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Faculteit Bedrijfseconomische Wetenschappen

master in de toegepaste economische
wetenschappen: handelsingenieur

Masterthesis

Exchange rate exposure, financial distress and firm value: a study of Belgian firms

Maryna Burke

Scriptie ingediend tot het behalen van de graad van master in de toegepaste economische wetenschappen:
handelsingenieur, afstudeerrichting accountancy en financiering

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2018
2019



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Acknowledgements

This thesis serves as the pinnacle of my academic studies in Business Engineering and indicates that I have acquired the necessary competences to complete my studies by addressing the research question: What is the relationship between exchange rate exposure, financial distress and firm value?

I would like to thank my thesis advisor Prof. dr. Mark Vancauteren at the University of Hasselt for giving me the freedom to determine the course of this paper, create my own work and giving valuable insights when needed. His patience is greatly appreciated. Furthermore, I would like to express my profound gratitude to my mother, brother and Belgian host family for their unfailing support during my studies and their encouragement during the research and writing of this master thesis.

Maryna Burke

May 2019

Abstract

The purpose of this master thesis is to establish whether there exists a non-monotonic relationship between financial distress and exchange rate exposure for Belgian non-financial public firms. The author hypothesizes that firms with moderate financial distress will bear less exchange rate exposure than firms with high and low levels of financial distress. This theory is based on a study by Akhigbe et al. (2014).

The methodology of this study comprises of a two-step regression model. In the first step the augmented market model will be used to estimate firm specific exchange rate exposure. The estimated exchange rate exposure will be used in the second step as the dependent variable in a multivariate regression analysis. The variable of interest, financial distress is measured using the Altman Z-score. The findings do not support the hypothesis. However, an indication of a non-monotonic relationship is found. Firms with moderate financial distress are more willing to accept higher levels of exchange rate exposure, when compared to firms with high and low levels of exchange rate exposure.

The originality of this study is the application of Akhigbe et al.'s (2014) theory to a Belgian case study and the use of daily stock returns as opposed to weekly or monthly stock returns to improve the accurateness of the analysis.

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1. Research Plan

1.1 Problem Statement

The volatility of exchange rates stands in stark contrast to the field of international economics 50 years ago. Since the fall of the Bretton Woods System in the 1970's it has become increasingly important to determine the effect of changing exchange rates on the economy. With increased volatility comes increased risk Adler & Dumas (1984). This risk increases transaction costs and reduces the value that can be created with international trade (Héricourt & Poncet, 2015).

A vast body of literature has been dedicated to the relationship between exchange rate risk and the value of companies, measured by their stock prices. Most studies in first world countries found small or insignificant effects (Grier & Smallwood, 2007; Philippe Jorion, 1991; Kanas, 2000). This is contrasted with the significant relationships between exchange rate volatility and stock prices in by Grier & Smallwood (2007) and (Cakan, 2013).

McKenzie (1999) discussed the ambiguity in both literature and empirical results on the impact of exchange rate volatility on trade. He states that there is increasing evidence that the effect of exchange rate volatility is not the same for different markets. Héricourt & Poncet (2015) state that firms in countries with strong financial markets can more easily navigate the sunk costs associated with the exploration of new export markets and the accompanying exchange rate volatility.

Another factor that can distort results between theory and reality is the amount of hedging that firms use to offset their exchange rate risk. Hedging can be described as the use of financial instruments to manage risk. According to the Modern Portfolio Theory by Markowitz (1991), the hedging of exchange rate risk by firms does not add value as investors can diversify their portfolio and eliminate company specific risk. In contrast, Papaioannou (2014) found in a study of non-financial firms in the US, that foreign exchange rate risk was one of the most frequently hedged risks. Although Adler & Dumas (1984) found that exchange rate risk cannot be perfectly hedged, the Arbitrage Pricing Theory by Ross (1976) states that investors are willing to pay a premium to avoid these sources of risk. Using modern finance theory Smith & Stulz (1985) find that companies hedge for three reasons: tax advantages, risk aversion by management and the costs of financial distress. Smith & Stulz (1985) add that the risk benefit of hedging does not outweigh its cost for companies with a low financial distress.

On the other hand, the discrepancy in results can also be due to bad models. (Agyei-Ampomah & Mazouz, 2013) argue that the two-factor model that Jorion (1990) suggested is not adequate. A sample of 269 non-financial firms from the UK were examined to determine a bad model could explain the weak empirical relationships found thus far. He found that Jorion's (1990) model was not optimal as it assumed that exchange rate exposure remained constant over time. Bartov & Bodnar (1994) attributed the lack of significant results to the mispricing of exchange rate exposure. The effect of exchange rates on stock prices are not instant and that a model should be used with lagged values for the changes in exchange rate exposure.

(Akhigbe et al., 2014) builds further on this and describes a non-monotonic relationship between financial distress and the hedging activities of companies. The influence of financial distress on foreign exchange exposure is investigated based on a three-tier risk model. Firms with little or no financial distress do not hedge, those with medium financial distress do hedge and those with high financial distress do not hedge. This agrees with Campello et al. (2010) who state that financially distressed firms bypass attractive investment opportunities due to financial constraints. Wei & Starks (2013) also find that companies who experience financial distress might not have resources to manage their exchange rate exposure and therefore their stock returns might be more sensitive to exchange rate volatility. This study is relevant for both policy makers and managers as knowledge about the effect of financial distress can indicate how firm value will be affected and if optimal hedging strategies are being used by the market. There still exists a lack of evidence for the effect of financial distress on exchange rate exposure on a firm level approach in the Belgian context. This study aims to bridge that gap. Analysing Belgian firms is relevant for two reasons. Firstly because of the importance of exports and imports as it amounts to roughly 85% and 84% of Belgium's GDP in 2017 (Global Edge, 2017).

Secondly, as Belgium uses the Euro but only contributes to a small percentage of the EU's total GDP, which amounted to 2,8% in 2016, the effect of a reversed causality between exchange rate changes and firm value will be minimized (Eurostat, 2017). A firm specific analysis is necessary as aggregate analysis cannot capture industry and firm specific currency risks that are necessary to understand which factors play a role in determining the degree of exchange rate exposure.

The remainder of this study will be structured as follows: chapter 2 reviews existing literature on the measurement of exchange rate exposure, thereafter chapter 3 provides a theoretical study of the determinants of exchange rate exposure. The empirical results of the relationship between financial distress and exchange rate exposure are discussed in chapter 4. Finally, chapter 5 presents the conclusion, limitations and suggestions for further research. The research questions of this study will be addressed next.

1.2 Research Questions

This paper will consist of three research questions. The first two are general questions that will provide more information about the definition and measurement of exchange rate exposure and the determinants of exchange rate exposure. These questions will be answered in a literature study. In the last question the empirical effect of financial distress will be tested.

1.2.1 What is the relationship between exchange rate exposure and firm value?

This question will discuss the different types of exchange rate exposure and review existing literature on the measurement and effect of exchange rate changes on firm value. Departing from the Arbitrage Pricing Theory by Ross (1976) this study assumes that investors are willing to pay a premium for hedging activities that reduce exchange rate exposure. This question aims to determine which model will be adequate to measure exchange rate exposure in the third empirical question.

1.2.2 What are the determinants of exchange rate exposure?

In the second question existing literature will be reviewed to identify the determinants of exchange rate exposure. This question is crucial for selecting control variables and finding an adequate measure of financial distress for the third empirical question. Furthermore, it forms a theoretical framework for hypothesis formulation.

1.2.3 How is the relationship between exchange rate volatility and firm value moderated by financial distress?

The last question will form the focus of this research paper. Here the measurement and determinants of exchange rate exposure, as found in the first two research questions, will be used to estimate the effect of financial distress on firm value. Specifically, the theory of Akhigbe et al. (2014) of a non-monotonic relationship between financial distress and exchange rate exposure will be investigated. The results of the estimated regression analysis will provide an answer to this research question.

1.3 Research Design

This research paper will start by analysing existing literature. Available data with regards to the financial data of public Belgian companies and relevant exchange rates will be processed and analysed. For financial data on Belgian companies the online databank Bel-first will be used. In addition to that, information regarding exchange rates is obtained from the ICE Data Services Database, accessed via Yahoo finance. Data for the trade weighted currency indexes is available from the European Central Bank. STATA will be used to analyse the data. To estimate yearly firm specific exchange rate exposure values, timeseries regressions will be utilized for daily observations grouped by firm and year. Yearly panel data is available to estimate the determinants of exchange rate exposure. A fixed effect model will be used. In this way regressions will be produced that indicate which determinants have a significant influence on firm value.

2. The relationship between exchange rate exposure and firm value

Exchange rate exposure, can be defined as the uncertainty of exchange rate fluctuations and its effect on firm value (Adler & Dumas, 1984; Bartov & Bodnar, 1994; Bodnar & Gentry, 1993; Jorion, 1990). Exchange rate exposure has become increasingly important for academics, managers and policy makers alike, since the end of the Bretton Woods system. The then fixed exchange rate system gave way to a flexible one, creating a new form of risk for companies, that could influence firm value. This part of the research paper aims to review existing academic literature and establish a theoretical base for this study.

In section 2.1 the different types of exchange rate exposure will be described. Section 2.2 explains how exchange rate exposure is measured. The influence of hedging activities is examined in section 2.3 and is followed by a conclusion in section 2.4.

2.1 Types of exchange rate exposure

Exchange rate exposure is discussed in academic literature based on three different dimensions (Prasad & Suprabha, 2015). These dimensions include transaction exposure, economic exposure and translation exposure. Jorion (1990) did not make a distinction and combined transaction and economic exposure as the total effect of exchange rate changes on the real assets of firms. Later academic works made a distinction between the short term and long-term effect of exchange rate exposure on cash flows and the value of real assets (Chow & Chen, 1998; Chow, Lee, & Solt, 2002; Shapiro, 1975). Transaction exposure thus pertains to current transactions such as imports and exports, while economic exposure refers to the unexpected changes in these cash flows in the future (Prasad & Suprabha, 2015). The third dimension, translation exposure, is referred to by Jorion (1990) as the foreign exchange exposure that foreign monetary assets face. Translation exposure is also known as accounting exposure as it is created during the consolidation process of financial statements of parent companies and their foreign subsidiaries (Prasad & Suprabha, 2015).

Transaction exposure can be reduced with financial hedging. Financial hedging reduces short term volatility of cash flows with the use of financial instruments such as foreign currency derivatives (Bartram & Bodnar, 2007). Economic exposure can be hedged with operational hedging. Operational hedging is defined as using flexibility in production such as price setting to reduce the long-term impact of exchange rate exposure (Bartram & Bodnar, 2007).

2.2 Measurement of exchange rate exposure

Exchange rate exposure is defined as the effect of the uncertainty of exchange rate fluctuations on firm value. This section investigates how the change in firm value is measured by exchange rate exposure. In academic literature two important methods for the measurement of exchange rate exposure can be identified (Prasad & Suprabha, 2015). These are the Capital Market Model (CMM) and the Cash Flow Approach. In the Capital Market Model, stock prices are used to approximate the change in firm value. On the other hand, the Cash Flow Approach uses foreign cash flows to determine the change.

Adler & Dumas (1984) laid the theoretic foundation for measuring exchange rate exposure as a regression coefficient. The model became known as the Capital Market Model. Exchange rate exposure is estimated with the following regression:

$$R_i = \alpha + \gamma_i R_x + \varepsilon_i$$

In this model R_i represents stock returns, coefficient γ_i is the exchange rate exposure of firm i and R_x is a basket of returns of foreign currencies.

Thereafter, the Augmented Market Model was introduced by Jorion (1990) and Jorion (1991). This two-factor regression includes stock return R_i as the dependent variable and market return R_m and the exchange risk factor e_i as independent variables. The regression model can be described in the following equation:

$$R_i = \alpha + \beta_1 e_i + \beta_2 R_m + \varepsilon_i$$

The coefficient β_1 represents the exchange rate exposure and β_2 the market risk of firm i , ε_i is the error term. This model aimed to explain a company's stock return based on market returns and the exchange risk factor. It gained popularity because of its simplicity and similar models were used in a study by Bodnar & Gentry (1993).

Jorion (1990) therefore, is the first known study to empirically measure exchange rate exposure. Analysing both multinational firms and domestic firms in the US during the period of 1971 to 1987, exchange rate exposure was found to be positively and significantly correlated to the degree of foreign involvement. On the other hand, purely domestic firms with no foreign sales or assets appeared to all have the same level of exchange rate exposure. In a subsequent paper, Jorion (1991) studied 20 value weighted industry portfolios for the same period of 1971 to 1987. While significant cross-sectional differences were found in industry exposure and movements in the foreign exchange rate, the result were unable to confirm that firm value or stock prices are correlated to foreign exchange rate changes.

Bodnar & Gentry (1993) examined industry level exposures for three first world countries: the USA, Japan and Canada. In this study the Capital Market model was augmented with a trade weighted exchange rate at industry level. The results indicate that between 20% and 35% of industries in all three counties, there exists a significant relationship between exchange rate changes and industry value. Bodnar & Gentry (1993) offer two hypotheses as to why so many industries do not have significant exposures. One explanation is that a single industry could participate in several activities that have different exposures. Another explanation is that firms use financial or operational hedging to reduce their exchange rate exposure.

In his study, Walsh (1994) examines the sources of the relationship between exchange rate exposure and stock returns. As opposed to a simple model containing only transaction and translation effect of exchange rate exposure, he introduces the effect of economic exposure. This long-term cashflow effect was determined by analysing the lagged relationship between exchange rate changes and operating income. Bartov & Bodnar (1994) show in an empirical study that

changes in the exchange rate has little power in explaining short term changes in stock returns. This confirms the findings of previous research articles, moreover also indicating that sample selection is not the only reason for failing to find a relationship. Furthermore, Bartov & Bodnar (1994) find a negative relationship between lagged values of exchange rates and stock returns.

Bartov & Bodnar (1994) give one possible reason as to why lagged values of changes in exchange rates have more explanatory power than contemporaneous changes. Investors might not use all the information available to them, when predicting changes in firm value. It would seem as though investors systematically underestimate or overlook the impact of exchange rate changes in a given quarter, only to correct their estimation in the next quarter, when extra information is available. However, Levi (1994) discusses the difficulties in estimating exchange rate exposure. By measuring exchange rate exposure as a regression coefficient, coefficients are forced towards statistical insignificance by the volatility of exposure. This leads to the wrong conclusions such as that firms are managing their foreign exchange exposure perfectly or that the market does not respond correctly to information regarding stock prices.

In a study of 65 industry stock portfolios during the period of 1977 to 1989, Chow et al. (1997) use contemporaneous as well as 1 and 2 year lagged regressions to capture both the transaction and economic exposure. The results indicate a negative relationship between transaction exposure and stock returns and a positive significant relationship between economic exposure and stock returns.

In a theoretical paper Bartram & Bodnar (2007) provide an overview of existing research concerning exchange rate exposure. The concept of exchange rate exposure puzzle was introduced to explain the phenomenon of empirical results not confirming academic theories. Rather than assigning the discrepancies to poor choice of empirical methods or sample selection as previous studies had done, the study suggested that the lack of significant results could be attributed to the result of financial and operational hedging. Empirical studies calculate exchange rate exposure net of hedging, which results in both firms with low foreign exchange exposure and firms with high foreign exchange exposure employing hedging strategies to show weak exchange rate exposures in regressions.

Martin & Mauer (2005) discuss two common empirical frameworks used in measuring exchange rate exposure. The first is the Capital market approach that uses the sensitivity of stock returns, that has been discussed thus far. The second model is named the Cash flow approach. This model measures exchange rate exposure based on cash flows generated by companies. The specific Cash Flow model discussed in the study is advocated by Martin & Mauer (2003), where exchange rate exposure can be estimated with the following equation:

$$UI_t = c + \sum_{q=0}^L w(q)X_{t-q} + u_t$$

where, UI_t is the unanticipated operating income is estimated for each firm by regressing current operating income on operation income lagged by four periods:

$$I_t = \theta_1 + \theta_2 I_{t-4} + ui_t$$

X_{t-q} in the previous equation represents the relative change of the foreign exchange rate and $w(q)$ the weighted foreign exchange rate exposure. L represents the lag length for the period t as determined by the Akaike information selection criterium. A similar model is used by Akhigbe et al. (2014), Bartov & Bodnar (1994) and Bartram (2008).

A second cash flow model was developed by Bodnar & Marston (2004) in response to the discrepancy between theory and empirical results obtained with the capital market model. For multinational firms, this Cash Flow Approach modelled exposure elasticity (δ) using three firm specific variables: the ratio of foreign currency denominated revenue to total revenue (h_1), the ratio of foreign currency denominated costs to total costs (h_2) and profits as a percent of total revenues (r).

$$\delta = h_1 + (h_1 - h_2) \left(\left(\frac{1}{r} \right) - 1 \right)$$

This model is not widely used in existing literature (Prasad & Suprabha, 2015). Martin & Mauer (2005) and Prasad & Suprabha (2015) compare the two methods for estimating exchange rate exposure and reach similar conclusions. Prasad & Suprabha (2015) study 30 Indian firms for the period of 2012-2013 and find that the Cash Flow approach is preferred as the Capital Market approach gave counterintuitive results. The study, however did not account for lagged values and thus economic exposure in the Capital Market Model. Martin & Mauer (2005) studied a sample of large U.S. banks, thus focusing on financial institutions, as opposed to this study. The study finds that Cash Flow approach, relative to the Capital Market approach finds more significant results for exchange rate exposure: 25% of the sample did not show cash flow sensitivity, while 70-100% of the sample did not show stock price sensitivity. Martin & Mauer (2005) also failed to account for economic exposure when using the Capital Market model.

2.3 Influence of Hedging

Hedging in the context of this study can be defined as the use of financial instruments or operational decisions to reduce the dependence of firm value on changes in exchange rate exposure (Smith & Stulz, 1985). Previous sections have already hinted at the influence that hedging has on the measurement of exchange rate exposure.

Smith & Stulz (1985) state firms hedge for three reasons. The first being that it carries tax reducing benefits. The second reason is that hedging reduces the expected costs of financial distress by managing the volatility of accounting earnings. Lastly, hedging activities are also determined by managerial risk aversion. Building further on this, Allayannis & Ofek (2001) found that a firm's choice to use currency derivatives was based on exposure factors such as foreign activities. The degree to which firms hedged their exchange rate risk depended on their individual exchange rate exposure. According to Bartram (2008), multinational firms experience significant exchange rate exposure, this effect however is found to be insignificant in many studies due to hedging on firm level. Allayannis et al. (2001) investigate the effect of operational and financial hedging. Operational hedging strategies are not found to be related to higher firm value, while financial hedges do result in smaller exchange rate exposures. The combined effect of both financial and operational hedging strategies is also associated with an increased firm value.

2.4 Conclusion

This chapter discussed the types and measures of exchange rate exposure and the influence of hedging. Exchange rate exposure is categorized into translation, transaction and economic exposure. This proves to be an important distinction as early models created to measure exchange rate exposure failed to account for the effect of economic exposure. This study will focus on the effects of transaction and economic exposure.

As seen in the literature there are many ways to model the relationship between exchange rate exposure and firm value. In previous studies there has been a discrepancy between the results suggested by theory and empirical results. This phenomenon was named the exchange rate exposure puzzle by Bartram & Bodnar (2007). According to their theoretical paper, this discrepancy is the result of hedging activities by companies. Hedging reduces the impact of exchange rate exposure. Furthermore, information about the hedging activities of companies are not readily available in financial statements, making it more difficult to control for these activities. Other reasons for the lack of significant results include sample selection and the empirical methods used, such as not using lagged values or proxies for hedging (Walsh, 1994).

Martin & Mauer (2005) and Prasad & Suprabha (2015) compared the two most used models for measuring exchange rate exposure and found similar results. The Capital Market Approach and the Cash Flow Approach. The results of Prasad & Suprabha (2015) indicate that the Cash Flow Approach is superior, as counterintuitive results were found with the Capital Market approach. The study, however, did not account for economic exposure by including lagged values of exchange rate changes. The Cash Flow approach does have the advantage of not requiring stock market data. This implies that also non-listed firms can be analysed. Following Wei & Starks (2013) the Capital market approach will be used in this study, due to the lack of foreign cash flow data on firm level, the availability of stock data and the possibility of incorporating economic exposure.

3. Determinants of exchange rate exposure

Following the reasoning of Choi (1995), this paper will focus on firm specific variables that could influence its exchange rate exposure. This is because aggregate macro economic analysis may not reveal the true firm specific exposure to foreign exchange rates. In the previous chapter the influence of hedging activities on exchange rate exposure also proved to be important.

The determinants will be classified into 4 sections: foreign involvement, proxies for hedging activities, industry characteristics, and financial distress. These determinants will be discussed in section 3.1, 3.2, 3.3 and 3.4 respectively. The first three sections aim to identify controls variables that are relevant to this study, while the purpose of section 3.4 is to gain a better theoretical understanding of the independent variable, financial distress. Finally, a conclusion follows in section 3.5.

3.1 Foreign involvement

Jorion (1990) found that foreign involvement had a significant positive correlation with exchange rate exposure. Foreign involvement was measured as the ratio of foreign sales to total sales. The FX exposure of domestic firms with no foreign activities, however, appears to be constant. In a study of 447 nonfinancial German corporations, Bartram (2004) also concludes that the effect of exchange rate exposure is both larger and more significant for firms with more international sales. In a sample of 171 Japanese multinational firms, He & Ng (1998) confirm that a firm's export ratio affects its exposure to changes in exchange rates.

3.2 Proxies for Hedging activities

Hedging is an important determinant of exchange rate exposure, and according to Papaioannou (2014), exchange rate exposure is one of the most hedged risks for nonfinancial companies. According to the Arbitrage Pricing Theory by Ross (1976), firm value is influenced by hedging activities. Due to unavailability of specific data concerning firm's hedging activities, existing literature uses proxies for hedging activities to control for above mentioned effect (Chow & Chen, 1998; Chow et al., 1997; He & Ng, 1998).

Allayannis & Ofek (2001) examine the use of currency derivatives for hedging purposes in a sample of 174 non-financial US firms. A significant negative relationship was found between foreign currency hedging and exchange rate exposure. This indicates that these firms successfully implement financial hedges to reduce their exchange rate exposure. Moreover, a firm's foreign involvement is an important indication of hedging activities.

The first proxy for hedging activities is firm size. Firm size is also used as a proxy for hedging activities as larger firms have more incentive to hedge because of economies of scale related to the cost of hedging (Doukas et al., 1999; He & Ng, 1998; Nance et al., 2012). Conversely, Chow & Chen (1998) proposes a dual model with determinants for short- and long-term exchange rate exposure. The effect of short-term financial hedging is more pronounced with small firms due to its affect on bankruptcy costs and that large firms are more inclined to use long term operational hedging due to economies of scale. Market capitalization and total assets are two common ways of indicating firm size. Market capitalization represents the value of a companies outstanding

shares and is used in studies such as Agyei-Ampomah & Mazouz (2013) and Wei & Starks (2013) as a proxy for hedging activities. Total assets is used by Akhigbe et al. (2014) as a proxy for hedging activities.

The second proxy for hedging is liquidity. Liquidity indicates a firm's ability to meet short term liabilities and indicates if firm's have the means to buy hedging instruments. He & Ng (1998) used factors such liquidity and leverage ratios as proxies for hedging activities. Japanese multinational firms with a lower liquidity ratio or a higher financial leverage are more likely to hedge and is less exposed to exchange rate risk. Bartram (2004) also lists firm liquidity as a significant determinant of exchange rate exposure. Chow & Chen (1998) also find that firms with low liquidity have high exchange rate exposures.

Leverage is the third proxy for hedging. Leverage refers to a firm's capital structure and debt to equity ratio. Firms with high leverage face what is called the moral hazard problem, where debtholders and equity holders have conflicting interests (Chow & Chen, 1998). Therefore, these firms are expected to hedge exchange rate risk to reduce the variance in firm value and their cost of capital. However, Chow & Chen (1998) find that Japanese firms with high leverage have high exchange rate exposure. Lastly, book to market value of equity is used to determine a firm's growth opportunities. He & Ng (1998) use the book to market value of equity as a proxy for a firm's growth opportunities.

3.3 Industry characteristics

The relationship between an industry's value or profitability and changes in foreign exchange rates depends on their activities (Bodnar & Gentry, 1993). These activities include making the distinction between export and import industries, foreign investments and other international ventures.

In Bodnar & Gentry (1993), industries are classified by Standard Industrial Classification codes (SIC). Multiple portfolios of firms from the USA, Canada and Japan for a period between 1979 and 1988 were studied and the study found that for all three countries, industry characteristics influenced exchange rate exposure in a way that confirms economic theory. In Canada and Japan, non-traded goods industries had an increase in value when home currency increased. Export industries are correlated with negative exchange rate exposures and import industries are correlated with positive exchange rate exposure.

Chow & Chen (1998) classified industries between traded and non-traded. 1110 firms in Japan were studied for the period between 1977 and 1991 and results indicate that Japanese import industries and non-traded industries have a bigger exchange rate exposure compared to export industries. Bartram (2004) concludes that industry sectors are significant determinants of exchange rate exposure. Choi (1995), however, find nonconclusive results for a relationship between exchange rate exposure and industry profits with 409 US multinational firms during the period of 1978 and 1989. Cross sectional differences between industries were not found.

3.4 Financial Distress

Wruck (1990) and Asquith et al. (1994) define financial distress as the financial position of a company where financial obligations are not covered by cash flow. Wei & Starks (2013) were one of the first researchers to specifically study the mediating effect of financial distress on exchange rate exposure. Firms with higher default probabilities exhibit higher degrees of exchange rate exposure. Akhigbe et al. (2014) built further on that study by examining the non-monotonic relationship between FX exposure and financial distress. This was inspired by a study Stulz (1996) did that describes the risk management of firms depending on their default likelihood being low, medium or high. According to the three-part model of Akhigbe et al. (2014), exchange rate exposure was the highest for firms with low levels of financial distress and firms with high levels of financial distress. Firms with a moderate amount of financial distress had the lowest exchange rate exposure. The remainder of this section will discuss existing literature on financial distress and FX exposure based on this framework.

According to Smith & Stulz (1985) companies will hedge their risk if incentivized to do so and if the reduction in expected exposure costs exceeds the costs of hedging. Guay & Kothari (2003) state that firms with low financial distress are more likely to leave their FX exposure unhedged or partially hedged. This is because the cost of exchange rate exposure is lower for financially sound firms. He & Ng (1998) found that within a sample of 171 Japanese multinationals that keiretsu firms are more likely to have a greater exchange rate exposure. Keiretsu firms form part of a bigger structure of companies that, while remaining financially independent, have strong business relationships. Keiretsu firms have a lower financial distress probability because of this integrated network.

Firms with higher expected distress costs, and moderate financial distress, be more inclined to hedge their foreign exchange rate exposure to reduce its impact (Kim & Kraple, 2016). Géczy et al. (1997) found that firms facing financial constraints can use hedging to reduce costs related to underinvesting in investment opportunities. Firms with the combination of high potential for growth and limited access to funds were most likely to use currency derivatives. The Arbitrage pricing theory as explained in Ross (1976) also states that investors are willing to pay more to reduce certain kinds of risks. Both He & Ng (1998) and Afza & Alam (2011) found that firms with less tangible assets and higher leverage ratios are more inclined to use hedging instruments to reduce the costs of financial distress and manage exchange rate exposure. Furthermore, Bartram & Bodnar (2007) argue that foreign exchange exposure that is found in empirical studies is not the full foreign exchange rate exposure firms face, but the net exposure left after hedging activities.

Lel (2012) studied the relationship between corporate governance and the use of foreign currency derivatives of 39 countries with significant exchange rate exposure. Using financing leverage as a proxy for financial distress he found that there existed a negative relationship between financial distress and hedging activities. He further stated that financial distress and exchange rate exposure are directly related.

Meckling (1976) provide a theoretical indication for the increased FX exposure of financially distressed firms. The agency problem could result in managers increasing the volatility of a

company's assets for firms facing a higher probability of default. Conversely Wei & Starks (2013) state that financially distressed firms have an increased cost of capital which makes it more difficult and expensive to access external funds to smooth out the effect of exchange rate exposure on cash flows. Kim & Kraple (2016) found a positive relationship between exchange rate exposure and financial distress. Campello et al. (2010) state that financially distressed firms bypass attractive investment opportunities due to financial constraints. Wei & Starks (2013) also found that companies who experience financial distress might not have the resources to manage their exchange rate exposure and therefore their stock returns might be more sensitive to exchange rate volatility.

Three different measures for exchange rate exposure are frequently used in existing literature (Akhigbe et al., 2014; Wei & Starks, 2013). Two are accounting based measures and the third is a market-based measure. The accounting-based measures are the Altman Z-score and the Ohlson O-score. The market-based measure is the Black-Scholes Merton Option pricing model.

The Altman Z-score was developed by Altman using financial ratios to predict financial distress and bankruptcy (Altman, 1968.) Using a statistical model with fixed coefficients and firm specific financial ratio's, the Z-score produces a single firm specific value, that proves to be a dependable model for forecasting financial distress (Siddiqui, 2012). The original model has been adapted throughout the years and additional models have been created to distinguish between certain industries. Particularly relevant for this study is the difference between the Z-score calculated for Manufacturing vs. non-manufacturing firms. The Altman Z-score (Altman, 2000) for manufacturing firms can be calculated as follows:

$$Z\text{-score} = 1,2A + 1,4B + 3,3C + 0,6D + 1,0E$$

Where:

A = working capital / total assets

B = retained earnings / total assets

C = earnings before interest and tax / total assets

D = market value of equity / total liabilities

E = sales / total assets

Whereas in the non-manufacturing Z-score the final financial ratio E is excluded to eliminate a possible industry effect as sales divided by total assets is a very sensitive and industry specific ratio (Altman et al., 2017):

$$Z\text{-score} = 6,56A + 3,26B + 6,72C + 1,05D$$

The calculation of the financial ratios presented by A, B, C and D is identical to that of manufacturing firms. The interpretation of the Altman manufacturing (non-manufacturing) Z-score is as follows: An Altman Z score under 1,8 (1,1) indicates financial distress, while companies with a Z score of 3 (2,6) or larger have a very low possibility of bankruptcy.

The second accounting -based measure for financial distress is the Ohlson O -score. A linear factor model incorporating nine firm specific financial ratios is used to calculate the O-score. Two of the

nine factors typically assume a value of zero. The Ohlson O-score is calculated as follows (Ohlson, 1980):

$$T = -1.32 - 0,407 \log\left(\frac{TA_t}{GNP}\right) + 6,03 \frac{TL_t}{TA_t} - 1,43 \frac{WC_t}{TA_t} + 0,0757 \frac{CL_t}{CA_t} \\ - 1,72X - 2,37 \frac{NI_t}{TA_t} - 1,83 \frac{FFO_t}{TL_t} + 0,285Y - 0,521 \frac{NI_t - NI_{t-1}}{|NI_t| + |NI_{t-1}|}$$

Where:

TA = total assets

GNP = Gross National Product price index level

TL = total liabilities

WC = working capital

CL = current liabilities

CA = current assets

X = 1 if total liabilities is more than total assets, or 0 if not

NI = net income

FFO = funds from operators

Y = 1 if a net loss is reported for the last two years, or 0 if not

Any result bigger than 0,5 indicates that the firm will default in the next two years. In a study done by Begley et al (1996) the performance of the Ohlson O-score and Altman Z-score is compared for the 1980's. The Ohlson O-score displays the strongest overall performance. In a more recent studies by Karamzadeh (2013) and Ashraf et al. (2019) the Altman Z-score more accurately predicts insolvency for both early and late stage financial distress. Ashraf et al. (2019) adds that the predictive ability of these models declines during financial crisis periods.

The last measurement for exchange rate exposure is a market-based model, the Black-Scholes-Merton Option pricing model, also known as the distance to default measure. Using Merton's (1974) theory of defining equity as a call option on a firm's assets, the expected default probability is expected to be the following:

$$BSMDM = N\left(-\frac{\ln\left(\frac{V}{F}\right) + \left(\mu - \frac{1}{2}\sigma_V^2\right)T}{\sigma_V\sqrt{T}}\right)$$

This equation can be described as the probability of a firm's assets assuming a negative value, indicating bankruptcy. V represents the market value of a firm's assets, while σ indicates the volatility of the asset market value. F is the book value of a firm's liabilities. Values V and σ are estimated simultaneously using the Black-Scholes Merton Option pricing model, as equity can be represented using the following call optioning:

$$V_E = VN(d_1) - Fe^{-r} N(d_2)$$

Where:

$$d_1 = \frac{\ln\left(\frac{V}{F}\right) + \left(r + \frac{1}{2}\sigma_V^2\right)T}{\sigma_V\sqrt{T}} \text{ and}$$

$$d_2 = d_1 - \sigma_V\sqrt{T}$$

Agarwal & Taffler (2008) compared the market based Black-Scholes-Merton Option pricing model with the accounting-based Altman Z-score model and found no significant difference in the predictive capability of these two models. Both models also failed to provide significant failure prediction results. Accounting measures, however, were found to have three advantages: firstly, financial statements usually capture the decline in a company's profitability, secondly, accounting policies mitigate window dressing and thirdly, information regarding loan covenants is presumed to be reflected in accounting-based models.

3.5 Conclusion

This chapter discussed determinants of exchange rate exposure based on a comprehensive literature study. This discussion forms the foundation for the selection of the variable of interest and control variables for the empirical study in the third chapter. Certain variables discussed in this chapter were not found to be statistically significant in studies, while for other variables it was not possible to find data. Two accounting-based, and one market-based model of financial distress was discussed. Respectively the Altman Z-score, the Ohlson O-score and the Black Scholes Merton option pricing model. Based on performance in existing research the Altman Z-score is chosen to be used as a measurement of financial distress. This accounting-based measure of insolvency will form the variable of interest in the empirical section. Furthermore, total assets, market capitalization, price to book ratio, quick ratio and debt ratio will be used as control variables in the empirical part of this study.

4. Exchange rate exposure, financial distress and firm value

Information collected in the previous sections concerning exchange rate exposure, firm value and determinants of exchange rate exposure be used in this section to empirically test the effect of financial distress on the exchange rate exposure of Belgian public companies. In section 4.1 the data and collection method will be discussed. Thereafter section 4.2 presents the methodology, and regression model used. Section 4.3 discusses the econometric model and the determinants which are included. Section 4.4 is a descriptive analysis of the data and is followed by an explanatory analysis in section 4.5. Results are presented and discussed in section 4.6; the conclusion.

4.1 Data

This master thesis investigates the effect of financial distress on exchange rate exposure for Belgian companies. To investigate this effect, two different econometric models and data sets are required. The first data set will be used to determine exchange rate exposure, while the second dataset will be used to analyse the determinants of exchange rate exposure.

Stock prices will be used in the first data set to determine the change in firm value that exchange rate exposure could cause. Therefore, the population of firms that are relevant are publicly traded Belgian companies. Daily data concerning EURONEXT Brussels stock prices and the EURONEXT Brussels All Share Index (BELAS) from the ICE Data Services Database, is accessed via Yahoo finance for the period of 2008 to 2017. The European Central Bank provides data concerning trade weighted currency indexes. Data pertaining to foreign involvement, such as foreign sales was not available, thus stock market and accounting based models will be used. Financial institutions and insurance companies are excluded as these firms are more inclined to use advanced hedging strategies.

For the second data set the Bel-first database is used to obtain financial information based on the Financial Statements of a sample of this population. Out of a total of 621.331 active companies listed in the database 140 remain after controlling for Belgian public companies listed on the EURONEXT Brussel stock exchange. After checking for data completeness and removing financial institutions, 53 companies remain with yearly financial information regarding the 10-year period of 2008 to 2017. NACEBEL 2008 industry classification codes are used to remove financial and insurance activities and make a distinction between manufacturing and non-manufacturing firms (Federal Public Service Belgium, 2019). These NACEBEL codes can be consulted in Table A1 in the appendix.

4.2 Methodology

The data obtained in section 4.1 will be used to estimate two different econometric models. The first model will use daily stock data to estimate the level of exchange rate exposure per year for each company. This information will then be used as the dependent variable in the second econometric model to analyse the determinants of exchange rate exposure. Both econometric models will be explained in more detail in section 4.3.

For the first econometric model, daily stock data is available for different companies. This would normally indicate a panel data analysis. However, company specific exposures are required per year as input for the second econometric model. Therefore, exchange rate exposure will be estimated by grouping daily data per year and per company with timeseries regressions. The second econometric model will incorporate panel data techniques as yearly financial data is available for different companies. A classic pooled ordinary least squares (OLS) would not be adequate for panel data as the heterogeneity of the different companies would be lost by combining all the observations. Therefore, a time fixed effect model (FEM) is used and intercept λ_t is created for each year with a dummy variable.

4.3 Econometric model

To find the effects of financial distress on exchange rate exposure two econometric models are used. In section 4.3.1 the Augmented Market model estimates exchange rate exposure as a regression coefficient. Section 4.3.2 presents the second step: a multivariate regression model that uses the estimated exchange rate exposure as a dependant variable.

4.3.1 Step 1: The Augmented Market model

To determine the exchange rate exposure of the selected firms, a variant of the two-factor model presented by Adler & Dumas (1984) will be used:

$$STOCK_t = \beta_{0t} + \beta_1 NEER_t + \beta_2 BELAS_t + u_t$$

Daily data will be grouped by year and a timeseries regression will be estimated per firm per year. The coefficient β_1 represents exchange rate exposure and β_2 market risk, u_t is the error term. This model aims to explain a company's stock return based on market returns and the exchange risk factor. It gained popularity because of its simplicity and similar models were used in studies by Bodnar & Gentry (1993) and Wei & Starks (2013). As this model will be regressed individually per firms in a specific year, the only relevant subscript is t that refers to the day. The relevant hypotheses for this model are:

$$H_0: \beta_1 = 0$$

$$H_a: \beta_1 \neq 0$$

The null hypothesis states that exchange rate changes have no effect on stock returns, while the alternative hypothesis states that firm value is determined by fluctuations in exchange rates.

4.3.1.1 Dependant variable

STOCK_t Represents the firms stock prices in week t . This variable is log transformed to facilitate interpretations and to ensure that the variable has a more normal distribution.

4.3.1.2 Independent variable

NEER_t Nominal effective exchange rate is a trade weighted exchange rate for the EURO with the 12 most important currencies. The index is computed as a weighted average of twelve bilateral exchange rates, defined as Euro per unit of foreign currency for the Australian dollar, the Canadian dollar, the Danish krone, the Hong Kong dollar, the Japanese yen, the Norwegian krone, the Singapore dollar, the South Korean won, the Swedish krona, the Chinese yuan, the British pound and the United States dollar. The weights are calculated annually based on the proportion of total trade with the European Union. Nominal exchange rates are used in most studies, and even though it would be more accurate to account for inflation, this effect seems to be negligible (Bartram & Bodnar, 2007.) This is the variable of interest, as the coefficient of this variable is the estimation of exchange rate exposure. Trade weighted indexes have the advantage of not resulting in collinearity, as opposed to individual exchange rates (Walsh, 1994).

4.3.1.3 Control Variable

BELAS_t Belgium All Share Index indicates the market index for stocks listed on the EURONEXT Brussels stock exchange for week t . Studies such as Adler & Dumas (1984), Bodnar & Gentry (1993) and Jorion (1990) control for market return to ensure that additional excess exchange rate exposure is estimated.

4.3.2 Step 2: Multivariate regression model

In the second part, the regression coefficient of NEER of each company is used as an estimator for exchange rate exposure. This estimation is used as the dependant variable FXEX in the multivariate model that follows:

$$FXEX_{i,t} = \beta_{0i,t} + \beta_1 HZSCORE_{i,t} + \beta_2 LZSCORE_{i,t} + \beta_3 MC_{i,t} + \beta_4 PB_{i,t} + \beta_5 DR_{i,t} + \beta_6 TA_{i,t} + \beta_7 QR_{i,t} + \alpha_i + \lambda_t + u_{i,t}$$

In this model, the subscript i refers to a unique identifier for each company and t refers to year. The subscript i can variate from 1 to 53 as 53 firms are included in this study. Subscript t represents the years 2008 to 2017 and thus varies from 1 to 10. The variables α_i and λ_t control for entity, or rather company, and time fixed effects respectively.

4.3.2.1 Dependant variable

FXEX_{i,t} The dependant variable is exchange rate exposure. It is obtained from the coefficient of the independent variable NEER in the previous regression and is expressed as a percentage.

4.3.2.2 Independent variable

ZSCORE_{i,t} The Altman Z-score is an accounting based measurement of financial distress used by Akhigbe et al. (2014) and Wei & Starks (2013) and is the variable of interest in this econometric model. Altman (2000) differentiates between manufacturing and non-manufacturing firms,

resulting in two separate calculations of ZSCORE. Two dummy variables are created: HZSCORE_{i,t} and LZSCORE_{i,t} which respectively indicates a ZSCORE greater than 3 (2,6) and a ZSCORE lower than 1,8 (1,1). A third variable to indicate the medium zone between high and low is omitted to prevent multicollinearity. LZSCORE corresponds to high financial distress and HZSCORE corresponds to companies with low financial distress. The interpretation of the variables HZSCORE and LZSCORE are relative to the medium group that has been omitted. According to Akhigbe et al.'s (2014) theory of a non-monotonic relationship between exchange rate exposure and financial distress, the coefficients β_1 and β_2 of HZSCORE and LZSCORE are expected to be positive relative to the medium group. The relevant hypotheses for this model are:

$$H_0: \beta_1 \leq 0, \beta_2 \leq 0$$

$$H_a: \beta_1 > 0, \beta_2 > 0$$

4.3.2.3 Control variables

Variables in this section control for omitted factors that may have an influence on the dependant variable and are based on economic theory.

MC_{i,t} Market Capitalization is the market value of a company and is used by Agyei-Ampomah & Mazouz (2013) and Wei & Starks (2013) to indicate the size of a company. In Chapter 3 of this paper, company size was recognized as a proxy for hedging activities, thus market capitalization is expected to have a negative coefficient. Due to the size of its values, MC is log transformed.

PB_{i,t} Price to Book Ratio indicates the growth opportunities of firms and is expected to be positively correlated to exchange rate exposure, as a higher PB ratio reduces firms incentive to hedge resulting in a greater exchange rate exposure (He & Ng, 1998).

DR_{i,t} The degree of leverage that a company uses is measured by the Debt Ratio (Kim & Kraple, 2016; Wei & Starks, 2013.) Leverage is expected to have a negative coefficient as firms with high leverage will hedge their exchange rate risk (He & Ng, 1998).

TA_{i,t} Total assets is used by Akhigbe et al. (2014) to indicate the size of a company. This serves as an indication or proxy for hedging activities and thus the coefficient of TA is expected to be negative. Due to the size of its values, TA is log transformed.

QRT_{i,t} The Quick Ratio is used as a measurement of liquidity and it expected to be negatively related to exchange rate exposure (Chow & Chen, 1998).

4.4 Descriptive analysis

The descriptive statistics consists of a concise interpretation of the characteristics of the variables used in the empirical analysis, as seen in Table 4.1 and 4.2. The variables that will be discussed in this chapter are quantitative and consist of a balanced data set of 26.089 observations in the first section and an unbalanced data set of 423 observations in the second section. Table 4.1 and 4.2 show key statistics such as the mean, variation and minimum and maximum values of each

variable. For instance, in Table 4.2 the mean value for ZSCORE is 1,49, a value which also corresponds to the medium zone of financial distress when taking in the account of number of non-manufacturing firms. The standard deviation of ZSCORE is 1,87, which is low because of the removal of 12 outliers in the data set, see Figure A1 in the appendix.

Table 4.1: Descriptive Statistics Augmented Market model variables

Data	STOCK	NEER	BELAS
N	26.089	26089	26089
Mean	31, 13	1.047.387	10.119,82
S.D.	62,57	71.833,15	2.260,34
1st Q.	4,74	981.533	8.209,58
2nd Q.	15,5	1.043.891	9.993, 08
3rd Q.	35,94	1.088.334	12.307.27
Min.	0, 01	912.970	5.312,81
Max.	2.225	1.200.139	13857,18
Kurt.	253,37	2,24	1,67
Skew.	11,49	0,32	-0, 07

(N=number observations, Mean, S.D.=Standard Deviation, 1st Q.=First Quantile, Min=Minimum, Max=Maximum, Kurt=Kurtosis, Skew=Skewness)

Skewness is a measure for asymmetry in a distribution. Skewness equals zero in a distribution where the mean and median values are similar. Kurtosis refers to the distribution of the tail values. A normal distribution has a kurtosis of 3. In Table 4.1 STOCK is the exception with a heavy tail and a right skewed distribution. This indicates that a log transformation of STOCK is recommended, see Figure A2 in the appendix. Table 4.2 also displays that the control variables MC, PB, DR, TA and QR display high values for kurtosis and skewness. As PB, DR and QR represent ratios, these variables will be left unchanged. MC and TA, however will be log transformed to simplify interpretations.

Table 4.2: Descriptive Statistics multivariate regression variables

Data	FXEX	ZSCORE	MC	PB	DR	TA	QR
N	423	423	423	413	421	423	416
Mean	0, 18	1,49	1.175,56	2,14	2,43	1.658,32	1,67
S.D.	2,99	1,87	2.760,20	3,47	4,68	3.466,78	5,17
1st Q.	-1,10	0,70	51, 03	0,89	0,73	98,1	0,33
2nd Q.	0,20	1,42	211,38	1,24	1,54	344,19	0,67
3rd Q.	1,45	2,40	900,50	2,38	2,5	1.614.66	1,32
Min.	-19,13	-8,66	0,55	-3,72	0, 03	0,41	0, 01
Max.	12,21	7,18	29.730,17	46,97	71, 31	21.640.20	65,18
Kurt.	9,15	9,40	43,34	86,10	121,28	17,85	80,77
Skew.	-0,43	-0,99	5,32	7,83	9,35	3,74	8,22

(N=number observations, Mean, S.D.=Standard Deviation, 1st Q.=First Quantile, Min=Minimum, Max=Maximum, Kurt=Kurtosis, Skew=Skewness)

Finally, the percentiles are the last characteristics to interpret and discuss. The first Quantile represents 25% of ordered values. For example, the 1st Quantile value 0,70 of ZSCORE means that 25% of the observations have a ZSCORE of 0,70, indicating financial distress. Notably, at least 75% of observations have medium or high financial distress.

The correlation matrix of variables used in the Augmented Market regression is presented in table 4.3 Transaction and economic exposure and the market return has a very weak correlation with stock returns. A weak correlation normally indicates that there is a relationship with the other variable. However, in large sample sizes it is still possible to find statistically significant

relationships. Transaction and economic exposure are highly correlated, as expected. Moreover, exchange rate exposure and the Belgian All Share Index seems to be negatively correlated.

Table 4.3: Correlation matrix of Augmented Market model variables

	STOCK	NEER	LNEER	BELAS
STOCK	1			
NEER	0,001	1		
LNEER	-0,007	0,900	1	
BELAS	0,058	-0,580	-0,627	1

Table 4.4 presents a correlation matrix of the variables used in the multivariate regression. All measures of hedging activities are negatively correlated to transaction exposure. All these results are intuitive. Market capitalization (MC) and Total Assets (TA) are highly correlated (0,827). Both these values are a measure for the size of a firm, which acts as a proxy for hedging activities.

Table 4.4: Correlation matrix of Multivariate regression model variables

	FXEX	LFXEX	QR	PB	DR	TA	MC	ZSCORE
FXEX	1							
LFXEX	0,825	1						
QR	-0,095	-0,055	1					
PB	-0,071	0,382	0,008	1				
DR	-0,042	-0,050	-0,128	0,201	1			
TA	-0,029	-0,092	-0,070	-0,044	0,016	1		
MC	-0,014	-0,094	-0,074	0,010	0,021	0,827	1	
ZSCORE	-0,030	-0,165	0,115	-0,106	-0,049	-0,021	0,099	1

4.5 Empirical results

This section presents the empirical results of the effect of ZSCORE and other control variables on the dependent variable FXEX. A hypothesis is formulated for each regression based on academic literature. These hypotheses are tested based on the p-values of a t-statistic. A small p-value indicates that the null hypothesis can be rejected. Robust standard deviations are used in all models. The results of the first Augmented Market model will be discussed in section 4.5.1. Thereafter section 4.5.2 presents the results of the multivariate model.

4.5.1 Augmented Market model

In the Augmented Market model time series regressions are modelled by firm and year. The effect of a trade weighted exchange rate index NEER on stock prices STOCK is estimated. A market index BELAS is included as a control variable. The coefficient of NEER represents the exchange rate exposure of the firm for that year and is used to measure transaction exposure. A Fisher type unit root test based on the augmented Dickey Fuller test is implemented to test the hypothesis H_0 : All panels contain unit roots, with H_a : At least one panel is stationary. The result of the unit root test is presented in Table A2 in the appendix. All 4 tests indicate that the hypothesis of a unit root cannot be rejected at a 10% significance level. The data is thus stationary.

Furthermore, LNEER is also estimated to measure economic exposure and thus the long-term effect of exchange rate on firm value. LNEER is the lagged value of NEER. Bartov & Bodnar, (1994) use a lag of one month, while Walsh (1994) suggests a six-month lag. The Akaike selection criteria is used to select the optimal lag length of 8 weeks.

Table A3 in the appendix shows an extract of the firm specific coefficients of FX economic exposure for 2017. Of the total 406 results for all companies in the dataset from 2008 to 2017, 329 or 57,9% of economic exchange rate exposure coefficients are significant on a 1% level. On the other hand, 301 of the 406 or 40,4% of transaction exposure coefficients are significant on a 1% level. For the calculation of the P Values a t-distribution is used, as the population standard deviation is not known. These coefficients can be interpreted as the average % change in firm value when the foreign exchange rate increases by 1%.

Additionally, a fixed effect panel data regression was estimated to give an overview of the total effect of transaction end economic exposure on firm value using all observations. The results are shown in table 4.5. These results are not useful for the estimation of the Multivariate regression model but do provide more insight into the data set. The coefficient of \ln_NEER is 0,978 which indicates that if exchange rate exposure increases by 1% that stock prices increase by 0,978%. This result is significant on the 5% level. Furthermore, an increase in the Belgian All Share Index of 1% corresponds, on average, with an increase stock price of 0,57%. As stock prices are determined by a range of macro-economic variables, the R^2 in this estimation is extremely small.

Table 4.5: Results FEM regressions- STATA

In_STOCK	Coef.	Robust St. Err.	Significance
\ln_NEER	0,978	0,371	**
\ln_LNEER	0,181	0,328	
\ln_BELAS	0,57	0193	***
$_cons$	-8,115	2,409	***
N = 122.502			
$R^2 = 0,01$			

Legend: * $p < 0,1$; ** $p < 0,05$; * $P < 0,01$**

4.5.2 Multivariate regression model

In this multivariate regression model the coefficients of NEER of LNEER will be represented as the dependent variables FXEX and LFXEX respectively, indicating transaction and economic exposure. Additionally, the combine effect of transaction and economic exposure will also be analysed. The year 2008 is excluded to prevent multicollinearity. A Hausman test reveals that H_0 : individual-level effects are adequately modelled by a fixed effects model cannot be rejected in favour of H_a : individual-level effects should be modelled by a random effects model. The results of the tests for normality and homoscedasticity are included in figure A3 and table A5 in the appendix. Residuals are distributed normally, while the null hypothesis of the standard errors being homoscedastic is rejected. Therefore, robust standard errors will be used in the regressions.

Table 4.6 presents the results of the FEM regressions. The first model measures the linear effect of financial distress on both economic and transaction exposure combined. Based on a study by Wei & Starks (2013), a negative effect is expected between financial distress and exchange rate exposure. In the estimated model the coefficient β_1 of ZSCORE, the variable of interest, equals 0.0031. A high value of ZSCORE indicates that the company is financially sound. When the ZSCORE increases by 0,01, exchange rate exposure is expected to increase by 0,00031 percentage points. This result is not statistically significant. A positive coefficient was found which does not confirm the hypothesis created by Wei & Starks (2013). Kim & Kraple (2016), however, found a positive relationship indicating that firm in financial distress might hedge their risk while firms that don't face bankruptcy are more prone to leave their risk unhedged, thereby increasing their exposure. TA represents the total assets of a company and is used to indicate the size of a company. It functions as a proxy for hedging, which reduces exchange rate exposure. Therefore Akhigbe et al. (2014) expects a negative relationship between TA and FXEX. The coefficient β_2 of \ln_TA is -0,05. Thus, if the total assets of a company increase by 1% then exchange rate exposure decreases by 0,05 percentage points on average. This result supports theory, although it is not significant.

The Debt ratio, indicated with DR, is a measure of leverage. He & Ng (1998) expect a negative relationship with the level of leverage in a company and exchange rate exposure. In model1 the coefficient of DR is 0.031. This value is neither significant nor can it be explained by theory presented by He & Ng (1998). An alternative explanation is that firms with high leverages do not hedge their exchange rate exposure and thus have higher levels of exposure (Akhigbe et al., 2014; Wei & Starks, 2013).

The growth opportunities of firms are indicated by their price to book ratio (PB) and is expected to be positively correlated with exchange rate exposure. This corresponds to the result found in model1. PB has a coefficient of 0,336. The last control variable QR, or rather the Quick ratio indicates the liquidity of a company. Chow & Chen (1998) expect a negative relationship between liquidity and exchange rate exposure. The coefficient β_5 of QR equals -0.022.

MC represents the market capitalization and thus the size of a firm. This variable is included as a proxy for hedging activities and is therefore expected to have a negative sign. The coefficient β_8 of \ln_MC is 0.529 indicating that if the size of a company increases with 1% that exchange rate exposure increases with 0.529 percentage points. This positive relationship is not expected but is also found in a study by He & Ng (1998).

Model2 incorporates the non-monotonic relationship between financial distress and exchange rate exposure as introduced by Akhigbe et al. (2014). Using this theory, companies with high and low financial distress is expected to have more exchange rate exposure when compared to companies with moderate financial distress. The results in model2 are unable to confirm this theory. HZSCORE, which indicates a financially sound company, has a coefficient β_1 equal to -0,374. This indicates that in comparison with companies with moderate financial distress, those with a high Z score and thus low financial distress have on average 0,374 percentage points less exchange rate exposure. LZSCORE also has a negative coefficient β_2 of -0,702. LZSCORE indicates that companies with a low Z score and thus high financial distress have 0,702 percentage points less

exposure than companies with moderate financial distress. While a non-monotonic relationship was found between exchange rate exposure and financial distress, it does not have the expected signs. A possible interpretation of these results can be explained by Wei & Starks (2013) that firms with higher financial distress hedge their exchange rate exposure, therefore resulting in the negative coefficient of LZSCORE when compared to moderate financial distress. Furthermore, firms who do not face financial distress have the means to hedge their exchange rate risk, giving a possible explanation for the negative coefficient of HZSCORE when compared to firms with a moderate level of financial distress.

Model3 and model4 represent transaction exposure. In model3 ZSCORE once again has a positive coefficient that is not significant. Interestingly is that both ln_MC (market capitalization) and QR (Quick ratio) are significant, on a 5% and 1% level respectively. In model4 ln_MC is once again significant on a 5% level and QR is significant on a 1% level. Lastly, model5 and model6 estimates economic exposure. In model 5 ZSCORE is significant on a 5% level. The coefficient β_1 of 0.074 indicates that if ZSCORE increases by 0,01 that exchange rate exposure increases by 0.074 percentage points. The R^2 in these regressions range between 0,16 and 0,24. It is not uncommon for regressions predicting economic exposure to have small values.

Variable	Overall exposure		Transaction exposure		Economic exposure	
	Model1	Model2	Model3	Model4	Model5	Model6
ZSCORE	0.031		0.018		0.074**	
HZSCORE		-0.374		-0.667		-0.374
LZSCORE		-0.702		-0.369		-0.702
ln_TA	-0.051	0.353	0.279	0.278	0.047	0.353
DR	0.031	-0.044	0.001	-0.008	-0.033	-0.044
PB	0.336	0.394	0.215	0.221	0.378	0.394
QR	-0.022	-0.012	-0.060***	-0.055***	-0.009	-0.012
ln_MC	0.529	0.149	0.798**	0.827**	0.153	0.149
YEAR						
2009	-1.418	-1.359*	-0.686	-0.672	-1.458*	-1.359*
2010	-1.059	-1.293*	-0.293	-0.273	-1.277*	-1.293*
2011	1.548*	-0.265	1.225**	1.212**	-0.222	-0.265
2012	0.502	-1.499**	1.407***	1.416***	-1.384**	-1.499**
2013	-2.254***	-2.292***	-0.703	-0.725	-2.253***	-2.292***
2014	1.154	0.759	1.556*	1.532*	0.791	0.759
2015	-1.164	-1.689**	-0.256	-0.301	-1.627**	-1.689**
2016	2.259	0.667	1.351*	1.342*	0.697	0.667
2017	-1.875*	-2.266**	-0.922	-1.000	-2.165**	-2.266**
_cons	-9.042	-8.892	-21*	-21*	-3.472	-8.892
N	398	398	398	398	398	398
r2	0.177	0.239	0.160	0.163	0.242	0.239

legend: * $p < .1$; ** $p < .05$; *** $p < .01$

Table 4.6: Results Multivariate FEM regressions- STATA

4.6 Conclusion

This section examined the effect of financial distress and other firm specific determinants on exchange rate exposure. In the first part, exchange rate exposure coefficients were estimated. The results indicate that 57,9% of economic exchange rate exposure coefficients are significant on a 1% level and 40,4% of the estimated transaction exposure coefficients are significant on a 1%. These estimated values of exchange rate exposure were then used as the independent variable in the second set of regressions.

A non-monotonic relationship was found between financial distress and exchange rate exposure. Surprisingly, this relationship found in Belgian firms does not have the expected sign as proposed by Akhigbe et al. (2014). This study found that both firms with high and low financial distress have less exchange rate exposure than firms with moderate financial distress. This can be explained by Wei & Starks (2013) that firms with higher financial distress are more prone to hedge their risk due to the added benefits, while firms with low financial distress have the funds to hedge their risk. Other findings include that for transaction exposure a significant relationship was found between the Quick ratio, indicating liquidity, and exchange rate exposure. The Quick ratio acted as a proxy for hedging activities, where a higher liquidity would indicate that funds were available to hedge and therefore exchange rate exposure would be mitigated (Chow & Chen, 1998). Another control variable that was found to be significant was market capitalization, indicating the size of a firm and included in the multivariate regression analysis as a proxy for hedging activities. Market capitalization was found to have a positive relationship with exchange rate exposure, which is not expected as it functions as a proxy for hedging activities. This positive relationship, however is also found by He & Ng (1998).

Certain empirical results of this study do not conform with the expected hypothesis. This can be attributed to the limitations of this study, such as lack of certain control variables. Variables such as foreign sales are relevant, but unfortunately data concerning these variables were not available on Bel-first.

5. Conclusion and further recommendations

5.1 Conclusion

The purpose of this master thesis was to investigate whether there exists a non-monotonic relationship between financial distress and exchange rate exposure for Belgian non-financial public firms. The author expected that firms with high and low financial distress were willing to accept higher degrees of exchange rate exposure based on a study by Akhigbe et al. (2014). A comparison of two measures of exchange rate exposure revealed that the Cash Flow model was preferred to the Capital Market model. Due to foreign cash flow data unavailability, the Augmented Market model was chosen to measure exchange rate exposure.

Control variables were classified into two groups: those that indicate foreign involvement and those that act as proxies for hedging activities. As information regarding foreign sales was not available, only the variables that act as proxies for hedging activities were included. Total assets, market capitalization, price to book ratio, quick ratio and debt ratio were used as control variables in the empirical part of this study.

Three models for measuring financial distress were discussed: the Altman Z -score, the Ohlson-O score and the Black-Scholes-Merton option pricing model. Based on performance in existing research the Altman Z-score was chosen to be used as a measurement of financial distress, the independent variable of interest.

The results indicate a non-monotonic relationship, but not with the signs expected by Akhigbe et al. (2014). Both firms with high and low financial distress have less exchange rate exposure than firms with moderate financial distress. This can be explained by Wei & Starks (2013) that firms with higher financial distress are more prone to hedge their risk due to the added benefits, while firms with low financial distress have the funds to hedge their risk. Other findings include that for transaction exposure a significant relationship was found between the Quick ratio, indicating liquidity, and exchange rate exposure. Another control variable that was found to be significant was market capitalization.

5.2 Limitations

This research paper has several limitations. These limitations pertain to data availability and selection of models and measures. In general, the data used is limited to the period of 2008 to 2017. Moreover, only 51 companies are included in the study. Extending the period that is being analysed and including more companies could result in additional insights and increase the applicability of the sample results to the bigger population.

The selection of the augmented market model used in the first set of regressions, as opposed to using the cash flow approach was based on the unavailability of firm specific foreign cash flow data. Martin & Mauer (2005) and Prasad & Suprabha (2015) recommend using a cash flow-based model as stock prices can be influenced by many macro-economic variables. The variable NEER representing exchange rate changes, is a trade weighted exchange rate for the euro, therefore it does not fully reflect Belgium's main trading partners.

Only one measurement of financial distress, the variable of interest, is incorporated into this study. This measurement is the Altman Z -score. In comparison, Akhigbe et al. (2014) used and compared the Black Scholes Merton option pricing model, the Altman Z-score and the Ohlson-O score. Wei & Starks (2013) used the Black-Scholes-Merton option pricing model and the Ohlson O score. Furthermore, certain key variables were not included in the multivariate regression analysis. This includes foreign sales and degree of hedging. To lessen the effect of a lack of hedging variables, proxies were incorporated into the regression models. Lastly, the time granularity of financial data obtained from Bel first was per year, limiting the preciseness of the study. Data on a quarterly or monthly granularity could offer additional insights.

5.3 Further studies

This study provides evidence for a non-monotonic relationship between financial distress and exchange rate exposure for Belgian firms. The results differ in sign with the theory which Akhigbe et al. (2014) suggested. In lieu of this difference it is suggested that further research is done in a Belgian context using other models to respectively measure exchange rate exposure and financial distress, such as the Cash flow approach and the Black -Scholes-Merton option pricing model. A trade weighted exchange rate index for Belgium can be incorporated into future augmented market model estimations in the Belgian market. Result in studies such by Bodnar & Gentry (1993) and Chow & Chen (1998) vary by industry, thus it seems promising to conduct a more in detail analysis of industry effects. In conclusion, further research can be done for different periods, for example comparing the period before and after 2008.

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Appendix

Table A1: NACE Codes, an industry standard classification system used in the EU (Federal Public Service Belgium, 2019)

LEVEL 1 CODES	LEVEL 2 CODES	Economic Area
A	01 - 04	Agriculture, Forestry and Fishing
B	05 - 09	Mining and Quarrying
C	10 - 33	Manufacturing
D	35	Electricity, Gas, Steam and Air Conditioning Supply
E	36 - 39	Water Supply; Sewerage, Waste Management and Remediation Activities
F	41 - 43	Construction
G	45 - 47	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	49 - 53	Transportation and Storage
I	55 - 56	Accommodation and Food Service Activities
J	58 - 63	Information and Communication
K	64 - 66	Financial and Insurance Activities
L	68	Real Estate Activities
M	69 - 75	Professional, Scientific and Technical Activities
N	77 - 82	Administrative and Support Service Activities
O	84	Public Administration and Defence; Compulsory Social Security
P	85	Education
Q	86 - 88	Human Health and Social Work Activities
R	90 - 93	Arts, Entertainment and Recreation
S	94 - 96	Other Service Activities
T	97 - 98	Activities of Households as Employers; Undifferentiated Goods and Services Producing Activities of Households for Own Use
U	99	Activities of Extraterritorial Organisations and Bodies

Table A2: Results of unit root tests

		Statistic	p-value
Inverse chi-squared (106)	P	90.728	0.855
Inverse normal	Z	-1.215	0.112
Inverse logit t (269)	L*	-0.072	0.142
Modified inv. chi-squared	Pm	-1.049	0.853

Table A3: FX economic exposure coefficients of individual firms in 2017

FIRM	YEAR	EXPOSURE	P VALUE	FIRM	YEAR	EXPOSURE	P VALUE
FLOB.BR	2017	4.459666	1.66E-22	EVS.BR	2017	-2.04336	1.25E-14
SOLB.BR	2017	0.872085	2.37E-07	ELI.BR	2017	-0.211	0.021751
TESB.BR	2017	1.085523	1.41E-11	CAMB.BR	2017	5.704104	1.07E-13
KBC.BR	2017	1.508625	2.23E-11	REI.BR	2017	-5.28919	8.59E-07
ENGB.BR	2017	0.370101	0.026636	REAL.BR	2017	0.367907	0.069328
IMMO.BR	2017	-0.87878	7.97E-13	MDXH.BR	2017	-3.23173	6.18E-09
SAB.BR	2017	-0.42184	0.011321	UNI.BR	2017	-6.65302	0.000675
REC.BR	2017	1.510509	1.47E-09	ICE.BR	2017	-4.18721	0.001081
HAMO.BR	2017	-6.35639	1.83E-13	BANI.BR	2017	-2.58271	8.71E-21
RES.BR	2017	-1.68293	8.93E-09	KEYW.BR	2017	0.375886	0.26569
OBEL.BR	2017	-1.30744	1.02E-06	CFEB.BR	2017	-0.11394	0.650733
ROU.BR	2017	-4.4117	2.69E-09	SIP.BR	2017	-0.28866	0.052927
SIOE.BR	2017	-0.87818	0.002477	MELE.BR	2017	0.879972	2.27E-05
FOU.BR	2017	-5.08368	3.29E-15	COLR.BR	2017	-0.62627	7.69E-06
AGFB.BR	2017	-1.2314	2.81E-06	DIE.BR	2017	-1.84405	1.33E-17
GREEN.BR	2017	1.976207	2.03E-09	CYAD.BR	2017	5.22543	1.8E-07
IBAB.BR	2017	-10.2912	5.98E-31	FLUX.BR	2017	-0.13954	0.089685
SOFT.BR	2017	-0.203	0.428157	BPOST.BR	2017	1.622359	1.99E-16
CONN.BR	2017	-1.8466	2.34E-11	KIN.BR	2017	1.887301	1.57E-10
DECB.BR	2017	2.806792	1.26E-08	BOTHE.BR	2017	3.044257	2.4E-09
BAR.BR	2017	-0.08205	0.634259	MITRA.BR	2017	1.456891	3.51E-10
PIC.BR	2017	1.018032	0.000296	NYR.BR	2017	1.942458	9.33E-06
PROX.BR	2017	-0.54545	0.005527	ECONB.BR	2017	-2.12624	2.31E-17
EURN.BR	2017	-0.44217	0.083827	UMI.BR	2017	4.546316	4E-17

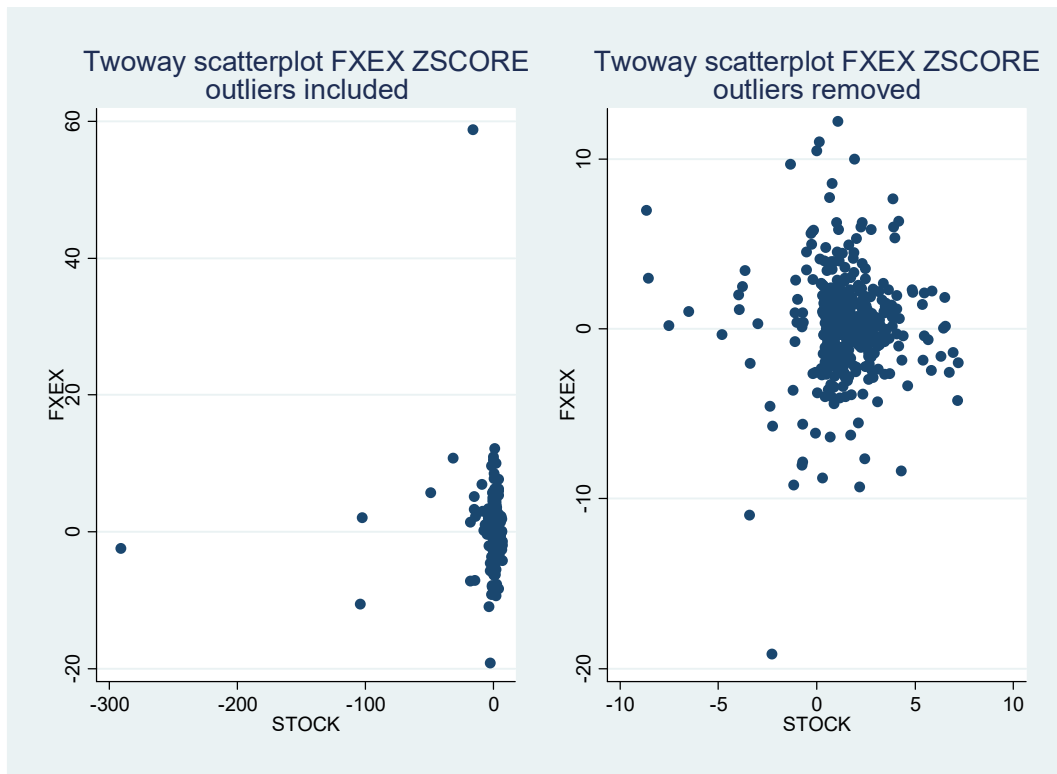


Figure A1: Outliers variable ZSCORE

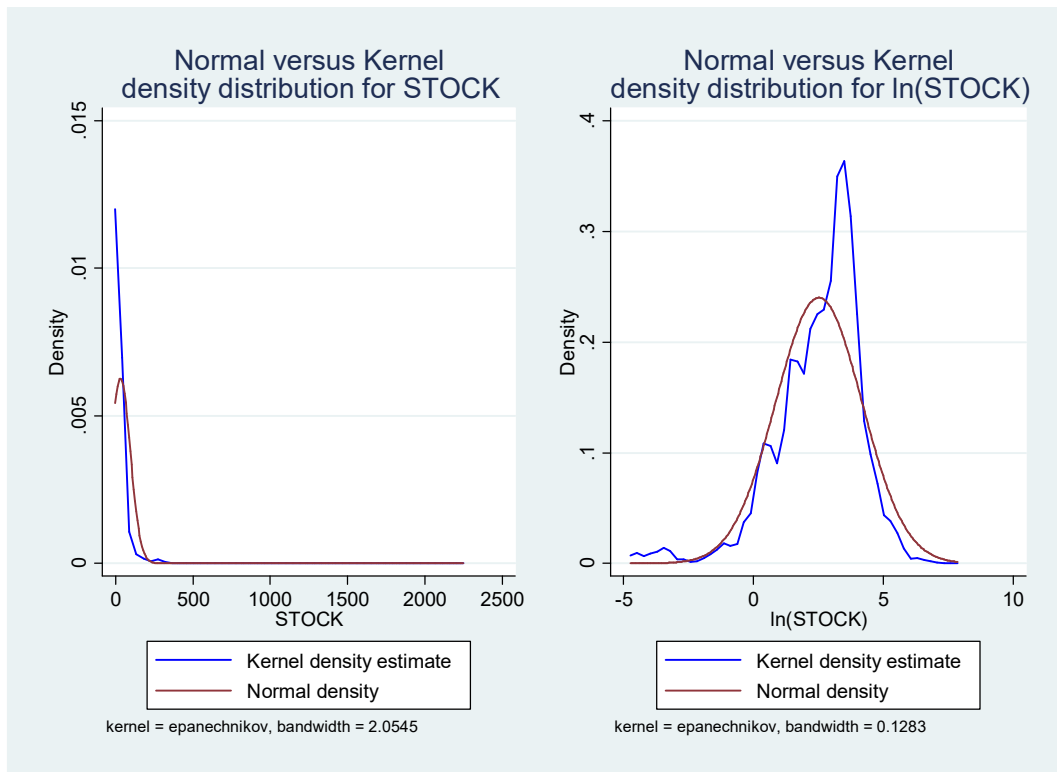


Figure A2: Log transformation STOCK

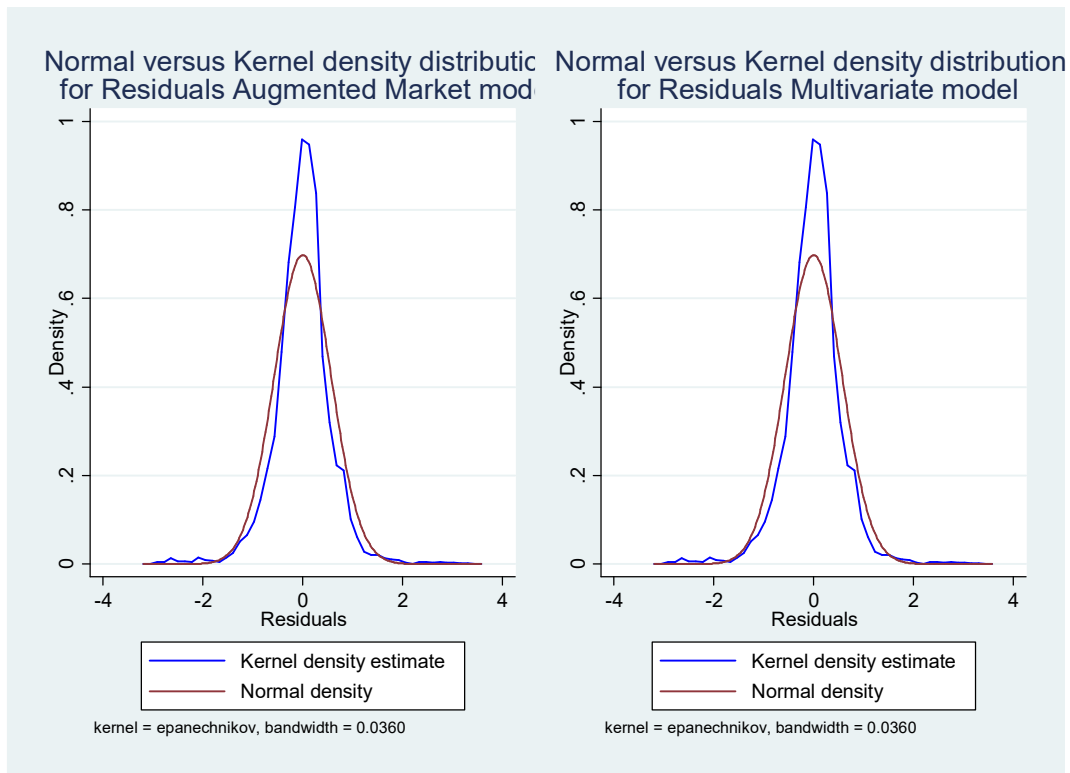


Figure A3: Normality of residuals

Table A5: Modified Wald tests for group wise heteroscedasticity in fixed effect regression model

	Statistic	p-value
Augmented Market model		
Chi2	3.6e+06	<0,000
Multivariate regression model		
Chi 2	3167,70	<0,000