INSIGHTS INTO CENTRAL AND EASTERN EUROPEAN COUNTRIES COMPETITIVENESS: ON THE EXPOSURE OF CAPITAL MARKETS TO EXCHANGE RATE RISK

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Unexpected fluctuations in exchange rates represent a matter of concern for all businesses nowadays as the volatility in exchange rates impacts businesses' cash flows, revenues and expenses, and eventually is reflected in the company's risk-return profile. Companies' exposures to exchange rate risk have considerably increased in the past decades, given the boost in international operations and the continuous diversification of businesses' activities at the global level. Despite the attention that businesses display to nominal exchange rates changes, it is the real exchange rate that should be of more concern to corporate managers, since they induce changes at the level of the competitiveness of the business. Our paper comparatively analyzes the exposure to changes in the nominal and real exchanges rates of the local currencies that companies from a number of four Central and Eastern European countries (Romania, Hungary, Czech Republic and Poland) and investigates the nature of the relationship between stock market performance and exchange rates in the four countries under consideration. We find limited evidence for contemporaneous and asymmetric exposure to nominal and real exchange rate risk in all four countries, but consistent evidence for three to four months lagged exposure.

Keywords: *exposure, exchange rate risk, nominal exchange rate, real exchange rate*

JEL classification codes: *F23, F31, G15*

1. INTRODUCTION AND THEORETICAL CONSIDERATIONS

Unexpected fluctuations in exchange rates represent a matter of concern for all businesses and particularly for those involved in international business, since the generalized adoption of floating exchange rates, at the beginning of 1970's. The volatility in exchange rates impacts businesses' cash flows, revenues and expenses, and eventually is reflected in the company's risk-return profile. At the same time, the increased globalization process that took place in the last decades has made exchange rates an issue that cannot be ignored by any company, no matter its degree of international involvement. Works in the field of international finance consider exchange rate risk as one of the most relevant components of financial management

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in modern times, since companies' exposures to exchange rate risk have considerably increased in the past decades, given the boost in international operations and the continuous diversification of businesses' activities at the global level.

In international finance research, corporate exposure to exchange rate risk is built upon the impact of exchange rate changes on a number of key-elements: shareholder's wealth, firm's assets and liabilities or company's financial position. Adler and Dumas (1984) define exposure to exchange rate risk as the change in the value of the firm induced by changes in exchange rates. This is one of the broadest definitions of exposure, followed by others, more specific. Eiteman, Stonehill and Moffett (2004) measure exposure by the potential change in company's profitability, its net cash flows and market value, determined by exchange rate changes. Holland (1993) locates foreign exchange exposure at the level of companies that own assets abroad, thus ignoring companies that operate in a purely national environment. Another definition is provided by Shapiro (2002) that understands by exchange rate exposure the degree to which a company is affected by exchange rates changes. Beyond the mere definition, international research demonstrates a higher homogeneity with regard to the exchange rate exposure types that a company faces. Depending on the moment in time when exchange rates change, a company might face: (1) *transaction exposure*, that arises whenever the firm commits or is contractually bounded to make or receive a payment at a future fate denominated in a foreign currency; (2) *translation exposure*, arising from the need to globally consolidate the financial reports of a multinational company, starting from affiliates' reports denominated in various currencies; and (3) *economic exposure*, seen as the change in the firm's present value as result of changes in the value of the firm's expected future cash flows and cost of capital, induced by unexpected exchange rate changes. As opposed to transaction and translation exposure, a firm will be confronted with economic exposure to exchange rates when unanticipated real, not only nominal exchange rate changes, have a non-zero effect on its expected future cash flows. Two main mechanisms that generate economic exposure can be identified: a conversion effect – given the lower amount in home currency that will be obtained after converting the same amount in a foreign currency at a lower exchange rate; and a competitive effect – given the change in the firm's competitive position that follows an asymmetric sensitivity of its revenues and expenses to exchange rate changes.

Empirical evidence on corporate exposure to exchange rate risk is almost entirely concentrated on the case of companies originated from developed countries, given the higher data availability for performing tests. At the same time, in most studies, the impact of nominal exchange rate changes, as opposed to real exchange rate changes is tested, following the rationale that inflation rates are small and that

any change in the nominal exchange rate level will directly generate changes in the real exchange rate level. Albeit this might be true for developed countries, traditionally displaying low inflation rates, in the case of less developed countries, where inflation rates are higher, the connection between nominal and real exchange rates is not as direct. Jorion (1990) examines US multinational corporations exposure to exchange rate risk for a 17 years period and concludes that share prices of these companies are not systematically influenced by changes in nominal exchange rates, but further research on American multinationals conducts to mixed results: Bartov and Bodnar (1994) and Choi and Prasad (1995) confirm Jorion's findings, while Allayannis (1996), Miller and Reuer (1998), Gao (2000) and Koutmos and Martin (2003) seem to detect a more significant link between the American companies share prices and changes in the nominal exchange rate of the dollar against various currencies. Research in the field also identifies lagged exposures, as well as asymmetric responses of share prices to changes in the dollar value. Outside the United States, Glaum et al. (2000) investigate German companies' exposure to changes in the nominal exchange rate of the German mark against the dollar during1974-1997 and find it as being significant. Their result is confirmed by Entorf and Jamin (2002), which identify the company's degree of involvement into international business and the level of the exchange rate as being two important factors in explaining the exposure. Dutch companies have been researched by De Jong et al. (2002) that find more significant exposures in phases of the Dutch guilder depreciation, after investigating 117 companies over a 5-year period (1994-1998). Doukas et al. (2003) examine the relation between the rate of return on a number of 1079 Japanese companies' shares and unexpected changes in the Japanese yen exchange rates between 1975 and 1995 and find significant exposures, which are higher in the case of multinational and exporting companies, being also positively linked to the degree of international involvement of the firm, on one hand, and negatively linked to the firm's size and its financial leverage. British companies also display significant exposure, according to El-Masry (2003), but depending to a large extent on the industry.

As mentioned above, less developed countries were less interesting for researchers: to our knowledge the only study released so far – Kyimaz (2003) – investigates Turkish companies for the period 1991-1998 and finds significant exposures to exchange rate risk, but also variable in magnitude from one industry to another. Companies from Central and Eastern Europe benefit from less attention in the literature. Horobet and Lupu (2005) analyse for the first time the Romanian companies' exposure to changes in the Romanian currency exchange rates against the euro and the U.S. dollar over the January 2000 – October 2005 period and find weak significant exposures to both currencies. They explain their findings by the reduced importance of the euro or dollar denominated cash flows and/or assets and

liabilities in the financial flows of Romanian companies, by the possible presence of internal hedging operations or by the low capital market efficiency. At the same time, they find that exposure to euro is asymmetric, by contrast with the dollar exposure. Horobet and Lupu (2006) extend their analysis to a number of 10 Central and Eastern European countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia and Romania) by taking into consideration changes in these countries' real exchange rates measured against the U.S. dollar and the euro. The results indicate the lack of contemporaneous and lagged exposures, which may be interpreted as a failure of stock market investors to incorporate changes in the competitive positions of firms in these countries in the stock returns. Horobet and Ilie (2007) investigate the link between exchange rate changes and stock market performance using cointegration and Granger causality tests, in order to capture the bi-directional influences between stock prices and exchange rates, applied to monthly data over 1999 to 2007. They conclude that there is a long-term equilibrium relationship between the stock market performance and the nominal and real effective exchange rates, while the information is generally transmitted from the stock prices to exchange rates with a one-month lag in the case of cointegrated variables. Also, the exchange rates are the leading variables for the stock prices and the stock market adjusts quite dramatically to changes in the exchange rates in one month time in the case of cointegrated variables.

Our paper studies the exchange rate exposure of national stock markets from Central and Eastern Europe, using nominal bilateral and effective exchange rates, as well as real effective exchange rates. When the stock market is studied, as opposed to individual companies or industries, we implicitly study how exporting, importing and import-competing firms are affected by exchange rate surprises. At the economy-wide level, one would normally expect that some activities should be affected positively by changes in exchange rates and some negatively: typically, a depreciation of the domestic currency should boost the revenues and profits of exporting companies, while an appreciation of the domestic currency should represent good news for importing companies. These effects on the stock market index could compensate each other, which may lead to the finding of a lack of exposure of stock markets to unexpected changes in exchange rates.

Exchange rate exposure cannot be interpreted only as the effect of purely exogeneous movements in the exchange rate on the value of the firm. It may very well happen that the estimate of exposure may reflect that exchange rates and stock prices are driven by the same shocks, which becomes more relevant if one studies the exchange rate exposure of an entire stock market as opposed to studying the exposure of a particular firm. At the same time, one may recognize that developments in the stock market may influence or may be influenced by monetary policy decisions and interest rates. This would perhaps lead one to examine the

interrelationships between the stock market and the currency markets in a VAR framework, using cointegration and Granger causality models. The authors choose in this paper to stay closer to the tradition in the exchange rate exposure literature that of including the exchange rate as the only independent variable in the main analysis.

The significant adding to the traditional analysis is the test for the presence of asymmetric exposures of Central and Eastern European capital markets to nominal and real exchange rate changes. Miller and Reuer (1998) observe that previous studies were based on the assumption that the financial performance effects associated with exchange rate appreciation and depreciation are symmetric. But this framework excludes the firms' ability of use real options to hedge economic exposures to foreign exchange rate movements: if they use them, then one should observe different exposure coefficients for periods of foreign currency appreciation and depreciation. Therefore, real option theory suggests that operational flexibility allows the firm to selectively exploit currency movements to its advantage while protecting the firm during periods when exposure would adversely affect firm value. If firms do not possess options for managing foreign exchange exposures, one would observe symmetric exposures for both appreciation and depreciation of foreign currencies. Also, one may observe firms with no exposure, regardless of movements in real values of foreign currencies. Miller and Reuer split their time series data into periods of currency appreciation and periods of depreciation and estimate two exposure coefficients for a firm. They find limited evidence for asymmetric exposures, but also no empirical evidence that U.S. manufacturing firms are exposed to foreign exchange movements in a symmetric fashion. Koutmos and Martin (2003) study nine U.S. sectors over the 1992-1998 period and find that in 25% of the cases the significant exposures are asymmetric, while using one-lag, 79% of the exposures are asymmetric. When investigating Korean companies, Oh and Lee (2004) observe that most domestic firms face asymmetric exchange rate exposures and that the pricing-to-market theory carries more conviction that the real option theory.

The paper is structured as follows: Section II overviews the conceptual distinctions between nominal and real exchange rates, Section III describes the nominal and real exchange rates evolution in Central and Eastern Europe after 1998, Section IV presents the data and methodology used in our analysis, Section V outlines our main findings, and Section VI concludes and delineates further research directions.

2. NOMINAL AND REAL EXCHANGE RATES

Analogous to concerns with the effects of inflation in the domestic setting on nominal versus real price levels, the effects of relative inflation rates between the home economy and the foreign economy matter for the exchange rate between the two countries. When the foreign inflation is higher and the home inflation does not change, the foreign currency would be expected to depreciate against home currency. Although the foreign currency will cost less now in home currency terms, this does not necessarily imply that the real value of goods and services purchases across borders decreased. The explanation resides in the fact that the increase in foreign prices for goods and services has exactly offset the decline in the value of the foreign currency, given higher inflation rates abroad than at home. Another way of expressing this phenomenon is to say that purchasing power remains the same in the two countries. In this case, while the foreign currency has undergone a nominal depreciation, it has not undergone a real depreciation. Therefore, what eventually matters for purchasing power between any two countries is not the simple change in the nominal exchange rate, but the change in nominal rates after adjustments for the changes in the relative inflation rates between the two countries have been made. The *real exchange rate* can be defined as the nominal exchange rate that takes into account the inflation differentials among the countries. When a currency appreciates in real terms, its purchasing power abroad has increased; when it depreciates in real terms, its purchasing power abroad has decreased. The importance of the real exchange rate to international business and finance research stems from the fact that it can and it is widely used as an indicator of relative competitiveness in the foreign business of a country.

Because of this important role it plays in an economy, the real exchange rate has been one of the most debated issues both in theory and practice. The debate over the real exchange rate is observable at the definition level, on one hand, and at the test level, on the other hand. Since the purpose of this paper is to link real exchange rates with changes in the competitiveness level, we will briefly review only the definition debate, as it is revealed by the existing calculation methods and interpretation of real exchange rates.

The various definitions of the real exchange rate can be categorized under two main types: the first type is linked to the theory of purchasing power parity, while the second is based on the distinction between the tradable and non-tradable goods. Although they may coincide in some special cases, applying these two types of definitions typically leads to different results. According to Purchasing Power Parity (PPP), the real exchange rate can be defined as the nominal exchange rate, adjusted by the ratio of the foreign country price level to the domestic country price level. In terms of this definition, the benchmark level of the real exchange rate equals 1, while a value higher than one can be interpreted as a real appreciation of the foreign

currency. The reverse is true when the real exchange rate has a value lower than 1. The definition on the basis of tradable and non-tradable goods takes the relative price of the tradable and non-tradable goods in a specific country as an indicator of the country's competitiveness level in the foreign trade. The rationale behind this definition is the related to the fact that cost differential between the countries are closely related to the relative price structures in these economies. Under the terms of this definition, a decline in the real exchange rate indicates a real appreciation of the domestic currency. Given an unchanged price structure in a country, a higher relative price of non-tradables leads to a decrease in the country's level of competitiveness against its trade partners. In practice, applying the second definition proves complex (it can only be made by considering the ratio of the prices of exportable or importable goods to the prices of the non-tradables) and for this reason the first definition is widely used.

Although more used, the PPP-based definition of the real exchange rates raises the issue of the price index employed in the computation. The wholesale price index (WPI) and the consumer price index (CPI) are two of the leading indices that can be used in these calculations, other alternatives being the gross domestic product (GDP) deflator and producers' price index (PPI). All these indices support criticism. The most important criticism to the real exchange rates calculated by using the WPI is that commodities included in this index are formed of tradables that are similar in nature and, therefore, their prices are not expected to differ substantially when measured in a common currency. Consequently, the changes in the real exchange rate calculated using the WPI would not sufficiently indicate the changes in a country's competitiveness level. The same criticism applies for the PPI as well: although in theory the PPI includes the prices in the services sector – categorized as non-tradables –, in practice such an index includes the prices in the primary and secondary sectors, which are categorized as tradables. On the other hand, the main problem with the real exchange rates calculated by using the CPI is that this index includes the non-tradable commodities, while the main problem with the GDP deflator is that the time series is not available on the monthly basis.

Apart from bilateral nominal and real exchange rates, international financial statistics operates with the concepts of nominal effective and real effective exchange rates. The *nominal effective exchange rate* of a country (NEER) or, equivalently, the "trade-weighted currency index" of the country aims to track changes in the value of the country's currency against the currencies of its main trading partners. The *real effective exchange rate* (or, equivalently, the "relative price and cost indicators") aims to assess a country's competitiveness in terms of prices and costs against its main competitors in international goods and services markets. The existing literature employs a wide range of prices to calculate real effective exchange rates, such as: consumer price index (CPI), GDP deflator, industrial production prices index (PPI),

nominal unit labour costs for the total economy or for the manufacturing industries, and the ratio between the prices of tradable and non-tradable goods. As an indicator of international competitiveness, the real effective rate is best to be used over a long-run horizon. Still, despite its widespread use, this indicator has some disadvantages. Specifically, the concept of international competitiveness is difficult to be measured at the economy level, as the indicator does not take fully into account the competition at firm level that includes factors such as product quality, innovation and reputation. Nevertheless, the use of real exchange rates may be explained by the fact that firms' international performances are highly influenced by macroeconomic evolutions, particularly in emerging countries. The methodologies used for the computation of the effective exchange rates differ between the International Monetary Fund, European Central Bank and OECD. In our research we have used the rates calculated according to the European Central Bank methodology. Specifically, the NEER is calculated as a weighted geometric average of the bilateral exchange rates against the currencies of trade partner countries and reported as an index; a rise in the index indicates a strengthening of the currency in nominal terms. The REER corresponds to the NEER deflated by nominal unit labour costs for the total economy and consumer prices (CPI/HICP); a rise in the index signifies a real appreciation of the currency and, by consequence, a loss of competitiveness.

3. EXCHANGE RATES IN CENTRAL AND EASTERN EUROPE

The enlargement of the European Union in May 2004, by the accession of ten Central and South-Eastern European countries, of which eight were former communist countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), followed by a second wave of accession at the beginning of 2007, that also involved two former communist countries (Bulgaria and Romania), represents an economic and political experiment that is entirely different from all previous accessions. The integration process of all these countries will directly impact their capital, money and currency markets, with a precise goal represented by the adoption of the common euro currency. The adoption of the euro is by far the greatest challenge all these countries were faced with since the moment of their accession to EU, and one of them – Slovenia – proved that the criteria imposed by the EU in order to adopt the euro can be achieved, as the country adopted the euro as its currency at the begging of 2007.

The exchange rate regimes of the former communist countries in the region are quite diverse, ranging from free floating to currency boards. The four countries included in our analysis currently used more flexible regimes, as compared to the remaining of the twelve former communist countries in the region: Czech Republic has a managed floating with no-predetermined path, as well as Romania, Poland uses an independent floating regime, Hungary enjoying the least flexible regime, as

its currency is pegged to the euro with a predetermined band of ±15%. It is worth pointing that during the past ten years, all the four countries have transformed their monetary policies by adopting the inflation targeting framework: Czech Republic in 1998, Poland in 1999, Hungary in 2001 and, more recently, Romania in 2005. Nevertheless, all of these countries will see their currencies replaced by the euro, but not until they will stay in the Exchange Rate Mechanism II (ERMII) at least two years before the euro adoption. This exchange rate arrangement, similar to the Exchange Rate Mechanism I that eventually led to the euro adoption by the initial twelve EU countries was introduced on January 1, 1999, and its role is to ensure convergence and easier euro adoption, by inducing higher stability at the level of exchange rates against the euro. Participation in ERMII is voluntary for all non-euro area member states; however, as ERMII membership is one of the convergence criteria for the eventual euro adoption, all new member states are expected to join the mechanism sooner or later. For the currency of each member state participating in the mechanism, a central rate against the euro and a standard fluctuation band of ±15% are defined.

When one observes the evolution of the four countries' exchange rates between January 1999 and December 2007 interesting patterns are revealed. Figures 1 and 2 depict the bilateral exchange rates of the domestic currencies against the U.S. dollar and the euro, respectively. The first observation is that the Romanian currency (RON) behave differently as compared to the other three currencies: while the Czech koruna (CZK), Hungarian forint (HUF) and Polish zloty (PLN) deppreciated until the end of 2000 against the U.S. dollar, afterwards entering an appreciating period until the end of 2007, RON depreciated heavily against the U.S. dollar until the end of 2001, then it somehow maintained its value against the U.S. dollar until mid-2004, but afterwards the trend was reversed and the Romanian currency began an overall appreciating phase against the U.S. dollar, also accompanied by higher volatility in the foreign exchange market. The same general pattern is to be discovered in the evolution of the four currencies against the euro, with two noteworthy observations: (1) CZK, HUF and PLN appreciated less against the euro as compared to the U.S. dollar during the considered timeframe; (2) the volatility of all four currencies against the euro was lower when compared to the volatility against the U.S. dollar – the standard deviation of monthly changes in exchange rates was 3.14% against the U.S. dollar and 1.47% against the euro in the case of CZK, 3.22% against the U.S. dollar and 1.84% against the euro for the HUF, 3.16% against the U.S. dollar and 2.64% against the euro for the PLN, and 3.07% against the U.S. dollar and 2.84% against the euro in the case of RON - , which suggests that central banks in these countries have made efforts to reduce the band of fluctuation against the common European currency, given the entrance of their currencies in the ERMII arrangement.

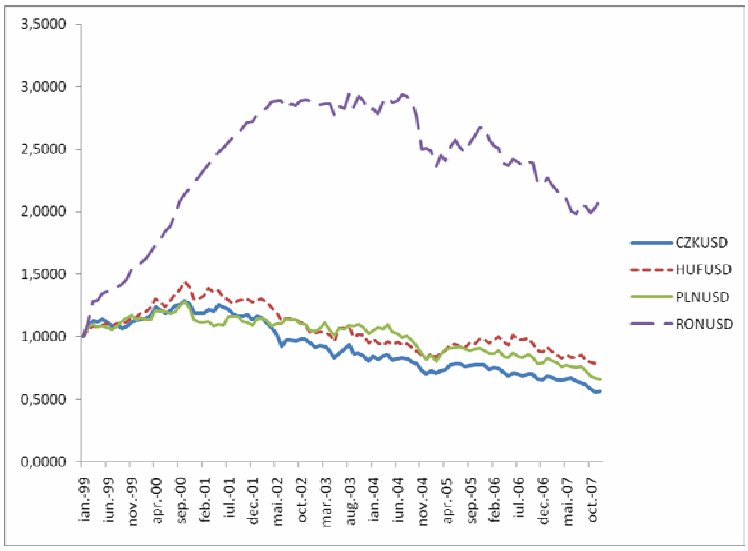

Figure 1. *Exchange rates of domestic currencies against the U.S. dollar, 1/1999-12/2007; January 1999=1*

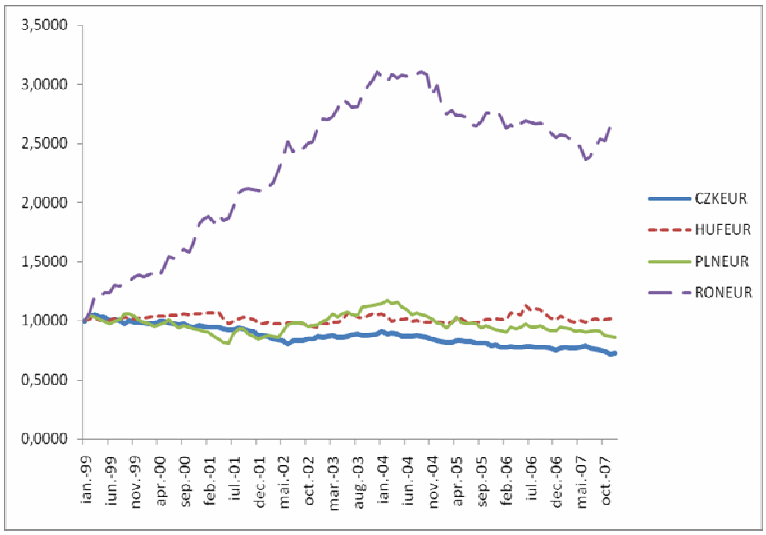

Figure 2. *Exchange rates of domestic currencies against the euro, 1/1999-12/2007; January 1999=1*

The nominal effective exchange rates, as measures of overall strength of the currencies against the currencies of their main trading partners, tell a slightly different story for the currencies in our study. As mentioned above, a rise in the NEER index indicates an appreciation of the currency in nominal terms. Figure 3 depicts the evolution of the NEER27 over the 1998-2007 period[1] and allows us to observe that the only currency showing a clear appreciating pattern is the Czech

[1] The evolution of currencies against NEER13, NEER36 and NEER41 is similar to NEER27.

koruna, while the Romanian currency depreciated massively by the end of 2007, reaching 40% of its value in January 1998. At the same time, the Hungarian forint and the Polish zloty fluctuated in value, with the forint having at the end of 2007 approximately the same value as the one in January 1998, and the zloty increasing by 10% its value at the end of 2007 as compared to January 1998.

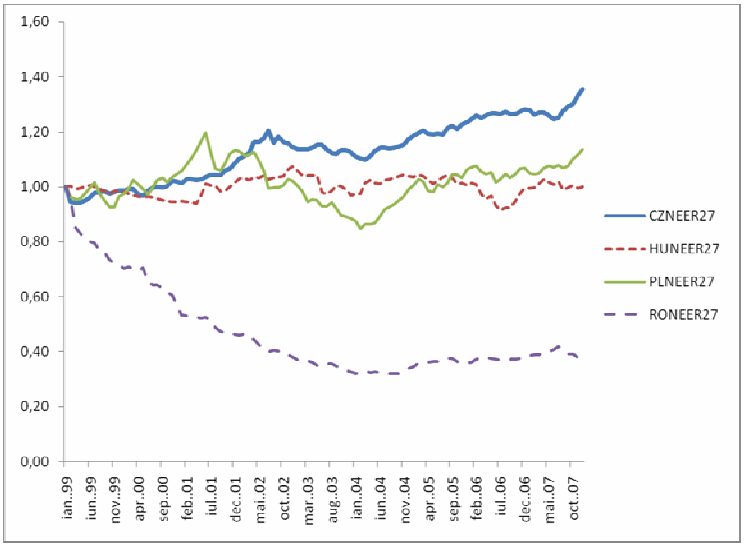

Figure 3. *Nominal effective exchange rates (NEER27) of domestic currencies against the euro, 1/1999-12/2007; January 1999=1*

Although in nominal terms the four currencies showed different patterns of evolution, when one analyzes the trends in these countries' competitiveness using the real effective exchange rates it may clearly observe the losses in competitiveness suggested by the real appreciations of domestic currencies during the 1998-2007 period. Of the four countries, Romania shows the heaviest loss in competitiveness, as its currency appreciated in real terms against its major trading partners by approximately 50% during the period, followed by the Hungarian forint, the Czech koruna and the Polish zloty. The RON real appreciation was more accentuated after the end of 2004 and it was coupled with a nominal appreciation of the currency against the U.S. dollar and the euro, as well as with a nominal depreciation against the currencies of trading partners.

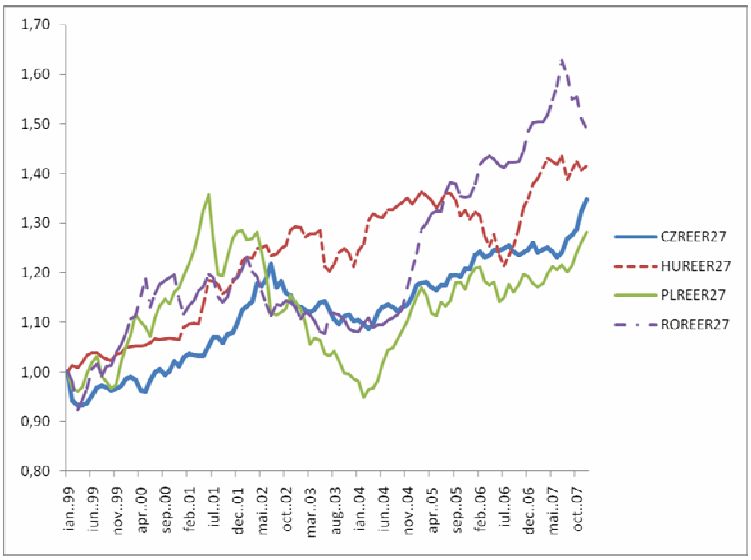

Figure 4. *Real effective exchange rates (REER27) of domestic currencies against the euro, 1/1999-12/2007; January 1999=1*

4. DATA AND RESEARCH METHODOLOGY

The research employs two sets of data on each of the four countries – Czech Rep., Hungary, Poland and Romania -, over the January 1999 – December 2007 period. The first set of data covers monthly values of local stock market indices, denominated in the local currencies. In order to track the performance of stock exchanges in the region we have used the MSCI (Morgan Stanley Capital International) indices for Czech Rep., Hungary and Poland, as well as their local stock exchange indices (PX50 for the Czech market, BUX for the Hungarian market, and WIG for the Polish market) and the BET and BET-C indices of Bucharest Stock Exchange for Romania. For what concerns the exchange rates data, we have used bilateral nominal exchange rates of the local currencies against the euro and the U.S. dollar, nominal effective exchange rates computed against the euro-13 are countries (NEER13), the EU-27 countries (NEER27), the main 36 trading partners (NEER36) and the main 41 trading partners (NEER41), and real effective exchange rates computed against the same trading partners as for the nominal effective rates (REER13, REER27, REER36 and REER41)[2]. The bilateral rates are end-of-month exchange rates collected from the websites of central banks from the respective countries, while data on nominal and real effective rates were collected from the

[2] The trading partners included in the construction of NEER13 and REER13 are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia and Spain. NEER27 and REER27 include also Bulgaria, Czech Republic, Cyprus, Denmark, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Sweden and United Kingdom. NEER36 and REER36 supplementary include Australia, Canada, Japan, Mexico, New Zealand, Norway, Switzerland, Turkey and United States. NEER41 and REER41 include above the already mentioned countries Brazil, China, Hong Kong, Korea and Russia.

database of the Directorate General for Economic and Financial Affairs of the European Commission.

In order to identify the relevance and magnitude of corporate exposures to changes in the exchange rates in these countries, we estimated ordinary least squares (OLS) regressions as follows:

$$(1) \qquad R_{i,t} = \beta_{0,t} + \beta_{1,t}\Delta S_{i,t} + \varepsilon_{i,t}$$

$$(2) \qquad R_{i,t} = \chi_{0,t} + \chi_{1,t}\Delta S_{i,t-k} + \eta_{i,t}$$

$$(3) \qquad R_{i,t} = \gamma_{0,t} + (\gamma_{1,t} + \gamma_{D,t}D_t)\Delta S_{i,t} + \omega_{i,t}$$

For market i, $R_{i,t}$ is the return on the national stock market (logarithmic change in the monthly value of the stock market index). $\Delta S_{i,t}$ is the logarithmic change in the nominal bilateral exchange rate of the local currencies against the euro and the U.S. dollar and in the nominal and real effective exchange rates of the domestic currencies. A positive change in the nominal bilateral exchange rates is interpreted as an appreciation of the foreign currency and a depreciation of the domestic currency, while a positive change in the nominal effective exchange rate is interpreted as an overall strengthening or appreciation of the domestic currency. On the other hand, a positive change in the real effective exchange rate signifies a real appreciation of the domestic currency against its trading partners and, consequently, a decrease in the competitiveness of the respective economy. The regressions indicated by (2) above test for the presence of lagged exposures up to 4 months: k=1 to 4. We also investigate for the presence of asymmetric exposure in regressions indicated by (3) above, using the following methodology: we constructed a dummy variable that captures the changes in the exchange rates and takes the value of one if $\Delta S_{i,t}>0$ and zero otherwise when bilateral exchange rates were used, and the value of one if $\Delta S_{i,t}<0$ and zero otherwise when nominal and real effective exchange rates were used.

The value of regression coefficients $\beta_{1,t}$, $\chi_{1,t}$ and $\gamma_{1,t}$ indicates the magnitude of the respective market overall exposure to exchange rate risk: the higher the value of the coefficient, the higher the exposure. The regression coefficient signs should be interpreted differently, depending on the exchange rate being used, as follows: (1) when bilateral rates against the U.S. dollar and the euro are used, a positive coefficient signifies that a depreciation of the domestic currency against the foreign currencies results in an increase in the value of the stock index and, consequently, in the value of companies in the respective country, the reverse being true for a negative coefficient; (2) when nominal effective exchange rates are used, a positive coefficient indicates that a strengthening of the domestic currencies is reflected in increases in the stock index' value, the reserve being true for negative coefficients: (3) when real effective exchange rates are used, a positive coefficient suggests that a real appreciation of the domestic currency, which is linked to a decrease in the

economy-wide competitiveness, results in positive returns in the local stock market, the reverse being true for a negative value of the coefficient.

5. EMPIRICAL RESULTS

5.1. Unit root tests

A stylized fact of individual economic time series is that they are non-stationary in levels and stationary in the first differences; that is, they are *I*(1). In particular, shocks in the level of an *I*(1) series are permanent, whereas shocks to the first difference are transitory. We used two traditional unit root tests, namely the augmented Dickey–Fuller (ADF) test and the Phillips–Perron (PP) test, to investigate the *I*(1) property. Both of these tests investigate the presence of a stochastic trend in the individual series. The standard ADF test for a unit root is based on the following equation:

$$\Delta x_t = \alpha + \beta t + \delta x_{t-1} + \sum_{i=1}^{k} \Delta x_{t-1} + \varepsilon_t$$

where $e \sim IDD(0,\sigma^2)$. The PP test is a non-parametric method of controlling for higher order serial correlation in a series. Both ADF and PP test statistics failed to reject the null hypothesis of the existence of a unit root in log levels but reject the same null hypothesis in the log first difference of the series. Thus, all the time series used in this study are integrated of order 1, or *I*(1).

5.2. Contemporaneous and lagged exposure to exchange rate risk

Table 1 presents the results of contemporaneous exposures to changes in nominal and real exchange rates for the fours markets in Central and Eastern Europe. All markets except Czech Republic show the presence of exposure to changes in the bilateral rate of their currencies against the U.S. dollar, and all markets except for Romania show exposure to changes in the bilateral rates against the euro. In all cases when exposure is identified, the coefficients are negative, implying that domestic currencies' appreciation against the dollar and the euro lead to increases in the value of stock indexes, indicating increases in companies' values. When nominal effective rates are used, Poland and Hungary are exposed to changes in all categories of rates, Czech Republic shows exposure only to changes in the NEER13, while no exposure was detected for Romania. While the overwhelming majority of coefficients is positive, suggesting that appreciations of domestic currencies lead to increases in companies' market value and depreciations generate decreases in companies' value, in the case of Czech Republic our results point to an inverse relation: for this country, an appreciation of the domestic currency is reflected in decreases in companies' market value, while a depreciation of the domestic currency leads to increases in firm's value. These results suggest, with the

exception of the Czech Republic, an exposure that is typical to importing companies, whose activities are boosted by appreciations of the domestic currency. When real exchange rates are used, only Hungary and Poland show positive exposure coefficients, which indicate that real appreciations of domestic currencies are reflected in positive returns in the stock market and in increases in local companies market value. This result is puzzling, since currencies real appreciations normally indicate losses at the economy-wide competitiveness, which should be reflected in turn by declines in companies' market values. We interpret our finding by the lack of representativeness of the companies listed in the stock markets in these countries for the economy-wide performance.

Table 1.

Contemporaneous exchange rate exposures for national stock markets, 1/1999-12/2007

Country	Regression coefficients $\beta_{1,t}$									
	USD	*EUR*	*NEER13*	*NEER27*	*NEER36*	*NEER41*	*REER13*	*REER27*	*REER36*	*REER41*
Czech Republic										
MSCI	0.133	0.049	-15.512**	0.730	0.689	0.653	0.848	0.725	0.681	0.642
	(0.230)	(0.491)	(6.416)	(0.604)	(0.581)	(0.566)	(0.527)	(0.544)	(0.525)	(0.511)
PX	-0.135	-0.655***	-3.018	0.002	-0.059	-0.075	0.350	0.125	0.059	0.036
	(0.164)	(0.344)	(4.691)	(0.434)	(0.417)	(0.406)	(0.379)	(0.391)	(0.377)	(0.367)
Hungary										
MSCI	-0.380***	-1.145*	1.306*	1.284*	1.263**	1.189**	1.094**	1.085**	1.070**	1.009**
	(0.217)	(0.369)	(0.461)	(0.481)	(0.486)	(0.481)	(0.448)	(0.468)	(0.477)	(0.473)
BUX	-0.391**	-0.928*	1.624*	1.577*	1.530*	1.483*	1.478*	1.450*	1.422*	1.382*
	(0.162)	(0.276)	(0.324)	(0.342)	(0.347)	(0.344)	(0.316)	(0.333)	(0.341)	(0.339)
Poland										
MSCI	-0.726*	-1.235*	0.966*	1.012*	1.051*	0.359	-0.279	0.934*	0.974*	0.967*
	(0.227)	(0.258)	(0.328)	(0.337)	(0.346)	(0.345)	(0.508)	(0.328)	(0.337)	(0.342)
WIG	-0.505*	-0.533*	0.955*	0.980*	1.008*	0.428***	0.069	0.930*	0.959*	0.971*
	(0.158)	(0.191)	(0.219)	(0.225)	(0.231)	(0.238)	(0.354)	(0.219)	(0.225)	(0.228)
Romania										
BET	-0.387	-0.273	0.039	0.048	0.025	0.043	0.221	0.390	0.401	0.427
	(0.281)	(0.306)	(0.370)	(0.380)	(0.396)	(0.402)	(0.382)	(0.452)	(0.482)	(0.495)
BET-C	-0.515**	-0.399	0.368	0.382	0.314	0.331	0.300	0.439	0.382	0.395
	(0.245)	(0.268)	(0.324)	(0.333)	(0.348)	(0.353)	(0.336)	(0.398)	(0.425)	(0.436)

Heteroskedasticity consistent standard errors within parenthesis.
* Significant at 1%; ** at 5%; *** at 10%

Table 2 presents the results for the lagged exposures and allows us to observe that all markets are exposed to past changes in exchange rates, in most cases the number of lags for which significant exposures were identified being three or four, with the only exception of Hungary, where one-month and two-month lagged exposures to changes in the value of the domestic currency against the U.S. dollar and the euro, respectively, were found. All markets suffer from exposure to nominal and real exchange rate risk, but the most interesting result, in our view, is indicated by the changes in the coefficients' sign, as opposed to contemporaneous exposure

coefficients. For euro exposures, coefficients are positive in Czech Republic, Hungary and Poland, suggesting that past appreciations of domestic currencies against the euro generate decreases in the current value of companies traded in these countries' exchanges, and past depreciations lead to increases in the current value of companies. When exposure is considered towards changes in the nominal effective rates, all countries show negative coefficients for three lags (Czech Republic, Poland and Romania) and four lags (Hungary and Poland). This indicates that the strengthening of domestic currencies is acknowledged by capital market investors as decreases in the current value of the firms with a three to four months distance. In terms of exposure to real exchange rate risk, the same number of lags – three and four – indicate significant exposures in all countries, while all coefficients are negative, suggesting that past real appreciations of domestic currencies are reflected in decreases in the current market value of companies from the respective markets.

Table 2.

Lagged exchange rate exposures for national stock markets, 1/1999-12/2007

Czech Rep.			*Hungary*			*Poland*			*Romania*		
Index	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$
MSCI	EUR [3]	0.860*** (0.480)	BUX	EUR [1]	-0.615** (0.284)	MSCI	EUR [3]	0.586** (0.276)	BET	NEER13 [3]	-1.011* (0.006)
MSCI	NEER13 [3]	-16.262* (6.141)	BUX	USD [2]	0.319** (0.161)	MSCI	EUR [4]	0.510*** (0.279)	BET	NEER27 [3]	-1.051* (0.370)
MSCI	NEER27 [3]	-1.536* (0.579)	BUX	NEER13 [4]	-0.627*** (0.351)	MSCI	NEER13 [3]	-0.817** (0.327)	BET	NEER36 [3]	-1.105* (0.385)
MSCI	NEER36 [3]	-1.408** (0.559)	BUX	REER13 [4]	-0.738** (0.335)	MSCI	NEER13 [4]	-0.714** (0.331)	BET	NEER41 [3]	-1.124* (0.391)
MSCI	NEER41 [3]	-1.297** (0.547)	BUX	REER27 [4]	-0.700** (0.352)	MSCI	NEER27 [3]	-0.864** (0.336)	BET	REER27 [3]	-1.058** (0.452)
MSCI	REER13 [3]	-1.448* (0.505)	BUX	REER36 [4]	-0.625*** (0.359)	MSCI	NEER27 [4]	-0.729** (0.341)	BET	REER36 [3]	-1.179** (0.482)
MSCI	REER27 [3]	-1.433* (0.522)				MSCI	NEER36 [3]	-0.895** (0.346)	BET	REER41 [3]	-1.219** (0.494)
MSCI	REER36 [3]	-1.322* (0.506)				MSCI	NEER36 [4]	-0.749** (0.351)	BETC	NEER13 [3]	-0.614*** (0.323)
MSCI	REER41 [3]	-1.227** (0.495)				MSCI	REER27 [3]	-0.790** (0.326)	BETC	NEER27 [3]	-0.627*** (0.331)
PX	EUR [3]	0.778** (0.348)				MSCI	REER27 [4]	-0.771** (0.329)	BETC	NEER36 [3]	-0.662*** (0.345)
PX	NEER13 [3]	-10.707** (4.524)				MSCI	REER36 [3]	-0.824** (0.336)	BETC	NEER41 [3]	-0.665*** (0.350)
PX	NEER27 [3]	-1.100** (0.425)				MSCI	REER36 [4]	-0.799** (0.339)	BETC	REER27 [3]	-0.805** (0.399)
PX	NEER36 [3]	-0.966** (0.411)				MSCI	REER41 [3]	-0.805** (0.341)	BETC	REER36 [3]	-0.903** (0.425)
PX	NEER41 [3]	-0.867** (0.402)				WIG	USD [4]	0.286*** (0.170)	BETC	REER41 [3]	-0.922** (0.436)
PX	REER13 [3]	-1.006* (0.371)				WIG	EUR [4]	0.624* (0.193)			
PX	REER13 [4]	-0.672*** (0.367)				WIG	NEER13 [3]	-0.587** (0.234)			
PX	REER27 [3]	-0.985** (0.384)				WIG	NEER13 [4]	-0.828* (0.227)			
PX	REER36 [3]	-0.869** (0.373)				WIG	NEER27 [3]	-0.625** (0.241)			
PX	REER41 [3]	-0.790** (0.365)				WIG	NEER27 [4]	-0.859* (0.234)			

Czech Rep.			*Hungary*			*Poland*			*Romania*		
Index	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$	*Index*	*Exchange rate and lag*	$\chi_{1,t}$
						WIG	NEER36 [3]	-0.645** (0.247)			
						WIG	NEER36 [4]	-0.879* (0.241)			
						WIG	REER27 [3]	-0.533** (0.234)			
						WIG	REER27 [4]	-0.846* (0.226)			
						WIG	REER36 [3]	-0.555** (0.241)			
						WIG	REER36 [4]	-0.870* (0.233)			
						WIG	REER41 [3]	-0.546** (0.245)			
						WIG	REER41 [4]	-0.853* (0.237)			

Lags within squared parenthesis. Heteroskedasticity consistent standard errors within round parenthesis.

* Significant at 1%; ** at 5%; *** at 10%.

5.3. Asymmetric contemporaneous exposure to exchange rate risk

Table 3 presents the results of the tests performed in order to assess the asymmetry in the exposure to exchange rate risk. Our findings show that Czech companies carry as asymmetric exposure to nominal and real exchange rate risk, while indications of asymmetry are limited for Hungary – only the exposure to changes in the forint against the U.S. dollar exchange rate is asymmetric – and Poland – here the asymmetry is identified for the nominal effective rate against the main 41 trading partners. At the same time, for Romanian companies the exposure to nominal and real exchange rate risk is symmetric, none of regression coefficients being statistically significant even at 10%.

Table 3.

Asymmetric exchange rate exposures for national stock markets, 1/1999-12/2007

Country and market index	*Exchange rate*	$\gamma_{1,t}$	$\gamma_{D,t}$
Czech Republic			
MSCI	NEER27	-1.003 (1.050)	3.386** (1.689)
MSCI	NEER36	-1.172 (0.982)	3.695** (1.589)
MSCI	NEER41	-1.110 (0.946)	3.565** (1.551)
MSCI	REER27	-0.794 (0.984)	2.936*** (1.593)
MSCI	REER36	-0.979 (0.938)	3.233*** (1.524)
MSCI	REER41	-1.025 (0.905)	3.262** (1.473)
PX			-0.966***
	USD	0.261 (0.284)	(0.569)
PX	EUR	0.367 (0.589)	-2.307** (1.087)
PX	NEER27	-1.221 (0.754)	2.391** (1.213)
PX		-1.376***	
	NEER36	(0.705)	2.616** (1.141)
PX	NEER41	-1.382** (0.678)	2.644** (1.110)
PX	REER13	-0.773 (0.710)	2.188*** (1.175)

Country and market index	*Exchange rate*	$\gamma_{I,t}$	$\gamma_{D,t}$
PX		-1.238***	
	REER27	(0.701)	2.633** (1.134)
PX	REER36	-1.354** (0.668)	2.750** (1.086)
PX	REER41	-1.398** (0.643)	2.807* (1.047)
Hungary			
BUX			-1.031***
	USD	0.122 (0.310)	(0.533)
Poland			
MSCI	NEER41	0.131 (0.342)	1.683* (0.573)
WIG	NEER41	0.208 (0.226)	1.633* (0.379)

Heteroskedasticity consistent standard errors within round parenthesis.
* Significant at 1%; ** at 5%; *** at 10%.

The small evidence for asymmetric exposures in Central and Eastern Europe may be explained by the inability of companies in the region to use real or financial options either in order to capture the positive effects of changes in exchange rates as reflected in higher market values, or with the intention of hedging the undesired exposures to adverse changes in exchange rates. At the same time, the result may indicate that stock market investors do not generally include in the market's return a premium for asymmetric changes in exchange rates, recognising in this manner the inability of domestic companies to benefit from periods of depreciations and appreciations of the local currency. In this framework, Czech companies seem to project a different image, as our results indicate the presence of positive asymmetric exposures when nominal rates are used – thus showing that companies take advantages from times when the local currency appreciates against the currencies of trading partners, and of negative asymmetric exposures when the bilateral rates against the U.S. dollar and the euro are being used – confirming that appreciations are positively used by local companies to increase their market value. On the other hand, the asymmetric exposure to changes in the real exchange rate of koruna indicates that real appreciations of the currency are hurting local companies by diminishing their market values.

6. CONCLUSIONS AND FURTHER RESEARCH

Our paper investigated the exposure of national stock markets from a number of four countries in Central and Eastern Europe – Czech Republic, Hungary, Poland and Romania – to nominal and real exchange rate risk, using monthly data on exchange rates and stock market returns over the January 1999 – December 2007 timeframe. We find that companies from the region show contemporaneous and lagged exposure to nominal and real exchange rate risk and that these exposures are of the same type in all countries, suggesting a similarity in the economic structure in terms of foreign operations activity – exporting versus exporting. Romania is the country where the evidence for exposure is mostly limited, indicating a lower market

efficiency and a poorer understanding from the part of capital market investors of Romanian companies operations. Another possible explanation for the low exposure in case of the Romanian market may be linked to the likely hedging of exposures through the use of internal techniques – such as cash flow matching, contractual clauses etc. – since one cannot identify a market for financial derivative contracts in Romania. An interesting result, which applies to all four markets, refers to lagged exposures. Two aspects are noteworthy, in this respect: first, significant exposures are mostly found for three or four lags (months, in our analysis), possibly linked to the typical maturity of commercial credit, suggesting that some time needs to pass until changes in exchange rates are captured by stock market returns; second, lagged exposures are the opposite of contemporaneous exposures, which may indicate that investors react immediately to depreciations/appreciations of domestic currencies against the U.S. dollar and the euro by increasing/decreasing the stocks' prices, while after a couple of months they change their perceptions and react inversely. The situation is different when the overall strength of the domestic currency is considered, as immediately investors seem to link appreciations to increases and depreciations to decreases in the market value of companies, while after three to four months they assess in an opposite manner the effects of exchange rate changes in companies' value.

For what concerns the impact of changes in the competitive positions of countries against their trading partners, contemporaneous exposures are found only in the case of Hungary and Poland and are somehow puzzling, as they show that real appreciations of these countries' currencies, which signify decreases in competitiveness, are immediately reflected in positive returns in the stock market. Lagged exposures, on the other hand, tell the expected story: negative changes in the competitive positions of all four countries are reflected in decreases in market returns. The small evidence in favour of asymmetric exposures may be explained by the inability of companies in the region to use real or financial options either in order to capture the positive effects of changes in exchange rates as reflected in higher market values, or with the intention of hedging the undesired exposures to adverse exchange rates changes.

The research on the topic of exchange rate exposure needs to be continued on several directions: (1) the analysis of exchange rate exposure of individual companies on these markets, aiming at evidencing the particularities of their operations that have a significant impact on the type and size of exposure; (2) the use of daily and weekly data, in order to better understand the short-term reactions of investors in the market to surprises in exchange rates; (3) the investigation of second-moment exchange rate exposure, besides the first-moment exposure, which will shed light on the effects that changes in the volatility of exchange rate changes may have on companies cash flows and market value.

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