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Euro-Dollar Parity: the 2022 Market and Impact on Companies

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Resumo

O mercado cambial é o maior mercado financeiro à escala internacional, em termos de volume, liquidez e valor, onde largos milhões são negociados todos os dias, afetando numerosos agentes económicos, sejam eles indivíduos, empresas ou países. Entre eles, a troca entre o euro e o dólar americano ocupa a maior parcela. Considerando o número de empresas que operam com mais de uma moeda, este mercado deve ser acompanhado de perto.

Com a desvalorização do euro em relação ao dólar a acentuar-se no meio de 2022, que levou à sua paridade pela primeira vez em cerca de 20 anos, questões relacionadas com o impacto real desses movimentos e a tendência que esta taxa de câmbio está a seguir tornam-se relevantes. Este estudo foi elaborado para encontrar e quantificar esse impacto nas empresas da Zona Euro e se o mesmo é significativo.

Para esse fim, utilizamos as taxas de câmbio históricas combinadas com dados em painel de resultados das empresas para identificar que variáveis são importantes para o estudo, qual o impacto da desvalorização do euro em relação ao dólar e se o mesmo é estatisticamente significativo.

Classificação JEL: F31, G30

Palavras-chave: Euro, Dólar Americano, Impacto Financeiro, Câmbio, Risco Cambial

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Abstract

The foreign exchange market is the biggest financial market in the world, in terms of trading volume, liquidity, and value, where trillions are traded every day, affecting millions of economic agents, whether those are individuals, corporations, or whole nations. Out of them, the trade of the US Dollar against the Euro takes up the biggest share. Considering the number of firms operating with more than one currency, these markets need to be closely followed.

With the depreciation of the Euro against the US Dollar being accentuated in the middle of 2022, leading these currencies to reach parity for the first time in nearly 20 years, questions regarding the real impact of this movement and the trend that this exchange rate had been following became relevant. This report was written to find and quantify what this impact was for companies in the Euro-Zone and if it is significant for them.

For that purpose, we use the historical exchange rates combined with panel data for the information collected from firms to create a regression and proceed to apply quantitative methods to these values, to find what variables are important to study, the impact of the depreciation of the euro against the dollar and if it is statistically significant.

JEL Classification: F31, G30

Keywords: Euro, US Dollar, Financial Impact, Foreign Exchange, Currency Risk

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Glossary

CPI – Consumer Price Index

ECB – European Central Bank

EU – European Union

EUR – Euro

FE – Fixed Effects

Forex/FX Markets – Foreign Exchange Markets

GBP – British Pound Sterling

ICB – Industry Classification Benchmark

IPO - Initial Public Offering

IRP – Interest Rate Parity

JPY – Japanese Yen

MNC – Multinational Corporation

OLS - Ordinary Least Squares

PPP – Purchasing Power Parity

RE – Random Effects

RER – Real Exchange Rate

USD – US Dollar

Introduction

The "US Dollar achieves parity with Euro for the first time in 20 years". This statement or a similar one headlined finance newspapers on the 12th of July 2022.

The Euro-Dollar exchange rate has shown different trends throughout the years, reflecting distinct moments in the world economy. Since 2003, the Euro has generally been considered a stronger currency than the US Dollar, but 2022 showed a different story, with these currencies reaching parity in different moments throughout the year and the euro being less valuable than the American dollar for around three months.

Considering the internationalized panorama that is a reality in nearly every sector, many companies deal with business abroad, trading inputs that make them get to the final product or outsourcing products and services, opening a world of possibilities for production. Some sectors are more prone to this, but the reality is that generally imports and exports can be a heavy part of the productive process of a company, and therefore something to consider carefully when analysing corporate finance matters. A predictable exchange rate makes dealing with these costs and profits easier, but big fluctuations can make or break the estimated financial results.

After the Covid-19 pandemic disrupted financial markets to values long not seen, overall growth seemed to be the trend, and not only did the market break even the pre Covid numbers, but it also surpassed the previous values in a lot of cases, especially with stock prices. Markets were reaching all-time highs.

2022 shook up all markets after the start of the war in Ukraine, with speculations surrounding a recession being more and more prominent. The Eurozone was expected to grasp most of the negative effects of this war. Supply chain disruptions, interest rates rising and inflation skyrocketing have all happened throughout this period, but another event seemed to get attention: the US Dollar started to gain power over the Euro, until the point where the exchange rate reached parity. The USD even surpassed the Euro for a while, until it eventually started depreciating in November. While companies that are overly dependent on these rates tend to use certain mechanisms to protect themselves, such as hedging strategies, this evolution can impact the financial results of some firms that are exposed to exchange rate risk.

Analysing the euro-dollar parity is, therefore, an issue worth examining given its dual impact. Not only is this (as well as many others) exchange rate impacted by the global economy at each time, but it will also have consequences on other agents, such as enterprises.

The euro and the US dollar are two of the most widely used and influential currencies globally, so they are tremendously significant for the world economy. In fact, the USD/EUR pair leads in average daily turnover, with a share of 22.7% in 2022 (see Annex A). The two currencies are extensively traded in foreign exchange markets and serve as key reserve currencies. The eurozone and the United States are major economic powerhouses, meaning that the euro-dollar exchange rate directly affects the competitiveness of European and American exports as well as the attractiveness of investing in one of these powerhouses.

Examining the euro-dollar parity helps understand the potential impact of central bank actions on exchange rates and their transmission to the broader economy, which includes businesses engaged in international trade or investment involving the eurozone, the United States, and other parts of the world. Since the exchange rates expose firms to "currency risk", which is the risk associated with fluctuations in exchange rates, which may impact revenues, costs, and profitability, this type of study may provide help in deciding to implement a hedging strategy or adjust the current one for better risk management.

Moreover, the euro-dollar rate is closely watched by speculators, traders, and investors, which means it will reflect the market sentiment to some extent, how confident or risk-averse investors may feel, and potential market trends to be looking for. Furthermore, many other factors play a role in this currency pair, like new policy announcements, geopolitical events, and economic data releases.

Even though the items mentioned in the last paragraph will not be under analysis in this paper, they are factors that play a role in the fluctuations of the euro-dollar exchange rate, and it can be of great interest to economists, policymakers, businesses, and investors to comprehend how relevant each is and to quantify their impacts.

This dissertation focuses mainly on finding how much the depreciation of the Euro against the US Dollar impacted European companies throughout the year 2022. By applying regression analysis and using panel and time series to research the correlational relationship between our variables, the goal is to quantify that impact, ultimately deciding if it is statistically significant, and taking the necessary distinctions in the process. Our main research question is: "How does the depreciation of the Euro against the US Dollar affect companies in the Eurozone?", which we split into two more specific questions: "How does the depreciation of the Euro against the US Dollar affect the stock returns of EURO STOXX 50 firms?" and "How does the depreciation of the Euro against the US Dollar affect the net income of EURO STOXX 50 firms, particularly in 2022?"

To carry out this objective, we intended to numerically describe the impacts mentioned, through linear regressions and mediation analysis, to pinpoint what is relevant and what is not. To do this, the companies that will be part of the sample are the ones that are part of the EURO STOXX 50, an index fund that includes some of the biggest firms in the eurozone.

The analysis is structured in the following way. Firstly, we conduct a literature review which focuses on exchange rate movements, the risk that they generate for firms and previous studies that have been conducted. This is followed by a chapter where we outline the most important concepts regarding this market and the evolution of the EUR/USD pair. The subsequent two sections focus on the data and methodology used to achieve results. The fifth chapter aims to discuss the results of the obtained regressions, and finally, the conclusion presents a summary of the main takeaways.

Our results show that the depreciation of the euro against the US dollar impacts the financial metrics of companies in the eurozone, especially considering a few years of results, although it is not excessively remarkable (both stock returns and net income suffer a small impact). In 2022 particularly, that effect is not statistically significant, but the possible impact of the depreciation of the Euro against the USD Dollar on the net income of European firms was found to be negative. How this situation will further evolve is still unknown, but given how big this market is, it is worth studying how these movements can impact firms and if it is of any relevance to them.

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Chapter 1
Literature Review

To start the analysis of how European multinational corporations (MNCs) were affected by the downward tendency of the euro in 2022, we start by reviewing the existing literature on this topic, focusing on key areas related to foreign exchange markets, exchange rates, risk management, and previous empirical studies. Each section will be structured to offer a clearer understanding of the topic.

1.1. Theories on exchange rate movements and impacts

The depreciation of the Euro isn't only relevant for small cross-border financial transactions, such as Americans or Europeans looking for a vacation overseas or to directly invest abroad. These are probably the least affected agents when compared with large enterprises that deal with trades in EUR/USD, as well as other currencies, as part of their operations (Copeland, 1989).

On a macro level, this type of event can make countries or economic unions reconsider certain aspects of their economic policy, including interest rates, the possibility of intervention in the foreign exchange market, and capital controls (Obstfeld & Rogoff, 1995). The evolution of exchange rates can help decode global macroeconomic trends and anticipate market reactions since currency parities reflect the overall economic conditions and market sentiment. In our time frame under discussion (the year 2022), mismatches between sustained growth in aggregate demand and overall constrained supply resulted in inflationary pressures after a prolonged period of very low inflation. The ECB, along with other major global central banks, withdrew monetary policy accommodation to restraint these inflationary pressures that had been arising since 2021 but intensified in the following year.

Regarding these movements, the Mundell-Fleming model, introduced by Mundell (1963) and Fleming (1962), provides insights into how exchange rate movements affect macroeconomic policies. This model explains how capital mobility and monetary policies influence exchange rates and the effectiveness of fiscal and monetary measures in an open economy, suggesting that free capital movement, fixed exchange rate and independent monetary policy cannot all coexist in an economy, and trade-offs must be made.

A few theories try to explain the response to movements in exchange rates and how risk should be managed. The first one is the Purchasing Power Parity Theory (PPP) (Cassel, 1918), where it is suggested that in the long run, exchange rates should adjust to equalize the purchasing power of different currencies. According to this theory, if a currency is expected to appreciate or depreciate, it will have an impact on the relative prices of goods and services between countries. Risk management strategies based on PPP theory involve monitoring inflation differentials between countries and adjusting currency exposure accordingly.

Keynes (1923) introduced the Interest Rate Parity (IRP) theory (even though it was later developed by other researchers) which states that the difference in interest rates between two countries should be equal to the expected exchange rate movements. This theory suggests that interest rate differentials will affect the demand for currencies, leading to exchange rate adjustments. Risk management strategies based on IRP theory involve considering interest rate differentials and adjusting investments or borrowing in different currencies to take advantage of higher interest rates while managing exchange rate risk.

A few decades later, Tobin (1956) presented the Portfolio Balance Approach as part of the Asset Market Model. The portfolio balance approach focuses on the role of investors' portfolio allocation decisions in driving exchange rate fluctuations. According to this approach, investors diversify their portfolios across different currencies based on factors such as risk and return expectations. Changes in portfolio preferences and capital flows can influence exchange rates. Risk management strategies based on the portfolio balance approach involve diversifying investments across different currencies and asset classes to reduce exposure to exchange rate fluctuations.

Moving on to a micro analysis, fluctuations in currency parities can impact companies' revenues, expenses, profitability, and cash flows, making the need to analyse them to assess and manage currency risk through strategies like hedging or adjusting pricing.

Previous work explores these topics but hardly ever the specific impact of currency devaluation on a group of companies. Given the particularity of this event, not because it had not yet occurred, but since the current conjecture has its particularities, there is a lack of literature regarding this very recent (as of writing) occurrence, even though they do exist. From now on, let us look into the EUR/USD exchange rates, which are both under a flexible exchange rate regime ("perfect floating" regime).

1.2. The relevance of the EUR/USD rate

In a study for IMK Düsseldorf, Priewe (2016) makes an in-depth analysis of the USD/EUR exchange rate (it uses the USD as the base currency and the Euro as the quote currency). The study analyses this exchange rate from the creation of the euro, where there have been long cycles of appreciation of either one of the two currencies up to almost parity. Priewe (2016, p.7) notes that, as far as this market goes, "disequilibrium is the rule, equilibrium a rare exception, not worth the name" and that the consequences of this "market failure" have not been studied enough.

Another interesting intake from this read relates to the description of the paradigm shift from classical theories (which starts with Cassel's (1918) Purchasing Power Parity theory), to the first understandings within behavioural finance, where foreign exchange is seen as a special financial asset that perfectly suits the construction of speculative bubbles and therefore highly sensitive to news (Frankel & Froot, 1986). It was also found that unexpected news (especially bad news and news in the U.S. rather than in Europe) had a heavier weight in how the market reacted and evolved (Ehrmann & Fratzscher, 2004). However, it is also mentioned that exchange rates are not chaotic, and they do not grow or fall forever ever since idiosyncratic[1] causes eventually generate turnarounds.

Some of the factors that are unanimously believed to affect exchange rates are the growth of the GDP, interest rates, and headline inflation. Particularly the last two factors were at the epicentre of the Euro-Dollar exchange rate situation since there is a tight connection between inflation periods and turnarounds in the tendency that this rate had been following.

1.3 Foreign exchange risk

Relevant to this project, nonetheless, is the analysis of how enterprises deal with the volatility of this exchange rate. If firms were not to use currencies out of their own, they would naturally be protected against any exchange rate risk, which is "a potential gain or loss that occurs as a result of an exchange rate change" (Giddy & Dufey, 2006). For European companies, which would mean trading only inside the euro area or with other EU countries whose currencies are pegged to the euro. Nevertheless, imports denominated in dollars happen on a large scale, particularly of raw materials and intermediate goods.

[1] Idiosyncratic causes refer to factors that are specific to individual assets or portfolios and can affect their performance or risk profile. These causes are distinct from systematic factors, that affect the overall market or economy.

To shield against the inherent risk, enterprises get to use a variety of external hedging techniques to mitigate the risk. There seems to be a positive correlation between the degree of currency exposure and the notional amount of exchange derivatives that a company contracts (Makar & Huffman, 1997). Possible strategies include forward exchange contracts, futures contracts, currency options, discounting bills receivable, factoring receivables, currency swaps, government exchange risk guarantees, and others (Shapiro & Hanouna, 2019). Short and long term hedging strategies should be differentiated.

In addition to the mentioned external hedging techniques, MNCs can utilize internal strategies, such as natural hedging, where they match foreign currency expenses with foreign currency revenues to mitigate exposure. This approach has gained attention in recent research (e.g. Shingal, Wermelinger, & Fauceglia, 2012) as a complementary method to traditional external hedging.

1.4. Types of Foreign Exchange Exposure

We can now distinguish three types of foreign exchange exposures for MNCs: Firstly, there is translation exposure, which arises because of the necessity to convert foreign currency financial statements into only one reporting currency to prepare a global consolidated financial statement (Kallianiotis, 2019). Secondly, we have transaction exposure, which is "the impact of settling outstanding obligations entered into before a change in exchange rates, but to be settled after a change in exchange rates" (Kallianiotis, 2019, p. 272). Thirdly, there is the economic, operating, or competitive exposure which measures the variation in the firm's present value resulting from any change in future operating cash flows triggered by an unpredicted change in exchange rates. The change in the present value depends on the effect that the exchange rate change has on costs, prices, and future sales volume.

The third exposure risk to MNCs' is truly relevant for this dissertation since it represents a threat to cashflows, cost of production, revenue, competitiveness, market value, and financial reporting. The two types of exposures that were first mentioned, although equally relevant to the firm and worth noting for the management to deal with them adequately, won't be the subject of analysis in this project, since transaction exposures are existing exposures of the firm, and operating exposures are likely anticipated but not easy to measure without access to those contracts. However, it can be challenging to isolate the impact of each exposure.

Furthermore, some researchers have explored the concept of behavioural exposure, which considers how managers' psychological biases and risk aversion affect foreign exchange

exposure decisions (e.g., Allayannis & Ofek, 2001). Understanding the behavioural aspect of exchange risk management can provide valuable insights into how MNCs make exposure-related decisions.

1.5. Enterprise Behaviour

Enterprises usually choose to price to markets, "behaving like the exchange rate had not changed, thereby reducing or increasing their profit margins" (Priewe, 2016, p.76). This comes in line with the opinion of the European panel of the January 2023 CfM-CEPR survey, which was "nearly unanimous that the ECB shouldn't respond to the euro's devaluation, but focus on maintaining price stability" (Ilzetzki & Jain, 2023). Such a way of action leads the EUR/USD exchange rate to cause strong effects on the prices of financial assets and capital flows which backfire on the real economy.

So, there is a certain amount of risk in having business involving transactions with different currencies, where for a European company a devaluation of the euro against the dollar will mean a gain if the companies hold any liabilities in US dollars but a loss when it comes to assets held in this foreign currency.

Kallianiotis (2019:27) defines exchange risk as the "exposure to unanticipated changes in the exchange rates" and portrays what these are for the individual investor as well as for multinational corporations (MNCs), combining both the financial markets and corporate finance sides and stating that these risks can have very significant impacts on firms' profitability, cash flows, and their market value if the management doesn't protect against this risk accordingly when dealing with exports and imports in their production process.

Adler and Dumas (1984), in one of the most cited papers on this subject, make an important distinction between currency risk and exposure. While exposure is defined in terms of what one has at risk, "currency risk" is translated into statistical quantities.

The best way MNCs can protect themselves is, again, by implementing hedging strategies, given that these contractual relationships to offset changes in the values of other contracts or physical assets redistribute the risk of foreign exchange losses. Since hedging against exchange rate movements can tackle some of the uncertainty surrounding future cash flows, it can also consequently steady other important measures, such as expenses, revenue, and earnings. Hedging may also signal trust to creditors that provide loans to MNCs, who enjoy the fact that the company is protecting itself against this risk, and the enterprise may even be able to borrow funds at a lower cost of capital.

Behavioural economics has also influenced studies on how firms respond to exchange rate movements. Barberis and Huand (2001) have shown that psychological factors and heuristics play a role in the decision-making process of firms when dealing with foreign exchange risk. This behavioural perspective sheds light on why some companies may not fully hedge their exposure or may exhibit inconsistent risk management behaviour.

1.6. Previous Studies

Even though a lot has been written in the theory of these impacts, not much has been said regarding how foreign exchange risk can impact the earnings of a group of companies. Now with some theory out of the way, let us investigate studies that have been conducted on foreign exchange rate change impacts. Panel data analysis is the dominant choice for similar studies, such as the effect of EUR/USD parity on the export of certain groups of countries, or at firm level. Financial companies are usually separated from non-financial corporations.

This is the case for Song, Tsai, and Watada (2009), who analyse how foreign currency movements affect Japanese manufacturing (non-financial) companies, more specifically the relationship between stock returns and currency fluctuations. For the methodology, they followed the work of Adler and Dumas (1984), creating a regression with panel data that related stock returns, changes in exchange rates, and market returns. The results showed that indeed there was an impact, which was amplified in some sectors (pharmaceuticals, electronic, foods, and beverage industries).

In another study by Jorion (1990), which works with a sample of 40 US multinational firms, a similar conclusion is reached in that there is a relationship between stock returns and exchange rates, even though it changes systematically across the different firms and is positively related to the percentage of foreign operations of U.S multinational enterprises.

Williamson (1998) explored the relationship between exchange rate exposure and competition in the world automotive industry and found that this exposure is lagged due to market inefficiencies in incorporating exchange rate changes into the returns of the firms and changes from country to country. Another study that comprised a group of Japanese firms, by He and Ng (1998), showed that around 25 percent of the sample displayed significant positive foreign exchange exposure, to an extent determined by firm size, leverage ratio, and export ratio.

It is also a fact that different sectors, enterprises, firm sizes, industry characteristics, and trade openness are all factors that can play a big role in this relationship between firms and

exchange rate fluctuations. Sahminan (2006) sums up the factors that determine the effects of exchange rate fluctuations on a firm, mentioning the currency composition of the balance sheet of the firm, how dependent they are on imported inputs, and how much of the output is produced to be exported, as well as the hedging strategy of the firm, if it is domestic or a multinational, and the financing and investment policy. Fluctuations in exchange rates could also impact the values of liabilities and assets of enterprises through a change in domestic currency values of foreign currency denominated ones.

To conclude this section, similar studies in terms of methodology have been carried out which highlight exchange rate impacts, using multivariate approaches, focusing on different countries, and targeting distinct areas that are affected by Foreign Exchange markets. Impactful moments in history triggered these analyses, like the 2008 recession or the Covid-19 pandemic. But since each moment in history has its particularities (and nominal fluctuations do not always mean changes in real terms, for instance), it is interesting to look at the movements in foreign exchange markets in 2022 and how impactful they were.

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Chapter 2
Foreign Exchange Market

2.1. Key Concepts and Agents

The Foreign Exchange Market, also called Forex or FX market, is the largest financial market when quantifying trading volume, liquidity, and value, so it is only natural that there is no shortage of articles and papers that discuss fluctuations in this market, even though these follow many different routes. The FX market is the global marketplace for trading one nation's currency for another, so it revolves around currency pairs, which are the combinations of two currencies traded in this market. In each pair, there is a base currency and a quote currency, representing how much of the quote currency is needed to buy one unit of the base currency. In the EUR/USD currency pair, the euro is the base currency, and the US dollar is the quote currency.

Key to this discussion is the definition of exchange rate: it is the price at which one currency can be exchanged for another currency. They can be fixed or floating, depending on the monetary system of the countries involved.

Some papers try to predict the evolution of future exchange rates, some explore hedging strategies for financial transactions or the use of derivatives in this market to protect against FX volatility. Then there is a more macro perspective on these markets, which includes the spillover effects that they can generate in other markets or even in the whole economy. The volatility of an underlying asset refers to the amplitude of changes in its value, so more of it implies a less stable currency pair.

Several entities participate in this market. Individuals gained increasing access to this market with the development of technology and the internet, which built a faster bridge between them and brokers. Non-financial enterprises go to this market when they partake in international business, which may involve selling the home currency to buy a different one. Banks intervene as well, both in their name and as an intermediary for the last two agents spoken about.

However, different from these are Central Banks and Governments, given that they play a regulatory role, intervening in the current floating system to mitigate the impact of events such as financial crises. These agents try to keep the exchange rates at stable values and control inflation, increasing or decreasing interest rates (which leads to a bigger demand or supply of

home currency, leading to appreciation or depreciation), by managing their foreign exchange reserves (buying or selling), through open market operations (buying or selling government securities). A more recent strategy is Quantitative Easing, where a central bank stimulates a certain economy by issuing new reserves and using them to purchase predetermined amounts of financial assets such as government bonds. This monetary policy action provides liquidity to the financial system, which improves economic activity.

This role played by Central Banks and Governments is crucial to this dissertation since it represents the cause for all the speculation surrounding the fall of the Euro in 2022. While the Federal Reserve started hiking interest rates in March, the European Central Bank only did so in July (Annex B). This, in addition to an already weakening Euro (the share of global official holdings of foreign exchange reserves was around 25% in 2003, but 20.6% at the end of 2021) and the triggering new conflict between Russia and Ukraine, brought the EUR/USD from $1.137 at the beginning of 2022, to parity by July and a year-to-date low of $0.960 on the 27th of September.

Since they will be key concepts throughout this study, let us define “currency depreciation” and “enterprise gains”. Currency depreciation refers to a decrease in the value of a country's currency relative to other currencies in the foreign exchange market and it occurs when the exchange rate decreases over time. On the other hand, enterprise gains refer to the profits or financial gains realized by a business or enterprise. If they occur, it means that the difference between the revenue generated by the enterprise and its total costs and expenses incurred during a given period is positive, or else there is a loss. Both concepts can come hand in hand because the evolution of the exchange rates that impact a certain firm can amplify any gains or reverse a situation from gains to losses.

2.2. Evolution of the Euro-Dollar exchange rate

Virtually all markets have taken several turns over the past few years, with world scaled events impacting most industries. The Euro-US Dollar evolved throughout the years in relation to the current economy at any given moment. The Euro was first introduced in 1999 as an electronic currency, only becoming a physical one in 2002. During this phase, the euro mostly lost value, starting at around 1.00 EUR/USD and falling to approximately 0.85 EUR/USD by the end of 2000.

The next big period was from 2002, when the euro started circulating as a physical currency, to 2008. The euro progressively appreciated against the US dollar, reaching its peak in mid-

2008. Some characteristics of this period that propelled the euro's appreciation were the economic stability of the Eurozone, favourable interest rate differentials (an important factor to weigh in on the recent euro-parity event, in 2022), and growing global demand for euro-denominated assets. By mid-2008, the exchange rate reached a peak at around 1.60 EUR/USD.

The following two years (2008 to 2010) were marked by the global financial crisis, triggered by the collapse of Lehman Brothers in September 2008. This had a significant impact on the euro-to-dollar exchange rate, since investors sought the relative safety of the US dollar, causing the euro to weaken. By mid-2010, the exchange rate dropped to approximately 1.20 EUR/USD.

After that, times kept being challenging for the euro. From 2010 to 2014 the Eurozone faced a sovereign debt crisis, mainly affecting countries like Greece, Ireland, Italy, Spain, and Portugal. Once again, investors' concerns about the stability of the Eurozone and the potential breakup of the euro led to increased volatility and a decline in the euro's value. In the following two years, the US economy showed signs of recovery, and the Federal Reserve began tapering its quantitative easing[2] program. This strengthened the US dollar against most major currencies, including the euro. By the end of 2016, the exchange rate was around 1.05 EUR/USD.

From 2017 until 2020, the euro experienced a period of relative stability against the US dollar, fluctuating between approximately 1.03 and 1.25 EUR/USD.

The start of a new decade came with a generalized turbulence in the world, which translated into financial markets. From 2020 to 2021, the euro started to weaken against the US dollar due to risk aversion and a flight to safety. However, as the global economy recovered and the European Union implemented measures to support its economies, the euro gradually appreciated. By September 2021, the exchange rate was around 1.18 EUR/USD. This evolution is shown in Figure 2.1.

***Figure 2.1**-EUR/USD Nominal Exchange Rate Evolution (1999-2022); Source: European Central Bank (2023)*

[2] Tapering is the withdrawal from a monetary stimulus program that has been executed and quantitative easing policies have stabilized the economy.

In 2022, the euro started at 1.1455 USD, but quickly began to decline in value in February as the war in Ukraine and rising energy prices began to weigh on the European economy. In September, the euro reached its lowest point of the year, at 0.9565 USD, due to factors including the ongoing war in Ukraine, rising inflation in Europe, and the aggressive interest rate hikes by the US Federal Reserve. A slow recovery started from there, but overall, the EUR/USD exchange rate lost 5.66% in 2022 (Figure 2.2).

***Figure 2.2**-EUR/USD Nominal Exchange Rate 2022 Evolution; Source: European Central Bank (2023)*

Kadırgan (2022) states that, historically, the USD appreciates during global financial downturns and depreciates during upturns. During that period, global liquidity tightened since other major currencies also depreciated against the USD. The reduction of foreign currency lending by risk-sensitive global banks, as a result of deteriorating corporate balance sheets, points toward fewer capital inflows, which in turn can lead to additional depreciation.

Chapter 3
Data

This chapter describes both the databases and the variables used to take conclusions on the subject under analysis.

3.1. Population and Sample Selection

Given the goal of this study, the population would comprise every European firm in the Eurozone. A good sample for this population includes a selection of firms in the Eurozone that are part of different sectors of activity since it is expected that some will have more sensitivity than others. Also, choosing bigger firms that are more likely to operate with different currencies and engage in importing or exporting activities will be helpful, since smaller firms are less likely to be significantly dependent on the foreign exchange market. The sample size should be big enough to allow unbiased results.

For this purpose, a quantitative analysis will be carried out as it is more objective. The collection of quantitative data will be fundamental to obtaining accurate results. To ensure that we have a broad enough period, the time frame chosen is the period between 2002 and 2022. Even though the official launch of the euro was on the 1st of January 1999, during its first 3 years this currency was solely used in electronic payments and for accounting purposes, making it an "invisible currency". Using those first 3 years as part of the sample could compromise the quality of the results; therefore, they will be left out of it. Our analysis will be aligned with the parsimony principle, which suggests that simpler models with fewer parameters are preferable.

There are essentially two axes that will be the main actors. Firstly, the EUR-USD yearly exchange rates from the year 2002 to 2022, which gives us a long enough period to look at the different cycles over the years. Secondly, data regarding the financial results of the chosen companies. For a more convenient sampling process, we will be picking an index for this study, with fifty European companies in the eurozone for the period mentioned above, where we will be looking for their reported earnings, as well as a few control variables.

Herewith comes the necessity to include panel data in both regressions. The use of panel data implies we get a much bigger amount of data than it would be possible given that the euro has not been around for as long as other currencies. The sectors to which the companies belong

will also be under analysis, which requires the use of dummy variables in the regressions. Furthermore, it is important to address that since the companies will be chosen via an index, our study will comprise listed firms only, which facilitates access to the required records.

For the development of this study, we chose the EURO STOXX 50 index, which is further described in the section below. Data about each of the companies part the index as of February 2023 will be used, as well as data regarding the returns of the index itself. Therefore, we will initially have 21 years of observation (from 2002 to 2022) and 50 firms under analysis. Each firm will be represented by i and the year of observation by t.

3.2. About the EURO STOXX 50 Index

Introduced in February 1998, the EURO STOXX 50 Index represents the performance of the 50 largest companies among the 20 super sectors in terms of free-float market cap in 9 Eurozone countries: France, Germany, Belgium, the Netherlands, Finland, Italy, Spain, Luxembourg, and Ireland. It captures about 60% of the free-float market cap of the EURO STOXX Total Market Index and it is one of the most liquid indices for the Eurozone. The industry and super sector each firm is inserted in is as per the Industry Classification Benchmark (ICB)[3] and according to the company's primary revenue source.

This stock market index consists of the leading blue-chip stocks in the Euro Zone. A blue-chip company is a "nationally or internationally recognized, well-established, and financially sound company that is publicly traded" (Chen, 2023). Blue chip companies sell high-quality and vastly accepted products and services. The large dimension of these companies often translates into a strong international presence and most of them conduct business across various countries, engaging in importing and exporting operations, making them more exposed to exchange risk which creates the necessity for hedging strategies to be implemented. These are mostly well-established companies that have the trust of investors.

Considering the diversity of sectors covered by this Index, it serves the purpose of distinguishing the impacts of the 2022 euro-dollar parity between them and how different they may be. Since it was created in 1998, it is possible to use it for our chosen time frame, and the dimension of the companies also assures that some international operations must occur. The composition of the index is reviewed every September and the one as of February 2023 can be found in Annex C, along with their market cap, home country, industry, and super sector.

[3] The ICB is a taxonomy system that assigns each company to one of the 11 industries, sectioned into 20 super sectors, which are further divided into 45 sectors, which then contain 173 subsectors.

Below, we can see the chart representation of the value of this index in euros since 2001, with an average return of 3.08%:

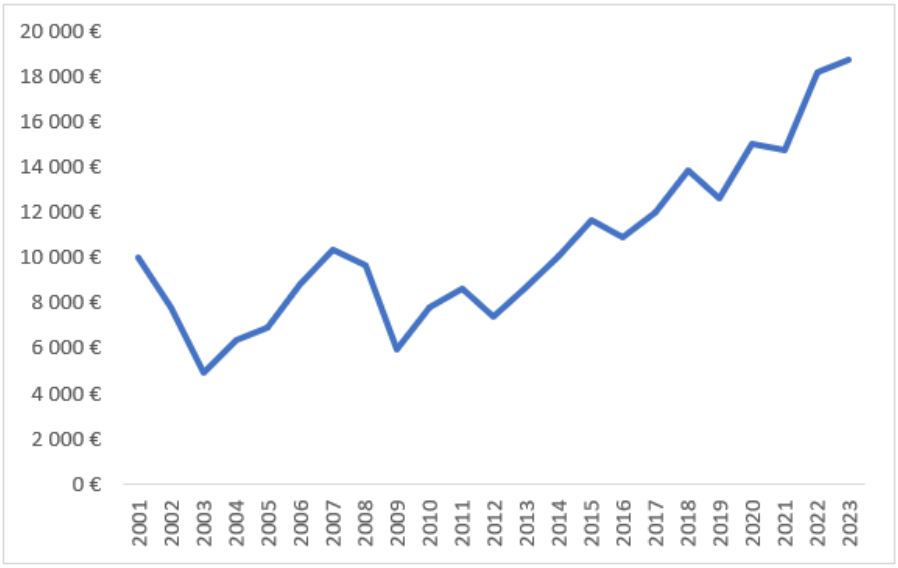

***Figure 3.1**-Historical Performance of the EURO STOXX 50 Index; Source: Backtest by Curvo*

The weight of the top 10 super sectors can be found in the figure below:

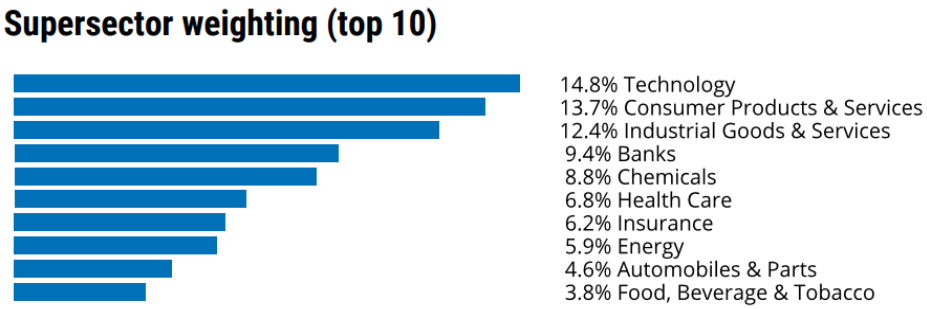

***Figure 3.2** - Supersector weighting; Source: Qontigo*

3.3. Impact on Stock Returns

In the first part of the analysis, we will be looking at the relationship between the annual stock returns of the EURO STOXX 50 firms and fluctuations in the EUR/USD exchange rate. This will be based on the Adler and Dumas (1984) approach, which mathematically defines exchange rate exposure in the following way:

$$Exposure\ of\ R\ to\ S_i = E(\partial R/\partial S_i) \quad (3.1)$$

which is the expected value of the partial sensitivity of R (the random return of a risky asset on a future date) to S_i holding other variables constant. Here we assume K number of states of nature, and in a given k the result R_k is linked with a vector of state variables, $S_k = \{S_1, \ldots, S_n\}_k$. In the case of exchange rate exposure, the state variable is the exchange rate E.

If both R and S are normal, the exposure of R to S_i becomes the partial regression coefficient of S_i in a linear regression of R on S. The definition of exposure can then be rewritten as

$$E\left(\frac{\partial R}{\partial S_i}\right) = E\left\{\frac{\partial[(R)|S]}{\partial S}\right\} = \frac{cov[S_i,R|S]}{var(S_i)} = b_{R,S_i|\bar{S}} \tag{3.2}$$

This type of approach is used by authors such as Bodnar and Gentry (1993), Dominguez and Tesar (2006), and Sahminan (2006). Hence the data to consider is the stock returns of the companies from the index, the yearly returns of this index, used as a proxy for market returns, and the percentage change in the EUR/USD exchange rate. This relationship is represented by the following regression:

$$R_{it} = \beta_{\mathrm{i}0} + \beta_1 \Delta FX_{USD,t} + \beta_2 R_{mt} + \varepsilon_{it} \tag{3.3}$$

where R_{it}, the dependent variable, is the annual stock return for firm i at the year of observation t, ΔFX_{USD} is the percentage change in USD from year $t-1$ to year t, R_{mt} the market return of the EURO STOXX 50 at year t and ε_{it} is the standard error. All variables, both dependent and independent, are measured in percentage.

The β_1 and β_2 measure the relationship between changes in their correspondent independent variables and the dependent variable, *ceteris paribus*. A positive β_1 indicates that an increase in the exchange rate (apreciation of the EUR against the USD) is associated with an increase in the asset's returns, while a negative value indicates the opposite. The β_2, on the other hand, shows us how sensitive the asset's returns are to overall market movements. A positive value suggests that the asset tends to move in the same direction as the overall market, while a negative one suggests it moves in the opposite direction. The magnitude of both betas shows the strength of these relationships. β_0, the intersect, illustrates the assets' expected return when there is no exchange rate change and no market return.

When it comes to the data regarding the exchange rates, we could either choose to use nominal exchange rates or real exchange rates. While nominal exchange rates are simply the price of one currency in terms of the other, real exchange rates introduce the concern for finding the relative price of foreign goods in terms of domestic goods, meaning they more accurately

measure the relative purchasing power of both currencies. With inflation, these rates should differ in value. A simple formula can be used to compute the real exchange rate (RER):

$$RER = e \times \frac{P^*}{P} \tag{3.4}$$

where in our case e is the nominal exchange rate EUR/USD, P^* is the average price of a good in the United States, and P is the average price of the same good in the euro area. Generally, the consumer price index (CPI) in each of these areas is used for the values of P^* and P. Below is the graphical representation of the historical evolution of both of those rates:

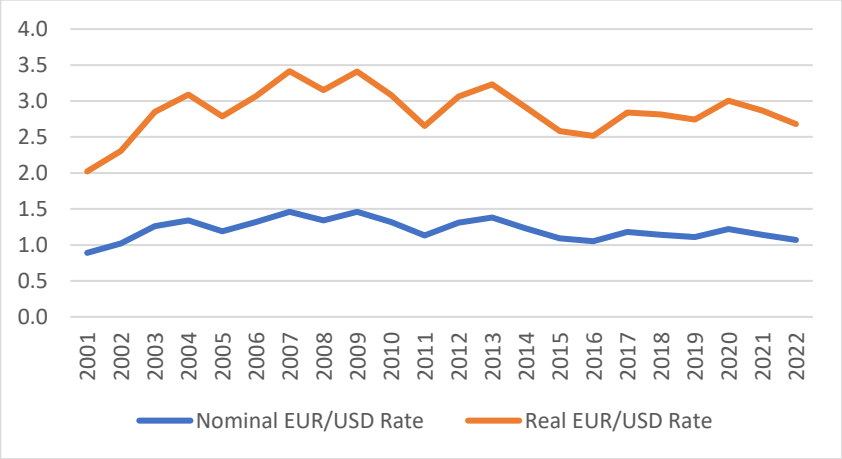

Figure 3.3 *- Historical Evolution of the Nominal and Real EUR/USD Exchange Rates*

For short-term financial analysis, the nominal exchange rates are frequently enough, and real exchange rates are preferable for long-term economic studies. Nominal exchange rates directly reflect market prices and investor behaviour in the short term, causing them to be the most immediate answer. Nevertheless, 2022 was a year with unusually high inflation, with headline inflation in the euro area reaching an average of 8.4% as measured by the Harmonised Index of Consumer Prices (HICP), contrasting with the average of 2.6% in 2021, according to ECB's annual report. In the US, the CPI rose by 6.5% in 2022, according to the US Bureau of Labor Statistics. The reasoning behind this goes back to the previous chapter of this paper. Even though the level of inflation seems to be comparable in both regions, this can potentially impact the accuracy of the obtained results. Additionally, to obtain the results we will be using a significantly period of 21 years. Therefore, we will be running the regression with both nominal and real exchange rates to better assess whether using real exchange rates significantly changes the results obtained:

$$R_{it} = \beta_{i0} + \beta_1 \Delta FX_{USDN,t} + \beta_2 R_{mt} + \varepsilon_{it} \tag{3.5}$$

$$R_{it} = \beta_{i0} + \beta_1 \Delta FX_{USDR,t} + \beta_2 R_{mt} + \varepsilon_{it} \quad (3.6)$$

where $\Delta FX_{USDN,it}$ represents the percentual variation in the nominal EUR/USD exchange rate, and $\Delta FX_{USDR,it}$ the percentual variation in the real EUR/USD exchange rate. The graphical representation of the independent variables is presented in the figure below, where it is evident that even though the evolution of both variations follows the same pattern, the real exchange rate variation is more stable than the nominal one:

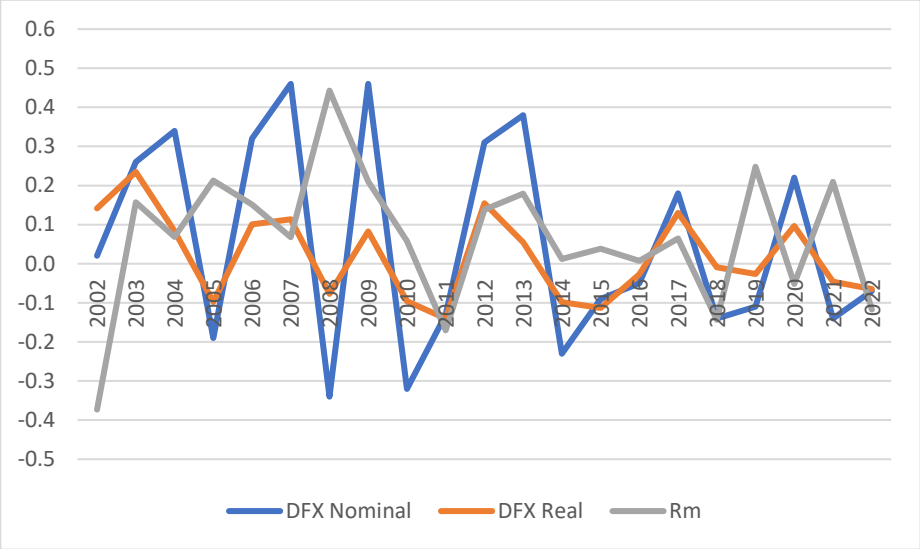

Figure 3.4 *- Independent Variables of Regressions 3.5 and 3.6*

To add an industry depth to the analysis, let us include some dummy variables in the regression. The included super sectors will be Automobiles and Parts (AP), Banks (BK), Chemicals (CH), Construction and Materials (CM), Consumer Products and Services (CP), Energy (EN), Food, Beverage and Tobbaco (FB), Health Care (HC), Industrial Goods and Services (IG), Insurance (IN), Technology (TE), Telecommunications (TL) and Utilities (UT). The super sectors "Financial Services" and "Travel and Leisure" will be left out to ensure the robustness and reliability of our analysis, since there is only one firm in each of those in our final sample. Since the reference category will be AP, it will not be visible on the regression. Each dummy variable will be represented by D, to indicate that it takes a value of 1 if the firm belongs to that super sector and 0 otherwise.

$$R_{it} = \beta_{i0} + \beta_1 \Delta FX_{USD,t} + \beta_2 R_{mt} + \beta_3 D_{BK,i} + \beta_4 D_{CH,i} + \beta_5 D_{CM,i} + \beta_6 D_{CP,i} + \beta_7 D_{EN,i} + \beta_8 D_{FB,i} + \beta_9 D_{HC,i} + \beta_{10} D_{IG,i} + \beta_{11} D_{IN,i} + \beta_{12} D_{TE,i} + \beta_{13} D_{TL,i} + \beta_{14} D_{UT,i} + \varepsilon_{it} \quad (3.7)$$

3.4. Impact on Financial Results

Studying the impacts of the depreciation of the euro against the USD on stock returns is important for shareholders, but firms may also be interested in estimating this impact in their financial results, to better prepare for situations like the 2022 one. For effective risk management, multinational firms should understand these fluctuations and their impact on earnings. This is especially crucial when dealing with multiple countries and different currencies, given that each one adds a new layer of risk.

Not only can this analysis of profitability impact the decision to invest by investors or shareholders, but the company might want to adjust its corporate strategy to better face exchange rate movements. This could mean standard hedging against currency risk, or even diversifying the geographical revenue source depending on the possibilities of the enterprise. Being aware of these effects may also be important for policymakers to adjust economic, fiscal, or monetary policies if it proves to be necessary.

As for the choice of metric, earnings are a commonly used and meaningful measure to assess the impact of currency depreciation and to provide a moderately comprehensive view of the firm's financial performance and competitiveness. It is for sure better than revenue or sales since costs can also be impacted by currency depreciation. Some ratios, like the return on equity (ROE), return on assets (ROA) and profit margin could make for a useful analysis in a context of uncertainty. Nevertheless, to better align with the objective of this research, we will be considering a broader metric. The earnings will be the dependent variable, represented as net income.

Having cleared the goal for this section, it is now important to figure out which variables are essential for this study. We will use the same sample of firms for this purpose. The dependent variable will be the net income. As for the regressors, the key one will show the impact that exchange rate changes has on net income. For this purpose, we use the "foreign exchange gain/loss" metric. This quantifies how much a company benefits or loses when changes in exchange rates occur and certain transactions are dependent on it (buying or selling goods or services, borrowing or lending money, or investing in foreign assets). It is important to control for firm size since larger firms often have more stable earnings than larger ones, so let us account for "total assets" as a control variable. Revenue is also important to consider, given that MNCs with higher revenue may have more stable earnings than firms with lower, so we want to control for this factor as well and add it as a regressor. The debt-to-equity ratio is a

measure of the financial leverage of the firms. Firms with more debt may be more affected by changes in the exchange rate, so we consider this factor.

These are all important variables to consider because they have a decent level of sensitivity to our matter of study. Other measures would be interesting for future analysis, but to keep this study more centred and to guarantee easier access to data, they will be left out of this study. That includes variables like the interest coverage ratio in the regression, to assess the firm's ability to meet its interest obligations, since fluctuations in exchange rate can impact interest expenses for firms if they have foreign-denominated debt. Another metric would be the operating margin, which measures the profitability of a firm's core operations and is relevant for understanding how changes in exchange rates impact the firm's profitability before considering non-operating factors. For firms with larger international operations, it is particularly relevant to account for the export-to-sales ratio, which captures the proportion of sales generated from exports (which can more immediately be impacted by exchange rate changes), however, this segment isn't always disclosed by firms, so it was left out due to difficulty in finding it for most the firms and years of observation.

Setting all this information in a regression that can explain how Foreign Gains/Losses impact Net Income, it is presented as follows:

$$NI_{it} = \beta_{i0} + \beta_1 TA_{it} + \beta_2 Rev_{it} + \beta_3 DE_{it} + \beta_4 FGL_{it} + \beta_5 D_{BK,i} + \beta_6 D_{CH,i} + \beta_7 D_{CM,i} + \beta_8 D_{CP,i} + \beta_9 D_{EN,i} + \beta_{10} D_{FB,i} + \beta_{11} D_{HC,i} + \beta_{12} D_{IG,i} + \beta_{13} D_{IN,i} + \beta_{14} D_{TE,i} + \beta_{15} D_{TL,i} + \beta_{16} D_{UT,i} + \varepsilon_{it} \quad (3.8)$$

where NI_{it} stands for the Net Income of firm i at time t, TA_{it} stands for the Total Assets of firm i at time t, Rev_{it} the Revenue (following the same panel data logic), DE_{it} the Debt-to-Equity Ratio, and FGL_{it} represents the Foreign Exchange Rate Gain/Loss.

Because part of those gains or losses are not explained by the changes in EUR/USD, we will need to try and quantify another relation, the one between FGL and $\Delta FX_{USD,t}$. For this part of the analysis, only nominal Exchange rates will be considered.

$$FGL = \beta_0 + \beta_1 \Delta FX_{USD,t} + \varepsilon_{it} \quad (3.9)$$

where $\Delta FX_{USD,t}$ is again the yearly variation in the EUR/USD nominal exchange rate.

3.5. Data Collecting Challenges

The first challenge that we encounter when it comes to data, is that even though we selected the Euro Stoxx 50 firms for our sample, this index has a dynamic composition, which, like we said

previously, is frequently reviewed. Using the composition of this index at each moment would lead to a very unbalanced set of data. Since our primary interest is understanding the impact of changes in exchange rates on the stock returns and earnings of firms, and not the evolution of the index itself, and to avoid the bias that could come from such unbalanced data, we will be considering a fixed composition. This way, we will take the 50 companies that were part of this index fund as of February 2023 and use them for each time frame.

Secondly, since we don't have monthly data on all the mentioned variables, the data will be collected yearly, which limits the analysis in the sense that it ignores the fluctuations that take place throughout the year and considers solely the difference from one year to the next.

Thirdly, 7 out of the 50 firms that were part of the Euro Stoxx 50 by February 2023 did not have stock price data from 2002. For three of these, they didn't have their Initial Public Offerings (IPOs) until later than 2002: Adyen (2018), Prosus (2019), and Vonovia (2013). On the other side, Ahold Delhaize, Anheuser-Busch InBev, Stellantis, and Linde all resulted from the merger of firms that were already publicly traded, so they were directly listed (after 2002). To resume the goal of avoiding unbalanced data, and because the impact on the sample size is not overly significant, we will leave these firms out, and keep the remaining 43 firms, adding up to a total of 903 (21×43) observations.

3.6. Data Sources

For the first part of our study, we have panel data (the stock returns for firm i at time t), time-series data (the change in exchange rate and the annual market returns), and dummy variables. The annual nominal exchange rates will be collected at the end of each period, meaning the last day of each year (December 31st). The nominal EUR/USD exchange rates were retrieved out of the platform *Statista*, the annual US CPI from the U.S. Bureau of Labor Statistics (where the base year is 1983), and the annual Euro area CPI from the European Central Bank (base year 2015). To be able to compute the yearly variation in the exchange rate, we downloaded the annual data from 2001 to 2022 and then calculated the percentage change from the value in years t and t-1:

$$\Delta FX_{USD,t} = \frac{FX_{USD,t} - FX_{USD,t-1}}{FX_{USD,t-1}} \times 100 \qquad (3.10)$$

For instance, the exchange rate variation for 2022 will correspond to the difference between the end-of-year exchange rate in 2022 and the end-of-year exchange rate in 2021.

The annual rates of return for the Euro Stoxx 50 had to be calculated using the existing data. After retrieving the yearly index value in points from *Statista*, the same simple formula can lead to the necessary data:

$$Rmt = \frac{IV_t - IV_{t-1}}{IV_{t-1}} \times 100 \quad (3.11)$$

where IV stands for the index value in points at a given year. The results obtained will be in percentage.

The end of year stock prices of each firm were downloaded from Yahoo Finance, and the annual stock returns were manually computed from those values, using the same methodology as for the last two variables. For the binary variables, the values for each firm were easy to obtain having the ICB classification of each firm, which we found on the Euronext website.

For the second part of the study, the needed values can usually be found in each firm's financial statements. The dependent variable is net income GAAP (Generally Accepted Accounting Principles), which can be found in income statements, as well as the revenue and foreign exchange rate gain/loss. It is computed by subtracting all expenses, including operating expenses, interest, taxes, and any other costs, from the company's total revenues or sales. The total assets can be found in balance sheets and the debt-to-equity ratio is computed using components from that financial statement as well (total debt divided by shareholders equity).

To facilitate the data collecting process, all the financial data above was sourced from Bloomberg, a reputable financial data provider. Aside from the debt-to-equity ratio, the variables are presented in millions of euros.

Chapter 4
Methodology

The present section introduces the selected methodology to forego the intended analysis and obtain results.

Just as mentioned previously, an unpredicted variation in exchange rates can translate into a direct impact on the enterprises' cashflows. This can affect measures like costs and revenues which ultimately can also translate into a shift in stock returns. To better understand the impact of the euro depreciation against the dollar, we will divide this section into two parts, one for each of the regressions, to comprehend how companies are affected by this and also how that translates into something that the stock owners would be able to notice.

4.1. Research Questions and Regressions

To answer our research questions, we use regressions (3.7), (3.8), and (3.9) to take conclusions and execute this analysis by using the statistical software R Studio. This will give us all the coefficients (β values) that indicate how each independent variable affects the dependent variable, and in what proportion,

Since we are working with some panel data, and to avoid biased results, there are three main types of models available: Pooled OLS, Fixed effects (FE), and Random effects (RE).

The FE model assumes individual effects of unobserved, independent variables as constant ("fix") over time and allows unobserved factors to be correlated with the dependent variable and vary across entities (endogeneity), and heterogeneity can be controlled. It can be portrayed with the following structure (Wooldridge, 2012):

$$Y_{\mathrm{it}} = \beta_1 X_{\mathrm{it}} + \alpha_i + \varepsilon_{it} \tag{4.1}$$

Here, αi is the unobserved entity-specific time-constant error term, which is possibly correlated with Xit. The idiosyncratic error term ε_{it} is assumed to be uncorrelated with Xit (exogen and non collinear). Therefore, FE controls for all time-invariant differences between companies. However, it is limited in the sense that it is not possible to estimate the effects of variables whose values do not change across time, and that if there is a small variation across time, where FE stops being efficient because the standard error from the model tends to be

large. An alternative is often the LSDV model (Least Squares Dummy Variables), in which the individual (fixed) effects are represented by dummy variables.

The Random Effects model assumes that differences across entities have some influence on the dependent variable, that the unobserved factors are not correlated with the dependent variable, and that it is possible to estimate those time-invariant variables. This model type determines the individual effects of unobserved, independent variables as random variables over time. The structure would look as follows:

$$Y_{\mathrm{it}} = \beta_0 + \beta_1 X_{\mathrm{it}} + \alpha_i + u_{it} \quad (4.2)$$

The $\beta 0$ is the intercept (which can be estimated) and αi is the unobserved entity-specific time-constant error term (here uncorrelated with Xit, in opposition with FE). Similar to FE, ε_{it} is assumed to be uncorrelated with Xit. This model can focus on both dependencies between and within individuals.

4.2. Firms' Financial Reports Overview

We will begin our analysis by reviewing the 2022 financial reports of a small group of firms, to get a sense of how the firms perceived the movements in exchange rate. This part of the process can help understand how most firms qualified those fluctuations (if they were beneficial or negative for the results of the firm) and if they were relevant at all.

4.3. Estimation Process

Firstly, we organized the data in different Excel spreadsheets, where $t = 1$ corresponds to the year 2002, and we have data until $t = 21$ (2022). An ID was attributed to each firm, so $i = 1, \ldots, 43$ (since we have a sample of forty-three firms).

Proceeding to the follow-up stage of our analysis, besides the change in exchange rates (which is the data set as previously), market returns, and dummy variables, the remaining variables all use panel data.

4.3.1. Stock Returns

The first step for both parts of our analysis will be importing the data into R studio. The approach to dealing with each part will be different. The stock returns study only has one panel data variable (the dependent), making the choice of the best model less straightforward. Therefore, we will estimate it using Pooled OLS, FE and RE, and using nominal and real exchange rates, to see how they compare, and which model seems best. Literature does not

agree with one singular approach, leading some authors to stick to Pooled OLS, while others branch out to FE or RE. Another approach used is estimating the model individually for each firm, resulting in i number of time series models, grouping those into categories (for example, sectors) and analysing the results by looking at the mean, variance, and quantiles of the coefficient of the variation of the exchange rate. To simplify the process, we will use the previous method. To conclude this section, we will perform some tests to see if some of the key linear model assumptions hold.

4.3.2. Net Income

Whether the right model is FE or RE depends on whether the individual, unobserved heterogeneity is a constant or random effect. So, we will start by performing a Pooled OLS, and a few tests to make sure basic assumptions are violated. Those will be Breusch-Pagan to identify heteroskedasticity and Durbin-Watson to identify autocorrelation. Next up, if these assumptions prove to be violated, we will select the most suitable model by using the Hausman test, which is a test of endogeneity. When running this test, the null hypothesis is "The covariance between the independent variables and alpha is zero." If this proves to be true, then RE is preferred over FE. If we reject the null, then we must go with the FE model. We reject the null if, after deciding a level of significance, the p-value is smaller than that percentage.

Having chosen the method, the next step will be to estimate it and obtain results, which will be for our group of firms and the period between 2002 and 2022. Since we are particularly interested in the year 2022, we will also perform an estimation to quantify the impact, using a cross sectional regression with the same sample of firms. This will be carried out using OLS.

Lastly, to find the impact of changes in the EUR/USD nominal rate, we will be undergoing two different approaches. Firstly, we will attempt to quantify that impact using regression (3.9) and multiplying the obtained coefficient by the ΔFX_{USD} value for 2022 and then by the coefficient of FGL in the 2022 Net Income regression. Secondly, we will use mediation analysis to quantify the impact of FGL on NI in percentage that happens through a mediator variable, $\Delta FX_{USD,t}$. This will allow us to compare the results of both approaches so that we have more confidence in our results.

Additionally, we will be looking several times at p-values and the level of significance for which the null hypothesis will be rejected. The criteria to not reject H_0 implies that the p-value is bigger than 0.05 (assuming a 5% level of significance, or a 95% probability) or 0.10, for a 90% confidence level.

Throughout these steps, we will have to interpret the coefficients. Another important metrics to look for will be the R-squared, which indicates the proportion of variance in the dependent variable explained by the independent variables.

Chapter 5
Empirical Results

5.1. Firms' Disclosed Information

Since appreciations and depreciation of the most used currencies worldwide (EUR, USD, JPY, and GBP for instance) can affect the financial results of certain firms, several enterprises include those on their annual financial reports, as well as their impact on some of the results. There was no exception in 2022, which signals the relevance of this event.

Kering, for instance, stated in their 2022 activity report that "2022 brought a sharp rise in the US dollar (and linked currencies) against the euro, along with a decline in the Japanese yen; those movements helped to increase regional differences in the prices of Luxury brands' products, encouraging people to buy those products during vacations" (Kering, 2023, p.12). From the same super sector, LVMH quantifies this impact "Overall, exchange rate fluctuations had a positive 928-million-euro impact on profit from recurring operations compared to the previous fiscal year. This total comprises the following three items: (i) the impact of exchange rate fluctuations on export and import sales and purchases by Group companies, (ii) the change in the net impact of the Group's policy of hedging its commercial exposure to various currencies, and (iii) the impact of exchange rate fluctuations on the consolidation of profit from recurring operations of subsidiaries outside the eurozone." (LVMH, 2023, p.7).

Iberdrola also claims to be exposed to currency risk, but that it "mitigates currency risks by ensuring that all its economic flows are carried out in the currency of each Group company, maintaining an adequate percentage of debt in foreign currency and/or through derivatives" (Iberdrola, 2023. p.45).

In the telecommunications sector, Nokia seemed to be impacted in different ways, where: "Research and development expenses (…) were negatively impacted by foreign exchange rate fluctuations" (Nokia, 2023, p.83) but net sales benefited from this and "contributed approximately 8% of the total Network Infrastructure growth in 2022." (p.84).

For BASF, "sales, opportunities, and risks arise in particular when the U.S. dollar exchange rate fluctuates. A full-year appreciation of the U.S. dollar against the euro by $0.01 would increase the BASF Group's EBIT by around €30 million, assuming other conditions remain the same. On the production side, we counter exchange rate risks by producing in the respective currency zones" (BASF, 2023, p.163).

We can see from these statements that in most cases there is a "win-lose" situation, where certain areas of business are negatively affected, and others benefit from fluctuations in exchange rates in a certain direction. Also, the fact that these firms sell their products and services in different countries may dissuade some consumers from buying but incentivize others (especially when international travel happens), generating a balance that prevents the company from facing big losses. In addition, nearly every firm mentions the need to hedge against currency risk for additional protection.

5.2. Impact on Stock Returns

For the estimation of the impact of the depreciation of the Euro against the US Dollar on the stock returns of a sample of firms, we started by leaving the dummy variables out of the analysis and estimated the coefficients using Pooled OLS, Fixed Effects, and Random Effects for the regression using nominal exchange rates and the one using real exchange rates. The obtained results are presented in the table below:

***Table 5.1**-Impact on Stock Returns, without Dummy Variables*

WITHOUT DUMMIES

	Nominal Exchange Rate			**Real Exchange Rate**		
Variables	Pooled OLS	Fixed Effects	Random Effects	Pooled OLS	Fixed Effects	Random Effects
Constant	0.0413**	-	0.0413**	0.0480**	-	0.0480**
	(0.0104)	-	(0.0109)	(0.0107)	-	(0.0110)
ΔFX	0.3408**	0.3408**	0.3408**	0.5034**	0.5034**	0.5034**
	(0.0375)	(0.0374)	(0.0374)	(0.0933)	(0.0932)	(0.0932)
Rm	0.4002**	0.4002**	0.4002**	0.4346**	0.4346**	0.4346**
	(0.0556)	(0.0554)	(0.0554)	(0.0572)	(0.0571)	(0.0571)
No of Obs.	903			903		
R^2	0.1355	0.1420	0.1362	0.0858	0.0899	0.0861
Adjusted R^2	0.1336	0.0980	0.1343	0.0838	0.0432	0.0840
F-statistic/Chisq	70.5288	70.9750	141.9500	42.2404	42.3796	84.7591

*Notes: The numbers in parentheses are the standard error of the estimates; ** means the estimation is significant at a 5% level of significance, * means the same at 10%; The last row shows the F-statistic for Pooled OLS and Fixed Effects, and Chisq for Random Effects.*

Let us look at the first estimation (Pooled OLS, using Nominal Exchange Rates) and interpret some of the statistics. The coefficients will be interpreted once we are sure of our final model.

R-squared (R^2) measures the proportion of the variance in the dependent variable (annual stock returns) that is explained by the independent variables (ΔFX and Rm). In this model, R-squared is 0.1355, indicating that these variables explain approximately 13.55% of the variation in annual stock returns. It is relatively low, suggesting that there are other factors not included

in the model that affect stock returns. The adjusted R-squared (Adj. R^2) is similar to R-squared but adjusts for the number of predictors in the model. It's 0.1336, which is very close to the R-squared value.

The F-statistic assesses the overall significance of the model. It compares the fit of the model with independent variables to a model with no independent variables (the null model). In this case, the F-statistic is 70.5288 with a small p-value ($p < 0.05$), indicating that this model is statistically significant.

In summary, this analysis suggests that both the percentage change in the EUR/USD exchange rate (ΔFXN) and the annual market return have statistical significance on annual stock returns. However, the low R-squared value indicates that there are other factors not considered in the model that also influence stock returns. A few examples of those factors can be industry specific variables, the change in other exchange rates, like the EUR/GBP and EUR/JPY, as well as lagged values of the variation in those exchange rates (which can capture autocorrelation and temporal patterns in stock returns).

To improve that statistic, let us include the sector-distinguishing dummy variables in the model (Table 5.2). We can now see that the only sectors that present statistical significance are Banks, Energy, Food, Beverage and Tobacco, Health Care, Insurance, Telecommunications, and Utilities. The reference industry is Automobiles and Parts (AP).

Table 5.2 - *Impact on Stock Returns, with Dummy Variables*

WITH DUMMIES

	Nominal Exchange Rate			**Real Exchange Rate**		
Variables	Pooled OLS	Fixed Effects	Random Effects	Pooled OLS	Fixed Effects	Random Effects
Constant	0.0752**	-	0.0752**	0.0819**	-	0.0819**
	(0.0280)	-	(0.0280)	(-0.0288)	-	(-0.0288)
ΔFX	0.3408**	0.3408**	0.3408**	0.5034**	0.5034**	0.5034**
	(0.0371)	(0.0374)	(0.0371)	(-0.0925)	(0.0932)	(-0.0925)
Rm	0.4002**	0.4002**	0.4002**	0.4346**	0.4345**	0.4346**
	(0.0550)	(0.0554)	(0.0550)	(-0.0566)	(0.0571)	(-0.0566)
BK	-0.0892**	-	-0.0892**	-0.0892**	-	-0.0892**
CH	-0.0446	-	-0.0446	-0.0446	-	-0.0446
CM	-0.0259	-	-0.0259	-0.0259	-	-0.0259
CP	0.0181	-	0.0181	0.0182	-	0.0182
EN	-0.0973*	-	-0.0973*	-0.0973*	-	-0.0973*
FB	-0.0553	-	-0.0553	-0.0553	-	-0.0553
HC	-0.0542	-	-0.0542	-0.0542	-	-0.0542
IG	-0.0046	-	-0.0046	-0.0046	-	-0.0046
IN	-0.0858*	-	-0.0858*	-0.0858*	-	-0.0858*
TE	0.0798*	-	0.0798*	0.0798*	-	0.0798*
TL	-0.1143**	-	-0.1143**	-0.1143**	-	-0.1143**
UT	-0.0762	-	-0.0762	-0.0762	-	-0.0762
No of Obs.		903			903	
R^2	0.1646	0.1420	0.1646	0.1150	0.0899	0.1150
Adjusted R^2	0.1515	0.0980	0.1515	0.1010	0.0432	0.1010
F-statistic/Chisq	12.500	70.975	175.001	8.238	42.380	115.33

The fixed effects model doesn't change because it doesn't make sense to add dummy variables, since the inclusion of fixed effects already controls for individual-specific heterogeneity, and adding dummy variables for the same entities would introduce perfect multicollinearity, leading to various problems in the estimation process. This way, we are left with Pooled OLS and Random Effects.

The random effects method uses the Chi-square statistic instead of the F-statistic. It measures the difference between the log-likelihood of the random effects models (including the random effects) and a model with no random effects (a fixed-effects or pooled OLS model). A higher Chi-square value indicates that the random effects model provides a better fit to the data when compared to a model without random effects.

Despite having performed six regression models to analyse the impact of the depreciation of the Euro against the US Dollar on annual stock returns, with and without dummy variables, using nominal and real exchange rates and different estimation methods, we excluded fixed effects because it doesn't allow the introduction of dummies, and the results are the same for Pooled OLS and Random Effects (at least when rounded to 4 decimals). This is because the firm-specific effects are relatively consistent across them since the dependent variable varies with time and entity, but the independent only with time. This means we confirm that the Pooled OLS is the best model and that Fixed Effects and Random Effects are not suitable for this specific analysis. Let us investigate the model using nominal rates and the one with real exchange rates and consider which one might be the most suitable and why.

Highlighting the R-squared and Adjusted R-squared, the values slightly increased when adding the indicator variables, which implies that the industry factor is relevant to this analysis. The models with dummy variables and nominal exchange rates have slightly higher values compared to the models with real exchange rates. This suggests that the nominal exchange rate model explains a bit more of the variation in stock returns. That may be because investors may react differently to changes in nominal exchange rates compared to real exchange rates. Currency movements can have psychological and speculative effects on investor behaviour, impacting stock prices more easily since real exchange rates are not as advertised.

When considering the F-statistic and the Chi-square, both highly substantial, we observe that these models are statistically significant. However, the F-statistic in the pooled OLS with nominal rates is higher than in the pooled OLS with real rates, and the same happens to the Chi-square. This indicates a better overall fit when using nominal exchange rates.

Given the above considerations, it appears that the Pooled OLS with dummy variables using nominal exchange rates is the most suitable among the models we have estimated. It has a

higher R-squared, adjusted R-squared, and F-statistic compared to the others, suggesting that it explains more of the variation in stock returns and provides a better fit for our data. Also, the coefficients for our main independent variables do not dramatically change when using real or nominal exchange rates, therefore the conclusions will not be very different by using one or the other.

However, the choice of model must align with the underlying assumptions of our analysis. For this, we will conduct diagnostic tests and examine the residuals to ensure that the chosen model meets the necessary assumptions for regression analysis.

5.2.1. Robustness Tests

The fact that this specific regression only uses panel data for the dependent variable and that the two regressors are time series, makes it not ideal for OLS to be used, but it does not perfectly fit random or fixed effects either.

As mentioned in the methodology section, for OLS to be suitable the assumptions of homoskedasticity and non-autocorrelation must hold. To find heteroskedasticity, we performed the White test, which is more generic than the Breusch-Pagan because it also evaluates for nonlinear forms of heteroskedasticity. We got the following results: BP = 9.9961, df = 14, p-value = 0.7625 (for Pooled OLS with dummies). With a p-value greater than 0.05, we cannot reject the hypothesis that the model is homoscedastic, meaning that there is no evidence of heteroskedasticity. To assess for serial correlation, we use the Breusch-Godfrey test, which determines whether there is autocorrelation in the residuals of a regression model. The result is LM test = 0.7016, df = 1, p-value = 0.4022. Since the p-value is greater than the common significance level of 0.05, we fail to reject the null hypothesis, meaning that the data does not provide enough statistical support to suggest that the errors are correlated. This way, we have no reason to believe that the model shows signs of autocorrelation or heteroskedasticity (Annex D). Additionally, the main independent variables (ΔFX and Rm) only show a correlation coefficient of 0.0494, which is reasonably low, indicating that it is not introducing bias in our model.

5.2.2. Final Model for Stock Returns Impact

Our final model for the estimation of how movements in the EUR/USD rate impact stock returns of European firms is as follows:

$$R_{it} = 0.0752 + 0.3408\Delta\widehat{FX_{USD,t}} + 0.4002\widehat{R_{mt}} - 0.0892D_{BK,i} - 0.0446D_{CH,i} - 0.0259D_{CM,i} + 0.0181D_{CP,i} - 0.0973D_{EN,i} - 0.0553D_{FB,i} - 0.0542D_{HC,i} - 0.0046D_{IG,i} - 0.0858D_{IN,i} + 0.0798D_{TE,i} - 0.1143D_{TL,i} - 0.0762D_{UT,i}$$

The constant (or intercept), 0.0752, represents the annual stock return that is expected when all exogenous are null, i.e., the independent variables and constant term.

The ΔFX (percentage change in EUR/USD nominal rate) estimated coefficient is 0.3408, which means that, *ceteris paribus*, a 1% increase in the percentage change in the variation in EUR/USD nominal exchange rate is associated with an increase of approximately 0.341 percentage points in annual stock returns of the firms under analysis. The coefficient is statistically significant at 5% significance ($p < 0.05$). The fact that this value is positive is as expected since an appreciation of the Euro would be expected to increase the confidence of investors in these companies and therefore the stock returns. However, the impact is small.

The coefficient for Rm (Annual Market Return from Euro Stoxx 50) obtained through this estimation is 0.4002. This suggests that, all else being equal, a 1% increase in the annual market return, using the returns from the Euro Stoxx 50 as a proxy, is associated with an increase of approximately 0.4002 percentage points in annual stock returns. It also presents statistical significance at 5%.

The only sectors that present statistically significant results are Banks and Telecommunications at 5% and Energy, Technology, and Insurance at 10%. Their interpretation requires a comparison with the reference category, AP. For instance, the coefficient of BK is -0.0892, meaning that, on, average, the impact on stock returns when the firm is a bank is 0.0892 percentage points lower than when it is an automobile company, *ceteris paribus*. Only Consumer Products and Services and Technology are more impacted than the reference category, showing a positive coefficient. The explanatory power of the model is very low, which indicates that more factors besides $\Delta FX_{USD,t}$ and R_m, and that those can be changes in other currency pairs or lagged values of the variations in exchange rates.

These results are coherent with the existing literature. Sahminan (2006) likewise found a small response of stock returns to fluctuations in exchange rates. This does not come as a surprise since firms try to attenuate this movement through strategies such as the use of derivatives transactions.

5.3. Impact on Net Income

5.3.1. From 2002 to 2022

Before presenting the results, it is important to understand how firms assemble their financial statements. In our sample, the consolidated financial statements are all presented in (millions of) euros. When it comes to balance sheets, most firms choose to record the items that were not in their home currency originally at the exchange rate at the end of the reporting period (31st of December of each year). In the income statement that translation happens at the average rate for the period (the full year, when looking at annual reports). Any translation differences that arise from these practices are recorded in equity as "translation adjustment".

A broader term that encompasses both translation adjustments and the recognition of foreign exchange gains or losses related to operational and transactional currency exposure and is also disclosed by most firms is "Effect of Foreign Exchange Rates". Aside from Air Liquide, Allianz, Axa, and Muenchener Rueck, which did not disclose these effects on their financial statements, the remaining firms in our samples do disclose those values. None of these firms released Foreign Exchange Gain/Loss (FGL) results, which makes sense since this is a more specific category within the "Effect of Foreign Exchange Rate" (EFE), so the previous should not exist without the latter. Additionally, none of the Banks in our sample include FGL, despite including EFE. That is because not only do banks operate differently than the remaining firms, not needing to trade foreign currency to buy or sell certain goods and services in a more physical sense, but they are also subject to specific regulatory requirements and accounting standards. Banks actively manage foreign exchange risk as part of their business operations, meaning that the gains and losses related to foreign exchange activities are often integrated into broader risk management strategies and may not be reported separately. That is why a lot of studies choose to focus solely on non-financial companies for this type of study.

Because of this lack of data for this variable, and the different nature of financial corporations, we will be excluding them from our analysis. After excluding the firms that do not have values for foreign exchange gains/losses and financial companies (banks, insurance and financial services) we lose eleven firms (Air Liquide, Allianz, AXA, Banco Bilbao Vizcaya Argentaria, Banco Santander, BNP Paribas, Deutsche Boerse, ING Group, Intesa Sanpaolo, Muenchener Rueck, Nordea Bank) and are left with thirty-two firms.

After estimating the model using Pooled OLS, and attesting that there is heteroskedasticity and autocorrelation (Annex E), we used the Hausman test to indicate if fixed or random effects

would be a better choice to handle this data set, and the latter was the response (Annex F). This makes sense with theory because random effects are seen as preferable when cross-sectional units from the sample (Euro STOXX 50) are drawn from a reasonably large population, which is the case (individual specific constant terms are perceived as randomly distributed). The results of Random Effects are presented in Table 5.3. All variables but Total Assets seem to be statistically significant at 5%, and the R-squared amounts to approximately 36%.

Just like before, adding information about the industry may slightly increase R-squared and help us understand how the results compare from one industry to another. By assigning distinct numerical values to each sector, we can quantify the impact of sector-specific factors on net income, thus enhancing our model's explanatory power. Moreover, the addition of dummy variables facilitates interpretability and communication of results, as they make it clear how each sector contributes to variations in net income.

***Table 5.3**- Impact on Net Income, Random Effects without Dummies*

Variables	Effects	Std. Error	
Constant	9.34E+02	2.71E+02	**
TA	-6.13E-03	3.37E-03	*
Rev	7.38E-02	6.60E-03	**
DE	-1.49E+03	2.42E+02	**
FGL	9.03E-01	2.10E-01	**
R^2	0.362	-	
Adjusted R^2	0.358	-	
Chisq	378.127	-	

After adding the dummy variables, we reach the results in Table 5.4. Because the coefficients of our main values do not change dramatically by introducing dummy variables, we will only analyse the latter model.

The intercept represents the estimated value of Net Income (NI) when all other independent variables are zero. In this case, it's approximately 119 million euros. The coefficient for TA is approximately -0.0089, which suggests that for a one-million increase in Total Assets, Net Income decreases by approximately 0.0089 million euros. The beta for Rev is approximately 0.0849, indicating that if Revenue increases by one million euros, Net Income increases by approximately 0.0849 million. The coefficient for DE is approximately -1,500.0, implying that an increase in the Debt-to-Equity Ratio is associated with a decrease of 1,500.0 million euros in Net Income. Lastly, FGL coefficient is approximately 0.873, meaning that an increase in

Foreign Exchange Gains/Losses is associated with an increase of approximately 0.873 million euros in our dependent variable.

Now, we have coefficients for sector dummies (CH, CM, CP, EN, FB, HC, IG, TE, TL, UT). These coefficients represent the impact of each sector on Net Income compared to the reference category (AP). Some of these coefficients are statistically significant (e.g., TA, Rev, DE, FGL, HC, UT) while the remaining are not. The R-squared is approximately 0.3776, indicating that the model explains about 37.76% of the variance in Net Income.

Table 5.4 - *Impact on Net Income, Random Effects with Dummies*

Variables	Effects	Std. Error	
Constant	1.19E+02	7.29E+02	
TA	-8.85E-03	3.53E-03	**
Rev	8.49E-02	7.50E-03	**
DE	-1.50E+03	2.66E+02	**
FGL	8.73E-01	2.10E-01	**
CH	-6.48E+02	-	
CM	1.07E+03	-	
CP	1.16E+03	-	
EN	-9.09E+02	-	
FB	1.57E+03	-	
HC	1.47E+03	-	*
IG	-3.16E+02	-	
TE	1.15E+03	-	
TL	-8.13E+02	-	
UT	1.57E+03	-	*
No of Obs.	672	-	
R^2	0.378	-	
Adjusted R^2	0.364	-	
Chisq	398.608	-	

5.3.2. The year of 2022

In terms of fluctuations in exchange rates, 2022 brought more media exposure than previous ones. After taking the previous model and considering that specific year, we are left with a set of cross-sectional data. The output for this regression using Ordinary Least Squares on R Studio is presented in Table 5.5.

***Table 5.5**- 2022 Net Income Regression*

Variables	Effects	Std. Error	
Constant	3.25E+03	1.11E+03	**
TA	1.05E-02	1.37E-02	
Rev	5.92E-02	2.22E-03	**
DE	-3.87E+03	1.57E+03	**
FGL	-1.02E+00	6.32E-01	
R^2	0.704	-	
Adjusted R^2	0.660	-	
F-statistic	16.060	-	

Once again, after introducing an industry-depth, we obtain the results in Table 5.6.

***Table 5.6-** Impact on Net Income 2022*

Variables	Effects	Std. Error	
Constant	4.44E+03	2.65E+03	
TA	5.79E-03	2.06E-02	
Rev	5.63E-02	3.95E-02	
DE	-2.52E+03	2.04E+03	
FGL	-8.67E-01	7.50E-01	
CH	-9.31E+03	-	**
CM	-1.74E+03	-	
CP	-3.48E+02	-	
EN	1.74E+03	-	
FB	-2.65E+03	-	
HC	-1.11E+03	-	
IG	-2.24E+03	-	
TE	-1.54E+03	-	
TL	-6.29E+02	-	
UT	-3.98E+03	-	
R^2	0.8128	-	
Adjusted R^2	0.6586	-	
F-statistic	5.271	-	

Here, we are using a cross sectional model focusing solely on 2022, using the same sample of firms. The direction that the main variables follow is not always the same as in the model from 2002 to 2022. The intercept, 4440 million EUR, represents the estimated value of NI when all other independent variables are zero for this specific point in time. The coefficient for TA estimates that an increase in 1 million assets increases Net Income by 0.0058 million euros, holding all other variables constant. The coefficient for Rev represents the estimated change in Net Income for a one-million increase in Revenue, holding all other variables constant. The

coefficient for DE is now -2,520.00, and the beta for FGL is estimated to be -0.867, holding all other variables constant. This means that, in 2022, an increase in foreign gains leads to a decrease in net income, which is different to what we saw from 2002 to 2022. None of these results is significant at 5% or 10%. The R-squared is approximately 81%, substantially high when compared to our panel data model.

5.3.3. Portion of EUR/USD Responsible

The Foreign Exchange Gains/Losses encompass additional revenue or costs that occur due to the exposure of the firm to currency risk. Nevertheless, most multinational corporations in our sample handle transactions not only in Euro or USD but other currencies such as the GBP, the JPY, the Chinese Yuan (CNY) or others.

Using the first method to assess the responsibility of the change in EUR/USD, we came to the results in Table 5.7.

Table 5.7*-Impact of ΔFXN on FGL*

Constant	29.848 (17.244)	*
ΔFX	-72.894 (66.287)	
R-squared	0.002	
Nº Observations	672	

Alternatively, performing mediation analysis with 500 bootstrapping simulations, the results are presented in the next table.

Table 5.8- *Mediation Analysis*

		95% CI	
		Lower	Upper
ACME	0.0135	-0.004	0.05
ADE	0.9030	-0.7475	2.6800
Total Effect	0.9165	-0.729	2.68
Prop. Mediated	0.0147	-0.204	0.04
Simulations	500		
Sample Size	672		

These results are compared as follows. We are examining the relationship between FGL and NI in the context of variations in the EUR/USD nominal exchange rate (DFXN) from 2002 to 2022. Specifically, we need to understand how much of the impact of FGL on NI is explained by variations in $\Delta FX_{USD,t}$.

In our first model, in Table 5.7, the relationship between FGL and $\Delta FX_{USD,t}$ is captured through a linear regression to assess the direct relationship between the two variables. The intercept (β_0) is estimated to be 29.848, with a standard error of 17.244. This is the expected value of FGL when $\Delta FX_{USD,t}$ is zero. The coefficient for $\Delta FX_{USD,t}$ is estimated to be -72.894, with a standard error of 66.287. This indicates that for a 1% increase in the variation of the EUR/USD exchange rate, FGL is expected to decrease by 72.894 million. Inversely, if the Euro depreciates by 1%, FGL is expected to increase by 72.894 million. The R-squared value is very low (0.0018), suggesting that $\Delta FX_{USD,t}$ alone explains very little of the variation in FGL. The p-value for $\Delta FX_{USD,t}$ is 0.2719, indicating that the relationship between $\Delta FX_{USD,t}$ and FGL is not statistically significant at common significance levels (e.g., 0.05). This suggests that $\Delta FX_{USD,t}$ may not be a significant predictor of FGL in this model at a 95% or 90% confidence level.

In our second model, depicted in Table 5.8, we used a different approach, Causal Mediation Analysis, which uses data from 2002 to 2022. This type of assessment is meant to understand the role of $\Delta FX_{USD,t}$ in mediating the relationship between FGL and NI. The key results from the mediation analysis are as follows.

The estimated ACME (Average Causal Mediation Effect) is 0.01346, with a 95% confidence interval ranging from -0.0038 to 0.05. This represents the average effect of the mediation pathway (through $\Delta FX_{USD,t}$) from FGL to NI. The coefficient for ADE (Average Direct Effect) is 0.9030, with a wide confidence interval from -0.7475 to 2.68. This represents the average direct effect of FGL on NI without going through $\Delta FX_{USD,t}$. The total effect of FGL on NI is estimated to be 0.9165, with a confidence interval ranging from -0.7289 to 2.68. The value for the total effect is, in fact, very similar to the impact found in Figure 5.4, where random effects were used. The proportion of the total effect that is mediated through $\Delta FX_{USD,t}$ is estimated to be 0.0147, with a wide confidence interval from -0.2040 to 0.04.

In this second model, we find that $\Delta FX_{USD,t}$ has a small effect on mediating the relationship between FGL and NI, with a low ACME. However, the confidence interval for the ACME includes zero, indicating that the mediation effect is not statistically significant at the 0.05

significance level. The ADE is also not statistically significant. Overall, this suggests that $\Delta FX_{USD,t}$ may not be a significant mediator in explaining the relationship between FGL and NI in your dataset.

In summary, Model 1 (the linear model) does not find a significant direct relationship between FGL and $\Delta FX_{USD,t}$, and Model 2 (mediation analysis) suggests that the mediation effect of $\Delta FX_{USD,t}$ on the relationship between FGL and NI is small and not statistically significant. These results indicate that variations in $\Delta FX_{USD,t}$ may not explain a substantial portion of the impact of FGL on NI in our dataset.

In 2022, the Euro depreciated by 0.07%. If we assume that the impact of $\Delta FX_{USD,2022}$ was significant, and that the coefficients from both these models could be applied to 2022 alone, using model 1 (in table 5.7) we would get the result that the variation in EUR/USD amounted to a foreign exchange gain of (-0.07)*(-72.894)=5.1026 million EUR on average for our sample of firms. Using FGL's coefficient in Table 5.6 (that explains the 2022 NI variations) we get to the value that, on average, the depreciation of the Euro against the US Dollar led to a decrease of (0.867)*5.1026=4.4239 million Euros on the net income of our sample of firms, which is a fairly small value considering the net income of most firms in our sample are hundreds of millions or even billions of euros (negative or positive). The mediation model estimated an impact of 0.01346 million euros on NI caused by a 1% increase in $\Delta FX_{USD,t}$. In 2022, that is (-0.07)*(0.01346)= -0.0009422 million euros, or approximately - 942 euros. This is significantly smaller than the value we obtained using the previous methodology, but the direction of the impact is the same.

A summary of the most relevant findings can be found below, with the impact of $\Delta FX_{USD,t}$ and FGL on each dependent variable (NI, R and FGL) and if it is significant or not.

Table 5.9 *– Summary of Results*

	2002 - 2022					
	NI	**Sig**	**R**	**Sig**	**FGL**	**Sig**
$\Delta FX_{USD,t}$	0.013	N	0.341	Y	-72.894	N
FGL	0.873	Y	-	-	-	-
	2022					
FGL	-0.867	N				
Estimated Impact, Linear Regressions:					**-4.424**	**M€**
Estimated Impact, Mediation:					**-942**	**€**
					(2022)	

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Conclusion

This dissertation introduced the research questions "How does the depreciation of the Euro against the US Dollar affect the stock returns of EURO STOXX 50 firms" and "How does the depreciation of the Euro against the US Dollar affect the net income of EURO STOXX 50 firms, particularly how much was that impact in 2022?"

By looking at the 2022 financial reports of firms, we found the effect of the depreciation of the Euro against the US Dollar had a mixed effect on the results of the corporations, positively impacting some sides of the businesses while negatively affecting others. It is also clear that most firms have a hedging strategy in place that mitigates those shocks.

When answering the first question, we observed that an increase in the annual percentage change in the EUR/USD exchange rate will lead to an increase in the stock returns of our sample of firms. Conversely, if a depreciation happens, that tends to cause stock returns to decrease. The obtained coefficient for $\Delta FX_{USD,t}$ is statistically significant and the model using nominal exchange rates is favored. Its value, 0.341, tells us that a 1% increase in the percentage change of the EUR/USD nominal rate translates into an increase of 0.341 percentage points in annual stock returns, *ceteris paribus*. When it comes to industry specific results, only Banks, Energy, Food, Beverage and Tobacco, Health Care, Insurance, Telecommunications, and Utilities present statistical significance. The sector that suffers the biggest impact is Telecommunications, indicating that if the firm is part of this sector, the expected change in R is an increase of 0.0798% when compared to a firm in Automobiles and Parts. These values are relatively small, which is coherent with other studies, where there is a small response to currency fluctuations.

Regarding the second research question, considering the period from 2002 to 2022, and excluding firms in the "Financials" industry, the coefficient of FGL signals that a one million euro increase in foreign exchange (a gain), leads to a 0.873 million euro increase in net income. This result is statistically significant, and in this case the Healthcare and Utilities sector also presents significance. Both these sectors provide essential services and products that people will consume even if the price shifts because they are considered essential.

Considering 2022 only, the coefficient of FGL was not found to be statistically significant, its value was very similar to the one in our previous estimation (0.867) but negative, meaning that a 1 million euro increase in foreign exchange gains means an 867 000 euro decrease in net

income, for non-financial corporations. Through linear regressions and mediation analysis we projected the depreciation of the euro against the dollar to cause a decrease in net income in 2022. These results are in agreement with the expected.

The approach foregone does have its limitations. The explanatory power of the models could be bigger, but we prioritized the balance between interpretability and complexity and attempted to avoid multicollinearity, which led to a smaller R-squared.

The use of Trade-Weighted Exchange Rates (TWER) could be beneficial. Different industries may have varying degrees of sensitivity to changes in exchange rates. Some industries, such as export-oriented sectors, like manufacturing, are highly sensitive to exchange rate fluctuations, while others, may be less affected. By using a TWER that accounts for the currency weights of a specific industry's trading partners, we could better capture the industry-specific effects of exchange rate movements.

Working with data from smaller periods would also increase the reliability of our models. For the net income part of the analysis, that would be working with quarterly data, and for our stock returns model weekly or monthly data. Another improvement could be the addition of lagged variables. By including lagged effects in the regression models, we would account for temporal dependencies, which can lead to more accurate and realistic modelling of the data.

A further limitation is not having information on how much firms rely on import/export sales and how big of a part those operations play in their financial performance. The amount of assets/liabilities that each firm has in foreign currency would also be helpful, since firms highly indebted in foreign currency may gain from appreciation in exchange rate, for example.

In conclusion, the world of foreign exchange markets is very large, and the ever-changing nature of firms, their operations, and holdings, allied with macroeconomic changes caused by a variety of world-scaled events creates the necessity for a constant revision of the firm’s strategy. It is most important that firms remain aware of this risk and manage it constantly according to each moment’s necessities.

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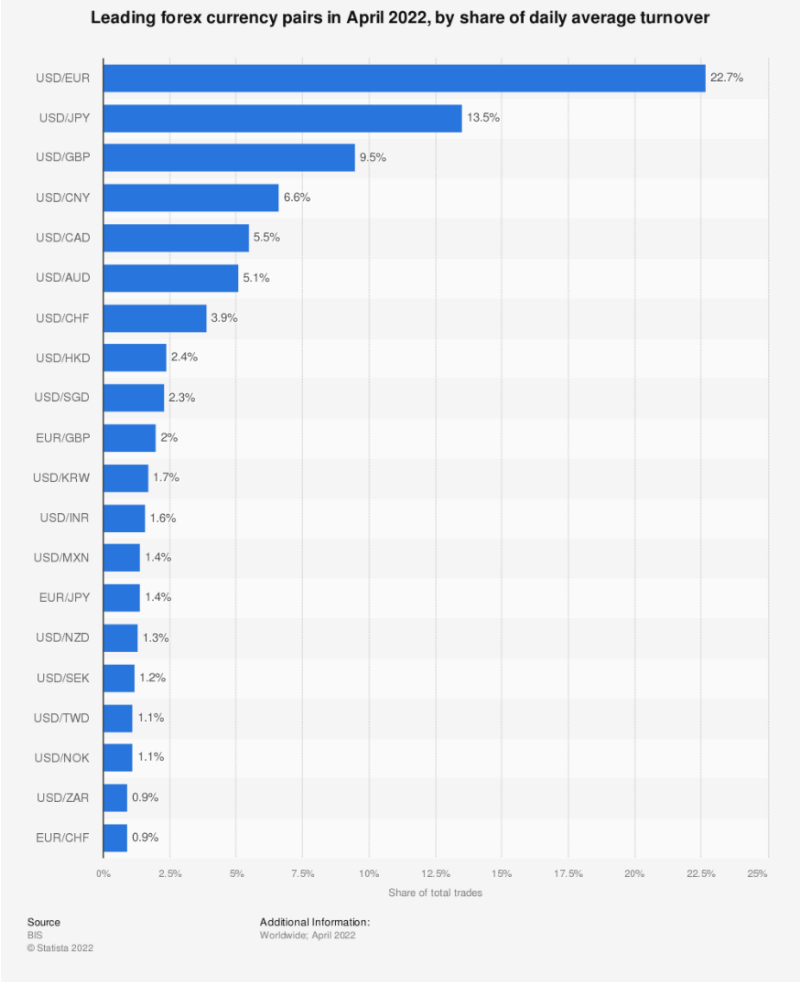
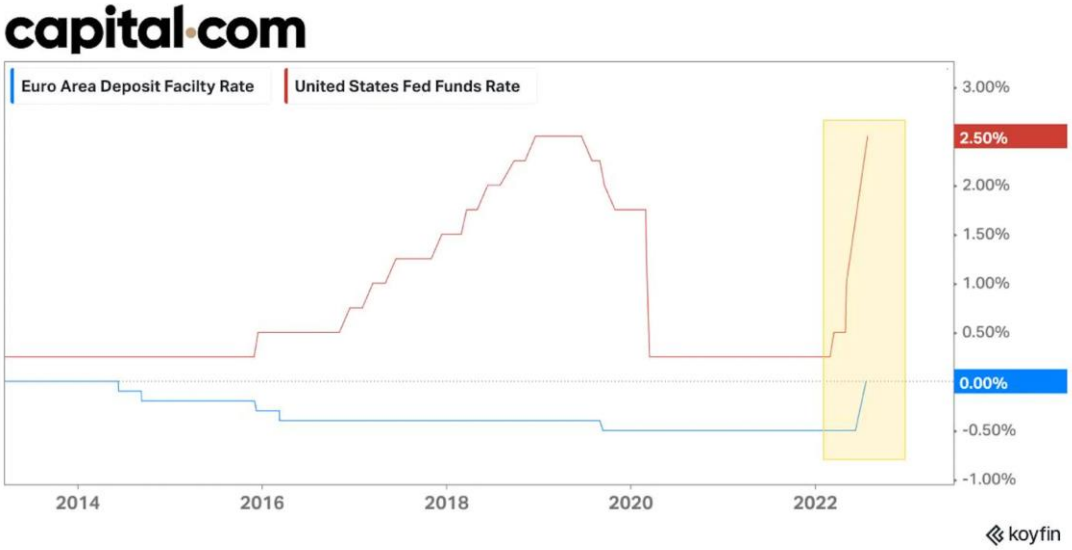
Annexes

Annex A - Most traded currency pairs in 2022



Source: Statista (2023)

Annex B - Monetary policy gap between the Federal Reserve and the ECB



Source: Capital.com, Data: Koyfin

Annex C - EURO STOXX 50 Composition as of February 2023

Company	Market Cap (in Billion €)	Country	ICB Industry	ICB Supersector
LVMH Moet Hennessy Louis Vuitton	398.78	France	Consumer Discretionary	Consumer Products and Services
ASML Holding	246.70	Netherlands	Technology	Technology
L'Oreal	201.31	France	Consumer Discretionary	Consumer Products and Services
Hermes International	178.83	France	Consumer Discretionary	Consumer Products and Services
Linde	159.47	Germany	Industrials	Industrial Goods and Services
TotalEnergies	149.96	France	Energy	Energy
Prosus	146.96	Netherlands	Technology	Technology
SAP	136.82	Germany	Technology	Technology
Siemens	121.99	Germany	Industrials	Industrial Goods and Services
Anheuser-Busch InBev	112.03	Belgium	Consumer Staples	Food, Beverage and Tobacco
Sanofi	111.50	France	Health Care	Health Care
Mercedes-Benz Group	106.87	Germany	Consumer Discretionary	Automobiles and Parts
Deutsche Telekom	100.28	Germany	Telecommunications	Telecommunications
Industria de Diseno Textil	89.42	Spain	Consumer Discretionary	Consumer Products and Services
Airbus	89.02	France	Industrials	Industrial Goods and Services
Allianz	88.97	Germany	Financials	Insurance
Schneider Electric	85.21	France	Industrials	Industrial Goods and Services
EssilorLuxottica	78.67	France	Health Care	Health Care

BNP Paribas	78.47	France	Financials	Banks
Air Liquide	77.31	France	Basic Materials	Chemicals
Volkswagen	76.44	Germany	Consumer Discretionary	Automobiles and Parts
Kering	70.79	France	Consumer Discretionary	Consumer Products and Services
Iberdrola	69.14	Spain	Utilities	Utilities
AXA	67.05	France	Financials	Insurance
BMW	63.93	Germany	Consumer Discretionary	Automobiles and Parts
Vinci	61.49	France	Industrials	Construction and Materials
Bayer	61.29	Germany	Health Care	Health Care
Banco Santander	59.48	Spain	Financials	Banks
Safran	55.52	France	Industrials	Industrial Goods and Services
Enel	54.55	Italy	Utilities	Utilities
Deutsche Post	51.56	Germany	Industrials	Industrial Goods and Services
Eni	51.03	Italy	Energy	Energy
Danone	50.44	France	Consumer Staples	Food, Beverage and Tobacco
Pernod Ricard	48.79	France	Consumer Staples	Food, Beverage and Tobacco
Stellantis	48.74	Italy	Consumer Discretionary	Automobiles and Parts
ING Group	47.56	Netherlands	Financials	Banks
BASF	47.14	Germany	Basic Materials	Chemicals
Intesa Sanpaolo	46.90	Italy	Financials	Banks
Muenchener Rueck	45.95	Germany	Financials	Insurance
Infineon Technologies	45.79	Germany	Technology	Technology
Banco Bilbao Vizcaya Argentaria	40.75	Spain	Financials	Banks
Adyen	40.15	Netherlands	Industrials	Industrial Goods and Services
Nordea Bank	40.10	Finland	Financials	Banks
CRH	32.65	Ireland	Industrials	Construction and Materials
Deutsche Boerse	32.08	Germany	Financials	Financial Services
Adidas	27.63	Germany	Consumer Discretionary	Consumer Products and Services
Ahold Delhaize	27.31	Netherlands	Consumer Staples	Personal Care, Drug and Grocery Stores
Flutter Entertainment	25.49	Ireland	Consumer Discretionary	Travel and Leisure
Nokia	24.38	Finland	Telecommunications	Telecommunications
Vonovia	20.91	Germany	Real Estate	Real Estate

Sources: dailyPik, Euronext

Annex D – Results of Breusch-Pagan and Breusch-Godfrey Tests

```
studentized Breusch-Pagan test

data:  white_test_model

BP = 9.9961, df = 14, p-value = 0.7625



        Breusch-Godfrey test for serial correlation of order up to 1

data:  pooledmethod_dummies

LM test = 0.70159, df = 1, p-value = 0.4022
```

Annex E - Results of Breusch-Pagan and Durbin-Watson Tests

```
> bptest(pooledmethod)

        studentized Breusch-Pagan test

data:  pooledmethod
BP = 108.28, df = 4, p-value < 2.2e-16
```

```
> pdwtest(pooledmethod)

        Durbin-Watson test for serial correlation in panel models

data:  NI ~ TA + Rev + DE + FGL
DW = 1.2588, p-value < 2.2e-16
alternative hypothesis: serial correlation in idiosyncratic errors
```

Annex F – Result of Hausman Test

```
> phtest(fixedmethod,randommethod)

        Hausman Test

data:  NI ~ TA + Rev + DE + FGL
chisq = 13.065, df = 4, p-value = 0.01096
alternative hypothesis: one model is inconsistent
```