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The "day-of-the-week" effects in the exchange rate of Latin American currencies

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Abstract

This paper studies the "day of the week.ªnomaly in the exchange rate of the currencies of Argentina, Brazil, Chile, Colombia, Mexico and Peru, with respect to the United States' dollar. In all cases, yields are stationary, allowing the combined use of linear regressions with GARCH, TARCH, and EGARCH models to explore the "day of the week.ªnomaly. The presence of .ªbnormal.ᵉᶠfects on some of the currencies is confirmed, particularly on Fridays and Mondays. In addition, volatility in exchange rates shows clusters of volatility as well as leverage effects. This work contributes to the literature by studying the "day of the week.ᵉᶠfect on the currency exchange rate market, an innovation with respect to the analysis of the stock market. The reported results are useful for currency brokers, foreign exchange risk managers, monetary authorities, and financial policy designers. Subsequent studies should incorporate transaction costs and tax implications to determine if there are economically interesting arbitrage opportunities in these markets.
JEL Classification: G14, G15, C58
Keywords: "Day-of-the-week" effect, exchange rate markets, Latin America, Market Efficiency, GARCH, EGARCH, TARCH.

El Efecto "día de la semana" en el tipo de cambio de las monedas latinoamericanas

Resumen

Este artículo estudia la anomalía "día de la semana" en el tipo de cambio de la moneda de Argentina, Brasil, Chile, Colombia, México y Perú, con respecto al dólar de Estados Unidos. En todos los casos, los rendimientos son estacionarios, lo que permite combinar regresiones lineales con modelos GARCH, TARCH y EGARCH, para explorar la anomalía "día de la semana". Se confirma la presencia de efectos "anormales" en algunas de las monedas, particularmente los viernes y los lunes. Además, la volatilidad en los tipos de cambio muestra racimos de volatilidad, así como efectos de apalancamiento. Este trabajo contribuye a la literatura al estudiar el efecto "día de la semana" en el mercado de tipos de cambio de moneda, una innovación con respecto al análisis del mercado accionario. Los resultados reportados son de utilidad para corredores de moneda, administradores de riesgo cambiario, autoridades monetarias, y diseñadores de política financiera. Estudios posteriores deberán incorporar los costos de transacción y las implicaciones fiscales para determinar si existen oportunidades de arbitraje económicamente interesantes en estos mercados.

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Resumen

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1. Introduction

In the early 1970s, Fama (1970) took Samuelson's (1965) work on the impossibility of anticipating the behavior of stock prices, combined it with Roberts' (1967) definitions of "Weak" and "Strong" forms of market efficiency, and added the new concept of "Semi-strong" form of efficiency, to propose the Efficient Market Hypothesis (EMH) (Fama, 1970). This theory describes the way in which financial markets incorporate the arrival of new market information into securities prices. The same theory suggests that financial asset prices in an efficient market must follow a "random walk", in the sense that it is impossible to predict the future trajectory of any individual security (or the market as a whole) based on historical or current publicly available information. The reason is simple, all past and present information has already been incorporated into the current price. Only the arrival of new information that is relevant to the pricing of the security (or to the market) should produce a realignment of securities prices.

While in the years that followed the publication of Fama's (1970) influential work, stock market efficiency was not seriously questioned, the 1980s saw a surge in studies that challenged the EMH in view of the evidence that there were some conditions in which investors could enjoy a degree of predictability about the securities' performance. Such is the case of DeBondt and Thaler (1985), who investigate whether the tendency of people to "overreact" to unexpected events can also be observed among stock market investors, and find empirical evidence that, indeed, the behavior of prices is consistent with the overreaction hypothesis. Furthermore, these authors report a weak-form inefficiency in the yields obtained during the months of January for stocks that were previously "winners" and "losers". The "loser" stock portfolios recorded exceptionally high yields during the months of January until five years after the integration of the study's portfolios. In addition, Zarowin (1989) analyzes whether the stock market reacts to the extreme profits of some firms by examining the returns during 36-month periods after issuers reported extraordinary profits (losses) and finds that the firms' stocks whose returns are extremely low obtain higher returns than the others with extremely high returns, and that the former are significantly smaller than the latter. In contrast, when low-profit firms' stock performance is compared to extremely high-profit firms of a similar size, there seems to be little difference, so the size of the firm and not investors' overreaction to extreme profits (losses) is responsible for the differences.

In several studies in which reported evidence apparently contradicts the assumptions of the EMH, stock returns seem to be associated with certain fundamental characteristics of firms (for example, value-stocks vs. growth-stocks, EPS multiples, etc.). Such phenomena are known as "market anomalies" and have motivated a wide interest among researchers because they represent the possibility of capturing extraordinary profits.

Another type of market anomaly that represents a deviation from the EMH includes the regularities observed at certain dates on the calendar. According to the EMH, investors should not be able to obtain extraordinary gains by using any calendar rules to open or close positions in financial securities, but numerous studies have documented the opposite. For example, there is evidence that, on average, the largest proportion of annual profitability is generated during the months of January (e.g., Haugen & Lakonishok, 1988; Ritter, 1988; Haugen & Jorion, 1996; Klock & Bacon, 2014). Or, there is the so-called

"Halloween" effect, according to which it is advisable to maintain equity positions only during the period from November to April, and avoid doing so during the rest of the year, that is, a strategy to sell in May and take positions in November (e.g., Bouman & Jacobsen, 2002; Lucey & Zhao, 2008; Jones and Lundstrum, 2009).

One more well-known case is the "end-of-the-month" anomaly, according to which the yield obtained by an investor at the end of a month and the beginning of the following month is significantly higher than the average daily returns for the rest of the month (e.g., Ariel, 1987; Cadsby & Ratner, 1992; Ross & Ziemba, 1996; Desai & Triverdi, 2012). Two other frequently studied anomalies are the "weekend" anomaly (e.g., Abraham & Ikenberry, 1994; Brockman & Michayluk, 1998; Chen & Singal, 2003) and the "day-of-the-week" anomaly (e.g., Smirlock & Starks, 1986; Dubois & Louvet, 1996; Gregoriou et al., 2004; Yalcin & Yücel, 2006; Chukwuogor-Ndu, 2006; Kristjanpoller, 2009).

Kristjanpoller (2009) declares that the "day-of-the-week" anomaly consists of the regular observation of stock market returns and volatility that are significantly different from the average on a certain day of the week. According to the EMH, any day is likely to record atypical, yields but, by the same token, their average yields and their volatility should be similar. The confirmation that there are significantly higher (or lower) yields on certain days of the week means that investors could buy shares on the days with abnormally low yields and sell them on the days with abnormally high yields, thereby obtaining higher returns than the market at large, a clear contradiction of the EMH tenets.

This study contributes to the literature in different ways. Firstly, and unlike most studies on the "day-of-the-week" anomaly that usually focus on the returns of stock market indices, we are interested in the market behavior of currency exchange rates. Our second contribution consists of studying the "day-of-the-week" anomaly in Latin American currency markets, which are closely linked to the United States dollar, but where each national currency has its own dynamics, a subject very seldom studied until now. Our third contribution consists of the use of a traditional Ordinary Least Squares regression model combined with GARCH, EGARCH and TARCH models recently employed in the "event studies" literature, that incorporate the asymmetric effects on the behavior of the interest variable in the analysis. Regarding the results reported here, we identify the presence of market anomalies in the sense described above for the different currencies in our sample and, according to our volatility measurements, we are able to confirm that those anomalies are more noticeable in some countries than in others. Moreover, we document the presence of asymmetric effects on the behavior of the currency exchange rate for most of the countries in the sample.

The second section of the paper contains an overview of the extensive literature on stock-market calendar anomalies, the most thoroughly studied market so far, and of the few works we found on the presence of calendar anomalies in the foreign exchange market. The third section presents the econometric models, the data, the results of the estimates, and their interpretation. The work concludes with some comments on the economic importance of the findings and suggestions for possible future lines of research.

2. Literature Review

The "day-of-the-week" anomaly has been extensively documented in the academic literature (e.g., Smirlock & Starks, 1986; Dubois & Louvet, 1996; Gregoriou et al., 2004; Yalcin & Yücel, 2006; Chukwuogor-Ndu, 2006; Kristjanpoller, 2009). The diversity of geographical areas, periods of analysis and econometric methodologies used in the "day-of-the-week" literature is abundant, and a comprehensive review by far exceeds the objectives of the present work. However, it is important to note that most of the previous works focus on stock market returns, almost always using stock market indexes and only in few cases studying other markets prices. Although some studies have paid attention to the "day-of-the-week" anomaly in the price of assets other than the stocks, such as some currency exchange rate markets or the bitcoin market (e.g., Ke et al., 2007; Decourt et al., 2017; Ma & Tanizaki, 2019), knowledge of how that anomaly is present in such alternative markets is still far from complete.

Precisely for that reason, the present study on the "day-of-the-week" anomaly in the foreign exchange markets of the main Latin American currencies represents a valuable contribution, as it broadens the spectrum of traditionally studied markets (particularly, the stock market), and reports the results obtained with a methodological approach that is sensitive to a changing volatility in the currency exchange-rate, depending on the day of the week observed. Notably, it explores the reality of the Latin American currency markets, which share many similarities due to the comparable level of economic development of all the countries in the area, which also share many common traits in their culture and history.

Exchange rates in Latin American economies have typically been affected by fluctuations in the price of raw materials that have large economic significance for some countries (e.g., oil in the cases of Brazil, Colombia and Mexico; copper for Chile and Peru, etc.), the events of international financial markets (international financial crises, economic cycle swings, etc.), the close commercial and financial ties among regional players and the enormous influence of the United States in the region, and the prevailing macroeconomic conditions and behavior of economic policy in each country. However, the maturity of the different foreign exchange markets is noticeably different, which is reflected in their depth and liquidity. That is partly why the foreign-exchange markets of the different Latin American currencies experience a different evolution with regard to the "day-of-the-week" anomaly.

To organize our literature review on the "day-of-the-week" anomaly, and because it has been the most extensively studied, the first part of this section reviews works centered on the stock market in the United States, some multinational markets and regional markets (including geographical regions, or groups of countries with common characteristics, e.g., emerging-countries) and individual countries. We also follow a chronological order in the review of each of the above categories in order to highlight the way the econometric methodology employed evolved over time, from simple models, which use only the Ordinary Least Squares (OLS) model, to much more sophisticated models that incorporate conditional volatility modeling with different GARCH models to improve the quality of estimates.

Among the first studies on the "day-of-the-week" anomaly, which use the OLS model, Cross (1973) focuses on the distribution of price changes in the S&P 500 index between 1953 and 1970. Its main conclusion is that the index has higher positive returns on Fridays than on Mondays, and that changes observed on Mondays have a partial dependence on changes observed the previous Friday. Another pioneering study that uses the same model is French (1980), who reports that yields on Mondays tend to be negative due to the fact that there is a "weekend" effect, and explains it as a consequence of market participants being excited about Fridays, but depressed on Mondays, so prices go up before the end of the week and down at the beginning of the new week.

Gibbons and Hess (1981) study balanced portfolios between 1962-1978 and reject the assumption that market returns are the same on all days of the week. In addition, they report that stocks have average negative returns on Mondays, and suggest that heteroscedasticity and autocorrelation in returns affect their results. A long-term study developed by Keim and Stambaugh (1984) uses a 55-year period of observation of the SP&500 to confirm the Monday effect. One of the first studies of the "day-of-the-week" anomaly in other national stock markets, besides the United States, is that of Jaffe and Westerfield (1985), who test for the presence of the "weekend" anomaly in the United Kingdom, Japan, Australia and Canada, and report the presence of the "Monday" effect for the United States, Canada and the United Kingdom, and the presence of the "Friday" effect in all countries, except the United Kingdom.

During the following decades, the quantity of published studies on the topic has not ceased to grow, confirming its importance from both the theoretical and the practitioners' perspectives. There are many studies focused on the North American market, which are briefly reviewed in this first block. For example, Smirlok & Starks (1986), who study the "day-of-the-week" anomaly during the 1963-1983 period with intraday observations of the Dow Jones index. They subdivide their observation period into three subperiods (1963-1968, 1968-1974, and 1974-1983) and define daily returns as the percentage of change in the Dow Industrial Index Average (DJIA) from the close of day t - 1 to the close of day t; opening returns are calculated as the change in the DJIA from the close of day t - 1 to the open of day t; and intraday returns are the changes in the DJIA every hour. They find that, for the entire period, Monday operations record negative returns every hour, while the market performance from Friday close to Monday opening was consistently positive. However, in the most recent subperiod, Monday average hourly returns after noon are all positive and the "weekend-effect" is explained by negative average returns from Friday close to Monday opening. This interesting evidence suggests that while the presence of abnormal "day-of-the-week" behavior in the DJIA cannot be rejected, its nature is changing over time and needs to be studied in shorter periods to avoid confusing the changing nature of abnormal returns with its absence.

The work of Lakonishok and Smidt (1988) investigates different calendar anomalies (monthly, semimonthly, weekend, holiday, end-of-December, and turn-of-the-month) for the United States market in the long term, using the closing prices of the Dow Jones Industrial Average from the first day of trading in 1897 (January 4) until June 11, 1986, approximately 90 years, and finds that the negative returns on Mondays are statistically significant for the whole sample and several sub-samples. Kamara (1997) identifies a tendency of the "Monday" effect to disappear in the United States market and investigates its possible causes. Carrying out an analysis of the SP500 index data from the small enterprises (low capitalization) index of the CRSP database for the period 1962-1993, this author finds that the "Monday" effect disappears for big companies after April 1992. Attempting to explain what is happening, the author proposes the argument that the disappearance of the Monday anomaly is due to the reduction of transaction costs that allow large investors to perform arbitration, a fact which seems to be corroborated by the increase in the volume of institutional participants' market transactions with respect to the transactions carried out by individuals. In the case of smaller companies, this study reports that the "Monday" effect persists and attributes it to higher transaction costs.

Brockman and Michayluk (1998) hypothesize that institutional investors (rather than individuals) cause negative returns on Mondays. With data for the NYSE-AMEX and NASDAQ indices for 1983-1993, and 1973-1993, they test the hypothesis that the orders executed on Mondays are influenced by the yields on Fridays and find a significant positive correlation between yields on those two days for institutional investors, but negative for individual investors. So, they conclude that institutional investors are the ones that create the Monday effect. Franses and Paap (2000) employ time-series to model the "day-of-the-week" effect, both in terms of yields and of the day-to-day volatility of the S&P 500 index between 1980 and 1994. To that end, they use a sophisticated Partial Periodic GARCH Integrated (PAR-PIGARCH) autoregressive model in the equation of the mean, which allows the autoregressive term to change with the day of the week. The PIGARCH part ensures periodic stationarity to the variance equation, and allows both the constant and the squared error term to change with the day of the week. The main findings are that yields are positive and significant for Wednesdays and that there is first-order autocorrelation on Mondays and Tuesdays. The equal-coefficients tests for the mean and variance equations are rejected, implying that the yields and volatility vary with the day of the week.

Kiymaz and Berument (2001) study the "day-of-the-week" effect in the SP500 index for the period between 1973 and 1997, using OLS models and GARCH (1,1). In the estimation of the mean equation GARCH models include autoregressive terms in the equation of the meean, and incorporate dummy variables for each day of the week. According to the estimation results of the MCO model, the Monday yields are, on average, negative, but not significantly different from zero; on Tuesdays, Wednesdays and Fridays, they are positive and significant; and when the estimation is made using a GARCH (1,1) model, the results obtained are similar, except that the Monday yields become positive. The largest significant volatility is recorded on Fridays, while the lowest corresponds to Wednesdays.

Birru (2018) is credited with the development of one of the most outstanding studies in recent years. With data from the CRSP database for AMEX and NASDAQ from July 1963 through December 2013, this author builds weighted-by-value portfolios and uses an OLS model to detect evidence of a predictable variation in the cross-section yield through different days of the week. Relative to non-speculative stocks, speculative stocks earn low-yields on Mondays, and high-yields on Fridays. These results are robust when tested for different sub-samples, and cannot be explained by specific news, buying or selling institutional movements, or changes in market liquidity. He also finds that Monday's negative mood produces low yields among speculative stocks and, in contrast, Friday's positive mood produces high-yields on that day. As can be observed from this short list, there are abundant signs of the presence of the "day-of-the-week" anomaly, in different periods, using different econometric methods and focusing on the different indices of the American markets.

A different group of studies focus on market calendar anomalies using multinational data samples. In the following paragraphs, several examples of this nature are briefly discussed. One example is the work of Condoyanni et al. (1987), who analyze the performance of the Sydney, Toronto, London, Tokyo, Paris and Singapore markets, and argue that it makes sense to keep searching for the internal factors that cause the "weekend" effect in the United States. However, when the same phenomenon is studied in foreign capital markets, it is advisable to purge the data of any effect induced by that market before investigating whether or not it is present elsewhere, considering its sheer size with respect to other developed markets, and, evidently, to emerging markets. Agrawal and Tandon (1994) analyze the stock market data of 18 countries (10 European, three Asian and two Latin American countries, and Canada, Australia and New Zealand), and find that seven of these countries have negative returns on Mondays; in eight countries there are significant negative returns on Tuesdays; in 12 countries there are significant positive returns on Wednesdays; in nine, positive and statistically significant returns on Thursdays; and in all cases, except Luxembourg, positive and statistically significant returns on Fridays.

Kiymaz and Berument (2003) investigate the "day-of-the-week" effect in the volatility of the largest world stock market indices during the period from 1988 to 2002. They use for their estimations a conditional variance methodology with GARCH (1,1) and GARCH-M (1,1) models. Their results suggest that the effect is present in both the performance and the volatility of returns. The highest volatility occurs on Mondays in Germany and Japan, on Fridays in Canada and the United States, and on Thursdays in the United Kingdom. Notably, in most cases the markets with greater volatility are, at the same time, those with lower trading volumes in the week. Dicle and Levendis (2014) seek to determine empirically if the "day-of-the-week" still exists in international capital markets and study 51 markets in 33 countries, during the period between January 2000 and December 2007. Their results show that the effect persists in a significant proportion of those markets and an analysis of 37.631 individual stocks listed on the same markets reveals that the "day-of-the-week" effect exists in a highly significant proportion.

Zhang et al.'s (2017) sampling method of "rolling-windows" combined with a GARCH model investigates the "day-of-the-week" anomaly in the stock returns of 28 major countries' and developed countries' stock markets to find that the anomaly exists in both developed and emerging markets. They propose the use of a single index to quantify the performance of the calendar effects and, on the basis of conventional t-tests on the index built, they conclude that the results are consistent.

Some of these studies have followed a regional perspective, in both a geographical sense and in the sense of grouping together countries (emerging countries, developed countries, etc.). Carefully selecting a small sample from a much broader range of works, the examples mentioned here include, in first place, Wong et al., (1992), who use a sample of Southeast Asian countries to investigate the "day-of-the-week" effect. The markets included in their sample are Singapore, Malaysia, Hong Kong, Taiwan and Thailand, and the observation period covers 1975 to 1988. These authors find positive effects on Wednesdays in Singapore, Malaysia, and Thailand, and on Saturdays in Taiwan. As a second example of this line of research, we mention the work of Choudhry (2000), who studied the "day-of-the-week" anomaly in India, Indonesia, the Philippines, South Korea, Malaysia, Taiwan and Thailand, between 1990 and 1995. Using a GARCH-T model (to treat non-normal error terms), he employs dummy variables for the days of the week in the equation of the mean, but no autoregressive terms nor a risk premium, and in the equation of the variance he again introduces dummy variables to test for the presence of significant changes in volatility depending on the "day-of-the-week". Surprisingly, yields in Thailand are significant on all the days of the week, and the dummy variables of the variance equation indicate significant effects on Monday for all markets, with the sole exception of India, and Indonesia presents a positive anomaly on all five days of the week.

Another example is the work of Brooks and Persand (2001), who analyze the presence of anomalies in five Asian markets for the period from 1989 to 1996, and report having found positive and significant returns on Mondays for Thailand and Malaysia, and negative, significant returns on Tuesdays, a result that contradicts Wong et al.'s (1992) aforementioned results for Thailand. In the case of Taiwan, they report negative effects on Wednesdays and, in the case of Malaysia, positive effects on Thursdays.

Kok and Wong (2004) analyze the presence of the "day-of-the-week" anomaly before, during and after the Asian crisis (1997) in five Asian markets (Malaysia, Singapore, Indonesia, Thailand and the Philippines). The sample covers the period 1998-2002, but is also divided into three sub-periods: before the crisis (1992-1997), during the crisis (1997-1998) and after the crisis (1998-2002). The econometric strategy uses MCO and GARCH-M models with dummy variables corresponding to each day-of-the-week, to test for the presence of anomalies. Before the crisis, the MCO model suggests the presence of daily patterns in all markets, but the "Monday" and "Friday" effects predominate. During the crisis, only the "Tuesday" effect is present in Thailand and the Philippines. In the case of Thailand, the before-the-crisis pattern of anomalies reappears once the crisis ends, while the other four markets show a completely different pattern (indicating a deep structural change in the dynamics of those markets). When using the changing volatility models, the "Monday" effect keeps its significance, but the other effects are lost. In addition, the "Tuesday" effect for Thailand and the Philippines ceases to be significant.

Ajayi et al. (2004) propose addressing the gap in the literature on the "day-of-the-week" anomaly among emerging countries, particularly among Eastern Europe countries. They carry out a study of 11 countries in that region. Their results indicate the presence of a "Monday" effect, with negative returns in six of the markets, and positive returns in the remaining five. Only two of the six negative coefficients and only one of the five positive ones are statistically significant. So these authors conclude that the evidence does not consistently support the presence of any significant patterns in the daily returns of the markets under study.

Apolinario et al. (2006) are interested in thirteen developed European stock markets, with observations for the period between 1997 and 2004. These authors use a GARCH model and a TARCH model with four lags in the equation of mean, and dummy variables for each day-of-the-week in the equation of the variance, but only find positive effects for France and Sweden on Mondays, and for Sweden on Fridays. In most countries there is high volatility on Mondays and Thursdays; in contrast, volatility is lower on Tuesdays and Fridays. Volatility responds to negative shocks more than positive ones, that is to say, it shows a significant asymmetry in all markets, except the Czech market. The authors conclude that the "day-of-the-week" effect is present in the volatility, but not in the returns of their sample.

Yalcin & Yucel (2006) expand the work of Berument and Kiymaz (2003) using an EGARCH-M (1,1) model in a sample of 20 emerging economies around the world, for different periods of time. Their results indicate that different daily return effects and volatility regularities are present in different countries. They confirm the presence of the "day-of-the-week" effect in returns, at significance levels of 1 % in only five cases. Similarly, volatility appears statistically significantly different from zero at 1 % in only five markets. The authors conclude that there is evidence of the "day-of-the-week" effect, but it is by no means consistent across the sample.

Chia, Liew and Wafa's (2008) study of the Taiwan, Singapore, Hong Kong and South Korea markets during the 2000-2006 period uses OLS and EGARCH-M models, with lags in the volatility equation of the media in both cases. The results of their estimates with OLS indicate the presence of the "day-of-the-week" effect for every day in the case of Taiwan, and for all days, except Wednesday, in Singapore. In the EGARCH-M model results, the positive Friday effect is present only in the case of Taiwan. These results imply that the "day-of-the-week" effects in this sample are due to variation in the risk premium earned by capital - all the daily dummies in the equation of the variance are significant. In addition, significant values are reported for the asymmetric term in the three variance equations.

Seif et al. (2017) find that the nine most advanced emerging markets (Brazil, Czech Republic, Hungary, Malaysia, Mexico, Poland, South Africa, Taiwan and Turkey) are marginally less efficient (in the sense of the EMH) when compared with the performance of the United States, in terms of the "month-of-the-year", "January-effect", "day-of-the-week", "holiday", and week-44-of-the-year ("Halloween" effect) anomalies. The study uses an OLS GARCH(1.1) model, depending on the type of anomaly, and the results of the test ARCH LM to check for the presence of variance continues in the residuals. With regard to the interest of this work, reference is made only to the results of the tests of the "day-of-the-week" effect. The evidence suggests that the reported negative abnormal returns observed in the United States market are weak, compared to those in emerging markets. Although in six of the ten markets the observed average performance is negative for Mondays, only in the case of Malaysia is it statistically significant. There is a stronger evidence of the existence of a positive effect on Fridays, in eight of the nine emerging countries, in five of which these results are statistically significant at conventional levels. The average yield on Fridays for the whole sample is 0.11 %, compared to -0.008 % on Mondays, and 0,062 % for the three remaining days of the week.

Zhang, Lai and Lin (2017) investigate the "day-of-the-week" anomaly in the returns of 28 equity markets of 25 countries - 13 developed and 12 emerging - using a GARCH model, and with data from January 1990 to July 2016. The results of this broad study indicate that the "Monday" anomaly is important for the SZC, Dow, Merval, Wig20, FTSEMIB and STI indices. The "Tuesday" anomaly is noticeable in the SPX and SPXT indices. The "Wednesday" anomaly is significant for MEXBOL, JCI, DAX, SMI, ACE57, NKY and NZSE50FG. The "Thursday" anomaly is significant for the SMEC, PX and PCOMP indices, and, finally, the "Friday" anomaly is significant for the IBOV, IPSA, RTSI$, XU100, SENSEX, FBMKLCI, IBEX and HIS indices. The authors conclude that the abnormalities are present in some of the markets, but in greater magnitude when measured in the local currency rather than in dollars.

Another group of works focuses on studying individual countries. For example, Alexakis and Xanthakis (1995) use the EGARCH-M model to study the Greek market, and find positive effects on Thursday and Friday between 1985 and 1994. In this model, the asymmetry coefficient in the equation of variance is positive and significant, which means that volatility rises when the return shocks are positive, contradicting expectations. Arsad and Coutts (1997) study the Financial Times Ordinary Shares Industrial Index of the United Kingdom between 1935 and 1994 and report significant negative returns on Monday, both for the entire period and for four of six sub-periods in which the sample is divided; they also find negative and significant returns in Tuesdays, but not in all sub-periods; in contrast, they report that on Fridays high yields are present and persistent in the entire period and in the six sub-periods studied.

Clare et al. (1998) study the Malaysian market from 1983 to 1993 and find significantly negative returns (at 10 %) on Mondays and Wednesdays, positive and highly significant (at 1 %) returns on Thursdays. After controlling for the difference in hours of operation corresponding to the Kuala Lumpur market, yields observed on Mondays are negative and significant, as in the United States. These authors introduce additional dummy variables in the equation of the variance, whose results are statistically significant and show the presence of "day-of-the-week" in the variance. Aydogan and Booth (2003) investigate the presence of "day-of-the-week" anomalies in the Turkish lira-United States dollar and the German mark-United States dollar, during the period 1986-1994, in both the "free" and the "official" markets, and they report that exchange rates exhibit "day-of-the-week" and "week-of-the-month" anomalies in both cases. In addition, they mention that in the case of the German mark they can confirm the presence of a "holiday" effect. The authors explain the anomalies described in terms of disbursement of cash patterns, including Treasury-bill auctions, as well as by the patterns of bank liquidity management.

Kristjanpoller (2012) studies of the largest markets in Latin America during the 1993-2007 period using GARCH models and finds evidence of negative Monday and positive Friday effects in several cases, despite the generalized awareness of market participants and the effect of lower transaction costs. Alt, Fortin and Weinberger (2011) use an alternative multiple- hypothesis testing approach for the Monday effect that includes the United States, Great Britain and Germany's stock markets. They find that their data supports the results of previous works published in the 1970s and 1980s, but that the effect vanished during the 1990s and 2000s in all three markets included in their sample. Rojas and Kristjanpoller (2016) use the same approach to study the market anomalies in Latin America's six major financial markets during 1991-2013, and subdivide the whole sample period into three subperiods. Using the same GARCH models to study the Monday effect, they find mixed evidence of Monday anomalies, but, once the Bonferroni correction procedure is employed, this disappears in both returns and volatility for most of the sample countries in the third period of their analysis.

The evidence presented by the works mentioned in the preceding paragraphs makes it clear that there is very robust evidence about the presence of the "day-of-the-week" anomaly in all the equity markets under study, and for very long periods of time. The majority of the studies identify and report positive returns on Fridays and negative returns on Monday. In some cases, the authors call this the "weekend" anomaly (or "weekend" effect), but this is really just the combination of the individual effects of the two days. Other days of the week show characteristic behaviors in other markets, but it is not possible to generalize to all countries and periods, in the same way as Fridays and Mondays.

The efforts to document and explain the apparent contradiction implicit in the fact that investors invest on Friday (or Saturday) in assets that they know are going to see their price diminish the next day of operations, have had limited success. In recent years a new possible explanation of the "Monday" effect has emerged. The returns obtained by the stocks of large companies have become positive on Mondays and, in some years, have been significantly higher than those of other days of the week. Some of the works that attempt to give an explanation of the "weekend" anomaly include Lakonishok and Maberly (1990), who try to connect sale-purchase patterns with market anomalies, and use data from the NYSE from 1962 to 1986 to determine whether the volume of operation, mainly driven by institutional investors, decreases on Mondays. They conclude that the negative returns on Monday are the consequence of the propensity to sell on Monday on the part of the individual investors, due to the fact that they mature these decisions during the weekend and materialize them on Mondays.

Abraham and Ikenberry (1994) use orders that are smaller than the standard to study the activity of individual investors. They propose that the negative return recorded on average on Mondays is a consequence of the returns recorded in previous days of stock market activity. When the performance of the previous Friday is negative, nearly 80 % of the time it is negative on the following Monday, but when Friday returns are positive, Monday returns are also marginally positive on average. The behavior of small investors seems to be at least one of the factors that contribute to the "weekend" effect. Small investors are the most active participants in the stock market on Mondays, particularly when bad news is released on that day to the market.

Brockman and Michayluk (1998) postulate an opposite hypothesis, that institutional investors are the ones which cause negative returns on Monday. To test their hypothesis, they use the NYSE-AMEX index for 1983-1993, and the NASDAQ index for 1973-1993, and find a significant positive correlation between index returns on Fridays and Mondays, but negative between Friday and Monday for returns obtained by individual investors, leading them to conclude that institutional investors are the ones that create the Monday effect. Chen and Singal (2003) use data from CRSP for the period from 1962 to 1999 to study the influence of the speculators on the "day-of-the-week" effect, and find that short sales affect prices in a meaningful and systematic way, and contribute to the "weekend" effect. The argument is that the inability to carry out transactions during the weekend leads speculators to close their positions on Fridays and reset them on Mondays, causing an increase in prices on Friday and a fall in prices on Monday. The evidence that supports this proposal comes from a comparison of stocks with high levels of short-selling and stocks with low levels of short-selling, stocks with and without actively exchanged options, initial public offerings without short-selling, and stocks with high volatility.

It is important to include in this review the work of Pettengil (2003), who performed a detailed review of the literature on the "Monday" effect and proposed one of the most comprehensive attempts to document the role played by statistical errors, interaction with other phenomena, the role of the market microstructure in recent years, the effects of information flows, the flow of the orders, and the effects of investor behavior.

In contrast to the relative abundance of published studies addressing the calendar anomalies in the stock market, similar studies for other types of assets have been limited so far. As mentioned before, our literature review identified very few examples of other published studies on market calendar anomalies. The first-in-time work on calendar anomalies in the financial markets identified is that of McFarland et al. (1982), who study the "day-of-the-week" effects in eleven foreign-exchange markets, including the dollar spot market and those of four of the major currencies used in international trade: the pound sterling, the German mark, the Japanese yen and the Swiss franc; as well as three other currencies of lesser importance in terms of the volume and frequency with which they are traded: the Australian dollar, the Spanish peseta and the Swedish crown. They also analyze the forward market of the four major currencies (at that time there was not a forward market for the less frequently traded currencies). Their main interest focuses on the statistical distribution of logarithmic variations of the exchange rate, which, they conclude, follow a non-normal distribution in all cases. These authors also report that dollar-denominated exchange-rate variations are high on Mondays and Wednesdays, and lower on Thursdays and Fridays, for all currencies. The results from Wednesday to Friday are consistent with the liquidation procedures used in the dollar market, and the results from Friday to Monday are consistent with an increase in the demand for dollars before the weekend.

Yamori and Aiko (2004) investigate the extent to which the transaction mechanism used influences the performance of the exchange rate. To do this, they analyze the returns of 29 daily exchange rates in the New York market and find that the "day-of-the-week" effect has existed since the 1980s for some of the currencies under study. The fact that the "day-of-the-week" effect exists only for some currencies suggests that the transaction mechanism is not able to explain the anomaly. In addition, the reported results reveal that the "day-of-the-week" effect disappears for almost all currencies during the 1990s. Ke et al. (2007) use the stochastic-dominance method with and without the risk-free assets to examine whether the days of operation ("day-of-the-week" effect) may affect exchange rate performance patterns in the foreign exchange market of Taiwan. Their results indicate that during the first three days of the week a participant can obtain higher yields with long positions in the Taiwanese currency, which confirms the presence of a "day-of-the-week" anomaly.

Berumenta et al. (2007) evaluate the presence of the "day-of-the-week" anomaly in Turkey's foreign exchange market (Turkish lira with respect to the United States dollar). The empirical evidence presented suggests that Thursday are associated with higher currency depreciation, and Mondays with a depreciation, comparing both with Wednesdays. In addition, they report that Mondays and Tuesdays are associated with higher volatility than Wednesdays. Romero-Meza et al. (2010) use a new statistical test, based on the coherence of the signal function, to detect subtle periodicities in the foreign-exchange market of the Chilean peso. They analyze a set of intraday prices and capture persistent cyclical movements that challenge the "Random Walk" theory. The authors offer an explanation for the detected microstructural behavior, including the "day-of-the-week" effect, for which they find that the market follows different behavior patterns, a potentially profitable discovery for operators in the market and for risk-assessment.

The following section introduces the methodological approach followed, the data used, the estimation results for the various models and their interpretation. The results obtained are comparable to those reported in the works reviewed in the previous section, and represent an original contribution to the knowledge of the foreign-exchange markets of Latin America, which also presents some important methodological innovations.

3. Methodology

Seven different models are estimated to identify the "day-of-the-week" effect in the foreign exchange markets of the most important Latin American currencies. The chosen models seek to respond to the operating characteristics of emerging markets, and are inspired on the methodological proposal of the work of Basher and Sadorsky (2006), Ahmed and Leng (2016), and Labov (2009). In Model 1, a regression is estimated between the logarithmic returns of each of the currencies (R_i) and five dummy variables, one for each day of the week, as follows:

$$R_{it} = \sum_{j=1}^{5} \delta_{ij} D_{jt} + \varepsilon 1_{it} \tag{1}$$

In equation (1), $i = 1, ..., 5$ corresponds to the number of countries in the sample and $D_{1T}, .., D_{5T}$, represent dummy variables that identify each day of the week. The error term is assumed to have an independent and identical distribution with zero mean and constant variance. When the Djt coefficients are found to be statistically significant, this means that there is a "day-of-the-week" effect for the corresponding days. The first model does not include any risk factor. This is an important consideration because daily yields may be higher (or lower) on different days of the week due to higher (or lower) risk. The second model adds as a market risk factor (MR) the performance of the SP&500 index, a variable that has a higher correlation with the behavior of Latin American markets and affects the local currencies compared to other global market indices such as, for example, the MSCI-WSMI. This model is represented in equation (2):

$$R_{it} = \sum_{j=1}^{5} \delta_{ij} D_{jt} + \beta_i MR + \varepsilon 2_{it} \tag{2}$$

In model 2 the risk factor is assumed constant throughout the week, but it is possible to add a dummy variable for each day of the week interacting with the MR slope to let risk vary daily. This is represented as Model 3, as in equation (3) below:

$$R_{it} = \sum_{j=1}^{5} \delta_{ij} D_{jt} + \beta_{ij}(D_{ij} MRP) + \varepsilon 3_{it} \tag{3}$$

The previous models are unconditional, and assume the MR does not have any asymmetric effects on currency exchange rate yields. That is, when the market return is positive, the associated return on exchange rates is not different in magnitude from the return observed when stock market returns are negative (Fletcher, 2000; Pettengill et al., 1995).

Model 4 establishes the relationship between the performance of the market and the yields of Latin American currency exchange rates that introduces conditionality, as shown in equation (4):

$$R_{it} = \sum_{j=1}^{5} \delta_{ij} D_{jt} + \beta_{iu} \left(D_{iu} MR \right) + \beta_{id} \left(D_{id} MR \right) + \varepsilon 4_{it} \tag{4}$$

where D_{iu} and D_{id} are dummy variables that identify the dates on which the market has either positive or negative returns. The first dummy takes a value of 1 if MR is positive and zero in the opposite case. The second dummy takes a value of 1 when MR is negative and zero when it is not.

Model 5 relates the MR with the returns of individual currencies, and includes the slope interaction between the day-of-the-week variables and the positive or negative values of MR. Therefore, the conditional risk may change from one day to the next, according to equation (5):

$$R_{it} = \sum_{j=1}^{5} \delta_{ij} D_{jt} + \sum_{j=1}^{5} \beta_{iju} \left(D_{ju} MR_t \right) + \beta_{ijd} \left(D_{jd} MR_t \right) + \varepsilon 5_{it} \tag{5}$$

Given that in most cases regressions using financial data produce residuals whose variance is not constant, one has to deal with the problem of heteroskedasticity. To that end, ARCH-GARCH models, which account for volatility "clusters" in the residuals - important changes in prices are associated with important changes in the variance of the residuals, are used. In general terms, the current level of volatility tends to be positively correlated with the immediately prior level of volatility (Brooks, 2014).

According to the original GARCH model assumptions, volatility responds symmetrically to both positive and negative shocks in prices (Engle, 1982). However, in reality, negative shocks usually produce much greater jumps in volatility when compared to positive shocks. This phenomenon, known as the "leverage effect", is due to the drop in the market value of a firm's equity, which increases its leverage and, as a result, shareholders perceive its cash flows as being riskier (Brooks, 2014). Modern econometric models are able to capture the leverage effect with different models: the GARCH Threshold models (TARCH), and the exponential GARCH (EGARCH) model.

The TARCH model was introduced by Zakoian (1994) and Glosten et al. (1993) as an extension of the original GARCH model proposed by Engle (1982). Model 6 captures the asymmetric response of volatility to positive and negative returns in MR by introducing an additional term in the conventional GARCH model, as represented in equation (6):

$$h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \varepsilon_{t-k}^2 I_{t-k} \tag{6}$$

where $I_t = 1$ if $\varepsilon_t < 0$ and $I_t = 0$ in the opposite case. The "good news" corresponds to $\varepsilon_{t-k} > 0$, and "bad news" to $\varepsilon_{t-k} < 0$, and each one impacts the conditional variance differently. When $\varepsilon_{t-k} > 0$, the conditional variance experiences an impact equal to α_i, while if $\varepsilon_{t-k} < 0$, the impact on the conditional variance is equal to $\alpha_i + \gamma_k$. If $\gamma_k \neq 0$, it can be concluded that the impact of the news is asymmetric and if, additionally, $\gamma_k > 0$, bad news increases volatility and the "leverage effect" is confirmed.

The exponential GARCH model (EGARCH), used in this work as Model 7 was originally proposed by Nelson (1991), with the conditional variance specification that is represented in equation (7):

$$log h_t = \omega + \sum_{j=1}^{p \sum_{t-j} \sum_{i=1}^{q} \alpha_i \left(\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| - E\left[\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| \right] \right) \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}}} \beta_j log \tag{7}$$

In this case, since the natural logarithm of the conditional variance is the dependent variable of the EGARCH model, the leverage effect is exponential and not quadratic. In addition, the variance forecasts are guaranteed to be positive, even if the parameters are negative. Therefore, there is no need to impose any non-negativity restrictions on the parameters. The presence of the leverage effects can be verified by testing the hypothesis: H0: $\gamma_k < 0$. In any case, if $\gamma_k \neq 0$, then there is an asymmetric behavior in the conditional volatility.

4. Data

The data for the analysis presented here were downloaded from a Bloomberg terminal, and include the exchange rate quotations of each local currency against the US dollar in direct parity terms (units of local currency per US dollar), with 3,180 observations ranging from January 3, 2003 to October 23 , 2018, for the currencies of Argentina, Brazil, Chile, Peru, Colombia and Mexico, as well as the S&P500 Index. Daily logarithmic returns are calculated as:

$$Rt = 100xLn(It/It-1), \tag{8}$$

where I_t represents the closing value of the variable of interest in date t.

Table 1. Descriptive statistics of the daily returns of Latin American currencies

	Arg	Bra	Chi	Col	Mex	Per	SP500
Mean	0.00074	0.00001	(0.00002)	0.00003	0.00020	(0.00002)	0.00036
Median	0.00040	(0.00036)	(0.00012)	(0.00006)	(0.00027)	0.00000	0.00075
Maximum	0.30799	0.07112	0.05660	0.06606	0.07977	0.18795	0.10424
Minimum	(0.04524)	(0.09837)	(0.05089)	(0.04743)	(0.06138)	(0.18739)	(0.09470)
Std. deviation	0.00841	0.01150	0.00785	0.00842	0.00830	0.00644	0.01234
Bias	17.22165	0.15113	0.18184	0.24213	0.79302	0.23974	(0.50509)
Kurtosis	587.33610	8.84009	7.98444	8.77983	12.27996	513.19770	12.09894
Jarque-Bera	45,399,147	4,531	3,309	4,457	11,744	34,489,998	11,105
Probability	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Observations	3,180	3,180	3,180	3,180	3,180	3,180	3,180

Source: Authors' own using data from Bloomberg.

According to the descriptive statistics presented in Table 1, the asymmetric returns of all currencies are leptokurtic. The Jarque-Bera statistic also confirms that, in all cases, the daily returns are not normal. The Dickey-Fuller[4] test to detect unit root tests confirms that all returns series are stationary.

Table 2 contains the correlation matrix for pairs of currencies. All correlations are positive, and some are moderately high (greater than 29 %), as in the case of the Brazilian real against the Chilean, Colombian and Mexican peso, or of that of the Mexican peso with those same three currencies. The SP&500 index causes exchange rate volatility due to financial flows that enter or exit these economies in response to the fluctuations of the United States market. The correlation between each currency and the S&P500 index consistently shows negative values, implying that positive movements of the index are associated with the strengthening of the dollar vis à vis the Latin American exchange rates, i.e., less demand for local securities due to the attractiveness of the New York market, and vice versa.

Table 2. Correlations between the daily returns of Latin American currencies and the S&P500 Index.

	Arg	Bra	Chi	Col	Mex	Per	SP500
Arg	1.00000						
Bra	0.08060	1.00000					
Chi	0.09899	0.31904	1.00000				
Col	0.08246	0.40822	0.29344	1.00000			
Mex	0.07690	0.55321	0.29356	0.40348	1.00000		
Per	0.02523	0.10192	0.09330	0.13219	0.10954	1.00000	
SP500	-0.05853	-0.47156	-0.24443	-0.31063	-0.53685	-0.06554	1.00000

Source: Authors' own using data from Bloomberg.

5. Results and Discussion

The estimation results for Model 1 are presented in Table 3, and show evidence of a positive and significant effect on Mondays in the cases of the Colombian and the Mexican currencies. None of the six currencies seem to have a "day-of-the-week" effect on Tuesdays. Neither Brazil nor Chile present any "day-of-the-week" effects, Colombia and Peru have a negative, significant and very significant effect, respectively, on Thursdays, while in the case of the Argentinean peso, there is a positive and highly significant effect on that same day. The Argentinean peso also shows a positive and significant effect on Fridays.

[4] The results of the Dickey-Fuller test are not reported in the body of this article due to space limitations, but are available upon request.

Table 3. Ordinary Least Squares regressions with dummies for each day of the week

Model 1	Arg	Bra	Chi	Col	Mex	Per
Monday	-0.00006	0.0008	0.00016	0.00041***	0.00125***	0.00014
t-statistic	-0.13637	1.40288	0.40159	2.913	3.056	0.42474
Tuesday	0.00029	-0.00037	0.00036	-0.00002	0.00007	0.00014
t-statistic	0.89195	-0.84126	1.2031	-0.0602	0.20655	0.59568
Wednesday	0.00059*	0.00021	-0.00015	0.00018	0.00025	0.00014
t-statistic	1.882	0.49247	-0.51249	0.58418	0.81267	0.59568
Thursday	0.00189***	0.00008	-0.00044	-0.0006*	0.00033	-0.00082***
t-statistic	5.881	0.17226	-1.47102	-1.87	1.04493	-3.31
Friday	0.00069**	-0.00034	0.00007	-0.00016	-0.00051	0.00005
t-statistic	2.14700	-0.76766	0.23588	-0.50409	-1.59418	0.20612

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

Model 2 includes, in addition to the dummy variables for each day, the S&P500 returns, because the conditions of the New York stock market drive significant activity in the currency exchange rate markets of Latin American countries. The estimation results of Model 2 (reported in Table 4) confirm the presence of a highly significant and positive effect on Mondays in Colombia and Mexico. In the previous model, returns on Tuesdays do not appear significant for any of the exchange rates, but once the control variable of the S&P500 returns is included, this model shows a positive and significant effect for the currencies of Chile, Peru and Mexico on that day. The "Wednesday" effect is positive and marginally significant only for Argentina's currency. Thursdays show a positive and highly significant performance for Argentina's currency, but negative and only marginally significant in the case of Colombia's currency, and also negative, but highly significant, for Peru's currency. On Fridays, the Argentinean currency again shows a highly significant and positive coefficient, and Mexico's currency has a negative and statistically significant coefficient. The values obtained for the market return betas are negative, less than one in absolute value, and highly significant for all six national currencies exchange rates. This suggests that in response to an upward movement in the US stock market, the exchange rates of the Latin American currencies appreciate vis-à-vis the US dollar, possibly indicating the market considers that favorable expectations for the region are associated with such movement.

Table 4. Ordinary Least Squares regressions with dummies for each day of the week and the S&P500 Index

Model 2	Arg	Bra	Chi	Col	Mex	Per
Monday	-0.00006	0.00076	0.00014	0.00120***	0.00122***	0.00013
t-statistic	-0.14572	1.50741	0.37467	3.01300	3.527	0.41519
Tuesday	0.00034	0.00022	0.00057**	0.00026	0.00055**	0.00049**
t-statistic	1.05854	0.56680	1.95700	0.86604	2.061	2.012
Wednesday	0.00060*	0.00038	-0.00009	0.00026	0.00039	0.00016
t-statistic	1.93300	0.99664	-0.32130	0.88249	1.48831	0.65153
Thursday	0.00191***	0.00026	-0.00038	-0.00052*	0.00048	-0.0008***
t-statistic	5.94000	0.66381	-1.29545	-1.68190	1.80014	-3.26
Friday	0.000675**	-0.00053	0.00000	-0.00025	-0.00066**	0.00004
t-statistic	2.09650	-1.35738	0.01300	-0.82802	-2.474	0.14576
SP500	-0.03979***	-0.44019***	-0.15614***	-0.21215***	-0.36225***	-0.03476***
t-statistic	-3.30000	-30.10000	-14.26000	-18.44000	-36.04	-3.762

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

Model 3 (whose estimation results are presented in Table 5) adds an interaction term between the S&P500 market returns and the dummies for each day of the week. The effects reported in Table 4 for Mondays are present again in Table 5, but this time they show a positive and significant effect for the Chilean peso. The interaction term for Mondays is negative and highly significant for Mexico's currency. Friday's interaction term coefficient is negative and highly significant for all countries. This could be an important discovery since the interpretation of this phenomenon suggests that when stock prices rise on average in the New York market, all six Latin American currencies studied experience an appreciation of their exchange rate, as suggested in Table 4, but which in Table 5 can be associated specifically with the last day of the week. A possible interpretation of this signal is that when New York's stock exchange has positive returns on the last day of the week, all six Latin American currencies tend to appreciate vis-à-vis the US dollar, and that this response is also present in the opposite direction, i.e. when the New York Stock Exchange drops on Friday. Foreign portfolio investors most likely take long positions in Latin American stocks and bonds on Fridays whenever the S&P500 follows a positive trend, and short positions in those same currencies in the event of negative signals from the S&P500 index.

Table 5. Ordinary Least Squares regressions with dummies for each day of the week and for the S&P500 Index

Model 3	Arg	Bra	Chile	Col	Mex	Per
Monday	-0.00006	0.00076	0.00014	0.00119***	0.00123***	0.00013
t-statistic	-0.14309	1.50680	0.36557	3.00500	3.5514	0.41524
Tuesday	0.00034	0.00029	0.00057*	0.00030	0.00055**	0.00054**
t-statistic	1.04927	0.75384	1.94557	0.97018	2.0777	2.1873
Wednesday	0.000586*	0.00039	-0.00009	0.00023	0.0004	0.00014
t-statistic	1.88550	1.05025	-0.31737	0.77875	1.55554	0.59894
Thursday	0.00192	0.00021	-0.00038	-0.00051	0.00049*	-0.00081***
t-statistic	5.97089	0.54498	-1.29385	-1.6799*	1.8308	-3.29
Friday	0.000656**	-0.00051	0.00002	-0.00026	-0.00065**	0.00003
t-statistic	2.03710	-1.30948	0.06125	-0.84429	-2.429	0.116
SP500 Monday	-0.02823	-0.46396	-0.19186	-0.27419	-0.29595***	-0.03537
t-statistic	-0.95340	-12.97126	-7.13164	-9.72276	-12.0	-1.56
SP500 Tuesday	-0.03843	-0.49458	-0.15505	-0.23624	-0.3664	-0.06803
t-statistic	-1.62446	-17.30712	-7.21357	-10.48500	-18.603	-3.75
SP500 Wed.	-0.00041	-0.49167	-0.15514	-0.12889	-0.40748	-0.00125
t-statistic	-0.01617	-16.05428	-6.57418	-5.33765	-19.3047	-0.0644
SP500 Thurs.	-0.06387	-0.32744	-0.15671	-0.21580	-0.38082	-0.01714
t-statistic	-2.40250	-10.19727	-6.48868	-8.52374	0.00123***	0.00013
SP500 Friday	-0.08320**	-0.39472**	-0.12338***	-0.22289***	3.5514	0.41524
t-statistic	-2.61280	-10.261	-4.26	-7.349	0.00055**	0.00054**

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10

Models 4 and 5 (whose results are reported in Tables 6 and 7) are conditional, and isolate the asymmetric effects of the stock market on the exchange rates. Model 4 is similar to Model 2, but the S&P500 index coefficient is replaced by two dummy variables whose value depends on whether the market return of the observation day is positive (sp500_up = 1, and sp500_down = 0) or negative (sp500_up = 0, and sp500_down = 1). The findings obtained from the estimation of Model 4 are slightly different from those observed in Tables 3 to 5, since in this case, the Peruvian currency shows a positive and marginally significant effect on Tuesdays. On Thursdays, there is a significant and positive effect for the Argentinean peso, and a negative and significant effect for the Colombian peso and the Peruvian sol. The negative and highly statistically significant observed coefficients for all countries for both upward movements (with the sole exception of the Argentinean peso) and downward movements of the S&P500, again confirms the sensitivity of exchange rates to what happens in New York's stock market.

Table 6. Ordinary Least Squares regressions with dummies for each day-of-the-week and for the S&P500 Index upward and downward movements

Model 4	Arg	Bra	Chi	Col	Mex	Per
Monday	-0.00016	0.00079	0.00002	0.00107**	0.00104***	0.00015
t-statistic	-0.36377	1.48279	0.05224	2.5613	2.863	0.44968
Tuesday	0.00023	0.00025	0.00044	0.00013	0.00035	0.00051*
t-statistic	0.65672	0.58138	1.36690	0.37298	1.20569	1.9025
Wednesday	0.00051	0.00040	-0.00021	0.00014	0.00022	0.00017
t-statistic	1.50923	0.98197	-0.67282	0.43847	0.76754	0.66998
Thursday	0.00182***	0.00028	-0.00049	-0.00064*	0.00031	-0.00079**
t-statistic	5.24200	0.67526	-1.56942	-1.92985	1.07664	-2.9596
Friday	0.00059	-0.00051	-0.00010	-0.00037	-0.00082***	0.00005
t-statistic	1.72174	-1.22156	-0.32412	-1.11627	-2.871	0.19758
sp500_upward	-0.02718	-0.44352***	-0.14067***	-0.19582***	-0.33925***	-0.03712**
t-statistic	-1.29052	-17.38000	-7.35300	-9.74300	-19.326	-2.2991
sp500_downward	-0.05065***	-0.43732***	-0.16946***	-0.22622***	-0.38206***	-0.03274**
t-statistic	-2.64000	-18.86000	-9.74500	-12.38000	-23.943	-2.2309

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

The estimations of Model 5 (reported in Table 7) confirm some of the effects of the day-of-the-week observed with previous models for individual currencies. However, Model 5 includes an interaction term that identifies the sensitivity of differentiated responses to the rise or fall of the S&P500 index, for each day of the week and for each currency. This makes it possible to observe the sensitivity of the response of currency exchange rates to rising and declining movements in the New York market more accurately. The total absence of statistical significance of the Argentinean peso exchange rate response to the rise or fall of the S&P500 index, and the sensitivity of the Peruvian sol only to the rise of the New York market on Tuesdays and Wednesdays are worth noting and raise complex questions. In contrast, the currencies of Brazil, Colombia and Mexico show a highly significant sensitivity to a rising market in New York on all days of the week, and that of Chile, from Mondays through Thursdays. Similarly, Brazil, Chile, Colombia and Mexico show a significant sensitivity to the declines of the S&P500 every day of the week, while Argentina's currency shows sensitivity only on Thursdays and Fridays, and Peru's currency seems to be totally immune to the declines of the S&P500.

Table 7. Ordinary Least Squares regressions with dummies for each day-of-the-week and for the interactions between the S&P500 Index upward and downward movements with individual currencies

Model 5	Arg	Bra	Chi	Col	Mex	Per
Monday	-0.00009	0.001264**	0.00058	0.001404**	0.001487**	0.00008
t-statistic	-0.16828	1.98980	1.20725	2.80180	3.4018	0.20667
Tuesday	0.00037	0.00001	0.00063	-0.00020	0.00069*	0.00048
t-statistic	0.86539	0.02189	1.61960	-0.48351	1.9374	1.45955
Wednesday	0.00065	-0.00052	-0.00046	-0.00031	-0.000621*	0.00012
t-statistic	1.57546	-1.03845	-1.22485	-0.79018	-1.8182	0.38556
Thursday	0.00157	0.00077	-0.00064	-0.00039	0.00051	-0.000799**
t-statistic	3.643**	1.48660	-1.63128	-0.95994	1.41654	-2.4164
Friday	0.00035	-0.00018	-0.00047	0.00006	-0.00098**	0.00008
t-statistic	0.73244	-0.30874	-1.09837	0.12408	-2.493	0.21147

Model 5	Arg	Bra	Chi	Col	Mex	Per
Monday rise	-0.02393	-0.538836***	-0.25666***	-0.305845***	-0.33404***	-0.02817
t-statistic	-0.42599	-7.95500	-5.03400	-5.72300	-7.1672	-0.65453
Tuesday rise	-0.04178	-0.468266***	-0.161176***	-0.189907***	-0.379212**	-0.062746**
t-statistic	-1.16712	-10.84900	-4.96070	-5.57700	-12.767	-2.2874
Wednesday rise	-0.00931	-0.362583***	-0.099597**	-0.05227	-0.26224***	0.00172
t-statistic	-0.20262	-6.54500	-2.38840	-1.19602	-6.8797	0.04887
Thursday rise	-0.01567	-0.40530***	-0.12054***	-0.23248***	-0.38319***	-0.01872
t-statistic	-0.32711	-7.014	-2.7714	-5.100	-9.6376	-0.50976
Friday rise	-0.03197	-0.449796***	-0.04274	-0.274832***	-0.27974***	-0.05986
t-statistic	-0.49002	-5.71720	-0.72172	-4.42770	-5.1671	-1.19723
Monday decline	-0.03090	-0.417546***	-0.151695***	-0.254572***	-0.27234***	-0.03983
t-statistic	-0.73811	-8.27170	-3.99190	-6.39220	-7.8402	-1.2415
Tuesday decline	-0.03368	-0.531979***	-0.146337***	-0.302076***	-0.34819***	-0.07554
t-statistic	-0.75008	-9.82550	-3.59040	-7.07180	-9.3457	-2.19538
Wednesday decline	0.00639	-0.590382***	-0.191073***	-0.187472***	-0.51854***	-0.00352
t-statistic	0.16503	-12.63700	-5.43300	-5.08620	-16.129	-0.11861
Thursday decline	-0.102247**	-0.265432***	-0.185515***	-0.202509***	-0.37893***	-0.01588
t-statistic	-2.46900	-5.31570	-4.93520	-5.14040	-11.027	-0.5004
Friday decline	-0.118011**	-0.357292***	-0.178171***	-0.187599***	-0.36985***	-0.04657
t-statistic	-2.35470	-5.91250	-3.91660	-3.93490	-8.8941	-1.21261

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

A comparison of the results of Tables 3-7 shows that the "Monday" effect is always present for the Colombian and Mexican currencies in all models, and the Friday effect for the Mexican peso. The distribution of the significant coefficients for the other days of the week hardly follows any regularity, but there are some consistencies. For example, the separation of up and down movements allows the detection of the "day-of-the-week" effect in a large number of cases (Table 7). However, the inclusion of the S&P500 index highlights the importance of its behavior in the movement of Latin American currencies. Similarly, the results of introducing the variables which interact with the up and down movements of the United States market with the days-of-the-week support interesting inferences, as is the case of the Friday effect combined with the behavior of the S&P500.

The following two models abandon the assumption that the variance of the residuals follows a constant volatility and use GARCH models to represent and estimate their behavior, to make them more reliable estimates of the significance of the coefficients. The order of the TARCH and EGARCH models was chosen in accordance with the AIC, to be (1.1). This result avoids the need to look at models in which the heteroscedasticity would be present in more distant lags, and therefore more difficult to estimate and interpret.

In first place, the estimation of the TARCH Model presented in Table 8 indicates that the ARCH terms are significant for all countries' currencies, confirming the presence of heteroscedasticity and volatility clusters.

The TARCH term is not significant only in Chile's currency, while, in the case of Brazil, Chile, Colombia and Mexico's currencies, the GARCH coefficients have values that are close to one, and are statistically significant, which means that the shocks of volatility are quite persistent. In the cases of Argentina's and Peru's currencies, the GARCH coefficients are also significant, but smaller. For Argentina's currency, the sum of the GARCH terms is greater than one, which implies an explosive variance result. The coefficient for the asymmetric effect is significant for all currencies, with the exception of the Chilean peso. It is positive for Argentina's and Peru's currencies and negative in other cases.

Table 8. Results of the TARCH Model estimation

Model 6	Arg	Bra	Chi	Col	Mex	Per
Monday	0.00011	0.0002	0.00005	0.00042	0.00081**	-0.00021**
t-statistic	1.12057	0.49128	0.17471	1.49679	2.7522	-2.98
Tuesday	0.00017***	-0.00005	0.00041	-0.00018	0.00034	0.00191***
t-statistic	3.228	-0.16221	1.699*	-0.84908	1.49669	43.209
Wednesday	0.00253***	-0.00038	-0.00024	-0.00035*	-0.00005	-0.00040***
t-statistic	140.34	-1.30111	-0.9669	-1.6546	-0.23355	-6.124
Thursday	0.00011	0.00008	-0.00048*	-0.00034	0.00013	-0.00073***
t-statistic	1.43634	-1.30111	-1.9244	-1.60799	0.53636	-9.542
Friday	0.00061***	-0.00024	-0.00026	-0.00069***	-0.00056**	-0.00065***
t-statistic	39.346	-0.70619	-0.90354	-2.884	-2.346	-8.75
Constant	0.000003***	0.000004***	-0.000001***	0.000001***	0.000001***	0.000005***
t-statistic	20.52	7.9477	7.1105	8.1021	5.602	52.4
Arch	2.11976***	0.19988***	0.07987***	0.14067***	0.10018***	0.91780***
t-statistic	23.784	7.9477	12.98	13.899	12.269	16.137
Garch	0.05652***	0.84042***	0.90339***	0.89225***	0.91327***	0.01642***
t-statistic	18.67	80.115	126.47	132.4	161.79	7.5211
Tarch	9.34717***	-0.13521***	-0.01099	-0.07722***	-0.04362***	8.97195***
t-statistic	52.886	-9.147	-1.0773	-8.543	-5.093	20.282

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

The estimates of the EGARCH models reported in Table 9 present some variations with respect to the TARCH model results. Robust "day-of-the-week" effects are detected every day for Argentina's and Peru's currencies; Monday, Tuesday and Friday effects are present for Mexico's currency; and Wednesday and Thursday effects for Chile's currency, but neither Brazil's nor Colombia's currencies show any "day-of-the-week" effects. The significant coefficients are all positive in the case of the Argentinean peso, negative for the Chilean peso, positive Monday and Tuesday, but negative on Fridays for the Mexican peso. They are negative on Monday, Thursday and Friday, but positive on Tuesday and Wednesday for the Peruvian sol. In all cases, the long-term volatility is significant and less than zero. The coefficient of Peru's sol is extraordinarily large and negative, close to -8. The ARCH terms are positive, except in the case of Peru's currency, significant, except in the case of Chile's peso, and less than one in value. The GARCH terms are significant and close to one, except for Peru's sol, which shows low persistence of volatility, but highlights the case of Argentina where the slightly greater than one coefficient is interpreted as an explosive and unstable process.

The EGARCH terms are significant, and reveal the presence of asymmetric effects, i.e., negative shocks cause larger peaks of volatility than positive shocks. Except in the case of Peru's and Argentina's currencies, their values are greater than unity, which means persistent volatility with a very long memory and a large leverage effect.

Table 9. EGARCH Model estimation results

Model 7	Arg	Bra	Chi	Col	Mex	Per
Monday	0.00115***	0.00035	0.00031	0.00036	0.00081***	-0.00037***
t-statistic	22.999	0.87903	1.05811	1.48446	2.8346	-7.888
Tuesday	0.00213***	0.00009	0.00042*	0.00011	0.00036*	0.0019***
t-statistic	64.319	0.31351	1.8519	0.56509	1.66471	53.981
Wednesday	0.00136***	-0.00033	-0.00043*	-0.00023	-0.00006	-0.00023***
t-statistic	93.61	-1.16825	-1.8304	-1.11789	-0.29079	-4.589
Thursday	0.00154***	0.00003	-0.0006**	-0.00006	0.00014	-0.00033***
t-statistic	93.61	0.08903	-2.377	-0.28501	0.63296	-9.880
Friday	0.00211***	-0.00011	-0.00021	-0.00035	-0.00046**	-0.00056***
t-statistic	76.199	-0.33321	-0.73853	-1.48935	-1.971	-14.80

Model 7	Arg	Bra	Chi	Col	Mex	Per
Constant	-0.8769***	-0.5116***	-0.39358***	-0.3686***	-0.30648***	-8.86141***
t-statistic	-33.40	-10.57	-9.350	-12.5	-9.80	-82.71
Arch	0.085131***	0.083557***	0.00726	0.051553***	0.052861***	-0.673214***
t-statistic	6.2187	8.8552	1.05181	9.0238	7.6586	-23.036
Garch	1.00259***	0.96359***	0.97251***	0.97678***	0.98229***	0.30372***
t-statistic	493.42	210.43	249.44	392.41	359.29	30.95
EGarch	1.34140***	0.22762***	0.16630***	0.19233***	0.17218***	2.07635***
t-statistic	95.879	14.311	16.844	18.555	19.072	73.828

Source: Authors' own using data from Bloomberg. Note: Statistical significance: * p<10 %;** p<5 %; ***<1 %.

Comparing the characteristics of both asymmetrical models, the TARCH is the best option because, according to its properties, it estimates the conditional variance as trend-stationary, while the EGARCH estimates it as not stationary. Another shortcoming of the EGARCH model mentioned by Engle and Ng (1993) is that it tends to overestimate the impact of the out-of-sample points, due to its exponential structure, producing predictions of very high variance. In this regard, it can be concluded that the estimates from Model 6, projected with the TARCH model, are the most representative of all estimates.

6. Conclusions

The extant literature has extensively documented the "day-of-the-week" effect in the stock market of many countries, but very little has been done to learn more about this anomaly in other financial assets' markets. The present work's original contribution consists, precisely, in addressing the "day-of-the-week" anomaly in the context of the six largest Latin American economies' currency exchange markets[5].

The purpose of this paper is to document whether there is a pattern of consistent behavior in foreign exchange markets in our sample countries, on specific days-of-the-week. This study uses conditional and non-conditional risk to investigate the day by day performance of the currency exchange rates of Argentina, Brazil, Chile, Colombia, Mexico and Peru, all against the United States dollar. The econometric models are refined from the simpler, Ordinary Least Squares regression model to the more sophisticated Asymmetric Conditional Heteroskedasticity EGARCH model, and confirm that as more information is incorporated and the models' restrictions are relaxed, our estimations are capable of detecting a greater number of "day-of-the-week" effects in the six national currency markets. The use of the North American market's most popular stock market index, the S&P500, as a control variable permits the identification of the enormous influence that investor behavior in the United States has on the exchange rates of Latin American currencies.

Some academic studies have referred to the disappearance of the "day-of-the-week" anomalies in some markets as a result of the systematization of processes and the increasing speed of information flows that allow a faster flow of buy and sell orders (e.g., Kohers et al., 2004). As a result, verification of the presence of such anomalies in the currency exchange rate market is relevant and should be useful for international treasury managers, risk managers in general, and monetary and financial policy designers in the countries involved. Indeed, the results suggest the presence of a typical behavior of the exchange rate of all the currencies in the sample, with greater or lesser intensity depending on the model used, but its scope is partial considering that it leaves out the study of the economic importance of these anomalies. A more in-depth exploration of that topic will

[5]Venezuela's currency exchange rate should have been included in the analysis, but the country's political and economic instability in recent years and the distortions that the government's intervention has induced fixing an official exchange rate while the "black-market" rate is many times higher, tipped the decision not to include it.

be the subject of subsequent work, which should include the transaction costs and fiscal effects of trading in order to determine whether the abnormalities detected represent an opportunity for arbitration or solely reflect inefficiencies arising from the frictions in the market.

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