EUROPEAN EQUITY MARKET DELINEATION
- A CRITICAL LOSS ANALYSIS USING PORTFOLIO OPTIMIZATION

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Abstract

This thesis provides a numerical application of standardized market definition procedures used in competition law to delimit relevant markets in the effects assessments of anticipated mergers and acquisitions. Given the international integration of European financial markets and an unprecedented number of M&A after the implementation of the MiFID-directive, this study examines the interchangeability between main European indices for a representative investor. By assuming a small but non-transitory increase in price of trading the Swedish index OMXS30 by a hypothetical monopolist, the potential profitability is evaluated using a critical loss-test. The critical loss represents the magnitude of actual loss that just makes it unprofitable to impose a small price increase. Clearly, increasing trading fees affects the incremental costs of intermediary dealer-brokers, resulting in increasing commissions and ultimately affecting the investor’s perception of OMXS30 expected returns. The actual loss is estimated using portfolio optimization theory on a dataset of indices. By disturbing the expected returns for OMXS30 with a minor negative factor and note the change in portfolio weight, the negative change serves as a proxy for the hypothetical monopolist’s volume decrease. The simulation results show that a small but non-transitory increase in price of trading OMXS30 would be profitable. This implies low outside substitutability, indicating a separate relevant market for trading of Swedish equities.

Keywords: Competition, Market delineation, Market microstructure, Relevant market, Financial regulation, Portfolio optimization, Portfolio theory, Critical loss, SSNIP-test, MiFID, Transaction costs

JEL Codes: C02, D20, D4, G11, G00
List of Tables

3.1 Critical loss for various margins and price increases .................................. 11
5.1 European indices ......................................................................................... 25
5.2 Average quarterly returns statistics 2009Q1-2011Q3 ...................................... 27
5.3 Cross-correlation table 2009Q1-2011Q3 ......................................................... 27
5.4 Risk-free rate .............................................................................................. 28
6.1 Tangency portfolio portfolio weights .............................................................. 31
6.2 Actual loss estimations ................................................................................. 31

List of Figures

3.1 Price increase profitability trade-off .............................................................. 10
4.1 Optimal risky portfolio .................................................................................. 21
5.1 Historical price development 2009Q-2011Q3 ................................................ 26
5.2 Trading fee increase effect of OMXS30 expected return ............................. 30
A.1 Efficient frontier - 2010 Q1 .............................................................. 40
A.2 Portfolio weights plot - 2010 Q1 ............................................................... 40
A.3 Efficient frontier - 2010 Q2 .............................................................. 41
A.4 Portfolio weights plot - 2010 Q2 ............................................................... 41
A.5 Efficient frontier - 2010 Q3 .............................................................. 42
A.6 Portfolio weights plot - 2010 Q3 ............................................................... 42
A.7 Efficient frontier - 2010 Q4 .............................................................. 43
A.8 Portfolio weights plot - 2010 Q4 ............................................................... 43
A.9 Efficient frontier - 2011 Q1 .............................................................. 44
Chapter 1

Introduction

Since the implementation of the Markets in Financial Instruments Directive (MiFID) in the European Union in November 2007, financial markets have undergone profound changes. The industry has been characterized by a competitive environment with entries of new alternatives market venues and at the same time an unprecedented number of mergers and acquisitions. When competition authorities review mergers, the relevant market delineation is a prerequisite to the effect analysis. In this thesis, the standardized market delimitation framework of Critical loss-analysis (Harris & Simons 1989), is implemented on the financial sector in order to examine if it is possible to delimit a separate relevant market for Swedish equities by an estimation of the potential interchangeability between main European stock indices.

As the concept of relevant market delimitation derives from the degree of product substitution, this paper aims to estimate the interchangeability between OMXS30 and other main European indices for a representative investor. Assume two products 1 and 2 that are potential substitutes. The idea of the Critical loss-test is to calculate if a monopolist of product 1 could increase prices without losing profits to producers of product 2. If such a price increase would be profitable, the conclusion is that the products 1 and 2 are not in the same relevant market (Davis & Garces 2010, pp.201). If the defined market is too narrow, the monopolist faces substantial outside substitution preventing the monopolist from increasing its prices. Therefore, one relevant market definition is the smallest set of products such that a monopolist would have incentive to raise prices.

By assuming away the presence of equity home bias or any other exogenous restrictions, an optimal risky portfolio from a given universe of main European indices including OMXS30 is calculated for various periods in time using portfolio optimization theory. Using the market delimitation methodology of a Critical loss-test, a hypothetical monopolist that controls all market venues for trading the main Swedish index OMXS30 is assumed to impose a small but non-transitory increase
in price of 10% on trading fees. The critical loss represents the magnitude of lost sales that just make it unprofitable to impose a small price increase.

The incremental trading costs for the intermediary broker firms are increased and render a higher commission paid by the investor for trading the OMXS30-index. In comparison to the other indices included, the increased commission decreases the investor’s expected return for OMXS30. The potential effect of the price increase would be decreased volumes of OMXS30 in favor of possible close substitutes. The effect of the price increase is simulated by disturbing the vector of expected returns and then re-solving the investor’s portfolio optimization problem for a number of different points in time. The eventual changes in OMXS30 portfolio weights are expected to be negative and represent the lost volumes for hypothetical monopolist. The expected decline in volume, or the actual loss, is compared with the critical loss in order to determine if the small but non-transitory increase in price would be profitable. If the estimated actual loss appears smaller than the critical loss, it implies that the increase in price would be profitable.

The main findings of this thesis are that the hypothetical trading fee increase would be profitable. For a small but significant non-transitory increase in price of 10% and an initial margin of 100%, the critical loss for a hypothetical monopolist corresponds to 9.1%. Given the computational results for all the specific points in time, the actual loss appears to be smaller than the critical loss indicating that a price increase would be profitable. Based on the assumptions that the representative investor makes the investment decision from historical risks and returns, these results shows that Swedish equities could be delimited as a separate relevant market.

The organization of the thesis is as follows. Chapter 2 constitutes a background to competition in the post-MiFID European financial market. In Chapter 3, market delimitation framework and critical loss-analysis is outlined. Chapter 4 describes financial theory including transaction costs, portfolio optimization and the concept of equity home bias. This chapter provides an overview of the theory used in the empirical experiment. Chapter 5 discusses the methodology for how the actual loss is being estimated. Finally, in Chapter 6, the computational results are presented succeeded by a discussion concluding the main results. A collection of time-specific plots from the simulations are found in the appendices.
Chapter 2

European financial market after MiFID

The MiFID-directive sought to promote competition between different trading venues in the interests of price competition, innovation and investor choice ultimately improving market efficiency (EC 2011). Trading of financial assets has historically been concentrated on national exchanges, but after MiFID the former national monopolies or Regulated Markets (RM) met competition from new alternative trading venues, Multilateral Trading Facilities (MTF). As a result of new entrants, the liquidity of the incumbent markets fragmented across multiple MTFs and also dispersed into different liquidity pools such as Broker Crossing Networks (BCN) facilitated by major investment banks (Storkenmaier, Wagener & Weinhardt 2012).

In the evaluation of MiFID-impacts, the Regulated Markets have expressed concerns that their regulatory requirements are more stringent and costly than those of the MTFs making an unlevelled playing field (CESR 2010). In the assessment of the forthcoming MIFID II-directive, the European Commission in 2011 identified a total of 231 different trading systems in the European Union, including 92 Regulated Markets and 139 Multilateral Trading Facilities. By the end of 2009, 20% of the total equity trading in the European Union was conducted on new MTF entrants (Ferrarini & Moloney 2012). Alongside the competing market venues offering both lit and dark order book trading there are also numerous off-order book trading alternatives such as dark pools and BCNs, Systematic Internalizes (SI) and Over-the-Counter (OTC)-trading that operate alongside the Regulated Markets and MTFs (Ferrarini & Moloney 2012).

By MiFID’s best execution requirements, brokers and investment firms are obliged to achieve the best possible result for client orders. By sophisticated order routing systems, the client-driven flows are optimized between different venues and off-book trading alternatives in order to first and foremost achieve the best price (Chlistalla & Lutat 2009). The legal framework of best execution alongside the liquidity fragmentation has increased the overall trading costs for some brokers. Typically local retail traders previously connected only to the primary market where disadvantaged
since connections to multiple venues and advanced IT-equipment to access the dis-
persed liquidity and secure best execution is potentially very costly. Liquidity is a
decisive factor for how orders are distributed among competing venues and it has
an effect on the transaction cost (Chlistalla & Lutat 2009).

The total transaction cost of securities trade is mainly consisting of implicit costs
determined by liquidity in terms of difference in bid-offer prices and order book
depth. Although a market venue posts the best bid-offer price, the market depth
or the amount of visible liquidity in the order book might be low resulting in wider
spreads, particularly for larger orders. See (Liquid Metrix 2013). The implicit cost
account for up to 80% of the total transaction cost, while explicit costs in terms
of commissions, fees and taxes are of minor significance (Latteman et al. 2012).
When executing orders on behalf of clients, brokerage firms charge a commission on
the basis of the value of the transaction. However a majority of the total trading
cost for the investor is the liquidity driven cost of the quoted bid-ask spread. The
real impact of overall trading costs for market participants after MiFID is not clear
since the cost reductions seems to be asymmetrically distributed between different
types of operators with varying business strategies (Ferrarini & Moloney 2012).

Although trading costs might have increased for some smaller market participants,
the overall market trend is substantially decreasing trading costs. A recent study
for the European Commission of trading costs across European trading platforms
estimated that the costs of on-book equity trading fell by an average of 60% between
2006 and 2009 (Oxera 2011). Although the cost per transaction has declined, the
average order size has also decreased, making the transaction costs actually increas-
ing in terms of value of the trade. The average order size decreased from €25,000
to €10,000 between 2006 and 2009. One explanation is broker firms splitting client
orders across different venues to access the different pools of dispersed liquidity and
to reduce market impact (Chlistalla & Lutat 2009). Another explanation is the
increased presence of High frequency-traders (HFT) and algorithmic trading strate-
gies (Oxera 2011).

An additional factor of competition in the aftermath of MiFID was differences in
tick sizes, or the smallest increment used to quote an asset price. When an MTF
lowered its tick size, it immediately gained higher volumes until competing venues
followed (Financial News 2009). The lack of a harmonized tick size-regime in the
European Union led to the so called “Tick size war” where competing market venues
undercut each other resulting in “race to the bottom” until harmonized tick sizes
the general reduction of tick sizes in Europe have contributed to narrow bid-ask
spreads resulting in reduced transaction costs (CESR 2010).

In many ways the technology has significantly changed the nature of competition
among market venues. Historically the main sources of revenue for stock exchanges
have been transaction fees, market data sales and listing fees charged to companies whose stocks are traded. However, the deregulation has re-shaped this traditional revenue structure. As a result of fragmentation and competition, some exchanges focus entirely on providing trading services and gain revenue from transaction fees rather than listing fees. Some market venues are also vertically integrated and besides trading also provide post-trading services such as clearing and settlement (Cantillon & Yin 2011).

New sources of revenue have also evolved, such as miscellaneous technical services demanded because of the emerging automated trading. As standing orders are generally matched in a price-time priority, the response times, often referred to as latency, to the market’s matching engine has become increasingly important to market participants, particularly for High-frequency traders. By co-locating its trading equipment in the same data center as the market venue, the low latency-connection enables fast response times to market information which reduces risk exposure and creates value for investors in terms of reduced spreads (Menkveld 2008). The activities of high-frequency traders have been credited for supplying liquidity in the market, reducing bid-ask spreads and eliminating arbitrage opportunities making markets more efficient, but in the meantime criticized for high order cancellation rates and increased intra-day price volatility (CESR 2010, SEC 2010).

As a competition parameter some trading platforms, typically the MTF-contenders, have imposed a maker-taker price scheme where only aggressive orders, taking liquidity from the market, requires payment. In the meantime passive orders, providing liquidity to the market, yields a negative-charge or compensation to the trading member. With liquidity generally seen as the most important determinant of market quality, the MTFs initially relied on generated liquidity from its founders, but were subsequently dependent on attracting outside flows as well. Improving liquidity by provide incentives for HFT-traders to quote prices and attracting as much trading as possible has been the main objective of competing European market venues after MiFID. Especially since liquidity is subject to strong positive network externalities (Chesini 2012).
Chapter 3

Critical loss analysis

In a dynamic financial market of competing venues and various off-book trading alternatives, several anticipated mergers have been investigated by competition authorities in Europe. In February 2010, the UK Office of Fair Trading (OFT) cleared the incumbent London Stock Exchange’s acquisition of the competing MTF Turquoise Trading Limited (OFT 2011). Following a reference by OFT the British Competition Commission (CC) cleared the Bats Global Market acquisition of Chi-X Europe Limited in November 2011 forming the largest pan-European MTF (CC 2011).

The following year, the European Commission (EC) blocked the proposed merger between Deutsche Börse and NYSE Euronext on the basis that the two market venues together controlled more than 90% of the global trade in area of European financial derivatives. The Commission concluded that the benefits of price competition in the relevant market would be taken away from derivatives customers (EC 2012).

3.1 Concepts of market delineation

The delineation of the relevant market plays a central role in different types of competition authority investigations, including merger cases. In both EU and U.S. jurisdictions, competition authorities must define markets before investigating competitive effects. The concept of market delineation is closely related to the concept of market power, where the latter can be defined as the ability for a firm to raise prices of its products or services above the competition level.

By defining a market and examine firms’ market shares the competition authority can get an initial hint of potential problems. In practice it can be problematic to determine how much substitution between two products that is needed for them to be in the same relevant market. There are several generally accepted techniques and quantitative methods used to define the relevant market in order to make
the decision-making process and the assessments consistent (Davis & Garces 2010, pp.161-162). In previous cases the European Commission (EC) and the European Court of Justice (ECJ) perceives very large market shares as evidence of dominance. However, both the EC and the ECJ have been criticized for paying too much attention to the market share and for neglecting other relevant market characteristics such as entry barriers (Hinloopen & Normann 2009, pp. 107-110). There is no exact market share boundary for dominance, but dominance is generally assumed for a market share above 50%. The measurement of a firm’s market share and potential dominance directly depends on the definition of the relevant market (Kirschner 2007, pp.31-33).

3.2 Hypothetical monopolist and SSNIP-test

In market delineation analysis, the hypothetical monopolist test (HMT) provides a standardized framework. The logic behind the test is to propose the candidate market with the smallest set of products such that a hypothetical monopolist would have an incentive to increase prices. If the delineation of the suggested market is to narrow, the monopolist would face strong substitution outside the proposed marked and will have no incentive to raise prices (Davis & Garces 2010, pp.201-202). In order to determine the smallest collection of products “worth monopolizing”, the price based implementation of the HMT-test is the so called SSNIP-test. It is the primary effects based approach that the European Commission applies in a market definition-process (Martin 2010, pp.788-799). It can either be used as a theoretical thought-experiment, or in some cases when relevant elasticizes are available, as an explicit econometrical analysis of demand.

The question at issue is whether a small but significant non-transitory increase in price, (hence a SSNIP-test), for a particular set of products and areas would result in a significant number of buyers turning to other sources of supply. If buyers would shift to other suppliers, those should be included in the relevant market definition (Martin 2010, pp.788-799). The test is based on the idea that products within the same market do not face significant pricing constraints from products outside the market. The term non-transitory is such as whether a monopolist of the product could profitably raise prices by 5-10% over the competitive price lasting for a foreseeable future (Coate & Fischer 2008, pp.1035), which is generally recognized as one year (Davis & Garces 2010, pp.201-202).

The SSNIP-test is performed to answer the question (Hinloopen & Normann 2009, pp.205-207):

Would a small but significant non-transitory increase in prices in the market of consideration be profitable for a hypothetical monopolist?
The HMT or SSNIP-test approach assumes that a monopolist controls all products within the market definition, and set its prices in order to maximize total profits. If a price increase would be profitable, one conclusion is that goods or services outside the market definition are not sufficient substitutes that can constrain price increases from being unprofitable.

What level that is considered a small but significant non-transitory price increase depends on the specific market. A market characterized by high volumes and small margins, a price increase would have an extensive effect on the profitability compared to a market with smaller volumes and higher margins. The conventional application of the SSNIP-methodology assumes a 5-10% price increase for a year. If there are sufficient grounds, upward or downward adjustments from the normal practice of 5-10% can be motivated when conducting the test (Davis & Garces 2010, pp.201-202).

3.3 Critical loss-test

To formally evaluate a SSNIP-test, it is not sufficient to just estimate own- and cross-price elasticities of demand, since information of the hypothetical monopolist’s marginal cost is needed to assess if the small but significant non-transitory increase in price would be profitable. Critical loss-analysis, introduced by Harris & Simons (1989), derives from the hypothetical monopolist-test and provides an applicable profitability evaluation method. Unlike the SSNIP-methodology, a critical loss-test aims to answer the following question (Davis & Garces 2010, pp.210-229):

\[
\text{How much do sales need to drop in order to render an x\% price increase unprofitable?}
\]

For a single product market, the derivation of the firm’s critical loss requires the original price \( P_0 \) and the higher price \( P_1 \) and the calculation of demand elasticities before and after the price increase, hence \( D(P_0) \) and \( D(P_1) \). The firm’s profit function is

\[
\Pi(P_1) - \Pi(P_0) = [(P_1 - P_0)D(P_1)] - [(P_0 - C)(D(P_0) - D(P_1))] = 0 \quad (3.1)
\]

where \( C \) is the firm’s constant marginal cost. Equation (3.1) can be rearranged as

\[
\frac{D(P_1) - D(P_0)}{D(P_0)} = - \frac{P_1 - P_0}{P_0} / \left( \frac{P_1 - P_0}{P_0} + \frac{P_0 - C}{P_0} \right) \quad (3.2)
\]

using equation (3.2), the critical loss-formula used to answer the question of the test can be rewritten as

\[
\%\text{Critical loss} = \frac{100 \times \%\Delta\text{Price}}{\%\Delta\text{Price} + \%\text{Initial margin}} \quad (3.3)
\]
It is clear from equation (3.3) that the size of the critical loss for a given price increase varies depending on the margin. If the initial margin is large, the critical loss becomes smaller. This is an important conclusion since firms with a high initial margin indicates that the company have market power and set prices to maximize its margins (Gravelle & Rees 2004, pp.143-155). High margins can indicate low price elasticities of demand which in return suggest a small actual loss for the hypothetical monopolist due to the increased price. The size of the critical loss appears small for companies with market power, which is important to bear in mind when comparing the estimated critical loss with the actual loss (Davis & Garces 2010, pp.210-229).

The evaluation of the profitability of a price increase is illustrated in Figure 3.1, where $A$ represents the gained revenue from higher prices on goods still sold, and $B$ represents the lost margins on goods no longer sold. The volume decrease is the hypothetical monopolists’ actual loss, and clearly if $A < B$, the price increase is not profitable (Carlton & Perloff 2005, pp.89).

![Figure 3.1. Price increase profitability trade-off](source)

The critical loss-test consists of the actual loss, estimated using a SSNIP-test and the critical loss that is mechanically obtained using Equation (3.3). Critical loss analysis can be seen as the “Break-even”-version of the SSNIP-methodology where the small but non-transitory increase in price would be profitable to the hypothetical monopolist if and only if:

\[
\text{Actual loss} \leq \text{Critical loss} \quad (3.4)
\]
3.4. FINANCIAL TRADING PLATFORMS

By applying equation (3.3) for different levels of the margin and for different increases in price, the effect of the critical loss are shown in table 3.1.

<table>
<thead>
<tr>
<th>Initial margin</th>
<th>Percentage Price Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>0%</td>
<td>100.0</td>
</tr>
<tr>
<td>10%</td>
<td>33.3</td>
</tr>
<tr>
<td>20%</td>
<td>25.0</td>
</tr>
<tr>
<td>50%</td>
<td>9.1</td>
</tr>
<tr>
<td>70%</td>
<td>6.7</td>
</tr>
<tr>
<td>90%</td>
<td>5.3</td>
</tr>
<tr>
<td>100%</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Table 3.1. Critical loss for various margins and price increases

Source: Equation (3.3)

3.4 Financial trading platforms

The industry for trading platforms on the financial market is assumed to consist of supplying firms that are building a capacity associated with comprehensive initial investments and that there are no actual additional cost for providing the services. When defining the marginal for a hypothetical monopolist in the market for Swedish shares, it is therefore reasonable to account only for the costs that the firm can dispose of as a result of the reduced volume. The costs that are not incurred if a firm ceases production is called the avoidable cost, and a firm only continue to produce if revenues exceed the avoidable cost. Hence, all costs that are not sunk costs or that will continue regardless of decision to shut down production are considered avoidable (Carlton & Perloff 2005, pp.58-60).

The incremental costs of the firm are different in the short-run and in the long-run. If long-run incremental costs are included in the measure, the hypothetical monopolist’s marginal becomes lower. For a critical-loss test, where the profitability of a price increase is evaluated, the short-run marginal is the relevant measure. The long-run incremental costs is more appropriate when analyzing firms’ capabilities to enter or remain in the market since levels of capital can be adjusted (Carlton & Perloff 2005, pp.61-62).

If the long-run marginal where to be used in the test, the critical loss would appear larger than when using a short-run marginal. The conclusion drawn from an estimated large critical loss is that the hypothetical monopolist would accept a greater decrease in volume than what had been the case if the short-run marginal had been used. The inference based on such estimation would result in a relevant market definition that is too narrow. Reversely, if the marginal is underestimated, the def-
inition of the market is wider than what is justified.

In order to be confident in the market delineation, it is preferable to define a relevant market that is too wide, than one that is too narrow. The critical loss-equation (3.3) shows the importance of choosing the relevant marginal. In this theoretical experiment, the increased price results in a volume loss, making the Average Avoidable Cost (AAC), a plausible cost measure. A conservative assumption of the relevant marginal is to let the total revenue derived from trading fees be pure profit.

As no actual margin is available, and in order to be cautious, a hypothetical monopolist controlling all market venues for trading the OMXS30-index are assumed to have an initial margin of 100%. By this conservative approach of a 100% initial margin, the revenue from trading fees for hypothetical monopolist is assumed to be pure profit. Referring to Table 3.1 a 10% trading fee increase and an initial margin of 100% results in a critical loss for the hypothetical monopolist of approximately 9.1% since:

\[ 9.1\% \approx \frac{100 \times 10\%}{10\% + 100\%} \quad (3.5) \]

Hence, 9.1% is the comparative value used in this thesis which implies that an estimated actual loss below 9.1% is considered potentially profitable.
Chapter 4

Investments and portfolio optimization

4.1 Order book mechanisms

Each stock exchange has mechanism used to match supply and demand determining the price of the traded securities. Typically there are two major market mechanisms in order book trading, quote-driven markets and order-driven markets. In quote-driven markets, market makers (providers of liquidity) commit to buy or sell securities at a given price. This result in that buyers and sellers never interact directly with each other, instead they trade with the market maker as an intermediary. The market makers self-imposed risk for holding securities and quote prices are compensated by the difference between the bid price and the ask price. Prices are adjusted by market makers in accordance with market conditions, in interaction with competing market makers and by the inventory of securities. In contrary, order-driven markets have buy and sell orders interacting directly with each other. Prices adjust to changes in the ratio of buy and sell orders (Cantillon & Yin 2011).

4.2 Transaction costs

Investment services providers serves a heterogeneous stock of clients, from professional investors such as credit institutions, pension funds or investment firms to small retail clients. When these different types of investment clients are trading financial instrument on exchanges, they normally instructs an exchange member broker to either buy or sell a security. The investment services providers (dealer-brokers) can be subdivided into two specific groups depending on the financial services provided. Discount brokers only supplies basic services such as executing orders on behalf of clients and providing price quotations for traded securities. These types of limited services have been increasingly available in recent years and are today offered by many banks and other financial institutions. On the other hand, full-service brokers, or financial consultants, provides a variety of financial facilitations such as company and sector analysis and specific buy or sell recommendations to their customers. In some cases, full-service brokers establishes discretionary ac-
counts on investors instructions where the broker are trusted to make independent buy and sell orders on behalf of the client (Bodie, Kane & Marcus 1998, pp. 65-73).

The post-MiFID liquidity fragmentation in Europe requires dealer-brokers to connect to multiple market venues in order to access the dispersed pools of liquidity. Exchange fees differ significantly across markets both in structure and in level making a comparison between different Regulated Market and Multilateral Trading Facilities problematic. Although price lists on lit market venues are transparent and non-negotiable, the total costs varies on a micro level since each specific firm have different strategies, trading volumes and fixed fees. The fixed fee charged by the market venue includes annual stock market membership, market data feeds, surveillance and management fees etc. The main fixed component that can be substantial is usually connectivity charge, ultimately affected by the number and the speed of connections to the trading platform. In addition to the fixed fees, the market venues also charge variable fees based on their members transaction volumes. The variable fees may also be subject to specific discounts based on the characteristics of the order flow such as internally matched orders or rebates when trading liquid index shares (Nasdaq OMX Nordic 2013). In summary the existence of numerous fee combinations and with some market venues, typically the MTFs, only charging for aggressive orders, it is clearly a challenge to compare the total trading costs for dealer-brokers (Chesini 2012).

Breaking down the transaction costs components of a specific order is also complicated since it involves complex relationships between many factors such as available liquidity, trade automation, price volatility, market impact, timing risk, opportunity costs, clearing and settlement costs and the particular execution cost on the market venue (Chesini 2012, pp.101). From the investor’s perspective, the total cost may also consist of further components such as searching costs, currency exchange risks and transaction taxes. Focusing specifically on the fundamental transaction cost for the investor, it consists of two particular components, the brokerage commission and the bid-ask spread. The commission compensates the broker for acting as an intermediary and typically consists of a minimum fixed charge and a variable charge calculated in basis points based on the value of the transaction. Historically, the commissions for trading common stocks were generally around 2% of the value of the transaction (Bodie et al. 1998, pp. 72-73), but a significant worldwide decline in brokerage commissions have followed since a rapid drop in U.S. brokerage commissions during the last decade. The global impact on commissions can be explained by the international financial market integration and increasing capital mobility (Chesini 2012, pp.101).

The difference in the quoted bid and offer price of the traded instrument represents a cost for the investor. One fundamental characteristic that the investor looks for is the ability to rapidly execute quantities of buy or sell orders in the market at a relatively low price impact. In order to generate and maintain sufficient liquidity in
4.3 INVESTMENT RETURNS

a market place, some market participants specialize in providing liquidity. The provision of liquidity is profitable by the implemented difference between buy and sell prices, the bid-ask spread. Most market venues today have electronic order books and are quote-driven markets where market makers are posting prices at which they commit to buy or sell a given security (Cantillon & Yin 2011, pp.330). The spread can be seen as risk compensation to the market maker providing liquidity, paid as markup by the investor for predictable immediacy of exchange (Demsetz 1968, pp. 35).

For large orders the implicit cost depends on the depth of the order book, since it is less probable to be able to execute the whole volume at the best offered price. If the amount of liquidity in the order book is low, the implicit bid-ask spread transaction cost can be significant for the investor. A highly liquid share such as those in main indices are generally characterized by narrow quoted spreads but if order book depth is sufficient still depends on the size of the order. Apparently, for an aggregated index the spread is averaged over the stocks in the index and it may also vary between venues offering trading in the particular index (Liquid Metrix 2013).

4.3 Investment returns

Let \( R_t \) represent the simple net return that determines the opportunity of the investment. In principle the rate of return of each asset depends on both changes in price and periodic dividend payments (Campbell, Lo & MacKinlay 1997, pp.9-13). However, for an index containing many different shares it is difficult to include dividend payments since they are firm specific. By excluding dividends, the simple net return or holding-period return only depends on price changes over time such as

\[
R_t = \frac{P_t}{P_{t-1}} - 1 \tag{4.1}
\]

By simplification, when including the transaction cost-component of the bid-ask spread, the investor buys the asset at time \( t \) at the ask price \( P^A_t = P_t + s/2 \) and holds the asset until \( t+1 \) when the asset it sold at the bid price \( P^B_{t+1} = P_{t+1} - s/2 \). The simple return of the investment is then

\[
R_t = \frac{(P^B_{t+1} - P^A_t)}{P^A_t} < \frac{(P_{t+1} - P_t)}{P_t} \tag{4.2}
\]

When including also the brokerage commission \( \tau \) depending on order size \( N \), the simple investment return is

\[
R_t = \frac{(1 - \tau)NP^B_{t+1} - (1 + \tau)NP^A_t}{(1 + \tau)NP^A_t} \tag{4.3}
\]
CHAPTER 4. INVESTMENTS AND PORTFOLIO OPTIMIZATION

The direct effect on the investment return by a change in the commission size is obtained by differentiating $R_t$ with respect to $\tau$ such as

$$\frac{\partial R_t}{\partial \tau} = -\frac{2}{(1 + \tau)^2} \frac{P^B_{t+1}}{P^A_t} = -\frac{2}{(1 + \tau)^2} \frac{P^B_{t+1} - s/2}{P^A_t + s/2}$$

(4.4)

Hence, for a small change in the commission $\delta$, the change in the investment return will be approximately $\delta \left( \frac{\partial R_t}{\partial \tau} \right)$. The level of the commission is assumed to cover the broker’s variable trading fee to the market venue. If the hypothetical monopolist increases its trading fees by 5-10% how will that affect the brokerage commission? To accurately estimate the change of the commission for a given change in the broker’s variable trading cost would be problematic. By assuming a low marginal for the broker and a complete pass-through of the broker’s increased variable cost to the investor, the effect of the increased trading fee is at least not underestimated.

Let $C$ denote the incremental cost and $CV$ the total cost for the broker to execute a transaction at the market venue. If the trading fee increases by a factor $\gamma$, the broker’s incremental costs increases by factor $\gamma \left( \frac{CV}{C} \right)$ and by the complete pass-through assumption, the commission level is increased by the same factor as the broker’s incremental cost

$$\frac{\gamma CV}{C} = \frac{\partial R_t}{\partial \tau} = \delta$$

(4.5)

Using equation (4.4) and (4.5) an expression on how an increased trading fee on the market venue indirectly affects the return of the investment can be derived as

$$\frac{\partial R_t}{\partial \tau} = -\gamma \frac{CV}{C} \frac{2}{(1 + \tau)^2} \frac{P^B_{t+1}}{P^A_t} = -\gamma \frac{CV}{C} \frac{2}{(1 + \tau)^2} \frac{P_{t+1} - s/2}{P_t + s/2}$$

(4.6)

In this study, the spread is assumed to be equal for all indices and constant over time. This is a limitation, although spreads in index shares are generally narrow. In order to simplify the exposition and isolate the eventual effect of investment return from an increased brokerage commission, the investment transaction cost is assumed to only depend on the commission. By assuming that $P^A = P^B = P \Leftrightarrow s = 0$, the investment return for order size $N$ and commission size $\tau$, is simply given by

$$R_t = \frac{(1 - \tau)N P_{t+1} - (1 + \tau)NP_t}{(1 + \tau)NP_t}$$

(4.7)

By simplification prices and returns are assumed to be exogenous in this thesis. The historical performance of the indices gives the investor a perception of the expected returns. Since the historical holding period returns can be either positive or negative, the expected returns relies on the approximation of the average historic performance. In this study an arithmetic average is used, which is simply the sum of returns in each period divided by the number of periods. When the objective is to forecast the performance of future periods using a particular sample of historic returns, an arithmetic average is useful (Bodie et al. 1998, pp.139-140). An alternative approach would be to use a geometric average also known as a time-weighted average return.
4.4 Portfolio risk and return

Rational investment behavior includes not only the expected return of an asset, but also the associated risk of the instrument. The expected return of most assets exhibits at least some degree of covariation with other assets. An investor that neglects the correlation of different assets exhibits an incorrect conception of the portfolio risk. The risk associated with the investors’ portfolio consists of a firm-specific or diversifiable risk and the market risk, also denoted systematic risk or non-diversifiable risk. By diversification into many different assets, the investor minimizes its exposure to firm-specific factors. Regardless of the number of assets, the portfolio cannot eliminate the systematic risk exposure. From a mean-variance perspective, it is portfolio diversification is effective when correlation between assets are less than perfectly positive correlated, when $\rho < 1$ (Bodie et al. 1998, pp.166-174).

The tradeoff between risk and return is a cornerstone of modern financial economics. Markowitz (1952) introduced the investor’s portfolio selection problem in terms of expected return and variance of return. In a survey to 38 asset management firms covering a total of $4.3$ trillion in equities, Fabozzi, Focardi & Jonas (2007) noted that Markowitz mean-variance optimization was the most dominant approach used in practice. The tradeoff between reward in terms of mean portfolio return and risk in terms of variance of portfolio return (Cochrane 2001, Markowitz 1952). Hence the first two moments of the portfolio is $\mu$ and $\sigma^2$, the mean and variance (Sharpe 1964).

The concept of mean-variance efficient portfolios relies on the following fundamental assumptions:

- The investor is only concerned with the expected return and the variance in the portfolio
- If two portfolios have the same expected return, the investor always prefer the portfolio with minimum variance

Let portfolios $A$ and $B$ have the expected return $E(R_A)$ and $E(R_B)$ and variance $\sigma^2_A$ and $\sigma^2_B$ respectively. Portfolio $A$ is assumed to be preferred to portfolio $B$ by all investors if

$$E(R_A) \geq E(R_B) \text{ and } \sigma^2_A \leq \sigma^2_B \quad (4.8)$$

By the mean-variance criterion portfolio $A$ dominate portfolio $B$. (Bodie et al. 1998, pp.173-174) For $N$ assets, the assets returns $R_i$ can be denoted as a column vector, see (Chiang & Wainwright 2005) or (Sydsaeter & Hammond 2008).

$$R = \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_N \end{pmatrix} \quad (4.9)$$
hence the vector of portfolio expected return is

\[ \mathbf{E}[\mathbf{R}] = E\left[ \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_N \end{pmatrix} \right] = \begin{pmatrix} E[R_1] \\ E[R_2] \\ \vdots \\ E[R_N] \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_N \end{pmatrix} = \mathbf{\mu} \tag{4.10} \]

and for \( N \) assets the covariance matrix \((N \times N)\) is

\[ \text{var}[\mathbf{R}] \equiv \begin{pmatrix} \text{var}(R_1) & \text{cov}(R_1, R_2) & \cdots & \text{cov}(R_1, R_N) \\ \text{cov}(R_2, R_1) & \text{var}(R_2) & \cdots & \text{cov}(R_2, R_N) \\ \vdots & \vdots & \ddots & \vdots \\ \text{cov}(R_N, R_1) & \text{cov}(R_N, R_2) & \cdots & \text{var}(R_N) \end{pmatrix} = \mathbf{\Omega} \tag{4.11} \]

in the covariance matrix \( \mathbf{\Omega} \), the variance of each asset is to be found in the diagonal forming a symmetrical matrix where \( \sigma_{ij} = \sigma_{ji} \) for \( i \in \{1, N\} \) and \( j \in \{1, N\} \) making \( \mathbf{\Omega}^T \) the transpose of \( \mathbf{\Omega} \) (Chiang & Wainwright 2005, pp.73-74).

\[ \text{var}[\mathbf{R}] = \begin{pmatrix} \sigma_{11}^2 & \sigma_{12} & \cdots & \sigma_{1N} \\ \sigma_{21} & \sigma_{22}^2 & \cdots & \sigma_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N1} & \sigma_{N2} & \cdots & \sigma_N^2 \end{pmatrix} = \mathbf{\Omega} \tag{4.12} \]

The column vector and its transpose of portfolio weights \( \omega_i \) for \( i = 1, \ldots, N \) are

\[ \mathbf{\omega} = \begin{pmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_N \end{pmatrix} \quad \text{and} \quad \mathbf{\omega}^T = \begin{pmatrix} \omega_1, \omega_2, \ldots, \omega_N \end{pmatrix} \tag{4.13} \]

The expected return of the portfolio can be written as

\[ \mathbf{\omega}^T \mathbf{\mu} = \begin{pmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_N \end{pmatrix}^T \begin{pmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_N \end{pmatrix} = \sum_{i=1}^{N} \omega_i \mu_i = \mu_{p} \tag{4.14} \]

where \( \mu_i \) denotes the expected return of asset \( i \) and

\[ \mathbf{\omega}^T \mathbf{\mu} = E[\mathbf{\omega}^T \mathbf{R}] = \mathbf{\omega}^T E[\mathbf{R}] \tag{4.15} \]

Finally, the variance of portfolio return is

\[ \mathbf{\omega}^T \mathbf{\Omega} \mathbf{\omega} = \begin{pmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_N \end{pmatrix}^T \begin{pmatrix} \sigma_{11}^2 & \sigma_{12} & \cdots & \sigma_{1N} \\ \sigma_{21} & \sigma_{22}^2 & \cdots & \sigma_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N1} & \sigma_{N2} & \cdots & \sigma_N^2 \end{pmatrix} \begin{pmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_N \end{pmatrix} = \sum_{i=1}^{N} \sum_{j=1}^{N} \omega_i \omega_j \sigma_{ij} \tag{4.16} \]
4.5. TANGENCY PORTFOLIO MATHEMATICS

It is common to include a risk-free (riskless) asset in the optimization formulation (Woodside-Oriakhi, Lucas & J.E. 2013, pp.409). The risk-free rate is the rate of return that the investor can earn with certainty. Any excess return of a share over the risk free rate is the risk premium. A Treasury bill or a money market fund can be regarded as a proxy for the risk-free rate. A bond issued by the government is considered risk-free in that sense that it is default-free. However, inflation may affect the risk-free asset return in real terms. It is however common to view a treasury bill as a risk-free asset when making investment decisions (Bodie et al. 1998, pp.143-153).

By introducing the risk-free asset $R_f$, the portfolios of consideration are composed by combinations of $N$ risky assets and the risk-free asset. The expected return of portfolio $p$ is then

$$\mu_p = \omega^T \mu + (1 - \omega^T \iota) R_f$$  \hspace{1cm} (4.17)

where $\iota$ is a conforming $(N \times 1)$ vector with each element equal to 1 (Campbell et al. 1997, pp.184-189).

### 4.5 Tangency portfolio mathematics

Given the simple order of preferences for the investor previously described, the mean-variance optimization gives the portfolio weights to choose to minimize portfolio variance $\omega^T \Omega \omega$ for an expected portfolio return, alternatively to maximize portfolio expected return $\omega^T \mu$ for a given portfolio variance. An investor choosing from $N$ risky assets and the risk-free asset $R_f$ the minimum-variance portfolio with expected return $\mu_p$ will be the solution to the following constrained optimization problem (Campbell et al. 1997, pp.181-190):

$$\min_{\omega} \omega^T \Omega \omega$$  \hspace{1cm} (4.18)

subject to

$$\omega^T \mu + (1 - \omega^T \iota) R_f = \mu_p$$  \hspace{1cm} (4.19)

The Lagrangian function is

$$L = \omega^T \Omega \omega + \lambda \left[ \mu_p - \omega^T \mu - (1 - \omega^T \iota) R_f \right]$$  \hspace{1cm} (4.20)

By differentiate $L$ with respect to $\omega$ and setting the first order conditions to zero and solve for $\omega$ gives

$$2 \Omega \omega - \lambda (\mu - R_f \iota) = 0 \hspace{1cm} (4.21)$$

combining equation (4.19) and (4.20) the scalar $\omega_p$ can be expressed as

$$\omega_p = \frac{(\mu_p - R_f) \Omega^{-1}(\mu - R_f \iota)}{(\mu - R_f \iota)^T \Omega^{-1}(\mu - R_f \iota)}$$  \hspace{1cm} (4.22)
The scalar $\omega_p$ depends on the mean of portfolio $p$ times the portfolio weight vector which does not depend on $p$ such that $\omega_p = C_p \overline{\omega}$ where

$$C_p = \frac{(\mu_p - R_f)}{(\mu - R_f \iota)^T \Omega^{-1}(\mu - R_f \iota)}$$

(4.23)

and

$$\overline{\omega} = \Omega^{-1}(\mu - R_f \iota)$$

(4.24)

Since the risk-free asset is included in the constrained optimization, all minimum-variance portfolios are a combination of the risk-free asset and given risky portfolios with weights proportional to $\overline{\omega}$. This risky portfolio represents the tangency portfolio whose weight vector is denoted $\omega_q$. By dividing the elements of $\overline{\omega}$ by their sum, the vector elements sum to one forming the portfolio weight vector $\omega_q$ of the tangency portfolio (Campbell et al. 1997, pp.184-189).

$$\omega_q = \frac{1}{\iota^T \Omega^{-1}(\mu - R_f \iota)} \Omega^{-1}(\mu - R_f \iota)$$

(4.25)

With the inclusion of the risk-free asset, all mean-variance efficient portfolios lie along the capital allocation line (CAL) from the risk-free asset to the tangency portfolio. The slope of the capital allocation between the risk-free return $(R_f, 0)$ and the portfolio $(\mu_a, \sigma_a)$ is determined by the Sharpe ratio or $sr_a$ which is defined as the mean excess return divided by the standard deviation of return

$$sr_a = \frac{\mu_a - R_f}{\sigma_a}$$

(4.26)

The allocation of portfolio weights that maximizes the Sharpe ratio, or maximizes the expected return per unit risk, is the tangency portfolio (Campbell et al. 1997, pp.184-189). The set of portfolios that offers the highest expected return for each level of portfolio variance forms the efficient frontier consisting of portfolio weights that can be considered as efficiently diversified.

If the entire investment is allocated in the risk-free asset, the investor earns the risk-free rate at a zero risk. In theory, the line is upward sloping indicating the increase in expected return for any given risk rate (Bodie et al. 1998, pp.154-155). The investor’s asset allocation depends on the trade of between risk and return. The optimal risky portfolio, or tangency portfolio, has the highest return per unit of risk, and will be chosen by investors with different risk-aversion. Investors will however differ in their allocation between the risk-free asset and the tangency portfolio of risky assets (Bodie et al. 1998, pp.178-179).
4.6 EQUITY HOME BIAS

Figure 4.1. Optimal risky portfolio
Source: Bodie et al. (1998)

The standard Markowitz-model is based on a single period return by considering the mean, variance and covariance of the assets. Since the analysis does not include any transaction costs, there is principally no penalty associated with trading making any assumption of investment horizon inapplicable. When transaction costs are taken into consideration, the investor also has to consider the investment horizon. Clearly, if two portfolios have the same mean return, but one is associated with a higher fixed or variable transaction cost, the required investment horizon for the second portfolio need to be longer to gain the same return (Woodside-Oriakhi et al. 2013, pp.406-407).

Various constraints may preclude a particular investor from choosing efficient frontier portfolios. Some clients may have a minimum acceptable rate of return (Woodside-Oriakhi et al. 2013, pp.408), or may be prohibited from taking short positions (negative positions) in any asset (Bodie et al. 1998, pp.180-181). As an additional optimization constraint the portfolio weights can be restricted such as $\omega_i \geq 0$ preventing investor from taking negative positions.

4.6 Equity home bias

As being outlined in Chapter 3, the merger effect assessment relies on the definition of the relevant market. It is obvious that potential dominance by a specific firm directly depends on how the competition authority delimits the relevant market. If the U.S. and the Asian financial markets are excluded due to regulatory
differences and other time zones, one comprehensive market definition would be a pan-European stock market where investors perceives shares from different EU-countries as close substitutes. Investments in foreign equities have increased during the past two decades, but despite foreign equities diversification opportunities many investors tend to keep a disproportionate share of domestic assets in their portfolios. This phenomena is known as *Equity home bias* and could be explained by international market frictions such as informational asymmetries, regulatory barriers and exogenous portfolio constraints (Coeurdacier & Guibaud 2011).

The correlation between stock markets depends on the level of financial integration between different countries, which in turn depends on how costly it is for an investor to trade and hold equities in another country. Huberman (2001) explained the home country bias with the tendency of people to invest in the familiar and French & Poterba (1991) showed that lack of international diversification appears to be the result of investor choices rather than institutional constraints, a tendency that conflicts the risk diversification rational of portfolio theory. French & Poterba (1991) concludes that people are more likely to concentrate their portfolios to stocks from companies they know of. Investors in different nations expected their domestic equity market returns to be higher than returns in foreign markets. Investors that are less informed on foreign markets and companies may reconcile a higher risk for such assets than just the historical standard deviations of returns.
Chapter 5

Estimation of actual loss

5.1 Theoretical background and methodology

One relevant market definition is the smallest set of products such that a monopolist would have incentive to raise prices. The experiment is a quantitative application of the market delineation concept of critical loss-analysis. The actual loss of the hypothetical monopolist due to a small but non-transitory increase in price is estimated using fundamental portfolio theory. The actual loss is compared to the critical loss based on the initial margin in order to determine whether the increase in price would be profitable or not.

The holding period return used in this study is assumed to only depend on changes in the assets pricing and the explicit commission cost associated with purchasing or selling the assets using an intermediary broker. The bid-ask spread is omitted from the analysis, as well as eventual firm specific dividend payments in the underlying assets. Average rate of returns are derived from historical performance and is used to estimate expected returns, variances and covariances. Using a risk-free rate, the expected returns vector and the variance-covariance matrix, an optimal risky portfolio is calculated by constrained optimization principles. The portfolio weights are restricted to the interval $\omega_i \in [0, 1]$ preventing the investor from taking negative positions.

The experiment aims to examine whether and to what extent the representative investor would rebalance the portfolio weight allocated in OMXS30 if a hypothetical monopolist raised the trading fees by 10%. By implementing a simple portfolio optimization-model, the tangency portfolio from a given universe of European main indices is constructed for each quarter of 2010 and 2011. The mean vector and covariance matrix are estimated using historical prices and the optimization model is constrained such that short-sales are not allowed. As a proxy for the risk-free rate the 3-month fixing rate STFIX rate is being used. The STFIX-rate is calculated daily by Nasdaq OMX as an average of Swedish government bonds and treasury
bills (Sveriges Riksbank 2013). By solving for the tangency portfolio, the weights in the different indices are noted for each given time period.

Thereafter, as a thought experiment, a hypothetical monopolist controls all platforms for trading the OMXS30-index. By assuming that the hypothetical monopolist rises the trading fees 10%, the incremental costs of the member dealer-brokers increases. If the cost increase is passed through to the investor it affects the brokerage commission associated with OMXS30 transactions. Since the expected return of the investment is assumed only to depend on historical prices and the size of the commission, an increased commission implies a lower expected return for OMXS30. The decrease in expected return is simulated by the creation of a disturbance vector affecting the expected return of OMXS30 negatively while the expected returns of the other indices are kept constant.

The tangency portfolio optimization is then re-solved for each given time period using the disturbed vector of expected returns. Since the transformation is linear, the variance-covariance matrix is unchanged. The expected negative change in portfolio weight allocated in OMXS30 represents the total volume decrease. This estimation serves as a proxy variable of the volume decrease or the actual loss of the hypothetical monopolist. Finally the actual loss is compared with the critical loss under the assumption that the initial margin of the hypothetical monopolist is 100%. If the actual loss is smaller than the critical loss for the different points in time, it indicates a plausible delimitation of a relevant market for the index OMXS30.

5.2 Underlying assumptions

The experiment also relies on these assumptions:

- The investment is made by a representative investor expecting future asset prices to increase.

- Assets prices are exogenous.

- The investor is restricted not to take negative positions by conducting short sales.

- The investor does not exhibits any equity home bias.

- The investor is trading via an intermediary dealer-broker and the investment is associated with a transaction cost.

- All indices result in the same brokerage commission level when purchasing or selling the index and the simulated commission increase only applies for trading the OMXS30-index.
5.3. DATASET AND SUMMARY STATISTICS

- The investor’s perception of the expected return of each index relies on the average historical performance. In this experiment it is assumed that the investor uses the arithmetic average of quarterly returns for the previous four quarters when making the investment.

- The portfolio risk is approximated by the variance in the historical returns of the underlying assets. The estimation is assumed to be reasonable if the historic returns are approximately symmetrically distributed around the assets mean return.

- As a proxy for the risk-free rate, the representative investor uses the Swedish 3-month STFIX-rate of Swedish government bonds and treasury bills.

- From the given universe of European main indices, the investor allocates portfolio weights to maximize the Sharpe ratio, which is equivalent to the tangency portfolio of the capital allocation line and the mean-variance efficient frontier.

- The depth of the order book is sufficient and the bid-ask spread is narrow such that is have no effect on the investment decision.

5.3 Dataset and summary statistics

The dataset include a total of six indices, where three are the indices of France, Germany and Great Britain and the other three are the main indices of the Nordic countries, Sweden, Denmark and Finland. The indices are presented in table 5.1. The number in each index represents the number of constituents.

<table>
<thead>
<tr>
<th>Index</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC40</td>
<td>France</td>
</tr>
<tr>
<td>DAX30</td>
<td>Germany</td>
</tr>
<tr>
<td>FTSE100</td>
<td>Great Britain</td>
</tr>
<tr>
<td>OMXC20</td>
<td>Denmark</td>
</tr>
<tr>
<td>OMXH25</td>
<td>Finland</td>
</tr>
<tr>
<td>OMXS30</td>
<td>Sweden</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Datastream

The historical nominal price development of the different indices under the selected time period is visualized in figure 5.1.
The available data set consists of the daily closing price of each index for the time period January 1 2010 to September 30 2011, (2010Q1-2011Q3). The closing prices are harmonized in terms of currency, but are collected from each index-specific primary market. It is not clear whether the daily closing price is the ask- or bid-price. By the previously elaborated assumptions the bid-ask spread is omitted from the transaction cost such that the only relevant component is the brokerage commission. Using daily data of historic prices, the daily holding-period return for a 90-day period is calculated for each day by

\[ R_t = \frac{P_t - P_{t-90}}{P_{t-90}} \]  

The arithmetic average of the estimated 90-day period return is then calculated for each specific quarter. The value is interpreted as the average relative price change of the index between the current day and the previous 90 days. The investor’s perception of the expected returns and the variances of the indices are assumed to derive from the moving average of the arithmetic mean returns of the previous four quarters prior to the investment date.

For an investor balancing its portfolio weights on 2010Q1, the arithmetic mean of 90-day holding period returns of 2009Q1-Q4 are being used. For 2010Q2 the mean of 2009Q2-2010Q1 and so on. In total there are eight specific investment pe-
5.3. DATASET AND SUMMARY STATISTICS

Periods during 2010 and 2011. The quarterly returns arithmetic average of each index for the entire sample period of 717 days is presented in Table 5.2. All indices have a positive mean return for the investigated time period. The OMXS30 exhibits the highest mean return but also the highest standard deviation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC40</td>
<td>0.005</td>
<td>0.128</td>
<td>-0.341</td>
<td>0.279</td>
</tr>
<tr>
<td>DAX30</td>
<td>0.038</td>
<td>0.129</td>
<td>-0.325</td>
<td>0.36</td>
</tr>
<tr>
<td>FTSE100</td>
<td>0.027</td>
<td>0.12</td>
<td>-0.359</td>
<td>0.356</td>
</tr>
<tr>
<td>OMXC20</td>
<td>0.046</td>
<td>0.147</td>
<td>-0.416</td>
<td>0.4</td>
</tr>
<tr>
<td>OMXH25</td>
<td>0.007</td>
<td>0.149</td>
<td>-0.367</td>
<td>0.322</td>
</tr>
<tr>
<td>OMXS30</td>
<td>0.072</td>
<td>0.154</td>
<td>-0.364</td>
<td>0.518</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Datastream

The historic returns of the different indices in the sample are highly correlated. A high correlation coefficient means that the indices co-vary over time which implies that two indices with similar returns and a high degree of covariation likely are interchangeable. Whenever asset returns are less than perfectly correlated there are benefits to diversification (Bodie et al. 1998, pp.174-175). The correlations between the indices are presented in Table 5.3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>CAC40</th>
<th>DAX30</th>
<th>FTSE100</th>
<th>OMXC20</th>
<th>OMXH25</th>
<th>OMXS30</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC40</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAX30</td>
<td>0.943</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTSE100</td>
<td>0.908</td>
<td>0.913</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMXC20</td>
<td>0.837</td>
<td>0.895</td>
<td>0.914</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMXH25</td>
<td>0.907</td>
<td>0.896</td>
<td>0.911</td>
<td>0.896</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>OMXS30</td>
<td>0.883</td>
<td>0.903</td>
<td>0.908</td>
<td>0.940</td>
<td>0.914</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Datastream

The risk-free rate used in this experiment is the quarterly average of the 3-month STFIX rate. The STFIX-rate is calculated daily by Nasdaq OMX as an average of Swedish government bonds and treasury bills (Sveriges Riksbank 2013). The risk-free rate used in the simulations is the average rate of the four quarters previous to the investment decision. For 2010Q1, the risk-free rate used is the mean of the four quarters of 2009 and so on.
Using the time series of prices for the different indices over the relevant time period a total of 8 expected returns vectors, 8 variance-covariance-matrices and 8 risk-free rate-values are created forming a base for the investment decision in each specific quarter of the years 2010 and 2011.

### 5.4 Vector disturbance factor

The trading fee increase of 10% is assumed to affect the brokerage commission for OMXS30-trading and as a consequence affect the representative investor’s perception of OMXS30 expected returns. The incremental cost of the intermediary dealer-broker increases as a result of the trading fee increase by the hypothetical monopolist and the increased cost are assumed to be 100% passed through to the investor.

In order to correctly estimate to what degree the commission increases requires insight in the share of the broker’s incremental cost that is related to variable market venue trading fees. For the Nordic indices the primary market is the incumbent Nasdaq OMX Nordic. With Nasdaq OMX Nordic as the former monopolist for Swedish equities, the current cash market price list serves as the most representative fee structure for a hypothetical monopolist for OMXS30. When studying the price list, it is clear that the fee structure involves fixed and value based transaction fees for both aggressive and passive orders. In addition the price list also includes a fee cap or maximum per executed order and a liquidity discount on shares that belong to OMXS30 index (Nasdaq OMX Nordic 2013).

Like the market venue trading fee, the commission is generally divided into a fixed
5.4. VECTOR DISTURBANCE FACTOR

charge and a variable charge of a few basis points depending on order size. It is reasonable to assume that in general, the total commission also has a minimum and a maximum. In order to define a plausible level of the brokerage commission for the representative investor, information of the average order size in OMXS30 is being used. During the relevant time period of 2010-2011, the average OMXS30 order in lit order books was approximately 70,000 SEK (Fidessa 2013).

The average order is used as a representative measure, bearing in mind that larger orders are usually sub-divided and even sent to different market venues in order to obtain best price and to reduce market impact. At the same time very small orders originated from private customers are presumably compiled into larger orders prior to execution in lit order books. Since the commission fee structure may vary between different dealer-broker, clients and even individual orders, an assumption of an average, generalized commission level is required. Since the Nasdaq OMX Nordic fee structure also consists of different fee lists it is difficult to estimate a representative “per order”-cost for the average broker. To avoid an underestimation of the true average trading fee, the maximum per executed order of 92.50 SEK in Fee list I are being used. For the average order size of 70,000 SEK, when ignoring fixed fees, the variable trading fee represents approximately just over 0.1% of the order size.

In this experiment the representative investor is assumed to make the investment decisions based on historic prices and merely use the dealer-broker as an intermediary to execute the purchase and sell orders. For such an execution facilitation the broker’s marginal is assumed to be narrow, say 5% such that 95% of the commission is derived from market venue trading fees. With rapidly decreasing commission levels globally, it is reasonable to assume a low marginal of intermediary brokers. By the assumption of a low broker marginal, the investment commission is approximately equal to the market venue trading fee. With a commission level of 0.1% of the order size, the total transaction cost for the investor is presumed to be 0.2% since the investment involves an initial buy order and a sell order in the end of the holding period.

With the assumption that the investor pays a 0.2% or 0.002 in commission of the order size and that 95% of the commission is derived directly from the market venue trading fees, a hypothetical 10%-increase in the trading fee would increase the commission by 9.5% such that 0.002 × 1.095 = 0.0219. The commission paid for trading OMXS30 increases from 0.002 to approximately 0.0022 or +0.02%. If the same commission level are being used for the indices included in the sample, the expected return of an OMXS30-investment are decreasing with -0.0002 or -0.02% compared to the other indices.

By equation (4.7), the increased commission level decreases the expected investment return for OMXS30. The assumptions of how the hypothetical trading fee
increase of OMXS30 would affect the investor’s expected return are summarized in Figure 5.2.

The initial eight vectors of expected returns for the different investment periods \( \mu_t \) for \( t = 1, ..., 8 \) are disturbed using a constructed column vector \( \Phi_t \) that negatively affects the expected returns of OMXS30 linearly, while the expected return of the other indices are kept constant. The same factor is used for all \( t \) such that \( \Phi_t = \Phi \).

The disturbed vectors of expected returns , are denoted \( \hat{\mu}_t \) and are calculated by

\[
\mu_t + \Phi = \hat{\mu}_t \quad \text{or} \quad
\begin{pmatrix}
    E(\text{CAC40}) \\
    E(\text{DAX30}) \\
    E(\text{FTSE100}) \\
    E(\text{OMXC20}) \\
    E(\text{OMXH25}) \\
    E(\text{OMXS30})
\end{pmatrix}
+ \begin{pmatrix}
    0 \\
    0 \\
    0 \\
    0 \\
    0 \\
    -0.0002
\end{pmatrix}
= \begin{pmatrix}
    E(\text{CAC40}) \\
    E(\text{DAX30}) \\
    E(\text{FTSE100}) \\
    E(\text{OMXC20}) \\
    E(\text{OMXH25}) \\
    E(\text{OMXS30\_dist})
\end{pmatrix}
\]

The transformation of the OMXS30-values are linear, so OMXS30 and the negatively disturbed OMXS30\_dist. are perfectly correlated and the variance-covariance matrices \( \Omega_t \) remains unchanged.

Figure 5.2. Trading fee increase effect of OMXS30 expected return
Chapter 6

Results and discussion

6.1 Computational results

Table 6.1. Tangency portfolio portfolio weights

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>CAC40</th>
<th>DAX30</th>
<th>FTSE100</th>
<th>OMXC20</th>
<th>OMXH25</th>
<th>OMXS30</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Q1</td>
<td>0</td>
<td>0.00109</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.99891</td>
</tr>
<tr>
<td>2010</td>
<td>Q2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00080</td>
<td>0.99920</td>
</tr>
<tr>
<td>2010</td>
<td>Q3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.43511</td>
<td>0</td>
<td>0.56489</td>
</tr>
<tr>
<td>2010</td>
<td>Q4</td>
<td>0</td>
<td>0</td>
<td>0.04307</td>
<td>0.74749</td>
<td>0</td>
<td>0.20944</td>
</tr>
<tr>
<td>2011</td>
<td>Q1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.25812</td>
<td>0</td>
<td>0.74188</td>
</tr>
<tr>
<td>2011</td>
<td>Q2</td>
<td>0</td>
<td>0.06837</td>
<td>0</td>
<td>0.40446</td>
<td>0</td>
<td>0.52717</td>
</tr>
<tr>
<td>2011</td>
<td>Q3</td>
<td>0</td>
<td>0.66292</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.33708</td>
</tr>
<tr>
<td>2011</td>
<td>Q4</td>
<td>0</td>
<td>0.99771</td>
<td>0.00229</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Datastream

Table 6.2. Actual loss estimations

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>OMXS30</th>
<th>OMXS30_dist</th>
<th>% Actual loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Q1</td>
<td>0.998911251</td>
<td>0.998910154</td>
<td>-0.00011</td>
</tr>
<tr>
<td>2010</td>
<td>Q2</td>
<td>0.999199649</td>
<td>0.999200611</td>
<td>0.00010</td>
</tr>
<tr>
<td>2010</td>
<td>Q3</td>
<td>0.5648929</td>
<td>0.5615865</td>
<td>-0.58531</td>
</tr>
<tr>
<td>2010</td>
<td>Q4</td>
<td>0.20944395</td>
<td>0.20279126</td>
<td>-3.17636</td>
</tr>
<tr>
<td>2011</td>
<td>Q1</td>
<td>0.7418798</td>
<td>0.7387037</td>
<td>-0.42812</td>
</tr>
<tr>
<td>2011</td>
<td>Q2</td>
<td>0.52717389</td>
<td>0.52258728</td>
<td>-0.87004</td>
</tr>
<tr>
<td>2011</td>
<td>Q3</td>
<td>0.3370791</td>
<td>0.3283735</td>
<td>-2.58266</td>
</tr>
<tr>
<td>2011</td>
<td>Q4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Datastream

The eight simulated investment dates are the first day of each quarter of 2010 and 2011. In each quarter the portfolio weights when using the original vector
\(\mu_i\) are presented in Table 6.1. In all quarters except the fourth quarter of 2011, the optimal risky portfolios have a non-zero weight for the OMXS30-index. When the optimization problem is re-solved with vectors \(\hat{\mu}_t\), all quarters with an initial OMXS30 portfolio weight, the weight decreases. The most extensive reduction where in 2010 Q4 where the OMXS30-weight decreased by just over 3% and the average estimated volume loss over all simulations where approximately -0.96%.

### 6.2 Concluding comments

For a small but significant non-transitory increase in price of 10% and an initial margin of 100%, the critical loss for a hypothetical monopolist corresponds to 9.1%. Given the computational results for all the specific points in time, the actual loss appears to be smaller than the critical loss indicating that a price increase would be profitable. Based on the assumptions that the representative investor makes the investment decision from historical index risks and returns, these results shows that Swedish equities could be delimited as a separate relevant market. In this thesis, the interchangeability between main European indices is tested using conventional portfolio optimization procedures. Although many underlying assumptions and simplifications are being made in order to conduct the simulations, the results shows that a small increase of the transaction cost do not have a significant effect on the representative investor’s portfolio weights. The exclusion of the bid-ask spread component from the transaction costs is indeed a limitation of the model although main indices are liquid shares with tight spread. The bid-ask spread can be a substantial part of the total trading cost especially for larger orders where it is more difficult to execute the entire volume at the best quoted price.

One plausible effect of an increased trading fee for OMXS30 is that it could lower the liquidity in the traded shares. This would cause an indirect effect such that the OMXS30-spread increases when the trading fee is raised by the hypothetical monopolist. Even though the model does not control for such an indirect effect, it is presumably not a problem. Since the index liquidity in the study is intentionally overestimated and the brokerage commission supposedly affects expected returns in liquid assets more than in illiquid assets with wider spreads, one can suggest that the simulated effect of increased trading fees is an overestimation of the real effect. Although, one counterargument is that the implicit trading costs indeed would increase due to increasing spreads. Since market venues are two-sided platforms with makers and takers of liquidity, another effect of a trading fee increase would be increasing costs for providers of liquidity. This thesis are focusing on the buy-side, where investors are trading through broker firms, but a general trading fee increase of a hypothetical monopolist would cause less profitability also for liquidity providers. High-frequency traders (HFT) providing liquidity are likely very fee sensitive due to high fixed costs and a low marginal on each executed trade. If no price discrimination is conducted by the hypothetical monopolist such that HFT is
6.2. CONCLUDING COMMENTS

also subject to increased trading fees, the HFT-firms presumably compensates their
decreasing margins by quoting wider. This would negatively affect the transaction
costs for investors as liquidity deteriorates. If the hypothetical monopolist would
take into account this elaborated indirect effect and expect liquidity to decrease, the
hypothetical monopolist would be disciplined in that sense when setting its prices.

The heterogeneity among financial market participants complicates any attempts to
estimate eventual substitutability between different instruments and asset classes.
Some investment decisions are based on fundamental analysis while others are based
entirely on technical analysis. Some orders have a conceived holding period of sev-
eral years, while others are measured in microseconds. Some investors are restricted
to actively allocate a minimum proportion in shares from a specific country or indus-
trial sector and even in the absence of formal restrictions; many investors’ exhibits
a degree of home bias. From this perspective, the substitutability between differ-
ent indices appears to be low, especially between different countries where currency
risk and additional brokerage fees may apply. What this study attempts to capture
is the representative investor that is essentially indifferent between the European
indices and might contemplate between where to invest. Even though the included
indices appears to be close substitutes due to high correlation coefficients, the dif-
fences in average holding period returns are of such importance that the simulated
brokerage commission appears to have little or no effect on the investment decision.
If the correlation between two indices is high and the returns are relatively equal,
the substitution is likely to be large. With similar expected returns of the included
indices and given the high degree of correlation, the decrease in OMXS30 portfolio
weights could had been of such extent that the price increase might not had been
profitable.

The imposed competition in European financial markets by the implementation
of the MiFID-directive has led to a fierce price competition between market venues.
With a comprehensive technological development and increasing automated trading,
market efficacy has improved and has brought lower trading fees to market partic-
ipants. These factors can be seen as the main explanations to the global trend of
rapidly decreasing commission levels. While brokerage commissions are decreasing,
the importance to access liquidity due to fragmentation has increased, switching
the focus of transaction costs from commissions to available liquidity in terms of
order book depth and bid-ask spreads. As for trading large orders, it is likely that
the brokers splits the order into several sub-orders and use multiple trading venues
to achieve the best execution for the client. While the European financial markets
is highly integrated with a harmonized regulatory framework and with alternative
market venues offering pan-European trading, investment decisions are almost as
diverse as individuals. In the absence of heterogeneous aspects such as equity home
bias or investment regulations, this study shows that an application of a price-based
hypothetical monopolist-test indicates that country specific shares can be delimited
as a separate relevant market.
References


REFERENCES


REFERENCES


Appendix A

R output

The expected returns and other index statistics are calculated in STATA, while R is used for the portfolio optimization using the quadratic optimization solver \textit{Solve.QP}.

The chosen investment dates are the first day of each quarter of 2010 and 2011, in total 8 different periods in time. The red dot represents the tangency portfolio chosen by the investor, while the light blue dot shows the minimum variance portfolio. The individual assets are the hollow dots and the dark blue dot shows the equal weights portfolio. For this portfolio simulation with 6 indices, the equal weighs portfolio with $\omega_i = \frac{1}{6}$ $\forall i$
APPENDIX A. R OUTPUT

Figure A.1. Efficient frontier - 2010 Q1

Figure A.2. Portfolio weights plot - 2010 Q1
Figure A.3. Efficient frontier - 2010 Q2

Figure A.4. Portfolio weights plot - 2010 Q2
APPENDIX A. R OUTPUT

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**Figure A.5.** Efficient frontier - 2010 Q3

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**Figure A.6.** Portfolio weights plot - 2010 Q3
Figure A.7. Efficient frontier - 2010 Q4

Figure A.8. Portfolio weights plot - 2010 Q4
Figure A.9. Efficient frontier - 2011 Q1

Figure A.10. Portfolio weights plot - 2011 Q1
Figure A.11. Efficient frontier - 2011 Q2

Figure A.12. Portfolio weights plot - 2011 Q2
Figure A.13. Efficient frontier - 2011 Q3

Figure A.14. Portfolio weights plot - 2011 Q3
Figure A.15. Efficient frontier - 2011 Q4

Figure A.16. Portfolio weights plot - 2011 Q4