Impact of Financial Market Uncertainty and Macroeconomic Factors on Stock-Bond Correlation in Emerging Markets

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Abstract

This paper examines the impact of global financial market uncertainty and domestic macroeconomic factors on stock-bond correlation in emerging markets. In particular, the impact is analyzed across different time horizons by applying wavelet analysis on a sample of 10 emerging markets. We find that time-varying stock-bond correlation patterns vary significantly between the time horizons. In particular, the correlation in short horizon changes the sign rapidly showing sustainable negative episodes while the correlation in long horizon stays positive most of the time. The most important factor influencing stock-bond correlation at short horizon is the monetary policy stance, while the factors with the highest impact in long term are inflation and stock market uncertainty. Finally, global stock market uncertainty plays more significant role than global bond market uncertainty in explaining stock-bond correlations in emerging markets.

JEL classifications: E44, F30, G15

Keywords: stock-bond correlation, emerging markets, macroeconomic factors, financial market uncertainty, wavelet analysis

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1. Introduction

This article focuses on the impact of global financial market uncertainty and domestic macroeconomic factors on stock-bond correlation in emerging markets at short and long time horizons. Examining the dynamics of the time-varying co-movements between stocks and bonds is important for several reasons. Stock-bond correlation is one of the most influential inputs to investors' asset allocation decisions. Moreover, investors' portfolio optimization, risk management and hedging choices may be improved drastically taking into consideration the relationship between two main asset classes. Finally, policy makers are increasingly using the information about the joint behavior of stocks and bonds in determining the market views on the inflation and the economic activity of the country. The issue of stock-bond correlation in emerging markets is recently gaining considerable attention due to increasing demand for the emerging market assets by the international investors seeking portfolio diversification benefits. In particular, government bonds of the emerging markets have become an attractive investment target in recent decade due to the following reasons: (i) emerging markets are among the world's fastest growing economies in which government bonds represent the second largest source of financing since 1990s; and (ii) increasing market liquidity and transparency in emerging bond markets (see, e.g. Bunda et al., 2009; Piljak, 2013). Additionally, assessment of stock-bond correlation dynamics at different time horizons is important for international investors in the context of portfolio rebalancing decisions.[1]

The purpose of this study is two-fold. By applying the wavelet analysis approach, we are able to examine stock-bond correlations over different time horizons in ten emerging

[1] True long-term relationship between stock and bond returns can be altered in a short horizon due to the short-term noise: investors' immediate consumption needs and portfolio optimization (see Harrison and Zhang, 1999).

markets during the period 2001-2013.[2] The advantage of applying the wavelet analysis in examining co-movement dynamics between asset classes is related to simultaneous consideration of time and frequency domains in one integrated framework. Second, we investigate impact of global financial market uncertainty (both stock and bond market uncertainty) and domestic macroeconomic factors on the stock-bond correlations at short- and long-term horizons. In line with previous studies on relationship between the stock-bond correlation and macroeconomic factors (Ilmanen 2003; Yang et al., 2009), we include inflation, business cycle patterns and the monetary policy stance in our analysis.

The literature on stock-bond correlations has been traditionally focused on developed markets (Andersson et al., 2008; Campbell and Ammer, 1993; Cappiello et al., 2006; Ilmanen, 2003). The most prominent issue within this stream of literature is related to examining various factors driving the stock-bond correlations. The debate on this issue still remains open, given the mixed evidence in the literature on the role of macroeconomic factors in driving stock-bond correlations. In particular, one segment of the literature documents the importance of the macroeconomic fundamentals, specifically inflation, business cycle environment and the monetary policy stance, in explaining stock-bond correlations (Ilmanen, 2003; Li, 2004; Yang et al., 2009). Yang et al. (2009) provide convincing evidence of time-varying stock-bond correlations over macroeconomic conditions (the business cycle, the inflation environment, and monetary policy stance) by using data for the US and the UK covering the past 150 years. Ilmanen (2003) points out inflation as a key driver of stock-bond correlation. High inflation periods lead to changes in common discount rates that dominate the cash-flow expectations and lead to the positive correlation between the two asset classes. Further findings demonstrate that stocks tend to outperform bonds

[2] A wavelet analysis approach has been applied in several studies to analyze financial time-series. For example, Rua and Nunes (2009), Graham et al. (2012), and Kiviaho et al. (2014) apply wavelet squared coherency to analyze international co-movement of stock market returns. Kim and In (2005) use wavelet correlations to study the co-movement between stock returns and inflation, while Kim and In (2007) apply wavelet analysis to examine relationship between changes in stock prices and bond yields in G7 countries.

during the business cycle expansions, while bonds outperform stocks during the business cycle contraction periods. Finally, easing the monetary policy has a positive effect on both stocks and bonds exhibiting the positive relation with the correlation of those two asset classes.

In contrast, Baele et al. (2010) argue that macroeconomic factors play only a minor role in explaining stock-bond correlations in the US market. Andersson et al. (2008) use data from the US, the UK, and German markets and find that inflation expectation is important determinant of stock-bond correlation, while economic growth expectation is not a relevant factor. Specifically, their result shows that stock and bond prices move in the same direction when the inflation expectations are high.

More recent study by Aslanidis and Christiansen (2014) provides new insights into the role of macroeconomic fundamentals in explaining stock-bond correlations. They find that macroeconomic factors have only little explanatory power when the stock-bond correlation is large positive; but however, when the stock-bond correlation is large negative, then macroeconomic fundamentals are most useful explanatory variables. The rationale behind this finding is that macroeconomic factors are important for bonds in all periods, while for stocks they are important only in very volatile periods.

One additional segment of the related literature provides evidence that stock market uncertainty plays an important role in explaining stock-bond correlations (Andersson et al., 2008; Connolly et al., 2005, 2007; Kim et al., 2006). The aforementioned studies are using implied volatility from equity index options as a proxy for stock market uncertainty, and suggest that implied volatility changes have an impact on market participants' risk aversion therefore affecting the stock-bond correlation. Considerable attention in those studies has been given to the "flight-to-safety" phenomenon, in which the correlation between stocks and bonds become significantly negative during periods of high market uncertainty (Gulko, 2002;

Connolly et al., 2005; Andersson at al., 2008; Baur and Lucey, 2009). In particular, the financial equity markets crashes make investors more risk averse, as they shift the funds from stock to bond markets.

Among the literature on stock-bond correlation, studies examining emerging markets are relatively scarce. In particular, Panchenko and Wu (2009) use the sample of 18 emerging markets to investigate how the stock-bond co-movement is affected by emerging stock market integration. In addition, Boyer et al. (2006) examine correlations between stock and bonds in emerging markets within the context of financial crisis contagion. More recently, Christopher et al. (2012) address the issue of the effects of sovereign credit ratings on time-varying stock-bond correlations in emerging countries worldwide.

Our study contributes to the literature in three ways. First, we add to the literature on stock-bond correlation by providing new evidence on the impact of macroeconomic factors and global financial market uncertainty from the perspective of emerging markets. Second, by using advantageous methodological framework of the wavelet analysis, we are able to examine differences in importance of macroeconomic and financial market uncertainty factors for the stock-bond correlations in long- and short-horizons. Third, we extend the literature on financial market uncertainty by examining connections between global bond market uncertainty and stock-bond correlations. Previous related studies on stock-bond correlation focused on the impact of uncertainty coming from stock market (Andersson et al., 2008; Connolly et al., 2005; 2007; Kim et al., 2006), while our study differs from the related studies by examining also the impact of uncertainty originating from bond market.

The empirical findings reported in this article show that global financial market uncertainty and domestic macroeconomic factors play important role in explaining the stock-bond correlation in emerging markets. In addition, time-varying stock-bond correlation patterns vary significantly between the time horizons. The short horizon correlation changes

the sign rapidly showing sustainable negative episodes during the crisis periods, which is consistent with the "flight-to-quality" phenomenon. The long horizon correlation stays positive most of the time indicating that emerging market stock and bond prices move in the same direction signifying "equity like"[3] properties of emerging market bonds in the long run.

Our findings also suggest that the most important factor influencing stock-bond correlation at short horizon is the monetary policy stance, while the factors with the highest impact on the stock-bond correlation in long run are inflation and stock market uncertainty. Furthermore, our empirical findings demonstrate positive long run relationship between inflation and stock-bond correlation suggesting that both stock and bond prices in emerging markets tend to move in the same direction during high inflation periods. Moreover, our analysis show that high equity market uncertainty, as measured by implied volatility, leads to a higher comovement of stock and bond prices in emerging markets. Finally, global stock market uncertainty plays more significant role than global bond market uncertainty in explaining stock-bond correlations in emerging markets.

The remainder of this paper is organized as follows. Section 2 presents data and the descriptive statistics. In Section 3, we set forth a brief description of the wavelet analysis approach. The empirical results are presented in Section 4, while Section 5 provides conclusions.

2. Data

2.1 Stock and bond market returns

[3] Emerging markets bonds are often considered as "equity like" assets because of higher country risk in emerging economies (see Kelly et al., 1998; Panchenko and Wu, 2009; Piljak, 2013).

The empirical analysis is performed using monthly data[4] for stock and bond returns on ten emerging markets and the United States. The selection of the emerging markets in our sample is based on the country composition of the J.P. Morgan Emerging Market Bond Index Plus (EMBI+)[5]. Stock market indices for each emerging market in the study are provided by Morgan Stanley Capital International (MSCI). The inclusion of US market in the study was due to its role as a global factor in the international financial markets as well as for the comparison with the emerging markets. Stock and bond markets of US are represented by the S&P 500 index and 10-year US government bonds, respectively. Similarly to Rua (2010), stock and bond price indices are converted to the monthly returns by taking the first difference of the natural log for each stock and bond price index. The use of monthly frequencies is due to the fact that data on macroeconomic factors used in further analysis are available only on monthly level. The source of the data is Thomson Reuters Datastream. The sample period spans from January 2001 until December 2013, leading to the sample size of 156 observations for all of the markets included in the study. The starting point for the sample period is dictated by the data availability.

(Insert Table 1)

Table 1 presents the summary statistics for stock and bond market returns for ten emerging markets and the US. As shown in Panel A, all of the emerging markets in the sample have positive and higher average stock returns than the US during the period under

[4] Monthly data are used for stock-bond analysis in Kim and In 2007 and Aslinidis and Christiansen 2014

[5] EMBI+ includes 18 countries. Our sample is limited to those countries with available data on stocks, bonds and macroeconomic factors for the entire sample period The EMBI+ is J.P. Morgan's most liquid US-dollar emerging markets debt benchmark. It tracks returns for actively traded debt instruments in emerging markets including Brady bonds, Eurobonds, and traded loans issued by sovereign entities. The EMBI+ index includes only issues with a current face amount outstanding of $500 million or more and remaining life of greater than 2.5 years. The J.P. Morgan indices are the most widely used and comprehensive emerging market sovereign debt benchmarks.

study. The highest stock returns are recorded for Colombia, Venezuela and Peru. The volatility levels of each of the emerging stock markets from the sample are higher than the volatility of US market. The least volatile emerging stock markets are Mexico and Philippines with the standard deviations of 0.071 and 0.073 respectively, while the most volatile emerging stock markets are Turkey, Venezuela and Argentina. Panel B presents the statistical properties of the bond returns for emerging markets and US. Similarly to observed pattern with stock markets, average returns of emerging market bonds are higher than US (except for Argentina). Standard deviations of emerging market bonds are greater than the US with the exceptions of Bulgaria and Mexico, suggesting that emerging countries have generally riskier bond markets. Emerging market with the most volatile bond returns is Argentina. The distribution of both stocks and bonds return series is non-normal, with kurtosis exceeding 3 in all cases (leptokurtic series) and showing negative skewness (except the US bonds).

(Insert Table 2)

The unconditional stock-bond correlations for each country included in the study are reported in Table 2. All emerging markets exhibit positive and statistically significant correlation between stocks and bonds. The level of unconditional stock-bond correlation differs substantially within the emerging market sample group ranging from 0.130 (Venezuela) to 0.683 (Brazil). On the opposite side, US market exhibit a negative statistically significant correlation of stock and bond returns during the time period under study (-0.366).

2.2 Domestic macroeconomic factors and global financial market uncertainty

The impact of domestic macroeconomic factors on emerging markets' stock-bond return correlation is examined using monthly data on inflation, business cycle patterns and the monetary policy stance. The consumer price index (CPI), the industrial production index (IP) and the three-month interbank interest rates (IIR) of each emerging market from the sample are used as a proxy for the domestic inflationary environment, business cycle patterns and monetary policy stance, respectively..[6]

To examine the impact of global stock and bond market uncertainty on the emerging markets stock-bond return correlation, we use implied volatilities extracted from the prices of stock and bond index options. The option-implied volatility is widely regarded as the best available estimate for the market uncertainty. To capture the uncertainty of US stock and bond markets, we use VIX and MOVE implied volatility indices, constructed by the Chicago Board Options Exchange and Bank of America Merrill Lynch, respectively. The VIX is calculated from S&P 500 Index option bid/ask quotes and represents 30-day measure of the expected volatility of the S&P 500 stock market Index. The Merrill Lynch Option Volatility Estimate MOVE index is a yield curve weighted index of the normalized implied volatility on 1-month Treasury options representing a market estimate of future Treasury bond yield volatility.[7]

3. Wavelets Analysis Approach

Wavelet transforms provide a highly useful and practical set of methods for analyzing economic time-series.[8] Wavelets can unravel both the time varying and frequency specific behavior of the variables. The classical frequency analysis method, the Fourier transform, can

[6] The data on the three-month interbank interest rates for Mexico and Peru were not available, so we used the one-month interbank interest rates instead.

[7] MOVE Index is a weighted average of volatilities on the two-, five-, ten-, and thirty-year contracts and represents a widely used measure of government bond volatility.

[8] For more information on Wavelet analysis see Torrence and Compo 1998 and Grinsted 2004.

only reveal static frequency properties. The wavelet transform, in turn, can reveal the dynamical behavior of the variable on different frequencies. For our purpose of studying the correlation structure between bond and stock markets, wavelet correlation analysis provides an appropriate framework for unraveling the dynamic and frequency specific properties of the correlation. Our analysis closely follows the approach of Rua (2010) and Croux (2001).

In wavelet analysis, the time and frequency localized properties of a time-series are extracted with the help of a wavelet function $\psi_{\tau,s}(t)$ by dilating and translating it with

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-\tau}{s}\right) \tag{1}$$

where s is the frequency parameter and τ expresses the position in time. By convoluting the function $\psi_{\tau,s}(t)$ with a time-series $x(t)$, one obtains the wavelet transform $W^x(\tau,s)$:

$$W^x(\tau,s) = \frac{1}{\sqrt{s}}\int_{-\infty}^{\infty} x(t)\psi^*\left(\frac{t-\tau}{s}\right)dt \tag{2}$$

where * is the complex conjugate. Now from the wavelet transformations W^x and W^y of two time-series $x(t)$ and $y(t)$ it is possible to obtain a wavelet correlation measure between these two variables:

$$\rho_{xy}(\tau,s) = \frac{\mathbb{R}(W^{xy}(\tau,s))}{\sqrt{|W^x(\tau,s)|^2|W^y(\tau,s)|^2}} \tag{3}$$

where $W^{xy}(\tau,s)$ is the cross-wavelet spectrum. The wavelet correlation measure $\rho_{xy}(\tau,s)$ takes values in [-1,1] and so is similar to the classical correlation coefficient. As the wavelet function, we use the Morlet wavelet $\psi_{\tau,s}(t) = \pi^{-1/4}e^{i\omega 0t}e^{\frac{-t^2}{2}}$, with $\omega_0 = 6$.

4. Results

4.1 Stock-bond correlation at short- and long-term horizons

In this section, we report the correlation of stock and bond returns obtained by applying the wavelet correlation approach. Stock-bond correlation output is illustrated by contour plots that involve three dimensions: frequency, time and the wavelet correlation value (height). The frequency dimension is shown on the vertical axis and range from the highest frequency of two months (top of the plot) to lowest frequency of four years (bottom of the plot). Time dimension is presented on horizontal axis. Finally, the height dimension (wavelet correlation) is pictured via different shades of gray in the Figures. The correlation scale ranges from -1 to 1 and is interpreted in the terms of darkness of the gray color. Increasing positive value of stock-bond correlation matches up with deepening darkness of gray, imitating the height in the surface plot; while the increasing negative stock-bond correlation is symbolized by lightening of gray color.

Three-dimensional setting of wavelet based correlation enables us to detect the areas of varying correlation between stock and bond series both over time (horizontal axis) and frequency bands (vertical axis). In this integrated framework, a dark gray area at the bottom (top) of the Figures corresponds to positive stock-bond correlation at low (high) frequencies, whereas a dark gray area at the left-hand (right-hand) side signify positive stock-bond correlation at the start (end) of the sample period (see Rua, 2010). Analogously, negative stock-bond correlation is matched with the light gray color. The frequency scale enables us to separate the stock-bond return correlation between short term and long term. Due to our relatively small sample period of thirteen years, the short term is considered to be the

fluctuations ranging between two to four months while the long term can be thought of as fluctuations between one to three years.

(Insert Figure 1)

Figure 1 presents the wavelet correlation of stock and bond returns in emerging markets and the US. We note several interesting findings from the visual assessment of the stock-bond correlation graphs presented in Figure 1. The evidence suggests that the stock-bond correlation of both emerging countries and US varies considerably across frequencies and over time.

Stock-bond correlations at short-term horizons (high frequency) tend to change the sign and magnitude rapidly, going from highly positive to negative episodes for most of the emerging markets in the sample. During the period from beginning of 2001 until the end of 2002 (period corresponding to "Dotcom market crash"), Argentina[9], Bulgaria, Colombia, Russia and Venezuela show sustainable episodes of negative stock-bond correlation. Emerging countries with the biggest drop in correlation of stock and bond returns during this time period are Venezuela (from +0.85 to -0.70) and Argentina (from +0.45 to -0.50). Other emerging markets in the sample, specifically Mexico, Peru, Philippines and Turkey showed increasing negative change in magnitude of stock-bond correlation during this period. Another great decrease and negative patterns of short-term stock-bond correlation can be spotted during the period corresponding to the financial crisis of 2008 in case of most of the emerging markets. Negative correlation is observed in case of Brazil, Bulgaria, Ecuador, Mexico, Peru, Russia and Venezuela. Country having the biggest drop in correlation during this period is Russia with a change from +0.70 to -0.65. Rest of the emerging markets in the

[9] This time period also coincides with the Argentina's debt default crisis.

sample showed a considerable decrease in magnitude of stock-bond correlation; however the correlation remains positive in the short-term horizon.

Assessment of the short-term horizon analysis of stock-bond correlation in emerging markets demonstrates that the stock-bond correlation varies considerably over time. In addition, we observe the sustained negative episodes of correlation in short term that seem to coincide with the crisis periods. This result is consistent with the "flight-to-safety" phenomenon observed in the developed markets (Gulko 2002; Andersson et al., 2008; Baur and Lucey, 2009). Our empirical finding further suggests that the short-term investors tend to switch their positions from stocks to bonds during the crisis period and that emerging market bonds provide a hedging opportunity for the emerging market stocks in the short run.

As can be seen from the Figure 1, the pattern of long-term horizon (low frequency) correlation between emerging markets stock and bond returns is quite different; the sign of correlation remains positive and less volatile for all of the emerging countries (with the exception of Venezuela that shows a short period of negative correlation). The highest levels of positive correlations between stock and bond returns are found in Bulgaria, Russia and Turkey (+0.95 for all) during the period following the financial markets crash in 2008. Highly positive stock-bond correlation at long-term horizon throughout the entire sample gives no support for the "flight-to-safety" phenomenon. This result suggests that long term investors do not see the emerging markets bonds as a safe asset compared to emerging market stocks. Therefore, the emerging market bonds exhibit properties of "equity like" assets due to the high country risk in emerging economies (Kelly et al., 1998; Panchenko and Wu, 2009; Piljak 2013).

The next step in our analysis includes assessment of stock-bond correlation pattern for US market at short and long horizon, and comparison with observed patterns in the emerging markets. Similarly to emerging markets, US stock-bond correlation at short-term horizon

changes rapidly from positive to negative. Lowest levels of negative correlation are found during the Dotcom crash (-0.80), and during the financial crisis of 2008 (-0.85). Stock-bond correlation for US demonstrate completely different pattern from the emerging markets at long-term horizon. Unlike the emerging countries, US market correlation between stock and bond returns remains negative in long horizon, demonstrating lowest values during periods corresponding to the "Dotcom crisis" and the financial crisis of 2008. Negative episodes of US stock-bond correlation are consistent with the literature suggesting that bonds tend to outperform stocks during the crisis periods leading to the negative relationship of stock-bond returns (Ilmanen, 2003).

4.2 Impact of global financial market uncertainty and domestic macroeconomic factors on stock-bond correlation

In the next stage of our analysis, we examine factors that may cause the time variation in the correlation between stock and bond returns of emerging markets at different time horizons. Previous evidence in the literature on developed markets suggests that inflation and economic growth unconditionally determine the government bond yields (Andersson et al., 2008). In particular, there is a negative relationship of inflation and economic growth with bond prices. The impact of growth and inflation on stock prices is somewhat uncertain.[10] Nevertheless, some studies suggest that high inflation has a negative impact on stock prices (Ilmanen, 2003). Monetary policy easing has a positive effect on both stocks and bonds and therefore the positive relation with the stock-bond correlation. Finally, financial market turbulence periods may cause risk-averse investors in developed countries to shift to safer assets, such as government bonds, causing "flight-to-safety" episodes.

[10] For more discussion on this issue please see Andersson et al. (2008).

To detect the impact of relevant factors affecting the stock-bond correlation in emerging markets we account for both global financial markets uncertainty and domestic macroeconomic factors. Global uncertainty factors used are VIX and MOVE indices that serve as proxies for US stock and bond market uncertainty, respectively. Domestic factors used to proxy the business cycle fluctuations, the inflation environment and the monetary policy stance are Industrial Production (IP), Consumer Price Index (CPI) and three-month interbank interest rates (IIR), respectively. Both global uncertainty and domestic macroeconomic factors used are at a monthly level with the sample period corresponding to the period used for wavelet correlation analysis.

We conduct regression analysis of the wavelet stock-bond correlation at different time frequencies on the aforementioned proxy variables for financial market uncertainty, domestic economic growth, inflation and monetary policy stance[11]. A separate OLS regression has been conducted for each emerging market in the sample as well as for the US[12]. Consequently, the following regression model is estimated:

$$WCOR_{i,f} = \alpha + \beta_1 VIX + \beta_2 MOVE + \beta_3 CPI_i + \beta_4 IP_i + \beta_5 IIR_i + \varepsilon_{i,f} \qquad (4)$$

where $WCOR_{i,f}$ denotes the wavelet correlation between stock and bond returns for country *i*; *f* is the frequency domain given at two different levels, expressed in time units of 3 months (short-term horizon) and 2 years (long-term horizon).[13]

[11] To check for the stationarity of explanatory variables used in the regression analysis two unit root tests were performed, specifically Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The lag length criterion for the unit root tests is based on Schwarz information criterion. The results suggest that the explanatory variables are stationary. Therefore, the null hypothesis of a unit root can be rejected for the time series used in regression analysis. The unit root tests results for all explanatory variables are not shown here due to space consideration, but they are available upon request.

[12] To check for the multicollinearity between the explanatory variables we rely on Variance Inflation Factor (VIF) test. The results suggest no multicollinearity problem among the variables. The VIF test results are available upon request. The interested reader on VIF measure should refer to O'Brien (2007).

[13] Similar approach in determining short and long horizons is applied in Kiviaho et al. (2014).

The regression results on the impact of global financial market uncertainty and domestic macroeconomic factors on stock-bond return correlation in emerging markets and the US are reported in Table 3. In common to most multi-country studies, slight differences in terms of significance levels and the coefficient signs of explanatory factors do exist in the regression models. Nevertheless, several interesting findings can be drawn from the empirical results of the regressions. Generally, the results suggest considerable variations in factors impacting the correlation in short-term horizon (high frequency) as opposed to the long-term horizon (low frequency).

(Insert Table 3)

Short term horizon analysis (given in panel A) reveals that there is at least one highly statistically significant factor of interest for each individual country. The results show that the domestic monetary policy stance is the most influential factor in a short term, being highly statistically significant in seven out of ten emerging markets. The coefficient sign of three-month interbank interest rate is changing across the countries, suggesting that the way how monetary policy affects the stock-bond correlation is not consistent in all emerging markets. For instance, in certain countries (Brazil, Colombia and Mexico) the sign of the IIR coefficient is positive, while for other countries (Argentina, Peru, Russia and Venezuela) the sign is negative. Factor with the moderate impact on short-term stock-bond correlation in the emerging markets is the US equity market uncertainty. The VIX index is statistically significant in five markets in short horizon analysis. Furthermore, the MOVE index has only a minor effect on the correlation in the short run, being significant in only three emerging markets. The business cycle pattern is the least influential macroeconomic factor in the short run as it is significant in only two markets, suggesting that the emerging market stock-bond

return correlation is virtually unaffected by the domestic business cycle patterns at the short horizon.

Panel B of Table 3 reports the impact of global financial market uncertainty and domestic macroeconomic factors on the correlation between stock and bonds at long-term horizon (low frequency). Generally, in comparison to the short-term horizon analysis, significantly higher impact of factors used on the stock-bond correlation is found at a long-term horizon. For each emerging market there were at least three statistically significant variables of interest that impacts the stock-bond correlation in a long run, while for certain countries there are four or even five significant factors. The explanatory power of the model (R-squared) considerably differs between short- and long-term analysis, ranging from 22% to 65% in a short-term, and from 74% to 96% for the long-term period.

The most influential macroeconomic factor for the long-term period stock-bond correlation is the inflation, as the consumer price index variable is highly significant in all ten emerging markets from the sample. This result is consistent with the general literature suggesting that the inflation can be seen as one of the key driving factors for the correlation between stock and bond returns. In particular, our results demonstrate that the inflation and stock-bond return correlation at long-term horizon are positively related, given that the sign of the estimated coefficient for inflation is positive in almost all emerging countries (except Brazil and Venezuela). Since bond prices are negatively related to inflation, our finding indicates that the high inflation has also a negative impact on stock prices, which is in line with Ilmanen (2003) and Andersson et al. (2008). Hence, negative relation of inflation with both stocks and bonds consequently leads to movement of stocks and bonds in the same direction, resulting in positive relation of the inflation and stock-bond correlation.

The second most important factor for explaining the long horizon correlation of emerging stocks and bonds is the global stock market uncertainty. The US stock market

implied volatility is found significant in nine out of ten emerging markets. Significant and positive sign for the VIX coefficient is found in seven countries, namely Argentina, Brazil, Bulgaria, Colombia, Peru, Russia and Venezuela, suggesting that high stock market uncertainty affects negatively both stocks and bonds in those emerging markets in the long run. This finding further implies that emerging markets stock and bond prices tend to commove more during the periods of high US equity market uncertainty.

Third influential macroeconomic factor for the stock-bond correlation in the long run is the business cycle, appearing significant in eight emerging markets. Estimated coefficients of the industrial production index are positive and statistically significant in seven countries, specifically Argentina, Bulgaria, Colombia, Peru, Russia, Turkey and Venezuela. This result indicates that the domestic trend in growth may have the similar effect on stock and bond returns in the long run, causing a positive correlation. The effect of monetary policy stance is similar in short- and long-term horizons. Similarly to the short horizon, the sign of IIR coefficient is not consistent in the long horizon. Empirical analysis also shows that MOVE index represents the least influential factor for the emerging market stock-bond correlation analysis in the long-term. Generally, the stock-bond correlation in emerging markets is virtually unaffected by the implied volatility of US bond market. Therefore, the US stock market uncertainty play much bigger role than US bond market uncertainty in impacting the correlation between stock and bond returns in emerging markets.

We continue our analysis with examining factors affecting stock-bond correlation in the US market at short and long horizons, and providing a brief comparison with the case of the emerging markets. Regression results for US market demonstrate that implied volatility of both stock and bonds impact the correlation of stock-bond returns at short and long horizons. Negative significant coefficient for VIX is consistent with the general literature on stock-bond correlation in developed markets and “flight-to-safety” phenomenon. Differently from

the emerging markets, the US stock-bond correlation is affected by the uncertainty originating also from bond market. Finally, similarly to the emerging markets, the estimated coefficients on CPI and IP are positive and highly statistically significant at long horizon, implying that growths in inflation and production have a positive impact on stock-bond correlation.

5. Conclusions

This article examines the short- and long-term horizon patterns of stock-bond correlation in emerging markets and driving factors behind time-varying correlations. In particular, we study the impact of global financial market uncertainty and domestic macroeconomic factors on stock-bond correlation. We utilize the powerful tool of wavelet correlations which enables us to simultaneously consider the time and frequency domains in the co-movement between stock and bond returns.

Our study contributes to the literature by providing new evidence on the impact of macroeconomic factors and global financial market uncertainty on both short- and long-term stock-bond correlations in emerging markets. While the previous studies focus on the impact of uncertainty coming only from stock markets we examine connections between global bond market uncertainty and stock-bond correlations.

Our empirical findings indicate that the stock-bond correlation in emerging markets differs considerably over time and between short and long horizons. Using the data from 10 emerging markets, namely Argentina, Brazil, Bulgaria, Colombia, Mexico, Peru, Philippines, Russia, Turkey and Venezuela, we find that the short-term correlations between stocks and bonds are changing the sign rapidly, showing sustained episodes of negative correlation corresponding to the crisis periods. Hence, short-term analysis suggests that rapid changes in

the correlation of emerging markets stocks and bonds during the crisis periods are consistent with the “flight-to-quality” phenomenon. Long-term horizon analysis demonstrates that the stock-bond correlation in emerging markets remain positive throughout the entire sample period, suggesting “equity like” properties of emerging market bonds in the long run due to the country specific risks.

Further results indicate that the macroeconomic factors can explain the time variations in the correlation of stock and bond returns in emerging markets both in short- and long-term horizons. Generally, macroeconomic factors have greater explanatory power in explaining the correlation in long run (low-frequency) compared to the short run (high frequency). The most prominent macroeconomic factor in the short-term analysis is the domestic monetary policy stance. Our analysis also suggests that monetary policy easing boosts the performance of both stocks and bonds producing the positive relationship with stock-bond correlation for Brazil, Colombia and Mexico, while easing monetary policy in Argentina, Peru, Russia and Venezuela leads to decoupling performance of stocks and bonds in the short run.

Long-term horizon analysis shows that inflation and the US stock market implied volatility represent the most important macroeconomic factors responsible for time varying of stock-bond return correlation. Furthermore, the long run analysis demonstrates a positive relationship between inflation and stock-bond correlation in emerging markets. Since bond prices are negatively related to inflation, our finding indicates that the high inflation has also a negative impact on stock prices. The empirical findings further indicate a positive relationship between the US stock market uncertainty and the stock-bond correlation in emerging markets. In addition, global stock market uncertainty plays more significant role than global bond market uncertainty in explaining stock-bond correlations in emerging markets.

The results of this study can offer interesting insights to both short- and long-term investors, as they can benefit from taking into account time and frequency domains analysis of stock-bond correlation in making asset allocation decisions. Moreover, our findings are also helpful in providing a new understanding on the influence of macroeconomic factors and financial market uncertainty on the stock-bond correlation in emerging markets at short and long horizons.

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Table 1: Descriptive statistic for stock and bond market returns

This table presents the summary statistics for stock (Panel A) and bond market returns (Panel B) in the emerging markets and the US. Data period spans from 1 January 2001 to 31 December 2013 for a total of 156 monthly observations.

Panel A: Stock market returns

	Argentina	Brazil	Bulgaria	Colombia	Mexico	Peru	Philippines	Russia	Turkey	Venezuela	US
Mean	0.0053	0.0103	0.0123	0.0235	0.0117	0.0169	0.0098	0.0123	0.0060	0.0190	0.0038
Median	0.0137	0.0153	0.0189	0.0310	0.0184	0.0198	0.0156	0.0246	0.0255	0.0137	0.0117
Maximum	0.4247	0.2509	0.3484	0.2225	0.1590	0.2394	0.1762	0.2770	0.3707	0.4838	0.1037
Minimum	-0.5392	-0.3864	-0.5816	-0.3308	-0.3664	-0.4470	-0.2788	-0.4350	-0.5318	-0.6398	-0.1839
Std. Dev.	0.126	0.105	0.109	0.085	0.071	0.090	0.073	0.101	0.141	0.127	0.045
Skewness	-0.760	-0.786	-1.164	-0.594	-1.219	-0.970	-0.406	-0.790	-0.622	-0.743	-0.836
Kurtosis	5.489	4.880	8.905	4.527	7.399	6.517	3.914	4.993	4.350	9.482	4.430

Panel B: Bond market returns

	Argentina	Brazil	Bulgaria	Colombia	Mexico	Peru	Philippines	Russia	Turkey	Venezuela	US
Mean	-0.0005	0.0092	0.0064	0.0090	0.0068	0.0088	0.0094	0.0108	0.0089	0.0093	0.0042
Median	0.0111	0.0131	0.0068	0.0119	0.0077	0.0109	0.0085	0.0109	0.0110	0.0145	0.0050
Maximum	0.2912	0.2349	0.0678	0.1155	0.1171	0.1159	0.0747	0.1046	0.1175	0.1246	0.0940
Minimum	-0.5781	-0.2099	-0.1739	-0.1340	-0.0753	-0.1584	-0.0970	-0.1369	-0.1715	-0.2553	-0.0736
Std. Dev.	0.101	0.049	0.023	0.031	0.023	0.036	0.024	0.030	0.040	0.051	0.023
Skewness	-1.683	-0.454	-2.902	-0.827	-0.132	-1.071	-0.560	-0.698	-0.941	-1.462	0.054
Kurtosis	10.738	11.935	26.598	7.954	6.837	7.125	4.870	6.997	6.544	8.173	4.514

Table 2: Unconditional stock-bond correlations

The table shows the unconditional correlations of stock and bonds returns for the emerging markets and the US. *** denote statistical significance at the 1% level.

	Correlation	t-statistics	Probability
Argentina	0.4786***	6.7640	0.0000
Brazil	0.6832***	11.6102	0.0000
Bulgaria	0.4023***	5.4533	0.0000
Colombia	0.5385***	7.9304	0.0000
Mexico	0.4312***	5.9316	0.0000
Peru	0.5249***	7.6528	0.0000
Philippines	0.4609***	6.4447	0.0000
Russia	0.6197***	9.7988	0.0000
Turkey	0.6752***	11.3607	0.0000
Venezuela	0.1304	1.6325	0.1046
US	-0.3662***	-4.8831	0.0000

Table 3: Relationship of the stock-bond correlations with the domestic macroeconomic factors and the global financial market uncertainty in emerging markets and the USA

This table represents the regression model results linking the short- and long-term horizons of wavelet correlation with domestic macroeconomic factors and global financial uncertainty (Equation 4). The explanatory variables include two global factors originating in US market: VIX (Chicago Board Options Exchange Implied Volatility Index as proxy for global stock market uncertainty) and MOVE (Merrill Lynch Option Volatility Estimate Index as proxy for global bond market uncertainty). Domestic macroeconomic factors include: CPI (the Consumer Price Index as proxy for inflation environment), IP (the Industrial Production Index as proxy for domestic business cycle fluctuations), and IIR (the three-month interbank interest rate as a proxy for monetary policy stance). Figures in parenthesis are the Newey-West robust standard errors. *, **, *** denote statistical significance at the 10%, 5% and 1% respectively.

Panel A: Short-term horizon (f=0.25 year)

	α	VIX	MOVE	$CPI_{domestic}$	$IP_{domestic}$	$IIR_{domestic}$	R^2
Argentina	-0.7843**	0.0130***	-0.0008	0.0029	0.0061	-0.0095***	0.652
	(0.3841)	(0.0043)	(0.0015)	(0.0025)	(0.0040)	(0.0021)	
Brazil	1.2880	-0.0023	-0.0019	0.0003	-0.0196	0.0304**	0.233
	(0.8743)	(0.0067)	(0.0020)	(0.0003)	(0.0136)	(0.0144)	
Bulgaria	-0.5015	-0.0154***	0.0009	0.0000	0.0032	-0.0515	0.260
	(0.3509)	(0.0052)	(0.0016)	(0.0001)	(0.0040)	(0.0320)	
Colombia	-2.2137***	0.0096*	-0.0016	0.0178***	0.0037	0.0772***	0.495
	(0.4879)	(0.0054)	(0.0020)	(0.0056)	(0.0043)	(0.0264)	
Mexico	-2.1035**	-0.0040	0.0036**	0.0306***	-0.0122	0.0746***	0.584
	(1.0204)	(0.0055)	(0.0016)	(0.0056)	(0.0111)	(0.0192)	
Peru	0.8891	0.0178***	0.0012	-0.0072	0.0007	-0.0968***	0.460
	(0.7675)	(0.0043)	(0.0014)	(0.0139)	(0.0032)	(0.0247)	
Philippines	-0.5863	-0.0167**	0.0058***	0.0035	0.0048	-0.0517	0.386
	(0.8768)	(0.0082)	(0.0019)	(0.0064)	(0.0031)	(0.0475)	
Russia	2.5270***	0.0093	-0.0007	0.0023*	-0.0238**	-0.0510***	0.240
	(0.7120)	(0.0064)	(0.0023)	(0.0013)	(0.0102)	(0.0117)	
Turkey	1.3502**	-0.0097	0.0044***	-0.0016	-0.0070*	-0.0091	0.284
	(0.5489)	(0.0062)	(0.0017)	(0.0034)	(0.0043)	(0.0167)	
Venezuela	1.0331***	0.0051	-0.0016	0.0006	0.0000	-0.0198***	0.228
	(0.3275)	(0.0057)	(0.0015)	(0.0005)	(0.0000)	(0.0044)	
USA	-3,0742	-0,0173*	0,0083***	0,0096**	0,0037	0,0121	0,190
	(2,0761)	(0,0099)	(0,0027)	(0,0045)	(0,0256)	(0,0545)	

Table 3 (continued)

Panel B: Long-term horizon (f= 2 years)

	α	VIX	MOVE	$CPI_{domestic}$	$IP_{domestic}$	$IIR_{domestic}$	R^2
Argentina	0.5106***	0.0039***	0.0004	0.0077***	0.0056***	0.0004	0.920
	(0.0604)	(0.0013)	(0.0003)	(0.0005)	(0.0006)	(0.0004)	
Brazil	0.9146***	0.0030***	0.0006**	-0.0001***	-0.0010	-0.0055**	0.789
	(0.1195)	(0.0009)	(0.0002)	(0.0000)	(0.0012)	(0.0027)	
Bulgaria	-0.0817	0.0029**	-0.0015***	0.0001***	0.0014*	0.0313***	0.858
	(0.0768)	(0.0014)	(0.0005)	(0.0000)	(0.0008)	(0.0067)	
Colombia	-1.6784***	0.0031*	-0.0002	0.0166***	0.0044***	0.0201**	0.930
	(0.1404)	(0.0019)	(0.0006)	(0.0015)	(0.0009)	(0.0083)	
Mexico	1.0286*	-0.0115**	0.0034***	0.0216***	0.0107	0.0067	0.740
	(0.5320)	(0.0049)	(0.0008)	(0.0052)	(0.0092)	(0.0163)	
Peru	-0.6752***	0.0036**	0.0000	0.0074**	0.0030***	0.0096	0.902
	(0.1873)	(0.0016)	(0.0005)	(0.0032)	(0.0008)	(0.0107)	
Philippines	0.7578***	-0.0007	0.0007***	0.0016**	0.0000	0.0160**	0.808
	(0.1070)	(0.0007)	(0.0002)	(0.0008)	(0.0003)	(0.0072)	
Russia	-0.7763***	0.0063*	0.0002	0.0019***	0.0081***	-0.0041	0.844
	(0.1896)	(0.0033)	(0.0009)	(0.0004)	(0.0026)	(0.0060)	
Turkey	2.0277***	0.0008	-0.0002	0.0076***	-0.0011*	-0.0180***	0.948
	(0.1030)	(0.0011)	(0.0003)	(0.0005)	(0.0006)	(0.0023)	
Venezuela	-0.0156	0.0023**	0.0000	-0.0023***	0.0002***	0.0009	0.958
	(0.0491)	(0.0009)	(0.0003)	(0.0001)	(0.0000)	(0.0007)	
USA	-2.0932***	-0.0018**	-0.0005*	0.0044***	0.0073***	-0.0106**	0.909
	(0.1910)	(0.0009)	(0.0003)	(0.0004)	(0.0022)	(0.0042)	

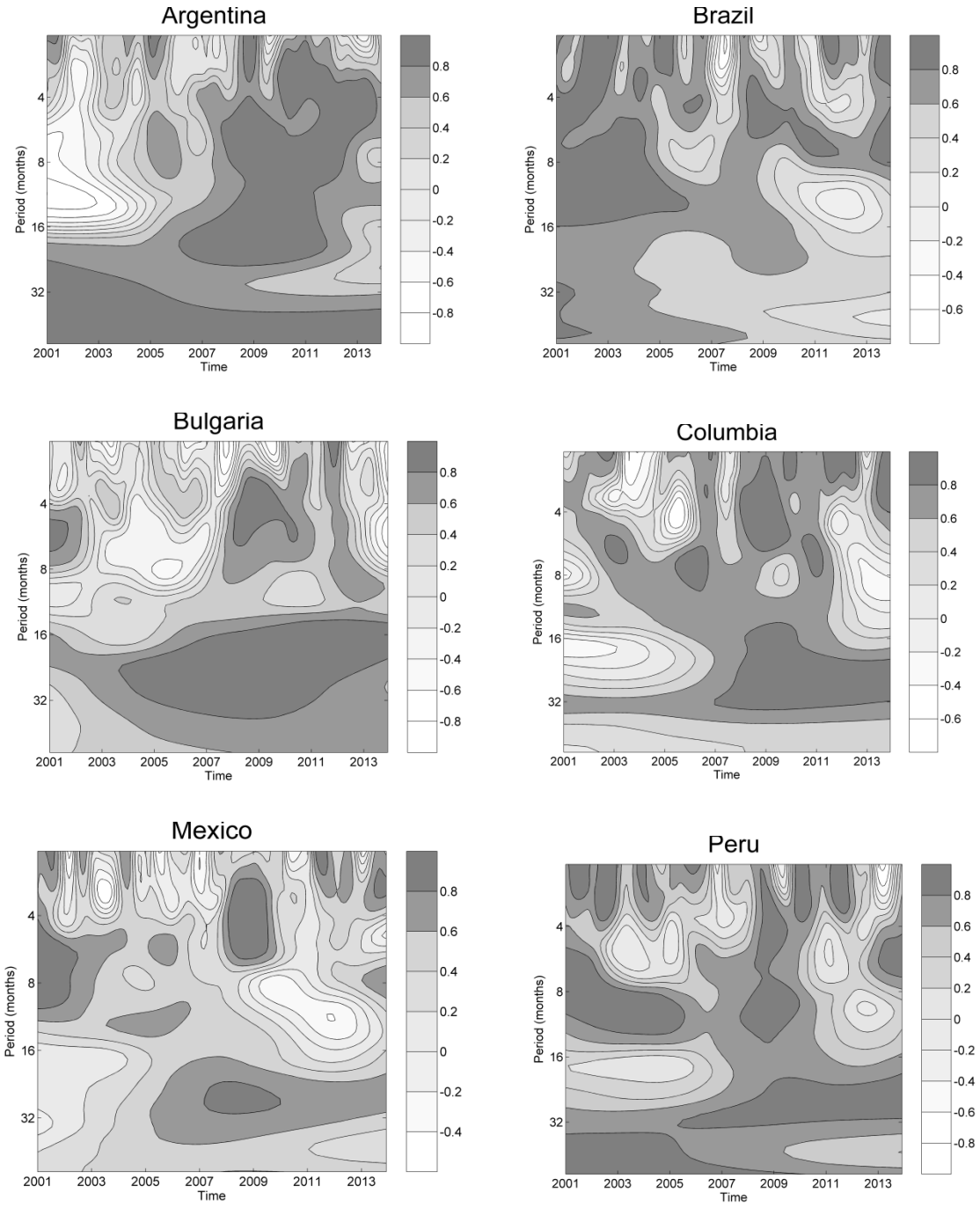

Figure 1: Stock-bond correlations for Argentina, Brazil, Bulgaria, Colombia, Mexico and Peru based on the wavelet correlation measure.

This figure presents the wavelet based correlation measure of the stock-bond correlations for both the emerging markets and the USA. Time and frequency are represented on the horizontal and vertical axes, respectively. The wavelet correlation value is pictured by different shades of gray color, indicated on gray scale from -1 to 1.

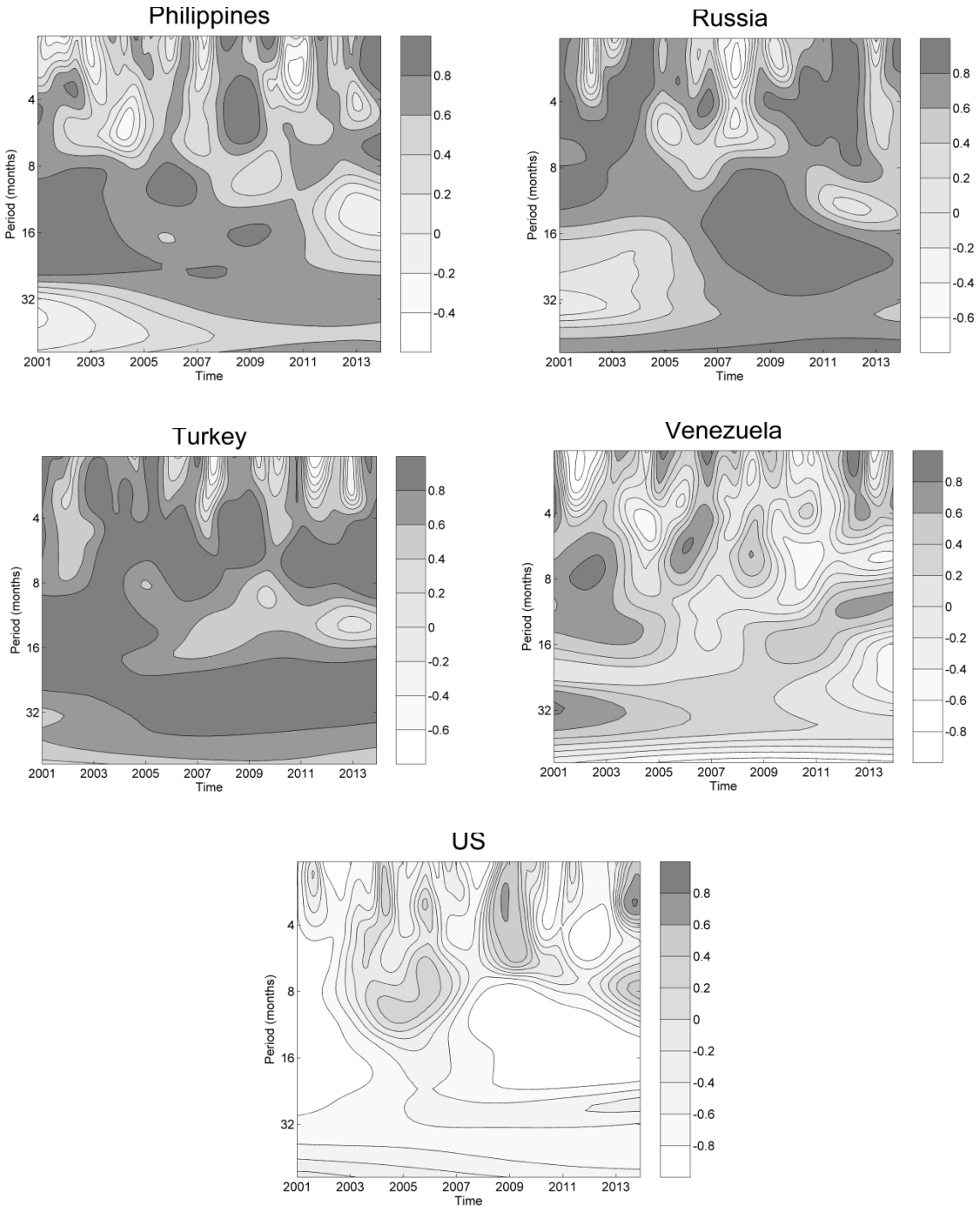

Figure 1 (cont.): Stock-bond correlations for Philippines, Russia, Turkey, Venezuela and the USA based on the wavelet correlation measure.

This figure presents the wavelet based correlation measure of the stock-bond correlations for both the emerging markets and the USA. Time and frequency are represented on the horizontal and vertical axes, respectively. The wavelet correlation value is pictured by different shades of gray color, indicated on gray scale from -1 to 1.