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How Sensitive is the Exchange Rate to External and Internal Factors in Mexico? A Comparative Analysis with 27 Developed and Emerging Economies

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Abstract:
This paper studies to what extent the exchange rate depreciation is affected by external factors (aggregate risk) and internal factors (idiosyncratic risk) in Mexico by carrying out a comparative analysis with 27 developed and emerging economies. Methodology: An APT-type model is adapted to measure the sensitivity of the depreciation of the exchange rate to factors related to capital markets and exchange rate investment strategies through the estimation of the corresponding "betas". Results: According to the obtained empirical results, the depreciation of the exchange rate, in general, has been relatively more sensitive to external factors related to movements in the stock market and speculation strategies in the foreign exchange market than idiosyncratic factors. The depreciation dynamics are qualitatively similar to both the overall average and the averages of the subsamples of emerging and developed economies. Finally, it is shown that Mexico is relatively more sensitive in terms of its currency depreciation if compared to other countries (higher betas in absolute values).
Keywords: Exchange rates, APT, emerging markets, developed economies, foreign exchange co-movements
JEL codes: F31; O24; G12; C13

¿Qué tan sensible es el tipo de cambio a factores externos e internos en México? Un análisis comparativo con 27 Economías desarrolladas y emergentes

Resumen:
Objetivo: Esta investigación examina en qué medida la depreciación del tipo de cambio se ve afectada por factores externos (riesgo agregado) y factores internos (riesgo idiosincrásico) en México mediante la realización de un análisis comparativo con 27 economías desarrolladas y emergentes. Metodología: Un modelo de tipo APT es adaptado para medir la sensibilidad de la depreciación del tipo de cambio a factores relacionados con los mercados de capital y las estrategias de inversión de tipo de cambio a través de la estimación de las "betas" correspondientes. Resultados: De acuerdo con los resultados empíricos obtenidos, la depreciación del tipo de cambio, en general, ha sido relativamente más sensible a los factores externos relacionados con los movimientos en el mercado de capitales y las estrategias de especulación en el mercado de divisas que los factores idiosincrásicos. La dinámica de depreciación es cualitativamente similar tanto al promedio general de la muestra como para los promedios de las submuestras de economías emergentes y desarrolladas. Finalmente, se muestra que México es relativamente más sensible en términos de su depreciación de la moneda en comparación con otros países (betas más altas en valores absolutos).
Palabras clave: Tipos de cambio, APT, Mercados emergentes, economías desarrolladas, co-movimientos de divisas
JEL Codes: F31; O24; G12; C13

1. Introduction

One of the questions that the financial economics literature has been interested for a time is to what extent the depreciation of the exchange rate is affected by external factors (aggregate risk) and internal factors (idiosyncratic risk)? There are several works in the specialized literature regarding the sensitivity of the exchange rate to external and internal factors in developed and emerging economies; see, for instance: Kaltenbrunner (2018), Dal Bianco *et al*. (2016), Nassif *et al*. (2011), Juhn and Mauro (2008), Venegas-Martínez (2006), Wei (2003), and González-Aréchiga *et al*. (2001), among others.

The present research is aimed at examining to what extent the exchange rate depreciation is affected by external factors (aggregate risk including stock market and carry trade strategies) and internal factors (idiosyncratic risk considering economic conditions and business environment in the country) in Mexico by carrying out a comparative analysis with 27 developed and emerging economies. To do that, we adapt the Arbitrage Pricing Theory (APT) to explain the depreciation of the exchange rate of a country through the corresponding betas. As it is known the CAPM model (Sharpe, 1964) allows estimating the profitability of an asset based on its risk and it provides an efficient estimator of the systematic risk (market risks).[1] Some of the theoretical assumptions for the aforementioned model are: 1) investors use the mean-variance approach (Markowitz, 1952), operations are carried out on a specific time horizon, 2) returns are normal, 3) there is symmetric information market efficiency, and 4) there is no market power *i.e*., it is not possible to influence on the price of the asset. This CAPM model explains the relationship between the level of risk and the expected return on the market through the beta coefficient that can be interpreted as the volatility of the return of an asset to changes in market returns, that is, it is a measurement of its volatility of returns relative to the entire market. The beta represents exactly the market risk if it is equal to one. When beta is greater than unity, the profitability of the asset has above-market returns with more risk and *vice versa* if beta is less than one. Finally, if beta is zero, the expected return on the asset equals the equilibrium yield of a risk-free asset.

Since that the CAPM model has strong assumptions, sometimes is better to consider the APT model (Ross, 1976), which is less restrictive, and it is not specific to systemic risks. In this case, the asset return is a linear combination of several factors and not only that of the rate of return on the market portfolio. Furthermore, APT does not require assumptions about the empirical distribution of asset returns, while

[1] Unsystematic risk, also known as "specific risk", this risk relates to individual stocks.

CAPM assumes normality. Importantly, APT has no limitations on the utility functions of individuals, while CAPM is based on investor's preferences (Ingersoll, 1987). The APT framework provides a more general approximation to the expected returns for assets due to the incorporations of microeconomic (commodities prices, corporate bond spreads) and macroeconomic (inflation, production, etc.) factor.

The main objective of this paper it to adapt the APT theoretical bases for estimating to what extent the behavior of the depreciation of the exchange rate is affected by aggregate and idiosyncratic risk factors. In the methodological section, we explained how the APT model is modified (APT-type model) to examine how the exchange rate depreciation is affected by external factors (aggregate risk) and internal factors (idiosyncratic risk) according to Obstfeld and Rogoff (1998)[2].

The paper is organized as follows: section 2 presents the descriptive statistics of the data; section 3 provides the methodology used to measure the sensitivity of the depreciation of the exchange rate to external and internal factors; section 4 discusses the obtained empirical results; finally, section 5 provides the conclusions.

2. Data Nature

Data for the modeling is obtained from the Morgan Stanley Capital International (MSCI) World Index is a market capitalization weighted through the free float, designed to measure the performance of developed capital markets. This index includes the following 23 developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States.

The Foreign Exchange Credit Suisse Rolling Optimized Carry Index (ROCI) is designed to capture the potential returns of the strategy of investing in higher yielding currencies to finance another underperforming. Individuals can take a long or short position in contracts on the exchange of two currencies at a future date. The index is constructed using an optimization model portfolio with a target annual volatility of 5%. This provides the weights that are used to invest in a basket of currencies of

[2] See also Corsetti *et al.* (2018).

developed countries (G-10) and less liquid countries (emerging markets), which is used in this investigation.[3] Alternatively, estimates can be made by using the ICI (Intelligent Carry Index) Barclays. This index is designed to capture the potential returns of the strategy of investing in higher yielding currency financing it with a low yield. The index is constructed as a linear combination of these strategies by setting a reference currency. The weights are calculated by optimizing a portfolio using the technique of mean-variance setting a risk level of 5%. The set of currencies that make up the index are 25 and include those belonging to the G-10 and currencies of emerging countries in Latin America: Brazil real and Mexico (23 countries related to MSCI World Index, Brazil and Mexico). The index is calculated by Barclays Capital and is denominated in US dollars and is also used in this research.

3. Methodology

The methodology includes several factors that measure the aggregate risk, particularly the risk of stock market and the risk implicit in the strategies of international markets carry trade, affecting the depreciation of the local currency-dollar. Specifically, the following model is estimated:

$$dep_{i,t} = \alpha_i + \beta_{i,m} r_{m,t} + \beta_{i,CT} r_{CT,t} + \varepsilon_{i,t}, \qquad (1)$$

where:

$dep_{i,t}$ stands for the depreciation of the exchange rate of country *i* against the US dollar at time *t*.
$r_{m,t}$ is the performance of the MSCI World (market risk) rate at time *t*.
$\beta_{i,m}$ denotes the sensitivity of country *i* to market risk (market).
$r_{CT,t}$ performance index is Credit Suisse Rolling Optimized Carry (carry trade strategy risk) over time *t*.
$\beta_{i,CT}$ denotes the sensitivity of country *i* at risk of carry trade strategy.
$\varepsilon_{i,t}$ is the idiosyncratic depreciation of country *i* at time *t*.

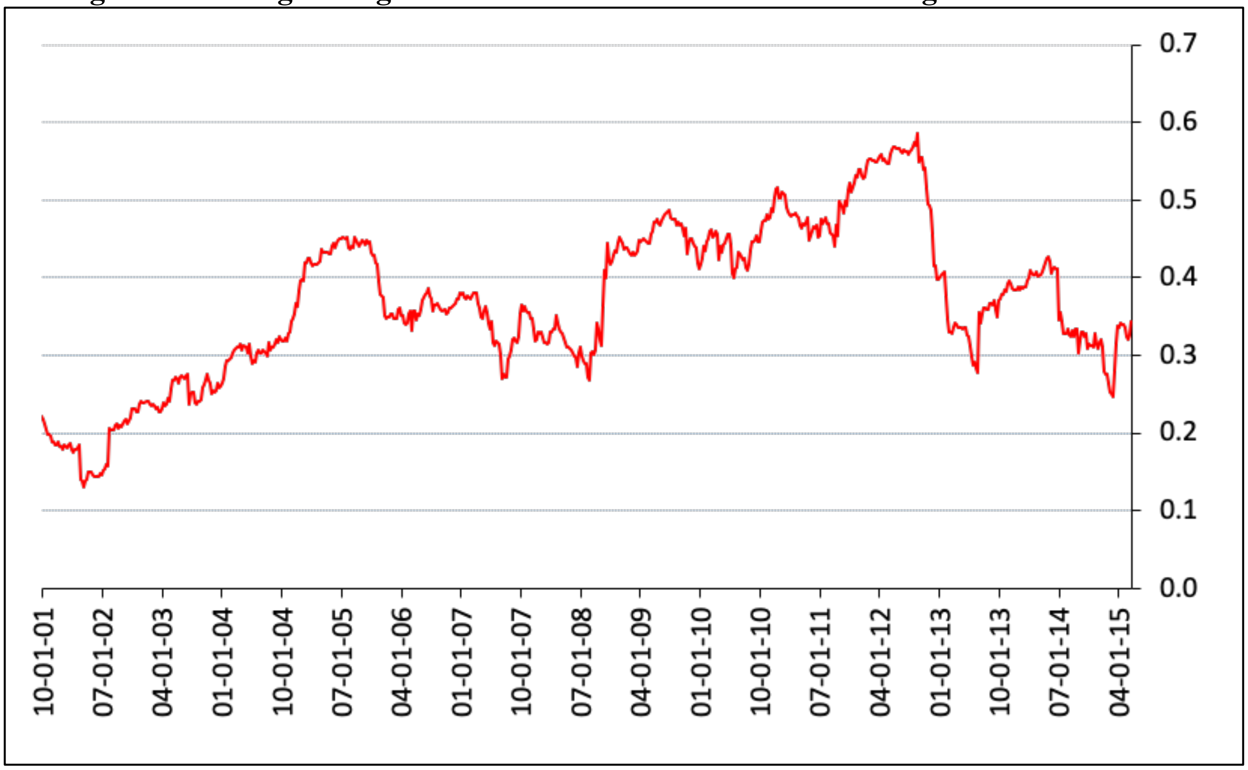
The estimations are carried out with linear regression applying ordinary least squares (OLS) methodology using a one year rolling window with weekly data. That is, each regression within the rolling window consists of about 52 weekly observations.

[3] The source from these time series is Bloomberg database.

4. Analysis of Empirical Results

The first part of this analysis is related to co-movements for the exchange rates under analysis. Figure 1 shows the moving average correlations for the 27 currencies all against the US dollar by using (1). The correlations are for a one-year rolling window using weekly data. We estimate these correlations and, subsequently, we obtain the moving average correlations.

Figure 1. Moving average correlations for the 27 currencies all against the US dollar

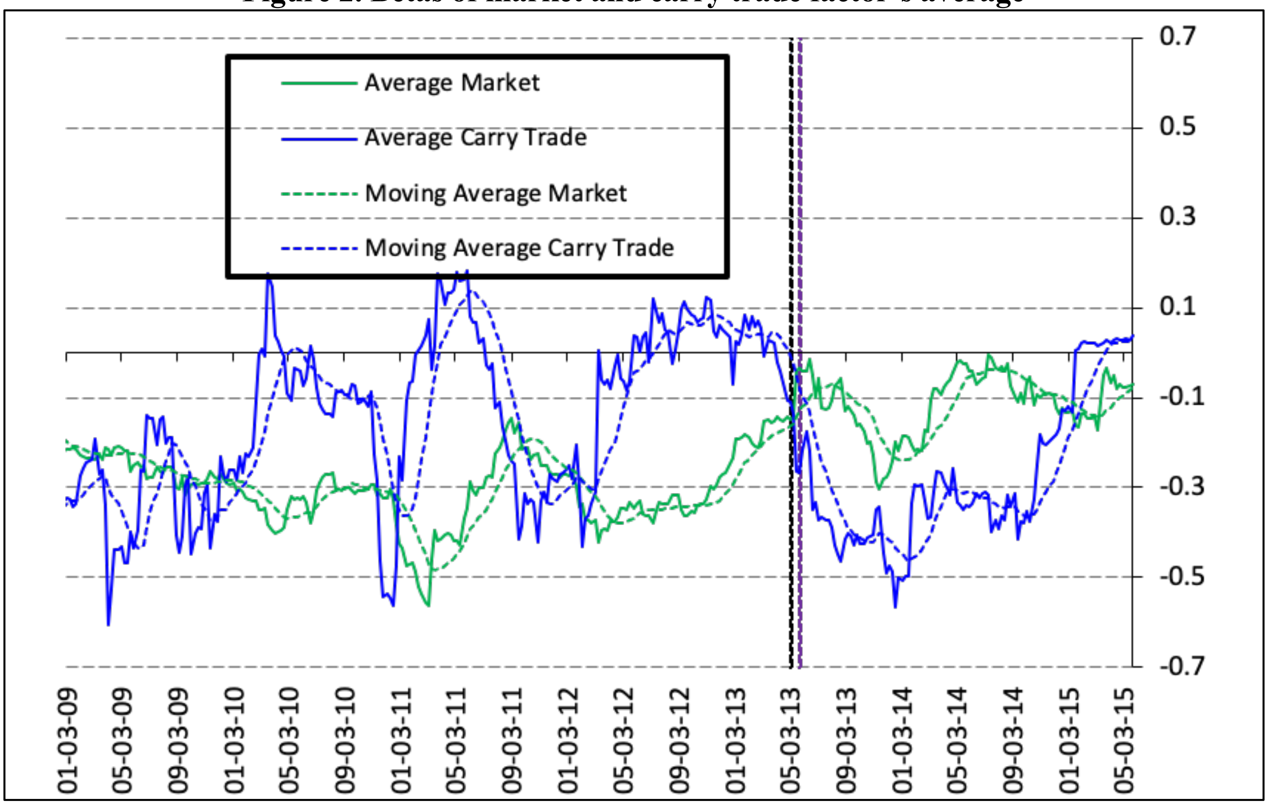


Source: Author's estimates using data from Bloomberg database. The rolling window correlation has a window-size of 52 weeks (approximately 1 year). The sample size is from January, 2001 until May, 2015.

As it can be observed in Figure, the average of the one-year rolling window correlations shows a peak (about 0.60) around September 2009 and since then there is sharp decrease in the magnitude of those correlation coefficients to reach levels of those observed in a pre-crisis period (February, 2008). The curve shows a small upward trend around the middle of 2013 and then goes down again, exactly a year after, to levels around 0.30 to then stabilize around that level.

During 2013 there were some relevant economic events, which are associated with volatility in financial markets. For example, May 22, 2013, is associated with high relative volatility in interest rates in the United States because of public statements by some members of the Federal Reserve Board (FED). Figure 2 shows a change that was observed in the slopes of the curves for the market average betas to the average carry trade betas. Both stock markets and strategies in the currency market on currency depreciation begin to move away from zero indicating a higher absolute value in the magnitude of the coefficients. The latter indicates a greater influence in terms of the magnitude of the parameters for both stock markets and carry trade strategies.

Figure 2. Betas of market and carry trade factor's average



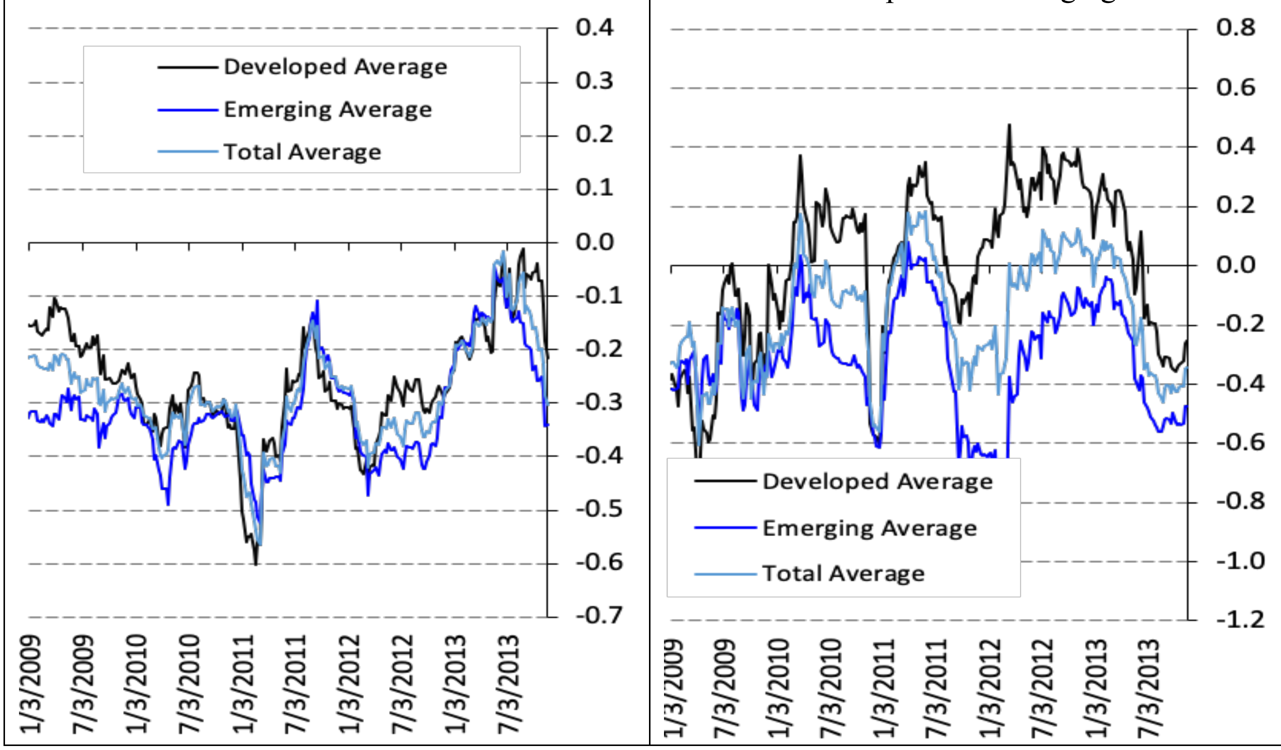
Source: *Author's own estimation using data from UBS and Bloomberg databases.*
The moving average has a window 12 weeks (approximately 3 months). The vertical dashed lines represent relevant dates of FED members announcements about possible interest rate movements, i.e., 'taper tantrum'.

An explanation of these results is that, with the public statements by some members of the FED during the month of May 2013, currency markets around the world were more sensitive (or mostly influenced) by both the stock markets and the exchange rate strategies. The turnaround is clearer to the average market betas, which were closer to zero and started to move away with a relatively steeper slope after the date threshold (vertical dashed lines in the figure). Both, stock markets and the exchange rate strategies, begin to move away from zero indicating a higher absolute value in the magnitude of the coefficients. However, from 2014 onwards the trend has reversed and both coefficients (on average) have been approaching to zero, indicating less influence of stock markets and carry trade strategies on the currency depreciation. Apparently, there is a possibility of a stabilization of expectations of possible movements in US interest rates. Figure 3 shows the betas from the market as averages and the relevant betas for the carry trade strategies. Both include the total average for emerging and developed economies.

Figure 3. Market and carry trade betas

a. Developing, developed and total market betas

b. Carry Trade Factor Betas Average Total and For Some Developed and Emerging Economies

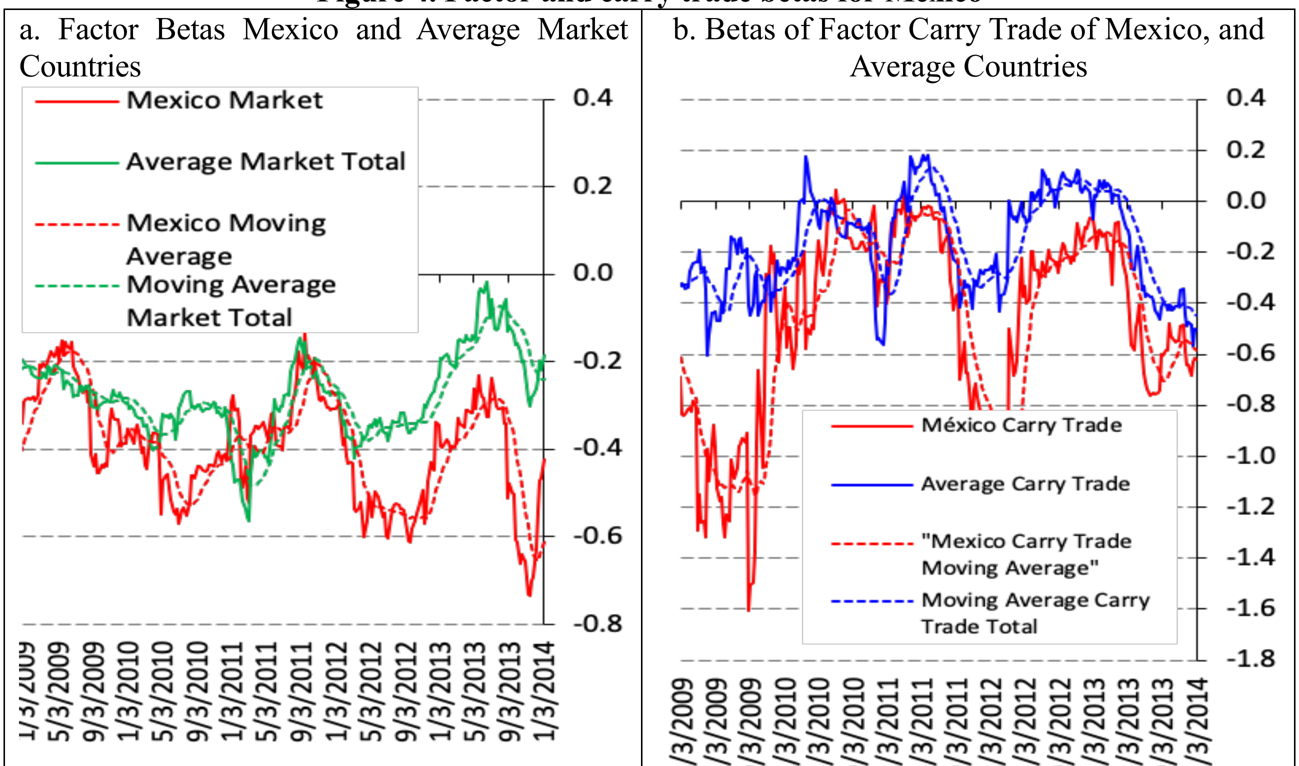


Source: Own estimations using data from Bloomberg.

It can be observed in Figure 3a that betas are lower than 1, whereas in Figure 3b, betas oscillate around zero. As the values of the betas are further away from zero (Figure 3a), this is an indication that the currency depreciation is more sensitive to changes in stock market (world) returns. On the other hand, the beta values for the carry trade (Figure 3b) are closer to zero on average indicating that depreciations of currencies are less sensitive to these types of strategies. However, looking at the beta values after 2013, it can be observed that these are moving away from zero showing that there is an increase in the sensitivity of exchange rate depreciations to movements in the carry trade index returns. This last phenomenon is very likely related to the FED 2013 'taper tantrum'.

In particular, for the Mexican case, we observe that the comparison of Mexico with the average of the countries under study has results qualitatively similar than those for the rest of the analyzed countries. These apply for both stock market and carry trade strategies relationships. Figure 4 shows the estimates of the betas for Mexico and its comparison with the average of the other countries.

Figure 4. Factor and carry trade betas for Mexico

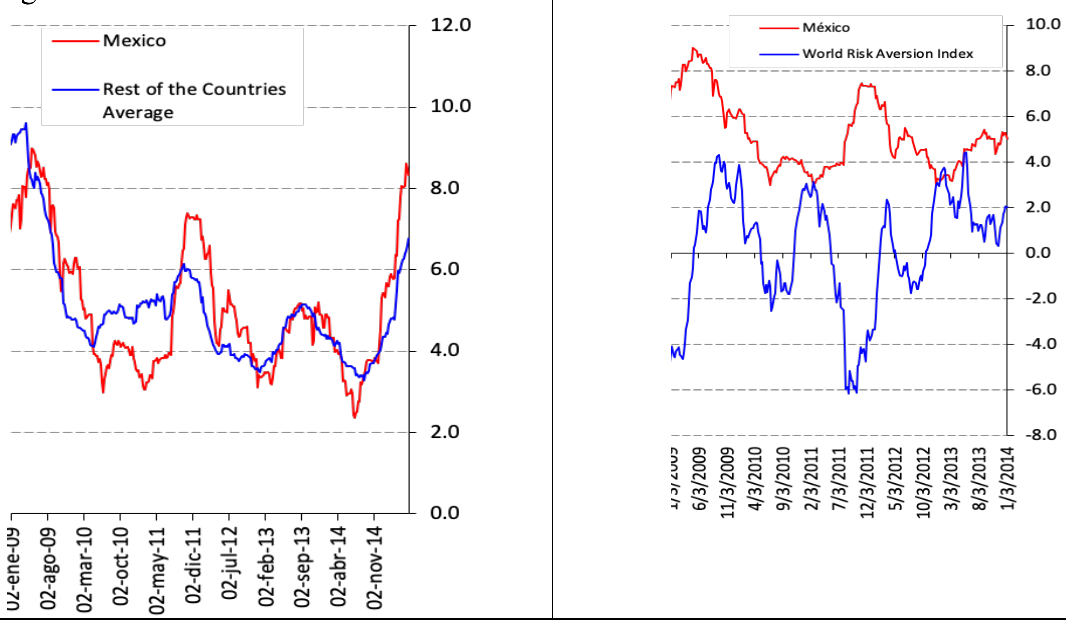


Source: *own estimates using data from Bloomberg. The moving average has a rolling window of 12 weeks (approx. 3 months).*

Figure 5 shows that the idiosyncratic component, which is equivalent to the error component in equation (1) *i.e.* $\varepsilon_{i,t}$ of Mexico and from the average of the other countries under analysis. This error component represents the idiosyncratic risk in the model. That is, the risk from economic conditions in the country itself. It is basically the part that is not explained by the systemic factors *i.e*., world stock market returns and carry trade strategies. Given that $\varepsilon_{i,t}$ are i.i.d. variables, the volatility is the annualized standar deviation of $\varepsilon_{i,t}$ expressed as a percentage. The country with the highest value of this idiosyncratic component is the one with higher not-diversifiable risk (or higher sovereign risk). It can be osbserved in Figure 4a that the Mexican idiosyncratic component was higher that the average of the other countries idiosyncratic components during 2011-2012. This situation can be related to difficult economic conditions in Mexico after the global crisis of 2008-2009. After those years this trend was reversed and it goes closer to the rest of the countries average. Figure 4b shows that the idiosyncratic component is higher than the risk aversion in other countries of the sample. The risk aversion 'proxy' is taken from a risk aversion index published by Credit Suisse.

Figure 5. Idiosyncratic component and Risk aversion of Mexico v.s. other countries

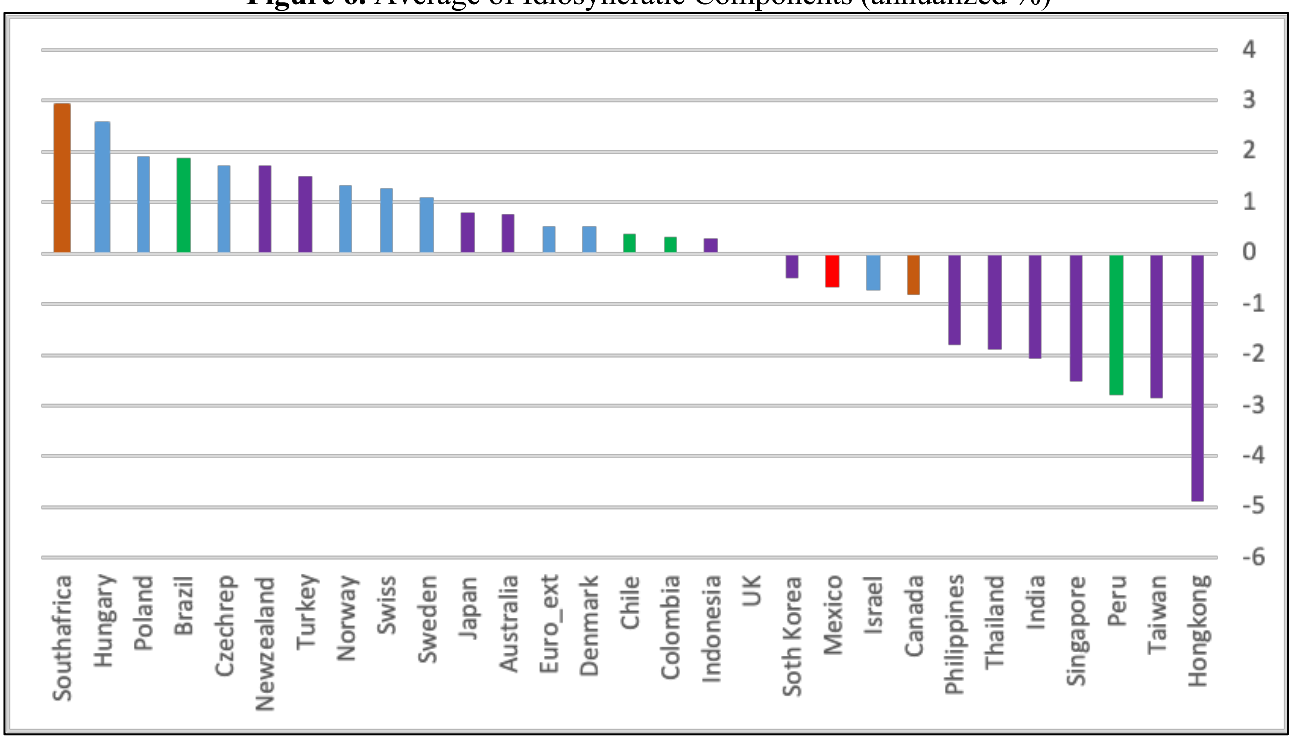
a. Idiosyncratic component of Mexico and Average Countries | b. Idiosyncratic component of Mexico and Risk Aversion



Source: *own estimates using data from Bloomberg. The moving average has a rolling window of 12 weeks (approx. 3 months). The Risk aversion index is the one published by Credit Suisse and includes several countries.*

Figure 6 shows the average from 2001-2015 of the idiosyncratic component for all the countries' currencies under study (South Africa, Hungary, Poland, Brazil, Czech Republic, New Zeland, Turkey, Norway, Japan, Australia, Denmark, Chile, Colombia, Indonesia, UK, South Korea, Mexico, Israel, Canada, Philippines, Thailand, India, Singapore, Peru, Taiwan and Honk Kong). Notice that most of these countries are not considered in the MSCI World Index. Again, this component in average indicates such a component of the depreciation of the currency in the regression, which cannot be explained by the two factors included in the model (capital markets and carry trade strategies). Some colors are used to associate the relevant country to a specific region. For example, Europe has the blue color, Latin America (Latam) has the green, countries considered in Asia (or closer to Asia) have the purple color and other countries that are not associated with these previously mentioned regions have the burn orange color. Since we are analyzing the Mexican case in more detail, this country has a red color, which is different than the rest of Latam countries. As we can observe in Figure 5, most of countries with higher idiosyncratic risk are the Europeans, then it follows Asia and, subsequently, Latam countries. Mexico's risk appears to be below average, which indicates that most of the Mexican peso depreciation is related to external factors, *i.e.*, stock market and carry trade strategies instead of idiosyncratic risk if we compare Mexico to the rest of the countries in the sample.

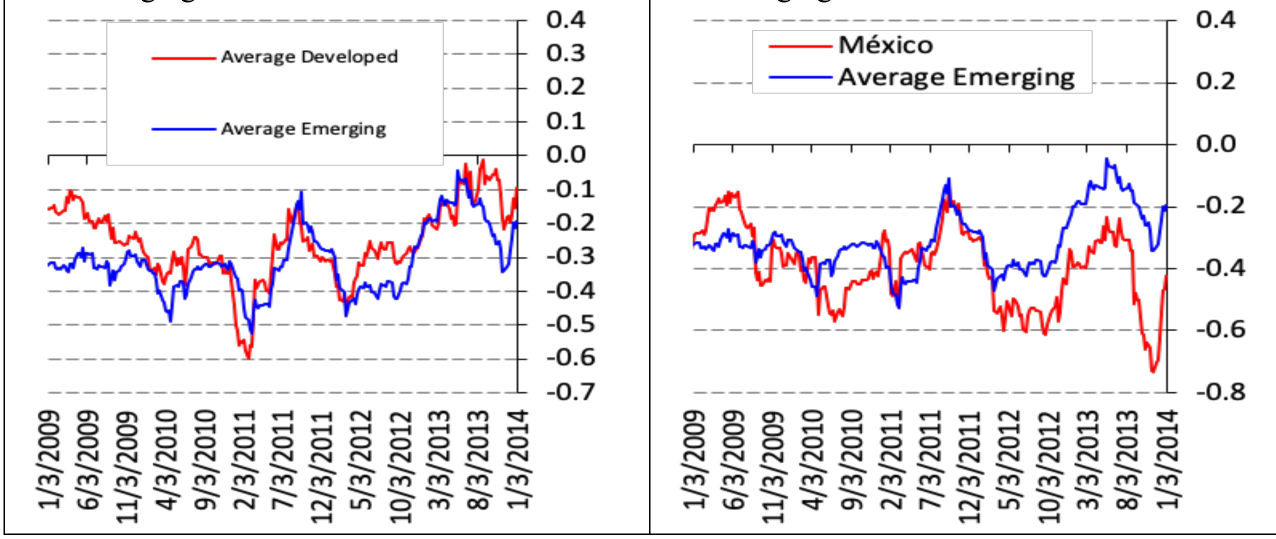
Figure 6. Average of Idiosyncratic Components (annualized %)



Source: *own estimates using data from Bloomberg.*

Figure 7. Average market factor betas for Mexico v.s. Emerging and Developed economies

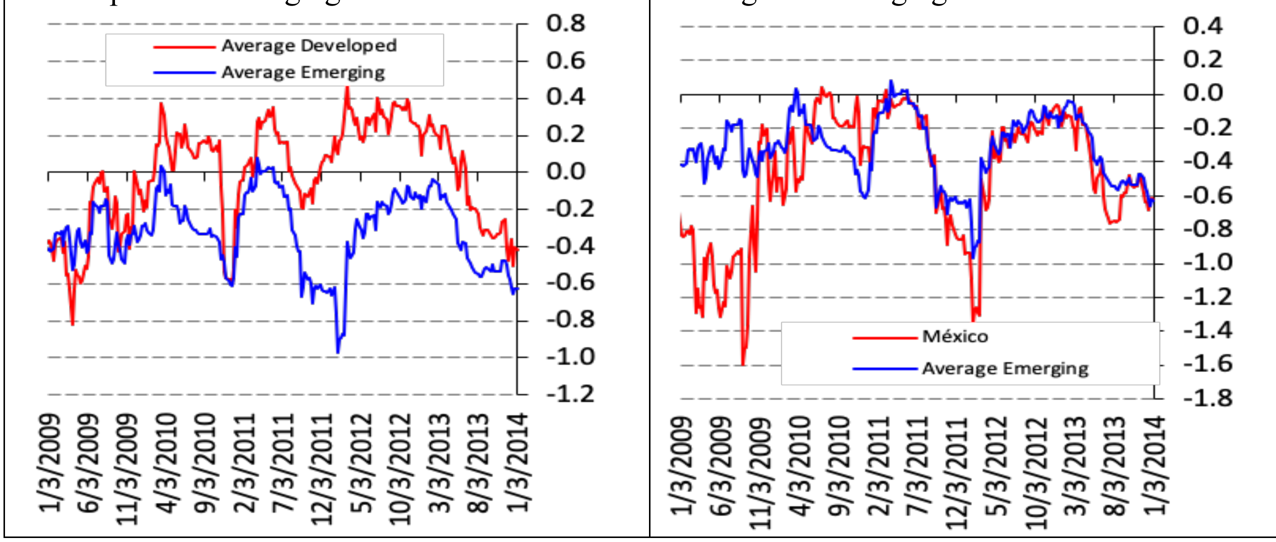
a. Market Factor Betas Average for Developed and Emerging Economies | b. Market Factor betas for México and Average for Emerging Economies



Source: *own estimates using data from Bloomberg.*

Figure 8. Carry trade average factor betas for Mexico, Emerging and Developed countries.

a. Carry Trade Factor Betas Average for Developed and Emerging Economies | b. Carry Trade Factor betas for México and Average for Emerging Economies

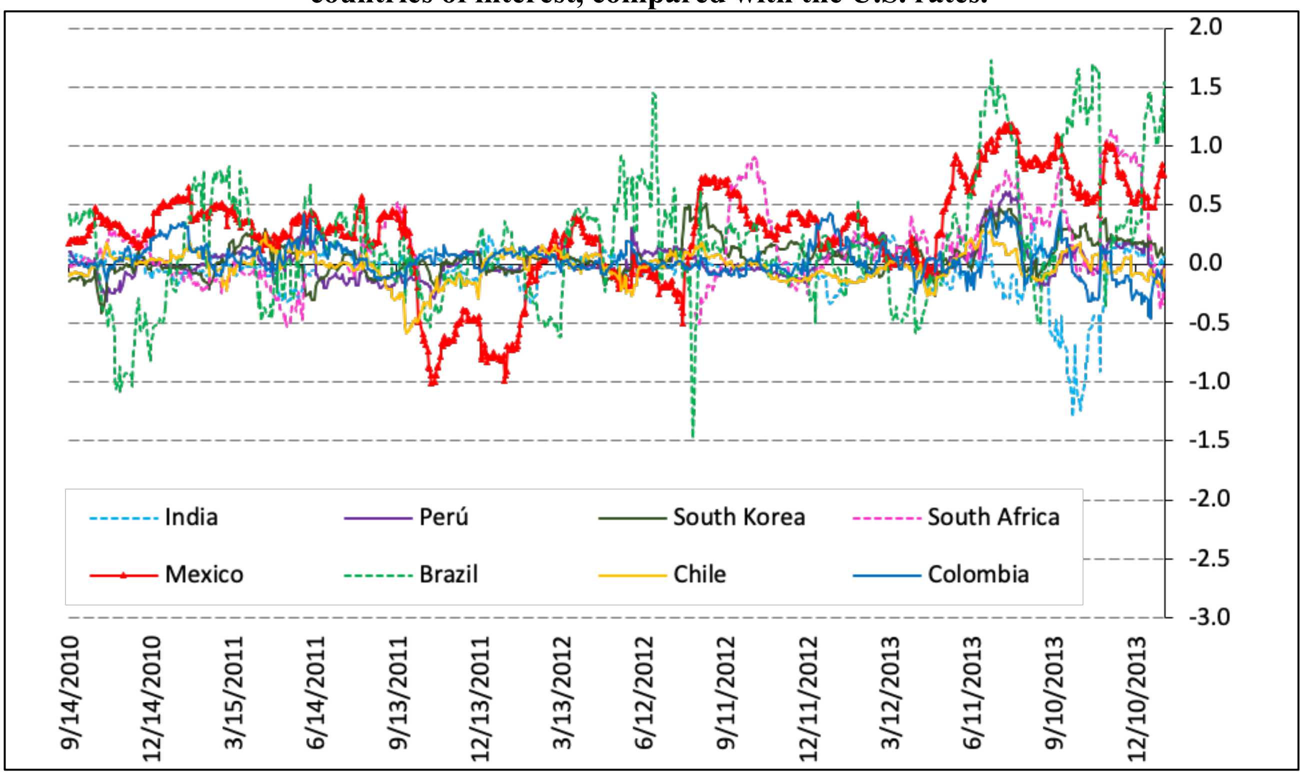


Source: *own estimates using data from Bloomberg. The moving average has a rolling window of 12 weeks (approx. 3 months).*

In Figures 7 and 8, we isolate the case of the Mexican betas (stock market and carry trade factors) and compare it with the relevant betas for those of emerging and developed markets. As it can be observed in Figure 7a betas for emerging and developed economies are qualitatively similar. It can be osberved in Figure 7b that betas relevant for Mexico are higher in absolute value compared than those for emerging economies. A possible explanation about this it can be the sensitivity that Mexican interest rates have with US interest rates. More details about it are shown below with estimations of the relationship with US and Mexican interest rates.

Figure 8a shows that in recent years the beta factor carry trade is higher in absolute values in emerging countries compared to developed ones. This may be related to the higher risk investors take in that type of currencies. In Figure 8b, it can be observed that Mexico has betas that are qualitatively similar to those of emerging countries, which is according to what it is expected.

Figure 9. Rolling window of regression's betas of the changes in the interest rate level of eight countries of interest, compared with the U.S. rates.



Source: *Own estimations using data from Bloomberg.*
The beta estimations correspond to a one-month rolling window with daily data.

Finally, Figure 9 shows the beta estimations corresponding to a one-month rolling window with daily data of 8 countries between the 10-year yields changes *vs*. US 10-year yields changes. It can be observe in that for the case of Mexico, the beta values are on average higher than the rest of the countries in the sample. The only country that has higher betas than Mexico is Brazil. The fact that Mexican interest rates are relatively more sensitive to US interest changes may be a reason why the estimated betas for Mexico in the factor model presented above are also relatively higher if compared with the average of emerging and developed countries especially for stock market factors. This exposure that Mexico has to external financial factors *i.e*., US interest rates, could explain the higher sensitivity that the Mexican peso depreciation has with World Capital Indices and carry trade strategies. Finally, it should be noted in Figure 9 that the higher marked volatility is present after 2012.

4. Conclusions

In the present research an APT-type model was estimated for several countries with the objective of quantifying factor affecting exchange rate depreciations. Two factors were included in the estimated models one was a proxy for world capital markets and the other was a proxy for exchange rate investments (carry trade strategy index). It can be concluded that overall a significant change was observed in the slopes of the curves for the market average as well as to the average carry trade. Both stock markets and strategies in the currency market on currency depreciation begin to move away from zero indicating a higher absolute value in the magnitude of the coefficients. The latter indicates a greater influence in terms of magnitude of both stock markets and strategies in the currency market on currency depreciation. Intuition with these results is that, as the public statements by the FED during May 2013 occurred, currency markets around the world were more sensitive (or mostly influenced) by both the stock markets and the exchange rate strategies. Since May 2013 there is higher relative volatility in interest rates in the United States because of the ‘taper tantrum’. The turnaround is clearer to the average market betas, which move away from zero with a relatively steep slope after that date threshold.

In particular, it is observed that the betas for both types of factors have changed the sign of correlation between the aforementioned from May 2013. Finally, it can be observed that Mexico is relatively more sensitive in terms of its currency depreciation if compared to other countries (higher betas in absolute values). A possible explanation for this could be its higher sensitivity to US interest rates as shown also with results of linear regressions.

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