to number of shares available. Furthermore the noise traders do not always look on the fundamentals but they go with the crowd.

Share dilution: It arises from issuing additional shares. Company can dilute shares in forms of issuing ordinary shares, stock options, warrants and convertible debt. All dilutions destroy long term shareholder value by decreasing the book value and earnings per share because they decrease the proportional ownership of existing shareholders.

Schill and Zhou (2001) analyzed the impacted of share dilution of the parent company on its value compared to the value of the subsidiary. They found out that the parent company may look cheaper but it may have future stock dilution traps greater than 20%. If an investor wants to own the subsidiary he would rather buy it directly and not indirectly through the parent company because by share dilution he would buy less of the subsidiary than it seems on the first look.

5.5.2. Risks connected to subsidiary arbitrage

Among the risks which are connected to arbitrage there are three major risks which affect the outcome of subsidiary arbitrage. Mitchell, Pulvino and Stafford (2002) analyzed 82 cases where the market value of the parent company is cheaper than the market value of its stake in the subsidiary during 1985-2000. They found out that there was a clear arbitrage opportunity but because of the inefficiency of the markets the arbitrage is not risk free and the returns are lower. If the arbitrage would not require capital and would be risk free as Dybvig and Ross (2001) says they are, the profit from subsidiary arbitrage would be much higher.

Horizon risk: The biggest thread for the arbitragers is idiosyncratic risk. The investors are long the parent company and short the subsidiary. They profit in case the price of the parent company goes up or in case the price of the subsidiary goes down. The quicker the prices converge the higher is the total profit. Mitchell, Pulvino and Stafford (2002) made an empirical study on situations where the subsidiary was cheaper than the parent company. In average the price of the mispriced stocks came back to equilibrium after 236 days. During this time the arbitrage has to bear the holding costs which represent a big portion of his total costs.

Number of Days Invested Using Rule 1 for all Investments								
Buy Threshold	Sell Threshold	Number of Investments	Minimum	Percentile			Maximum	Mean
				25 th	50 th	75 th		
1,00	0,8	110	1	29,0	92,0	274,0	2 796,0	236,3
1,25	1,0	75	2	28,5	84,0	213,0	2 413,0	214,4
1,50	1,0	39	13	92,5	159,0	258,3	2 370,0	343,1
Number of Days Invested Using Rule 1 for Converged Investments								
Buy Threshold	Sell Threshold	Number of Investments	Minimum	Percentile			Maximum	Mean
				25 th	50 th	75 th		

1,00	0,8	79	3	25,0	74,0	207,5	1 804,0	176,5
1,25	1,0	40	2	26,5	66,5	127,5	1 792,0	164,7
1,50	1,0	20	13	46,0	117,5	163,0	1 792,0	265,9
Number of Days Invested Using Rule 2 for all Investments								
Buy Threshold	Sell Threshold	Number of Investments	Minimum	Percentile			Maximum	Mean
				25 th	50 th	75 th		
1,00	0,8	130	3	46,0	155,5	380,0	2 818,0	309,7
1,25	1,0	119	3	41,5	114,0	285,0	2 818,0	236,0
1,50	1,0	67	7	68,8	182,0	336,0	2 804,0	327,7
Number of Days Invested Using Rule 2 for Converged Investments								
Buy Threshold	Sell Threshold	Number of Investments	Minimum	Percentile			Maximum	Mean
				25 th	50 th	75 th		
1,00	0,8	94	3	35,0	109,0	279,0	2 818,0	271,1
1,25	1,0	79	4	34,3	68,0	229,0	2 818,0	205,2
1,50	1,0	41	7	55,0	100,0	278,8	2 804,0	290,5

Table III - Investment Horizon
(Source: Mitchell, Pulvino and Stafford (2002))

This table shows the investment horizon for four different cases. The most relevant and conservative is the first case: Number of Days Invested Using Rule 1 for all Investments. The rising Buy Threshold number indicates rising difference in prices between the parent company and its subsidiary. The higher was the difference in value of the two companies the longer it took for the prices to converge. If we divide the number of days to percentiles, it is rising from 29 days in the 25th percentile up to 274 in the 75th percentile. The maximum number of days was 2 796 until the prices came back to non-arbitrary levels.

Number of Days Invested for Converged Investment says how long it took for prices to come back to their equilibrium level just in cases where the mispricing was eliminated. The periods are shorter because it does not count situations where the mispricing was not eliminated.

Margin risk: There are some situations which do not allow the prices to come back to their fundamental value. According to Mitchell, Pulvino and Stafford (2002) empirical evidence shows that in 27,3% of the arbitrage opportunities the mispricing was not eliminated. It was because the stocks of the parent company were delisted, different or parent company acquired remaining shares of the subsidiary, other company acquired the parent or parent also with subsidiary. All of these situations made it impossible for the arbitrageur to still be short the subsidiary company and at the same

time to be long the parent company. For this reason he would record a loss from such trade.

The idiosyncratic risk is also connected to volatility. The price of the two shares might divergent even more and in such case the arbitrage would have a risk of margin call. If the investor gets a margin call he has to add capital or partially liquidate the position. Both of these forced moves lower the investor's profit. If he has to add capital he cannot invest the money elsewhere and he loses because of opportunity cost. In case of partial liquidation the investor has to close part of his trade with loss and his position also becomes smaller and by this his future profit would be also smaller.

Pulvino and Das (1999) described a case where the volatility played a big role on a real example on Creative Computers and Ubid. The primary business of Creative Computers was selling computers and accessories. The company was the parent firm and a 100% owner of Ubid. Ubid was an internet shop where companies and also other people could buy and sell goods. Creative Computers sold 20% of Ubid shares in an initial public offering in 1998. At the first day of trading with both shares the market value of Creative Computers was \$ 271,2 million and the market value of Ubid was \$ 439 million. The Creative Computer's stake in Ubid was worth \$ 351,2 million.

In this case an investor could buy Creative Computers for \$ 271,2 million. He would receive a stake in the subsidiary Ubid worth \$ 351,2 million and the parent company Creative Computers for free. If an arbitrageur would go long the parent company and short the subsidiary he would make a certain profit of \$ 80 million. The only problem was that during the time the price of the parent company finally reached the price of the subsidiary the prices of both shares have more divergent.

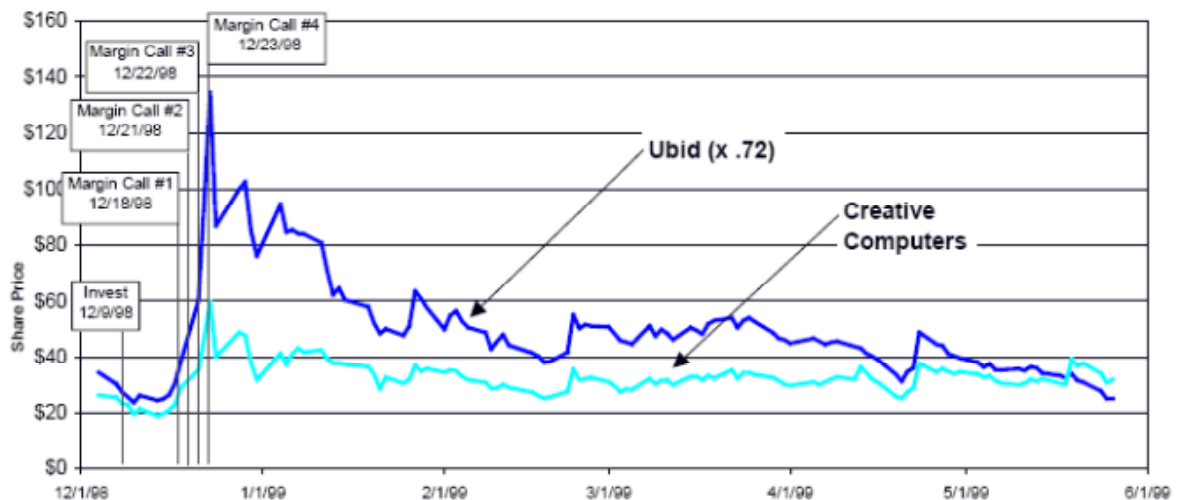


Figure IV - Stock prices path of Creative Computers and Ubid
(Source: Mitchell, Pulvino and Stafford (2002))

On this figure the authors have shown at which point would have the arbitrage invested. They assumed that the investor was fully invested and did not have any cash cushion. He would invest at the beginning of December 1998 when the price difference was pretty small but large enough to make profit. Few days later, at December 18th, the prices have diverged so much that the arbitrage would get a margin call according to NYSE and NASD requirements. He would have to record a 26% loss just in seven days. The price discrepancy did not finish but have wider even more. The arbitrage would receive three more margin calls just in the first two months of trading where he would have lost consequently 84%, 91% and 63% of his remaining capital. The markets finally eliminated the arbitrage opportunity at May 1999, six months from the initial investment. The arbitrage would have a negative 99% profit from this trade because of margin requirements compared to positive 45,9% profit if there would be no margin requirements. The arbitrage can avoid the margin call by being partially in cash or by diversification. In the case of Creative Computers and Ubid the best case scenario when the arbitrage would hold part of his investments in cash as a cushion against margin calls his profit would be just 8,7%. The investor can decrease the idiosyncratic risk by diversification on more stocks but he cannot eliminate it completely (Shleifer and Vishny (1997)).

The figure below shows the value of one dollar invested in a portfolio of arbitrage opportunities where the stake in the subsidiary company was worth at least 25% more than the parent company in 1986-2000. The value of the portfolio was steadily increasing until 1998 when big problems occurred. First the Creative Computers and Ubid shares have diverged and later 11 out of 15 at that time arbitrage opportunities have increased their price difference. This would bring the value of the portfolio to negative value and would cause a margin call. The portfolio has decreased the number of margin calls but also did not totally protect the arbitrageur.

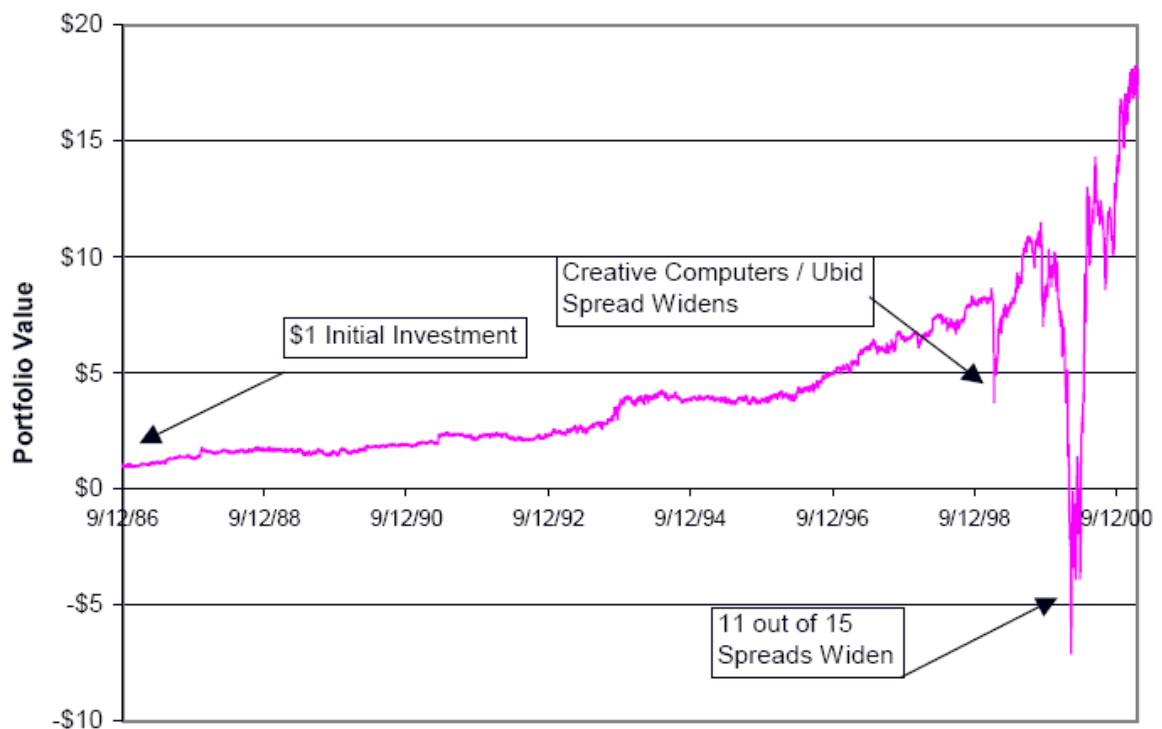


Figure V - Daily portfolio values
(Source: Mitchell, Pulvino and Stafford (2002))

Greater fool risk: Owen Lamont (2000) wrote about a risk that there is someone who is willing to buy the already overpriced security for even a higher price. For an arbitrageur who is short the overpriced security this represents a big threat because it can ruin his position. Lamont described a real case example, which happened in 1999, with Cordant Technologies and its subsidiary Howmet International. Howmet International was trading at \$ 14,0625 per share at 11th October and was already overpriced compared to its parent company by \$ 2,51 per share. Every rational investor would buy the parent company and sell the subsidiary. This simple transaction could also be done by the management of the parent company and they would bring greater value to its

shareholders. Management was not rational and tried to buy the already overpriced subsidiary for even higher price, for \$ 17 per share. If this transaction would be realized the rational arbitrageur would book a loss because there was a greater fool who was willing to buy the already overpriced shares for even higher price.

5.5.3. Short selling constraints

There are many reasons why the rational investors did not take advantage of the arbitrage opportunity and why they did not push the prices back to non arbitrage levels. Shleifer and Vishny (1997) wrote about idiosyncratic risk, transaction costs and liquidity risk. All of these risks certainly have an effect on the prices of the securities but the short selling constraints also influence the prices (Lamont and Thaler (2003)). In fact they argue that it is the most important factor why prices are not drag back to their equilibrium. When an investor wants to short a stock he has to borrow it from another investor or financial institution. Investor who borrows a share in order to short the stock usually receives interest but in some rare cases he has to pay interest. It is all determined by supply and demand of the stock. By subsidiary arbitrage the supply of stocks is very limited because the capitalization of the subsidiary is relatively small and majority is usually still held by the parent company. Because of the limited supply the cost of shorting the stocks is much higher and this makes it riskier. Miller (1977) described the effect of short selling constraints on price. The larger are constraints the more is the price of the stock affected by optimistic investors.

6. Risks connected to arbitrage

Despite that the Efficient Market Theory states that there is no risk connected to arbitrage there are some risks which are mostly very hard to calculate or to influence by arbitrageurs. Arbitrageurs are sometimes too much leveraged and have to take large positions compared to their capital because they try to profit from very small price movements. Because of the leverage any mistake can have devastating consequences. In such case the arbitrageur would have losses which might result in a margin call. A margin call is a warning sign from the broker company that the investor has to post additional collateral because the existing is not sufficient anymore. He can post the collateral in form of cash or security in order to cover previous and possible future losses (Shleifer and Vishny (1997)).

6.1. Execution risk

This risk is connected with cross country arbitrage. If an investor trades with a security on two different stock exchanges with different opening hours then he cannot buy and sell the stock simultaneously. In such case he is exposed to a risk that the price will diverge by the time he can finish his trade.

In order to make a trade for every unit of demand there has to be a unit of supply. If the demand exceeds supply there is a certain risk that the order will not be fulfilled at all or it will be fulfilled for slightly different price. Kozhan and Tham (2009) wrote about execution risk and its effect on arbitrageurs. They described how the arbitrageurs compete for the best possible price and how they create uncertainty and additional costs in average to all arbitrageurs. Immediately after an arbitrage opportunity arises all rational investors who know about it will try to make profit. The competition is so large that they try to capture even the slightest security mispricing and therefore the exact price of the security is very important. For example when the supply of the underpriced security is x and the demand is $x + y$ than just a certain amount of the demanded quantity can be executed for the market price. The other part will be executed for the second best price which may not be in the arbitrary level anymore. If the price for which the arbitrageur buys the security is different from the market price it can decrease his profit or make a

loss. The price difference can happen in an environment where there are more rational investors than irrational. The higher is the demand over supply the higher is the chance that the arbitrageur would not get the best possible price and therefore suffer a loss. Roll, Schwartz and Subrahmanyam (2007) described the effect on liquidity on execution risk. The greater is the liquidity the smaller is the execution risk.

6.2. Counterparty risk

Every investor is exposed to counterparty risk. If his trading partner defaults to meet his obligations then the investor loses money. This risk occurs usually just in extreme situations like financial crisis. One of the latest example could be American International Group (AIG) if the government would not bail them out in 2008 they would default on their CDF contracts.

6.3. Holding costs

These costs represent the amount of money investor has to pay during the trade in order to maintain the position. If the holding costs exceed profit of the arbitrage then the investor would have a loss.

6.4. Liquidity risk

In theory arbitrage is not connected with price movement risk because the investor is perfectly hedge against market movements. If both of his positions move the same direction he loses money by one position and offsets the loss by profiting from the other position. But in case his trades do not move the same direction he may temporally lose money. This is not a problem by Efficient Market Theory defined by Eugene F. Fama (1965) or the Capital Asset Pricing Model defined by Sharpe (1964) and Arbitrage Pricing Theory defined by Ross (1976) because they assume that the market consist of

many small investors who make infinite bets against market mispricing. So the loss in one position does not ruin the whole investors account.

Andrei Shleifer and Robert W. Vishny (1997) discussed the risk connected with arbitrage in their paper *The Limits of Arbitrage*. They believe that in reality the arbitrage market consist of few highly specialized large market participants who operate with client's money. The arbitragers have to consider the unsystematic risk of their investment because they are orientated just on a specific part of the market and it is very difficult to diversify the risk. If the arbitrageur sees a mispriced asset he buys the cheaper and sells the more expensive one. Normally the asset prices adjust very quickly in favor of the trader and he makes profit. But there is a possibility that the prices of the two assets will move more away from each other, thus creating an opportunity for bigger profit from arbitrage but on the other hand this creates temporary loss. This temporary loss from arbitrage is what Shleifer and Vishny (1997) described in their paper. This loss arises because if an investor buys for example one forward contract on rice on Tokyo stock exchange for \$ 95 and sell the same type of the contract on New York stock exchange for \$ 100 he will make a sure profit when the contract expires. However if the prices of the forward contracts move more away from each other, the contract on Tokyo stock exchange will cost \$ 90 and the price of the other contract will stay the same, then the arbitrageur will have a temporary loss of \$ 5. According to Shleifer and Vishny (1997) clients of the arbitrageur do not know the details of each trade, partly because it is complicated and partly because the arbitragers do not want to reveal their know-how. Clients pick the best arbitrageur based on the highest expected return. The expectancy of the return is derived from past returns and the level of management fee. This implies that the poor performing arbitragers lose capital and good ones gain the resources. This puts pressure on money managers for short term profit.

Shleifer and Vishny (1997) described how the process of arbitrage works in reality on a simple example. They believe that on the arbitrage market there are three participants: specialized arbitragers, noise traders and investors who put their money in investment funds which are run by the arbitragers. This simple example consists of three time periods $t = 1, 2, 3$. The price of the asset at t_3 equals fundamental value.

In case where at time t_1 the asset price does not equal its fundamental value, the arbitragers would try to take advantage of such situation, and they would invest against the noise trader's sentiment. At t_2 the price of the asset depends on who invests more money. If the arbitragers invest more money than the noise traders then the price will

come back to equilibrium and the arbitragers will have profit at t_2 . On the other hand there is also a possibility that noise traders will put more money on this trade and the price of the asset will move more away from its fundamental value. In this case the arbitragers will experience a temporary loss and under this scenario more possibilities can arise. The first one is that the arbitrageur is fully invested therefore he has no additional money to cover the temporary loss. He can solve the problem by closing the otherwise profitable trade with a loss or adding capital from clients. If the clients are rational they will add capital because there is a riskless opportunity to gain profit. But the clients base their decision on past performance and because the trader is making a loss, even though it is temporary, they might decide not to add capital. In such situation the trader would be forced to close his position with a loss. The clients might even pull the money out because of the poor performance and they might give the money to a different more profitable arbitrageur. This will put more pressure on the losing arbitrageur and he would be forced to sell a bigger part of his position.

The second scenario is that the investor is not fully invested and after the price moves more away from its fundamental value he can add more money to his position until he is fully invested. By this scenario the arbitrageur is also under risk of losing clients but to certain extent he can cover the withdrawals with the money which he kept in cash.

6.5. Noise trader risk

The discount of close-end funds can be also explained by noise traders (Shleifer and Summers (1990)). Close-end fund is an investment fund with a fix number of shares. This means that when new investors want to participate and invest in that fund he has to buy shares from another investor. The price of the fund is determined by market participants and in theory should equal its net assets otherwise an arbitrage opportunity would arise. In reality the close-end funds trade at a discount to its net assets and it is because noise traders risk. An arbitrageur could in theory buy the cheaper close-end fund and sell the more expensive stocks in right proportions but he might have to wait very long time for the prices to come back to their fair value. The close-end fund can be underpriced forever but the discount can increase or decrease overtime. Ordinary investors cannot predict the behavior of noise traders and therefore require additional

return for bearing the noise traders risk. Lee, Shleifer and Thaler (1991) demonstrated on an empirical study the positive relationship between noise trader's sentiment and prices of securities and close-end funds. The discount of various close-end funds correlate together. If investors are pessimistic than all close end funds sell at a deeper discount however if they are optimistic they sell at smaller discount or at premium to net assets. Further they found that the close-end funds discount is lower when there is overall optimism on the market and other stocks are also going up. The figure below compares number of IPO's with percentage discount on close-end funds during 1966-1985. The line graph represents the level of discount. The funds were selling for a discount when the line is above 0 and they were selling at premium when the line is below 0. The bar graph represents number of IPO's in each year. The number of IPO's is positively correlated with overall market optimism therefore the more IPO's are in each year the greater is the market optimism. The figure shows that the discount was lowest in years when the number of IPO's was the greatest and the funds were selling even for a premium in late sixties and early seventies when the optimism was at its highest level. Next ten years the market was very pessimistic and the funds were selling at a deep discount. In the mid eighties the sentiment turned again and so did the level of discounts on close end funds.

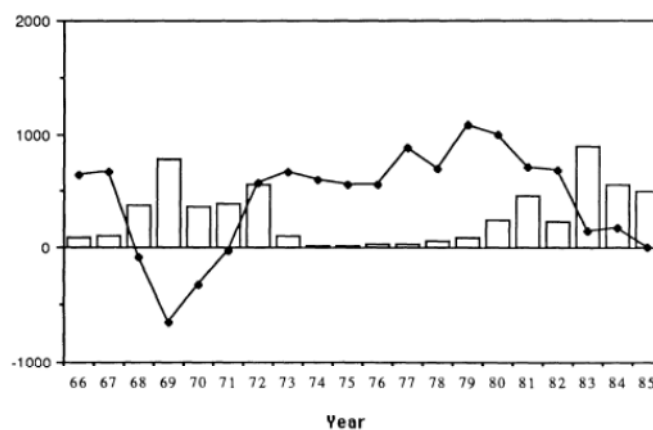


Figure VI - Number of IPO's compared to discount on close-end funds
(Source: Lee, Shleifer and Thaler (1991))

7. Costs of arbitrage

The strong form of Efficient Market Hypothesis assumes that there are no information or transaction costs (Fama (1991)). In reality investing on the stock exchange is always connected with costs which are often underestimated. Investors have to calculate for example with trading costs, holding costs and opportunity costs. These costs make to certain extend even the arbitrage inefficient. This is not true according to Efficient Market Theory defined by Eugene F. Fama (1965) or the Capital Asset Pricing Model defined by Sharpe (1964), because investors would not buy an overpriced or sell an underpriced asset so the arbitrage opportunity would never occur. Jeffrey Pontiff (2006) has described the effect of costs on arbitrage. Every investor always tries to take advantage if he sees any mispricing of any asset. He makes this because he can make safe profit but if the costs of making the trade are higher than the gain his profit would be negative. In this case the investor would never enter such trade and the asset will be out of its equilibrium price. Investors enter just such trade by which their net gain is positive. There are two main costs which make the financial market more inefficient. They are the transaction cost and holding cost. Each of these costs has different impact on the trade.

7.1. Transaction costs

Transaction costs are for example fees to the broker, commissions and bid ask spreads. Fees and commissions to the broker is a fix amount or a small percentage from the invested money. Bid ask spread is the difference between the buying and selling price of the asset. The size of the difference depends on liquidity. The higher is the liquidity the smaller is the spread and the smaller is the transaction cost. These fees are usually very small and easy to calculate. They impact just the moment when the investor enters the transaction or when he exits.

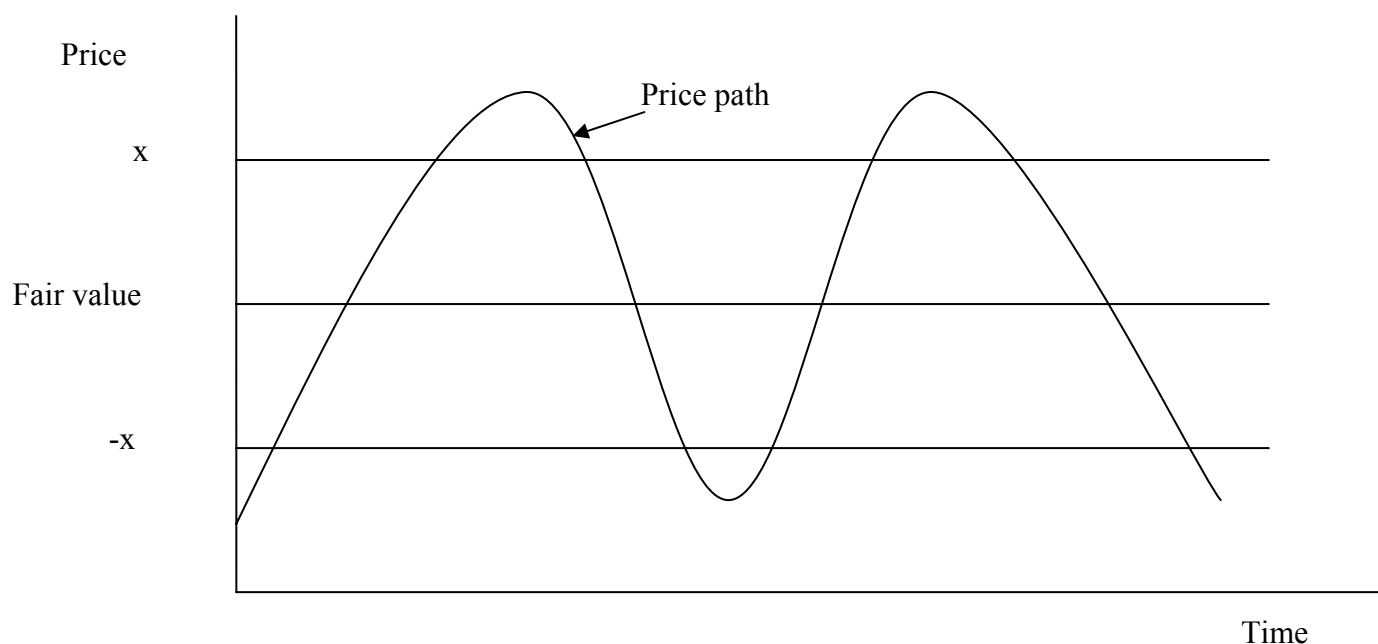


Figure VII - Hypothetical mispricing process in the presence of transaction costs
(Source: Pontiff (2006))

This graph shows us the effect of transaction costs on the price of the asset. The line in the middle is the fair value of the asset and the curve is the theoretical price path. The lines above and under the fair value line are the lines which show us where is the arbitrage not profitable. Since between the lines the arbitrageur would have a loss he does not invest until the price of the asset exceeds one of these lines. When the price is higher than x or lower than $-x$ the arbitrageur makes profit thus he would try to bring the price of the asset closer to equilibrium. The higher are the transaction cost the more inefficient is the arbitrage market.

7.2. Holding costs

According to Tuckman and Vila (1992) holding costs occur during the time investor holds any asset. They include for example opportunity costs of capital and systematic risk. Holding costs are much more difficult to calculate because the investor often does not know when the price will come back to its fundamental value. The costs increase with time which investor holds the asset.

Consider two assets, A and B, with the same risk and the same cash flow at the same day in future. In this case asset A is more expensive than asset B by the amount X. In situation where there are no holding cost an intelligent investor would buy asset B and short asset A. He would realize a certain profit of X today and the future cash flows would equal so he would have no extra costs. This was a theoretical example but in reality it is different. In order to short a stock the investor has to give collateral. After that he can short asset A and borrow money in order to buy asset B. The outcome is the same and the arbitrage does not pay any additional money when he makes the trade. He has to pay just holding cost and because of these costs the arbitrage is not risk free as the efficient market theory claims. The present value of holding cost could be greater than X or smaller. If the present value of the holding costs are smaller than X then the trade will be profitable. In case the holding costs are greater than X there are two options for the trader. The first one is that the trade is not profitable and he does not enter any position. The second option is that the prices of asset A and B would equal sooner and he can also exit the position sooner. In such case even this trade might be profitable.

7.2.1. Idiosyncratic risk

One of the most important components of holding costs is idiosyncratic risk. Jeffrey Pontiff (2006) has described it as “*the key holding cost associated with equity trading*”.⁶ Idiosyncratic risk is more known as unsystematic risk. Every security has systematic and unsystematic risk. Systematic risk is the market risk which cannot be diversified away. It is for example the change in interest rate. On the other hand the unsystematic risk is the individual risk of every company or industry. This risk can be cut down through proper diversification. However the risk cannot be eliminated entirely and the investor has to calculate with it. Shleifer and Vishny (1997) argued that arbitrageurs care about idiosyncratic risk because they have just limited number of opportunities where they can invest their money.

⁶ Pontiff (2006), pp 41

7.2.2. Dividend yield

The amount of money a company pays to its shareholders in form of dividends is negatively correlated with the level of holding costs. The greater is the dividend yield the smaller are the holding costs. There are two reasons why they have negative correlation. The first is that dividends tend to decrease the holding period and thus decrease the total amount of holding costs. The second reason is that dividends also decrease the future value of the positions and since the level of holding costs depends on the value of the position, dividends decrease the holding costs.

7.2.3. Interest rate

Interest rate represents the opportunity cost of every investment since the trader can use his capital in a different way. The higher is the rate of interest the higher is the opportunity cost thus the holding cost for the arbitrageur.

8. Application in practice

In this chapter I have used papers and empirical studies and I have applied them into practice. The analysis examines mergers and acquisitions which are now (7.12.2012) in progress on major stock exchanges around the world. The previous studies (Dukes, Frohlich and Ma (1992) and Jindra and Walkling (2004)) have shown huge returns which many times exceeded 100% per annum.

The sample consists out of 103 companies. Most of the companies have market capitalization below \$ 500 million and the average is \$ 1 351 million. The size of the target companies makes it very difficult for big investment funds and corporations to undertake any investment decisions. At the time when the acquiring company officially announced offer to buy the target the average announce premium was 42,35% however investors cannot buy shares for historical prices. For the calculations I have used current average premium which is 8,38%. It is lower because the time to successful merger is shorter.

Average announce premium	42,35%
Average current premium	8,38%
Average market capitalization of target	\$ 1 351,9 million
Cash offers	62,14%
Stock offers	19,42%
Cash & stocks offers	18,45%

Table IV - Average Merger and Acquisition
(Source: Bloomberg)

In the final sample I have excluded all companies which have lower premium than 5%. The final sample consists out of 26 companies and the success or failure of all the mergers is expected to be decided in late December 2012 and in 2013.

Target	Acquirer	Payment Type	Offer Per Share	Target Price	Current Premium in %
KIT digital	Private	Cash	3,75	0,72	420,83
Best Buy Co.	Private	Cash	26,00	12,41	109,51
Advocat Inc.	Private	Cash	8,50	5,24	62,21
PLX Technology	IDT	Cash&Stocks	6,83	4,57	49,42
Trunkbow International	Private	Cash	1,46	1,11	31,53
MEMSIC	Private	Cash	4,00	3,13	27,79
ECB Bancorp	CFB	Stocks	17,43	14,05	24,06
China Shengda Packaging Group	Private	Cash	1,40	1,13	23,89
LJ International	Private	Cash	2,00	1,62	23,46
Shengtai Pharmaceutical	Private	Cash	1,65	1,34	23,13
Mesa Energy	Armada Oil	Stocks	0,17	0,14	22,83
KBW Inc.	Stifel Financial	Cash&Stocks	17,50	14,95	17,06
Wecast Industries Inc.	Private	Stocks	11,00	9,70	13,40
Alliance Bankshares	WashingtonFirst Bankshares	Cash&Stocks	5,26	4,70	11,99
Commercial Solutions Inc.	Private	Cash	1,50	1,35	11,11
Hyduke Energy Services Inc.	Private	Cash	0,83	0,75	10,67
Nexen Inc.	CNOOC Ltd.	Cash	27,50	25,17	9,27
Astral Media Inc.	BCE	Cash	50,00	46,02	8,65
Progress Energy Resources Corp.	Private	Cash	22,00	20,25	8,64
Outdoor Channel	Private	Cash&Stocks	8,00	7,45	7,38
SuperMedia Inc.	Dex One	Stocks	2,50	2,34	6,84
WSB Holdings	OLB	Cash&Stocks	6,25	5,86	6,6
Imation Corp.	First Quantum	Cash&Stocks	70,00	66,1	5,9
Bluegreen Corp.	BFC	Cash	10,00	9,47	5,54
Knight Capital	Private	Cash	3,50	3,33	5,11
Cymer Inc.	ASML Holding	Cash&Stocks	92,16	87,76	5,01

Table V - Merger and Acquisition offers
(Source: Bloomberg)

There are many factors which affect the success rate of mergers. Hoffmeister and Dyl (1981) found a negative correlation between the size of the target company and successful merger. This analysis does not analyze the various factors and their impact on successful merger and calculates with the probability of 83% (Bruno (2010)). The

probability was calculated on 8137 merger deals between 1997-2009 around the world. Other studies came up with similar or higher results. Brown and Raymond (1986) calculated the success rate over 90%. The expected profit is calculated with the following formula (Baker and Savasoglu (2002)).

$$\text{Expected profit} = P * \sum W_i * (OP_i/TP_i-1) + (1-P) * \sum W_i * (PF_i/TP_i-1)$$

P = Probability of successful merger and acquisition – 83 % (Bruno (2010))

W_i = Weight of the target company calculated based on market capitalization

OP_i = Offered price

PF_i = Market price of the target company in case of merger failure at the day of failure announcement

TP_i = Market price of the target company at 7.12.2012

Every company is included in the final result proportionally based on its market capitalization. In the calculation the costs, as transaction, holding and foreign exchange hedging costs, are not included. After the completion or failure of the merger the money is held in cash with no interest on it. The return on mergers which have failed is very difficult to calculate because the price can move to different levels. It can decrease to levels before the merger offer, it can decrease even more substantially below the pre-offer levels or it can decrease above pre-offer levels. I have assumed a conservative case where the price would decrease to pre-offer level. The return in case of merger failure is positive because the current market price is on average below the market price when the merger was announced.

$$\text{Expected profit} = 83\% * 27,83\% + 17\% * 11,12\% = 24,99\%$$

The expected profit during 7.12.2012-7.12.2013 is 24,99% per annum compared to average return on US equities since World War II 6,9% per annum (DeLong and Magin (2009)). The biggest risks connected to this arbitrage strategy are the merger success rate and the downside risk in case of merger failure. The other risks are execution and counterparty risk. Every investor has to be aware of these risks and he has to pick the right counterparty very carefully. There is no liquidity risk by this strategy because it

does not require any leverage. On the other hand leverage might increase the potential profit.

9. Conclusion

This paper examined arbitrage in stock markets, the various types, reasons for arbitrage and risks which the arbitragers have to face. There are clear signs that the market prices do not always equal their fundamental values but because of the costs and risk it is not always possible to take advantage of the price discrepancies (Shleifer and Vishny (1997)). If the rational investors would face just the transaction costs and no additional risk than the price discrepancies could not be 100% corrected. They would still move in the range between fair value and fair value with transaction costs Pontiff (2006).

There are many investment funds which made great trades with certain profit according to Efficient Market Hypothesis but they bankrupt. The best know is Long-Term Capital Management (Edwards (1999)). They made huge bets with high leverage on bonds, dual listed companies and others securities where the managers saw an arbitrage opportunity. In the first four years of existence they had average returns over 30% per annum but later the risks of arbitrage turned against them. Prices of dual listed companies has widen even more, Russia refused to repay its bonds and they were forced to liquidate positions even though the market was illiquid and they had to close otherwise profitable trades with a loss.

One of the reasons why even rational investors might lose money is the unpredictability of noise traders Black (1986). Lee, Shleifer and Thaler (1991) and Shleifer and Summers (1990)) examined to which extend the noise can move prices so even a perfect rational trade might lose money. The main conclusion of this paper is that even though the prices do not always reflect the fair value it is not always profitable to take advantage of the price discrepancies.

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Curriculum vitae

First name and surname: **Karol Hochschorner**
Country of origin: Slovakia
Tel: 00421/904605166
E-mail: karol.hochschorner@gmail.com

Education: 1994-1998, elementary school Drieňová 16, Bratislava
1998-2006, Mercury Private College – private high school focused on Economics, Management, Banking and foreign languages
2004-2004, Ashwaubeton High School, Wisconsin USA
2006-2009, Fachhochschule Wiener Neustadt – Bachelorstudy - Business Consulting International – International accounting and finance
2009-2013, Universität Wien – Masterstudium Internationale Betriebswirtschaft

Foreign languages: **English:** 8 years in high school + private courses, study abroad: Florida – 1 month, California – 1 month, Wisconsin – 6 months, England – 2 months
German: 8 years in high school, 4 on elementary school + private courses, study abroad: Germany – 2 months
Czech: same level as mother language
Mother Language: Slovak

Certificates: **English certificates:** International English Language Testing System (IELTS), FCE, Oxford Certificate
German certificates: Deutsches Sprachdiplom (Zweite Stufe), Deutsch Geschäftssprache Zertifikat

Work experience: **Ravak Slovakia s.r.o. :** (summer 2006) Assistant of a manager in a logistic center.
Stavcontact plus s.r.o. : (summer 2007) I was a member of a project team. Our goal was to increase sales.

AB Asset Management k.s. : (2011-2013) Executive officer

Further qualification: work on computer: MS Office, Internet
Personal development courses

Organizational skills and competencies:

Organizational skills: organizing sport events and school ceremonies

Organizational and communication skills and work in a team and with people: I was chairman of the school council

Ability to adapt to multicultural environment

Driving license: category B

Interests: sport: tennis, hockey, football, table tennis
financial markets, mathematics, reading