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RELATIONSHIP BETWEEN REMITTANCES AND MACROECONOMIC VARIABLES IN TIMES OF POLITICAL AND SOCIAL UPHEAVAL: EVIDENCE FROM TUNISIA'S ARAB SPRING

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Abstract

If Tunisia was hailed as a success story with its high rankings in economic, educational, and other indicators compared to other Arab countries, then the 2011 popular uprisings demonstrate the need not only for political reforms, but also for major economic reforms. The Arab Spring underscores the fragility of its main economic pillars, including tourism and Foreign Direct Investment. In such turbulent times, this paper examines the economic impact of migrant remittances expected to have a countercyclical behavior. Our results reveal that, prior to the Arab Spring, the impacts of remittances on growth and consumption seem negative and positive respectively, while their influence on local investment varies. These three relationships held in the short term. By considering the period surrounding the 2011 uprisings, the investment effect of remittances becomes negative and weak in the short and medium terms, but becomes positive and strong on growth and consumption in the long term.

JEL Classifications: F21; F22; F24; E6; O10.

Keywords: Remittances; economic growth; domestic investment; consumption; Tunisia; Arab Spring.

ملخص

إذا كانت تونس تحظى بكونها قصة نجاح مع تصنيفها المرتفع في المؤشرات الاقتصادية والتعليمية وغيرها من المؤشرات مقارنة بالدول العربية الأخرى، فإن الانتفاضات الشعبية عام 2011 تظهر الحاجة ليس فقط للإصلاحات السياسية، وإنما أيضا للإصلاحات الاقتصادية الكبرى. ويؤكد الربيع العربي هشاشة ركائزه الاقتصادية الرئيسية، بما في ذلك السياحة والاستثمار الأجنبي المباشر. وفي هذه الأوقات المضطربة، تبحث هذه الورقة الأثر الاقتصادي للتحويلات المالية المهاجرة التي يتوقع أن يكون لها سلوك مضاد للتقلبات الدورية. وتكشف نتائجنا أنه قبل الربيع العربي، تبدو آثار التحويلات على النمو والاستهلاك سلبية وإيجابية على التوالي، في حين يختلف تأثيرها على الاستثمار المحلي. هذه العلاقات الثلاثية التي عقدت في المدى القصير. وبالنظر إلى الفترة المحيطة بانتفاضات عام 2011، يصبح الأثر الاستثماري للتحويلات المالية سلبيا وضعيفا على المدى القصير والمتوسط، ولكنه يصبح إيجابيا وقويا على النمو والاستهلاك على المدى الطويل.

1. Introduction

On December 17, 2010, a young Tunisian street merchant, Mohamed Bouazizi, ended his life by setting himself on fire, sparking unrest in Tunisia. His tragic suicide was seen as an act of despair, humiliation and protest over the explosive problems confronted by the majority of Tunisians who were no longer able to accept inequalities, corruption, lack of freedom, unemployment…etc. The winds of change that swept across Tunisia triggered a "domino" effect in different Arab countries, including Egypt, Libya, Syria and Yemen. The term "Arab Spring" has come to present these popular revolutions. In the aftermath of the euphoria of the 2011 protests, Tunisia experienced an evolving volatility and slow-moving growth. Before the downfall of Ben Ali's 23-year-old regime, Tunisia was one of the widely cited development success stories in the Middle East and North Africa (MENA) region, and was portrayed as a "top reformer" as far as institutional reform was concerned (Pollack, 2011). Its economy is more prosperous, with a growth rate projected to exceed five percent in 2011, outpacing the averages of low-middle-income countries. Thanks to the 1986 structural adjustment program and the "economic miracle" macroeconomic improvement beginning in the late 1990s, the country has also succeeded in keeping its domestic and external economic imbalances under control. Further, there have been positive advances in education and women's rights. However, issues of youth unemployment, corruption, civil and political rights, and unequal wealth distribution have received much less attention. In fact, despite evident economic and educational progress, the social conditions of the Tunisian people have deteriorated, and the corruption and inequalities have reached a very high level. It comes as no surprise that popular uprisings occur in such a framework.

The Arab Spring produced immediate negative repercussions on economic development. There has been a sharp decline in annual growth: one percent per year between 2011 and 2015. The national economic base suffered. According to the National Institute of Statistics of Tunisia, the Foreign Direct Investment (FDI) plunged by 7.6 percent in 2016 compared to 2010. Also, tourist arrivals and revenues collapsed by 30.8 and 35.1 percent, respectively. Additionally, the dinar depreciated substantially. It is expected that a decline in tourist arrivals can have a large effect on the Tunisian economy since tourism is a source of direct employment and foreign currency reserves. Further, the trade deficit rose markedly, reaching 13.6 percent of the GDP.

In order to alleviate the adverse effects of such political instability on economic outcomes, there is a need to consider counter-cyclical financing mechanisms and other pillars of the Tunisian economy. The most tangible of these are migrant remittances; the income that migrants send home, potentially cushioning the harmful effects of this political and social upheaval. In fact, in times of crises (2008 and 2011), remittance flows showed resilience (World Bank, 2012). Nevertheless, these financial flows did not attract much attention from successive Tunisian governments, unlike other countries, such as Morocco, where they have been and still are one of the major sources of financing the economy (Bouoiyour, 2006).

In this study, we test whether remittances may boost economic development, stabilize consumption fluctuations, and stimulate investment activities, with reference to the case of Tunisia witnessing the 2011 Arab Spring unrest. While a large strand of literature has focused on how remittance inflows interact with economic growth and investment (Glystos, 2002; Fayissa and Nsiah, 2008; Yang, 2008; Tansel and Yasar, 2009; Barajas et al, 2009 and others), very little was devoted to the stabilizing effects of remittances on consumption variations. In fact, one of the most threatening impacts of output shocks is consumption instability, which negatively influences the welfare of agents (for instance, Bhaumik and Nugent, 1999; Kedir and Girma, 2003; Castaldo and Reilly, 2007). Also, a limited number of studies have analyzed the ability of remittances to act as a buffer against shocks (Lueth and Ruiz-Arranz, 2007; Chami et al, 2005). This paper extends previous literature in the following important aspects. First, it simultaneously examines the impact of remittances on economic growth, domestic investment

and consumption. It is necessary to note that a few attempts have been made to empirically investigate the development impacts of remittances in the case of Tunisia (Mesnard, 2005; Jouini, 2015; Kouni, 2016). Second, it seeks to identify the channels through which remittances can spur Tunisia's growth during turbulent times. Third, it revisits the relationship between remittances and macroeconomic variables, placing particular attention on a possible nonlinear relationship. The majority of previous researches on the issue has ignored the non-linearity of the relationship between remittances and economic development, or has employed a quadratic term to capture nonlinearity. With respect to the effect of remittances on macroeconomy, Ruiz et al (2009) showed a positive link between remittances and economic growth in parametric estimations, whereas such a relationship disappears when nonlinearity is taken into account using semi-parametric and non-parametric methods. Additionally, by analyzing the effects of inward remittance flows on per capita GDP growth in Bangladesh during the period 1974-2006, Hassan et al (2012) argued that the developmental impact of remittances might not be linear. Accurately, they found a U-shaped relationship that exists between remittances and long-term total factor productivity growth, where the impact of remittance flows on growth is initially negative but becomes positive later on. They attributed these outcomes to the "unproductive" use of remittances in the beginning, followed by "more productive" utilization in late stages. In line with these findings, our empirical strategy seeks to verify the non-linear linkage between remittances and some macroeconomic variables. However, our approach differs from the existing literature because we are able to address such a relationship in an unstable framework using a novel empirical strategy that accounts for the nonlinearity pattern. To avoid misspecification biases from imposing an arbitrary functional form, we apply a new data analysis tool, namely Empirical Mode Decomposition (EMD), which decomposes each time series into a scale-on-scale basis and estimates the correlation at each scale. The motivation behind the use of this technique arises in the desire to extract intrinsic characteristics inherent to the time series. Prior research has been performed by employing different techniques, particularly a cointegration analysis or an Autoregressive Distributed Lag (ARDL). Listing all existing estimators is definitely beyond the scope of this study. As the existing literature on the relationship between remittances and macroeconomic variables is rather inconclusive, it warrants for further empirical investigation. Sun and Meinl (2012) claimed that most data convey noises caused by the intricate structure of irregularities and roughness. They thus use wavelet analysis to "de-noise" the data and avoid the manifold irregularities along with different time-scales and frequency components. Every component resulting from a wavelet transform has parameters that determine its scale and level over time, which avoids the possible non-stationarity problem. However, it would be more appropriate to have a transform that would not solely allow dealing with a non-stationarity problem, but also carrying out an adaptive transform basis. A successful data assessment is heavily sensitive to the choice of data-scale representation and is able to provide reliable and robust data-association metrics for real data. For this purpose, it is important to account for data driven scales free from rigid mathematical constraints to reflect the inherent movements embedded in the data, without a priori knowledge. In this regard, EMD has proven to be effective in a broad range of applications for extracting signals from data generated in noisy nonlinear and non-stationary processes (Huang et al, 1998, 2003; Huang and Attoh-Okine, 2005). Recently, particular attention has been given to EMD due to its ability to disentangle any signal into its scale components, its flexibility to handle non-stationary data, and its capacity to provide an alternative representation of the association structure between time series on a scale-by-scale basis.

Using a multi-scale correlation analysis via EMD drew results that were quite interesting. Prior to the Arab Spring, the hidden short-term factors of remittances explained the economic growth negatively, the local productive investment varyingly and the consumption positively. These results change fundamentally when accounting for the period surrounding Tunisia at the onset

of the Arab Spring. While the findings remain stable for the remittances-investment linkage (negative, weak and driven by short- and medium-term factors), the remittances-growth and remittances-consumption cycles became positive, greater and explained by long-term inner features. These findings are fairly robust to the control for the endogeneity bias and for the use of further signal approaches.

Section two of this paper presents a literature review on the channels through which remittances can enhance economic growth in developing countries. Section three gives some stylized facts, while section four discusses the methodology and provides a brief data overview. Section five reports and discusses our results. Section six checks the robustness of our findings and section seven concludes and offers relevant policy implications.

2. Literature Review

In light of the increasing evidence on the substantial role of remittance flows relative to other flows in developing countries, it is not surprising that policymakers and academics devoted tremendous attention to their developmental role throughout the last decade. A wider macroeconomic literature has concentrated on the impact of remittances on growth, investment, consumption, and monetary and exchange rate policies. The findings, nevertheless, are mixed and sometimes controversial.

Literature has underscored various channels through which migrant remittances can spur economic growth in developing countries. However, it has proven uneasy to fully support the idea that remittances provide a boost to the economic growth of recipient economies, and whether they help lighten economic hardship. Concerning this point, remittances can mitigate output growth volatility because of their relative stability. Some papers argued that remittances may act as a countercyclical stabilizer in receiving countries. For example, Chami et al (2005) indicated that remittances have a tendency to move counter-cyclically with the GDP in recipient countries, consistently with the model's implication that remittances are compensatory transfers. However, Lueth and Ruiz-Arranz (2007) found that remittance receipts in Sri Lanka may be less capable of absorbing shock than initially believed.

A limited strand of literature testing the direct relationship between remittances and economic growth typically showed "multi-sided" outcomes. Estimating panel growth regressions both on the full sample of countries (84 countries) and for emerging economies only, Barajas et al (2009) claimed that remittances had, at best, no impact on economic growth. Fayissa and Nsiah (2010) investigated the aggregate impact of remittances on the economic growth of 18 Latin American countries for the period 1980-2005 and showed that a 10 percent increase in remittances led to an 0.15 percent increase in the GDP per capita income. Using the Solow growth model, Rao and Hassan (2012) explained the impact of remittances on growth by distinguishing between the indirect and direct growth effects. They found that these funds were likely to have a positive but modest effect on economic growth. These authors identified seven channels through which remittances could have indirect growth effects: the volatility of output growth, the exchange rate, investment rate, financial development, inflation rate, FDI and current government expenditure. To a larger extent, the surveyed literature suggested different channels through which remittances could spur economic growth. In the short term, remittances allowed home countries to strengthen the foreign-exchange reserves helping to adjust their economy. Nevertheless, the rather extensive literature on remittances provided further insights on the effects of remittances on consumption and investment (El-Sakka and Mcnabb, 1999; Glytsos, 2002). Accordingly, for a sample of five Mediterranean countries (Egypt, Greece, Jordan, Morocco and Portugal), Glytsos (2002) analyzed the impact of remittances on growth and deduced that the good done to growth by rising remittances is not as great as the bad done by falling remittances.

From an economic development viewpoint, a vexing question remains: Are remittances spent on consumption, or are they used for productive investments? Remittances are generally spent on consumption, but there is some evidence that international remittances may be channelled into productive investment in the long term. In this context, some studies looked into the effects of remittances on domestic investment (and hence, indirectly on growth) and supported these optimistic conclusions. For example, Woodruff and Zenteno (2004) analyzed such effects using the data of a survey of more than 6,000 self-employed workers and small firm owners located in 44 urban areas in Mexico, and estimated that more than 40 percent of the capital invested in microenterprises in urban Mexico was associated with migrant remittances. There is also evidence supporting that return migration could increase investment in some developing countries like Egypt (McCormick and Wahba, 2003; Wahba and Zenou, 2009) and Tunisia (Mesnard, 2004). Potentially, in countries where access to credit is a major obstacle for entrepreneurship, return migration invigorated the propensity of returnees to become self-employed upon their return, in addition to the positive impact of accumulated savings on the decision to become self-employed. Additionally, it has been commonly argued that investment is directly linked to the development of the financial system (Aggarwal et al, 2006; Giuliano and Ruiz-Arranz, 2009). By analyzing the effect of remittances in Tunisia during the period 1987-2012, Kouni (2016) argued that remittances contributed to economic growth. The author showed that the amount of remittances allocated to investment is smaller than the remittances allocated to consumption. He also indicated that remittances played a potential role in explaining the share of the sectoral value added in GDP. In particular, a rise of about one percent in remittances allocated to investment increased the value added to GDP ratio by one percent to four percent.

Even though remittances allow home countries to strengthen their foreign exchange reserves by influencing their macroeconomic equilibrium and GDP growth, the rather extensive literature on remittances provides some insights about their detrimental impact on economic growth through the effect of the Dutch Disease. This could result from the reduced competitiveness of the tradable sector after an appreciation of the real exchange rate. This logic can be illustrated using the results reported by Amuedo-Dorantes and Pozo (2004). The authors found, for a sample of 13 Latin American and Caribbean countries, that remittances have the potential to inflict economic costs on the export sector of receiving countries by inducing a loss of international competitiveness. In the case of Tunisia, Chnaina and Makhlouf (2015) showed that an increase in workers' remittances of one percentage point of GDP is associated with an appreciation of Tunisia's real exchange rate by 0.39 percent.[1] There are other channels through which remittances could affect growth, namely human capital and labor supply. Thus, remittances can stimulate investment in human capital and health as well (Mansuri, 2006; Valero-Gil, 2008). They may also influence economic growth through their effects on labor force participation. However, these effects of remittances are sensitive to the considered countries. Some migration research showed a negative effect on labor supply if remittance income substitutes for labor income. They also had a disincentive impact on work and savings in the origin community of migrants, i.e. the moral hazard phenomenon (Chami et al, 2005), leading to a decrease in labor supply. Nevertheless, as noted by Özden and Schiff (2006), such a decline in labor supply caused by remittances may prompt high productivity.

3. Migration Flows and Remittances to Tunisia

Migrants from Tunisia are predominantly destined for Europe, and for historical and political reasons, France has attracted the majority of the Tunisian community abroad. According to the

[1] Bouoiyour and Selmi (2016) tested the occurrence of the Dutch Disease hypothesis (i.e. whether the increase of remittance flows leads to an appreciation of the real effective exchange rate) in the Tunisian case, and provided evidence supporting such a hypothesis. They further found that this effect operates strongly through the differential price and modestly via the nominal effective exchange rate.

official data, 1,223,213 Tunisians (i.e. 10 percent of the Tunisian population) were residing abroad in 2012, more than one million of whom lived in Europe (668,668 in France). Tunisian migration flows to traditional European countries like France and Germany have increased during the last decades largely due to family reunifications, whereas migration to the other destination countries is mainly explained by labor migration. This is the case, for example, of the migration to Gulf countries, which is generally temporary and responsive to economic and political backgrounds in Tunisia and in these host countries. High unemployment and recent political instability in the country are potentially the most important reasons for emigration. Young and graduate unemployment represents a hassle in the lives of many individuals in Tunisia. The official data suggest that in 2012, graduate unemployment rates (tertiary education level) in Tunisia, stood at 26.1 percent. Furthermore, the high-skilled emigration grew significantly over the past two decades, reflecting the selective nature of migration by educational attainment and the general improvement in the level of education in the country. The OECD data about the emigration rate of highly educated persons[2] in 2010-2011 show that almost 10 percent of Tunisia's skilled workforce are living abroad (OECD, 2013). Note that there was a significant increase in irregular migration flows towards Europe during the time of the revolution. A prominent feature linked to Tunisian migration is the important funds sent by migrants, which increased noticeably during the last two decades. In 1990, around $0.5 billion international remittances were received. By 2008, this number rose to $1.9 billion, reaching $2.35 billion in 2014. These official statistics reported by the Central Bank of Tunisia largely underestimate the total amount of migrant remittances because Tunisian migrants frequently used informal modes of transfer. In Tunisia, informal remittances carried by travellers from Europe (migrants, family, friends and acquaintances) were estimated to account for 38 percent of the total remittance receipts (IOM, 2011).

The growing importance of remittances to Tunisia is reflected in Figure 1, where we reported the evolution of these flows as a percentage of GDP. Remittances as a share of GDP varied between 3.77 and 5.01 percent during the period 1995-2015. As such, remittance receipts might have a significant impact on the Tunisian development in a period of political and social upheaval. Representing one of the potential sources of foreign currency and national saving for Tunisia, these inflows of remittances played a pivotal economic role in the periods of hardship. In fact, remittances represented 28.7 percent of national saving in 2012.

By examining Figure 1, we note that neither the 2008 economic crisis nor the 2011 uprisings had a strong influence on remittance flows from Tunisian migrants. It should be noted that remittances to Tunisia essentially come from European and Arab countries. In fact, they are widely originated from France, with Germany and Italy trailing far behind. Among Arab countries, the Gulf Cooperation Council countries (GCC)[3] are the main countries sending remittances, followed by Libya. However, the latter was before the Arab Spring, which caused a marked decline in remittances sent from Libya.

4. Methodology and Data

It is recognized that the investigation of dynamic interactions between time series is an important issue that has long posed challenges to economic agents and academics. In investigating the effects of remittances, most empirical studies use techniques that look for linear positive or negative relationships. However, the relationships between remittances and macroeconomic variables may be nonlinear, especially when focusing on an unstable context. In general, the historical data of time series are the result of complex economic processes that

[2] The emigration rate of highly educated persons from country i is calculated by dividing the highly educated expatriate population from country of origin i by the total highly educated native-born population. Highly educated persons correspond to those with a tertiary level of education.

[3] Within the GCC region, the main remittances sending countries in 2013 were the Saudi Arabia and the United Arab Emirates (Central Bank of Tunis 2014).

include policy shifts, structural changes, sudden shocks, and political tensions, among others. The combined influence of these various events is the root of distributional characteristics of financial and macroeconomic time series, such as asymmetry, nonlinearity, heavy-tailness and extreme values. Given these considerations, the primary objective of this study is to revisit the relationship between remittances, economic growth, investment, consumption and the real effective exchange rate, while accounting for the scale-on-scale variation (i.e. nonlinearity) and the hidden factors that may drive it.

The literature is quite rich in methods of assessing time-varying correlations. The traditional time series analysis tools usually rely on Fourier transforms in one way or another. Nevertheless, according to Huang et al (1998), the Fourier transform might prompt inaccurate information due to the nature of the transform in the time domain. Even wavelet analysis, developed to deal with non-stationarity and local frequency changes, produces confusing and sometimes contradicting results when applied to environment and climate signals (Sonechkin and Datsenko, 2000; Oh et al, 2003). By performing the wavelet approach, it is not always easier to determine local frequency changes because the spectrum is generated by stepping through several predetermined frequency components, generally showing blurred findings. The wavelet method has a problem of shift variance. More accurately, if the start point varies by dropping the initial point, for example, the wavelet transform may reveal distinct outcomes. However, the EMD method makes no assumption about linearity or stationarity, and the Intrinsic Mode Functions (IMFs) are often easily described.[4] A signal can be disentangled into the sum of a finite number of zero mean oscillating components with symmetric envelopes defined by the local maxima and minima. EMD is based on the sequential extraction of energy associated with distinct frequencies ranging from high fluctuating components (short term) to low fluctuating modes (long term).

In practice, the IMFs are extracted level by level. The high frequency oscillations riding on the corresponding low frequency oscillations are identified, and then the next level highest-frequency local oscillations of the residual data are extracted. The sifting algorithm to create IMFs in EMD consists of two steps. First, the local extremes in the time series data $X(t)$ are identified. Second, all the local maxima are connected by a cubic spline line $U(t)$ generating the upper envelope of the time series, and another cubic spline line $L(t)$ generating the lower envelope. For this purpose, we initially measure the mean m_1 for different points from upper and lower envelopes, given by:

$$m_1 = (U(t) + L(t))/2 \quad (1)$$

The difference between the original data and m_1 is the first component (Figure 3), called h_1.

$$X(t) - m_1 = h_1 \quad (2)$$

If the h_1 is not an IMF, we have to repeat the sifting process till it is reduced to an IMF. Then, in the subsequent steps of the sifting process, the first component h_1 is treated as if it were the data, i.e.:

$$h_1 - m_{11} = h_{11} \quad (3)$$

The sifting process would be done k times until acceptable tolerance is reached:

$$h_{1(k-1)} - m_{1k} = h_{1k} = c_1 \quad (4)$$

If the resulting time series h_{1k} is an IMF, then it is dubbed as c_1, which is the first real component satisfying the definition of IMFs (see figure 5). Equation (2) could be rewritten as follows:

[4] For detailed discussion of the EMD technique and comparison to other time series analysis tools, you can refer to Huang et al. (1998) and Flandrin et al. (2004).

$$X(t) - c_1 = r_1 \quad (5)$$

Equation (5) will also be repeated many times until the residue (*r)* becomes a monotonic function from which no more IMFs can be extracted.[5] The last residue is the trend of the data. Ultimately, equation (5) can be denoted as:

$$X(t) = \sum_{i=1}^{n} c_i + r_n \quad (6)$$

To sum up, the decomposition of the signal into IMFs is carried out as follows: after determining the positive peaks (maxima) and negative peaks (minima) of the original signal, we construct the lower and the upper envelopes of the signal by the cubic spline method (red). In addition, we measure the mean values (blue) by averaging the upper envelope and the lower envelope. Additionally, we subtract the mean from the original signal to find the first intrinsic mode function (IMF 1). Then, we calculate the first residual component by subtracting the IMF 1 component from the original signal. Finally, we repeat the steps above until the final residual component becomes a monotonic function and no more IMFs can be extracted.

After the partition of the original series into different scales, each one related to different timing frames, the correlation is estimated at each scale. By using this newly econometric tool, it is possible to de-noise the original series and look at detail patterns (tees). In this way, correlation analysis-based EMD provides a rich source of potential nonlinear dynamics depicting temporal dependence. Throughout this study, we consider three regressions: (1) the regression of real per capita growth[6] (gGDP) on remittances to GDP (REM/GDP) and potential control variables commonly considered as the main determinants of economic growth, including FDIs to GDP (FDI/GDP), investment to GDP (INV/GDP), credits to private sector (Credits/GDP), trade openness (or the level of exports plus imports to GDP, noted OPEN) and real effective exchange rate (REER or the ratio between prices of tradable and non-tradable goods where an increase in the price of tradable goods corresponds to a real depreciation); (2) the regression of domestic investment (INV/GDP) on remittances and other explanatory variables including (FDI/GDP), gGDP, Credits/GDP, OPEN, inflation (CPI), and real interest rate (RIR); and (3) the regression of consumption to GDP (CONS/GDP) on remittances, gGDP, Credits/GDP, CPI and RIR. Because we lack sufficient observations to estimate after the Arab Spring, we have made two estimates for two different periods. The first corresponds to the period before the Arab Spring, spanning between 1990:Q1 and 2010:Q4 (i.e. 85 observations), and the second refers to an extended period (prior to and post Arab Spring event), spanning between 1990:Q1 and 2015:Q3 (i.e. 104 observations).

The chosen sampling period is due to data availability. The data on remittances, investment, real per capita growth and the additional explanatory variables were collected from world development indicators (CD-ROM), the quandl website and Econstats™. In order to assess the dynamic dependencies (correlation and causality) among the focal variables, we have transformed the variables by taking natural logarithms to correct for heteroskedasticity and dimensional differences between the investigated time series.

5. Results

5.1 The decomposition of remittances and macroeconomic variables via EMD

The fundamental question of this study is beyond the classic debate opposing the impact of remittances on consumption with that on investment. This research seeks to test whether these linkages evolve over different time scales (or frequencies). It also assesses to what extent the Arab Spring strengthens remittance matters. Our objective is to identify how decomposing the

[5] For more details about the way EMD works, please refer to the following link: http://perso.ens-lyon.fr/patrick.flandrin/emd.html

[6] We have used population series to convert the time series into per capita.

variables into intrinsic mode functions can be useful in examining such relationships during turbulent times. Unlike standard methods, signal approaches (in particular, a correlation analysis-based EMD approach and a frequency domain causality test) permit uncovering the inner factors that may drive the effects of remittances on growth, investment and consumption, which would stay hidden otherwise.

Figure A.1 (Appendices) displays the EMD outcomes for the variables of interest. We show that, for the restricted and the whole period, the real per capita growth, remittances, investment and consumption were decomposed into seven IMFs plus one residue. Since the number of IMFs is limited and restricted to log2N where N is the length of data[7], the sifting processes produced only seven IMFs for each variable. All the derived IMFs were listed from a high frequency component to a low frequency band, and the last one is the residue. Remarkably, the frequencies and amplitudes of all the IMFs evolved over time and changed when moving from the first period (before the Arab Spring) to the second period (before and after the Arab Spring). As the frequency changes from high to low, the amplitudes of the IMFs become wider. We discuss three main frequency components: short term (IMFs 1-2), medium term (IMFs 3-4) and long term (IMFs 5-6-7). Table 1 presents the time scale interpretation of EMD. Since seven IMFs had been derived for the two considered periods, the interpretation of frequency components is the same for the two investigated periods.

Table 2 reports some measures given to depict the derived IMFs more accurately: the mean period of each IMF, the correlation between each IMF and the original data series and the variance percentage of each IMF. The mean period corresponds to the value obtained by dividing the total number of points by the number of peaks for each IMF. Pearson correlation and Kendall rank correlation coefficients help determine the correlations between the various IMFs and the original data. Because IMFs are intrinsically independent, it is possible to sum up the variances and employ the percentage of variance to measure the contribution of each IMF to the total volatility of the original data set.

In doing so, we obtain findings that are quite interesting. Before the Arab Spring, the real per capita GDP growth was highly driven by short-term inner factors (IMFs 1-2). For the whole period, the contributions of trend and long-term hidden features (IMF 6) became stronger; likewise for remittances (IMFs 1-2-3 for the restricted period and IMF7 for the prolonged period) and consumption (IMFs 1-2-3 for the period before the Arab Spring and IMFs 6-7 when accounting for the aftermath of the Arab Spring). Unlike gGDP, REM/GDP and CONS/GDP, INV/GDP was likely to be sensitive to short-term factors (IMFs1-2) for the two investigated periods.

The findings reported in table 3 give more precise information about the three main mono-components (short- and long-term factors) determining growth, remittances, investment, consumption and real effective exchange rate, in addition to sustaining the aforementioned outcomes displayed in table 2. We find that the contributors of the variation of the variables of interest change by moving from the restricted to the whole period, with the exception of INV/GDP. The latter is still driven by high fluctuating components during the two investigated periods. For the rest of the variables, the quickly fluctuating oscillations seem to be the major driving factors in the restricted period, while the long-term factors determine their variations when considering the onset of the Arab Spring (i.e. the whole period). However, the investment to GDP appears to be driven by high frequency components for the two periods.

Figure 6 indicates that each component explaining the evolution of gGDP, REM/GDP, INV/GDP and CONS/GDP exhibits dissimilar characteristics. Consistently with the

[7] The EMD technique generates itself the modes depending to the data. For more details about data extraction, please refer to Huang et al. (2003).

aforementioned outcomes, for the restricted period (left side graph) economic growth, remittances and consumption appear driven by high frequency components, while they seem determined by low frequency components over the whole period (right side graph). Nevertheless, for the two periods under study, investment was determined by short-term features.

Despite the meaningfulness of the above results, it is important to determine the existence of hidden factors driving the relationships between remittances and macroeconomic variables (i.e. growth, investment and consumption) rather than identifying what drives the time series separately. So our main purposes are (1) to assess whether the relationship between remittances and these macroeconomic variables is time-varying, and (2) to examine whether the effect of remittances on Tunisia's growth may differ from the period prior to the Arab Spring to the period post the 2011 uprisings, and from one scale to another. To this end, we use a scale-on-scale correlation analysis while addressing the endogeneity problem.

5.2 A correlation analysis-based EMD

We use an OLS-based EMD to assess the dynamic dependencies among remittance flows and macroeconomic variables in an unstable context. Our procedure consists of regressing remittances on gGDP, INV/GDP and CONS/GDP, even if we account for potential control variables in both time domains (i.e. the whole period) and among different time scales. This exercise aims to compare the time domain analysis with the multi-scale investigation in order to create a benchmark.

5.2.1 Remittances and growth

Table 4 summarizes the estimates related to the relationship between remittances and economic growth for time domains and across different time scales. Based on the time domain analysis, we note that remittances have no significant influence on economic growth over the restricted period (i.e. before the onset of the Arab Spring), while the effect appears significant and weaker when accounting for the post Arab Spring period (i.e. the whole period). Dissimilar results are found when conducting a multi-scale analysis, highlighting that the relationship between remittance flows and growth is time-varying. In particular, the relationship is negative, weak and occurred in the medium term (IMFs 3-4) during the restricted period. However, for the whole period (before and after the Arab Spring), remittances exert a positive and significant impact on Tunisia's growth; such a relationship is dominantly driven by long-term hidden factors (IMFs 5-7). It is true that remittance flows have never been considered as a strategic variable in the Tunisian economic policy. When comparing Tunisia to Morocco, the strategic path towards migration and remittances seems totally opposite. Unlike Tunisia, Morocco has conducted an "aggressive" policy aimed at attracting remittances via the establishment of organizations dedicated to migration, such as the Ministry in Charge of Moroccans Living Abroad, Council for the Moroccan Communities Abroad…etc. It is important to mention that the economic situation of both countries is radically different. Before the Arab Spring, Tunisia witnessed stable economic and political conditions and strong growth. Foreign investors tended to settle easily. The openness policy played a vital role in boosting the development of a solid and innovative manufacturing industry. This is why Tunisia was the "champion" compared to the rest of the MENA region and a "good student" according to World Bank and IMF criteria. However, this opulence masked the existing reality of corruption and inequalities that have played a great role in the popular uprising, which actually aggravated the socioeconomic situation that motivated it. Morocco, for its part, was characterized by a stable political situation, great resilience in dealing with external shocks (the 2008 economic crisis and the Arab Spring in particular), but its growth is volatile due to its rain-fed agriculture. Our results support that remittance inflows to Tunisia can be served as a countercyclical stabilizer and a shock-absorber. They show that before the Arab Spring, remittances had a negative and

medium-term (IMF 4) influence on growth, whereas its effect in the whole period was positive and determined by long-term factors (IMFs 5-7).

Further, during the period prior to the Arab Spring, the FDI had a positive and significant impact on growth among different time horizons. Foreign investors were highly attracted to the political stability and high growth. However, during the uncertainty surrounding Tunisia in the onset of the Arab Spring, the FDI's impact on gGDP became very volatile; it was likely to be negative and positive depending on the variation of the IMFs, but what appears meaningful is that the FDI effects fell considerably by moving from the restricted to the whole period. This outcome may be explained by the deterioration of the Tunisian security situation and the lack of medium- and long-term economic visibility.

Our previous results indicate that remittances help promote economic growth during turbulent times. It is yet to address whether remittances are spent on consumption or channeled into productive investment. To this purpose, we regress investment and consumption on remittances and other relevant control variables.

5.2.2 The uses of remittances: productive investment vs. consumption

A further step consists of analyzing the relationship between remittances and domestic investment to GDP, and remittance inflows and consumption to GDP. The time domain and scale-on-scale results of the regression of investment on remittances are summarized in table 5.

From the time domain analysis, we note that remittances show a negative influence on investment prior to the Arab Spring, and an insignificant effect when accounting for the period after the 2011 uprisings. From the multi-scale investigation, different outcomes were gathered. For the two periods under study, the linkage between REM/GDP and INV/GDP seemed to be driven by short-term factors (IMFs 1-3). In terms of the sign of the coefficient of remittances, we note some changes by moving from the restricted to the lengthy period. Before the Arab Spring, the effect of remittances on investment to GDP was varying (negative for IMF 2 and IMF 3, and positive for IMF 1), while its influence was statistically negative and significant (IMF 2) when considering the whole period (prior to and post Arab Spring). These findings suggest that Tunisians living abroad send their money to support their families and not for investment opportunities. These findings also underscore the usefulness of correlation analysis-based EMD when assessing the remittances-investment nexus.

Table 6 reports the time domain and the multi-scale correlation outcomes of the regression of consumption on remittance inflows. All the findings go in the same direction: that remittances have a positive impact on consumption, either for the restricted or the prolonged period. However, the correlation results derived from EMD appear finer as we can see when exactly the relation in question is positive and when it is insignificant. Specifically, a positive link between the focal variables was found in the short term (IMFs 1-2) over the period before the aftermath of the Arab Spring. However, by considering the period after the Arab Spring, we show that the impact of remittances on consumption became positive and more pronounced (i.e. driven by long-term inner features: IMFs 6-7). Potentially, a sharp complementarity among the remittances-growth and remittances-consumption cycles was shown, sustaining the evidence that remittances to Tunisia had mostly been spent for excessive consumption rather than for the improvement of national investment.

6. Robustness

There are different ways to ascertain whether our results are fairly solid. Throughout the rest of our study, we specify two sets of robustness checks. First, we control for a possible endogeneity bias via 2SLS-based EMD. Second, for the majority of studies on the relationship between remittances and economic development, the main question to be answered focuses on

whether remittances are a statistically significant factor in boosting economic development. Another interesting question in relation to remittances and economic development should be that of causation: asking whether remittance flows cause economic development or vice-versa. Because correlation does not imply causation, another focus of this study is to verify whether there exists a cyclical causal relation between remittances and the focal macroeconomic variables (growth per capita, investment to GDP and consumption to GDP). For this purpose, we utilize a frequency domain causality test.[8] The frequency domain analysis offers an appropriate alternative tool by examining causality in the frequency domain, while standard causality tests focus only on the time domain.

6.1 Endogeneity

The endogeneity bias is one of the methodological challenges that confront research on international migration and remittances. This can occur if remittances are sent to the home country for altruistic motives or if there is an increase in workers' remittances coinciding with a rise in migration from countries with low economic growth. A way to correct for the endogeneity biases is to carry out two-stage least squares (2SLS) or GMM using lag of the explanatory variables as instruments (for example, see Giuliano and Ruiz-Arranz, 2009; Barajas et al, 2009). In the current study, we apply a 2SLS-based EMD to re-analyze the dynamic dependency between remittance inflows and macroeconomic variables in an unstable context, while controlling for the endogeneity problem. We summarize the 2SLS-based EMD findings of the regressions of growth, investment and consumption on remittances and further explanatory variables in tables 7, 8 and 9, respectively. Our results robustly reveal that before the onset of the Arab Spring, remittances negatively affected the per capita economic growth and positively affected the consumption; such relationships held in the short- or the medium-terms. However, we note a time-varying impact of these financial flows on domestic investment; it was negative in some IMFs (IMF 2) and positive in others (IMF 1), but it was likely to be significant only in the short-term. By accounting for the period after the Arab Spring, the investment effect of remittance inflows became weaker and determined by short- and medium-term factors, while positive, strong and long-term effects of remittances on growth and consumption were found. Moreover, our findings also unambiguously show that, either considering the restricted period or the whole period, an increase in remittances is significantly linked to an appreciation of real effective exchange rate; such a relationship is validated at longer time horizons. These outcomes seem consistent with the findings derived from the OLS-based EMD, and confirm the effectiveness of the scale-on-scale correlation analysis compared to the time domain assessment (tables 4, 5, 6 and 7).[9]

6.2 The frequency domain causality results

A further step in the robustness check consists of employing a frequency domain causality test[10] to test whether there is a causal relationship between remittances and the focal macroeconomic variables from one frequency to another. The figure contains the test statistics with their five percent critical values for the frequency bands involved (solid line) over the interval [0, π]. The frequency (ω) on the horizontal axis can be translated into a cycle or periodicity of T weeks by $T=(2\pi/\omega)$ where T is the period. Figure 7.1 describes the evolution of the causal relationship between growth and remittances depending on frequency

[8] While EMD is performed within a discrete time framework, the frequency domain causality has a spectral content across a continuous range. The frequency domain causality test provides clearer cycle information almost in real time, while business cycles cannot be identified before a cycle has been completed.

[9] Instead of using time domain analysis allowing us to analyze the relationship between remittances and macroeconomic variables throughout the entire period, the correlation analysis-based EMD permits seeing how the investigated linkage behaves across various time-scales.

[10] For details about the procedure of this technique, you can refer to Overview A.1 (Appendices).

transformations. Before the Arab Spring, we support a medium-term unidirectional causality from remittances to growth, especially when $\omega \in [1.30\pi - 2.60\pi]$, corresponding to a cycle length between 2.4 and 4.5 quarters. However, a long-term causal relation running from remittances to growth happened when focusing on the whole period (before and after the Arab Spring), in particular when $\omega \in [0.01\pi - 0.98\pi]$, corresponding to a cycle superior to 6.4 quarters. The reverse link is not validated at any frequency and at any estimation period.

For the impact of remittances on investment, a slight change was marked by moving from the restricted to the whole period (figure 7.2). Prior to the Arab Spring, remittance inflows caused domestic investment in high frequencies through the Granger casuality (when $\omega \in [2.81\pi - 3.03\pi]$, in particular for a cycle less than 2.2 quarters). This relationship remained driven by quickly fluctuating components for the whole period. Nevertheless, the impact of remittances on INV/GDP was stronger for the second period as the cycle expands to 2.7 quarters ($\omega \in [2.27\pi - 3.03\pi]$).

As for the remittances-growth cycle (figure 6.1), a causal link running from remittances to consumption (figure 7.3) was supported in the short term for the restricted period (when $\omega \in [2.70\pi - 3.03\pi]$), corresponding to a cycle length inferior to 2.3 quarters), and in the long term for the whole period (when $\omega \in [0.01\pi - 0.54\pi]$), corresponding to a cycle above 11.6 quarters).

Overall, the frequency domain causality findings seem consistent with the correlation analysis-based EMD. Specifically, the consideration of the Arab Spring period in our estimates led to sharp changes in the remittances-growth and remittances-consumption cycles; while they are valid in the short term for the restricted period, they are explained by long-term oscillations for the whole period. This confirms the consistency of these two cycles. The remittances-investment cycle and remittances-real effective exchange rate changed too, but moderately. However, the linkage between REM/GDP and INV/GDP remained driven by short-term factors for the two periods.

7. Conclusion and Policy Implications

Before the downfall of Ben Ali's regime, Tunisia succeeded in having a prosperous economy, but the Arab Spring destabilized the country and underscored the weakness of the pillars of its economy, which failed to withstand this shock. Tourism collapsed, FDI dried up, the foreign trade did not resist, and the dinar depreciated. Unusually, remittances survived and even rose, highlighting their countercyclical behavior. In light of this observation, this study attempts to determine the channels through which these financial inflows can help boost economic growth in a country that witnessed extreme social and political turmoil. This article uses newly econometric techniques containing several novel features that set this study apart from the literature on the issue. We use a multi-scale analysis based on EMD. This method aims to disentangle each variable into different scaling components and estimate the correlation between the variables under study at each scale. These methods allow us to extract intrinsic features inherent to the time series. This is expected to yield more accurate and minute scrutiny, which would estimate the "complex" relationship between remittances and macroeconomic variables, i.e. economic growth, domestic investment and consumption in an unstable context.

Because we have not enough observations for an estimation of the post-Arab Spring period, we thought to consider (1) a restricted period prior to the aftermath of Arab Spring, and (2) a whole or extended period before and after the onset of the Arab Spring. Despite this limitation, three relevant outcomes are drawn. First, although the effect of remittances on growth is negative and dominantly determined by short-term inner factors in the restricted period, it becomes positive and driven by long-term factors in the extended period. Second, while in the

restricted period, the impact of remittances on investment is likely to be variant (negative in some scales and positive in others) and explained by short-term inner features. In the extended period, this effect becomes negative, weak and driven by short- and medium-term factors. Third, migrant remittances have a positive and significant effect on consumption in the two periods. However, this effect is held in the short term in the restricted period and in the long term in the whole period.

These findings suggest that it is unnecessary to oppose the two transmission channels (consumption vs. investment) through which remittances can significantly affect Tunisia's growth. In particular, we find that remittances are driven by the need to support the families of migrant workers rather than by investment considerations. This suggests the importance of remittances as a coping mechanism against shocks without typically turning the recipients into investors, thus stimulating entrepreneurial activities, rising formal sector employment, and generating multiplier effect.[13] Even if they are not used "productively," a positive and long-term impact on growth appears robust. In times of crisis, remittances will help families heal and continue sending their children to school. This type of behavior may potentially reflect, in certain circumstances, a preferable investment for the families. However, within the context of political and social unrest, investors' disquiets over the economic prospects of this country exacerbate, harming the investment climate. What is noticeable these last weeks, however, is that Tunisians are witnessing a sharp devaluation of the dinar. As a result, the export-competing companies would be harmfully influenced by the real exchange rate overvaluation and the related potential loss of international competitiveness. The adverse effects of the loss in external competitiveness can be mitigated by stimulating internal competitiveness. The Tunisian authorities should open different economic sectors to competition, develop a fair administrative business environment and undertake proactive reforms, tax benefits, organization, governance mechanisms and other regulations to strengthen the involvement of Tunisians residing abroad in the national development process. Through a new legal and institutional framework for investment[14] (law no. 71 of September 30, 2016), Tunisia aims to overcome the long-winded economic difficulties to change the current economic model and adopt a new economic model based on efficiency and productivity. This can be done through the encouragement of investment in innovative sectors and sectors with higher added value and the enhancement of export capacity and technological content of the Tunisian economy. This would help boost the competitiveness of the national economy and mitigate the low employment rate and the country's regional disparities. Tunisia is at a turning point today, facing multiple challenges as well as potential opportunities. The new law is expected to stimulate the investment environment and market opportunities for businesses in Tunisia.

Last but not least, on the basis of this paper's findings, we cannot affirm that the remittance flows are able to fully cushion the uncertainty surrounding Tunisia's current situation. They have certainly increased remarkably, affecting both the balance of payment and the wellbeing of families who receive them directly, but this situation is exogenous and their total impact will depend on policy measures taken to encourage them. Once political stability is achieved, special attention is needed to channel remittance inflows towards productive investments. This requires learning more about the range of barriers used for investment, as well as the effective institutions that can effectively guide recipients of remittances towards making the most of the remittances they receive.

[13] This can happen but in infrequent cases. Papers that focused on the impact of remittances on investment seem very scarce. Generally, migrants come to invest in their country of origin under the condition that they monitor their investment themselves. For a summary of these studies, you can refer to Bouoiyour et al (2016).

[14] For more details about the new law, you can visit this link: http://www.ilboursa.com/marches/tunisie-les-principales-caracteristiques-du-nouveau-cadre-juridique-de-l-investissement_11291

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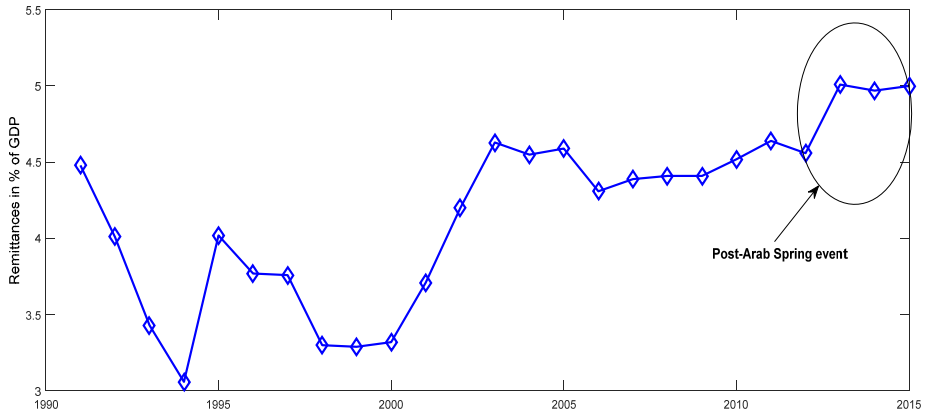
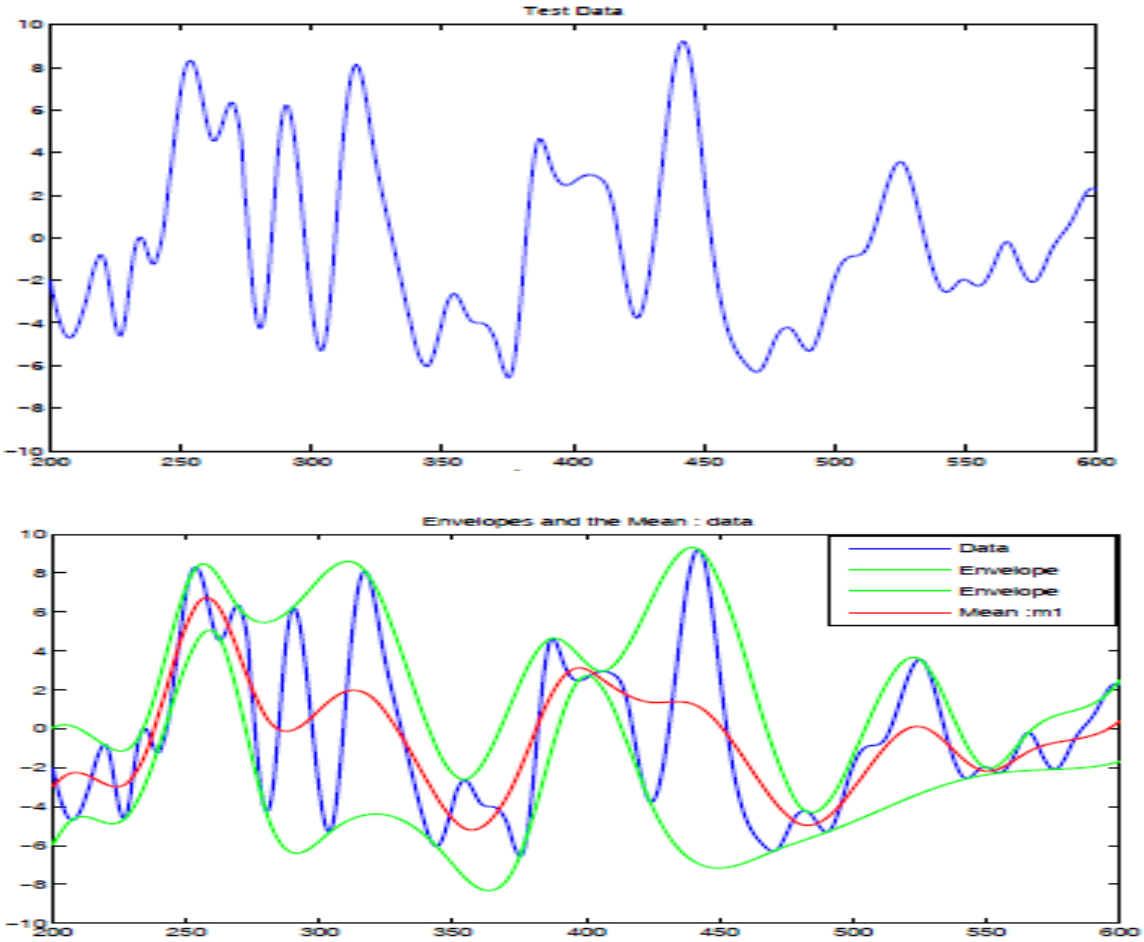
Figure 1: Remittances to Tunisia



Source: World Bank.

Figure 2: The Identification of The Upper and Lower Envelopes and the Mean



Note: The data (blue) upper and lower envelopes (green) are defined by the local maxima and minima respectively, and the mean value of the upper and lower envelopes is given in red.

Figure 3: The First Component: Original Signal-m_1

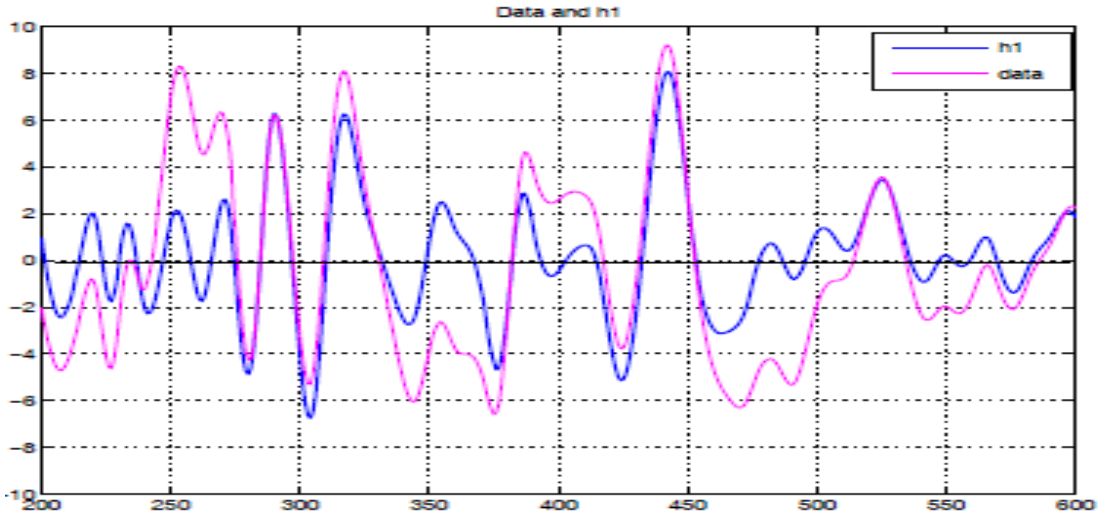


Figure 4: The Sifting Process

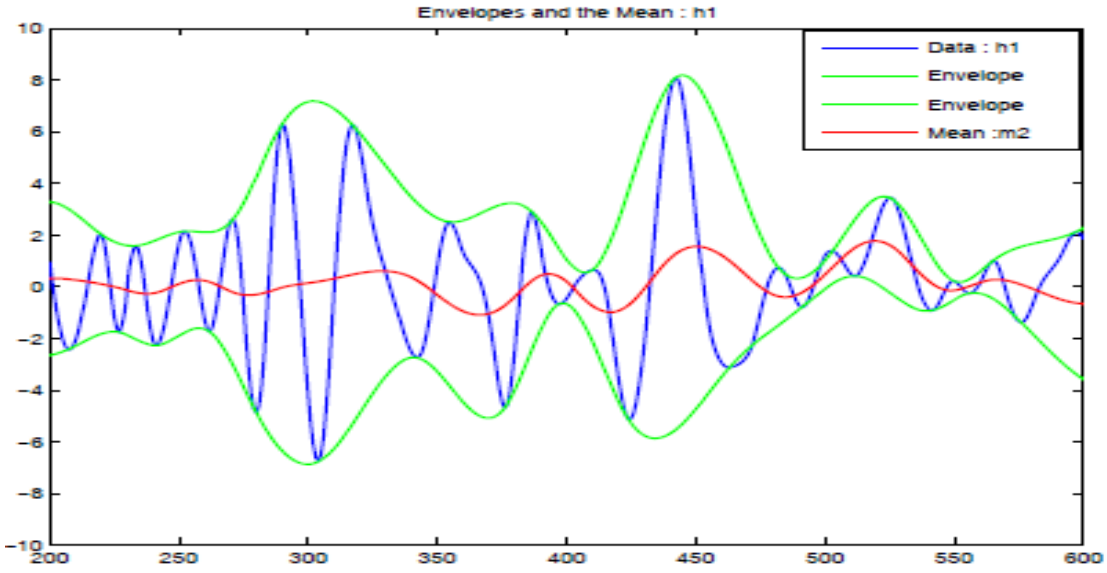


Figure 5: The First Residual Component: Original Signal –c_1

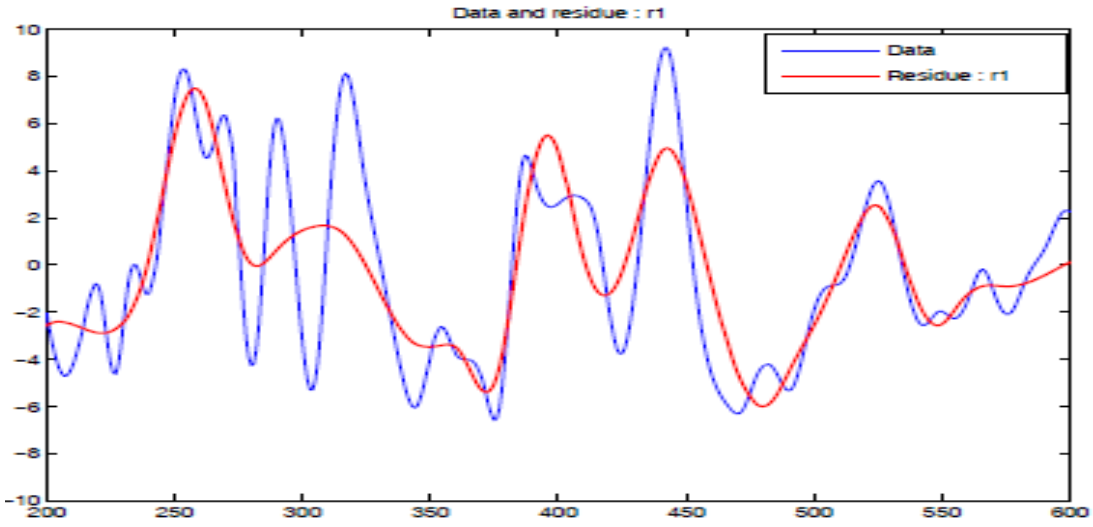


Figure 6: The Hidden Characteristics of the Variables of Interest

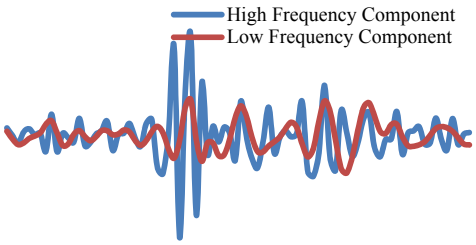
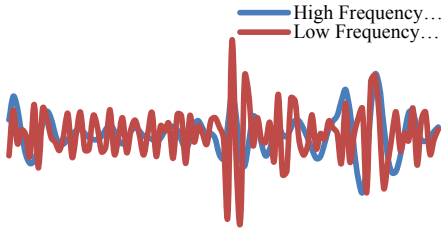
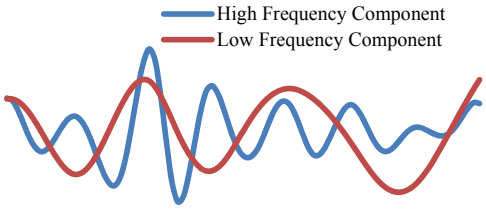
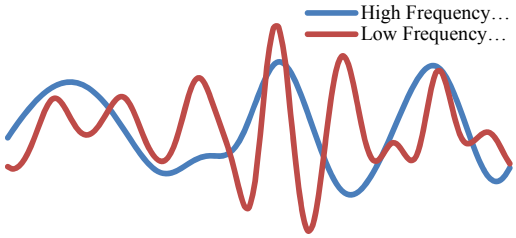
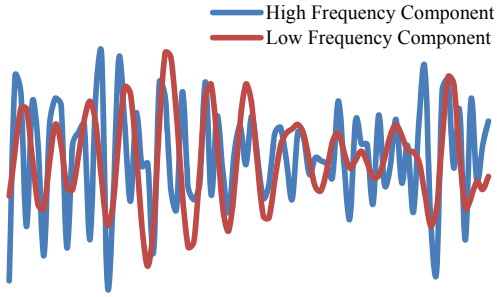
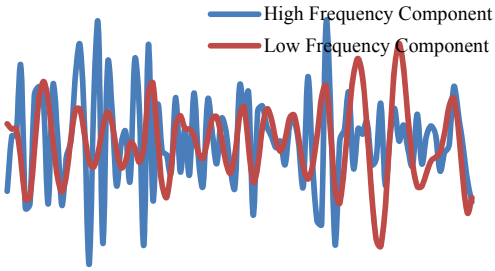
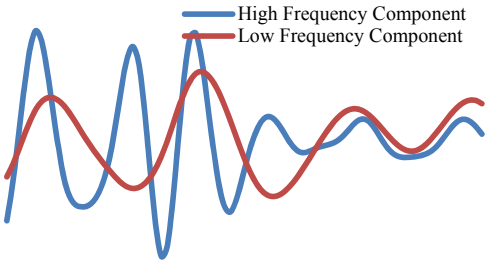
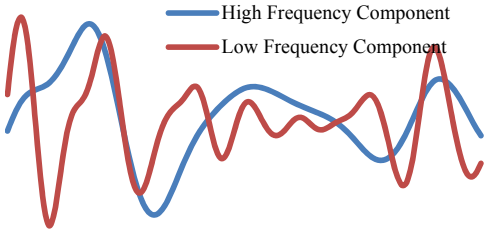
Restricted period (1990:Q1-2010:Q4)	Whole period (1990:Q1-2015:Q3)
gGDP	
	
REM/GDP	
	
INV/GDP	
	
CONS/GDP	
	

Figure 7: The Frequency Domain Causality between Remittances and Macroeconomic Variables

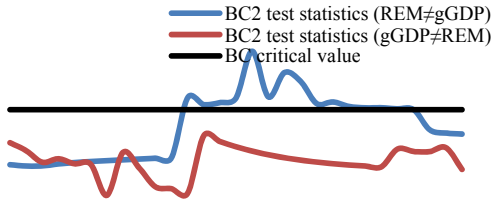
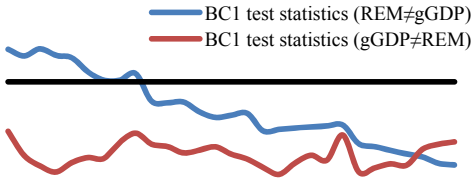
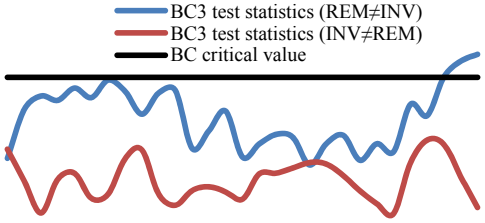
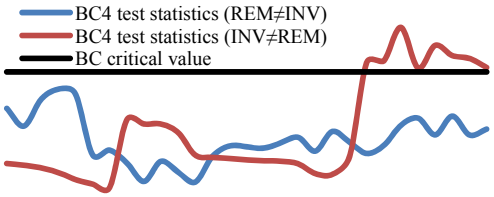
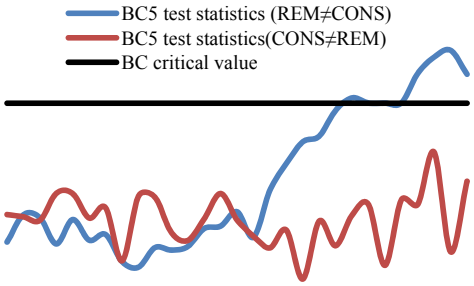
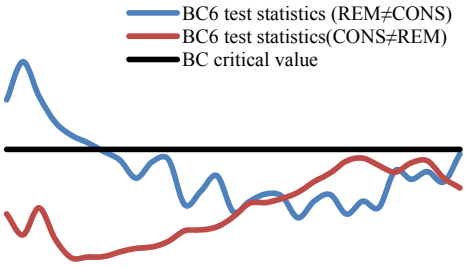
Restricted period (1990:Q1-2010:Q4)	Whole period (1990:Q1-2015:Q3)
7.1. REM/GDP and gGDP	
	
7.2. REM/GDP and INV/GDP	
	
7.3. REM/GDP and CONS/GDP	
	

Table 1: Interpretation of Modes Based on EMD

Modes	Mode interpretation
IMF1	Short term: within one to two quarters
IMF2	
IMF3	Medium term: above two quarters and less than three years
IMF4	
IMF5	Long term: above three years
IMF6	
IMF7	

Table 2: IMF Features

	Restricted period (1990:Q1-2010:Q4)				Whole period (1990:Q1-2015:Q3)			
	Mean period	Pearson correlation	Kendall correlation	Variance as % of the sum of (IMFs+residue)	Mean period	Pearson correlation	Kendall correlation	Variance as % of the sum of (IMFs+residue)
gGDP								
IMF1	1.33	0.496***	0.433*	33.22%	1.86	0.059	0.052*	1.16%
IMF2	1.42	0.285*	0.197**	24.08%	36.72	0.312***	0.258**	16.17%
IMF3	4.79	0.104**	0.098*	2.51%	8.15	0.132*	0.117**	4.76%
IMF4	6.49	0.169*	0.110**	8.03%	5.38	0.099**	0.043	3.81%
IMF5	9.57	0.095	0.087	0.98%	2.04	0.062	0.038	1.78%
IMF6	13.58	0.088	0.071	1.57%	39.14	0.456**	0.414*	41.56%
IMF7	18.19	0.103*	0.095	3.87%	12.23	0.113***	0.101*	3.13%
Residue		0.414**	0.376**	25.69%		0.324**	0.289*	32.67%
REM/GDP								
IMF1	5.00	0.421**	0.309***	25.61%	1.56	0.105***	0.101*	1.849%
IMF2	8.12	0.376**	0.256***	13.42%	2.38	0.212***	0.196**	18.13%
IMF3	16.77	0.165***	0.154**	12.50%	3.17	0.295***	0.288***	6.45%
IMF4	22.49	0.505**	0.461*	8.12%	4.95	0.183**	0.172*	8.95%
IMF5	23.86	0.484*	0.083	3.11%	5.78	0.109*	0.100**	2.732%
IMF6	24.74	0.075*	0.052	2.27%	7.45	0.108***	0.097**	1.611%
IMF7	26.63	0.132**	0.096***	1.91%	11.69	0.404**	0.387**	24.87%
Residue		0.410***	0.393***	13.03%		0.269**	0.261***	22.34%
INV/GDP								
IMF1	1.87	0.492***	0.445**	32.00%	18.79	0.322***	0.300**	3.13%
IMF2	7.46	0.397*	0.361**	28.73%	20.24	0.292*	0.175**	38.67%
IMF3	8.53	0.158*	0.143**	15.89%	26.12	0.101**	0.069**	39.19%
IMF4	10.29	0.098	0.065	1.43%	9.08	0.123***	0.119**	1.52%
IMF5	11.37	0.124*	0.115**	1.15%	13.72	0.162**	0.135***	1.93%
IMF6	16.85	0.092*	0.088*	1.26%	6.56	0.114*	0.097*	0.95%
IMF7	24.56	0.054	0.039	2.84%	14.15	0.095*	0.076**	1.05%
Residue		0.102	0.084	3.09%		0.303*	0.281*	18.51%
CONS/GDP								
IMF1	3.29	0.333**	0.328***	35.16%	4.21	0.112	0.099	0.68%
IMF2	5.88	0.197**	0.169*	18.42%	5.16	0.109**	0.076	0.56%
IMF3	8.17	0.168***	0.154***	16.12%	6.10	0.086	0.054	0.12%
IMF4	10.46	0.117*	0.103	6.05%	8.93	0.131**	0.116**	7.14%
IMF5	10.93	0.068	0.045	0.78%	15.34	0.195***	0.167***	9.23%
IMF6	11.76	0.104	0.092*	2.08%	16.47	0.262***	0.199**	30.97%
IMF7	12.54	0.044	0.036	0.28%	19.58	0.203***	0.197*	22.03%
Residue		0.172**	0.168***	16.68%		0.256*	0.234**	28.15%

Notes: ***, ** and *: Correlations are significant at the 1%, 5% and 10% levels, respectively (two-tailed).

Table 3: Correlations and Variance of Components

	Restricted period (1990:Q1-2010:Q4)			Whole period (1990:Q1-2015:Q3)		
	Pearson correlation	Kendall correlation	Variance as % of the sum of WDFs	Pearson correlation	Kendall correlation	Variance as % of the sum of WDFs
gGDP						
High frequency component	0.325*	0.318**	57.96%	0.113***	0.077	6.89%
Low Frequency component	0.279***	0.256***	5.72%	0.398**	0.367**	59.11%
Trend component	0.108*	0.102**	25.69%	0.313**	0.300*	32.67%
REM/GDP						
High frequency component	0.412*	0.373**	45.62%	0.217**	0.181***	11.08%
Low Frequency component	0.169*	0.123*	12.14%	0.455***	0.424**	49.92%
Trend component	0.357***	0.329***	23.03%	0.398**	0.372***	22.34%
INV/GDP						
High frequency component	0.467**	0.389*	51.23%	0.523**	0.510***	63.04%
Low Frequency component	0.081	0.064	8.45%	0.131*	0.092	4.12%
Trend component	0.329***	0.296**	13.09%	0.267*	0.195*	18.51%
CONS/GDP						
High frequency component	0.481**	0.295*	48.78%	0.123**	0.110***	10.98
Low Frequency component	0.116*	0.100*	11.21%	0.411***	0.372***	46.72%
Trend component	0.398***	0.354**	16.68%	0.267*	0.195*	28.15%

Notes: ***, ** and *: Correlations are significant at the 1%, 5% and 10% levels, respectively (two-tailed).

Table 4: Regression of Economic Growth on Remittances

	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
	Restricted period (1990:Q1-2010:Q4)							
C	4.5521**	5.328**	5.134***	5.179***	5.092**	5.137***	5.634***	5.553***
	(2.689)	(2.976)	(4.268)	(3.768)	(2.915)	(4.118)	(4.348)	(4.492)
REM/GDP	0.1157	0.0389	0.1234	**-0.0161***	**-0.0258***	**-0.0251****	0.0682	0.0689
	(1.575)	(1.542)	(1.376)	**(-1.863)**	**(-1.779)**	**(-2.359)**	(1.158)	(1.109)
FDI/GDP	0.0718*	0.0629**	0.0914*	-0.0124	0.0393*	0.0697**	0.0332*	0.0617*
	(1.862)	(2.698)	(1.976)	(-1.356)	(1.791)	(2.638)	(1.719)	(1.935)
INV/GDP	0.0389**	0.1255	0.1345	0.0562**	0.1002*	0.0411**	0.0876*	0.1157**
	(2.671)	(1.469)	(1.387)	(2.943)	(0.079)	(3.017)	(1.923)	(2.814)
OPEN	0.1145***	0.0651	0.145***	0.0134	-0.0188	0.0098**	0.0410	0.0367
	(3.815)	(0.589)	(3.542)	(1.156)	(0.706)	(2.923)	(1.067)	(1.156)
Credits/GDP	0.0924*	0.1155*	0.1094**	0.1561	-0.1345	-0.2671	-0.532	0.2619
	(1.723)	(1.914)	(2.619)	(0.956)	(-0.546)	(-1.423)	(-1.493)	(1.433)
REER	-0.1568**	-0.098**	-0.0862**	-0.193***	-0.1724*	-0.146***	-0.208**	-0.2095**
	(-2.492)	(-2.517)	(-2.678)	(-4.562)	(-1.854)	(-3.617)	(-2.775)	(-2.813)
R2	0.85	0.84	0.88	0.86	0.88	0.89	0.86	0.88
	Whole period (1990:Q1-2015:Q3)							
C	3.892***	4.892***	4.689***	4.159**	4.356**	5.102***	4.814***	4.415***
	(3.759)	(5.168)	(4.689)	(3.029)	(3.145)	(3.924)	(4.189)	(3.624)
REM/GDP	0.0054*	0.0135	0.0324	0.0145	0.0357	**0.0452****	**0.0877*****	**0.1095***
	(3.589)	(1.673)	(1.649)	(1.427)	(1.126)	**(2.789)**	**(3.524)**	**(1.823)**
FDI/GDP	0.0913*	0.0675**	0.0532	0.0372	0.045	0.0479	0.0572**	0.0652**
	(2.014)	(2.435)	(1.432)	(1.542)	(1.601)	(1.134)	(2.517)	(2.617)
INV/GDP	0.0135**	0.0102	0.0562	0.0113	0.055**	0.0276	0.0478**	0.0697*
	(2.518)	(1.459)	(1.398)	(1.3185)	(2.567)	(1.792)	(2.610)	(1.886)
OPEN	0.1052***	0.068***	0.0912**	0.0625***	0.084***	0.136**	0.1345***	0.0965**
	(3.710)	(4.563)	(2.651)	(4.298)	(3.498)	(2.594)	(4.126)	(2.345)
Credits/GDP	0.0641*	0.0723*	0.0542**	0.0651*	0.0489*	0.0469**	0.0345*	0.0452**
	(1.865)	(1.875)	(2.921)	(1.932)	(1.932)	(2.765)	(1.699)	(2.610)
REER	-0.134***	-0.197**	-0.267**	-0.2452***	-0.189*	-0.072	-0.078**	-0.065**
	(-3.772)	(-2.514)	(-2.498)	(-4.092)	(-1.796)	(-1.605)	(-2.501)	(-2.708)
R2	0.86	0.88	0.85	0.87	0.84	0.87	0.88	0.84

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively.

Table 5: Regression of Investment on Remittances

	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
	Restricted period (1990:Q1-2010:Q4)							
C	2.4561**	1.9203	1.3803	1.8219	2.0042	3.655***	4.325***	1.8023**
	(2.651)	(1.122)	(1.327)	(1.266)	(1.523)	(3.254)	(3.645)	(2.895)
REM/GDP	-0.0345*	**-0.0763***	**-0.0807***	**-0.0621***	0.0187	0.0210	0.0200	0.5723
	(1.692)	**(-1.812)**	**(-1.942)**	**(-1.734)**	(0.121)	(0.112)	(1.161)	(0.408)
FDI/GDP	-0.0167**	0.0353	-0.0550*	-0.0759*	0.0138	0.0833	-0.016***	-0.027**
	(-2.501)	(0.597)	(-1.841)	(-1.871)	(0.440)	(0.654)	(-3.176)	(-2.358)
gGDP	0.0245***	0.0134	-0.0106	-0.0073	0.0093	-0.0201	0.0183	0.0363*
	(3.659)	(0.703)	(0.801)	(0.870)	(0.553)	(0.736)	(1.297)	(1.761)
OPEN	0.06239*	0.0932	0.0763**	0.0764*	0.4321	0.0679*	0.1389	0.1056**
	(1.876)	(1.213)	(2.451)	(1.893)	(1.279)	(1.843)	(1.267)	(2.418)
Credits/GDP	0.0196*	0.3167	0.1982	0.0113*	0.0345**	0.0452**	0.0512*	0.1567
	(1.838)	(1.512)	(1.367)	(1.768)	(2.456)	(2.138)	(1.913)	(1.083)
CPI	-0.093***	-0.1698**	-0.1690**	-0.1777**	-0.1118*	0.1393*	0.0048	-0.0194
	(-3.404)	(-2.595)	(-2.552)	(-2.689)	(-1.729)	(1.912)	(0.873)	(0.512)
RIR	-0.1934**	-0.211***	-0.222***	-0.220***	-0.217***	-0.195***	-0.061***	-0.05***
	(-2.671)	(-4.231)	(-3.761)	(-3.6251)	(-4.118)	(-3.672)	(-4.110)	(-3.819)
R2	0.79	0.89	0.87	0.84	0.80	0.75	0.92	0.95
	Whole period (1990:Q1-2015:Q3)							
C	6.8729**	7.5233***	7.6826**	8.3058*	8.6777***	8.6513***	1.5678	7.5233*
	(2.597)	(3.562)	(2.675)	(1.672)	(3.845)	(3.345)	(1.004)	(1.976)
REM/GDP	0.0862	-0.452	**-0.123****	0.2816	-0.1377	0.0184	-0.0070	0.2815
	(1.542)	(-1.328)	**(-2.514)**	(0.252)	(-0.839)	(1.037)	(-0.982)	(0.276)
FDI/GDP	-0.0324*	0.0165	-0.0321*	0.0432*	-0.0020	-0.0125	-0.0106	-0.0165*
	(-1.810)	(0.015)	(-1.834)	(-1.697)	(-0.730)	(-0.170)	(-0.318)	(-2.132)
gGDP	0.0453*	0.0421	-0.0120	0.0096	0.0074	0.0881**	0.0686***	0.1345
	(1.769)	(0.275)	(0.192)	(0.184)	(0.372)	(2.545)	(2.632)	(1.307)
OPEN	0.1042**	0.1084*	0.0452***	0.0333***	0.0371***	0.1097*	0.0817*	0.1084
	(2.610)	(1.884)	(3.551)	(4.162)	(3.742)	(1.941)	(1.876)	(1.221)
Credits/GDP	0.0432**	0.0568*	0.4135	0.0755*	-0.0658	-0.0612	0.0157**	0.1414
	(2.619)	(1.899)	(0.522)	(2.066)	(-0.920)	(-0.931)	(3.008)	(0.752)
CPI	-0.0368**	-0.0216*	0.0258	-0.0130	-0.0030	-0.0251*	0.0194	-0.0216
	(-2.491)	(-2.093)	(0.273)	(-0.528)	(0.898)	(-1.876)	(0.532)	(-1.133)
RIR	-0.032***	-0.0121*	-0.0370	-0.0183*	-0.0023	-0.0070	-0.1223*	-0.0121*
	(-3.425)	(-1.698)	(-0.213)	(-2.083)	(-0.934)	(-0.807)	(-1.765)	(-1.945)
R2	0.91	0.95	0.94	0.96	0.95	0.91	0.85	0.95

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively.

Table 6: Regression of Consumption on Remittances

	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
		Restricted period (1990:Q1-2010:Q4)						
C	4.521**	4.458***	4.430***	4.422***	4.563***	4.5801**	4.545**	4.467***
	(2.814)	(3.456)	(4.115)	(3.629)	(3.515)	(2.764)	(1.986)	(3.197)
REM/GDP	0.043*	**0.086***	**0.089***	0.0035	0.0130	-0.0044	0.022	0.024
	(1.892)	**(1.823)**	**(1.802)**	(0.661)	(0.602)	(0.772)	(0.697)	(0.661)
Credits/GDP	0.134*	0.168***	0.1525**	0.1475*	0.0972*	0.0450	-0.049	0.046
	(1.715)	(3.245)	(2.671)	(1.796)	(2.043)	(0.436)	(-0.368)	(0.228)
gGDP	0.031**	0.020*	0.0345	0.0353	0.0174*	0.0286	0.052	0.067
	(2.671)	(1.979)	(0.448)	(0.445)	(2.101)	(0.607)	(1.267)	(0.226)
CPI	-0.196**	-0.27***	-0.261***	-0.25***	-0.243**	-0.21***	-0.1***	-0.213**
	(-2.871)	(-3.149)	(-4.005)	(-3.814)	(-2.976)	(-4.116)	(-3.812)	(-2.689)
RIR	-0.062*	-0.045	-0.0370**	-0.0329*	-0.0121	-0.0068	-0.005	-0.005*
	(-1.967)	(-1.531)	(-2.678)	(-1.985)	(-0.459)	(-0.691)	(-0.710)	(-2.038)
R2	0.86	0.90	0.86	0.84	0.83	0.87	0.83	0.79
		Whole period (1990:Q1-2015:Q3)						
C	4.169***	4.469***	3.907***	3.979***	1.616	11.83**	1.429	6.283***
	(3.841)	(4.576)	(3.763)	(3.986)	(1.156)	(2.561)	(1.514)	(3.612)
REM/GDP	0.050**	0.034	0.0310	0.0806	0.0226	0.0635	**0.097***	**0.115***
	(2.687)	(0.321)	(1.001)	(0.399)	(0.273)	(0.340)	**(1.876)**	**(2.834)**
Credits/GDP	0.095	0.122*	0.1573	0.1095*	0.0339	0.0211	0.007	0.334
	(1.115)	(1.916)	(0.004)	(1.928)	(0.162)	(0.274)	(0.653)	(0.515)
gGDP	0.041*	0.022**	0.0504*	0.8952	0.3240	0.0261	0.018	0.122
	(1.705)	(2.397)	(1.886)	(0.450)	(0.210)	(0.117)	(0.228)	(0.786)
CPI	-0.076**	-0.200	-0.109***	0.5006	-0.0239	-0.0135	-0.004	-0.183**
	(-2.631)	(-0.963)	(-3.658)	(0.260)	(0.425)	(0.570)	(0.840)	(-2.356)
RIR	-0.071**	-0.056*	-0.068***	-0.0568	-0.08***	-0.072**	-0.105*	0.141
	(-1.642)	(-1.765)	(-3.914)	(-1.119)	(-4.112)	(-2.334)	(-1.921)	(-1.196)
R2	0.89	0.91	0.95	0.99	0.99	0.86	0.92	0.90

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively.

Table 7: Regression of Economic Growth on Remittances (Control for Endogeneity)

	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
	Restricted period (1990:Q1-2010:Q4)							
C	-3.6942*	-4.894	-6.488	-8.207	-6.752	-3.553	-2.086	-5.346
	(-1.699)	(-1.324)	(-1.474)	(-1.532)	(-1.347)	(-0.753)	(-0.493)	(-1.236)
REM/GDP	-0.0034*				**-**			
	(-1.782)	-0.020	-0.012	0.007	**0.019****	-0.014	0.067	-0.009
		(-1.214)	(-0.724)	(0.362)	**(-2.316)**	(-0.220)	(0.654)	(-0.359)
FDI/GDP	0.0051*	0.004***	0.024	0.031**	0.003**	0.010***	0.003***	0.002***
	(1.812)	(4.267)	(0.341)	(2.990)	(2.201)	(5.498)	(4.380)	(4.138)
INV/GDP	0.1018*	-0.141	0.203*	0.028**	0.131	0.054**	0.110*	-0.005
	(1.7054)	(-1.504)	(1.698)	(-2.505)	(0.524)	(2.789)	(1.758)	(-0.203)
OPEN	0.0962**	-0.009	0.293***	-0.019	0.122	0.115*	0.125*	0.116*
	(2.506)	(-0.185)	(4.053)	(-0.604)	(1.680)	(1.813)	(1.722)	(1.806)
Credits/GDP	0.1168	0.041	0.167	-0.022	-0.046	0.136	0.076	0.113
	(1.005)	(0.588)	(1.225)	(-0.680)	(-0.511)	(0.404)	(0.534)	(0.814)
REER	-0.2273*	0.244	0.132	0.098	0.241	0.004	-0.369*	-0.252**
	(-1.794)	(0.962)	(0.320)	(0.472)	(1.084)	(0.012)	(-1.903)	(2.593)
Cragg-Donald F-statistic	36.29	32.17	34.49	41.05	36.78	24.21	30.16	29.48
	Whole period (1990:Q1-2015:Q3)							
C	-3.2569	-1.796	1.144	-27.759	-17.953	-48.916	-13.690	15.511
	(-1.389)	(-0.756)	(0.157)	(-0.819)	(-0.753)	(-0.370)	(-0.462)	(0.279)
REM/GDP	0.0192*	0.027	0.456	0.273	0.223	**0.050***	**0.035****	**0.127*****
	(1.832)	(0.105)	(0.266)	(0.568)	(0.343)	**(1.739)**	**(2.525)**	**(3.433)**
FDI/GDP	-0.0772**	-0.067*	-0.569	-0.215	-0.114*	-0.09***	0.011***	-0.098
	(-2.694)	(-1.789)	(-1.125)	(-1.176)	(-1.897)	(-3.742)	(4.292)	(-1.954)
INV/GDP	0.0298*	0.010	1.129	0.082*	0.076**	0.023	0.067	0.061*
	(1.794)	(0.835)	(1.186)	(1.911)	(2.589)	(1.414)	(0.925)	(1.911)
OPEN	0.0892**	0.097**	0.102*	0.089***	0.115**	0.114***	0.098**	0.038*
	(2.567)	(2.546)	(1.956)	(3.972)	(2.756)	(2.913)	(2.765)	(1.816)
Credits/GDP	0.0342*	0.021*	0.010	0.031***	0.045**	0.026***	0.047	0.035***
	(1.801)	(1.713)	(1.365)	(3.009)	(2.879)	(5.139)	(1.251)	(3.818)
REER	-0.1945***	-0.081**	-0.123	-0.045*	-0.606	-0.168	-0.362	-0.285
	(-3.189)	(-2.695)	(-0.657)	(-1.923)	(-0.865)	(-0.924)	(-1.415)	(-0.717)
Cragg-Donald F-statistic	34.89	36.21	31.67	31.72	34.07	25.28	32.18	30.89

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. 10% and 15% critical value of Stock–Yogo weak idetification test are 17.02 and 13.85, respectively; the null hypothesis of weak instruments or Cragg–Donald F-statistic test can be rejected when the associated F-statistic values appear stronger than the critical values by thresholds provided by Stock and Yogo (2005).

Table 8: Regression of Investment on Remittances (Control For Endogeneity)

	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
	Restricted period (1990:Q1-2010:Q4)							
C	-6.542**	-9.321*	-8.324	-6.7***	-6.739***	-7.459*	-7.212**	-6.542***
	(-2.345)	(-1.894)	(-1.234)	(-7.234)	(-3.513)	(-1.867)	(-2.852)	(-4.510)
REM/GDP	-0.039**	**0.062***	**-0.134*****	-0.074*	0.146	0.102	0.056	0.105
	(-2.632)	**(1.796)**	**(-3.865)**	(-1.891)	(0.975)	(1.136)	(1.189)	(1.128)
FDI/GDP	-0.009**	-0.061	0.073	-0.303	-1.006	-0.07***	-0.06***	-0.083**
	(-2.684)	(-1.238)	(1.234)	(-1.278)	(-1.135)	(-3.291)	(-4.011)	(-2.612)
gGDP	0.369	0.819	-0.256	0.274	0.139	0.124	0.436	0.185
	(1.045)	(0.227)	(-1.616)	(0.812)	(1.000)	(1.514)	(1.048)	(1.313)
OPEN	0.107*	0.079	0.081*	0.164	0.210	0.131	0.146**	0.137*
	(1.863)	(1.426)	(1.891)	(1.424)	(1.358)	(1.976)	(2.525)	(1.924)
Credits/GDP	0.035*	-0.151	-0.167	0.129	0.472	0.031*	0.026***	0.022***
	(1.942)	(-1.303)	(-1.411)	(1.101)	(0.869)	(1.756)	(4.158)	(3.194)
CPI	-0.168*	-0.135*	-0.678	-0.105	-0.367	-0.225*	-0.171*	-0.215**
	(-1.875)	(-1.912)	(-1.193)	(-1.247)	(-1.235)	(-1.834)	(-1.912)	(-2.472)
RIR	-0.094**	-0.178*	-0.092	-0.076*	-0.023*	-0.129	-0.182	-0.045**
	(-2.352)	(-1.796)	(-1.414)	(-1.543)	(-1.703)	(-0.738)	(-0.503)	(-1.615)
Cragg-Donald F-statistic	26.79	25.67	26.71	26.72	28.32	28.01	28.00	29.12
	Whole period (1990:Q1-2015:Q3)							
C	-4.503**	-3.792***	-4.123**	-4.58***	-4.096**	-4.100*	-4.196**	-4.811**
	(-2.689)	(-4.525)	(-2.525)	(-4.515)	(-2.323)	(-1.891)	(-2.613)	(-2.356)
REM/GDP	-0.129	-0.145*	**-0.136***	0.063	0.045	0.021	0.356	0.142
	(-1.639)	(-1.909)	**(-1.811)**	(1.286)	(0.678)	(0.616)	(1.325)	(0.796)
FDI/GDP	-0.061**	-0.156	0.368	-0.245	-0.358	-0.062	-0.08***	-0.056*
	(-2.342)	(-1.103)	(0.511)	(-1.567)	(-1.034)	(-1.245)	(-3.629)	(-1.869)
gGDP	0.067***	-0.621	0.421	0.094**	0.156	0.092*	0.088*	0.122
	(3.109)	(-0.855)	(1.236)	(2.678)	(1.245)	(1.956)	(1.875)	(1.074)
OPEN	0.051*	0.039*	0.098***	0.164	0.167	0.234	0.065*	0.113
	(1.768)	(1.892)	(3.819)	(1.424)	(1.023)	(1.126)	(2.100)	(1.045)
Credits/GDP	0.038*	-0.009	0.076*	0.129	0.067	0.028***	0.138	0.156
	(1.910)	(-1.134)	(1.810)	(1.101)	(1.008)	(3.896)	(1.249)	(0.689)
CPI	-0.083**	-0.095***	-0.096**	-0.105	0.135	-0.131	-0.138	-0.034*
	(-2.819)	(-3.621)	(-2.553)	(-1.247)	(0.921)	(-1.424)	(-1.256)	(-1.826)
RIR	-0.045**	-0.038*	-0.515	-0.051*	-0.312	-0.085*	0.096	-0.005
	(-2.378)	(-1.864)	(-1.123)	(-1.747)	(-0.767)	(-1.698)	(-1.002)	(-0.912)
Cragg-Donald F-statistic	24.56	23.15	29.07	26.15	28.14	21.87	22.13	25.67

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. 10% and 15% critical value of Stock–Yogo weak idetification test are 17.02 and 13.85, respectively; the null hypothesis of weak instruments or Cragg–Donald F-statistic test can be rejected when the associated F-statistic values appear stronger than the critical values by thresholds provided by Stock and Yogo (2005).

Table 9: Regression of Consumption on Remittances (Control for Endogeneity)

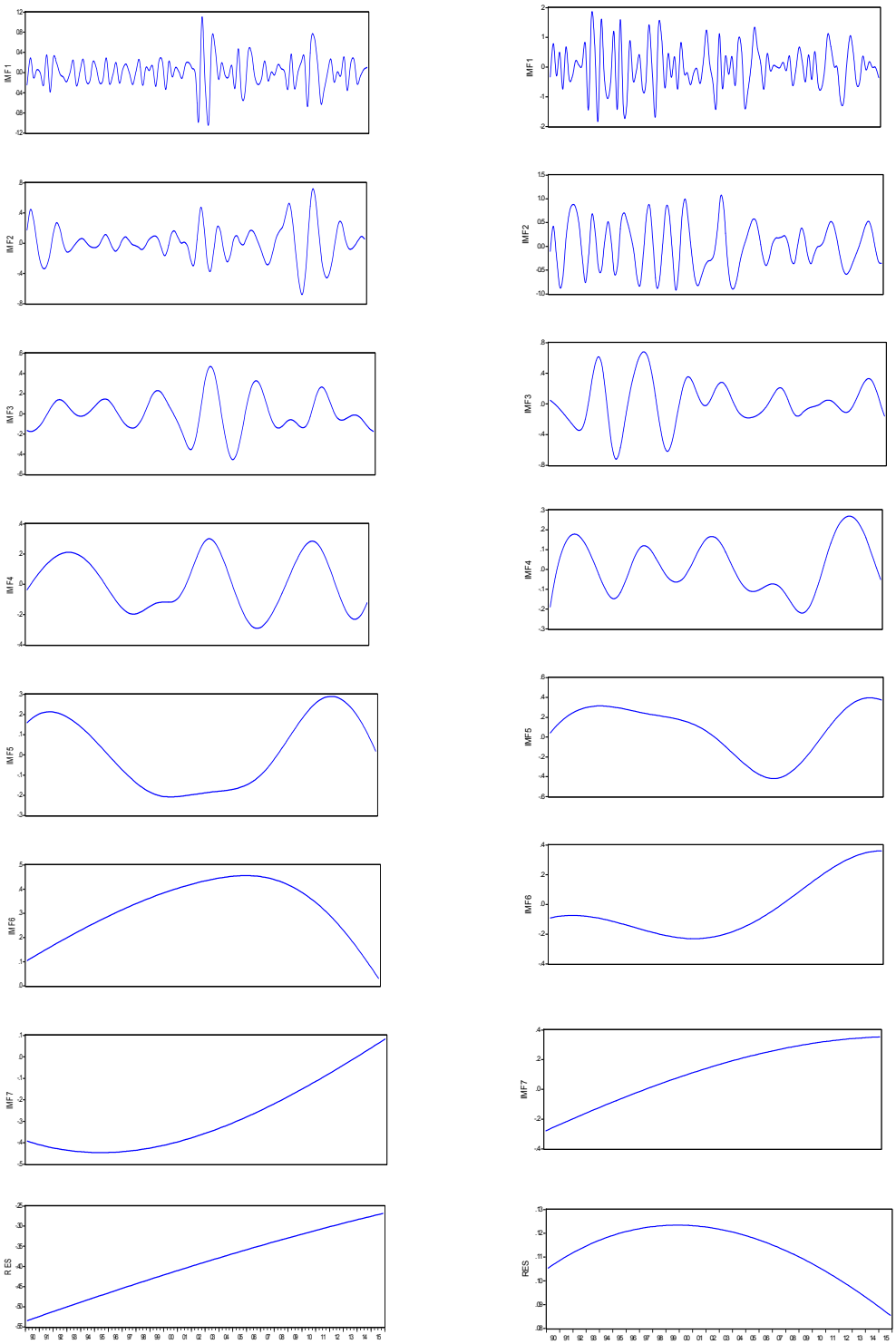
	Time domain	IMF1	IMF2	IMF3	IMF4	IMF5	IMF6	IMF7
Restricted period (1990:Q1-2010:Q4)								
C	3.109***	2.891***	1.783*	2.672**	1.924***	2.345***	1.356**	1.642***
	(3.571)	(3.912)	(1.881)	(2.936)	(3.876)	(4.516)	(1.972)	(3.514)
REM/GDP	0.067**	**0.103***	**0.095****	0.114	0.167	0.279	0.313	0.129
	(2.871)	**(1.834)**	**(2.717)**	(1.639)	(1.056)	(0.832)	(1.042)	(1.361)
Credits/GDP	0.068**	0.092	0.126***	0.119***	0.549	0.212	0.083*	0.215
	(2.425)	(1.414)	(4.267)	(3.125)	(1.309)	(1.192)	(1.914)	(1.318)
gGDP	0.029***	0.023**	0.011*	0.014*	0.097*	0.017*	0.069	0.108*
	(3.814)	(2.511)	(1.912)	(1.822)	(2.064)	(1.695)	(1.254)	(1.935)
CPI	-0.181***	-0.214**	-0.156**	-0.194***	-0.167**	-0.212***	-0.162*	-0.171**
	(-3.619)	(-2.356)	(-3.004)	(-4.361)	(-1.982)	(-4.918)	(-1.724)	(-2.526)
RIR	-0.037**	-0.023	-0.011*	-0.049	0.014	-0.044*	-0.052*	-0.021**
	(-2.618)	(-1.414)	(-1.749)	(-1.020)	(1.187)	(-1.781)	(-1.912)	(-2.814)
Cragg-Donald F-statistic	22.35	19.87	21.42	20.98	21.15	22.37	23.14	21.68
Whole period (1990:Q1-2015:Q3)								
C	3.892*	4.056	3.246	4.156***	4.092**	4.156***	3.565**	3.916***
	(1.716)	(1.127)	(1.214)	(3.672)	(2.627)	(3.492)	(2.482)	(3.227)
REM/GDP	0.129*	0.062	0.131	0.114	0.110	0.098	**0.135****	**0.126*****
	(1.876)	(1.378)	(0.907)	(1.316)	(1.458)	(1.945)	**(2.691)**	**(3.711)**
Credits/GDP	0.056***	-0.01***	0.096	0.054	0.076	0.049	0.069***	0.088*
	(3.809)	(-4.213)	(1.154)	(1.319)	(1.020)	(1.286)	(4.712)	(1.972)
gGDP	0.034**	0.021*	0.023**	0.076	0.100	0.094	0.045*	0.094**
	(2.573)	(1.699)	(2.167)	(1.434)	(0.928)	(1.518)	(1.758)	(2.076)
CPI	-0.186**	-0.28***	-0.197**	-0.234***	-0.256**	-0.267*	-0.245**	-0.189*
	(-2.714)	(-4.312)	(-2.652)	(-3.861)	(-2.489)	(-1.993)	(-2.417)	(-1.762)
RIR	-0.066***	-0.072*	-0.096**	-0.110**	-0.08***	-0.072**	-0.105*	0.141
	(-3.298)	(-1.914)	(-2.527)	(-2.314)	(-4.112)	(-2.334)	(-1.921)	(-1.196)
Cragg-Donald F-statistic	23.18	21.04	20.18	19.76	18.34	17.26	20.13	19.82

Notes: ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. 10% and 15 % critical value of Stock–Yogo weak identification test are 17.02 and 13.85, respectively; the null hypothesis of weak instruments or Cragg–Donald F-statistic test can be rejected when the associated F-statistic values appear stronger than the critical values by thresholds provided by Stock and Yogo (2005).

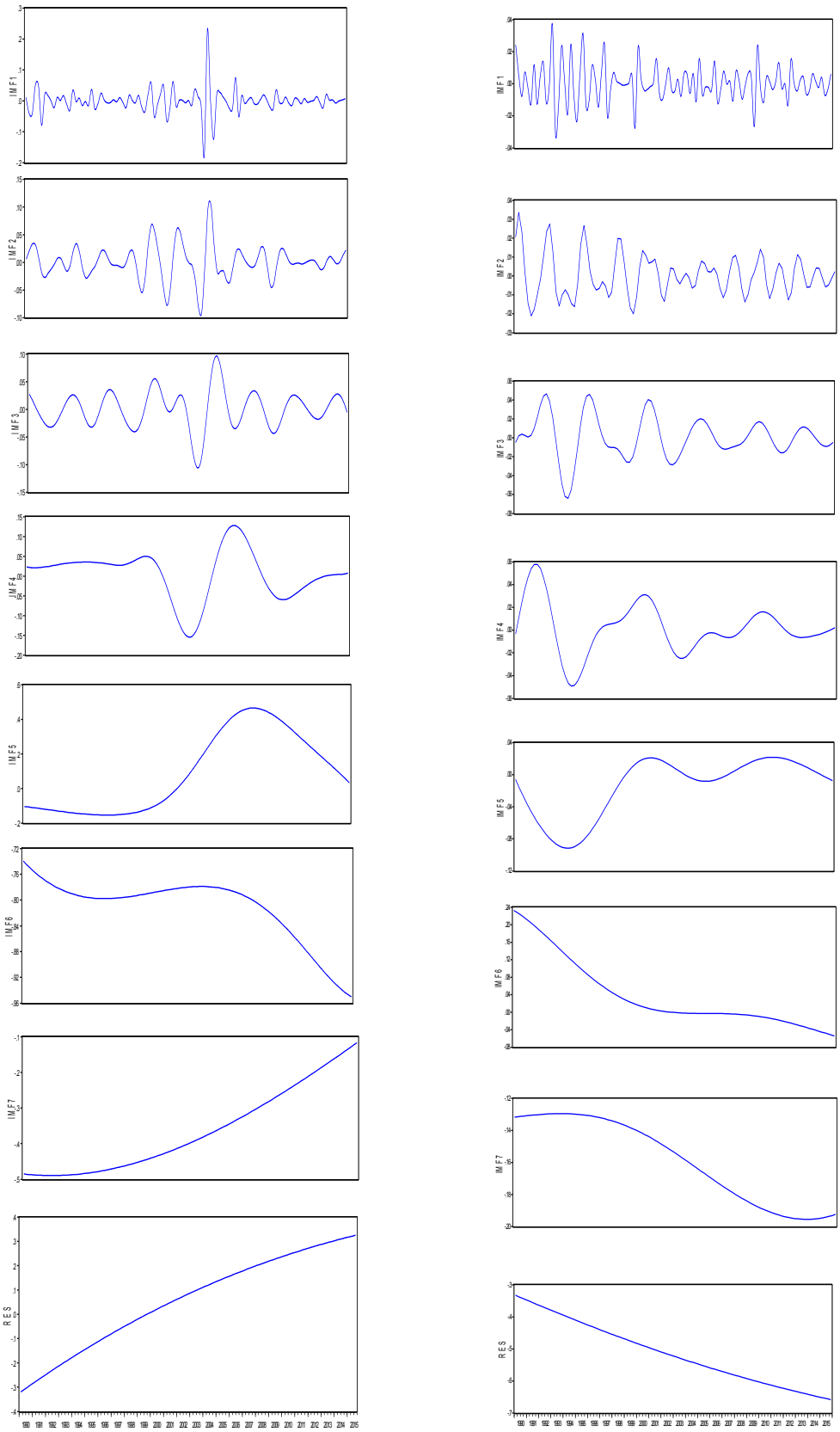
Appendices

Figure A1: The IMFs involved in gGDP, REM/GDP, INV/GDP and CONS/GDP

Restricted period (2000:Q1-2010:Q4)	Whole period (2000:Q1-2015:Q3)
gGDP	



REM/GDP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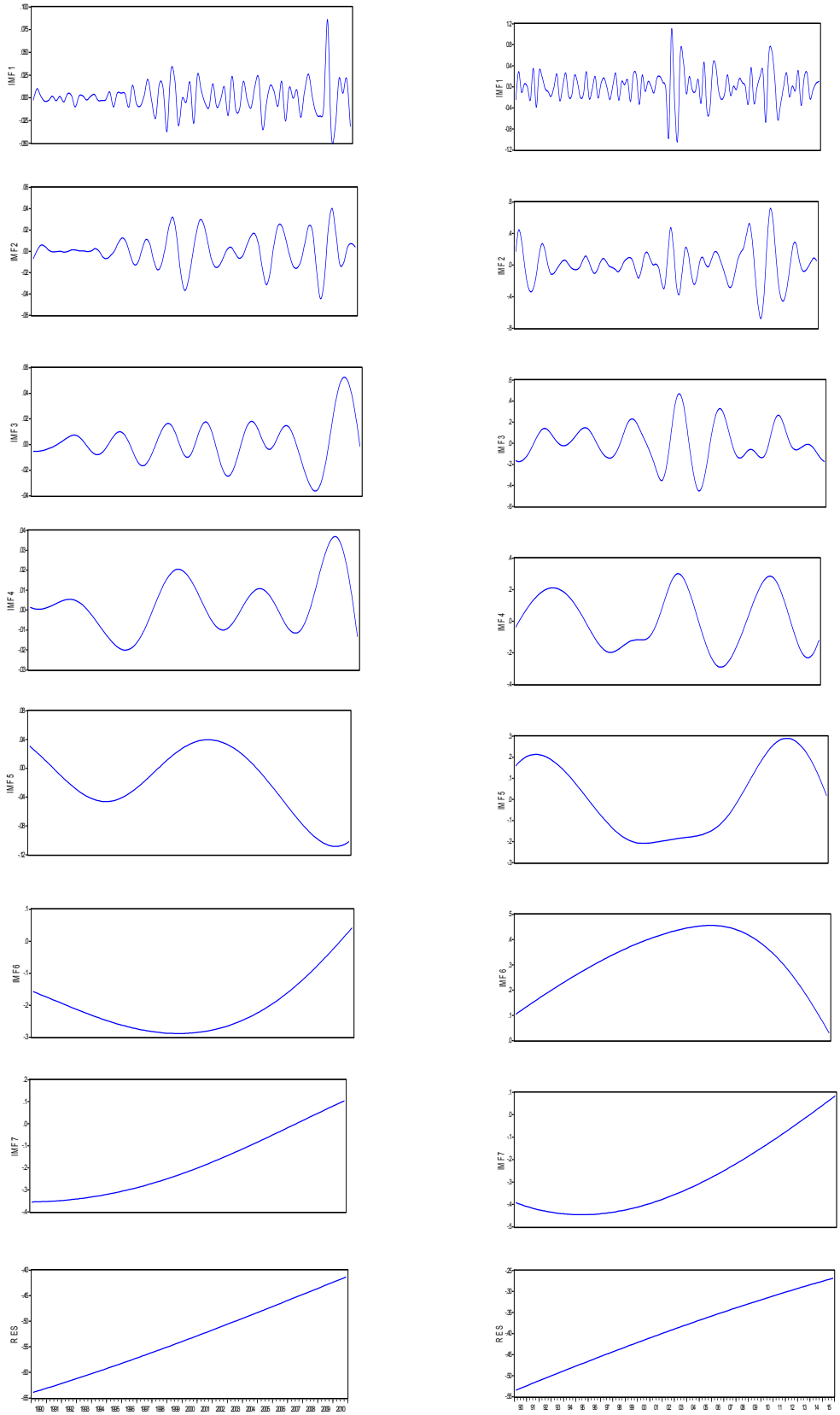
IMF2
IMF3
IMF4
IMF5
IMF6
IMF7
RES
IMF1
IMF2
IMF3
IMF4
IMF5
IMF6
IMF7
RES

INV/GDP



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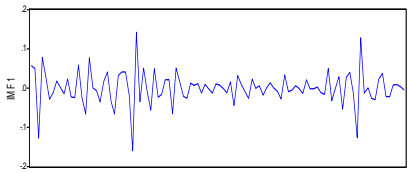
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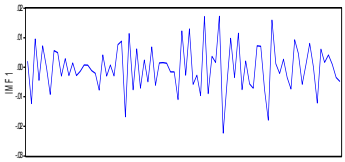
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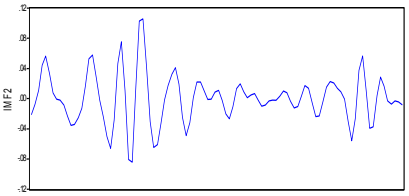
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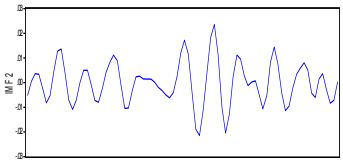
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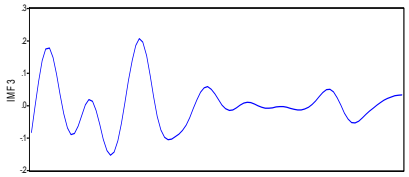
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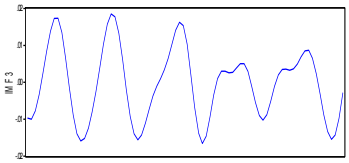
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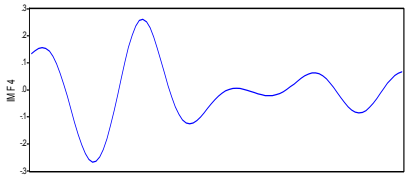
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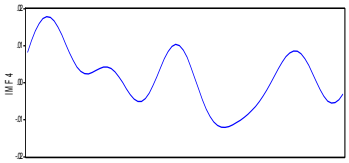
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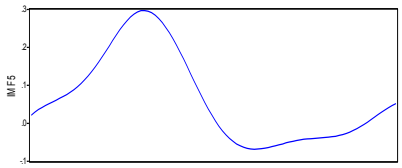
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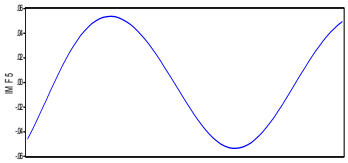
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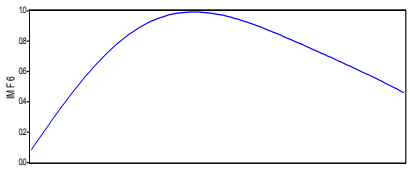
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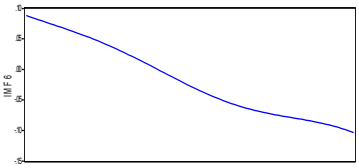
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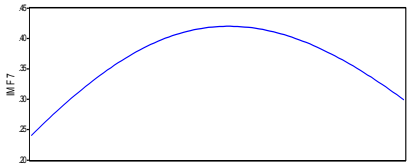
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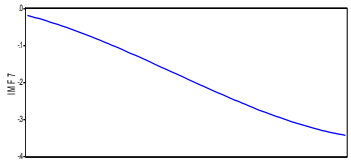
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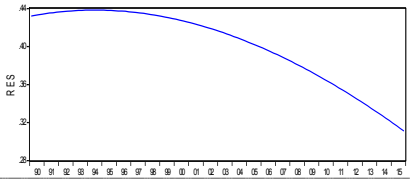
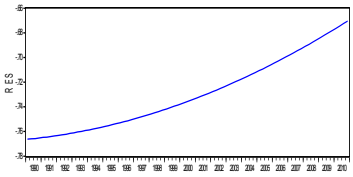

RES


RES

Overview A.1. A Frequency Domain Causality Test

The present paper attempted to assess the causal linkage between remittances and macroeconomic variables through a recently developed signal approach of Breitung and Calderon (2006). Use of this approach allows for the disentangling of the Granger causality in the frequency domain, and then identifies if the predictive power is concentrated at the quickly fluctuating components (high frequency) or at the slowly fluctuating components (low frequency). This distinction is very important in studying causality. Although conceptually interesting, the standard Granger causality test does not permit discerning the variant characteristics of the signals involved, which normally play a significant role on the underlying series; hence the usefulness of the decomposition of various frequencies of data variables that may help policy makers in the formulation of adequate decisions. Precisely, the covariance of these variables is disentangled into various spectral components. The aim is that a stationary process can be depicted as a weighted sum of sinusoidal components with a certain frequency, enabling the evaluation of the underlying cyclical properties of the times series studied and the linkage between them.

To review the testing procedure, let us suppose that a two-dimentional time series vector $[x_t, y_t]$ is generated by the following stationary VAR(p) model:

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \begin{pmatrix} \phi_{11}(L)\phi_{12}(L) \\ \phi_{21}(L)\phi_{22}(L) \end{pmatrix} \begin{pmatrix} x_{t-1} \\ y_{t-1} \end{pmatrix} + \begin{pmatrix} \mu_t \\ \upsilon_t \end{pmatrix} = \begin{pmatrix} \psi_{11}(L)\psi_{12}(L) \\ \psi_{21}(L)\psi_{22}(L) \end{pmatrix} \begin{pmatrix} \varepsilon_t \\ \eta_t \end{pmatrix} \text{ ,t=1,…, T} \qquad \text{(A.1)}$$

where $\phi_{ij}(L) = \phi_{ij,1}L^0 + ... + \phi_{ij,p}L^{p-1}$ for $i, j = 1,2$ and $[\mu_t, \upsilon_t]' \sim iid(0, \sum)$. Note that is positive definite and let G be the lower triangular matrix of the Cholesky $G'G = \sum^{-1}$; $[\varepsilon_t, \eta_t]'$ is defined as $G[\mu_t, \upsilon_t]'$ and $\psi_{ij}(L)$ for $i, j = 1,2$ are defined accordingly.

Then, the population spectrum of *x*, denoted by $f_x(\omega)$, can be derived from the previous matrix and expressed as follows:

$$f_x(\omega) = \frac{1}{2\pi}\left\{ \left|\psi_{11}(e^{-i\omega})\right|^2 + \left|\psi_{12}(e^{-i\omega})\right|^2 \right\} \qquad \text{(A.2)}$$

The main goal of this technique is to test whether x_t Granger cause y_t, at a given frequency λ, even if we control for Z_t (additional control variables). Geweke (1982) developed a measure of causality denoted as:

$$M_{x \to y/Z}(w) = \log\left[1 + \frac{\left|\psi_{12}(e^{-iw})\right|^2}{\left|\psi_{11}(e^{-iw})\right|^2} \right] \qquad \text{(A.3)}$$

As $\left|\psi_{12}(e^{-iw})\right|^2$ is a complex function of the VAR parameters, Breitung and Candelon (2006) and in order to resolve this drawback, argued that the hypothesis $M_{x \to y/Z}(\omega) = 0$ corresponds to a linear restriction on the VAR coefficients.

$$H_0 : R(\omega)\phi(L) = 0 \qquad \text{(A.4)}$$

where $R(\omega) = \begin{bmatrix} \cos(\omega)\cos(2\omega)...\cos(p\omega) \\ \sin(\omega)\sin(2\omega)...\sin(p\omega) \end{bmatrix}$

The significance of the causal relationship can be tested by a standard F-test or by comparing the causality measure for $\omega \in [0, \pi]$ with the critical value of a χ^2 distribution with 2 degrees of freedom, which is 5.99.