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The Foreign Exchange Rate Exposure of Portuguese Firms Before and After the Introduction of the Euro

by

Luís Miguel Correia da Torre

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Advised by:

Professora Doutora Ana Paula Serra

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Biographical Notes

Luís Miguel Correia da Torre was born in 5^{th} May, 1979, in Porto, Portugal. He completed his "Licenciatura" in economics in 2008, with an average grade of 14. After his graduation, he enrolled on the Master in Finance because he considered that a deeper knowledge on this field would be important to his academic and professional development. He concluded all courses of the Master in February, 2010, with an average grade of 16.

Since 2007, he has been assigned the position of Financial Consultant in a Real Estate Development company.

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Last but not the least, I want to dedicate this dissertation to my late father, Alfredo Torre. I feel very sad that he is not alive to be by my side in this step of my life. One of the last things he told me was to prepare and finish this dissertation. He will always be alive in my heart and in my memories.

Abstract

The primary objective of this dissertation is to understand whether Portuguese stocks are exposed to exchange rate risk and how this exposure changed after the introduction of the Euro. We use a sample of non-financial stocks from the PSI General index. We estimate the foreign exchange rate exposure of those stocks to a nominal effective exchange rate and to four bilateral exchange rates (US Dollar, Yen, Pound Sterling and Real). The period of analysis is from 1990 to 2007, which is divided into two sub-periods, from 1990 to 1998 and from 1999 to 2007. We also test whether significant changes in stock return volatility and market risk took place after the introduction of the Euro. We show that there were significant reductions in market risk after 1999. Results suggest that there are more significant exposures to bilateral exchange rates than to the effective exchange rate. There is some evidence that the majority of significant exposures to bilateral exchange rates were negative before the introduction of the Euro and reversed toward zero after 1999.

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1. Introduction

Over the last 16 years, since Adler and Dumas (1984), many empirical studies addressed the issue of foreign exchange rate exposures. Understanding how stocks are exposed to exchange rate variability is relevant for the financial manager to decide whether he should hedge the exchange rate risk and to define the level of exposure that should be hedged. A survey of financial risk management by US non-financial firms in 1998 (Bodnar, 1999), suggests that 83% of US financial managers that use derivatives utilize them, at least in part, to hedge currency risks. It also suggests that derivatives are more used by large firms (83%) than by small firms (12%) and that they are positively related with the percentage of foreign expenses and revenues. Correia (2009) analyses the use of derivatives and the exchange rate exposures of Portuguese firms between 2002 and 2007 and find some evidence that the use of derivatives is negatively related with the absolute exchange rate exposures.

The majority of studies find that there are very few stocks significantly exposed to exchange rates, fact that most financial economists find puzzling. The development of derivative instruments, the increased internationalization of firms, which provides higher levels of geographic diversification, the increase of natural hedging and methodological issues, are considered, among others, as possible explanations for those weak results.

Bartram and Karolyi (2006) suggest that the introduction of the Euro had a negative impact on the exposure of stock returns to exchange rate changes, while Muller and Verschoor (2006) suggest that only 13% of European firms are significantly exposed to the Yen, 14% exposed to the US Dollar and 22% exposed to the Pound Sterling.

Our objective is to understand whether stocks of Portuguese firms are exposed to exchange rate changes and if FX exposures changed significantly after the introduction of the Euro. Since this event may be compared to a shift to a fixed exchange rate regime, we expect that FX exposures of Portuguese stocks decreased.

Following Bartram and Karolyi (2006) and Bartov et al.(1996), we analyse the impact of the introduction of the Euro on stock return volatility and on systematic risk measured by the market beta. Then, we estimate the foreign exchange rate exposures of non-financial stocks from the PSI General index. The period of analysis is from 1990 to 2007, that is, eight years before and after the introduction of the Euro. We use a nominal effective exchange rate (NEER) computed by Eurostat and four bilateral exchange rates: the US Dollar, the Yen, the Pound Sterling and the Real. Following the majority of the studies, we use monthly returns. However, we also estimate FX exposures using overlapping annual returns to test whether there is a lagged relationship between exchange rates and stock returns. We also test whether FX exposures are affected by the size of firms and the percentage of foreign sales.

Some of our findings are in line with most other studies (Bartram and Karolyi, 2006; Bartov et al, 1996; Muller and Verschoor, 2006; Correia, 2009). We find that, before the introduction of the Euro, only about 10% of stocks in our sample were significantly exposed to the NEER, 23% to the US Dollar, 14% to the Yen, 19% to the British Pound and 33,3% to the Real. Our results also suggest that most of the stocks that are significantly exposed to bilateral exchange rates have negative exposures.

The dissertation is organized as follows: Section 2 reviews the existing literature on foreign exchange rate exposures. Section 3 describes the data sources and the methodology. Section 4 discusses the results, while section 5 presents cross-sectional analyses motivated by Bartram and Karolyi (2006).

2. Literature Review

Since Adler and Dumas (1984), there has been substantial literature published on the field of international finance and economics, that attempts to measure the exposure of the value of the firm to unanticipated exchange rate changes. Most studies extend the model proposed by Adler and Dumas (1984) which defines FX exposure as a coefficient of a regression of stock returns against the spot exchange rate.

$$R_{it} = \alpha_0 + \delta_1 RX_t + u_t$$

The interpretation is as follows: company stock returns (R_{it}) are determined by the spot exchange rate of its domestic currency (RX). The coefficient δ_1 measures the sensitivity of the firm's value to the exchange rate changes.

This model does not define a relation of causality between exchange rates and stock returns. As denoted by Jorion (1990), this concept may be seen as a simple statistical decomposition, where FX exposure may reveal the simultaneous impact of shocks on both variables. In accordance to this, the relation between the two variables depends on the nature of the shock.[1]

In the model of Adler and Dumas, δ_1 measures the total FX exposure. This model has a strong caveat that was identified by researchers: there are omitted variables that are correlated with δ_1 and that affect market returns. This makes OLS generally inconsistent (Wooldridge, 2006). To overcome this issue, in most studies that followed, the model was augmented with the market returns. Since market returns, measured by an index, are affected by macroeconomic events, controlling the model for market returns captures the effect of those variables on the price of stocks, removing them from the error term. However, with market returns, δ_1 is no more a measure of total exposure but a measure of residual exposure (Bodnar et al., 2003).

After the work of Adler and Dumas (1984), many researchers focused their attention on the sensitivity of the value of multinational firms to the exchange rate variability. Although FX exposure of multinationals to exchange rate risks is usually perceived as being higher, firms without international trade operations might also be affected by the variability of the domestic currency. Domestic firms can be affected, among others, by (i) shocks on the aggregate demand; (ii) the cost of traded inputs; or (iii) when they

1 For instance, if shocks affected both variables in opposite directions, the coefficient δ_1 would be negative.

compete in the domestic market with imports (Jorion, 1990). In any case, most studies acknowledge that there is, indeed, a measurable difference on the FX exposure of the multinational and domestic firms.

Bartov et al. (1996) try to identify changes on the market betas of multinational US firms, before and after the collapse of the Bretton Woods system. The authors created control samples with domestic firms, to compare the changes on the market betas before and after the event. They concluded that *"Overall, these results suggest that the stock return variability of multinational firms is positively related to exchange rate variability. Alternatively, these results may be interpreted as implying that increased exchange rate variability contributes relatively more to increased stock return volatility for U.S. multinational firms than for other less multinational firms"*(Bartov et al., 1996, p.119).

Most studies find low exposures to exchange rates. Bartov et al. (1996) point out three possible reasons for that: (i) firms' activities can have opposite exposures to exchange-rates, (ii) the investors may wait for the release of the firm's performance data to perceive the effect of exchange rates on firm's cash flows, delaying the adjustment of its stock price and (iii) firms that are exposed to exchange rate changes can take offsetting positions, using derivatives and other forms of hedging, such as natural and balance sheet hedging.

Jorion (1990), out of a sample of 287 US multinationals, find that only 15 firms are significantly exposed to unanticipated exchange rate movements. He suggests that exposures to exchange rates have a positive relation with the proportion of foreign sales, as predicted by international finance theory. Bodnar and Gentry (1993) analyze, at the industry level, the effect of currency volatility on the market value of industry portfolios. They find that the impact of exchange rate movements on industries returns is larger for Canada and Japan than for USA. They argue this result is consistent with the prediction that exchange rate impact is larger in small and internationally oriented economies. Nevertheless, they find that between 20% and 35% of the industries in their sample have statistically significant exchange rate exposures.

HE and NG (1998), following Bartov et al. (1996) suggestion that stock prices could be explained by lagged instead contemporaneous exchange rates, estimate the FX exposures of multinational Japanese firms, with both lagged and contemporaneous observations. They find low evidence of a lagged relationship. Instead, the results suggest that the value of Japanese multinationals is positively related to a depreciation of the Yen, particularly in three sectors: electric machinery, precision equipment and transport equipment. These results are consistent with Williamson (2001), whose research on automotive industry suggests that the currency exposure of a firm is a function of its foreign sales, the cost structure of the foreign competition, the degree of competition and the firm's hedging practices.[2] Moreover, his findings suggest that operational hedging decreases exchange rate exposure, which is consistent with the predictions of international finance theory.

The extensive research on the exposure of stocks to foreign exchange rates, suggests that US multinationals exposure is lower compared with other countries.[3] Dominguez and Tesar (2006), in a paper written in 2001, analyze the exchange rate exposures in a sample of eight industrialized and developing countries, with the exception of US[4]. At country level, the extent of exposure is robust.[5] The research postulate that exposure is more prevalent in small size firms and, as suggested by previous studies, in firms engaged in international activities.[6]

Bartram and Karolyi (2006) analyze if there were significant changes in stock return volatility and foreign exchange rate exposure after the introduction of Euro.[7] Following Jorion (1990), Williamson (2001) and Bodnar and Wong (2003), they selected multinational firms from Europe, Japan and US, based on the relative importance of their foreign sales.[8] With the exception of Poland and Austria, market return volatility increased for all countries in the sample after the introduction of the Euro. They find that the variance of stock returns increased more in countries outside the Euro Area. These results suggest that Euro Area firms benefited from a reduction in exchange rate risk, reflected in lower increases in market return variances. Yet, there were no significant differences on the volatility of stock returns between multinational firms with business in Europe and non-multinational firms. They also analyze the effect of the Euro on market betas. Reduced market betas for multinational firms with foreign business activities in Europe, when compared to control samples, suggest that the introduction of the Euro decreased the market risk for many firms. It also posits that exchange risk is at least in part non diversifiable. Bartram and Karolyi (2006) also estimate the impact of the Euro on the exchange rate exposures. They find that the sign of the changes in the exposure for most

2 As predicted by theory, the price elasticity of demand is crucial for the impact of exchange rate variability.
3 Examples: Bodnar and Gentry (1983); Stulz and Griffin (2001).
4 The eight countries in the sample are: Chile, France, Germany, Italy, Japan, the Netherlands, Thailand and the United Kingdom.
5 The estimates depend on the type of the exchange rate (Bilateral or traded-weighted).
6 Bartram and Karolyi (2006); Bartov et al. (1996); Stulz and Griffin (2001).
7 The authors decided to use January 1st, 1998 as the effective event date to accommodate possible market anticipation, following Bris et al. (2004).
8 For US and Japan, they used firms with commercial trade with Euro Area countries.

firms was the opposite of the initial exposure.[9] That is, for the firms which had negative exposures before the Euro, the change was positive and the opposite for the firms which had positive exposures. These estimates suggest that the introduction of the Euro induced a net reduction in foreign exchange rate exposures, which is in line with the economic theory.

Bartram and Karolyi (2006) draw the attention to the fact that misspecifications in the model may explain the low exposures found by this and previous studies. They argue that there is strong evidence that part of the exchange rate risk may be systematic. In the standard model, exposure is measured by the coefficient of exchange rate changes, controlling for market movements. Because of this, if exchange rate risk is in part systematic, the model will only capture the diversifiable risk, failing to capture the entire exposure.

These authors also argue that multinational firms usually benefit from higher diversification options, which should allow them to have lower market betas. It is expected that the shift from flexible to fixed exchange rates reduces multinationals foreign exchange rate exposure, but on the other hand it is also expected that it decreases diversification opportunities, increasing market risk.[10] They noted that "(…) *the documented results occur despite and not because of increased market integration"*.

Other possible explanation for the above mentioned results is lower financial leverage. The authors analyzed the firms' leverage before and after the Euro, and found that leverage increased for the three samples and that this increase was not significantly different for multinational firms and size control firms.

They investigated sub-samples of firms, split by sales, foreign to total sales ratio, geographic region and industry characteristics. The results are in line with the previous ones: (i) market betas and their reduction after the Euro are higher for firms with above-median sales; (ii) the absolute exchange rate exposure is higher for multinationals with below-median sales; (iii) the exposure is larger for multinationals that have a higher proportion of total foreign sales or of higher proportion of foreign sales in Europe; (iv) changes and levels of exposure have the opposite signs, which means that exposure

9 The estimated dummy's coefficient represents the change on exposure after the introduction of the Euro. One should take in consideration that some other event may have affected the stock prices as well, besides exchange rates changes.

10 Bartov et al. (1996) suggest that benefits from international diversification may fall over time due to increasing market integration after the change to flexible exchange rates. Market integration should increase the correlation between US and foreign markets, diminishing diversification benefits. Nevertheless, they found low correlation increase between US and foreign markets, after the collapse of the Bretton Woods system.

decreased significantly toward 0; and (v) the exposure's changes (reduction) after the introduction of the Euro were higher for firms which had higher exposures before.[11] With regard to the degree of competition, the analysis suggests that firms in more competitive industries had significantly larger decreases in market betas.[12] With respect to traded and non-traded goods, the results are also in line with economic intuition since the estimates suggest larger reductions to firms in traded goods industries.

More recently, following the methodology used by Bartov et al. (1996), Muller and Verschoor (2009) analyze the effects of major financial crises, at the end of the nineties on US stock return volatility that are active in those countries.[13] They find that stock return volatility and market betas increased in the aftermath of the events, when compared to other US multinationals with no activities where the crises occurred.

This article also presents some evidence in favor of the importance of exchange risk on the cost of capital.[14] They find that manufacturing sectors had an insignificant change in market risk following the increased volatility of Asian currencies. The authors argue that US manufacturing products are less substitutable than more service-oriented products and therefore, they are less exposed to exchange rate shocks.[15] With respect to the size of firms and the Asian crisis, results suggest that the increase in systematic risk was particularly strong for very small firms. These results are fairly different from the ones estimated by Bartram and Karolyi (2006) who found that small size firms had lower market betas changes after the introduction of the Euro than larger firms.[16] With respect to FX exposure, Muller and Verschoor (2009) noted: *"(...) the impact of firm size on*

11 Note that below-median sales firms have lower market betas and higher exposures. We may interpret that lower sales firms are more exposed to the component of foreign exchange risk that is diversifiable. On the opposite, higher sales firms are more exposed to "systematic" exchange rate risk. One possible explanation for these results is the fact the stock prices of bigger multinationals, because they represent a larger proportion of the indices used as market proxies, may have higher correlation with those indices. On the other hand, these results suggest that above-median firms are more likely to hedge than below-median firms.

12 In industries with lower degree of competition, the price elasticity of demand is also lower, which enables firms to a higher pass-through coefficient. When firms reverberate exchange rate variability in prices, they are less exposed to exchange rate risk. (Bodnar and Wong, 2002)

13 Mexico 1994; Argentina 1995; Brazil 1999; Asian financial crisis in Thailand, Malaysia, Indonesia and Korea in 1997.

14 Results suggest that Agriculture, Mining and Construction Industries were heavily affected by the Asian crisis. Moreover, Transport Communication and Transport, the Wholesale and Retail Trade and the Finance and Services sectors experienced a sharp and statistically significant increase in systematic risk (Muller and Verschoor, 2009).

15 Another possible explanation proposed by Muller and Verschoor (2009) is that as Asian demand for US manufacturing goods decreased, Asia expanded its position in manufacturing products which, in turn, increased Asian demand for intermediate manufacturing goods from US.

16 In contrast, below-median sales firms had higher foreign exchange rates exposure and larger changes in exposure after 1998.

exposure is ambiguous (...)". They recall that Nance et al. (1993) suggest that larger firms, because they benefit from economies of scale, are more likely to hedge. On the other hand, they argue that smaller firms face higher bankruptcy costs because their probability of financial distress is higher, which should incentivize these firms to hedge more than larger ones. Bartram and Karolyi (2006) find that smaller firms have higher exposures to diversifiable exchange rate risks. [17]

Chue and Cook (2008) approach exposure in a slightly different perspective. Their goal is to assess *"whether emerging market firms as a class are negatively affected by exchange rate devaluations, not just how they perform relative to their respective country averages"* (p.1349). They model the excess return on a stock as being explained by the trade-weighted domestic exchange rate and the excess return on the world stock index.[18] [19] They analyze two periods, one from January 1, 1999 to June 30, 2002 and other from July 1, 2002 to June 30, 2006. They find that in the first period the FX exposures are negative for most countries.[20] In the second period, the estimates are quite different. They find negative exposures only in three countries: Korea, Pakistan and Taiwan.[21] Results further suggest that the FX exposure of firms, in the first period, are related negatively with the level of international foreign currency debt, the level of total debt and the level of external debt in the country where the firm is located. In the second period this relationship disappears or reverses sign. Chue and Cook (2008) argue that the identified changes in exchange rate exposure, coincides with a *"changing structure in many emerging markets' debt"*(p.1361). They present, also, some evidence that the use of derivatives in developing countries more than tripled from one period to the other.

Muller and Verschoor (2006) investigate the exchange rate exposures of European firms. They find that 13% of stocks are significantly exposed to the Yen, 14% to the US Dollar and 22% to the Pound Sterling. They also suggest that since there are significant negative and positive exposures, in aggregate they might not be economically significant. With respect to return horizon, they find higher exposures on the long-run. They argue that this results from the fact that hedging activities are more efficient on the short-run. Their results suggest that most firms that are exposed to the Dollar, the Yen and Pound Sterling, are positively affected by an appreciation of the domestic currency. The authors argue that

17 Dominguez and Tesar (2006) drew the same conclusion for other eight countries besides the US.

18 The authors define excess stock market returns as the difference between the domestic currency stock return and domestic short term interest rate.

19 According to the authors, the return of the world stock market in excess of the three month US T-bill rate.

20 Domestic currency depreciation has a negative impact on excess stock market returns.

21 In the first period, out of a sample of 15 countries, only four countries did not show negative exposures: India, Pakistan, South Africa and Venezuela.

this is in line with economic intuition because European firms import from those countries materials that are used on the production of goods that are exported to the world market. Moreover, with respect to Portugal, their estimates suggest that Portuguese firms benefit from the devaluation of the US Dollar and Pound Sterling, and from the appreciation of the Yen. Cross-sectional analyses suggest that the exposure to the US Dollar is positively related with the size of the firm.

Correia (2009) analyzes FX exposures of Portuguese firms and their relation with the use of derivatives. He find a few number of Portuguese firms that might be significantly exposed to exchange rates. With respect to the use of derivatives, his study suggests that absolute FX exposures might be negatively related with the use of derivatives.

Summary

Bartram and Karolyi (2006) suggest that the introduction of the Euro had a negative impact on net absolute exchange rate exposures and market risk. Correia (2009) argues that there were very few Portuguese firms in the PSI General that were significantly exposed to exchange rate changes from 2002 to 2007. Muller and Verschoor (2006) suggest that significant FX exposures to the US Dollar and Pound Sterling are mainly positive. Williamson (2001) argues that bilateral exchange rates are more appropriate to estimate FX exposures and that these are positively correlated with the percentage of foreign sales, while Bartov and Bodnar (1994) and Dominguez and Tesar (2006) posit that exchange rate exposures increase with the time horizon.

In this Dissertation, we follow the approach of Bartram and Karolyi (2006) to analyze how the FX exposures, market betas and stock volatility of non-financial stocks from the PSI General changed after the introduction of the Euro. We test whether annual overlapping returns and bilateral exchange rates yield more significant exposures than monthly returns and the NEER, respectively. Further, we analyze whether the size of firms and the percentage of foreign sales play any role on FX exposures.

3. Data and Methodology

3.1. Data

In this dissertation we use two types of exchange rates: (i) Nominal Effective Exchange Rate and (ii) Bilateral Exchange Rates, downloaded from Eurostat and Datastream. The NEER is a traded-weighted exchange rate, computed by European Statistics authorities. This type of exchange rate is commonly used as a measure of the competitiveness of a country in terms of prices. The benefits of using this measure is that it "*(...) represents the currency environment that a firm would face on average.*" (Aggarwal and Harper, 2010, p. 1622). However, many firms might be exposed to only one exchange rate that is not highly correlated with the traded-weighted index. In these cases, currency indices tend to net out the effects of different currencies faced by firms. Dominguez and Tesar (2006) compute, for several countries, the percentage of times that firms are exposed to the US Dollar but are not exposed to the traded-weighted exchange rate. They conclude that traded-weighted exchange rates are not a good indicator of overall exposure, when taken alone.[1]

We measure the bilateral exchange rates in terms of the Euro and ECU. To obtain the exchange rate between the Portuguese currency and other currencies, before 1999, we compute the cross-rate by dividing the rate EUR/ECU in the other country's currency by the rate of EUR/ECU in escudos. In this dissertation we use indirect quotations. This means that, either with NEER or bilateral exchange rates, an increase in the exchange rate represents an appreciation of the domestic currency.

The Market's Proxy and the Sample

To proxy the market returns we use the PSI General, a value-weighted index. However, in recent years, this proxy does not capture the opportunity set of a Portuguese investor that is not confined to investing in Portuguese stocks.[2]

Bodnar and Wong (2003) argue that larger firms are strongly correlated with value-weighted indices. Since they are typically more involved in foreign activities, they tend to have higher negative exposures to an appreciation of the domestic currency. However, the stronger correlation with the index, disguise the higher negative exposures relatively to smaller firms. This happens because the market beta captures a part of the exchange rate

1 Other authors also claim that bilateral exchange rates are more appropriate to measure FX exposures (e.g. Williamson, 2001).
2 A global index could be a more efficient proxy.

effect. However, the findings of Dominguez and Tesar (2006) suggest that the estimates are similar using value-weighted and equal-weighted indices.

The sample consists of 34 non-financial firms, that integrate the PSI General constituent list at December, 31. We remove from the sample Reditus, Galp, Martifer, Ren and all Football clubs. Galp, Martifer and Ren were removed because they have very few observations within the analysed period and Reditus because its stock return volatility is very high in 2002.

One caveat of this sample is that it was not possible to include in it, firms that were in the PSI General but no longer exist. This represents a survivorship bias because we cannot extrapolate measurements to the universe of Portuguese companies but only to those that survived.

Period

The period of analysis is from 1990 to 2007. It is divided into two sub-periods: (i) from 1990 to 1998; and (ii) from 1999 to 2007. The objective is to compare the evolution of foreign exchange rate exposures and market betas before and after the introduction of the Euro. We further divide the first period into two sub-periods, from 1990 to 1993 and from 1994 to 1998 to run some of the proposed tests. The goal is to capture possible FX exposure and market beta changes before and after Portugal entered the European Exchange Rate Mechanism (ERM).

Return Horizon

Following the majority of studies in this topic, we use monthly returns. However, the selection of the return horizon raises the issue whether the relation between stock market returns and exchange rate returns are contemporaneous or not. If one assumes that markets are efficient and information is perfect and complete (available instantly to everyone), exposure should be independent of the return horizon.

There are mixed results on this issue. For instance, HE and NG (1998) suggest that FX exposure of Japanese firms is contemporaneous. On the other hand, Bartov and Bodnar (1994) suggest that the stock returns have a stronger relationship with lagged as opposed to contemporaneous USD/YEN changes. They present some evidence that stocks that are consistently exposed to exchange rate changes have a foreseeable stock price reaction around financial reports announcements, based on exchange rate variation over the previous quarter. Dominguez and Tesar (2006) argue that exchange rate exposures increase with the time horizon for most firms in their sample.

The question is how long stocks take to incorporate the exchange rate changes. A contemporaneous relationship means that investors perceive quasi-immediately the effect of exchange rates on the present value of future cash flows.

To test whether the significance of foreign exchange rate exposures increases with larger return horizons, we estimate exposure coefficients using annual returns with overlapping monthly returns. This technique allows to use annual returns without loosing no more than 12 observations. However, some statistical issues arise from this technique. Using overlapping returns usually creates a moving-average error term which violates the OLS assumptions and, thus, estimates are inefficient and error terms biased. Later on, we present the methodology used to control the estimates for the effects of serial correlation with overlapping returns.

3.2. Methodology

3.2.1 Market Betas

The market beta measures the exposure of a firm to market risk, also known as systematic risk. In the literature about exchange rate exposures, there is no consensus about the nature of exchange rate risk. Nevertheless, Bartram and Karolyi (2006) results suggest that the introduction of the Euro decreased market betas of multinationals, which may corroborate that exchange rate risk is in part non-diversifiable.

In order to identify possible impacts of the introduction of the Euro on the market betas, we regress the following model at the firm level:

$$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + u_t \quad (3\text{-}1)$$

where R_{it} is the stock return of the firm, R_{mt} the PSI General return and $R_{mt}D_t$ the slope dummy variable that controls the model for the introduction of the Euro. β_1 corresponds to the market beta and β_2 is the marginal effect of the introduction of the Euro in the market beta. That is, the market beta is estimated by β_1 before the Euro and by $\beta_1 + \beta_2$ after the Euro.

The coefficients are controlled for serial correlation and the standard-errors for heteroskedasticity with the Newey-West method.

3.2.2. Foreign Exchange Rate Exposures

In order to estimate FX exposure coefficients we use two models. The first one is the augmented model of Adler and Dumas (1984), which controls the foreign exposure for the market returns.

$$R_{it} = \delta_0 + \delta_1 R_{mt} + \delta_2 RFX_t + u_t \quad (3\text{-}2)$$

where R_{it} is the firm's stock return, R_{mt} the PSI General return and RFX_t the exchange rate return. δ_2 estimates the exchange rate exposure. This model is named throughout the dissertation as "Standard Model".

Bartram and Karolyi (2006) propose another approach to measure the foreign exchange rate exposure and its variation between two periods. Their model is an extension of the model in equation (3-3), augmented with the exchange rate and a slope dummy variable that controls the euro effect on the exposure coefficient. The model is as follows:

$$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + u_t \quad (3\text{-}3)$$

where R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999. We name this model as "Slope Dummy Model".

When controlling for market returns, the model capture possible macroeconomic risk factors that affect the value of the firm. This raises a problem of a possible collinearity between market returns and exchange rate changes. If, as other macroeconomics variables, exchange rates affect market return then exchange rate changes will affect stock's value through systematic risk. To capture the possible currency effects on market returns, orthogonal market returns relative to the exchange rate can help overcome the collinearity problem. Bris et al. (2006) argue that with orthogonal market returns they "*(...) measure exchange rate exposure in the absolute sense, not relative to the market as a whole*."(p. 761).

To estimate orthogonal market returns, one have to regress the index returns on the exchange rate returns:

$$R_{mt} = \gamma_0 + \gamma_1 RFX_t + \varepsilon_t \quad (3\text{-}4)$$

where R_{mt} is the index return and RFX_t the exchange rate return. The residuals of that regression are used as the orthogonal market returns.

If γ_1 is not statistically different from zero, the orthogonal variable induces an error which will bias the estimates. Because of this, following the approach of Bris et al. (2004), we decided not to use orthogonal market returns when the p-value is higher than 10%.

3.2.3. Serial Correlation

After regressing the initial models, the errors are tested for serial correlation.[3] The primary method used is the Breusch-Godfrey Serial Correlation LM Test. The advantages of this test are that it may be used for higher order serial correlation and to test models with lagged dependent variables.

Besides the LM test, the serial correlation is analyzed with correlograms so that can be understood if it arises from an auto-regressive process (AR), from a moving-average process (MA) or both. Then, if necessary, the AR(q) and MA(q) terms are added to the model (ARIMA).

With respect to annual returns with overlapping monthly returns, the serial correlation is more likely. We analyze the severeness of serial correlation with correlograms and LM test.

3.2.4. Heteroskedasticity

With respect to heteroskedasticity, we follow the recommendation of Wooldridge (2006) and test for heteroskedasticity after correcting the model for the presence of serial correlation.[4] The test used is the Breusch-Pagan-Godfrey and it tests for the null hypothesis of homoskedasticity.

3 Ignoring the importance of serial correlation may lead to biased results, because, unlike heteroskedasticity, it affects the estimated coefficients beyond the standard errors.

4 p.275 and p.436

4. Results

4.1. Volatility of Stock Returns

Motivated by Bartram and Karolyi (2006) and Bartov et al. (1996), we test differences in stock volatility across periods, for each firm. The sample was divided into two periods, before and after the introduction of the Euro.

It is expected that stock return volatility has a positive relationship with foreign exchange rate volatility (Bartov et al., 1996). Firms with higher FX exposures are expected to have higher stock volatility when compared to others. This means that when exchange rate regimes shift to fixed exchange rates, the stock volatility of multinational firms should decrease when compared to non-multinationals. [1]

To test whether stock return volatility increased or decreased after the introduction of the Euro, we perform equality variance tests at the firm level. Further, we test whether volatilities are different for the two periods, using the Wilcoxon test.

Table A.1 reports the standard deviations in each period, at the firm level, along with the F-test of variance equality. The test rejects, with a confidence level of 90%, the null hypothesis of no changes for 14 out of 21 firms. The median of the standard deviations decreases from 0.1126 to 0.0941 after the introduction of the Euro. The p-value of the Wilcoxon median equality test is 0.0872, rejecting the null hypothesis. Thus, these results suggest that stock volatility decreased after 1999.

The evidence that individual stock return volatility decreased after the Euro is not in line with Bartram and Karolyi (2006). They compared the volatility of stock market returns in European countries, before (1990-1997) and after the Euro (1998-2001). Their estimates suggest that the variance of Portuguese stock returns more than doubled since the introduction of the Euro. There are some differences between the two studies: (i) the post-euro period in this study is much longer and have the same number of observations as the first, (ii) Bartram and Karolyi (2006) considered that the markets anticipated by one year the introduction of the Euro, while in this study it is considered the effective date (January 1999) and (iii) there could be differences between the two samples as well.

On the other hand, Billio and Pelizzon (2002) find that stock return volatility decreased in

1 Some authors also argue that return volatility of multinational firms, because they have more diversification opportunities, should increase after a shift to a fixed exchange rate regime in comparison with non-multinational firms (e.g. Bartram and Karolyi, 2006).

Spain and Italy, after the introduction of the Euro. They argue that in historical unstable economies like those two countries, is expectable that stock return volatility decreases "*(...)because of the convergence of the stochastic process of fundamentals towards that of the more stable European countries*".[2] Since Portugal fits that description, one can apply that interpretation to our findings.

Bartov et al. (1996) posit that after the collapse of the Bretton Woods system, stock return volatility increased for US domestic firms but it was higher for US multinationals. They argue that the change of exchange rate regime to floating rates and the macroeconomic instability contributed to those findings.[3]

The comparison of the results of the studies of Bartram and Karolyi (2006) and Bartov et al. (1996), suggests that the change to a fixed exchange rate regime decreases stock return volatility. Thus, reported increase of stock volatility after the introduction of the Euro, suggested by Bartram and Karolyi (2006), could not be driven by the change to a fixed exchange rate regime.[4]

2 Billio and Pelizzon (2002), p. 4

3 As noted by Bartram and Karolyi (2006) and Bartov et al. (1996), the change to flexible exchange rates, could have created new opportunities of diversification, which could have had a negative impact on stock volatility of multinational firms, when compared with other firms.

4 Bartram and Karolyi (2006) argue that there is "*...evidence that firms with greater Euro currency exposure (namely, those located in the Euro area) benefited most through the reduction in exchange rate risk as manifested in lower increases in stock return volatility*".

4.2. Market Betas

Table 1 reports the descriptive statistics of the estimated β_1 (market betas) and β_2 (change after the introduction of the Euro) for all firms in the sample. As expected, almost all of them (19 out of 21) have statistically significant market betas (β_1) with a confidence level of 99%, and the median is near one (1.01).[5] The median of β_2 tends to be closer to zero because negative and positive coefficients cancel each other. Even though, the median is -0.3437 and is statistically different from zero, according to the Wilcoxon sign rank test, and negative for 86% of the firms. Out of the three firms with positive β_2, only one is significant at 1% level of significance, while the other two have p-values above 0.50. These results strongly suggest that systematic risk of these stocks decreased after the introduction of the Euro and are in line with Bartram and Karolyi (2006). They also find that market betas decreased significantly after the introduction of the Euro.

Following Bartram and Karolyi (2006), we tested whether market betas reduction could stem from a decrease on financial leverage. Since financial leverage more than tripled after the introduction of the Euro, we reject that hypothesis.

Table 1. Descriptive Statistics of Market Betas.

$R_{it}=\beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \mu_t$

R_{it} is the market return of the firm, R_{mt} the PSI General return and $R_{mt}D_t$ the slope dummy variable that controls the model for the introduction of the Euro. β_1 corresponds to the market beta and β_2 estimates the market changes after the introduction of the Euro. The market beta is estimated by β_1 before the Euro and by $\beta_1 + \beta_2$ after the Euro.

	β_1	β_2
Mean	0.9789	-0.3271
Median	1.0143	-0.3437
Maximum	1.8059	1.6226
Minimum	0.0078	-1.1067
Std. Dev.	0.3876	0.5745
Negative changes after 1999		18

5 Wilcoxon signed rank test does not reject the hypothesis of the median being equal to 1.

4.3 Foreign Exchange Rate Exposures

4.3.1. Standard Model

The first approach to measure the foreign exchange rate exposures follows the traditional model, as explained in section 2 [equation (3-2)].

Before regressing the models, it is necessary to decide whether to use orthogonal market returns, as in Bris et al. (2004). A simple regression of the PSI General returns on the NEER, in the first period, yields a statistically significant coefficient (p-value of 0.0374). However, this regression is seriously affected by serial correlation which strongly biases the latter estimate. After controlling for an auto-regressive process of order one (AR(1)), the p-value of the coefficient γ_1 of equation (3-4) increases to 0.1990. In the second period, after controlling for serial correlation, the coefficient is, again, not statistically significant (p-value = 0.2821). Based on these results, we decided to use raw market returns.

Table 2 reports the descriptive statistics of exposure coefficients (δ_2) with individual samples and the t-statistics (wilcoxon signed rank) which test whether the mean (median) is equal to 0.[6] Table 3 reports the means and medians of FX exposures, with common samples, along with equality tests.

Only in the second period one rejects the hypothesis that the median of exposures is 0. Nevertheless, the median decreased from -0.36 to -0.80, but this is not statistically significant, according to Wilcoxox rank sum test. The percentage of negative FX exposures before (after) 1999 is 66,7% (67,6%), from which only one (one) stock is significantly exposed to foreign exchange rates. Moreover, in the first period, there are two statistically significant FX exposures, one positive and the other negative. With respect to the second period, there are three significant coefficients, one negative and two positives.

Correia (2009) also finds only few statistically significant exposures in a very similar sample, as well. With a significance level of 10%, his estimates suggest that there are three out of 36 statistically significant exposures between 2002 and 2007.

6 Individual samples means that in each period the number of firms is different.

Table A.2 separate firms whose net absolute FX exposure decreased after the euro from those whose net absolute FX exposure increased. Out of a sample of 21 firms, the net absolute exposure decreased in ten of them. The FX exposure of nine stocks shifted sign, four from positive to negative exposures and five in the opposite direction. These mixed results seem to suggest that there is no identifiable pattern of variations on FX exposure after the Euro in this sample.

The changes of exposure (Δ) reported on Table A.2 were computed the following way:

$$\Delta = |\beta_2|^{[1999;2007]} - |\beta_2|^{[1990;2007]}$$

The previous equation means that if the sign of exposure changed between periods, Δ will not be the difference of β_2 between periods but its difference in absolute value. It is important to address this issue to prevent misinterpretations.

Table 2. FX Exposures at the firm level with individual samples

$R_{it}=\delta_0 + \delta_1 R_{mt} + \delta_2 RFX_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General return and RFX_t the exchange rate return. δ_2 estimates the exchange rate exposure.

	δ_2		
	1990-1998	**1999-2007**	**1990-2007**
Mean	-0.4646	-1.1620	-1.2198
Median	-0.3606	-1.1464	-1.0328
Maximum	3.3211	6.6770	4.5628
Minimum	-4.0751	-6.5919	-6.5919
Std. Dev.	1.9067	2.8206	2.4143
t-statistic	0.2774	0.0221	0.0051
Wilcoxon signed rank	0.2813	0.0183	0.0048
Observations	21	34	34

Table 3. FX Exposures before and after the introduction of the Euro, with common samples.

$R_{it}=\delta_0 + \delta_1 R_{mt} + \delta_2 RFX_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General return and RFX_t the exchange rate return. δ_2 estimates the exchange rate exposure. The equality tests test whether one can reject the hypothesis that the means and medians are equal across the two periods.

		δ_2	
	N	**Mean**	**Median**
1990-1998	21	-0.4646	-0.3606
1999-2007	21	-0.6070	-0.8055
Equality tests			
Anova F-Test (Mean)		0.8414	
Wilcoxon adj (Median)		0.7247	

4.3.2. Slope Dummy Model

Table A.3 reports the estimates of the slope dummy model. β_1 and β_2 estimates are not reported because they are very similar to those estimated by equation (3-2). Firms with positive FX exposures, before 1999 (β_3), are on the top and firms with negative FX exposures are on the bottom. Table 4 presents the descriptive statistics of the full sample.

There are 14 (7) stocks with negative (positive) exposures before 1999, which is not in line with Bartram and Karolyi (2006).[7] There are only two firms with significant FX exposures and three with significant changes after 1999. The median of β_3, according to Wilcoxon signed rank, is not statistically different from 0. According to the Wald Test, the hypothesis that $\beta_3+\beta_4$ is equal to zero is rejected only in three firms.

The median of β_4 is clearly negative for firms with positive β_3 (-1,7334) and positive for firms with negative β_3 (0.5719). This suggests that the change in FX exposure is mean-reverse toward zero. Wilcoxon test (Table 5) rejects the hypothesis that the median of β_4 is the same for firms with positive and negative exposures before 1999, with a confidence level of 90%.[8]

Table 4 shows that the mean and the median of β_4 have opposite signs. This evidences the presence of at least one negative outlier, which is correct. It also highlights the fact that the median is robust to outliers, unlike the mean.

These findings are, once more, consistent with Correia (2009). The number of significant FX exposures that he estimates from 2002 to 2007 is the same we find after the introduction of the Euro (three). With respect to the sign of exposures, the results are inconclusive.

7 Bartram and Karolyi (2006) estimates suggest that there were more firms with statistically significant negative exposures to a depreciation of the domestic currency,

8 With respect to β_3, results have some similarities with those estimated for δ_2. There are 14 negative exposures and the number of statistically significant coefficients is the same.

Table 4. Descriptive Statistics - FX exposures

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	β_3	β_4
Mean	-0.4710	-0.1197
Median	-0.5184	0.3451
Maximum	2.8449	4.8632
Minimum	-4.0552	-6.9323
Std. Dev.	1.8787	3.0194
t-statistic	0.2736	0.0509
wilcoxon signed rank	0.2807	0.0591

Table 5. FX Exposure changes after 1999.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	β_4	
	Mean	**Median**
Positive FX exposures before 1999	-1.5333	-1.7334
Negative FX exposures before 1999	0.5872	0.5719
Anova F-Test (Mean)	0.1325	
Wilcoxon (Median)	0.0932	

4.3.3. Annual Returns

One possible reason for the previous insignificant results, may be the possibility that investors do not perceive the effects of exchange rate changes on the value of stocks when those changes occur, but only when financial reports are publicly disclosed.

Bodnar and Wong (2000) find that the FX exposure of US firms increases monotonically with the return horizon. However, they argue that the percentage of statistically significant FX exposures only increases noticeably with return horizons of 24 months or longer. This suggests that "*(...) may be a long lag time until the full incorporation of exchange rate changes into firm value"* (Bodnar and Wong ,2000, p.16). Chow et al. (1997), on the other hand, only find noticeable increases at three or five year horizons. Muller and Verschoor (2006), in a sample of European firms, also find that the number of statistically significant FX exposure coefficients increase with the return horizon.

In this section, we use annual returns with overlapping monthly returns. The problems that arise from the use of overlapping observations have been a matter of discussion among many researchers (Harri and Brorsen, 2009). Using overlapping observations creates a moving average error term, making the parameters estimated by OLS inefficient and biased. All estimates are analyzed using correlograms to identify whether the serial correlation stems from the existence of an AR process or MA process. To correct these processes are used ARIMA models.

We use the "Slope Dummy Model". On the top of the Table A.4 are reported the estimates at firm level and on the bottom the descriptive statistics along with statistic tests and the number of significant coefficients in each period.

T-statistics and Wilcoxon signed rank only reject the null hypothesis for β_1. That is, one cannot reject the hypothesis that the means (medians) of the other three coefficients are zero. There are only three stocks with significant FX exposures before the Euro (all of them negative) and five (three positive and two negative) with statistically significant changes after 1999.

In comparison with monthly returns, there is one more statistically significant FX exposure before the introduction of the Euro, two more significant changes after 1999 and the three significant FX exposures are negative. After 1999, net absolute FX exposures decreased about 18% with annual returns whereas with monthly returns increased about 4,26%.

These results suggest that before the introduction of the Euro, significant FX exposures were negative.

4.3.4. Foreign Exchange Rate Exposures before the Euro

Portugal entered the ECU basket of currencies in 1989, but was only accepted into the European Exchange Rate Mechanism (ERM) in April 1992. In the previous three years, the main goal of Portuguese monetary policies was to defend a strong escudo, shadowing the Deutsche Mark (Macedo et al. 1999). When joining the ERM, Portuguese authorities committed themselves to respect the ERM's exchange rate fluctuation bands, 2,5% around the central rates until July 1993. In September 1992 occurred a currency crisis which led the Pound Sterling and Lira out of the ERM. As a consequence of other ERM currencies devaluations, such as the Irish Punt (10%), Peseta (8%) and Escudo (6,5%), European governments opted to widen ERM's fluctuation bands to 15% (Jonung and Drea, 2010).

Since 1994, European Union governments implemented strong measures to meet the convergence criteria that were set in the Maastricht treaty, which would allow countries to adopt the Euro as part of the first group, in January 1st, 1999. One should expect that, within this period, escudo rates stabilized around the DM.

In this section, the first period (before the Euro) is divided into two sub-periods, one from 1990 to 1993 and the other from 1994 to 1998.[9] The objective is to identify possible foreign exchange rate exposure changes that might have occurred in the second period, as a consequence of the convergence criteria.

Figure 1. NEER returns between 1990 and 2007

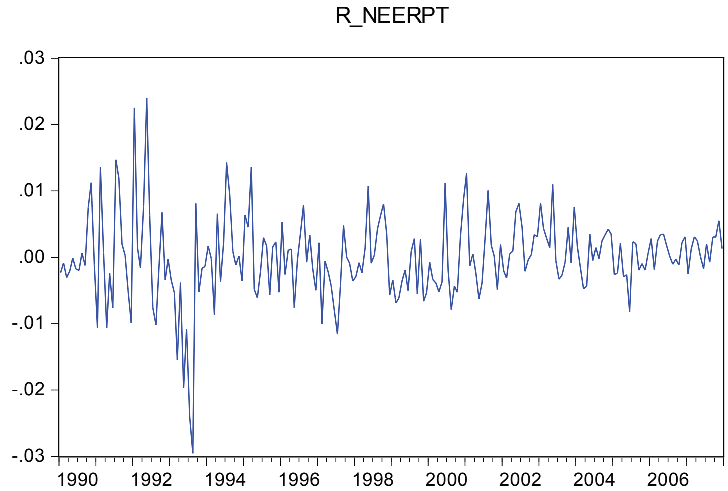


Figure 1 suggests that the Portuguese Nominal Effective Exchange Rate (NEER) volatility

9 One caveat of dividing the first period into two sub-periods is that between 1990 to 1993 stock market returns are only available for 14 firms.

decreased since 1994. It is expectable thus that this decrease might have reduced the foreign exchange rate exposure of Portuguese stocks in our sample.

Table 6 shows that the standard deviation of NEER decreased after 1994 and that the hypothesis that the variance is equal across the two periods is rejected.

Table A.5 shows the estimates of the Slope Dummy Model. As expected, most stocks have statistically significant market betas (with the exception of two firms), The results suggest that market risk decreased after 1994 (β_2), but only six out of 14 are significant, all of them negative.

The median of FX exposures before 1994 (β_3) is negative and the median of FX exposures changes (β_4) is positive. There are three significant FX exposures (all of them negative) and three FX exposure changes after 1994 (all of them positive). The hypothesis that FX exposure is equal to zero after 1994 (β_3+β_4) is rejected only in two firms.

The systematic risk reduction is in line with the findings of Bartram and Karolyi (2006) and Bartov et. al (1996) because the convergence criteria almost pegged escudo to the ECU, which is comparable to a change to a fixed exchange rate regime. However, this reduction may be a consequence of other economic phenomenons besides the exchange rate volatility. With respect to FX exposures, the results are inconclusive.

Table 6. NEER's standard deviation before and after Portugal entered the ERM.

Nominal Effective Exchange Rate	
	St. Deviation
1990-1993	0.0453
1994-1998	0.0335
Variance Equality Tests	p-value
Bartlett	0.0288

4.4. Bilateral Exchange Rates

In the previous section we estimated exchange rate exposures of Portuguese firms with the nominal effective exchange rate (NEER). In this section, the NEER is replaced by the US Dollar, Yen and the Pound Sterling, all of them used in Muller and Verschoor (2006), and the Real.

The bilateral exchange rates are defined in terms of the foreign currency, that is, the foreign currency's value of one Euro or Escudo. If the Euro or Escudo appreciates (depreciates), the exchange rate increases (decreases).

Again, there is the question whether to use orthogonal market returns. We regressed the market returns on the bilateral exchange rate returns. The estimates were then corrected for serial correlation and heteroskedasticity. We only find statistically significant coefficients with the PTE/USD and PTE/BRA exchange rates. Therefore, we decided to use orthogonal market returns only with those two currencies. The model is also regressed with the raw market returns, so that the estimates can be compared.

Table A.6, Table A.7, Table A.8 and Table A.9 report the coefficient estimates along with their p-values, for each bilateral exchange rate. On the bottom we show the descriptive statistics, statistic tests and the number of significant FX exposures.

4.4.1. US Dollar

There are five (three) stocks with significant exposures (changes in exposure after 1999) to the US Dollar.[10] That is, the number of significant FX exposures more than doubled in comparison to the NEER.

Out of 21 firms in the sample, there are 17 stocks (81%) with negative FX exposures and only negative coefficients are significant. On the other hand, there are 13 positive FX exposure changes after 1999 and significant exposures are positive. These estimates suggest that significant FX exposures to the US Dollar were negative before 1999 and that absolute exposures decreased after 1999.

As expected, we find more statistically significant FX exposure coefficients with orthogonal market returns than with raw market returns. This results from the fact that with raw market returns the market beta captures the impact of exchange rates changes

10 However, with non-orthogonal market returns (not reported), there are only three firms with exposure coefficients that are statistically significant at a significance level below 0.15.

on market risk.

The observed reduction of exposure to the US Dollar is consistent with the increased use of financial hedging in the last decade (Chue and Cook, 2008; Correia, 2009).

4.4.2. Yen

With respect to the Yen, there are three significant FX exposure coefficients (β_3) before 1999 and four significant FX exposure changes after 1999. All the three firms with significant FX exposure coefficients, have negative FX exposures (β_3) and positive changes after 1999 (β_4). As a consequence, their net absolute exposure to the yen decreased after 1999.

The median of net absolute exposures strongly decreased since 1999, from 0.36 to 0.20, which is statistically significant (Table 7).

Table 7. Net absolute exposures to the Yen

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999. Net absolute exposures before 1999 are estimated by $|\beta_3|$, while net absolute exposures after 1999 are estimated by $|\beta_3 + \beta_4|$.

	Mean	Median
Net absolute exposures before 1999	0.4393	0.3572
Net absolute exposures after 1999	0.2261	0.1957
Anova F-Test (Mean)	0.0133	
Wilcoxon rank sum	0.0221	

4.4.3. Pound Sterling

There are more significant coefficients than with the Yen, as expected (Muller and Verschoor 2006). All firms with significant exposure coefficients (four) have negative exposures and positive changes after 1999 (β_4), all of which with significance levels below 0.10. The median of net absolute exposures decreased from 0.46 to 0.23. As with the Yen, this difference is statistically significant according to Wilcoxon test (Table 8). With respect to the median of β_4, one cannot reject the hypothesis that it is zero.

Table 8. Net absolute exposures to the Pound Sterling

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.Net absolute exposures before 1999 are estimated by $|\beta_3|$, while net absolute exposures after 1999 are estimated by $|\beta_3 + \beta_4|$.

	Mean	Median
Net absolute exposures before 1999	0.4961	0.4649
Net absolute exposures after 1999	0.3209	0.2260
Anova F-Test (Mean)	0.1004	
Wilcoxon (Median)	0.0783	

4.4.4. Real

With respect to Real, the estimates have additional difficulties. Since 1989, Brazil has changed its currency three times: cruzado novo (1989-1990), Cruzeiro (1990-1993), Cruzeiro Real (1993-1994) and Real since then. The change in 1990 was merely a change of name, but in August 1993 a unity of the new Cruzeiro Real was equivalent to 1000.00 unities of the former Cruzeiro. In May 1994, the name and the value was again changed to Real, with a value of 2750.00 unities of the former Cruzeiro Real.

To rule out the noise induced by several changes of unity of measure, the FX exposure to the Brazilian currency is only measured since June 1994, one month after the introduction of the Real.

There are seven firms (33,3%) with statistically significant exposures (negative exposures), of which, all of them have positive changes in FX exposure after 1999. The medians of β_3 and β_4 are negative and positive and the hypotheses of them being equal to zero are rejected.

With respect to net absolute exposures, the median decreases from 0.5058 to 0.1683 and according to Wilcoxon test, these differences are statistically significant even with a confidence level of 99%.

One special note to the fact that the number of statistically significant market betas (β_1) is lower than those estimated with other measures of exchange rates. This is a consequence of using orthogonal market returns. The same did not happen with the US Dollar because the correlation between the Real and the Psi General is higher than the correlation between the Portuguese index and the American currency.

Table 9. Net exposures to the Real

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999. Net absolute exposures before 1999 are estimated by $|\beta_3|$, while net absolute exposures after 1999 are estimated by $|\beta_3 + \beta_4|$.

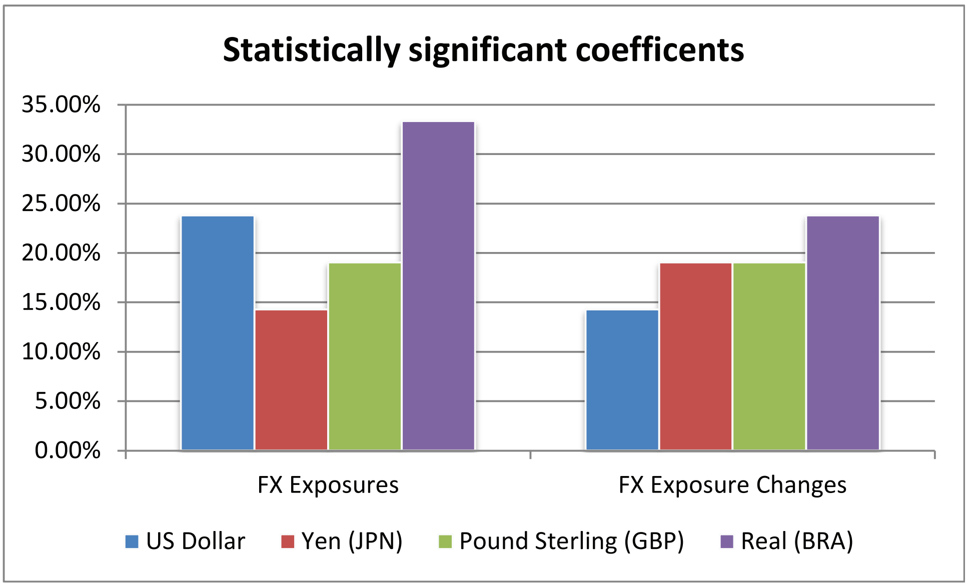
	Mean	Median
Net absolute exposures before 1999	0.5635	0.5058
Net absolute exposures after 1999	0.2381	0.1683
Anova F-Test (Mean)	0.0007	
Wilcoxon (Median)	0.0007	

Comparative Analysis

These results suggest that for the Portuguese stocks in our sample, the bilateral exchange rates are more efficient to measure FX exposures than the NEER, which is in line with the findings of Dominguez and Tesar (2006). They argue that effective exchange rates might be less efficient to estimate exposures because stocks have opposite exposures to different currencies. There is also some evidence that some stock returns in our sample were negatively exposed to the Real, US Dollar, Pound Sterling and Yen before 1999, and that those FX exposures decreased after the introduction of the Euro.

The results also suggest that stocks in our sample are more exposed to the Real than to the other three currencies. One possible explanation for these results might be the fact that the value of Real has been strongly correlated with the US Dollar since its inception (the correlation coefficient between the two currencies is 0.41), particularly before the introduction of the Euro. That is, some of the estimated exposure to the Real can result from the FX exposure to the US Dollar, which may explain the higher number of significant coefficients. It is important to keep in mind that a significant FX exposure does not mean that the firm value is directly affected by the exchange rate volatility (refer to Jorion,1990).

Figure 2. **Statistically significant coefficients with a confidence level of 90%.**



To test the null hypothesis that FX exposures are equal to zero ($\beta_3+\beta_4$) after the introduction of the Euro, we performed Wald Tests. The null hypothesis is rejected for four firms with the US Dollar, two firms with the Yen, one firm with the Pound Sterling and ten firms with the Real. These results might suggest that, in our sample, after the Introduction of the Euro, the number of stocks in our sample that were significantly exposed to the Pound Sterling decreased more than to the other currencies. This may result from the fact that the correlation between the British currency and the Euro is expected to be higher than with the other currencies.

Correia (2009) estimate FX exposures to the US Dollar, the Pound Sterling, the Swiss Franc and the Real, from 2002 to 2007. Out of a sample of 36 firms, he found three statistically significant exposures to the US Dollar, four to the Swiss Franc, nine to the Pound Sterling and four to the Real. These results are not in line with our findings. The fact that the length of the periods are different, might explain these differences.

5. Cross-sectional analyses

5.1. Size of Firms

Bartram and Karolyi (2006) suggest that larger firms have higher market betas and lower foreign exchange rate exposures.[1] Dominguez and Tesar (2006), Bartov et al. (1996) and Stulz and Griffin (2001) also suggest that smaller firms have higher exposures than larger firms. On the other hand, Muller and Verschoor (2006) suggest that larger European firms are more exposed to the US Dollar than smaller ones.

In this section, we evaluate whether size plays a role in the cross-sectional variation of foreign exchange rate exposures and market betas, by comparing large-caps, medium-caps and small-cap firms.

5.1.1. Market Betas

Table 10 shows that there are no statistically significant differences of market betas or of their changes after the Euro, across different size groups.

While our results are inconclusive, Bartram and Karolyi (2006) suggest that market risk of small firms was lower and foreign exposures were higher before the Euro. Muller and Verschoor (2009) suggest that small American firms suffered higher increases in their market betas as a consequence of the Asian Crisis than the larger ones.

5.1.2. Foreign Exchange Rate Exposure and the Size

5.1.2.1. Nominal Effective Exchange Rate (NEER)

Table 11 reports means and medians of FX exposures and the changes after the introduction of the Euro, for large, medium and small-caps. Median Chi-square tests reject the hypothesis that there are no differences across firm sizes with the two variables. The median of FX exposures for large-caps is positive and negative for medium and small caps. With respect to FX exposure changes after 1999, the medians have opposite signs, suggesting that FX exposures reversed toward zero.

1 As noted by Muller and Verschoor (2009), on the one hand larger firms are more likely to hedge currency risks because of economies of scale, but on the other hand smaller firms have more costs of financial distress, which should incentivize them to hedge.

Table 12 shows that large-cap firms have a higher percentage of significant FX exposures and small caps, the lowest. On the other hand, negative exposures are more common within small and medium-cap firms, than in the large-cap firms.

It is puzzling that the median of FX exposures are positive for large-caps in the first period. Bodnar and Wong (2003), for instance, argue that negative FX exposures are more common in larger firms. They suggest that smaller firms usually are more domestic oriented and so they benefit from an appreciation of the domestic currency since imports become less expensive. However, as mentioned on the methodology section, they also argue that value-weighted indices soak up the higher negative exposures that larger firms tend to have in comparison to smaller firms.

Table 10. Market Betas categorized by size

$R_{it}=\beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \mu_t$

R_{it} is the stock return of the firm, R_{mt} the PSI General return and $R_{mt}D_t$ the slope dummy variable that controls the model for the introduction of the Euro. β_1 corresponds to the market beta and β_2 is the marginal effect of the introduction of the Euro in the market beta. The market beta is estimated by β_1 before the Euro and by $\beta_1 + \beta_2$ after the Euro.

	Large Caps	Medium Caps	Small Caps
Mean	1.1363	1.0998	0.8904
Median	1.0507	0.8405	1.0143
Std. Dev.	0.3981	0.6187	0.3337
Equality Tests - p-values			
Anova F-Test (Mean)		0.4294	
Median Chi-square		0.7543	
Change of Market Betas after 1999M01			
	Large Caps	Medium Caps	Small Caps
Mean	-0.3719	-0.5125	-0.2671
Median	-0.5453	-0.3437	-0.3184
Std. Dev.	0.4390	0.5304	0.6525
Equality Tests - p-values			
Anova F-Test (Mean)		0.8020	
Median Chi-square		0.7543	

Table 11. FX exposures categorized by size

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	FX Exposures Befores 1999		*FX Changes after 1999*	
	Mean	***Median***	***Mean***	***Median***
Large Caps (A)	*1.0401*	*1.7638*	*-1.4297*	*-1.4712*
Med-Caps (B)	*-1.6810*	*-1.8202*	*1.0501*	*0.9470*
Small-Caps (C)	*-0.7730*	*-0.7826*	*0.1143*	*0.3829*
Equality Tests - p-values				
Anova F-Test (Mean)		*0.0838*		*0.5032*
Med. Chi-square		*0.0889*		*0.0179*

Table 12. Significant and negative FX Exposures

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

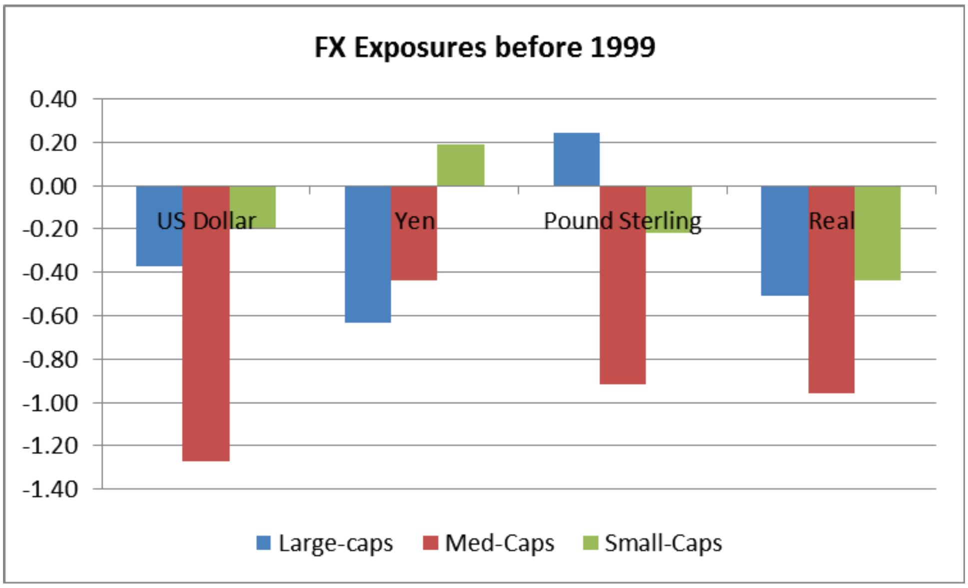
R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	Large-caps	**Med-caps**	**Small-caps**
Number of negatives	2	3	9
% negatives	40.00%	100.00%	69.23%
p-value <0,10	1	0	1
%p-value <0,10	20.00%	0.00%	7.69%

5.1.2.2. Bilateral Exchange Rates

Figure 3 shows that for most bilateral exchange rates, the FX exposures were negative before 1999, across different size groups. There are two exceptions, the exposure of small-caps firms to the Yen and the exposure of large-caps to the Pound Sterling, the only two cases the Chi-square tests reject the null hypothesis (Table 13). Nevertheless, Figure 3 suggests that small-cap firms, in our sample, were less exposed to bilateral exchanges rates than the other two size groups.

Figure 3. FX Exposures (medians) before 1999, categorized by size



With respect to FX exposure changes after 1999 (Figure 4), exposures inverted toward zero across all size groups, with the exception of FX exposure of large-caps to the Real. The changes, with the exception of the latter, seem to be proportional to the exposures before 1999 (with opposite signs). According to Chi-square tests, only the changes of exposure to the Yen do not have statistically significant differences across size groups.

Once again, it is important to analyse FX net absolute exposures, so that one can understand whether FX exposures decreased after 1999 or simply changed their signs. Figure 5 shows that FX net absolute exposures decreased across all size groups, except exposure of small-caps to the US Dollar. This may be a consequence of a possible FX exposure increase of small firms to countries that use the US Dollar as primary international trade currency, of which Brazil might be an example.

Figure 4. FX exposure changes after 1999, categorized by size

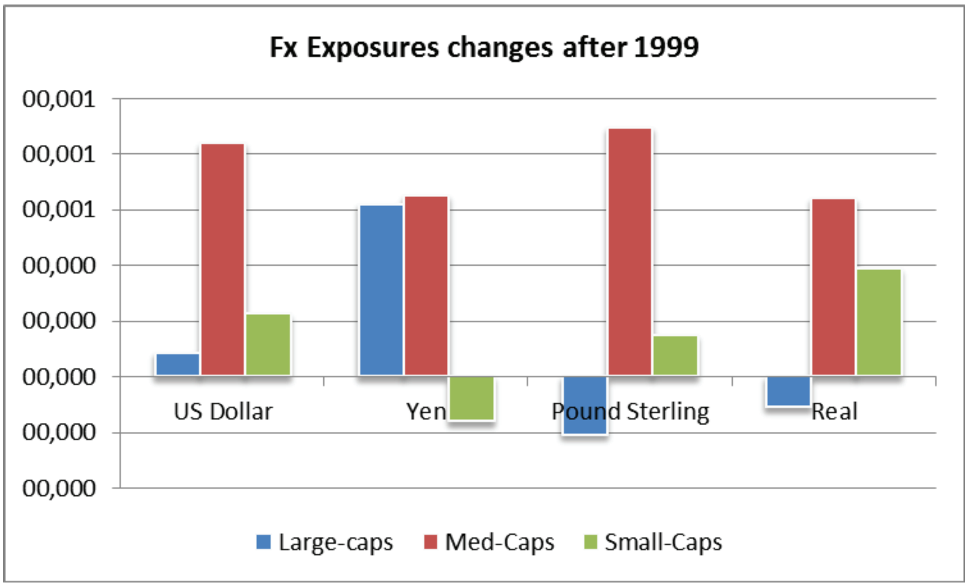


Figure 5. FX net absolute exposure changes after 1999

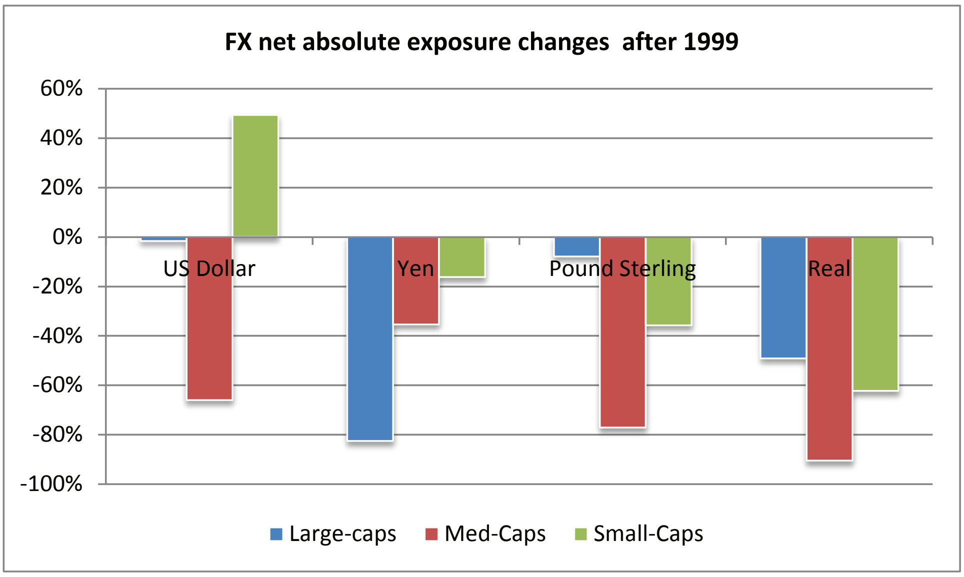


Table 13. Exposures to bilateral exchange rates categorized by size of firms

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	FX Expores before 1999				Changes in FX exposures after 1999			
	Large-caps	Med-Caps	Small-Caps	Chi-square	Large-caps	Med-Caps	Small-Caps	Chi-square
US Dollar	-0.3699	-1.2692	-0.1945	0.1456	0.0861	0.8381	0.2249	0.0889
Yen	-0.6308	-0.4354	0.1913	0.0028	0.6190	0.6493	-0.1615	0.1341
Pound Sterling	0.2454	-0.9140	-0.2176	0.0131	-0.2089	0.8940	0.1482	0.0179
Real	-0.5058	-0.9553	-0.4404	0.7543	-0.1103	0.6396	0.3862	0.0179

Table 14. Net absolute exposures to bilateral exchange rates categorized by size of firms.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	FX net exposures before 1999				FX net exposures after 1999			
	Large-caps	Med-Caps	Small-Caps	Chi-square	Large-caps	Med-Caps	Small-Caps	Chi-square
US Dollar	0.3699	1.2692	0.1945	0.1456	0.3637	0.4311	0.2906	0.5541
Yen	0.6308	0.4354	0.2347	0.1341	0.1099	0.2814	0.1965	0.0179
Pound Sterling	0.2454	0.9140	0.3797	0.1456	0.2260	0.2086	0.2440	0.7543
Real	0.5058	0.9553	0.4404	0.7543	0.2572	0.0899	0.1660	0.2485

5.2. Foreign Sales

5.2.1. NEER

The ratio of foreign sales as a percentage of total sales, has been considered by most literature as relevant to explain FX exposures (eg, Williamson, 2001). Following the approach of Bartram and Karolyi (2006), firms were classified as above-median and below-median, in respect to the proportion of foreign sales on their total sales.[2] [3] Because this data was not available for all firms, our sample was reduced to 13 stocks. Again, one should enhance the fact that sample size is very small.

Table 15 reports the medians of FX exposures for each group. Before 1999 (after 1999), in firms whose foreign sales percentage is below-median, the median of FX exposures is -0.52 (-0.46) and in the remaining 0.07 (-0.60).

In the first period, they suggest that firms that have lower percentage of foreign sales, are more exposed to exchange rate variations (negative exposures) than firms with higher percentage of foreign sales (positive exposures). In the second period the results are more consistent with economic predictions because they suggest that above-median firms are more negatively exposed to foreign exchange rates than below-median firms. Nevertheless, since Wilcoxon's p-values are very high for both periods, one cannot reject the hypothesis that there are no differences across both groups over both periods.

Table 15. FX exposures categorized by foreign sales as a percentage of total sales.

$$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	1990-1998	1999-2007
Below-median	-0.5184	-0.4642
Above-median	0.0794	-0.6040
Equality tests		
Wilcoxon	0.6171	0.9436

If the results of the first period were significant, they would not be consistent with Bodnar and Wong (2003). They find strong evidence that negative FX exposures are positively related with the percentage of foreign sales. Jorion (1990) noted that exchange rates also affect domestic firms and pointed three possible factors. Out of the three factors that are

2 Bartram and Karolyi (2006) used this classification in respect to total sales.

3 It was computed the mean of the percentage of foreign sales in each period, to decide where each firm fits.

pointed by Jorion, only the third could explain the results of the first period. Domestic firms can be negatively affected by an appreciation of domestic currency because foreign goods become cheaper, increasing the competition in the domestic market (domestic competition from foreign firms increase). However, this should affect firms with foreign sales in the same way. An appreciation should turn domestic goods more expensive in terms of foreign currencies, decreasing the foreign demand for domestic goods.

Nance et al. (1993), cited by Muller and Verschoor (2009), argue that larger firms hedge more due to economies of scale. That is, firms more exposed to foreign markets may hedge more because their marginal gains from hedging are higher (they have more to loose). Firms that are less exposed to foreign markets, because their main activity does not depend on foreign sales, perceive that the benefits of hedging do not surpass the costs.

Bartram and Karolyi (2006) suggest that after the introduction of the Euro exchange rate exposures decreased more for firms with higher proportion of foreign sales and that those firms had higher exposures before the Euro.

Table 16 reports the medians of net absolute FX exposures. The differences are, once more, not statistically significant and not consistent across the two periods. That is, we find no evidence that, in our sample, foreign sales affect the FX exposure.

Table 16. FX net absolute exposures categorized by foreign sales as a % of total sales.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999. The net absolute exposure after 1999 is estimated by $|\beta_3+\beta_4|$.

	1990-1998	1999-2007
Below-median	1.7638	1.0478
Above-median	0.8316	1.2959
Equality tests		
Wilcoxon	0.2840	0.9431

5.2.2. Bilateral Exchange Rates

Table 17 reports the medians of FX exposures, before 1999, for each currency. On the bottom of the table are reported the p-values of equality tests.

Table 17. FX exposures, before 1999, categorized by foreign sales as a % of total sales.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	USD	JPN	GBP	BRA
Below-median	-0.3699	-0.1781	-0.1864	-0.5332
Above-median	-0.5147	-0.6308	-0.0875	-0.5058
Equality tests				
Wilcoxon	1.0000	0.2013	0.7983	0.7015
Med. Chi-square	0.5930	0.1088	0.5930	0.5930

Above-median firms have higher exposures to the USD Dollar and to the YEN and lower to the British Pound and Real. All medians are negative and the differences are not statistically significant.

Table 18 reports the medians of exposures changes after 1999. It suggests that FX exposure coefficients of above-median firms had larger changes than those of below-median firms, with the exception of the exposure to the USD.[4]

Table 18. FX exposures changes after 1999, categorized by foreign sales as a % of total sales.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	USD	JPN	GBP	BRA
Below-median	0.3865	0.1011	0.0514	0.1941
Above-median	0.2249	0.6190	0.0652	0.3710
Equality tests				
Wilcoxon	0.7015	0.1599	1.0000	0.7983
Med. Chi-square	0.5930	0.1088	0.5930	0.5930

The fact that above-median firms changes of exposure were higher, may be an evidence that those firms increased the use of hedging after 1999, in comparison with other firms. If that is true, the net absolute exposure of above-median firms should have decreased more than the net absolute exposure of below-median firms, after 1999, which is corroborated by Table 19.[5] The net absolute exposure of above-median firms decreased more than the net absolute exposure of below-median firms, which is in line with Bartram and Karolyi (2006) findings, though not statistically significant.

4 Because the medians of exposure coefficients, before 1999, are negative, this may be an evidence that net absolute exposures decreased.

5 Correia (2009) presents some evidence that the use of derivatives is related with lower FX exposures.

Table 19. FX net absolute exposure changes after 1999

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

FX net absolute exposure changes = $|\beta_3+\beta_4| - |\beta_3|$

	USD	JPN	GBP	BRA
Below-median	0.0924	-0.1615	-0.0605	-0.1102
Above-median	-0.0975	-0.5509	-0.2089	-0.3367
Equality tests				
Wilcoxon	0.7983	0.0409	0.7983	0.5229
Med. Chi-square	0.5930	0.1088	0.5930	0.5930

6. Conclusions

This research presents evidence that after the introduction of the Euro the systematic risk of Portuguese firms decreased, which should have affected the cost of capital. One of the consequences was that the capital structure of most firms became highly leveraged. With respect to foreign exchange rate exposures, in line with most studies, particularly with Correia (2009), the estimates are statistically very weak. With the NEER, the maximum number of statistically significant exposures we estimate occur when we use annual returns (14%). Moreover, with annual returns, most of the statistically significant coefficients are negative, which suggests that most stocks in our sample are negatively exposed to an appreciation of the Euro/Escudo. Results also suggest that foreign exchange rate exposures might have decreased after the Euro.[1]

We present evidence, also, that the use of bilateral exchange rates provides better results than the use of effective exchange rates. With the US Dollar and the Real, the percentage of statistically significant exposures is 29% and 33%, all of them negative. These results suggest that Portuguese stocks that are significantly exposed to those currencies benefit from the depreciation of the Euro/Escudo. The number of significant exposures to bilateral exchange rates seem to had decreased significantly since 1999, which can stem from the introduction of the Euro and from the increase in the usage of derivatives (Correia, 2009; Chue and Cook, 2008).[2]

Correia (2009) find some evidence that firms that are more dependent on exports might have lower exposures. With respect to that matter, our results are inconclusive.

It would be important that future studies take in consideration disaggregated data about costs and revenues in different currencies. Moreover, following the evidence suggested by this dissertation and by previous studies (eg Bartov et al.,1994), that the number of significant FX exposures increases with the return horizon, a study about foreign exchange rate exposures with returns longer than one year could be enlightening. Furthermore, following Aggarwal and Harper (2010), our study could be complemented with foreign exchange rate exposures estimated with the three factor model. It could be useful to understand if that model yields stronger results than the model used in this dissertation.

Two important factors that determine exchange rate exposures are the competitiveness of the industry and the pass-through coefficient. Future studies might investigate whether

1 According to the estimates computed with annual returns.

2 We should keep in mind that FX exposures do not measure a causality relation between exchange rates and stock returns.

stock returns within industries that produce goods or services that are substitutable have higher FX exposures than firms within industries that produce goods with low price elasticity of demand.

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Annexes

Table A.1. Standard deviations of stock returns and variance equality *F*-test statistics.
F-test statistics test if the variances of the two periods are equal, at the firm level.

Firms	**1990-1998**	**1999-2007**	***F*-test**
Cimenteira	0.0945	0.0583	0.0002
Compta	0.0581	0.1513	0.0000
Corticeira	0.1124	0.0614	0.0000
Estoril	0.1126	0.0535	0.0000
Fisipe	0.1215	0.1739	0.0003
Immob	0.1189	0.1019	0.1124
Inapa	0.1106	0.0575	0.0000
Jeronimo	0.1153	0.0877	0.0050
lisgrafica	0.1603	0.4384	0.0000
Mota	0.0939	0.1018	0.5231
Orey	0.1117	0.1666	0.0000
Papelaria	0.1437	0.0749	0.0000
Portucel	0.1043	0.0674	0.0021
PT	0.1157	0.0855	0.0301
Semapa	0.0808	0.0733	0.4906
Soares	0.1294	0.1133	0.1705
Sonae Indústria	0.1652	0.0941	0.0000
Sonae SGPS	0.1322	0.1146	0.1411
Sumol	0.1284	0.1298	0.9143
Toyota	0.0873	0.0632	0.0009
Vista Alegre	0.1098	0.1045	0.6045
Descriptive Statistics			
Mean	0.1146	0.1130	0.1426
Median	0.1126	0.0941	0.0009
Maximum	0.1652	0.4384	0.9143
Minimum	0.0581	0.0535	0.0000

Table A.2. Net absolute exposures changes after 1999

$R_{it}=\beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \mu_t$

R_{it} is the stock return of the firm, R_{mt} the PSI General return and $R_{mt}D_t$ the slope dummy variable that controls the model for the introduction of the Euro. β_1 corresponds to the market beta and β_2 is the marginal effect of the introduction of the Euro in the market beta. The market beta is estimated by β_1 before the Euro and by $\beta_1 + \beta_2$ after the Euro.

Δ- Firms whose net absolute exposure decreased after 1999. Δ+ Firms whose net absolute exposure increased after 1999.

	Δ-	**Δ+**	**Signs**	
			1990-1998	**1999-2007**
Cimenteira	-1.8747		+	+
Compta		4.1987	-	-
Corticeira		0.0150	-	+
Estoril	-0.5839		-	-
Fisipe		4.9516	+	-
Immob	-0.3110		-	-
Inapa	-3.7406		-	+
Jeronimo	-0.1030		+	+
lisgrafica		4.6956	+	+
Mota		0.5437	-	+
Orey		0.6195	-	-
Papelaria	-3.6900		-	+
Portucel		1.7061	-	-
PT	-2.7452		+	-
Semapa	-0.6176		-	-
Soares		0.7269	+	-
Sonae Indústria	-0.9953		-	-
Sonae SGPS	-0.2017		-	-
Sumol		3.7912	-	-
Toyota		2.3464	-	+
Vista Alegre		0.6614	+	-
Mean	-1.4863	2.2051		
Median	-0.8065	1.7061		
Changes of sign			9	
Number of changes to Positive Exposure			5	
Number of changes to Negative Exposure			4	

Table A.3. Estimates of Slope Dummy Model

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999. Firms are classified according to the sign of FX exposures before 1999.

β_3^+	β_3	β_4
Cimenteira	2.3218	-1.7334
Fisipe	1.4112	-6.9323
Jeronimo	1.7638	-0.2767
lisgrafica	1.8628	4.8632
PT	2.8449	-3.1795
Soares	0.5065	-1.5053
Vista Alegre	0.3999	-1.9694
Median	**1.7638**	**-1.7334**

β_3^-		
Compta	-0.9611	-4.3988
Corticeira	-1.1567	2.1791
Estoril	-1.0017	0.3829
Immobl	-1.8182	0.3451
Inapa	-3.9812	4.1199
Mota	-0.5184	1.5662
Orey	-0.7826	0.5068
Papelaria	-4.0552	4.5491
Portucel	-0.2412	-1.4712
Semapa	-2.7045	0.637
Sonae Indústria	-1.8202	0.947
Sonae SGPS	-1.4886	-0.4876
Sumol	-0.1412	-3.7134
Toyota	-0.3312	3.0582
Median	**-1.0792**	**0.5719**

Table A.4. Estimates for Annual Returns with overlapping monthly returns.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the residual exchange rate exposure before 1999 and β_4 FX exposure changes after 1999.

	β_1		β_2		β_3		β_4	
Cimenteira	0.7975	0.0000	-0.3263	0.0290	2.2834	0.3157	-3.1395	0.1792
Compta	0.1517	0.1852	1.0827	0.1126	-0.5998	0.4748	-2.3537	0.2402
Corticeira	1.1287	0.0000	-0.4968	0.0076	-1.1559	0.3217	0.8897	0.6551
Estoril	1.0255	0.0000	-0.5404	0.0031	-1.2002	0.3412	-3.4262	0.0755
Fisipe	0.7351	0.0001	-0.2033	0.4559	-0.6339	0.7170	-3.8263	0.2067
Immob	0.3805	0.0370	0.0140	0.9593	-2.7156	0.0929	2.0702	0.4906
Inapa	0.7726	0.0001	-0.4360	0.0219	-3.2218	0.0117	2.2795	0.1580
Jeronimo	1.1850	0.0000	-0.0537	0.7628	1.4259	0.2492	-1.0617	0.4094
lisgrafica	0.9298	0.0023	0.2614	0.4994	3.5894	0.5637	1.7215	0.7994
Mota	0.3446	0.1061	0.2061	0.4283	1.8325	0.5919	-2.0657	0.5194
Orey	0.5913	0.0206	-0.4773	0.2268	1.4043	0.5348	2.7603	0.5059
Papelaria	0.9181	0.0010	-0.4576	0.1146	-1.6731	0.2324	4.0299	0.0726
Portucel	0.4072	0.0001	0.4396	0.0003	-0.3976	0.8553	-0.7678	0.6928
PT	0.7023	0.0000	0.5708	0.0001	2.8603	0.1966	-3.1264	0.1138
Semapa	0.6543	0.0000	0.0218	0.8797	-1.9576	0.4129	1.0578	0.6309
Soares	0.8169	0.0002	0.3566	0.3249	0.2384	0.8993	0.5282	0.8477
Sonae Indústria	2.7767	0.0027	-1.8629	0.0340	-3.9689	0.0534	5.4873	0.0646
Sonae SGPS	1.6038	0.0002	0.3109	0.4320	-2.6782	0.1936	0.2621	0.9181
Sumol	1.1524	0.0011	0.5388	0.3567	-0.3807	0.8058	-0.5963	0.8390
Toyota	0.6296	0.0000	-0.1445	0.3645	-1.2108	0.2589	4.6590	0.0102
Vista Alegre	0.8689	0.0001	-0.3236	0.1232	0.5080	0.5927	-3.7828	0.0081
Descriptive Statistics								
Mean	0.8844		-0.0724		-0.3644		0.0761	
Median	0.7975		-0.0537		-0.5998		0.2621	
Maximum	2.7767		1.0827		3.5894		5.4873	
Minimum	0.1517		-1.8629		-3.9689		-3.8263	
Std. Dev.	0.5448		0.5966		2.0468		2.8501	
Observations					21			
t-statistic	0.0000		0.5845		0.4242		0.9038	
wilcoxon signed rank	0.0001		0.7022		0.4240		1.0000	
p-value <0,10	19		7		3		5	

Table A.5. Estimates of the Slope Dummy Model for the interval [1990;1998].

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the return on the NEER, β_1 the market beta before 1994, β_2 market beta changes after 1994, β_3 is the estimated FX exposure from 1990 to 1994 and β_4 the FX exposure changes from 1994 to 1998.

	β_1		β_2		β_3		β_4	
	coefficient	**p-value**	**coefficient**	**p-value**	**coefficient**	**p-value**	**coefficient**	**p-value**
Compta	-0.0821	0.6606	0.0253	0.9111	-1.5474	0.0795	2.3709	0.1582
Estoril	0.9013	0.0058	0.0619	0.8737	-1.9974	0.1860	3.1250	0.2778
Fisipe	1.7298	0.0000	-0.7551	0.0596	1.1143	0.4684	-0.8777	0.7646
Immob	0.3306	0.3705	0.3528	0.4308	-1.8665	0.2810	-0.6780	0.8370
Inapa	1.5994	0.0000	-1.0208	0.0036	-3.6007	0.0076	1.0116	0.6895
Jeronimo	1.2011	0.0000	0.4199	0.2755	0.3087	0.6925	4.7598	0.0789
Orey	0.7887	0.0073	-0.0975	0.7807	-0.8127	0.6221	1.0147	0.6980
Papelaria	1.6296	0.0105	-0.9671	0.1537	-3.6970	0.1373	0.8326	0.8176
Soares	2.2425	0.0000	-1.8177	0.0000	1.2778	0.5747	1.1917	0.7438
Sonae Indústria	2.8811	0.0002	-1.3264	0.0905	-0.0352	0.9808	0.2009	0.9595
Sonae SGPS	2.1364	0.0000	-0.8019	0.0276	-2.8088	0.0453	6.2891	0.0193
Sumol	1.5903	0.0001	-0.5899	0.2124	-1.0461	0.6030	4.8135	0.0589
Toyota	1.1183	0.0000	-0.6642	0.0322	0.4949	0.6762	-1.6387	0.4692
Vista Alegre	0.7794	0.0165	0.1912	0.6231	0.1127	0.9402	0.7861	0.7840
Descriptive Statistics								
Mean	1.3462		-0.4993		-1.0074		1.6572	
Median	1.3957		-0.6270		-0.9294		1.0132	
Maximum	2.8811		-1.8177		-3.6970		-1.6387	
Minimum	-0.0821		-1.8177		-3.6970		-1.6387	
Std. Dev.	0.7898		0.6740		1.6447		2.3379	
Observations					14			
	p-value		**p-value**		**p-value**		**p-value**	
t-statistic	0.0000		0.0159		0.0393		0.0199	
Wilcoxon signed rank	0.0014		0.0328		0.0788		0.0238	
p-value <0,10	12		6		3		3	

Table A.6. Foreign Exchange Rate exposures to the US Dollar.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General orthogonal market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the estimated FX exposure from 1990 to 1998 and β_4 the FX exposure changes from 1999 to 2007. Since the introduction of the Euro, in 1999, the exchange rate is the EUR/USD.

	β_1		β_2		β_3		β_4	
Cimenteira	1.2267	0.0000	-0.9879	0.0000	-0.1284	0.7378	-0.2353	0.5948
Compta	-0.0900	0.5179	1.7644	0.0090	0.1140	0.6979	-0.4116	0.3722
Corticeira	1.2344	0.0000	-0.7416	0.0007	-0.5267	0.0285	0.9049	0.0139
Estoril	0.8804	0.0000	-0.5767	0.0142	-0.4828	0.0622	0.3423	0.3851
Fisipe	1.2982	0.0000	-0.8655	0.0345	0.1148	0.7985	-0.7924	0.2492
Immob	0.5776	0.0048	-0.3449	0.2681	-0.3171	0.3562	-0.1675	0.7494
Inapa	1.0109	0.0019	-0.7662	0.0249	-0.1612	0.7158	0.2249	0.6265
Jeronimo	1.6083	0.0000	-0.7863	0.0155	-0.0886	0.6497	0.2696	0.4603
lisgrafica	0.7914	0.4415	-0.0708	0.9571	-0.5918	0.8135	1.0529	0.7131
Mota	0.4828	0.0807	0.0665	0.8460	-1.4883	0.0505	2.1277	0.0113
Orey	0.7629	0.0033	-0.6114	0.1220	-0.1945	0.6514	-0.0543	0.9335
Papelaria	1.1149	0.0044	-0.8208	0.0558	-0.5492	0.2574	0.7582	0.1675
Portucel	0.8110	0.0000	-0.0328	0.8915	-0.5903	0.3380	0.4122	0.5209
PT	1.2650	0.0025	0.2350	0.5667	-0.5147	0.4422	0.0861	0.9046
Semapa	0.6004	0.0018	-0.0694	0.7715	-1.2692	0.0093	0.8381	0.1235
Soares	1.0586	0.0000	-0.3961	0.2271	-0.0959	0.7907	0.3865	0.4839
Sonae Indústria	1.8680	0.0000	-1.1910	0.0056	-0.8400	0.3344	0.6421	0.4710
Sonae SGPS	1.7332	0.0000	0.2452	0.3387	-0.3699	0.1845	-0.2703	0.5199
Sumol	1.2747	0.0000	0.0569	0.8613	0.0386	0.9145	-0.4399	0.4228
Toyota	0.5908	0.0031	-0.1727	0.5170	-0.5318	0.0478	0.7393	0.0378
Vista Alegre	0.8588	0.0000	-0.2826	0.3367	0.1087	0.7376	-0.3491	0.4812
Descriptive Statistics								
Mean	0.9980		-0.3023		-0.3983		0.2888	
Median	1.0109		-0.3449		-0.3699		0.2696	
Maximum	1.8680		1.7644		0.1148		2.1277	
Minimum	-0.0900		-1.1910		-1.4883		-0.7924	
Std. Dev.	0.4555		0.6321		0.4262		0.6625	
p-value	0.9405		2.9405		4.9405		6.9405	
Observations				21				
	p-value		**p-value**		**p-value**		**p-value**	
t-statistic	0.0000		0.0404		0.0004		0.0596	
wilcoxon signed rank	0.0001		0.0101		0.0006		0.0885	
p-value <0,10	19		9		5		3	

Table A.7. Foreign Exchange Rate exposures to the Yen

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the estimated FX exposure from 1990 to 1998 and β_4 the FX exposure changes from 1999 to 2007. Since the introduction of the Euro, in 1999, the exchange rate is the EUR/YEN.

	β_1		β_2		β_3		β_4	
Cimenteira	0.9992	0.0000	-0.7153	0.0001	-0.6578	0.2364	0.7647	0.1845
Compta	-0.0010	0.9927	1.6155	0.0197	-0.1165	0.5380	0.5002	0.2403
Corticeira	1.2284	0.0000	-0.7177	0.0004	-0.3271	0.1048	0.5265	0.1041
Estoril	1.0479	0.0000	-0.7515	0.0002	0.2263	0.3439	-0.4939	0.0714
Fisipe	1.1573	0.0000	-0.6483	0.0684	0.1913	0.5856	-0.3437	0.5554
Immob	0.6546	0.0006	-0.3216	0.2705	0.4242	0.1459	-1.0847	0.0211
Inapa	1.0374	0.0007	-0.8336	0.0118	0.1346	0.7011	-0.0473	0.9031
Jeronimo	1.4539	0.0000	-0.7010	0.0353	-0.1932	0.6560	0.3849	0.4701
lisgrafica	1.1250	0.1964	-0.2131	0.8548	1.3015	0.3811	-1.3025	0.5065
Mota	0.6274	0.0060	-0.0713	0.8114	-0.4354	0.3100	0.6493	0.2286
Orey	0.6813	0.0031	-0.5912	0.0990	0.1373	0.7087	0.6197	0.2972
Papelaria	1.0035	0.0018	-0.7652	0.0307	-0.6285	0.2327	0.8768	0.1133
Portucel	0.8379	0.0000	-0.0726	0.7265	-0.6308	0.0239	0.6190	0.0846
PT	1.1162	0.0002	0.2090	0.5204	-0.9180	0.1799	1.0278	0.1439
Semapa	0.7756	0.0000	-0.2014	0.3393	-0.1781	0.5355	-0.1033	0.7786
Soares	0.9680	0.0017	-0.1706	0.7002	0.3572	0.1333	-0.1615	0.7006
Sonae Indústria	1.7123	0.0000	-1.0298	0.0073	-0.9685	0.0603	1.3781	0.0258
Sonae SGPS	1.5804	0.0000	0.2712	0.4442	-0.5033	0.2067	0.3329	0.4633
Sumol	1.1823	0.0000	0.2036	0.5082	0.2347	0.4449	-0.3015	0.5411
Toyota	0.6735	0.0004	-0.1837	0.4745	0.0954	0.6444	0.1011	0.7396
Vista Alegre	0.9842	0.0000	-0.3703	0.1726	0.5661	0.0373	-0.5303	0.2230
Descriptive Statistics								
Mean	0.9926		-0.2885		-0.0899		0.1625	
Median	1.0035		-0.3216		-0.1165		0.3329	
Maximum	1.7123		1.6155		1.3015		1.3781	
Minimum	-0.0010		-1.0298		-0.9685		-1.3025	
Std. Dev.	0.3700		0.5750		0.5468		0.6851	
p-value	0.9405		2.9405		4.9405		6.9405	
Observations					21			
	p-value		**p-value**		**p-value**		**p-value**	
t-statistic	0.0000		0.0324		0.4598		0.2900	
wilcoxon signed rank	0.0001		0.0123		0.3849		0.2238	

Table A.8. Foreign Exchange Rate exposures to the Pound Sterling.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the estimated FX exposure from 1990 to 1998 and β_4 the FX exposure changes from 1999 to 2007. Since the introduction of the Euro, in 1999, the exchange rate is the EUR/GBP.

	β_1		β_2		β_3		β_4	
Cimenteira	1.0914	0.0000	-0.8005	0.0005	0.5015	0.3895	-0.7275	0.2439
Compta	-0.0081	0.9354	1.6387	0.0214	-0.2176	0.3958	-0.0264	0.9628
Corticeira	1.2773	0.0000	-0.7588	0.0002	0.2846	0.3572	0.2903	0.5524
Estoril	0.9388	0.0000	-0.6521	0.0013	-0.9208	0.0048	1.1285	0.0266
Fisipe	1.2094	0.0000	-0.7057	0.0480	0.6968	0.2255	-0.7987	0.3739
Immob	0.5863	0.0023	-0.2802	0.3421	-0.4649	0.3037	0.4650	0.5150
Inapa	0.9522	0.0015	-0.7438	0.0231	-1.0125	0.0388	0.9125	0.0979
Jeronimo	1.5043	0.0000	-0.7439	0.0309	0.4701	0.1320	-0.0940	0.8679
lisgrafica	0.9873	0.2657	-0.0800	0.9458	-0.4737	0.8474	1.8929	0.5449
Mota	0.5939	0.0111	-0.0266	0.9301	-0.6853	0.3089	0.8940	0.2836
Orey	0.6514	0.0056	-0.5322	0.1405	-0.1285	0.8265	0.1482	0.8709
Papelaria	0.9812	0.0039	-0.7325	0.0492	-1.0633	0.0412	1.5910	0.0090
Portucel	0.8751	0.0000	-0.1065	0.6122	-0.0875	0.8727	0.0652	0.9114
PT	1.1191	0.0033	0.1748	0.6459	0.2454	0.7000	-0.2089	0.7515
Semapa	0.6915	0.0000	-0.1257	0.5499	-1.1431	0.0132	1.0128	0.0767
Soares	0.9085	0.0029	-0.1020	0.8184	-0.3797	0.4197	0.0605	0.9202
Sonae Indústria	1.7329	0.0000	-1.0349	0.0068	-0.9140	0.2254	0.4754	0.5870
Sonae SGPS	1.6053	0.0000	0.2742	0.4462	-0.0838	0.8242	-0.2540	0.6924
Sumol	1.1873	0.0000	0.1958	0.5230	0.3597	0.4437	-1.1700	0.1159
Toyota	0.6509	0.0007	-0.1526	0.5503	-0.1864	0.5209	0.0514	0.8944
Vista Alegre	0.9271	0.0000	-0.3108	0.2561	-0.0989	0.8132	-0.4039	0.5419
Descriptive Statistics								
Mean	0.9744		-0.2669		-0.2525		0.2526	
Median	0.9522		-0.2802		-0.1864		0.0652	
Maximum	1.7329		1.6387		0.6968		1.8929	
Minimum	-0.0081		-1.0349		-1.1431		-1.1700	
Std. Dev.	0.3905		0.5794		0.5574		0.7772	
Observations					21			
	p-value		**p-value**		**p-value**		**p-value**	
t-statistic	0.0000		0.0475		0.0510		0.1520	
wilcoxon signed rank	0.0001		0.0150		0.0885		0.1866	

Table A.9. Foreign Exchange Rate Exposures to the Real.

$R_{it} = \beta_0 + \beta_1 R_{mt} + \beta_2 R_{mt} D_t + \beta_3 RFX_t + \beta_4 RFX_t D_t + \mu_t$

R_{it} is the firm's stock return, R_{mt} the PSI General orthogonal market return, RFX_t the exchange rate return, β_1 the market beta before 1999, β_2 market beta changes after 1999, β_3 is the estimated FX exposure from 1990 to 1998 and β_4 the FX exposure changes from 1999 to 2007. Since the introduction of the Euro, in 1999, the exchange rate is the EUR/BRA.

	β_1		β_2		β_3		β_4	
Cimenteira	1.2110	0.0000	-1.0032	0.0000	-0.1354	0.6346	-0.1103	0.7114
Compta	-0.1038	0.7223	1.9064	0.0000	0.3306	0.5288	-0.3789	0.4932
Corticeira	0.8565	0.0000	-0.3795	0.1154	-1.0354	0.0019	0.9983	0.0041
Estoril	0.6894	0.0350	-0.4018	0.2522	-0.9997	0.0958	0.8314	0.1700
Fisipe	0.8309	0.0169	-0.6154	0.1836	-0.3537	0.5932	-0.2566	0.7115
Immob	0.5238	0.2347	-0.2358	0.6161	-0.9638	0.0572	0.8941	0.0825
Inapa	0.4475	0.0044	-0.2650	0.1922	-0.8612	0.0018	0.6952	0.0159
Jeronimo	1.7602	0.0000	-0.9565	0.0016	-0.1435	0.7256	-0.1137	0.7913
lisgrafica	0.8653	0.3876	-0.3380	0.7965	-0.4257	0.8202	-0.3007	0.8779
Mota	0.5239	0.0566	-0.0054	0.9877	-1.3283	0.0395	1.2385	0.0606
Orey	0.5222	0.1710	-0.3886	0.4402	-0.4392	0.5255	0.4241	0.5589
Papelaria	0.6443	0.0042	-0.3257	0.2684	-0.6265	0.1264	0.7126	0.0967
Portucel	0.8485	0.0000	-0.1310	0.5750	-0.5359	0.2918	0.2509	0.6265
PT	1.1997	0.0024	0.3370	0.4103	-0.5058	0.3415	0.3710	0.4860
Semapa	0.6608	0.0000	-0.1880	0.4562	-0.9553	0.0927	0.6396	0.2610
Soares	0.4507	0.1125	0.4249	0.2497	0.0388	0.9392	0.1941	0.7158
Sonae Indústria	1.4025	0.0000	-0.6652	0.0496	-0.3635	0.4301	0.3903	0.4204
Sonae SGPS	1.1744	0.0033	0.6846	0.1277	-0.5724	0.0334	-0.1593	0.5769
Sumol	0.5441	0.0486	0.7227	0.0461	-0.5332	0.2796	0.1102	0.8313
Toyota	0.4783	0.0725	-0.0423	0.8948	-0.4404	0.1430	0.3862	0.1943
Vista Alegre	0.8869	0.0010	-0.3364	0.3284	0.2461	0.6018	-0.5216	0.2926
Descriptive Statistics								
Mean	0.7818		-0.1049		-0.5049		0.2998	
Median	0.6894		-0.2650		-0.5058		0.3710	
Maximum	1.7602		1.9064		0.3306		1.2385	
Minimum	-0.1038		-1.0032		-1.3283		-0.5216	
Std. Dev.	0.4051		0.6481		0.4271		0.4944	
p-value	0.9405		2.9405		4.9405		6.9405	
Observations					21			
	p-value		**p-value**		**p-value**		**p-value**	
t-statistic	0.0000		0.4670		0.0000		0.0116	
wilcoxon signed rank	0.0001		0.2108		0.0003		0.0199	
p-value <0,10	16		5		7		5	