LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
School of Business
Finance

Henri Sipilä

EXCHANGE RATE VOLATILITY AND THE USE OF FOREIGN CURRENCY DERIVATIVES: IMPACT OF 2008 GLOBAL FINANCIAL CRISIS

Supervisor/Examiner: Associate Professor Sheraz Ahmed

Examiner: Professor Mikael Collan

TIIVISTELMÄ

Tekijä:	Sipilä, Henri
Tutkielman nimi:	Valuuttakurssien volatiliteetti ja valuuttajohdannaisten käyttö: Vuoden 2008 globaalin finanssikriisin vaikutus
Osasto:	Kauppatieteellinen tiedekunta
Pääaine:	Rahoitus
Vuosi:	2013
Pro gradu –tutkielma:	Lappeenrannan teknillinen yliopisto 79 sivua, 11 kuvaa, 5 taulukkoa, 5 liitettä
Tarkastajat:	Associate Professor Sheraz Ahmed Professor Mikael Collan
Hakusanat:	valuuttajohdannaiset, valuutta, suomalaiset yritykset
Keywords:	currency derivatives, currency, Finnish firms

Tämän tutkimuksen tarkoituksena on selvittää valuuttakurssien volatiliteetin vaikutusta yritysten valuuttajohdannaisten käyttöön. Erityisesti kiinnostuksen kohteena on vuoden 2008 globaali finanssikriisi, joka kasvatti pääomamarkkinoiden riskitasoa huomattavasti. Muutosta valuuttajohdannaisten käytössä tarkastellaan erityisesti eri periodien keskiaroja vertailemalla sekä täydentävällä mallilla, lineaarisella regressiolla, jota hyödyntäen voidaan katsoa mallin kokonaisvaikutusta. Tutkimusaineistona on käytetty yritysten julkaisemia tilinpäätöstietoja tilikausilta 2006–2011. Valuuttakurssien volatiliteetit on laskettu käyttäen hyväksi EKP:n päivittäin julkaisemia noteerauksia kullekin tutkimuksen kohteena olevalle valuuttaparille. Volatiliteettien perusteella aineisto jaetaan kolmeen periodiin näin volatiliteetin perusteella. Tulosten perusteella voidaan päätellä, että valuuttamarkkinoiden kasvanut riski ei kasvattanut yritysten valuuttajohdannaisten käyttöä tutkituissa kolmessa valuuttaparissa. Myöskään valuuttakurssien volatiliteetti ei tämän tutkimuksen puitteissa paranna aikaisempien mallien estimointivoimaa.

ABSTRACT

Author:	Sipilä, Henri
Title:	Exchange rate volatility and the use of foreign currency derivatives: Impact of 2008 global financial crisis
Faculty:	School of Business
Major:	Finance
Year:	2013
Master's Thesis:	Lappeenranta University of Technology 79 pages, 11 figures, 5 tables, 5 appendices
Examiners:	Associate Professor Sheraz Ahmed Professor Mikael Collan
Keywords:	currency derivatives, currency, Finnish firms

This thesis examines the impact of foreign exchange rate volatility to the extent of use of foreign currency derivatives. Especially the focus is on the impacts of 2008 global financial crisis. The crisis increased risk level in the capital markets greatly. The change in the currency derivatives use is analyzed by comparing means between different periods and in addition, by linear regression that enables to analyze the explanatory power of the model. The research data consists of financial statements figures from fiscal years 2006-2011 published by firms operating in traditional Finnish industrial sectors. Volatilities of the chosen three currency pairs is calculated from the daily fixing rates of ECB. Based on the volatility the sample period is divided into three sub-periods. The results suggest that increased FX market volatility did not increase the use foreign currency derivatives. Furthermore, the increased foreign exchange rate volatility did not increase the power of linear regression model to estimate the use foreign currency derivatives compared to previous studies.

ACKNOWLEDGEMENTS

Working with thesis has been a very interesting and challenging experience. After many ups and downs during the process there are many people to thank for pushing me to finish this thesis. Great thanks goes to professors Sheraz Ahmed and Mikael Collan who, especially in the later parts of the process, guided me towards the end with great knowledge.

My parents Merja and Jarmo have pushed me towards the goal and being supportive during all this time, sincere thanks for doing that. Most of all, I would like to thank Juulia for her irreplaceable support during these four five years of studies at Lappeenranta and Vantaa.

Helsinki, April 22nd, 2013

Henri Sipilä

Table of Contents

1 INTRODUCTION

1.1 Overview of the study

The focus of this study is to identify how foreign exchange rate volatility has impacted on foreign exchange transaction risk management in large non-financial Finnish firms. This will describe if and how firms adjust their hedging activities when foreign exchange market risk level can be seen increasing. While Finland can be regarded as an open economy, large firms in various industrial sectors operate in global markets either through their sales or purchasing activities. Firms seek global markets to increase their sales potential or raw materials to find cheaper “ingredients” for their manufacturing. It can be said that only very few large firms are not exposed to exchange rate risk. The outcome of this study is to illustrate whether traditional Finnish industrial firms have adjusted their hedges with respect to foreign exchange market risks dynamically before, during and after the financial crisis that began in 2008. Results will help to define if changes in foreign exchange market risk increase firms’ desire to increase their hedge level of foreign exchange risk. If not firms might be hedging statically according to their policies regardless of market conditions.

This study is interesting because it will shed light on how dynamically Finnish firms hedge their foreign exchange risk. While many companies, especially large ones, have effective policy to define target hedge ratio. It is then under risk that firms don’t hedge according to market risk but only based on their policies. This information is useful for foreign exchange sales people in corporate banking. They can use the results to estimate if increase in market risk level is likely to increase firms’ interest to purchase more hedging products.

Theoretical background of this study is a combination of theories from risk management and finance. Effective risk management enables firms to fulfil its strategy and reach for both short and long term targets. Usually this is

the task of financial department or treasury department to manage financial risks. Commonly financial risk management is centralized to either finance or treasury top management. Foreign exchange risk management is centralized very often to treasury department. Other risks such as operative and insurance risks are usually managed in large firms by separate risk management team. Since the foreign exchange risk very well identified among the large firms instead of analyzing the existence of foreign risk management it is more interesting to analyze the extent of foreign risk management. Theoretical background is drawn in to a coherent analysis by combining and analyzing relevant, found previous state-of-the-art studies. In the analysis of the previous studies attention is paid only to the most relevant input of those studies with respect to this study.

The focus of this study is to analyze the impact of changes in market risk level to the extent of foreign exchange risk hedging. Financial risks are commonly divided into three categories.

1. Credit risk consists of counterparty creditability and valuations related products.
2. Operational risks are those that incurs by the internal activities of an organization.
3. Market risks are those which may have impact on value of the portfolio. Portfolio may consist of either real or financial investments or both. Among the market risks there are defined to be:
    a. equity,
    b. interest rate,
    c. commodity and
    d. foreign exchange risks

This study focuses to the foreign exchange risk that is under the market risk.

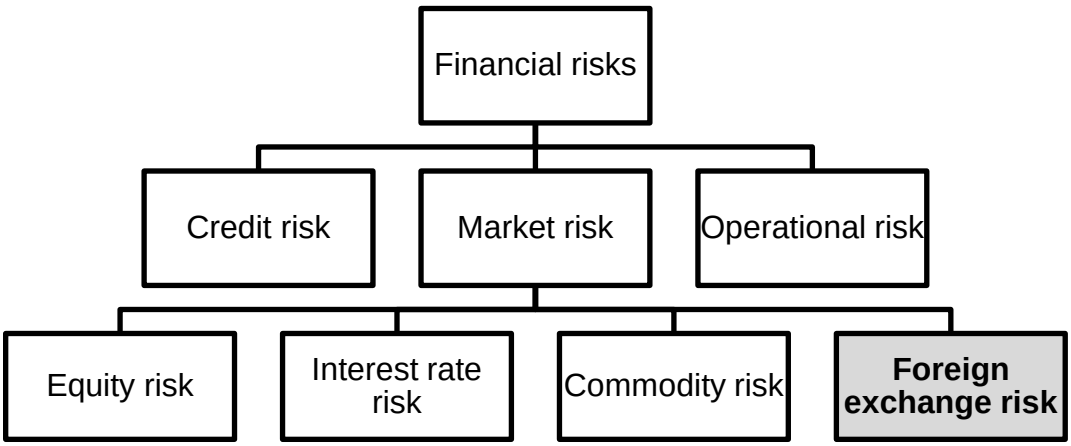


Figure 1.Scope of the study on foreign exchange risk.

As an example of how firms operatively distribute their risk management Metso Plc recognizes also strategic, operational, hazard and other risks. Furthermore, in the financial risks there are also interest rate risks and commodity price risks that are not covered in the study. This framework is only to deepen the understanding that financial risks studied here are only part of the risk framework faced by one of the firms in the sample group.

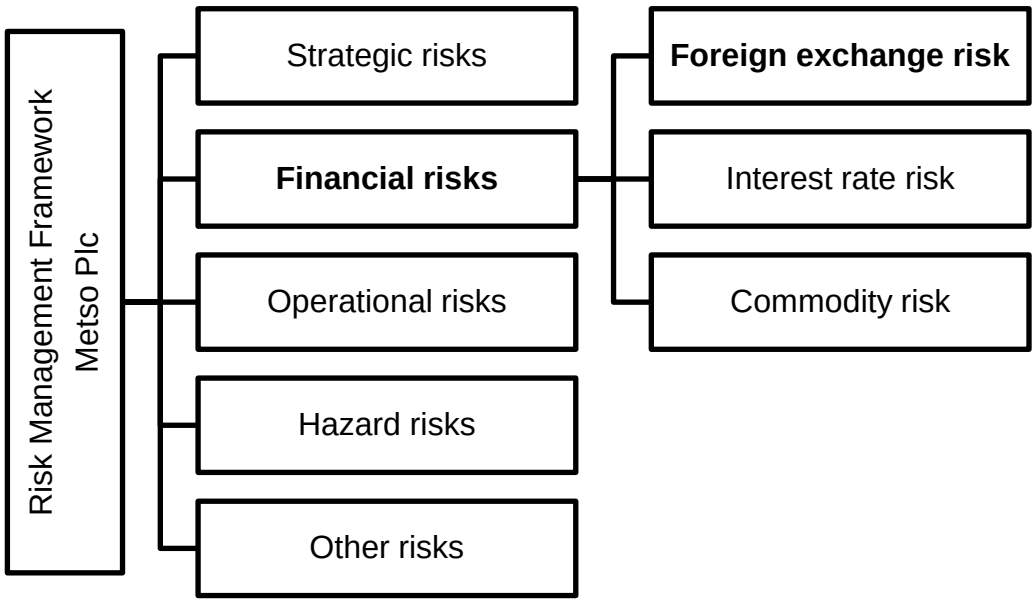


Figure 2.Risk management framework of Metso Plc (Metso Plc 2012)

1.2 Focus of the study

The scope of this study is on the Finnish firms. Previous studies in the field of derivatives use have focused on either some other country or geographical area. Very few studies have paid attention to the country specific aspects of Finland. Finland could be regarded as somewhat open economy. In this respect there are only few limitations in regulation that would effect on derivatives use of firms. Furthermore, small domestic markets encourage firms to seek opportunities overseas and hence, to bear possibility of foreign currency risk to increase their markets. To meet the geographical scope of the study no firms that have their headquarters abroad are included in the sample group. In those firms it is likely that risks that are commonly hedged with derivatives are managed centrally at the group headquarters from the point of view of the foreign parent company. Therefore in these transactions counterparty of derivatives transactions would be some internal party in the group structure. Financial risks that are managed centrally or from the view point of parent company could be dealt with completely different principles at subsidiary. In this study firm is regarded to be Finnish if it has its group headquarters in Finland and reports its consolidated group financial statement for the entity registered in Finland.

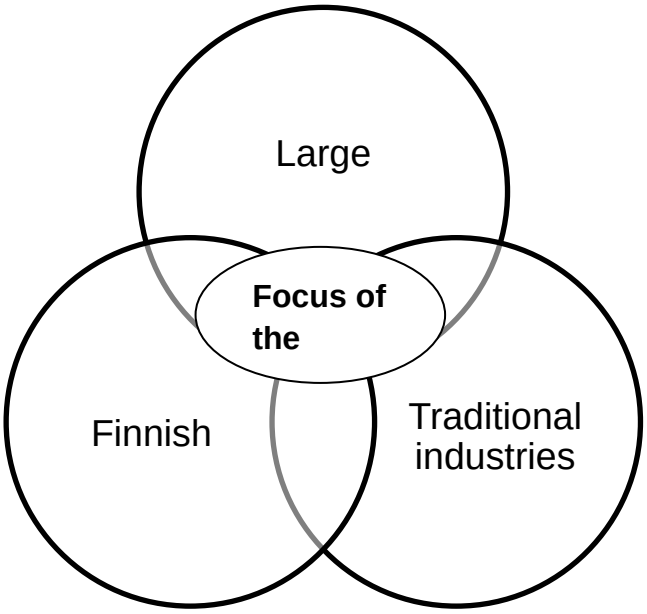


Figure 3.Focus area of the study.

Large and publicly traded firms are in the scope of the study to have rather homogenous sample group. Large in the scope of this study are those listed in either Large- or Mid-Cap lists in Nasdaq OMXH stock exchange. Size and listed stocks put firms under a rather tight regulation on how information is distributed annually and quarterly. While these firms are more regulated it also leads to a situation where the reported information follows better the same principles and, in many cases are even approved by the same auditors. Therefore the data and information from company to another can be expected to be well comparable. Size limitations on the firms have been placed in order to limit too large variations between different companies. When only stock listing would be the limitation there is a possibility of issues. While some firms may have billions of euros net sales, others have very small, only couple of millions. In that case it would be more difficult to have homogenous sample group that have not too wide variation in its descriptive statistics.

This study pays attention only to the three traditional industrial sectors in Finland. These are Oil & Gas, Basic Materials and Utilities. In these three sectors operate some of the largest and oldest firms in Finland. These are based on the Industry Classification Benchmark (ICB) sector classifications and their ICB codes are 0001, 1000 and 7000 respectively. Firms operating in these sectors do not face the issues related to financial firms. Financial firms are likely to be more active firms in trading operations; many firms may focus directly to trading of capital markets products. Furthermore, these sectors are generally regarded as traditional firms.

This study focuses to analyze the sample data collected of derivatives use at company level. Sample group is identified from the information collectable from Nasdaq OMX Nordics web page. Sample group is selected by choosing the largest firms in the selected industry classes. Classification is based on the Nasdaq OMX classification. Data of derivatives use is collected by reading through financial statements of the sample group firms. Publicly traded firms should state their open derivatives positions at the year-end financial statement notes according to international financial reporting standards (IFRS). In this study a firm is recognized to use derivatives in its operations if it had an open position reported at the year-end financial statement. From each company the nominal value of derivatives used for hedging is collected on three very commonly used currency pairs. These are:

- EUR/USD
- EUR/SEK
- EUR/NOK

EUR is regarded as the base currency for the sample group companies since they are all headquartered in Finland. Many firms may have as well internal risks in other currency pairs and in those where EUR is not a base currency. These situations might exist for example when Finnish firm have

a subsidiary in Sweden which has sales in Norwegian Krone. Risk in this case is in SEK/NOK. However, other than EUR based currency risks are seldom among the large Finnish firms and hence, excluded from the analysis.US Dollar, Swedish Krone and Norwegian Krone are selected to be the key currency pairs in this study since they can be said to be highly important for Finnish firms. Many other currencies can also be of high significance for many companies, but these three are common for the whole sample group. US dollar is interesting since it is the currency of international trade with European euro. Swedish and Norwegian Krones are important for Finnish firms since many of them receive large part of their sales in those currencies, if not in US dollars.

The scope of the study is not to analyze the whole Finnish markets or firms abroad. This study does not focus on other fields of the risks firms face in their operations than the financial risks. There is no analysis on the use of interest rate or commodity derivatives. Furthermore, the analysis of this study focuses only on the hedging of transaction risk. That is those risks that are related to hedge foreign currency risks raised from sales and/or purchases in foreign currencies than the operational currency of the parent company in the group structure.

1.3 The research question

In this study it is examined how the foreign exchange derivatives nominal values have changed on average during the years 2006 to 2011 in reported derivatives positions. This time period is distributed based on the global financial crisis that began 2008.To be able study how have the nominal values changed around the 2008 global financial crisis other, more detailed aspects have to be studied to support that. It is required to study more detailed how has the foreign exchange risk level changed during the study period. Furthermore, it is also needed to study how the

nominal values of derivatives use have evolved during the period. With these two supporting questions it is possible to answer the final research question.

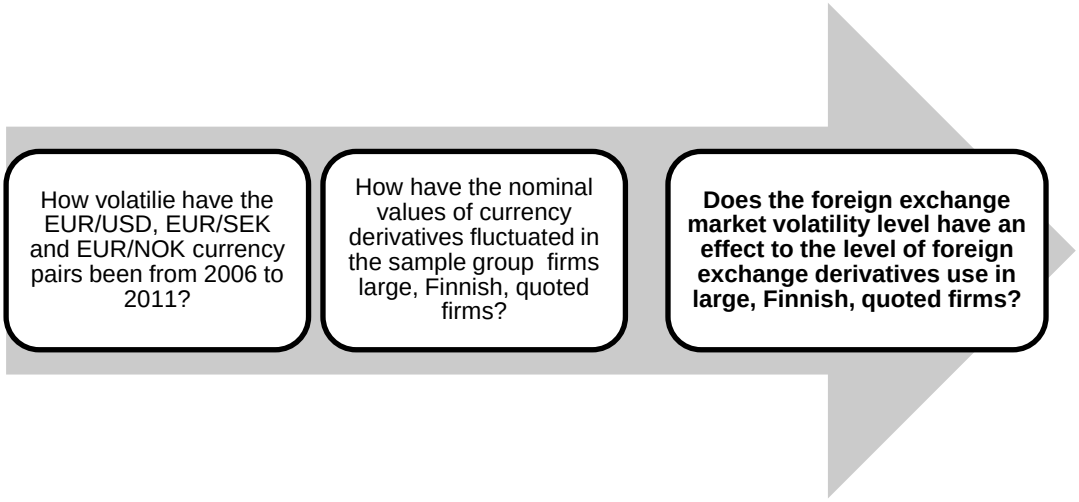


Figure 4.The research question and sub-questions.

The sub-questions provide insight on reliability and on how well results received in the analysis of the primary research question can be generalized. The sub-questions here describe both currency markets and overall year-over-year fluctuations in the nominal values of derivatives hedges. Currency market volatility as such provides information from the risk sensitivity of that specific market. Currency markets are highly liquid compared to other parts of the capital markets. Still, high volumes in the market do not describe at all the magnitude of changes in that market. The other participant of the primary research question is analyzed as such to see how much do firms adjust their derivatives use at all. Nominal values of the derivatives use can of course be in relation of the market volatility, but to see if it changes at all is worth studying. If company follows only its policies and does not observe market nominal value would change only in relation to underlying. While we are handling only those derivatives used to hedge transaction risk the underlying asset is the future cash flow. Hence, nominal values of hedges would change in relation to net sales.

Therefore, if nominal values of derivatives hedges do change relatively much it can be seen that there are other aspects effecting on the hedging habits.

The methods used to conduct in this study are basic econometric methods. That is, economical applications of standard statistical methods. These methods are used to conduct the analysis of the sub-questions. Primary research question is studied by comparing percentage changes in the nominal values of derivatives and changes in annual daily volatilities.

Introduction section is followed by theoretical framework in section two including both review of the state-of-the-art previous literature and review of the key financial theory. In section three research methods and sample group are dealt with. Section four focuses on the results of the empirical analysis and in section five conclusions are drawn.

2 THEORETHICAL FRAMEWORK

2.1 Financial theory behind the study

Theoretical background of this study culminates to corporate risk management. It is very commonly used to state that, in principle, in corporations risk management is irrelevant to the value of the firm. This classical statement of Miller and Modigliani (1958) however points out few not so commonly understood conditions. This statement applies only when

- Conditions of the efficient market hypothesis apply.
- Instrument that investor would like to purchase are available at market price anytime investor is willing to make the trade.

Their first proposition related to the efficient markets assumes that interest rate level is not affected by the leverage of a firm excluding the tax effect. This means that an investor is able to sell and buy instruments without any transaction fees, taxes etc. Their propositions I and II, under the conditions mentioned in their study (Miller, M., Modigliani, F. 1958), imply that neither cost of capital nor the financial structure of a firm have effect on the firm value. The capital structure insignificance is the Proposition III where they come into a conclusion that no matter how the firm capital structure is build up or adjusted it has no impact on firm value. It is however important to bear in mind that the scope of the proposition is the choice of instruments used for financing future investments. Bonds or stocks used as a source of new funding effect on firm value similarly. The theorem will not apply to the investment decision itself. The investment decision may very well have impact on valuation. (Miller, M., Modigliani, F. 1958)

Corporate risk management as a framework has been studied generally widely and from the very corners of it. This might be because the risk management in corporations is conducted by the personnel that may not always have such an academic perspective on the field they are working

on. Sophisticated mathematical models may every once in a while go over their heads. According to Malkin (1994) George Soros has stated in the US Congressional testimony that even the sophisticated investors may not always be aware of the risks related to the products. Few examples of this are Procter & Gamble's significant loss in a basically harmless interest rate swaps deals. The loss in their trade totalled up to 157 million US dollars back in 1994. The idea was to assume that interest rates would continue fall and fixed debt was swapped to floating. However, this is only a small unsuccessful deal compared to what a German industrial conglomerate Metallgesellschaft AG lost on its purely speculative trades on oil futures only a year before Procter & Gamble case. Metallgesellschaft AG booked a total loss of over 1,3 billion US dollars. In both cases relevant risks were not properly analyzed and underlying product related volatility was misinterpreted. (Malkin, L. 1994)

The previous examples only show the top of the iceberg of publicly pointed out losses. They however highlight the importance of derivatives in an extreme case to firm value. The Miller and Modigliani (1958) statements lasted as a principle of a modern finance until the 1970s recently during the past decades the theorem has been taken a little bit further. As the financial markets have been observed to not to operate as efficiently as it was assumed. In the modern finance internally generated funding has appeared to be the most tempting choice for a firm in respect of cost of funding. On the other hand, it turns out that the role of risk management would be to ensure the availability of funding for a firm to make value creating investments. While the further implication of modern finance applies it is of high importance for corporate risk management personnel to ensure that financial risks such as foreign currency rates changes or interest rate changes have no effect on the investment opportunities of a firm by cutting down the cash flow. (Froot et al. 1994)

How the financial risk is then defined? Often risk is defined as a chance for a downside uncertainty; a possibility of loss. However, in financial

sciences risk is later on defined according to Markowitz (1952) Portfolio selection. In his work on the modern portfolio theory he deals with the relation of risk and return. The risk in modern portfolio theory is measured as a variance of portfolio return. In this respect it is also possible that risk, as a variance, can have also upside. In other sense, this means that risk, according to Markowitz (1952) may have a positive return. Risk and return would go hand-in-hand where higher risk can lead to a greater return but also to a greater loss. In corporate risk management, hedger would prefer to achieve certainty of the level of return. In this perspective, in corporate risk management only certain level of risk is selected and then return would be given.

2.2 State-of-the-art literature review

State-of-the-art literature review is conducted to find the most relevant previous studies to draw comprehensive analysis on the current stage of the studies. The database search included three global scientific databases. Each of the databases is a well-known science journal database. EBSCO provides various databases specialized for different fields in science. Here the business database has been used to provide most accurate matches. Other two, Emerald Journal and Elsevier Science Direct, are general scholar databases. The search tool used to perform the database search conducted cross-database check to remove multiple matches. Therefore, one study shows up in the total numbers only once even though the same study can be found in multiple sources.

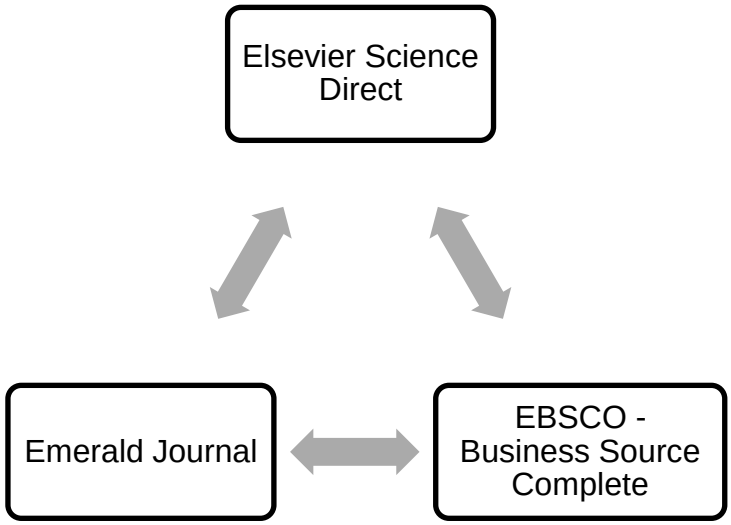


Figure 5. Databases used to collect an overview on previous state-of-the-art research.

In the three databases search was conducted to find the most up-to-date and accurate state-of-the-art studies in the fields of currency volatility and hedging. The search was begun with looking for proper terms and to see what kind of results databases would provide. After going back and forth with the possible search terms and by reviewing search results with different combinations the final terms ended up to be the following:

"Currency *Exchange Volatility AND Risk Management AND Derivative?*"

The first search in the databases was performed with the combination of terms *Currency volatility* AND *Transaction risk management*. However, these turned out to be too general and slightly off the topic terms. These resulted up to 3153 results, but with low quality. It was pointed out that term: risk management brought in many results that had nothing or very little to do firm firms, volatility or hedging activities. It was first defined deeper to see if including derivatives in the term would support with the better quality in the results. With including derivatives the amount of results decreased to 1327. This also improved the quality to be more

accurately on the topic. Need for further analysis of search terms was inevitable when it was noted that only very few of the results were match to the topic of this study.

After the review of the previous search outcomes it was noted that both terms *Currency* and *Exchange* needed to be included. Volatility could be included as part of the first search term to specify that it is the combination of foreign exchange rates and their volatilities. *Transaction Risk Management* needed to be adjusted so that also those articles that didn't include transaction risk would be included. The amount of results increased greatly because of this, but the quality of the most relevant studies increased significantly. Term "Derivative?" was kept in as one of the search parameters. With these terms the total amount of results ended up to be 2015. Even though many out-of-scope results were included in the group, attention was paid to the 100 most relevant results to find out the appropriate state-of-the-art studies for further analysis. The flow of the search process is shown in the figure 5.

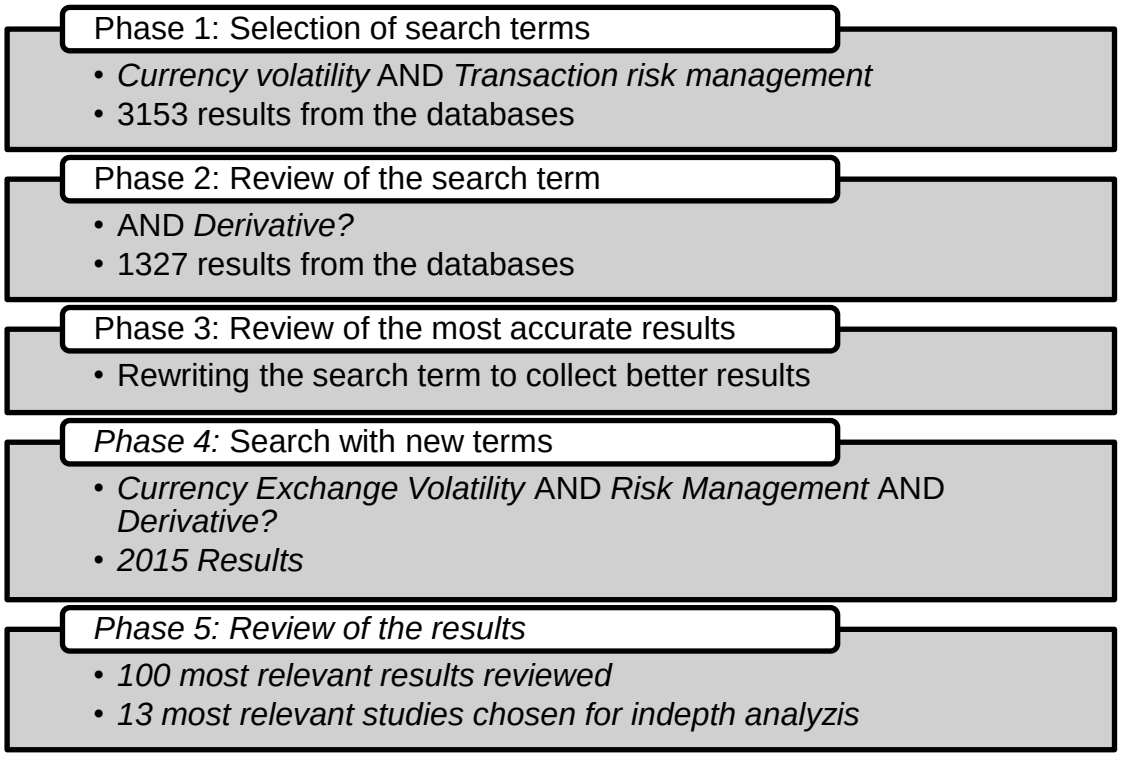


Figure 6.Process flow of search for the state-of-the-art research on the topic.

Phase five (5) begins with a quite trivial scanning of the results. Only those related to the relevant fields were considered during this phase. Many results from the database search were far out of the scope. Some for example paid attention to purely statistical models (e.g. Wang et al. 2013) or commodities markets (e.g. Silvennoinen, A. & Thorp, S. 2013). Many relatively close studies were left out due to focus on stock price movement (e.g. Hagelin, N. & Pramborg, B. 2005). On the other hand, many studies in this field have paid close attention to the value creation capability of derivatives use (e.g. Shi, L. et al. 2010). The third very common class in the search results that was left out of the scope was banking related articles. While this study pays attention to the hedging activities in non-financial firms, banking (e.g. Sudacevschi, M. 2010) and capital markets trading (e.g. Angelidis, T. & Degiannakis, S. 2005) related articles are left

outside from the relevant literature related to this study. The number of most relevant academic studies focused in the review is 13.

There could be done distribution to two classes when reviewing relevant literature. Two features which separate relevant articles are whether their focus is on the determinants of derivatives use or more generally corporate risk management practices. As El-Masry (2006, 137) states there have commonly been two groups of studies in the field during the past two decades. The first one pays special attention to the determinants of corporate hedging policies while the other group studies the use of derivatives by non-financial firms. This distribution is also the scope of this literature review. The prior group provides valuable knowledge on a bit more general level while the latter one focuses on the key determinants. The distribution is shown in the table 1 below.

Table 1.Classification of the found and relevant state-of-the-art studies.

Year	Author(s)	Article
Features of Corporate Risk Management:		
2011	Aabo, T., Kuhn, J., Zanotti, G.	Founder family influence and foreign exchange risk management
2007	McMillan, D. G. & Speight, A. E. H.	Weekly volatility forecasts with applications to risk management
2006	Bartram, S. M.	The use of options in corporate risk management
2006	Muda, M. S. & Yazid, A. S.	The Role of Foreign Exchange Risk Management in Malaysia
2005	Abor, J.	Managing foreign exchange risk among Ghanaian firms
2001	Benrud, E.	Useful Properties of Exchange Rate Forecasts for Risk Management and Derivative Pricing
2001	Brown, G. W.	Managing foreign exchange risk with derivatives
Determinants of derivatives use:		
2012	Hung, W. & Nguen, H.	Exchange rate exposure and the use of foreign currency derivatives in the Australian resources sector
2011	Afza, T. & Alam, A.	Corporate derivatives and foreign exchange risk management
2010	Tai, C-S.	Foreign exchange risk and risk exposure in the Japanese stock market
2008	Klimczak, K. M.	Corporate hedging and risk management theory: evidence from Polish listed companies
2007	Aretz, K., Bartram, S. M., Dufey, Gunter	Why hedge? Rationales for corporate hedging and value implications
2006	El-Masry, A. A.	Derivatives use and risk management practices by UK nonfinancial companies

2.2.1 Features of corporate risk management

Many features of the derivatives use have been studied in multiple studies during the decades and especially past couple of years. As El-Masry (2006) points out, commonly used phrase, it is the primary goal of risk

management to minimize the probability of unfavourable outcomes in business. It is those features that are related to that target of risk management, either means of achieving the target or outcomes to investors or owners, which defines the first group of articles.

In the next paragraphs some relevant features supporting the field of study are gone through. These topics that are generally studied in previous research papers provide good background for the topic of this study. 1) *Sources of risks firms hedge* will help to understand why it is important to focus especially on to the hedging of transaction risks. It will be shown under the paragraph, that there are several sources of financial risks. Still, it is shown that many most of the found state-of-the-art studies have found the transaction risk to be the most significant risks to be hedged with derivatives. 2) *Level of sophistication of hedging activities* is commonly studied to draw conclusions on how common it is to use more complex hedging products such as derivatives. This paragraph supports how reasonable it is to study the use of derivative products. If level of sophistication was found to be very low in general, it would be hard to generalize results of this study in any way.3) *Importance of the volatility* provides in-depth insight on the importance of the foreign exchange rate volatility on firms' hedging activities. Also, importance of accurately estimating volatility and its impact on decision making in firms is considered.

Sources of risk firms hedge

Many studies have paid attention to the impact of both global and local financial crisis to a valuation of a firm. It has been focused on how a financial crisis, and especially increased currency fluctuation have caused firms great deal of troubles. Muda and Yazid (2006) focus especially on the impacts of regional financial crisis in Asia 1997-1998. They analyze how the Malaysian multinational firms face the crisis and more importantly how have the multinationals involve foreign exchange risk management

during the crisis. It is also studied does the crisis impact on the density of the centralization of the risk management. Muda and Yazid (2006, 53-54) highlight that some of their results are rather obvious. Objective of the foreign exchange risk management appears to be to avoid losses in cash flows related to the fluctuations in foreign exchange rates. This is in both operational and net cash flows. Furthermore, this objective had changing importance for firms around the 1997-1998 Asian financial crises. The importance was highest during the crisis but decreased after that while remaining at higher level than what it was before the financial crisis. (Muda, M. S. & Yazid, A. S. 2006)

Other great field of importance for corporates related to corporate risk management appears to be shareholder value. Muda and Yazid (2006, 54) find significant evidence that firms aim to manage foreign exchange rate risk to avoid losing firms shareholder value, or more, to increase it. As well as managing cash flow risk firms pay increasing attention to the shareholder value effects caused by foreign exchange risk during the crisis. The level importance remained at a higher level after the crisis than what it was before the beginning of crisis in 1997.

In the further analysis by Muda and Yazid (2006) they came in to a conclusion that before, during and after the crisis Malaysian multinational firms paid most attention to managing short-term transaction risk compared to other sources of foreign exchange risk. Long-term transaction, translation and economic foreign exchange risks all had minor importance. With a significance level of 1 % they came into a conclusion that there are differences in the in the types of currency exposures managed. The scale in their study was 1-5 where 1 is the least important and 5 the most important. Short-term transaction exposure is the primary risk with mean ranks of 3,22 before the crisis, 3,49 during the crisis and 3,24 after the crisis. The second most important risk managed among the Malaysian multinationals was long-term transaction risk with mean ranks 2,35, 2,40 and 2,51 respectively.

These results of Muda and Yazid (2006) are strongly supported by Aabo, Kuhn and Zanotti (2011) in their study of founder family influence to foreign exchange risk management. Aabo et al. (2011) studies medium sized manufacturing firms operating in Denmark. They draw conclusions that firms are most likely to hedge transaction risk and then operational risks (both less than one year and over one year). Furthermore, founder family influenced firms are more likely to hedge in all of the abovementioned classes than their non-founder family influenced counterparts. Most notable difference is in hedging translation risk where other than founder family influenced firms, measured by median, do not hedge at all while up to 20 % of founder family influenced companies hedge translation risk. (Aabo et al. (2011)

Level of sophistication of hedging activities

While it has been commonly studied what are the risks hedged, it is as commonly analyzed the products generally used to manage those risks. More than plainly analyzing all the possible products many studies have focused to the level of sophistication of risk management. This is often performed by measuring the magnitude of usage of more complicated risk management products such as options or on a wider perspective, derivatives. Among the many, Abor (2005) studies the level of sophistication but focus is in the Ghanaian firms. Results of his study indicate that nearly half of the firms (45 %) have neither department nor named personnel managing firms' exchange rate risk. Ghanaian firms tend to manage their foreign exchange risk by adjusting prices and buying and saving foreign currency in advance. Abor (2005, 317) highlights many reasons for this but are mostly related to the macroeconomic conditions. Low level of education and high inflation rates added to the very volatile market conditions makes it very unfavourable for firms to seek hedging strategies.

Bartram (2006) studies extensively how options are used in non-financial firms and compares the results between USA and UK located firms and compares these rather developed countries to others. He pays close attention to the selection of products used for hedging foreign exchange risk. On a worldwide level Bartram (2006, 162) notes that out of all the derivatives transactions (including OTC derivatives products) the foreign exchange options amount 5 % of the all open positions. Foreign exchange derivatives total about 25 % of all the open derivatives positions. These figures, however, include both financial and nonfinancial firms and both hedging and speculative positions and are thus not comparable to figures from nonfinancial firms. Bartram draws a conclusion that a across various countries significant amount of non-financial firms (15-25 %) employ options in their operations. He also highlights (Bartram 2006, 177) that the vast number of options users is because those are very flexible instruments that allow firms to hedge various types of underlying exposures.

While many studies have comprehensively analyzed wide group of geographical areas or large number of firms some pays attention to the very depth of one firm. Brown (2001) finds out, while studying one company for extensive period, that for the one firm it appears to be the capability of competitive pricing that motivates to hedging of foreign exchange risk. For that company it appears to be that put options are preferred because of their favourable accounting treatment and competitive pricing (Brown 2001, 403). Furthermore, Brown (2001, 444) notes that the firm analyzed prefers to rather not to hedge at all than use other derivatives than options when the underlying currency is illiquid and availability of well-priced options is limited. Even though the study pays attention to only one firm it shows that when the level of sophistication is high enough it leads firm to use generally the most efficient product under the limitations of accounting treatment. This is something that can’t be paid attention to in a higher level of studies where for example financial

statement level data is analyzed but identifies that level of derivatives use can be in fact effected by accounting treatment of different products.

Importance of the volatility

When planning short and long-term business decisions on an international level firms are to pay attention to the volatilities of relevant currencies to comprehensively understand risks related to the decision. It is then worth paying attention to the forecasts of foreign exchange rates and how accurate those are. In this way firms may also estimate expected volatility on that currency pair and measure risk rising from the exchange rates. This will have impact on firms' investment decisions, among the other risks. Benrud (2001) analyzes how well the foreign exchange rate forecasts on JPY/USD have succeeded to estimate future volatility during the decade from 1989 to 1999. His study is based on the theory that exchange rate forecast dispersion can estimate future volatility. This is compared to whether the estimated volatilities could match with the implied volatility derived from the derivatives prices. Based on Benrud (2001) findings it can be said that the tested theory can be used as an efficient method the estimate future volatility. However, many further studies in this field are required in order be able to argue that this is solid theory. (Benrud, E. 2001)

Brown (2001, 465-466) makes two relevant findings in his study that sheds the study of Benrud (2001) in to a new light. First of all, some forecasters are constantly better than others. This implies that firms should seek those forecasters who are more accurate and employ their figures in the business decisions. Furthermore, forecast dispersion can add information to the implied volatility and not only act as an alternative. By further developing their analysis work, firms could hence achieve higher rate of accuracy on volatility estimates than by using only implied volatilities. This could give firms better tools to measure their expected risks rising from currency volatilities.

McMillan and Speight (2007) went further than Brown in their work. They further developed models which firms could use to improve their capabilities to estimate future volatilities and foreign exchange rates. In their study (2007, 214) it is analyzed how well weekly volatility forecasts can be employed in corporate risk management activities while employing it to hedge ratios and value-at-risk (VAR) measures. With more sophisticated econometrical methods (GARCH, TGARCH and CGARCH) than the one used by Brown (simple linear regression) they find that GARCH-type methods are superior to those less complicated models when estimating weekly volatility forecasts. Furthermore, they highlight that in a corporate risk management environment GARCH models improve time varying estimates of hedge ratios and VARs used for adjusting optimal hedge ratios. (McMillan, D. G. & Speight, A. E. H. 2007)

2.2.2 Determinants of derivatives use in firms

In addition to the common features of derivatives use in firms, El-Masry (2006) identifies another largely studied field, determinants of derivatives use. Many studies during the past decades have focused to identify key determinants on why and to what extent firms use derivatives in their operations. It has been on focus to identify possible determinants among the publicly observable figures to be able to find out whether it can be easily estimated what types of derivatives firms are likely to use- Furthermore, if they employ derivatives, does it have impact for example on firm market value or to other observable determinants. Especially with the determinants it is valid to analyze studies from the most recent years since latter studies have used the findings of previous studies to improve and further develop models. Therefore, the latest study shall include the latest information related to determinants.

Many studies in the field of determinants of derivatives use have focused on large and developed economies such as USA, Canada, and Great Britain. In those countries the research data is quite often easily available

and reported figures in financial statements can be regarded as reliable. This can be because of the financial accounting standards, and especially those regulating public corporations. El-Masry (2006) studied with a large sample of 401 British firms for reasons why those firms choose to use or not to use derivatives in their operations. He contributed to the on-going discussion with rather obvious results where larger and publicly traded firms are more likely to use derivatives. Also, international firms are more likely to use derivatives than their locally operating counterparts. Furthermore, related to the finding that the most commonly hedged risk is foreign exchange risk it was found that in fact the need to smooth foreign exchange volatility was the greatest determinant on selection whether or not to use derivatives. On the other hand, reasons for not to use derivatives are just as understandable. Significant proportion of the sample group reported that either the exposure is not large enough or the costs related to the establishing and maintaining derivatives hedging program exceed possible benefits. El-Masry (2006, 157) highlights that his results are in line with previous studies conducted in other countries. This can't be seen as a surprise since both countries (USA where most previous studies were conducted at) and the UK are under Anglo American culture where regulation and business culture are alike. (El-Masry 2006)

Aretz, Bartram and Dufey (2007) are in line with El-Masry (2006) results. It is clear outcome that firms have motivation to lower their cash flow volatility. The volatility caused by changes in foreign exchange rates can be mitigated and may in fact increase firm value as the firm itself becomes less risky. Aretz et al. (2007) take the idea a little bit further to find the consequences of lower cash flow volatility. They noticed (2007, 445) that lower cash flow volatility may increase firm value through the fact that those firms have smaller risk of default and hence, have to bear lower expected cost of capital. However, Aretz et al. (2007, 445-446) continue that empirical results supporting this idea is somewhat mixed and cannot

be interpreted unambiguously. This issue is supported by Klimczak (2008) with empirical data of 150 companies listed in Warsaw Stock Exchange in Poland. Klimczak (2008), on the other hand, differentiates his study by focusing more to a theory rather than hypothesis. Klimczak (2008, 37), on contrary to the results of El-Masry (2006) and Aretz et al. (2007), highlights that among the Polish companies there seems to be tendency to hedge accounting exposure rather than direct cash flow exposure. However, an economy of scale, or size of a company, is found to be common determinant in all of these studies.

Tai (2010) have a somewhat different approach to the topic. He applies MGARCH-M and NLSUR to determine whether foreign exchange risk is observable in firm valuation in Japanese stock markets. His (2010, 522) empirical results show that even though significantly large exposure to foreign exchange risk can be observed, it is not observable on firm pricing in stock markets. However, through further testing there can be found highly significant evidence that also through Japanese stock markets it is observable that the aim of hedging is to lower cash flow volatility which, in case of Japan can be seen to lower firms' cost of capital (Tai, C. 2010). Also in the analysis of Afza and Alam (2011) it is highly statistically significant that foreign sales impact on firms' willingness to use foreign exchange derivatives. They don't take position whether foreign sales might have impact on the magnitude of usage of foreign exchange derivatives.

Afza and Alam (2011) have an approach of Mean difference and Logit models to analyze what they find to be the key determinants among those firms that employ currency derivatives. It is also in focus to determine what are the key characteristics to differentiate those who employ derivatives and who doesn't. Among the many findings, Afza and Alam (2011, 414) comes into a conclusion that firms with higher financial distress costs are significantly (at 10 % level) more likely to employ foreign exchange derivatives. Other statistically significant determinant among the users is the size of a firm with positive relation to the usage of derivatives. Similar

impact of a size of firm has been found among the other studies and can be connected to the both economies of scale and extent of foreign sales. (Afza, T. & Alam, A. 2011)

Afza and Alam (2011, 415) are able to show that among the Pakistan firms firm growth options have positive impact on firm's tendency to use foreign exchange derivatives. This is because those firms have greater motivation to hedge their risks to maintain their growth opportunities. Nguen and Yip (2012) takes the concept of determinants bit further than plainly studying time series. In their study of exchange rate exposure among the Australian firms it is focused on dynamic relation of the hedging and foreign exchange risk. However their results in dynamic relation during the financial crisis are somewhat inconclusive and insignificant, Nguen and Yip (2012, 166) gather enough information to be able to draw the conclusion that the hedging increases during the financial crisis period. However, it appears to them, too, that size of the firm have the most significant impact on the extensity of foreign exchange derivatives usage.

Many recent studies have clearly shown that there is a relation between the use of foreign currency derivatives and either/or hedging foreign cash flow volatility or size of a firm. These determinants are somewhat interrelated since larger firms are more tend to have foreign sales. Among the other reasons this makes it difficult for many studies to have statistically significant results on the determinants of derivatives use. However, as many studies have found commonly important factors the conclusion can be drawn there. In many studies it is found that to smooth cash flow volatility is the key motivation to hedge foreign exchange risk. In this respect, to be able to effectively hedge it is worth analyzing the impact of foreign exchange volatility to derivatives use.

2.3 Financial crisis and currency prices

In addition to the different determinants of derivatives use in firms and other key matters of derivatives in corporate hedging this study lies strongly on the relation of foreign exchange volatility around the global financial crisis of 2008. The global financial crisis in the focus of this study, as well as other financial crises, has changed the capital markets momentarily. Some regulation may end up having changed capital markets for good, but while it is years of work to implement global, European or even national regulation those effects are to be seen. Short term impacts, on the other hand, are more of a shock in the market and impacts of those can be expressed on weekly, daily or even intra-day data. These shocks, among the many other things, can be caused by surprising news or released economical data. Other sectors of capital markets react to those shocks, but this study pays attention only to those related to foreign exchange markets in its simplest form.

In figure seven (7) it can be seen that foreign exchange rates that are studied in this work, i.e. foreign currency prices, have reacted similarly but at different times to the global financial crisis. In the figure seven it is seen how global financial crisis impacted on some of the foreign exchange rates. EUR/USD exchange rate began to depreciate more intensively in 2008. This expresses how the financial crisis had its roots in USA. It started as a sub-prime crisis and evolved to have impact wider in the financial sector. However, in the first peak it can be seen that originally the crisis was thought to be somewhat American phenomena or an error in the system. Hence, USD was found to be riskier currency and while it was started to be avoided, the relative price of EUR/USD started to depreciate. However, during the summer of 2008 it was noted that the crisis has in fact impact on the European economy. The exchange rate reflected that and relative valuation appreciated as now euro zone was found to be close to as risky as USD zone. After this, in the beginning of 2009 until the end of the 2010 the EUR/USD exchange rate fluctuates very much. The

fluctuation, or volatility, expresses well how uncertain the situation was at around that time. The fluctuation (volatility) decreases notably in 2010 and 2011 when the uncertainty somewhat eased.

When looking at the EUR/SEK and EUR/NOK exchange rate movements it shows the other side of depreciating EUR. Once again, the financial crisis was thought to consider only USD and euro zones, not the Scandinavian currency regions. This led to a situation where EUR and USD depreciated compared to other currencies. When an economy suffers from negative outlooks, the need for that currency decreases and compared to another currency it will appreciate. This is the case what happened for the EUR during the autumn of 2008. Especially in the beginning of the 2009 SEK and NOK had appreciated against EUR. It shows clearly that the Swedish and Norwegian Krones act very similarly in relation to euro. One likely reason for this could be the close economic relation of these two countries. Both of the Krones had peaks in their volatility as well as the USD in 2008-2009. After the most uncertain period of the crisis it is clearly seen how the volatility of the Krones decreases in 2010-2011 since the fluctuation in the currency price appears to be smaller.

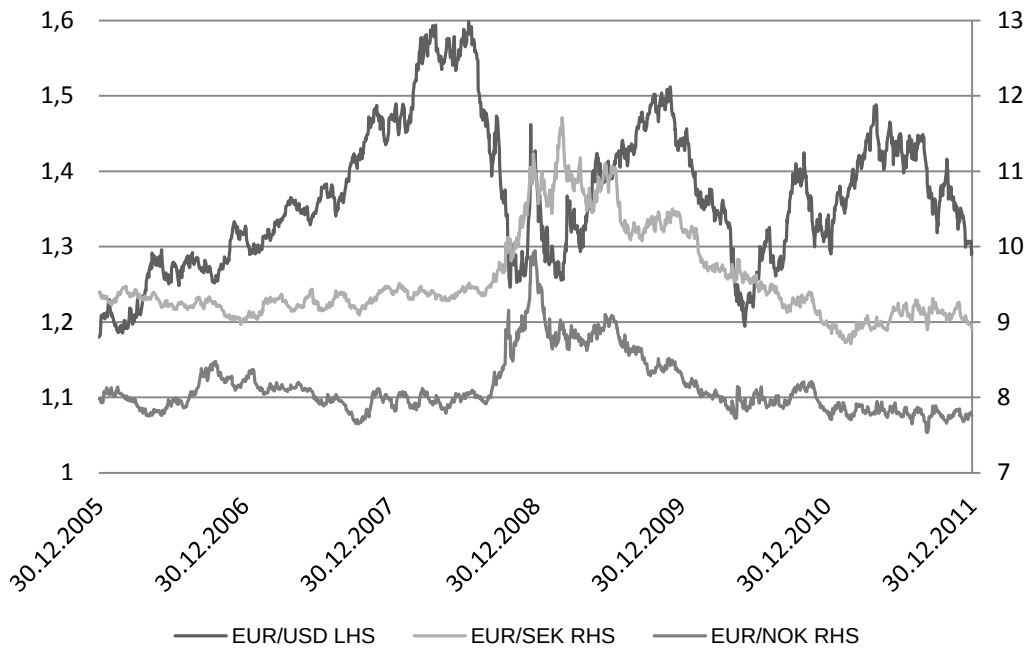


Figure 7. EUR/USD (left hand side scale), EUR/SEK (right hand side scale) and EUR/NOK (right hand side scale) European central bank daily foreign exchange rates from 30.12.2005 to 30.12.2011.

Increased fluctuation of foreign exchange rates of the USD, SEK and NOK compared to euro (foreign exchange rate volatility) have impacted on Finnish listed firms. Impact on Finnish listed firms can arise from two ways:

- Increased market uncertainty for the operative activities
- Increased volatility in capital markets products

The increased market uncertainty for the operative activities of firms comes from imports and exports and from sales activities. Increased uncertainty increases, in many cases, anticipation of the firms for the worse times. Economic downturn is ready when large number of firms begins to anticipate and decreases their purchases. Then the actual decrease in demand realizes.

This study, on the other hand, focuses on the capital market risk firms face. Capital market risk in the focus of this study is impact of foreign

exchange rate fluctuation, or volatility, to transaction risk of listed Finnish firms. Transaction risk is the risk arising from the foreign currency related operations of a firm. The factor guiding this study is the idea that it cannot be said that increase or decrease in the currency price as such is bad for a firm. For some firm that imports products that it buys in USD it is better to have increased EUR/USD exchange rate. On the other hand, a firm which exports to USA decrease of exchange rate would be better. After all, the thing that matters is uncertainty of future outcome. During the financial crisis this uncertainty increased when the fluctuation increased. When firms are unable to plan their export/import activities and are uncertain about the prices they end up paying this have negative impact on their activity. This uncertainty can be managed with currency derivatives and by buying or selling needed currency in advance with futures, forwards or options.

3 SAMPLE DESCRIPTION AND RESEARCH METHOD

Some previous state-of-the-art studies have performed comparative analysis of impacts of financial crises. For example Muda and Yazid (2006) performed their study focusing around the times of the Asian financial crisis of 1997-1998. In their study the comparison was made between three different time periods: before, during and after the crisis. This same distribution is also employed in this study, too. In many contexts the starting point of the global financial crisis has been considered to be the fall-down of Lehman Brothers. This took place on September 9th, 2008 when the company applied for US chapter 11 handling. This can be regarded as a turning point when the financial crisis can be seen to begin. Many indications of the crisis had been received earlier, but after the publication of the Lehman Brothers bankruptcy markets around the world began to realize losses. However, some arguments have been presented that many features of the market turnaround had taken place earlier in the 2008. Because of those events the whole 2008 appeared to be somewhat time of uncertainty. Therefore, the whole year of 2008 is regarded to be a part of the period of financial crisis. In comparison to Muda and Yazid (2006) this study is distributed also to three time buckets which are:

1. Before the global financial crisis 2006-2007
2. During the global financial crisis 2008-2009
3. After the global financial crisis 2010-2011

It is under question whether the financial crisis actually has ended at all even by the end of the 2011. In this study, however, it is regarded to having ended at around the end of the year 2009, or at least reached to more constant level. This is based on the idea that around that time period the global financial crisis changed its nature from financial crisis to more of an economic crisis effecting on nations rather than only financial sector. In this respect, the actual global financial crisis has ended. After all, it is highly questionable if the crisis has actually ended or has it only changed

its nature. This must be noted when the results of this study are further analyzed.

Even though the financial crisis didn't start or end in the end of the year it can be still considered to have impact during the whole year. When financial statement figures are analyzed, many of those are impacted of the changes in the economic climate during the year. Higher risk level could be expected to increase hedging already in the summer or beginning of the 2008, even though the actual turning point hadn't taken place by then. Balance sheet figures are continuous figures and are hence not that much impacted of short term changes. Also hedges that are made are usually longer than just one or two months. Still, open hedges in the end of the year are done based on the understanding of the current situation at that moment. In this respect it isn't that critical to identify exact date but comparison can be made between full year figures to identify the situation at that moment.

3.**1 Sample data**

3.1.1 Firms in the sample group

The sample data consists of 10 large firms with their headquarters in Finland. List of firms was collected based on Nasdaq OMXH Nordic listing of Finnish Large and Mid-Cap firms. After the complete list was collected out of the Nasdaq OMX Nordic's service some elimination was done. First of all, Talvivaara Oyj is rather new firm in Finnish stock market and hence, will not have data on the whole sample period. Remaining 10 firms all had continuous track of data for the period from 2006 to 2011. All the firms outside ICB classes 0001, 1000 and 7000 were excluded. These classes represent traditional, basic industries in Finland and in this study are considered to be:

- Oil & Gas (ICB 0001)
- Basic Materials (ICB 1000)
- Utilities (ICB 7000)

This classification enables to focus on rather homogenous group of sample firms. For example firms operating in consumer services have very different need for products in their manufacturing activities. On the other hand, retail business has very different figures in foreign sales while they might have extensive purchasing abroad. Including these firms would have complicated and twisted analysis and results of the study when firms in the sample group were too heterogeneous. Due to small markets in Finland, there is only one listed firm in OMXH Nordic Large- and Mid-Cap lists in both Oil & Gas (Neste Oil Oyj) and Utilities (Fortum Oyj) segments. Therefore majority, eight firms out of 10, operate in Basic Materials. Firms that match these sample group criteria are expressed in the table 2 below.

Table 2. Firms that are in the sample group with selected criteria.

Firm	Industry	Segment in Nasdaq OMXH stock exchange listing
Fortum Oyj	Utilities	Large-Cap
Kemira Oyj	Basic Materials	Large-Cap
Neste Oil Oyj	Oil & Gas	Large-Cap
Outokumpu Oyj	Basic Materials	Large-Cap
Stora Enso Oyj	Basic Materials	Large-Cap
UPM Kymmene Oyj	Basic Materials	Large-Cap
Alhstrom Oyj	Basic Materials	Mid-Cap
Metsa Group Oyj	Basic Materials	Mid-Cap
Rautaruukki Oyj	Basic Materials	Mid-Cap
Ruukki Group Oyj	Basic Materials	Mid-Cap

In the sample group distribution between firms in Large- and Mid-Cap is very even. 60 % of the firms in the sample group are Large-Cap firms whereas 40 % of the firms are Mid-Cap sized. Furthermore, it can be seen that those firms in Large-Cap listing have net sales on average roughly 8 billion euros. (Figure 8) That is about four times the net sales of those in Mid-Cap (2,2 billion euros). Even though firms have rather large difference in their average net sales, the case is very different with the greatest value in Mid-Cap and smallest value among the Large-Cap firms. The largest net sale in Mid-Cap is with the Metsa Group Oyj (5,3 billion euros) whereas Outukumpu Oyj has the smallest net sales among the Large-Cap firms (5 billion euros). On the other hand the difference between the largest and smallest firm in the sample group is very large. Neste Oil Oyj operates with 15 420 million euros net sales when the smallest net sale is with the Ruukki Group with 159 million euros.

The situation is the same with the total of assets where the largest firm in Mid-Cap class has larger value of balance sheet than the smallest firm in Large-Cap. On the other hand, the largest firms, Fortum Oyj or Neste Oil Oyj, depending on the measure, are in the very different figures in all measurement compared to the smallest firm, Ruukki Group Oyj. This highlights that differentiating firms based on their market values, as Nasdaq OMX Nordic does in their classification, is not very constant metric to measure the size of the firm.

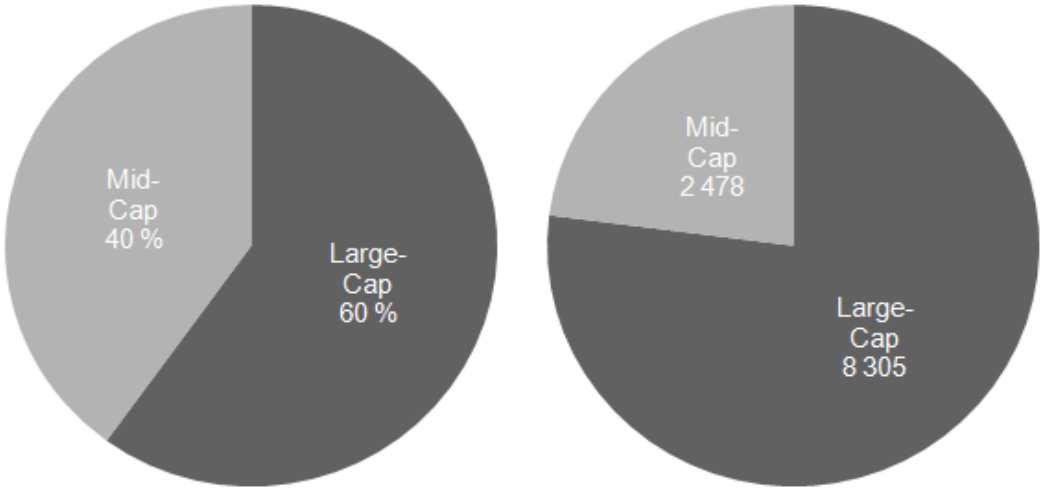


Figure 8. Distribution of firms in NASDAQ OMX Nordic classification between Large- and Mid-Cap sized firms (Left) (NASDAQ OMX 2013) and the average Net sales in millions of euros.

In the table 3 there are shown the average nominal of open foreign exchange derivatives positions per currency pair over the study period. This table illustrates that there has not been any major changes in the nominal values of derivatives positions. It shows that the absolute value of the position has not changed much year-over-year. In EUR/USD currency pair the peak was experienced in 2006 while in EUR/SEK it was one year later, in 2007. In notable less hedged EUR/NOK currency pair the year 2006 had the largest average hedges.

Table 3.Average amount of open derivatives position in the end of fiscal year (in millions of euros). Average position is calculated from absolute values.

Year	EUR/USD	EUR/SEK	EUR/NOK
2006	368	713	61
2007	306	771	49
2008	327	629	36
2009	347	719	26
2010	327	694	33
2011	372	709	27

The table above (table 3) illustrates well how important it is to measure hedges as proportion of sales instead of absolute values. This is also based on the scope of the study where the focus is on transaction risk. As described previously, transaction risk is that risk arising from firms sales in foreign currencies. Therefore, in this study nominal values of open derivatives positions in the end of each year is divided by the net sales. This will not show the exact cash flows firms hedge but will work as an illustrative assumption of hedge ratio. In the appendix 1 there are shown hedge ratios used to measure changes in firms hedging activity. In the figures it can be seen that during the period of 2008 and 2009 firms slightly increased their use of derivatives in relation to their net sales.

3.1.2 FX rates and volatility

Foreign exchange volatilities play key role in this study. They are analyzed to answer a sub-question of this study. That is, whether foreign exchange rate volatilities increased when the global financial crisis of 2008-2009 began. In this study it has been assumed that the financial crisis has increased the foreign exchange rate volatility. Also it has been assumed that after the crisis volatility, i.e. market risk level, would decrease but not to as low levels as before the crisis. Volatilities in this study are calculated using daily ECB fixing rates and annualized to reveal full year volatilities. There are multiple factors effecting currency volatilities but it is not in the focus of this study to dive into those.

In this study currency volatility is calculated according to generally used expression of volatility, standard deviation of daily returns of daily rates. The standard deviation equation for the sample is expressed below in equation one (1).

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{N - 1}} \quad (1)$$

where:

s = the standard deviation

x = each value in the sample, that is, daily return of FX rate

$\bar{x}$ = the mean of the daily returns

N = the sample size

Each of the volatilities calculated from daily values of one year are annualized with assuming 252 business days per year. This is done in order to ensure comparable volatilities for each currency pair. The equation for annualized volatilities is expressed in equation two (2) below:

$$s_A = s * \sqrt{252} \quad (2)$$

where:

s_A = Annualized volatility of FX rate

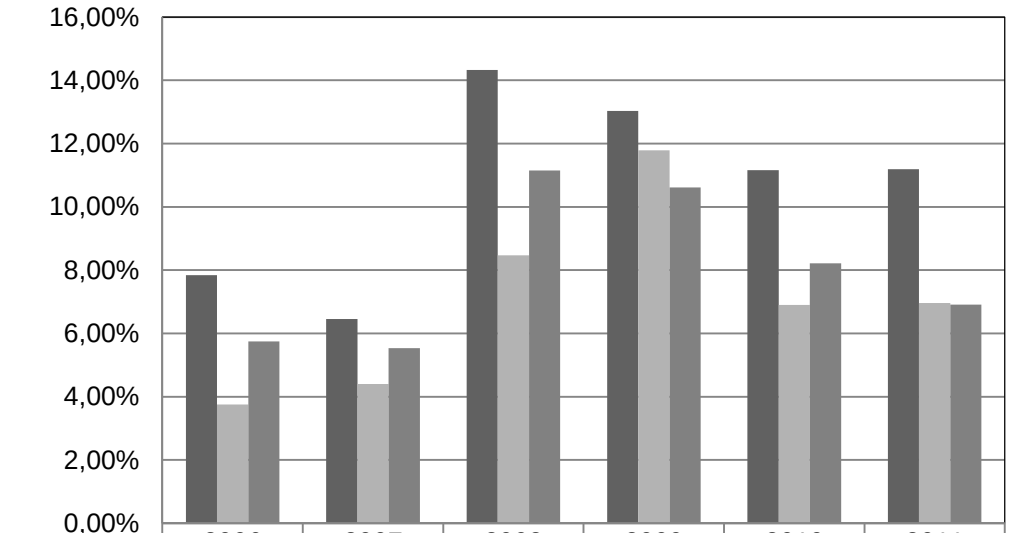
Below in figure eight (8) it is expressed graphically how annual volatilities of three currencies in the focus of this have developed before, during and after the global financial crisis. It can be visually observed that volatilities of all the currency pairs in the scope (EUR/USD, EUR/SEK and EUR/NOK) have been on their lowest levels before the financial crisis. EUR/USD recorded its lowest figures in 2007 (6,45 %), but increased greatly only one year later, in 2008, to up to 14,32 %. While the EUR/USD had largest volatility before and during the crisis compared to other two currencies, it also remained as the most risky currency pair after the crisis with volatility of 11,20 % per annum. The increase from the low volatility period of 2007 to high volatility period of 2008 was 7,87 percentage points. EUR/USD volatility has remained at high levels after the crisis with 4,75 percentage points higher volatility than before the crisis. Decrease from the peak of 2008 has been only 3,12 percentage points. Based on

EUR/USD volatilities it can be said that markets didn't feel that confident after the financial crisis, in 2010-2011, than what they felt before the year 2008.

Swedish Krone has had the lowest volatility of the three currencies. Only in two years out of six it has had higher volatility than the Norwegian Krone. In Swedish Krone the lowest annual volatility took place in 2006 when it was only 3,76 %. Unlike EUR/USD volatility, Swedish Krone had its peak in volatility in 2009 when it was up to 11,79 %. The increase from the bottom to up was 8,03 percentage points. Part of the change (4,06 percentage points) took place from 2007 to 2008 and the rest between 2008 and 2009. After the financial crisis the volatility of Swedish Krone decreased quite a lot and relatively quickly. Already in 2010 the volatility had decreased by 4,89 percentage points to 6,90 %. This shows that Swedish Krone, and Swedish economy, did not realize the risks of financial crisis locally until the 2009 while only part of the increase took place in 2008, on contrary to EUR/USD where the main increase took place in 2008. Also, some recovery took place quicker than with EUR/USD. However, the notably high decrease after the financial crisis period, the volatility of Swedish Krone remained also at higher level. Hence, markets in Sweden didn't either realize positive market outlooks after the crisis but remained sceptical. (Figure 9)

In figure nine (9) it can be seen that Norwegian Krone had the similar pattern as it was with the EUR/SEK and EUR/USD. Lowest levels of volatilities took place before the crisis in 2006 and 2007 (5,74 % and 5,53 % respectively). Similarly to EUR/USD, also Norwegian Krone had its peak in the volatility in 2008 (11,15 %) when the increase from the lowest figures (2007; 5,53 %) totalled up to 5,62 percentage points. Also, as well as with the EUR/USD, the decrease in the volatility realized smoother than what it was with EUR/SEK. The lowest figures in EUR/NOK volatility realized in 2011 when the volatility had decreased from the peak of 2008 by 4,24 percentage points to 6,91 %. However, the volatility remained at

higher level than what it was before the crisis with premium of 1,17 percentage points.



	2006	2007	2008	2009	2010	2011
EUR/USD	7,84%	6,45%	14,32%	13,03%	11,16%	11,20%
EUR/SEK	3,76%	4,40%	8,46%	11,79%	6,90%	6,96%
EUR/NOK	5,74%	5,53%	11,15%	10,61%	8,21%	6,91%

Figure 9. Presentation of annual volatilities of currency pairs calculated from the ECB daily fixing rates. Annual volatility measured as annualized standard deviation.

All three currency pairs support the idea of dividing the timeframe into three slots that are before, during and after the financial crisis. All three currency pairs had their two least volatile years in 2006 and 2007, highest figures in 2008 and 2009 and medium figures in 2010 and 2011. This is consistent with the Muda and Yazid (2006) finding of Asian financial crisis of 1997 that the volatility of foreign exchange rate is usually lowest before the crisis, highest during it and decreases, but remains at increased levels after the financial crisis. Furthermore, all three currency pairs realized rather similar changes in volatilities in transitions from the low to high volatility periods and in transition from high to medium volatility periods. In this sense, sub research question of whether global financial crisis has increased the foreign exchange rate volatility can be found to match with

the assumption with these three currencies. Still, it is important to bear in mind that this study employs only daily values of foreign exchange rates. Other intervals such as weekly or hourly rates may have impact on these figures. This is not likely, however, to compromise these figures since it can be assumed that periods will have similar descriptive even though volatilities would have been calculated with different intervals. Other currency pairs may have very different figures and even the periods may not fit to the ones used in this study.

3.2 Research model

3.2.1 The t-test

The econometric model applied to perform analysis on whether firms have relatively higher derivatives positions during the financial crisis than before and after it can be conducted by analyzing if positions have statistically significant difference between periods. In this study an econometric model of *t*-test is applied to find if the statistical significance exists. Since the data groups are related it is to be used paired version of t-test. This is exactly to test before-after situations and fits to the scope of this study well. In this way it can be compared if in a currency pair the mean of open relative derivatives position has statistically changed. After this, it can be measured by how much it has changed. Therefore, assumed hypothesis that are tested are:

H0: Change in relative derivatives position = 0
H1: Change in relative derivatives position ≠ 0

T-test requires several assumptions to take place in order to be used. Only a few of those are to prevent from using t-test for analysis but more to guide into which t-test to apply. In many cases Student's *t*-test is regarded to be the *t*-test while it in fact is limited to few cases. Student's t-test is

limited to the cases where it is tested the null hypothesis of whether the means of two normally distributed are equal. Student's *t*-test, however, requires in addition to normal distribution that variances of sample groups are equal. When this assumption does not hold it is usually applied Welch's *t*-test. Assumptions related to Student's *t*-test according to Fadem (2008) are:

- Each of the populations compared should follow normal distribution
- Two populations being tested should have equal variances
- Data sets are sampled independently

Normal distribution with the data of relative open derivatives positions is ensured by normalizing each sample for before, during and after the global financial crisis of 2008. The equal variances are tested using the *F*-test of equal variances of two datasets. It could also be taken a conservative approach and assume that variances are unequal. The *F*-test of equal variances is insensitive to normality of datasets. Hence, it is tested with sample data that have not been tested. In the *F*-test the null hypothesis is that variances are equal and is calculated as in equation 1 below:

$$F = \frac{(SEE_R - SSE_U)/J}{\mathrm{SSE_U}/(\mathrm{T} - \mathrm{K})} \tag{3}$$

where:
SSE_R = Restricted sum of squared errors
SSE_U = Unrestricted sum of squared errors
J = Number of hypothesis tested
T = Sample size
K = Number of estimated parameters

F-test for the sample data shows that none of the three comparison pairs have unequal variances at 1 % significance level at any point, that is, none of them is highly significant. Hence, none of the compared samples have unequal variances with high significance. Only two sample groups in

EUR/NOK have significant *F*-test values at 5 % level. These two could be regarded to have unequal variances and therefore Student's *t*-test would not be suitable. (Table 4) However, in this study only highly significant results are considered at this point and Student's *t*-test can be applied to determine if sample groups have significantly different means between different periods. Complete results are shown in appendix 2.

Table 4. Key statistics on F-test of equal variances.

Currency pair	Statistic	BC-DC	DC-AC	BC-AC
EUR/USD				
	F-test value	0,8226	1,2762	1,0498
	p-value	0,3879	0,3611	0,4717
EUR/SEK				
	F-test value	2,0107	1,0988	2,2092
	p-value	0,1564	0,4454	0,1267
EUR/NOK				
	F-test value	4,4702	0,9609	4,2954
	p-value	0,0180**	0,4768	0,0204**

* = Significant at 1 % level, ** = significant at 5 % level, *** significant at 10 %level.

BC = Period before the crisis, DC = Period during the crisis and AC = Period after the crisis.

The third assumption of independent variables does not hold in the case of this study. This is classical before-after comparison in which case subjects of testing are related to each other. In this case Student's t-test would give incorrect values but more proper tool to analyze data is to apply *t*-test for two paired samples. Paired t-test is rather simple to conduct. The model is based on estimating if standard error of mean differences is not large enough to proof difference of means to be statistically different from zero. The equation of paired *t*-test is written as below in equation 2:

$$T = \frac{\bar{d}}{\mathrm{SE(d)}} \quad (4)$$

where:

T = the *t*-test statistics
$\bar{d}$ = mean difference of the sample
SE(d) = standard error of mean differences

Results of the paired *t*-test are reported in section four (4) where comparison to previous studies is made. However the simple method, it is able to draw picture on whether the financial crisis could have been one determinant to define the extent of derivatives use among the Finnish firms. However the simple model it holds the capability to provide information on whether use of currency derivatives have increased when the financial crisis began and decreased after the most intensive phase.

3.2.2 Multiple linear regression model

Because of the many limitations and lack of capability to provide comprehensive results the study is supported with multiple linear regression used to determine how well, among the few other determinants identified in previous literature. This is done to test how well the foreign exchange volatility in fact stands out among the other determinants. Comparable independent variables have been chose amongst those which have found to be at least to some extent significant independent variables in previous studies. If not the exactly same variable have been chosen, another variable measuring the same effect is used to in those cases.

The multiple linear regression model is able to capture more information about the impact on dependent variable, i.e. change in derivatives use. Inclusion of multiple variables enables to analyze combined impact of all the variables and hence, further analysis on the reasons behind the reached result. The multiple regression model is written is equation five (5) below.

$$DERUSE_t = \alpha + LTOTAS + LSALE + ASTOE + EX_x + Y_1 + \ldots + Y_6 \quad (5)$$

where:

α = 0. Since the dummy variables Y_t consists of all the possible scenarios, the constant needs to be zero to avoid perfect multicollinearity in the model.

$DERUSE_t$ = use of foreign currency derivatives over periods *t*

α = constant variable

$LTOTAS$ = 10 root logarithm of total assets to measure size of the company

$LSALE$ = 10 root logarithm of total net sales to measure the volatility of operations

$ASTOE$ = Assets to equity ratio to indicate company leverage, i.e. financial distress costs

EX_x = annualized exchange rate volatility of currency pair *x*, calculated from daily changes, to measure currency volatility

Y_t = binomial dummy variable for year *t* (2006-2011) to capture impact of different time periods

When the linear regression is applied it is important to bear in mind five assumptions that are linked to the quality and applicability of the model. The same assumptions apply for the simple linear regression model and those are presented below. The test of multicollinearity of the independent variables is presented in appendix 3. Results for that express that LTOTAS and LSALE correlate highly with each other (at the rate of 0,86).

However, in the scope of this study those are in more of a supporting role and the very highest quality of accuracy of significance is not crucial. Still, it needs to be taken into consideration that the R^2 is likely to be slightly increased.

1. $E(u_t) = 0$; The average value of the errors is zero
2. $var(u_t) = \sigma^2$; Variance of the errors is constant
3. $cov(u_i, u_j) = 0 \; for \; i \neq j$; Covariance between the error terms is zero
4. x_t are non stochastic
5. The disturbance terms are normally distributed

4 RESULTS

4.1 Presentation of the results

4.1.1 Paired *t*-test

In this study a paired *t*-test was performed to find out whether large, non-financial listed firms headquartered in Finland increased their hedging activities in three major currencies (EUR/USD, EUR/SEK and EUR/NOK). The results of this study should be read with various limitations in mind. In sample data description it is showed how the volatility in aforementioned currency pairs increased at the time of the global financial crisis of 2008. In this respect, the methodology applied in the analysis, the paired *t*-test conducted for the extent of derivatives use related to net sales should change along the market risk, i.e. increase during the times of the financial crisis and decrease after it. This methodology helps to understand if impacts of global financial crisis measured by foreign exchange volatility have impact on the extent of derivatives use among the large, non-financial publicly listed firms. This would help one to understand if during the increased market risk period of global financial crisis firms increase their extent of derivatives use.

In table five (5) the most important results of the paired *t*-test are presented. By only comparing differences in means it can be said that results generally support the concept where the greatest extent of derivatives have been used during the financial crisis. For the EUR/USD currency pair hedges the results are the most clear of the three currency pairs. In the periods of before the financial crisis it seems that the difference of means is statistically insignificant (*t*-statistic of 0,8439 and p-value 0,42). This is according to the hypothesis. The statistically significant change took place in 2008-2009. The *t*-statistic of -2,5924 (p-value of 0,029) shows together with the mean difference of 2,03 percentage points that firms in the sample group increased their use of EUR/USD derivatives

position dedicated for hedging transaction risk. The 95 % confidence level sets the range between 0,26 % - 3,8 %. In the periods of after the financial crisis the difference of means reveals that there was minor decrease in the relative derivatives position first and then slight increase. However, the change was no longer statistically significant but shows that firms had no longer clear need to increase their hedge levels. This is understandable while since even though the EUR/USD volatility decreased the general uncertainty visible in other factors remained. Hence, firms didn't perhaps feel themselves too confident.

Table 5. Results of the paired *t*-test conducted for the large, non-financial and public listed Finnish firms.

	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
EUR/USD					
t-statistic	0,8439	-0,5099	-2,5924	0,7242	-0,7788
p-value	0,4206	0,6224	0,0291**	0,4873	0,4561
Pearson correlation	0,6355	0,8227	0,9156	0,8574	0,3396
Mean difference	-1,17 %	0,48 %	2,03 %	-0,69 %	1,58 %
95% confidence level	3,13 %	2,14 %	1,77 %	2,16 %	4,59 %
EUR/SEK					
t-statistic	-0,2297	1,1684	-1,7602	1,3741	-0,2285
p-value	0,8235	0,2727	0,1122	0,2027	0,8244
Pearson correlation	0,9972	0,9993	0,9907	0,7787	0,9672
Mean difference	0,35 %	-5,20 %	3,61 %	-2,48 %	0,22 %
95% confidence level	3,45 %	10,06 %	4,64 %	4,08 %	2,22 %
EUR/NOK					
t-statistic	0,9353	1,5149	1,3229	-0,8522	0,7622
p-value	0,3741	0,1641	0,2185	0,4162	0,4654
Pearson correlation	0,9960	0,9980	0,9976	0,7787	0,9672
Mean difference	-0,30 %	-0,48 %	-0,20 %	0,29 %	-0,11 %
95% confidence level	0,73 %	0,72 %	0,34 %	0,76 %	0,32 %

* = Significant at 1 % level, ** = significant at 5 % level, *** significant at 10 %level.

With regard to EUR/SEK related statistics it shows that there was no statistically significant change in relative hedge positions. The most significant change took place, as well as with the EUR/USD, between 2008 and 2009 where the p-value reached 11 %. The difference of means in that period is 3,61 percentage points so the change would have been great with more consistent sample group data. Figures related to the EUR/SEK act as assumed. There was no major increase in the relative hedge positions within the period of before the crisis (2006-2007). However, the great but statistically insignificant decrease between 2007 and 2008 is unexpected. There is observable explanation for this. Two large companies (Fortum Oyj and Outokumpu Oyj) in EUR/SEK hedge wise had peaks in their sales in 2008. Meanwhile, both firms decreased their EUR/SEK hedges dramatically. This might be for example because both firms expected unfavourable changes to take place in the coming periods. In EUR/SEK the decrease from during the crisis –period was the most clear, however statistically insignificant. The decrease was 2,48 % where as the increase between 2010-2011 was only 0,22. Hence, the relative hedge level was at lower level in the after the crisis period that what it was in the during the crisis period. (Table 5)

The third currency pair EUR/NOK has the worst situation with regard to significance of the test statistics. None of the periods had significant results which lead to a situation where no conclusive analysis can be drawn. However, when significance levels are compared with each other it shows that transition from before the crisis to during the crisis periods led to most significant results (p-values ~0,2 when in transition and ~0,4 in other periods). EUR/NOK is the least hedged currency pair in the sample group and this leads to a situation where around half of the firms had no hedge position in EUR/NOK. In addition, or because of this, changes between years act in different than those of EUR/USD and EUR/SEK pairs. The only period of increase was between 2009-2010 where the increase in relative hedges was 0,29 percentage points. (Table 5)

In all three currency pairs the hedging ratio remained very flat over the periods. Firms didn't adjust their hedging in a way that greater proportion of the sales would have been hedged but the "dependent variable", the hedge ratio, didn't change in the study period. Because of this, the *t*-statistic was relatively low over the test period. Only the slight peak experienced in the *t*-statistics between 2008-2009 supports that in fact firms would have increased their hedging ratio, while only in the EUR/USD the increase led to statistically significant results. There are two features that can be observed. There are some details in the sample group companies operations that make them to be more sensitive to EUR/USD hedge ratios. Without further analysis it can be assumed that EUR/USD exchange rate volatility has either direct or indirect impact on firms operations and hence, cash flows. Still, within the assumptions of this study even the EUR/USD risk was relatively stable hedged. The other reason could be that since well developed firms usually have well developed operations in treasury and risk management activities. One common piece of treasury risk management is that there are well established treasury or finance policies which set limitations on hedge ratios etc. In case the policy is not written to be interpreted flexibly it may have impact also on the flexibility of the hedging activities. That means that hedge ratio would be the target in changes conditions. The concept is presented in figure 10. The study shows that there would be no change in the "hedge" ratio over the study period even though the foreign currency volatility was observed to having increased during that time.

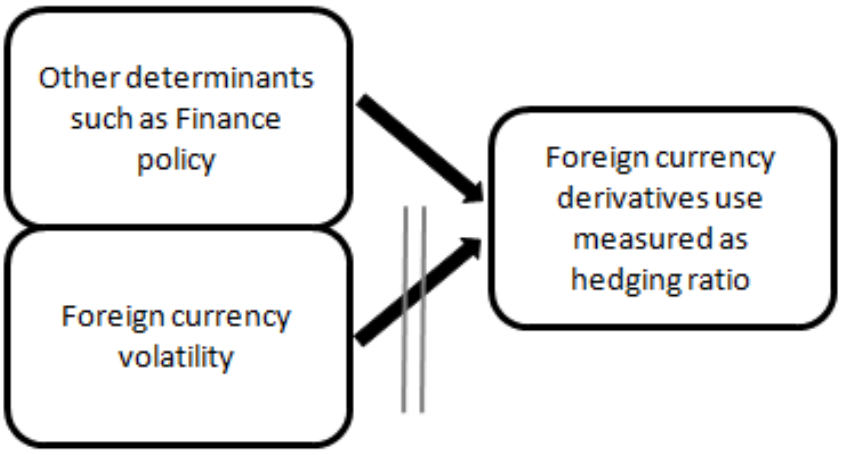


Figure 10. Impacting factors on to the use of foreign currency derivatives used to hedge transaction risk.

Results of the supporting model of linear regression are presented in appendix five (5). In the results it easily observable that the annualized volatility does not support any better significance to the framework even though estimated with linear regression model. Because of the serial correlation between datasets the model is not BLUE (Best Linear Unbiased Estimate) and therefore significances must be very carefully analyzed. The correlation takes place between the volatility and year dummies. However, by looking at the coefficients of the currency volatilities it can be observed that by this model there is no sign of any impact of currency volatility to the use foreign currency derivatives. Only those variables not related to exchange rate volatility or year dummies had some understandable values in coefficients and p-values. This supports even more the idea that firms have not changed their use of derivatives much during the analysis period, possibly because of the constant hedging policy. Also, firms may assume that their hedging policy at each time provides adequate security for changes in foreign currency risk.

Regardless of the limitations of linear regression model, the “traditional” explanatory variables receive quite understandable values. Interestingly, the Scandinavian currency pairs, EUR/SEK and EUR/NOK receive quite

decent values in two respects. First and foremost, the EUR/SEK currency pair had some significant explanatory power what comes to the extent of derivatives use. One must be very careful when interpreting those since EUR/SEK position is very strongly led by Fortum Oyj. Small change in the position of that one firm has impact on the significance. Still, this is slightly positive sign that this phenomenon could exist. The other aspect is that those “traditional” explanatory variables, total assets and net sales, had the greatest impact on the use of derivatives. In EUR/SEK the coefficient of total assets is interestingly high, 0,9084. This is probably because of the economies of scale in hedging. Large firms have higher knowledge and are tend to employ more complicated products in hedging. Still, this could be mostly impacted by the Fortum Oyj. This is further supported by the point that in EUR/NOK, however highly significant, the coefficient of total assets is only 0,0411. Hence, based on this there is not likely to be any true significance in the total assets in this context.

4.2 Comparison to previous studies

Even though the results of the *t*-test are not mostly statistically significant they are to some extent comparable to previous studies. Through this comparison it can be drawn a picture whether the extent of foreign exchange derivatives use could, under specified circumstances, be affected by the foreign exchange rate volatility. There are two main features that can be compared to previous studies: (1) Have the change been in similar respect during the previous crises, mainly identified by Muda and Yazid (2006) and (2) how does the foreign exchange rate volatility compare to other determinants of derivatives use.

In their questionnaire survey Muda and Yazid (2006) applied the similar set-up to this study with distribution of before, during and after the crisis. Because of the different set-ups of the studies the comparison is made on

the more generalized level. In very basic level of the corporate risk management Muda and Yazid (2006, 53-54) note in their study of 1998 Asian financial crisis that transaction risk management was of highest importance to sample group during the crisis, second highest after the crisis and less important before the crisis. Still, the transaction risk management was the most important of the all choices over all three periods. This supports the findings of this study that, even though statistically insignificant, the firms exercised more transaction risk management during the crisis than before or after the period.

One reason for the similar behaviour in firm's activity in foreign exchange risk management is given by Muda and Yazid (2006, 54). Firms are willing to pay a margin to secure some level of cash flows. That means that firms are willing to give up some positive cash flows to secure some certain level. There seems to be increased will to secure a certain level of cash flows at the times of more risk in the markets. Firms may, According to Muda and Yazid (2006, 54), enjoy the smoother cash flows for example through lower borrowing costs. As well as for the firm foreign exchange rate volatility is a risk, for investor the cash flow volatility can be seen as one source of risk. This would imply that firms have willingness to adjust their foreign exchange risk management during the crisis. However, the result of this study is not conclusive. Among the Malaysian firms the policy and guiding of the foreign exchange risk management is very informal (Muda, M. S. & Yazid, A. S. 2006, 58). Hence, to put into that context it may not be suitable reason for statistically unchanged use of derivatives in the majority of compared periods. This needs to be understood carefully since markets in question are very different. There seems not to be significant increase in the derivatives use. This could be because of three reasons below and expressed in figure 11.

1. Firms manage their transaction risk related to foreign exchange in other ways than by derivatives

2. Firms follow their corporate hedging policy by the book and do not adjust the hedge level according to market risk
3. There was increased interest in the foreign exchange risk management but this did not lead to an increased hedge level

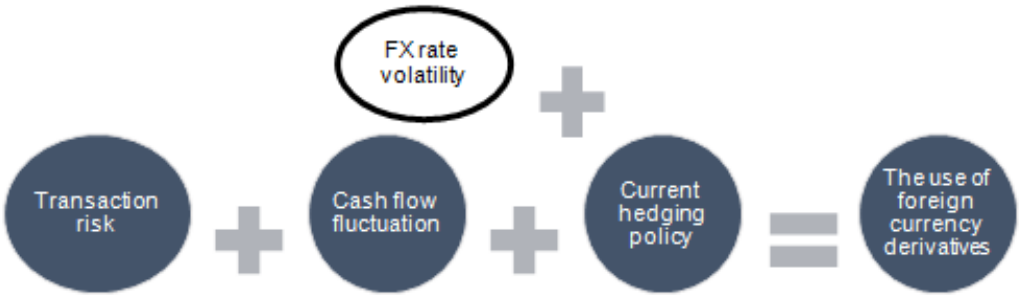


Figure 11. Findings of this study related to findings of other studies.

In addition to more generalized terms expressed above the results of this study can be compared to the significant individual explanatory variables found, among the other, by Afza and Alam (2011) where they found several significant factors impacting the use vs. no-use decision. It was found that most significant determinants for firms' decision to use derivatives were financial distress costs, foreign sales and liquidity of a firm (all highly significant at 1 % level). Especially when compared to such highly significant determinants the foreign exchange rate volatility brings very little, if any, additional value to the model. Based on the Afza and Alam (2011) findings it appears that most significant explanatory variables are internal and external determinants are in less importance.

There are supporting studies to enhance the idea that foreign exchange risk management is done in order to control cash flow fluctuation and hence, manage firm level risk. Afza and Alam (2011, 417) revealed that in another rather small economy, Pakistan, the aim of using foreign exchange derivatives is to maximize shareholder's value. This is achieved

through lower financial distress costs. (Afza, T. & Alam, A. 2011, 416) This is in line with the findings of this study that when in higher risk periods firms would have small tendency to oversee their foreign exchange risk more carefully. Even though this study found only one statistically significant change in derivatives use in the sample period there are more supporting signs that with this phenomenon couldn’t take place with different set-up.

5 CONCLUSIONS

This thesis examines the impact of increased foreign exchange volatility to the extent of currency derivatives use applied for hedging transaction risk among the large, non-financial Finnish firms. It is measured if the increased currency market risk period, the global financial crisis of 2008, increased firms' hedge ratios or is the hedging more static operation. The methodologies used to determine this phenomenon are simple test of means and multiple linear regression. The three compared periods analyzed in this study are the low risk period before the financial crisis (2006-2007), the high risk period of during the financial crisis (2008-2009) and the medium risk period of after the financial crisis (2010-2011). It is assumed that the changes in the extent of hedging take place in transitions from one period to another, that is, between years 2007-2008 and 2009-2010. Sample group consists of 10 large- and mid-cap firms headquartered in Finland and operating in traditional industrial sectors. The hedging activity was analyzed in three generally important currency pairs for firms operating in Finland, EUR/USD, EUR/SEK and EUR/NOK.

The results of this study are measured as a possible estimating capability of foreign exchange market risk, measured as FX volatility, to see whether firms increased their amount of currency derivatives. It appears with this sample group that firms wouldn't increase their extent of currency derivatives use even though the foreign exchange volatility was observed to having increased during the high risk period. When the concept is applied in regression it is found similar results. Foreign exchange volatility does not seem to impact on the use foreign currency derivatives. Especially when compared to previous studies where the findings support that interest to hedge especially transaction and cash flow risk increased, it shows that the foreign exchange rate volatility does not add any value to the existing models estimating the extent of use of foreign currency derivatives.

The practical implication of this study suggests that large, non-financial Finnish firms do not adjust their direct hedging (i.e. EUR/USD risk hedged with EUR/USD derivatives) based on foreign exchange rate volatility. This is mainly because in the sample group it was noted that the notional amount of derivatives decreased very slightly when the net sales decreased during the high risk period. There is however very small implication in the results that the extent of derivatives use would have increased in the peak of high risk period but results are far from significant to be generalized.

This study has many limitations which have impact on the extent these results can be generalized. First and foremost, it is reasonable to ask how well the sample group presents their comparable firms operating in Finland. Sample group being relatively small and representing firms only on selected, traditional industrial sectors it shows that results can be directly pointed out only to those firms. However, the sample group consists of some of the largest and most stable firms which did not face any great structural changes during the study period. Therefore, the sample group can be generalized to some extent. For example Outokumpu Oyj faced great structural rearrangement during the fiscal year 2012 and 2013 and results would have therefore been quite different. These firms in the sample group all have notably large foreign operations compared to for example domestic construction firms or retail sector.

The second limitation is greatly related to the selected currency pairs and how those are dealt with. The question whether these currency pairs are the ones capturing proper information is answered in section one. Still, it can’t be said that these currency pairs would be the only ones that should be focused on when doing further analysis. For the large Finnish firms new currencies in Asia are in growing importance. Also many firms in the sample group have operations in South-America. All these regions have their specifics that may lead to different types of results. The other aspect of the currency pairs is related that when measuring currency pair volatility

it does not directly answer which currency is more volatile. Also, because of the option pricing (increased implied volatility increases option premium) the correlation between currencies becomes more important. When firms net buy options they may want to seek for the cheaper currencies which, still, correlates to the hedged one. These two aspects in this study are covered with an assumption that EUR/USD related risk is hedged only with EUR/USD related products. This assumption is justifiable since because of the dynamic nature of the firms' operations the relative proportion of each currency used for hedging may change either because of the change in underlying position or because of the change in expected correlation of different currencies. In addition, in the long-term analysis there might appear new instruments which cannot be included in the model such as bond issued in foreign currency.

This study leaves open many interesting research opportunities. Foreign exchange rate volatility as such requires much more analysis. It should be posted in fully comparable setting to those of previous studies to confirm its significance as an explanatory variable for derivatives use. To put into the exactly same context with the same sample group it provides valuable data on whether the foreign exchange rate volatility truly does not explain the change in the use of foreign currency derivatives. On the other hand, this study can be expanded to cover all the industrial sectors in Finland to see whether the observed phenomena is only related to those in selected industrial sectors or can it be generalized to all firms operating in Finland. Furthermore, it is interesting to further compare the difference of models when the dependent variable is the extent of derivatives use and binomial variable of use vs. no-use.

REFERENCES

Aabo, T., Kuhn, J. and Zanotti, G. 2011. Founder family influence and foreign exchange risk management. *International Journal of Managerial Finance*.Vol.7, Iss. 1, pp. 38-67.

Abor, J. 2005. Managing foreign exchange risk among Ghanaian firms. *The Journal of Risk Finance*, Vol. 6, Iss. 4, pp. 306-318.

Afza, T. & Alam, A. 2011. Corporate derivatives and foreign exchange risk management. *The Journal of Risk Finance*, Vol. 12, Iss. 5, pp. 409-420.

Angelidis, T. & Degiannakis, S. 2005. Modelling risk for long and short trading positions. *The Journal of Risk Finance*, Vol. 6, Iss. 3, pp. 226-238.

Aretz, K., Bartram, S. M., Dufey, G. 2007. Why hedge? Rationales for corporate hedging and value implications. *The Journal of Risk Finance*, Vol. 8, Iss. 5, pp. 434-449.

Bartram, S. M. 2006. The use of options in corporate risk management. *Managerial Finance*, Vol. 32, Iss. 2, pp. 160-181.

Benrud, E. 2001.Useful properties of exchange rate forecasts for risk management and derivative pricing. *Thunderbird International Business Review*, Vol. 43, Iss. 3, pp. 451-468.

Brown, G. W. 2001. Managing foreign exchange risk with derivatives. *Journal of Financial Economics*, Vol. 60, pp. 401-448.

El-Masry, A. A. 2006. Derivatives use and risk management practices by UK nonfinancial companies. *Managerial Finance*, Vol. 32, Iss. 2, pp. 137-159.

Fadem, B. 2008. High-Yield Behavioural Science (High-Yield Series). Hagerstown, Maryland, Lippincott Williams & Wilkins

Froot, K. A., Scharfstein, D. S and Stein, J. S. 1994. A framework for risk management. *Journal of Applied Corporate Finance*, Vol. 7, Iss. 3, pp. 22-33

Hagelin, N. & Pramborg, B. 2005. Foreign exchange exposure, risk management, and quarterly earnings announcements. *Journal of Multinational Financial Management*, Vol. 15, Iss. 1, pp. 15-30.

Hung, W. & Nguen, H. 2012.Exchange rate exposure and the use of foreign currency derivatives in the Australian resources sector. *Journal of Multinational Financial Management*, Vol. 22, pp.151– 167.

Klimczak, K. M. 2008. Corporate hedging and risk management theory: evidence from Polish listed companies. *The Journal of Risk Finance*, Vol. 9, Iss. 1, pp. 20-39.

Malkin, L. 1994. Procter & Gamble's Tale of Derivatives Woe [Internet document]. Available at: http://www.nytimes.com/1994/04/14/business/worldbusiness/14iht-procter.html

McMillan, D. G. & Speight, A. E. H. 2007. Weekly volatility forecasts with applications to risk management. *The Journal of Risk Finance*, Vol. 8, Iss. 3, pp. 214-229.

Muda, M. S. &Yazid, A. S. 2006.The role of foreign exchange risk management in Malaysia. *The Irish Journal of Management*, Vol. 26, Iss. 2.

NASDAQ OMX Nordic 2013. Latest share information. [Accessed on 26.03.2013], Available at: http://www.nasdaqomxnordic.com/osakkeet/

Shi, L., Wang, P-F.and Zhou, J. 2010. Financial risk management and enterprise value creation Evidence from non-ferrous metal listed companies in China. *Nankai Business Review International*, Vol. 1,Iss. 1,pp. 5-19.

Silvennoinen, A. & Thorp, S. 2013. Financialization, crisis and commodity correlation dynamics. *Journal of International Financial Markets, Institutions and Money*, Vol. 24, pp. 42-65.

Sudacevschi, M. 2010. The innovations on the financial markets. Using Derivatives for banking market risk coverage. *Internal Auditing & Risk Management*, Vol. 20, Iss.4, pp. 49-60.

Tai, C-S. 2010. Foreign exchange risk and risk exposure in the Japanese stock market. *Managerial Finance*, Vol. 36, Iss. 6, pp. 511-524.

Wan, H., Yang, H., Zha, Y. 2013. Autocorrelation type, timescale and statistical property in financial time series. *Physica A: Statistical Mechanics and its Applications*, Vol. 392, Iss. 7, pp. 1681-1693.

APPENDICES

Appendix 1: Nominal values of currency derivatives related to net sales of firms.

Firm		2006	2007	2008	2009	2010	2011
Alhstrom Oyj	EUR/USD	0,00 %	0,00 %	8,26 %	10,88 %	12,71 %	5,55 %
Fortum Oyj	EUR/USD	0,82 %	2,63 %	2,04 %	3,00 %	3,13 %	3,42 %
Kemira Oyj	EUR/USD	1,19 %	1,32 %	0,10 %	1,90 %	1,24 %	0,53 %
Metsa Group Oyj	EUR/USD	5,16 %	2,80 %	1,94 %	3,87 %	3,98 %	4,62 %
Neste Oil Oyj	EUR/USD	12,22 %	14,29 %	13,12 %	20,01 %	12,02 %	11,81 %
Outokumpu Oyj	EUR/USD	12,90 %	0,33 %	2,83 %	5,29 %	4,00 %	4,87 %
Rautaruukki Oyj	EUR/USD	11,14 %	13,16 %	11,17 %	9,85 %	13,04 %	18,08 %
Ruukki Group Oyj	EUR/USD	2,18 %	0,00 %	0,32 %	0,39 %	0,00 %	17,77 %
Stora Enso Oyj	EUR/USD	1,93 %	3,33 %	3,22 %	8,38 %	5,83 %	4,92 %
UPM Kymmene Oyj	EUR/USD	5,42 %	3,41 %	3,11 %	2,88 %	3,57 %	3,74 %
Mean of hedges		**5,30 %**	**4,13 %**	**4,61 %**	**6,64 %**	**5,95 %**	**7,53 %**
Change in percent units			-1,17 %	0,48 %	2,03 %	-0,69 %	1,58 %
Alhstrom Oyj	EUR/SEK	0,00 %	0,00 %	0,64 %	0,15 %	0,58 %	0,25 %
Fortum Oyj	EUR/SEK	150,55 %	140,66 %	95,85 %	111,33 %	94,73 %	102,82 %
Kemira Oyj	EUR/SEK	0,40 %	0,50 %	0,93 %	0,70 %	0,00 %	0,51 %
Metsa Group Oyj	EUR/SEK	3,28 %	3,30 %	2,78 %	2,83 %	3,40 %	3,14 %
Neste Oil Oyj	EUR/SEK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Outokumpu Oyj	EUR/SEK	3,28 %	13,22 %	6,91 %	22,64 %	16,81 %	12,66 %
Rautaruukki Oyj	EUR/SEK	7,06 %	6,71 %	4,93 %	5,95 %	9,11 %	9,36 %
Ruukki Group Oyj	EUR/SEK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Stora Enso Oyj	EUR/SEK	2,58 %	6,26 %	6,62 %	11,18 %	5,34 %	3,47 %
UPM Kymmene Oyj	EUR/SEK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Mean of hedges		**16,71 %**	**17,06 %**	**11,87 %**	**15,48 %**	**13,00 %**	**13,22 %**
Change in percent units			0,35 %	-5,20 %	3,61 %	-2,48 %	0,22 %
Alhstrom Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Fortum Oyj	EUR/NOK	11,76 %	8,55 %	5,54 %	4,16 %	3,65 %	2,27 %
Kemira Oyj	EUR/NOK	0,08 %	0,19 %	0,00 %	0,00 %	0,00 %	0,00 %
Metsa Group Oyj	EUR/NOK	0,08 %	0,33 %	0,23 %	0,33 %	0,43 %	0,67 %
Neste Oil Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Outokumpu Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Rautaruukki Oyj	EUR/NOK	3,53 %	3,35 %	1,82 %	1,13 %	4,39 %	4,43 %
Ruukki Group Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Stora Enso Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
UPM Kymmene Oyj	EUR/NOK	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %
Mean of hedges		**1,55 %**	**1,24 %**	**0,76 %**	**0,56 %**	**0,85 %**	**0,74 %**
Change in percent units			-0,30 %	-0,48 %	-0,20 %	0,29 %	-0,11 %

Appendix 2: Complete presentation of F-test statistics

A: EUR/USD

	BC	*DC*
Mean	0,0471	0,056271314
Variance	0,0021	0,002607295
Observations	10,0000	10
df	9,0000	9
F	0,8226	
P(F<=f) one-tail	0,3879	
F Critical one-tail	0,3146	

	DC	*AC*
Mean	0,0563	0,067428714
Variance	0,0026	0,00204296
Observations	10,0000	10
df	9,0000	9
F	1,2762	
P(F<=f) one-tail	0,3611	
F Critical one-tail	3,1789	

	BC	*AC*
Mean	0,0471	0,067428714
Variance	0,0021	0,00204296
Observations	10,0000	10
df	9,0000	9
F	1,0498	
P(F<=f) one-tail	0,4717	
F Critical one-tail	3,1789	

B: EUR/SEK

	BC	*DC*
Mean	0,1689	0,13672209
Variance	0,2055	0,102194159
Observations	10,0000	10
df	9,0000	9
F	2,0107	
P(F<=f) one-tail	0,1564	
F Critical one-tail	3,1789	

	DC	*AC*
Mean	0,1367	0,131095595
Variance	0,1022	0,093008589
Observations	10,0000	10
df	9,0000	9
F	1,0988	
P(F<=f) one-tail	0,4454	
F Critical one-tail	3,1789	

	BC	*AC*
Mean	0,1689	0,131095595
Variance	0,2055	0,093008589
Observations	10,0000	10
df	9,0000	9
F	2,2092	
P(F<=f) one-tail	0,1267	
F Critical one-tail	3,1789	

C: EUR/NOK

	BC	*DC*
Mean	0,0139	0,006601955
Variance	0,0011	0,000237603
Observations	10,0000	10
df	9,0000	9
F	4,4702	
P(F<=f) one-tail	0,0180	
F Critical one-tail	3,1789	

	DC	*AC*
Mean	0,0066	0,007923795
Variance	0,0002	0,000247274
Observations	10,0000	10
df	9,0000	9
F	0,9609	
P(F<=f) one-tail	0,4768	
F Critical one-tail	0,3146	

	BC	*AC*
Mean	0,0139	0,007923795
Variance	0,0011	0,000247274
Observations	10,0000	10
df	9,0000	9
F	4,2954	
P(F<=f) one-tail	0,0204	
F Critical one-tail	3,1789	

Appendix 3: Correlation matrix of the independent variables

A: EUR/USD

	LTOTAS	*LSALE*	*ASTOE*	*USD*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
LTOTAS	1,00									
LSALE	0,86	1,00								
ASTOE	0,18	0,25	1,00							
USD	0,03	-0,05	0,18	1,00						
2006	-0,03	0,02	-0,08	-0,46	1,00					
2007	0,01	0,08	-0,21	-0,64	-0,19	1,00				
2008	0,02	0,04	0,04	0,60	-0,20	-0,19	1,00			
2009	0,00	-0,10	0,02	0,39	-0,20	-0,19	-0,20	1,00		
2010	0,02	-0,02	0,07	0,08	-0,20	-0,19	-0,20	-0,20	1,00	
2011	0,01	0,01	0,15	0,09	-0,20	-0,19	-0,20	-0,20	-0,20	1,00

B: EUR/SEK

	LTOTAS	*LSALE*	*ASTOE*	*EUR/SEK*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
LTOTAS	1,00									
LSALE	0,86	1,00								
ASTOE	0,18	0,25	1,00							
EUR/SEK	0,03	-0,09	0,13	1,00						
2006	-0,03	0,02	-0,08	-0,55	1,00					
2007	0,01	0,08	-0,21	-0,42	-0,19	1,00				
2008	0,02	0,04	0,04	0,24	-0,20	-0,19	1,00			
2009	0,00	-0,10	0,02	0,80	-0,20	-0,19	-0,20	1,00		
2010	0,02	-0,02	0,07	-0,03	-0,20	-0,19	-0,20	-0,20	1,00	
2011	0,01	0,01	0,15	-0,01	-0,20	-0,19	-0,20	-0,20	-0,20	1,00

C: EUR/NOK

	LTOTAS	*LSALE*	*ASTOE*	*EUR/NOK*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
LTOTAS	1,00									
LSALE	0,86	1,00								
ASTOE	0,18	0,25	1,00							
EUR/NOK	0,03	-0,06	0,12	1,00						
2006	-0,03	0,02	-0,08	-0,46	1,00					
2007	0,01	0,08	-0,21	-0,48	-0,19	1,00				
2008	0,02	0,04	0,04	0,63	-0,20	-0,19	1,00			
2009	0,00	-0,10	0,02	0,52	-0,20	-0,19	-0,20	1,00		
2010	0,02	-0,02	0,07	0,04	-0,20	-0,19	-0,20	-0,20	1,00	
2011	0,01	0,01	0,15	-0,23	-0,20	-0,19	-0,20	-0,20	-0,20	1,00

Appendix 4: Complete presentation of *t*-test statistics

A: EUR/USD

	2006	*2007*
Mean	0,052964739	0,041284607
Variance	0,002509414	0,002737654
Observations	10	10
Pearson Correlation	0,635548022	
Hypothesized Mean Difference	0	
df	9	
t Stat	0,843939201	
P(T<=t) one-tail	0,210284264	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,420568529	
t Critical two-tail	2,262157158	

	2007	*2008*
Mean	0,041284607	0,046101563
Variance	0,002737654	0,002094396
Observations	10	10
Pearson Correlation	0,822658396	
Hypothesized Mean Difference	0	
df	9	
	-	
t Stat	0,509936664	
P(T<=t) one-tail	0,311182583	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,622365167	
t Critical two-tail	2,262157158	

	2008	*2009*
Mean	0,046101563	0,066441066
Variance	0,002094396	0,003427976
Observations	10	10
Pearson Correlation	0,915631862	
Hypothesized Mean Difference	0	
df	9	
	-	
t Stat	2,592413281	
P(T<=t) one-tail	0,014549032	

t Critical one-tail	1,833112923
P(T<=t) two-tail	0,029098065
t Critical two-tail	2,262157158

	2009	*2010*
Mean	0,066441066	0,059529061
Variance	0,003427976	0,002352967
Observations	10	10
Pearson Correlation	0,857395169	
Hypothesized Mean Difference	0	
df	9	
t Stat	0,724239431	
P(T<=t) one-tail	0,243658662	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,487317324	
t Critical two-tail	2,262157158	

	2010	*2011*
Mean	0,059529061	0,075328366
Variance	0,002352967	0,003790553
Observations	10	10
Pearson Correlation	0,339584296	
Hypothesized Mean Difference	0	
df	9	
t Stat	-0,778829877	
P(T<=t) one-tail	0,228034271	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,456068542	
t Critical two-tail	2,262157158	

B: EUR/SEK

	2006	*2007*
Mean	0,167148331	0,170648945
Variance	0,221648124	0,19046969
Observations	10	10
Pearson Correlation	0,997221253	
Hypothesized Mean Difference	0	
df	9	

t Stat	-0,229679562
P(T<=t) one-tail	0,411737866
t Critical one-tail	1,833112923
P(T<=t) two-tail	0,823475732
t Critical two-tail	2,262157158

	2007	*2008*
Mean	0,170648945	0,118663962
Variance	0,19046969	0,08781788
Observations	10	10
Pearson Correlation	0,999339932	
Hypothesized Mean Difference	0	
df	9	
t Stat	1,168415863	
P(T<=t) one-tail	0,136328235	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,272656471	
t Critical two-tail	2,262157158	

	2008	*2009*
Mean	0,118663962	0,154780219
Variance	0,08781788	0,118675546
Observations	10	10
Pearson Correlation	0,990735555	
Hypothesized Mean Difference	0	
df	9	
t Stat	-1,760153671	
P(T<=t) one-tail	0,056117536	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,112235072	
t Critical two-tail	2,262157158	

	2009	*2010*
Mean	0,154780219	0,129976657
Variance	0,118675546	0,085443064
Observations	10	10
Pearson Correlation	0,997343911	
Hypothesized Mean Difference	0	
df	9	

t Stat	1,374084403
P(T<=t) one-tail	0,101331733
t Critical one-tail	1,833112923
P(T<=t) two-tail	0,202663465
t Critical two-tail	2,262157158

	2010	*2011*
Mean	0,129976657	0,132214533
Variance	0,085443064	0,10105384
Observations	10	10
Pearson Correlation	0,998359096	
Hypothesized Mean Difference	0	
df	9	
	-	
t Stat	0,228467746	
P(T<=t) one-tail	0,412194621	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,824389242	
t Critical two-tail	2,262157158	

C: EUR/NOK

	2006	*2007*
Mean	0,015451672	0,012419575
Variance	0,001409192	0,000767625
Observations	10	10
Pearson Correlation	0,995955768	
Hypothesized Mean Difference	0	
df	9	
t Stat	0,935264219	
P(T<=t) one-tail	0,187033009	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,374066017	
t Critical two-tail	2,262157158	

	2007	*2008*
Mean	0,012419575	0,007586687
Variance	0,000767625	0,000313869
Observations	10	10
Pearson Correlation	0,997980765	
Hypothesized Mean Difference	0	

df	9
t Stat	1,514895829
P(T<=t) one-tail	0,082050026
t Critical one-tail	1,833112923
P(T<=t) two-tail	0,164100052
t Critical two-tail	2,262157158

	2008	*2009*
Mean	0,007586687	0,005617222
Variance	0,000313869	0,000172421
Observations	10	10
Pearson Correlation	0,997551805	
Hypothesized Mean Difference	0	
df	9	
t Stat	1,322853385	
P(T<=t) one-tail	0,109254048	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,218508097	
t Critical two-tail	2,262157158	

	2009	*2010*
Mean	0,005617222	0,008470095
Variance	0,000172421	0,000284659
Observations	10	10
Pearson Correlation	0,778686867	
Hypothesized Mean Difference	0	
df	9	
t Stat	-0,852248647	
P(T<=t) one-tail	0,208088991	
t Critical one-tail	1,833112923	
P(T<=t) two-tail	0,416177983	
t Critical two-tail	2,262157158	

	2010	*2011*
Mean	0,008470095	0,007377496
Variance	0,000284659	0,000220163
Observations	10	10
Pearson Correlation	0,967224333	
Hypothesized Mean Difference	0	
df	9	

t Stat	0,762225054
P(T<=t) one-tail	0,232715746
t Critical one-tail	1,833112923
P(T<=t) two-tail	0,465431493
t Critical two-tail	2,262157158

Appendix 5: Complete presentation of linear regression statistics

A: EUR/USD

Regression Statistics	
Multiple R	0,6432
R Square	0,4137
Adjusted R Square	0,2882
Standard error	525,3619
Observations	60

	Coefficients	*Standard error*	*t statistic*	*P value*
Intercept	0	0	0	0
LTOTAS	-108,1732	259,7574	-0,4164	0,6789
LSALE	322,9399	253,4500	1,2742	0,2085
ASTOE	-192,4704	147,7111	-1,3030	0,1985
EUR/USD	-3694,9073	11201,6484	-0,3299	0,7429
2006	346,5315	668,1135	0,5187	0,6063
2007	216,7817	560,2629	0,3869	0,7005
2008	569,7547	1309,4662	0,4351	0,6654
2009	591,1335	1176,0648	0,5026	0,6174
2010	480,5409	980,0785	0,4903	0,6261
2011	533,4278	981,3700	0,5436	0,5892

B: EUR/SEK

Regression Statistics	
Multiple R	0,7494
R Square	0,5617
Adjusted R Square	0,4628
Standard error	0,2736
Observations	60

	Coefficients	*Standard error*	*t statistic*	*P value*
Intercept	0	0	0	0
LTOTAS	0,9084	0,1353	6,7141	<0,001***
LSALE	-0,6938	0,1320	-5,2561	<0,001***
ASTOE	0,0753	0,0769	0,9794	0,3321
EUR/SEK	-19,6400	8,5458	-2,2982	0,0258**
2006	-0,0308	0,2553	-0,1207	0,9044
2007	0,1333	0,2918	0,4570	0,6497
2008	0,7914	0,5769	1,3718	0,1762
2009	1,3868	0,8481	1,6352	0,1083
2010	0,4486	0,4557	0,9846	0,3296
2011	0,4942	0,4592	1,0763	0,2870

C: EUR/NOK

Regression Statistics	
Multiple R	0,6232
R Square	0,3883
Adjusted R Square	0,2582
Standard error	0,0206
Observations	60

	Coefficients	*Standard error*	*t statistic*	*P value*
Intercept	0	0	0	0
LTOTAS	0,0411	0,0102	4,0369	<0,001***
LSALE	-0,0317	0,0099	-3,1974	0,0024**
ASTOE	-0,0014	0,0058	-0,2383	0,8127
EUR/NOK	-0,4788	0,5118	-0,9356	0,3540
2006	0,0124	0,0225	0,5545	0,5817
2007	0,0097	0,0219	0,4417	0,6606
2008	0,0287	0,0458	0,6258	0,5343
2009	0,0197	0,0434	0,4544	0,6515
2010	0,0136	0,0323	0,4205	0,6759
2011	0,0081	0,0267	0,3023	0,7637