

Financial Risk Exposures and Risk Management: Evidence from European Nonfinancial Firms

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Previous empirical studies concerning corporate risk management have attempted to show that the use of derivatives as a hedging mechanism can be value enhancing (e.g., Allayannis & Weston, 2001; Bartram, Brown & Fehle, 2009; Jin & Jorion, 2006). Implicit to these tests has been the assumption that firms use derivatives solely for the purpose of hedging. However, despite firms' pronouncements in favour of derivatives use for hedging purposes, it is not clear whether this is the case. Indeed, hedging, by definition, will seek to reduce the level of risk to which a firm is exposed. On the other hand, when derivatives are used to take advantage of perceived market imperfections (speculation), they will increase risk. There is substantial literature concerning nonfinancial firms that suggest that changes in financial prices (foreign exchange rate, interest rate and commodity price risk) affect firms' value (e.g., Bartram, 2002; Hagelin & Pramborg, 2004; He & Ng, 1998; Jorion, 1990; Tufano, 1998). Furthermore, it is a common belief that financial price exposures are created via firms' real operations and are reduced through the implementation of financial hedging strategies (Bali, Hume & Martell, 2007). The purpose of this paper is to analyse whether risk management practices are associated with lower levels of risk. We use monthly returns of 308 European firms traded in Euronext over the period from 2006-2008. We pursue Jorion (1990) and Allayannis and Ofek (2001) two stages framework to investigate, firstly, by considering simultaneously the three main categories of financial price risk, the relationship between firms' value and financial risk exposures; subsequently, the risk behaviour inherent to firms' real operations and to the use of derivatives and other risk management instruments. As a result, our primary assertion relies on the fact that hedging policies affect the firm's exposure to changes in financial price factors; however, we do not discard the fact that the magnitude of a firm's exposure to risks affects hedging activities. The interaction between financial price exposures and hedging activities is tested by using the three stage least square regression technique. Our major findings are as follows: Firstly, we find evidence that the sample firms exhibit higher percentages of exposure to the three categories of risks analysed when compared to previous empirical studies. Secondly, we find evidence that the broad array of hedging activities is associated to significant reduction in financial price exposures, which suggest that firms use risk management instruments for hedging purposes. In contrast, the significant influence of the firm's real operations on exposure is only achieved within the scope of exchange rate risk. Despite the straight argument in favour of the dependence of hedging decisions on exposure factors, the empirical results do not corroborate the existence of this relationship.

1. Motivation and Overview

Over the last three decades, we have assisted to an increase in the volatility of the prices of financial and nonfinancial assets. In face of this reality, risk management activities have become standard practices for firms facing financial risks. At first glance, this development seems to highlight the potential benefits perceived by corporate agents at the firm's value level. However, despite the current popularity of risk management, there is a large discussion in academic literature concerning the truthful contribution of risk management to firm value (e.g., Carter, Rogers & Simkins, 2006; Jin & Jorion, 2006).

The vast majority of the existing empirical literature has attempted to show that the use of derivatives as a hedging mechanism can be value enhancing; first, by trying to uncover which theory of hedging best describes firms' use of derivatives (e.g., Bartram *et al.*, 2009; Mardsen & Prevost, 2005); later, by testing directly the impact of risk management activities on firm value (e.g., Allayannis & Weston, 2001; Guay & Kothari, 2003; Jin & Jorion, 2006). Implicit to these tests has been the assumption that firms use derivatives solely for the purpose of hedging. However, despite firms' pronouncements in favour of derivatives use for hedging purposes, it is not clear whether this is the case.

The view that volatility of financial prices affects a firm's value and, therefore, the price of its stocks is generally recognized. In this context, there is substantial literature concerning nonfinancial firms that suggests that changes in financial prices (foreign exchange rate, interest rate and commodity prices) affect firms' value. The main focus is on foreign exchange exposures (e.g., Hagelin & Pramborg, 2004; He & Ng, 1998; Jorion, 1990) or (less often) on interest rate exposures (e.g., Bartram, 2002; Sweeney & Warga, 1986). In contrast, the impact of commodity price changes on corporations is analysed only in a few studies (e.g., Bartram, 2005; Tufano, 1998). However, these studies have met limited success in documenting significant financial price exposures (e.g., Bartram, 2005; Hagelin & Pramborg, 2004; Jorion, 1990).

Until recently, little effort has been directed towards analysing whether firms are successful or not in reducing risk pertaining to financial price exposures when hedging instruments are used. To the best of our knowledge, the study from He and Ng (1998) is the first one to suggest that the extent of exchange rate exposure is determined by the firm's hedging activities. In line of this study, other recent works, such as the ones from Allayannis and Ofek (2001) and Hagelin and Pramborg (2004), documented a significant reduction in foreign exchange exposure sustained by the use of currency exchange derivatives. Subsequently, in a recent study, Bali *et al.* (2007), based on a sample of firms of four selected industries, analyse simultaneously the three categories of risks and suggest that hedging with derivatives is only significantly related to commodity price exposure. Despite the fact that the majority of existing empirical literature relates to the implicit assumption that firms that do not use derivatives are not hedging, recent research also examines the association between exposure and proxies for firms' on-the-balance hedging activities (e.g., Allayannis, Ihrig & Weston, 2001; Carter, Pantzalis & Simkins, 2003; Hagelin & Pramborg, 2004; Williamson, 2001).

Our paper intends to analyse whether firms use risk management instruments for hedging or for speculative purposes. We use monthly returns of 308 firms listed in Euronext during the period from 2006-2008. We pursue Jorion (1990) and Allayannis and Ofek (2001) two stages procedure to investigate, firstly, in the field of time series analysis, the relationship between firm value and exchange risk, interest rate risk and commodity price risk factors, all together; and afterwards the effect of hedging activities and firms' real operations on financial price exposures estimated in the first stage. Our proxy of hedging activities is, similarly to Judge (2006), a dummy variable that points out to the use/non-use of hedging instruments by category of risk (which includes off-balance sheet and on-balance sheet instruments). Our

primary assertion relies on the fact that hedging policies affect the firm's exposure to changes in financial price factors; however, we do not discard the fact that the magnitude of a firm's exposure to risks affects hedging decisions.

This paper adds to described areas of research by quantifying the impact of the use of derivative and non-derivative instruments on financial price exposures, making use of a broader sample of nonfinancial firms across all industries. Besides, there are few published papers about hedging activities by means of data from Continental Europe, namely with data based on the International Accounting Standards 32 and 39 that require detailed reporting on derivatives, and none that we know use data on a sample formed by Euronext countries. Furthermore, we are motivated by the lack of empirical evidence concerning the interrelationship between financial price exposures and hedging, which we believe is scarcely investigated and limited to the US (Carter *et al.*, 2003).

The remainder of the paper is organized into four more sections. Next section presents the concept of financial price exposure, namely foreign exchange rate exposure, interest rate exposure and commodity price exposure and explores the determinants of these exposures in reviewing the existing empirical evidence. This is followed by the description of the sample and the methodology (section 3). Section 4 contains the empirical results. Finally, section 5 concludes the paper.

2. Empirical Evidence on Financial Price Exposures of Nonfinancial firms

Financial risks for nonfinancial corporations consist – broadly defined – of unexpected changes in foreign exchange rates, interest rates and commodity prices. In this sense, financial price exposure can be defined as the influence of financial price changes on the future cash flows of the firm. Since firm value is represented by the present value of future cash flows, financial price exposure is the sensitivity of firm value to financial price changes. Initial research in this area analyses stock returns to provide empirical measures of corporate exposure to financial risks. Most of this research has been devoted to exchange rate exposure (e.g. Jorion, 1990; Williamson, 2001) and while some has tested for interest rate exposure (e.g., Bartram, 2002), this has been largely for financial firms. Subsequent research investigates the effect of hedging in financial risk exposures, predominantly in foreign exchange exposure (e.g., He & Ng, 1998; Nguyen & Faff, 2003).

The focus of existing empirical exposure studies on foreign exchange rate risk has been justified with the argument that exchange rate risk represents a major source of risk, due to its higher volatility, when compared to other financial prices (Jorion, 1990). Nevertheless, a comparison of the standard deviations of various financial prices (exchange rate, interest rate and commodity price) reveals that in recent years interest rate and commodity price display even higher volatility than foreign exchange rate (Bartram, 2005). Therefore, the impact of interest rate and commodity price changes on firm value can be classified as an important issue for corporate risk management.

This section discusses the relationship between financial price risks and stock returns and explores the determinants of exposure, in reviewing the existing empirical literature related to the present study and highlighting the main conclusions that have emerged.

2.1. Foreign Exchange Rate Exposure

Following seminal work by Adler and Dumas (1984), empirical studies have measured exchange rate exposure by the slope coefficient from a regression of firms' stock returns on exchange rate changes. To prevent misspecification of the model, Jorion (1990) add the return on the market index to control for market movements:

$$R_{i,t} = \beta_{0,i} + \beta_{1,i} \cdot R_{s,t} + \beta_{2,i} \cdot R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where, $R_{i,t}$ is the rate of return on the i^{th} firm's common stock in period t , $R_{s,t}$ is the rate of change in a trade-weighted exchange rate and $R_{m,t}$ is the rate of return on the CRSP (Centre for Research in Security Prices) value-weighted market index. $\beta_{1,i}$ represents a firm i 's exchange rate exposure independent from the effect that these currencies have in the overall market; $\beta_{2,i}$ a firm i 's return sensitivity to market risk and $\varepsilon_{i,t}$ denotes the white noise error term. Examining the monthly stock returns of 287 US multinationals in the period from 1971-1987, the author finds that only about 5,5% of the firms are significantly exposed to exchange rate risk.

In line with Jorion (1990), several other studies were carried out. For firms on the stock market in the US, researchers have applied various specifications of the Jorion's framework to investigate the significance of exposure for particular samples of industries or firms, including multinationals firms (e.g., Amihud, 1994; Choid & Prasad, 1995), nonfinancial firms (e.g., Allayannis & Ofek, 2001; Crabb, 2002), firms in the automotive industry (Williamson, 2001) and broader samples of industries (e.g., Bodnar & Gentry, 1993).

Amihud (1994) finds no significant exchange rate exposure for a sample of 32 US exporters from 1982 to 1988. To some extent, Choid and Prasad (1995) provided strong evidence of significant exposure. They examined a sample of 409 multinational firms that have foreign sales, profits and assets of at least 25% of their respective totals. About 15% of the firms are significantly exposed. Furthermore, Bodnar and Gentry (1993) show that roughly 30% of industries in the US, Japan and Canada have significant exposure to exchange rate movements. However, they find that the percentage of industries significantly exposed is smaller for the US than for Canada and Japan, which puts forward that industries in smaller and more open economies are likely to be more exposed to exchange rate risk. In the case of Williamson (2001), that analyses automotive industry in the US, significant exposure occurs only for certain firms.

Whereas most papers focus on US financial markets, several studies have also been surveying other markets, such as Japan (Bodnar & Gentry, 1993; He & Ng, 1998; Williamson, 2001), Canada (Bali *et al.*, 2007; Bodnar & Gentry, 1993), Australia (Khoo, 1994; Nguyen & Faff, 2003), Sweden (Hagelin & Pramborg, 2004; Nydahl, 1999), and broad samples of countries (Bartram, Brown & Minton, 2010), among others. In general, these studies have had somewhat more success in documenting a significant contemporaneous relation between firms' stock returns and changes in foreign exchange rates. For example, He and Ng (1998), studying exchange rate exposure of Japanese multinational firms over the period from 1978-1993, find that roughly 25% of the 171 firms in the sample yield significant positive exposure coefficients. Also, Nydahl (1999), analysing the exchange rate exposure of Swedish firms with a foreign sales ratio of at least 10%, finds that approximately 26% of the 47 firms in the sample are significantly exposed to exchange rate changes. On the other hand, Khoo (1994), examining the foreign exchange rate exposure of mining companies in Australia, finds very weak evidence of such exposure. He binds this lack of exposure to the extensive use of hedging by mining firms. Summing up, the empirical evidence on the impact of exchange rates on firm value in non-US markets is not conclusive either.

A controversy point in Jorion's augmented market model concerns the definition of the exchange risk factor. The empirical literature often employs one of the following proxies: a trade weighted exchange rate or a bilateral currency exchange rate. The aforementioned studies typically use a trade-weighted exchange rate index (e.g., Bali *et al.*, 2007; Bodnar & Gentry, 1993; Jorion, 1990). Despite the view of Williamson (2001), among others, that points out lack of power to the tests using a trade weighted of currencies, when the firm is mostly exposed to only a few currencies, Nydahl (1999), employing alternatively a trade weighted exchange rate index and a bilateral currency exchange rate, concludes that there are not significant differences. In what respects sampling frequency, the use of monthly data is

recurrent (e.g., Allayannis & Ofek, 2001; Bali *et al.*, 2007; Choid & Prasad, 1995; Jorion, 1990). Allayannis and Ofek (2001) justify this option by the fact that daily and weekly exchange rate indices frequently exhibited problems of misalignment between stock return and exchange rate series.

2.2. Interest Rate Exposure

The majority of interest rate exposure studies are restricted to financial firms (e.g., Oertmann, Rendu & Zimmermann, 2000) which have mainly financial assets and, thus, are expected to exhibit different sensitivity with regard to changes in interest rates, when compared to nonfinancial firms. However, changes in interest rates are also important for nonfinancial firms. First, interest rate risk impacts on the value of nonfinancial firms through changes in cash flows generated by operations, which arise due to interest rate direct effect on the cost of capital. In addition, there may be indirect effects of interest rate risk on the competitive position of firms, impacting also on their expected cash flows. Finally, interest rate risk may influence firms' value due to changes in the value of their financial assets and liabilities.

Within the scope of nonfinancial firms, very little empirical evidence is found concerning interest rate risk impact on firm value. Sweeney and Warga (1986) conducted an extensive study of interest rate sensitivity and pricing in the US stock market. They concluded that changes in the government bonds yields clearly affect to a much larger extent electric utilities industry than the NYSE firms as a whole. Similarly, research on the interest rate sensitivity of nonfinancial firms outside the US is relatively sparse. Prasad and Rajan (1995), using a sample of four industrialized countries in the period from 1981-1989, group individual stock returns data into industry-based portfolios. Their results indicate that interest rate risk varies among countries and that there are industries with significant exposure to interest rate risk, specifically in Japan and Germany. Confirming these results, Bartram (2002) also reports a significant rate exposure in German nonfinancial firms.

According to the existing evidence, most of the empirical studies on interest rate risk are based on a two-index model developed by Stone (1974), which includes an interest rate change factor in addition to the traditional market index.

2.3. Commodity Price Exposure

The economic commodity price exposure describes the effect of unexpected price movements of commodities on firm value. This effect is primarily determined by firms' economic business activity. On the other hand, indirect effects result from the economic interdependence of companies in the economic value chain. In general, a relevance of a commodity as an input (output) factor should lead to a positive (negative) exposure. Despite the fact that changes of all production factors on the range of products have, potentially, a direct economic effect on the firms' cost and/or revenue, only some inputs and outputs, namely commodities, are traded on the spot/or futures exchanges of international financial markets. Nevertheless, the effectiveness of commodity risk management on commodity price exposure reduction seems unquestionable; yet, very little attention to this matter has been attracted to date at the empirical literature level.

Exceptions are made to several empirical studies based on American gold mining industry (Petersen & Thiagarajan, 2000; Tufano, 1998), gas and oil industry (Jin & Jorion, 2006) and airline industry (Carter *et al.*, 2006). This is justified by the fact that companies in those industries turn out fairly homogeneous products, which imply relatively simple exposure structures. On the other hand, being industries with strictly disclosing rules brings about the conception of high level databases on risk management practices. These studies

make use of the common approach assessed in the literature – a two factor augmented market model, which includes a commodity price change factor.

To our knowledge, the few studies that focus on commodity price exposure over a broad sample of nonfinancial firms across multiple industries are the ones by Bartram (2005) and Bali *et al.* (2007). Bartram (2005) makes use of a sample of 490 German nonfinancial firms, but limits his analysis to the sensitivity of firm value toward commodity price risk. He tests if commodity price risk that has not been hedged may negatively (positively) affect stock prices in industries for which a certain commodity represents an important input (output) factor in the production process. The author reports that the percentage of firms with significant exposures to commodity price risk is in the range of 4,5% - 15,9%. In the case of the study carried out by Bali *et al.* (2007), the focal point is the interaction between firms' risk exposures, derivatives use and firms' real operations. Evidence is found that commodity derivatives users have increasingly inherent risk exposure, which may suggest that hedging with derivatives is not always important to a firm's return rate and may be linked to other nonfinancial and economic factors.

2.4. Determinants of Financial Price Exposures

With respect to factors that influence exchange rate exposure, several authors, such as Jorion (1990), Bodnar and Gentry (1993), Amihud (1994), Allayannis and Ofek (2001), Williamson (2001) and Bali *et al.* (2007) have found in their studies that a higher foreign involvement, proxied by ratio of foreign sales to total sales, implies a stronger correlation between a depreciation (appreciation) of the dollar and an increase (decrease) in stock market values. When the focus is the interest rate exposure, Bartram (2002) investigates two partial exposure determinants: financial leverage and firm liquidity and finds only a significant relation between the magnitude of interest rate exposure and firm liquidity. Instead, Bali *et al.* (2007) consider only financial leverage as a proxy for firms' real operations.

Williamson (2001), among others, recognizes that the low significance of empirically exposure coefficients reported may arise because what is really being measured is exposure that remains after the firm has engaged in some hedging activity. Bartram (2002) emphasized that nonfinancial firms should be able to immunize firm value against changes in interest rates to some extent by matching the interest rate sensitivity of their assets and liabilities through active risk management. Additionally, Bartram (2005) suggested that firms for which commodity price volatility is an important source of risk are likely to efficiently implement their risk management strategies, rendering net commodity price exposure perceived much smaller than gross exposure. It seems likely that, to the extent that hedging activities are efficiently implemented, they have a direct impact on the nature and characteristics of a firm's exposure. In spite of the recognition of the influence of hedging activities on firms' exposures, only a few authors try to incorporate the impact of hedging on exposures analysis.

In the field of commodity price exposure, Tufano (1998) considers the hedging activities to be a potential determinant of exposure. Additionally, he tests several other potential determinants strictly related to the gold mining industry. Similarly, Jin and Jorion (2006) investigated the effect of hedging with derivatives and of gas and oil reserves on the commodity price exposure of a sample of US oil and gas firms. More recently, Bali *et al.* (2007) investigated the effect of derivatives use and of firms' real operations, represented by the ratio of total inventory to total sales, on commodity price exposure.

Focusing on internal hedging strategies, Williamson (2001) shows that foreign production decreases exchange rate exposure, which is consistent with the idea that an exporter can counteract the sensitivity of the cash flow to exchange rate movements by having costs denominated in the local currency. Corroborating conclusions are drawn by Carter *et al.* (2003). Other authors try to empirically link estimated exposure coefficients with data on

foreign hedging activities. Nydahl (1999), Allayannis and Ofek (2001) and also Nguyen and Faff (2003) assess data on foreign exchange derivatives usage; Carter *et al.* (2003), Hagelin and Pramborg (2004) and Bartram *et al.* (2010) consider data on both internal and external hedging activities. Additionally, Carter *et al.* (2003) account for the fact that the magnitude of a firm's exposure to foreign exchange risk affects its hedging decisions. In other words, they recognize that foreign exchange rate exposure and hedging are endogenously determined.

Another set of studies is based on optimal hedging theories, which postulate that non hedging firms should be more exposed to currency movements than hedging companies (He & Ng, 1998; Nguyen & Faff, 2003). Particularly, He and Ng (1998) use variables that proxy for firms' incentives to hedge to examine the influence of presumed hedging activities.

3. Sample Description and Methodology

3.1. Sample Description

The initial sample includes all nonfinancial firms listed on Euronext belonging to the following indexes at December 31, 2007: Brussels all Shares (BAS) Price,¹ CAC all shares,² Amsterdam Exchanges (A-DAM) all shares³ and PSI General.⁴ We required that firms have sufficient accounting data for 2007 and stock return data for the years 2006-2008 reported on the *Infinancials* database. Simultaneous, we required that they have an annual report in English for the same year published on firms' web site.⁵ We did not take into account multiple listings by the same firms, selecting the main market where different alternatives arise. This approach left us with 308 firms in our final sample.

Accounting data, with the exception of information on foreign firm sales, originates from the *Infinancials* database. Data on risk management instruments used and on foreign sales was manually collected from firms' annual reports. In line with Judge (2006), we created a dichotomous variable by category of risk for the use/non-use of hedging instruments.

Following Allayannis and Ofek (2001), the data sets use a firm's monthly returns for the three years surrounding 2007 (2006-08). We use a trade-weighted exchange risk index – the Euro effective index –⁶ to proxy for the foreign exchange risk factor. The proxy used to represent the interest rate risk factor is the three-month Euro Interbank Offered Rate (Euribor). Both the nominal effective exchange rate and the three-month EURIBOR data were obtained from the European Central Bank. To represent the commodity price risk factor we consider the Euronext Rogers International Commodity Index (RICI) provided by Uhlmann Price Securities.⁷ The MSCI Euro index provided by Morgan Stanley Capital International Barra is used as proxy for equal-weighted returns market index.⁸

Firms are ranked into industries according to the Industry Classification Benchmark (ICB) classification codes in the *Infinancials* database. This procedure results in firms' distribution by nine industries. The largest industry – Industrials – represents 27,6% of the sample, followed by Technology, which represents 18,5% of the sample. The country composition is as follow: Belgium firms represent 23,4% of the sample, French firms 26%, Dutch firms 38,3% and Portuguese firms 12,3%.

3.2. Methodology

We use a two-step approach procedure to investigate the effect of a firm's hedging activities and real operations on its exposure to financial risks. This study provides more complete estimates of firms' financial risk by extending Jorion (1990) and Allayannis and Ofek (2001) exposure models for currency exchange risk, to also include interest rate and commodity price risk. The use of these three categories of risks is also investigated in Bali *et al.* (2007). In the first stage, we estimate the stock exposure of each firm in our 2007 data. In

the second stage, we examine the relationship between financial price exposures already estimated, hedging activities and firms' real operations.

A) Time Series Analysis: Measuring Stock Price Exposure

As mentioned in the previous section, the current approach adopted in literature to estimate a firm's stock exposure to financial price risk is a two factor augmented market model. In line with Bali *et al.* (2007), in the first stage regression we provide estimates of individual firms' exposure by category of risk using a four-factor augmented market model:

$$R_{i,t} = \beta_{0,i} + \beta_{1,i} \cdot FX_t + \beta_{2,i} \cdot \Delta IR_t + \beta_{3,i} \cdot CP_t + \beta_{4,i} \cdot MSCI_t + \varepsilon_{i,t} \quad (2)$$

where $R_{i,t}$ is the stock rate of return for firm i in month t ; FX_t is the rate of return on a moving trade-weighted average exchange rate index (in € per unit of foreign currency in period t); ΔIR_t is the monthly rate of change in the short-term interest rate factor in period t ; CP_t is the monthly rate of return on a commodity index in period t ; and $MSCI_t$ is the monthly rate of return on the MSCI Euro index in period t . The coefficient $\beta_{1,i}$ represents the exchange rate exposure, $\beta_{2,i}$ represents the interest rate exposure, $\beta_{3,i}$ represents the commodity price exposure and $\beta_{4,i}$ firm i 's return sensitivity to market risk.

B) Cross Sectional Analysis: Determinants of Financial Price Exposure

Previous studies (e.g., Allayannis & Ofek, 2001; Carter *et al.*, 2003; Hagelin & Pramborg, 2004; He & Ng, 1998; Nydahl, 1999) analyzed the efficiency of hedging activities by examining the determinants of the financial price exposure in a cross sectional regression with the exposure coefficients estimated for each category of risk as the dependent variable:

$$\beta_{i,x} = \alpha_0 + \sum_{j=1}^n \alpha_j Z_{j,i} + \eta_i \quad (3)$$

Financial risk management and the level of exposure are possibly endogenous (Carter *et al.*, 2003). Several authors argue that firms with more exposure have higher probabilities of become hedgers (e.g., Bartram *et al.*, 2009; Lel, 2009). In that sense, if financial exposures and hedging activities are interrelated, then financial exposures should be a function of hedging activities and of firms' real operations (Bali *et al.*, 2007; Bartram, 2002). Similarly, hedging instruments usage should be a function of the financial price exposures magnitude and of other factors also related with firms hedging decisions. In order to determine whether this is the case, the following system of equations for each category of risk is formulated:

(i) For exchange rate exposure:

$$|\beta_{1,i}| = \alpha_0 + \alpha_1 \cdot DUM_FX_i + \alpha_2 \cdot FS/TS_i + \eta_i \quad (4)$$

$$DUM_FX_i = \delta_0 + \delta_1 \cdot |\beta_{1,i}| + \delta_2 \cdot TAX_i + \delta_3 \cdot LEV_i + \delta_4 \cdot CAPEX_i + \delta_{5,i} \cdot PE_i + \delta_6 \cdot INS_i + \delta_7 \cdot ASSET_i + \delta_8 \cdot DIV_i + \delta_9 \cdot GDP_i + \xi_i \quad (5)$$

(ii) For interest rate exposure:

$$|\beta_{2,i}| = \alpha_0 + \alpha_1 \cdot DUM_IR_i + \alpha_2 \cdot LIQ_i + \eta_i \quad (6)$$

$$DUM_IR_i = \delta_0 + \delta_1 \cdot |\beta_{2,i}| + \delta_2 \cdot TAX_i + \delta_3 \cdot LEV_i + \delta_4 \cdot CAPEX_i + \delta_{5,i} \cdot PE_i + \delta_6 \cdot INS_i + \delta_7 \cdot ASSET_i + \delta_8 \cdot DIV_i + \delta_9 \cdot GDP_i + \xi_i \quad (7)$$

(iii) For commodity price exposure:

$$|\beta_{3,i}| = \alpha_0 + \alpha_1 \cdot DUM_CP_i + \alpha_2 \cdot TI/TS_i + \eta_i \quad (8)$$

$$DUM_CP_i = \delta_0 + \delta_1 \cdot |\beta_{3,i}| + \delta_2 \cdot TAX_i + \delta_3 \cdot LEV_i + \delta_4 \cdot CAPEX_i + \delta_{5,i} \cdot PE_i + \delta_6 \cdot INS_i + \delta_7 \cdot ASSET_i + \delta_8 \cdot DIV_i + \delta_9 \cdot GDP_i + \xi_i \quad (9)$$

where: $|\beta_1|$, $|\beta_2|$ and $|\beta_3|$ represent the magnitude of the exchange rate exposure, the magnitude of the interest rate exposure and the magnitude of the commodity price exposure, respectively; $ASSET$ is the natural logarithm of total assets; $CAPEX$ is the ratio of capital expenditures to total assets; DIV is the dividend yield, measured by gross dividend per share divided by closing stock price; DUM_FX is a dummy which is assigned a value of 1 if a firm uses either external or internal foreign exchange hedging instruments, 0 otherwise; DUM_IR

is a dummy which is assigned a value of 1 if a firm uses either external or internal interest rate hedging instruments, 0 otherwise; *DUM_CP* dummy which is assigned a value of 1 if a firm uses either external or internal commodity hedging instruments, 0 otherwise; *FS/TS* is the ratio of foreign sales to total sales as a proxy for firms' real foreign operations; *GDP* is the natural logarithm of gross national product per capita; *INS* is the percentage of ordinary shares held by insiders; *LEV* is the financial leverage, measured by ratio of total debt to total assets; *LIQ* is the ratio of cash-flow to total assets as a proxy for the expected costs of financial distress; *PE* is the price earnings ratio; *TAX* is the net operating losses to total assets, and *TI/TS* are the revenues from commodity operations, measured by ratio of total inventory to total sales.

In our estimation of equations (4), (6) and (8) we test if a firms' use of hedging instruments affects its exposure to the underlying risk factor. If firms use risk management instruments' as a hedge against financial risk exposures, the absolute value of exposure should be negatively related to risk management instruments use.¹⁰ If, on the other hand, firms use risk management instruments, namely derivatives, to speculate, we should expect a positive relation between risk management instruments' use and the absolute value of inherent financial price risks.

Additionally, in equations (4), (6) and (8) we test if a firm's real operations are important determinants of specific risk exposure. With respect to exchange rate exposure, we expect a net exporter to be hurt by an exchange rate appreciation (that is to say, the return on its stock should decrease), thus producing a positive exchange rate exposure. In contrast, if a firm is a net importer, then the appreciation of the euro should benefit it, therefore producing a negative exposure. So, for a given exposure, an increase in revenues from foreign operations should increase exposure. However, when we take the absolute value of exchange rate exposure, we cannot hypothesize any relation between the absolute value of exposure and the ratio of foreign sales to sales (e.g., Allayannis & Ofek, 2001). Similarly, we take the same approach for commodity price exposure, supported on the fact that commodity price exposures can be identified empirically in a particular industry either as an input factor or as an output factor in the production process (Bartram, 2005). In what concerns interest rate exposure, we hypothesize, similarly to Bartram (2002), that firms with high level of liquidity have less significant expected costs of financial distress. As a result, one can expect the interest rate exposure to be negatively related with firms' liquidity.

In line with the optimal hedging theory, the ratio of net operating losses to total assets proxy's for the convexity of firm's tax schedules. The great majority of the variables that are used to test the relation between taxes and derivatives usage are based on the existence of net operating losses (e.g., Marsden & Prevost, 2005; Nance, Smith & Smithson, 1993). Usually, the hypothesis tested is as follows: the greater the firm's probability of incurrence in tax loss which will be carried forwards, the greater the probability of the firm's engagement in hedging should be. The second variable is leverage, which is a proxy for the probability of financial distress (Lel, 2009; among others). We expect firms with greater degree of financial distress to engage more often in hedging activities.

The theory predicts that hedging can enhance firms' value if it can decrease the agency costs of debt. It was suggested that these agency costs of debt are more evident in firms with more growth options, as these firms could have a high probability of underinvestment or asset substitution. In line with Lin and Smith (2008), we use, to proxy for investment, the ratio of capital expenditures to total assets and, to proxy for growth opportunities, the price to earnings ratio. In testing managerial risk aversion prediction, we use the percentage of ordinary shares held by insiders (e.g., Bartram *et al.*, 2009; Marsden & Prevost, 2005). It is suggested that managers have greater incentives to hedge when their wealth is more closely tied to their firms' well-being.

We control for firm size because the establishment and implementation of a hedging programme involve some fixed costs (Nance *et al.*, 1993). Larger firms that have access to risk management expertise, or that have economies of scale in hedging costs, are more likely to hedge than smaller firms. However, there are circumstances where smaller firms have more incentive to hedge than larger firms; for instance, smaller firms will hedge more, because they face greater bankruptcy costs. Similarly, we include GDP per capita to control for the availability of derivatives and their costs (Lel, 2009). Finally, we consider that the presence of liquid assets could also reduce the need for hedging with derivatives (e.g., Marsden & Prevost, 2005; Nance *et al.*, 1993). We control for liquidity through dividend yield and expect that firms with lower dividend payouts are less likely to hedge.

So, consistently with previous studies on optimal hedging theories δ_1 , δ_2 , δ_3 , δ_4 , δ_5 , δ_6 and δ_9 in equations (5), (7) and (9) are expected to be positive. In contrast, δ_8 is expected to be negative and δ_7 could be either positive or negative.

In a subsequent test we investigate if an increase in hedging in one category of risk may reduce the exposure to risk in another category. For this test we substitute *DUM_FX*, *DUM_IR* and *DUM_CP* with *DUM_ALL*. *DUM_ALL* is assigned a value of 1 if a firm uses either external or internal hedging instruments; otherwise the variable is assigned a value of zero.

The interaction between financial price exposures and hedging activities is tested by using the three stage least square regression technique (3SLS), in Gretl (version 1.8.6) to obtain the estimates of equations described above.

4. Results and Discussion

Table 1 shows some descriptive statistics of the above listed variables. In average, about 24% of firms' total assets are financed by debt. The average value of the size variable is 16,158. This converts in about € 10.407 millions. The average percentage of foreign sales is 29,9% and firms' inventory represents, on average, 18,1% of total sales.

Table 1:
Sample Summary Statistics

Variables	Mean	Std. dev.	Minimum	Maximum
ASSET	16,158	4,139	8,79	25,95
CAPEX	0,053	0,049	-0,0628	0,318
DIV	0,021	0,020	0	0,117
FS/TS	0,299	0,265	0	0,985
GDP	10,277	0,243	9,641	10,438
INS	0,072	0,392	0	6,58
LEV	0,240	0,175	0	1
LIQ	0,069	0,105	-1,00	0,479
PE	41,167	228,27	0	3048,9
TAX	0,015	0,061	0	0,469
TI/TS	0,181	0,987	0	16,986

Note. The statistics reported are obtained through Gretl (version 1.8.6). ASSET = proxy for firm size, measured by the natural logarithm of total assets; CAPEX = proxy for firm investment, measured by the ratio of capital expenditures to total assets; DIV = dividend yield proxy for firm liquidity, measured by the gross dividend per share divided by the closing stock price; FS/TS = proxy for firms' foreign real operations, measured by the ratio of foreign sales to total sales; GDP = proxy for the availability of derivatives in capital markets, measured by the natural logarithm of gross national product per capita; INS = proxy for the managerial risk aversion, measured by the percentage of ordinary shares held by insiders; LEV = financial leverage proxy for the probability of financial distress, measured by the ratio of total debt to total assets; LIQ = proxy for the expected costs of financial distress, measured by the ratio of cash-flow to total assets; PE = proxy for growth opportunities, measured by the price earnings ratio; TAX = proxy for the convexity of firm tax schedule, measured by net operating losses to total assets; TI/TS = proxy for the need to hedge commodity price, measured by the ratio of total inventory to total sales. All the variables, with the exception of foreign firms' sales, originate from the *Infinancials* database. Data on firms' foreign sales was manually collected from firms' annual reports.

In Table 2 we report the percentage of hedgers and non hedgers by category of risk instrument. As may be observed, the percentage of hedgers is generally high, 78,6% for exchange rate hedgers and 61% for interest rate hedgers. Exception is made to commodity hedging instruments usage. Only 17,5% of the firms on the sample use commodity hedging instruments, which may be consistent with Bartram's (2005) view that only few corporate cash flows are affected by commodity price changes.

Table 2:

Summary Statistics of Hedging by Category of Risk Instrument

	All Categories		Exchange rate		Interest rate		Commodity	
	Obs.	% of sample	Obs.	% of sample	Obs.	% of sample	Obs.	% of sample
Hedgers	267	86,7%	242	78,6%	188	61%	54	17,5%
Non hedgers	41	13,3%	66	21,4%	120	39%	245	82,5%

Note. This table reports the use of risk management instruments for the sample of 308 firms. The second column provides data on the number of hedging and non hedging firms; the fourth, sixth and eighth columns report the number of hedgers and non hedgers by category of risk instrument.

A) Time Series Analysis: Measuring Stock Price Exposure

Before we investigate the firms' financial price exposure, we investigate the series stationarity properties. The augmented Dickey-Fuller (ADF) test is applied to each time series to discard the existence of the unit root in the series analysed. The vast majority of our time series for returns on individual securities is integrated of order zero; 16,2% of the time series are integrated of order one and 1,6% are integrated of superior order. In what concerns the financial price exposure factors and the market index, they are all stationary on the levels. We also investigated the serial autocorrelation and, in line with Fama (1990), we have applied ARMA specification to the time series on the return of the commodity price factor, in order to achieve a specification of the variable with white noise residuals (the so-called innovations).

The relation between changes in stock prices and changes in financial price exposure factors is analysed by the estimation of equation (2). Standard errors of the coefficients are estimated by using the Newey-West method to correct for autocorrelation and heteroscedasticity. For all the categories of risk, the regression yields a percentage of firms with significant exposure below the 10% significance level (Table 3). The interest rate exposure factor shows the highest significance, with a percentage of 35,4%. Additionally, with regard to the other exposure factors, firms exhibit higher percentages of significant cases when compared with previous empirical studies.¹¹

B) Cross Sectional Analysis: Determinants of Financial Price Exposure

The interrelation between financial price exposures (exchange rate, interest rate and commodity price exposures) and hedging activities is tested by applying the 3SLS method on the equations (4) – (9) described above. However, since previous studies use mainly the OLS regression technique, we perform the tests also with the OLS regression. We present the 3SLS and OLS results in Table 4 and Table 5.

The results of the 3SLS regression indicate, as expected, that exchange hedging instruments' usage has a negative influence in inherent exposure (e.g., Allayannis & Ofek, 2001). In contrast, the degree of foreign firms operations impacts positively on the exchange rate exposure. The results do not support the view that the magnitude of exchange rate exposure influences hedging with exchange rate instruments. When we investigate the fact that an increase in hedging in one category of risk may reduce the exposure to risk in another category, we substitute the currency hedging variable by the variable that proxies for the hedging instruments inherent to all categories of risk. The results of 3SLS regression are analogous. Yet, the OLS regression results differ from the 3SLS results. They indicate that

there is no significant interaction between currency hedging activities and inherent exposure, and the degree of firms operations does not have a significant influence on the exchange rate exposure. As for the case of all hedging instruments, we verify that hedging activities still exhibit a significant negative influence in the exchange rate exposure.

Table 3:
Summary Statistics on Financial Price Exposures

Panel A. Descriptive statistics of exchange rate exposure coefficients					
	All Cases	Belgium	France	The Netherlands	Portugal
Mean	-0,558	-0,511	-0,688	-0,604	-1,411
Minimum	-42,386	-7,149	-6,399	-7,340	-42,386
Maximum	8,413	6,011	4,351	6,258	8,413
Std. Dev.	3,202	2,299	1,794	2,224	7,272
N° positive/negative cases	113/195	28/44	37/81	36/44	12/26
% significant cases	27,9%	26,4%	33%	26,25%	18,4%
Panel B. Descriptive statistics of interest rate exposure coefficients					
	All Cases	Belgium	France	The Netherlands	Portugal
Mean	-0,190	-0,235	-0,199	-0,333	-0,401
Minimum	-5,467	-1,704	-2,411	-0,506	-5,467
Maximum	1,066	1,025	6,399	1,042	0,560
Std. Dev.	0,551	0,559	0,520	0,184	0,943
N° positive/negative cases	110/198	26/46	43/75	34/46	7/31
% significant cases	35,4%	30,6%	36,4%	43%	26,3%
Panel C. Descriptive statistics of commodity price exposure coefficients					
	All Cases	Belgium	France	The Netherlands	Portugal
Mean	-0,045	0,043	0,089	0,104	-0,208
Minimum	-1,860	-0,677	-0,745	-0,990	-1,859
Maximum	1,395	1,395	2,411	0,968	0,793
Std. Dev.	0,387	0,333	0,339	0,362	0,554
N° positive/negative cases	167/141	39/33	68/50	48/32	12/26
% significant cases	22,4%	20,8%	22%	26,25%	18,4%

Note. This table reports descriptive statistics of β_{ix} - the exchange rate exposure (Panel A), the interest rate exposure (Panel B) and the commodity price exposure (Panel C) – estimated from the equation (2) for the period from January 31, 2006 until December 31, 2008. The percentage of significant cases is achieved at 10% or lower levels of significance.

Similarly, within the scope of the interest rate exposure, the 3SLS results indicate that an interrelation between the interest rate exposure variable and hedging activities does not exist. The significant negative effect of hedging activities on exposure is in line with Bartram (2002), but only limited to the variable that represents all categories of risk. In addition, there is no significant effect of liquidity on interest rate exposure. Also, the coefficients estimates in OLS regressions do not establish a significant link between exposure, firms' real operations and hedging.

In analysing the commodity price exposure, the 3SLS results indicate, as expected, a negative effect of hedging activities on such exposure (Jin & Jorion, 2006; Tufano, 1998), although limited to the use of the variable that proxies for all hedging activities. Additionally, in the case of commodity price exposure, the revenues from commodity operations do not have a significant effect on exposure. In contrast, the OLS results indicate a positive interrelationship between commodity price exposure and commodity hedging activities.

In examining the control variables, we verify that the OLS results indicate that size (*ASSET*) and gross national product per capita (*GDP*) have a positive influence and dividend yield (*DIV*) has a negative influence in exchange rate hedging instruments. These are as expected. In contrast, 3SLS results do not display any variable with significant effect on hedging activities. The 3SLS results indicate that size (*ASSET*) and financial leverage (*LEV*) have, as expected, a positive influence in interest rate hedging instruments. Inversely, the

Table 4:
3SLS and OLS Regression Results when Hedging Variable is assigned by Category of Risk

Independent variables	Dependent variables in the 3SLS regression						Dependent variables in the OLS regression						Predicted Influence	
	$ \hat{\beta}_1 $	DUM_FX	$ \hat{\beta}_2 $	DUM_IR	$ \hat{\beta}_3 $	DUM_CP	$ \hat{\beta}_1 $	DUM_FX	$ \hat{\beta}_2 $	DUM_IR	$ \hat{\beta}_3 $	DUM_CP		
Const	4,306*	289,567					2,242*	-4,347*						
$ \hat{\beta}_1 $		-14,813						-0,005						+
FS/TS	2,344*						-0,032							na
DUM_FX	-4,141*						-0,610							-
Const			0,388*	-2,326					0,346*	-3,961*				
$ \hat{\beta}_2 $				-0,703						0,017				+
LIQ			-0,073						-0,117					-
DUM_IR			-0,083						-0,008					-
Const					0,366*	-0,749					0,273*	-0,941		
$ \hat{\beta}_3 $						-0,306						0,191*		+
TI/TS					-0,014						-0,010			na
DUM_CP					-0,454						0,074*			-
<i>Control variables:</i>														
ASSET		-0,662		0,037*		0,007		0,015*		0,038*		0,008		na
CAPEX		-19,250		0,685		-0,275		0,201		0,695		-0,407		+
DIV		70,619		1,283		1,195		-2,358*		1,712		1,453		-
GDP		-24,329		0,223		0,088		0,480*		0,354*		0,089		+
INS		0,107		-0,101*		-0,019		-0,018		-0,105*		-0,016		+
LEV		-10,817		1,021*		-0,009		0,035		1,129*		0,083		+
PE		0,006		-1,4e ⁻⁰⁴		-6,9e ⁻⁰⁵		-7,9e ⁻⁰⁵		-1,8e ^{-04*}		-8,7e ⁻⁰⁵		+
TAX		-11,637		-0,874		-0,473		-0,058		-0,802*		-0,547		+
R ²	---		---		---		0,01	0,13	0,001	0,32	0,013	0,047		

Note. The statistics reported are obtained through Gretl (version 1.8.6). In the predicted influence column – na – means that there is no prediction. $|\hat{\beta}_1|$, $|\hat{\beta}_2|$ and $|\hat{\beta}_3|$ represent the magnitude of exchange rate exposure, the magnitude of interest rate exposure and the magnitude of commodity price exposure, respectively; ASSET = proxy for firm size, measured by the natural logarithm of total assets; CAPEX = proxy for firm investment, measured by the ratio of capital expenditures to total assets; DIV = dividend yield proxy for firm liquidity, measured by the gross dividend per share divided by the closing stock price; DUM_FX, DUM_IR and DUM_CP are dummies which are assigned a value of 1 if a firm uses either external or internal foreign exchange hedging instruments, interest rate hedging instruments and commodity hedging instruments, respectively; FS/TS = proxy for firm foreign real operations, measured by the ratio of foreign sales to total sales; GDP = proxy for the availability of derivatives in capital markets, measured by the natural logarithm of gross national product per capita; INS = proxy for the managerial risk aversion, measured by the percentage of ordinary shares held by insiders; LEV = financial leverage proxy for the probability of financial distress, measured by the ratio of total debt to total assets; LIQ = proxy for the expected costs of financial distress, measured by the ratio of cash-flow to total assets; PE = proxy for growth opportunities, measured by the price earnings ratio; TAX = proxy for the convexity of firm tax schedule, measured by net operating losses to total assets; TI/TS = proxy for the need to hedge commodity price, measured by the ratio of total inventory to total sales. All the variables, with the exception of foreign firm sales, originate from the *InfFinancials* database. Data on firm foreign sales was manually collected from firm's annual reports.

* Indicates values that the coefficients are significant at 10% or lower levels.

Table 5:
3SLS and OLS Regression Results when Hedging Variable represents All Hedging Instruments

Independent variables	Dependent variables in the 3SLS regression						Dependent variables in the OLS regression						Predicted Influence	
	$ \hat{\beta}_1 $	DUM_ALL	$ \hat{\beta}_2 $	DUM_ALL	$ \hat{\beta}_3 $	DUM_ALL	$ \hat{\beta}_1 $	DUM_ALL	$ \hat{\beta}_2 $	DUM_ALL	$ \hat{\beta}_3 $	DUM_ALL		
Const	5,792*	278,358					2,676*	-3,379*						
$ \hat{\beta}_1 $		-12,992						-0,008						+
FS/TS	2,064*						0,065							na
DUM_ALL	-5,372*						-1,087*							-
Const			0,715*	-6,324*					0,391*	-3,575*				
$ \hat{\beta}_2 $				0,751						0,002				+
LIQ			-0,433						-0,120					-
DUM_ALL			-0,106*						-0,058					-
Const					0,508*	-2,706*					0,329*	-3,518*		+
$ \hat{\beta}_3 $						-0,588						-0,031		na
TI/TS					-0,009						-0,011			-
DUM_ALL					-0,257*						-0,049			-
<i>Control variables:</i>														
ASSET		-0,761		0,016*		0,013*		0,015*		0,015*		0,015*		na
CAPEX		-37,689		0,552		0,451		0,486		0,519		0,522		+
DIV		-2,022		0,195		-0,320		-0,376		-0,374		-0,399		-
GDP		-22,932		0,638*		0,338*		0,385*		0,401*		0,396*		+
INS		-0,441		-0,006		-0,005		-0,007		-0,006		-0,005		+
LEV		-19,311		0,384*		0,200		0,228*		0,242*		0,247*		+
PE		0,0025		4,8e ⁻⁰⁵		-5,7e ⁻⁰⁶		-8,7e ⁻⁰⁶		5,1e ⁻⁰⁶		-6,6e ⁻⁰⁵		+
TAX		-10,434		0,094		-0,090		-0,098		-0,084		-0,078		+
R ²	---		---		---		0,018	0,133	0,002	0,128	0,005	0,13		

Note. The statistics reported are obtained through Gretl (version 1.8.6). In the predicted influence column – na – means that there is no prediction. $|\beta_1|$, $|\beta_2|$ and $|\beta_3|$ represent the magnitude of exchange rate exposure, the magnitude of interest rate exposure and the magnitude of commodity price exposure, respectively; ASSET = proxy for firm size, measured by the natural logarithm of total assets; CAPEX = proxy for firm investment, measured by the ratio of capital expenditures to total assets; DIV = dividend yield proxy for firm liquidity, measured by the gross dividend per share divided by the closing stock price; DUM_ALL is assigned a value of 1 if a firm uses either external or internal hedging instruments; FS/TS = proxy for firm foreign real operations, measured by the ratio of foreign sales to total sales; GDP = proxy for the availability of derivatives in capital markets, measured by the natural logarithm of gross national product per capita; INS = proxy for the managerial risk aversion, measured by the percentage of ordinary shares held by insiders; LEV = financial leverage proxy for the probability of financial distress, measured by the ratio of total debt to total assets; LIQ = proxy for the expected costs of financial distress, measured by the ratio of cash-flow to total assets; PE = proxy for growth opportunities, measured by the price earnings ratio; TAX = proxy for the convexity of firm tax schedule, measured by net operating losses to total assets; TI/TS = proxy for the need to hedge commodity price, measured by the ratio of total inventory to total sales. All the variables, with the exception of foreign firm sales, originate from the *Infancials* database. Data on firm foreign sales was manually collected from firm's annual reports.

* Indicates values that the coefficients are significant at 10% or lower levels.

percentage of ordinary shares held by insiders (*INS*) has an unexpected negative effect over interest rate hedging instruments. In addition, the OLS results demonstrate that gross national product per capita (*GDP*) has also a positive influence in hedging, and that price to earnings ratio (*PE*) and net operating losses (*TAX*) have a negative influence, contrarily to the prediction that it is positive. Neither 3SLS nor OLS suggest any variable significantly related with commodity hedging instruments.

For the most part, when we use the hedging variable that seeks to represent for all the range of hedging activities, we verify that size (*ASSET*), gross national product per capita (*GDP*) and financial leverage (*LEV*) have, as expected, a positive influence in hedging activities.

5. Conclusions and Further Directions

This paper presents a comprehensive investigation of the financial risk exposures of European nonfinancial firms, based on the analysis of 308 firms during the period from 2006-2008. We built on previous studies that have used multifactor market models to access the level of financial risk exposures (exchange rate exposure, interest rate exposure and commodity price exposure), all together. In addition, taking into consideration the influence of both internal and external hedging instruments, we extend the recent investigation on the determinants of such exposures, recognizing that financial risk exposures and hedging are endogenous.

We document that sample firms exhibit higher percentages of exposure to the three categories of risk analysed when compared with previous empirical studies. Moreover, we find evidence that hedging activities are an important determinant of firms financial risk exposures. However, the empirical results do not confirm that hedging decisions depend on exposures factors. As for the association between firms' real operations and inherent exposures, this is only confirmed in the extent of exchange rate exposure. Summing up, the results suggest that firms use risk management instruments for the purpose of hedging.

A possible limitation appointed to this kind of study is the fact that the measure of exposure used seeks to represent already a net exposure, that is to say, the exposure that remains after the firm has engaged in some hedging activity. We suggest, for further research, the search for better measures of financial risk exposures.

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¹ The BAS price index is a market capitalization weighted index that includes the Belgian stocks that are listed on Euronext Brussels market.

² The CAC all shares is a market capitalization weighted price index composed of all stocks listed on Euronext Paris with an annual velocity of more than 5%, irrespective from market capitalization.

³ The A-DAM all shares index is a market capitalization weighted price index and comprises all shares listed on Euronext Amsterdam market.

⁴ The PSI General index is a market capitalization weighted index that only includes shares issued by companies that are listed on Euronext Lisbon.

⁵ In view of the number of firms that presents annual report in English on the Portuguese sub-sample, we made an exception. We have considered both, firms with annual report presented in Portuguese or in English.

⁶ The trade weighted Euro effective exchange rate index covers 22 currencies. In order of weighting they are Great Britain, USA, Japan, Switzerland, Sweden, China, Hong Kong, Taiwan, Denmark, South Korea, Poland, Singapore, Czech Republic, Russia, Turkey, Hungary, Malaysia, India, Norway, Canada, Thailand and Brazil.

⁷ The RICI represents the value of a basket of commodities employed in the global economy, ranging from agricultural and energy products to metals and minerals. The value of this commodity basket is tracked via futures contracts on 35 different exchange-traded physical commodities, quoted in four different currencies, listed on eleven exchanges in five countries.

⁸ The MSCI Euro index is a subset of the MSCI Pan-Euro index and includes the largest and most liquid stocks from the ten European Union countries. The countries included in the index are: Austria, Belgium, Finland, France, Germany, Ireland, Italy, The Netherlands, Portugal and Spain.

⁹ The returns are adjusted for the payment of dividends, stock splits, etc.

¹⁰ In what respects exchange rate exposure, the use of risk management instruments should decrease exchange rate exposure for firms with positive exposures and increase (decrease in absolute value) exchange rate exposure for firms with negative exposures.

¹¹ Jorion (1990) shows that only 5% of his sample exhibits significant exchange rate exposure. Choi and Prasad (1995) document that only 15% of their sample experience significant exchange risk. He and Ng (1998) report that about 25% of their sample has significant exchange rate exposure. For German firms, Bartram (2002) finds a linear interest rate exposure in the range of 6,4% to 18,8% and Bartram (2005) finds that the fraction of sample firms with statistically significant commodity price exposure is roughly 4,5% to 15,9%.