Impact of digitalization and exchange rate on remittance: Evidence from south Asian countries

Zaki Ahmad[1*], Zohoor Abdallah Mahmoud Hussin[2], Mohammad Helmi bin Hidthiir[3], Mustazar Mansur[4], Mohamed Ali ALI[5]

[1]*Islamic Business School, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.*
[2]*Imam Mohammed Ibn Saud Islamic University (IMSIU), Applied College, Saudi Arabia.*
[3]*School of Economics, Finance and Banking, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.*
[4]*Faculty of Economics & Management, National University of Malaysia, Malaysia.*
[5]*Department of Finance, College of Business Administration in Hawtat bani Tamim, Prince Sattam bin Abdulaziz University, Saudi Arabia.*

Corresponding author: Zaki Ahmad (*Email: 94zakiahmad@gmail.com*)

Abstract

The main objective of this study is to analyze the impact of digitalization, exchange rate, political stability, employment, and inflation rate on remittances in the short and long run in three South Asian countries, India, Pakistan, and Bangladesh, from 2003 to 2022. Using panel ARDL and wavelet coherence techniques, the findings reveal that digitalization does not have a direct and lasting impact on remittances in both the short and long run. However, there is evidence of a positive short-term correlation in the wavelet. On the other hand, exchange rates (EXC) emerge as a significant driver of remittances, impacting them both in the short and long term. Political stability (PST) and employment (EMP) appear to be less influential, as their coefficients remain insignificant in both time frames, although they exhibit short-term correlations with remittances in wavelet analysis. In contrast, inflation (INF) significantly affects remittances in both the short and long run, with short-term analysis highlighting its leading role in shaping remittance behavior. The results hold important implications for advancing financial inclusion in the context of remittances. Policymakers can enhance digital infrastructure for short-term remittance facilitation, targeting improved accessibility and efficiency, and implement exchange rate stability measures to ensure predictable remittance inflows over both short and long periods. Additionally, they should acknowledge the short-term significance of political stability and employment for remittances while focusing on broader economic stability and inflation control to support remittance behavior in the long run.

Keywords: Digitalization, Exchange rate, Panel ARDL, Remittance, South asian countries, Wavelet coherence.

1. Introduction

In recent decades, there has been a significant surge in the widespread adoption of Information and Communication Technologies (ICT), transforming them into pivotal drivers of economic and social activities, not only in developed nations but also in developing countries. This phenomenon has sparked a growing body of research exploring the relationship between digitalization and economic growth. For instance, Lee et al. [1] demonstrated that the expansion of mobile telecommunications significantly contributed to economic growth in sub-Saharan Africa, while Bojnec and Fertő [2] found that increased internet access and gross capital growth played a positive and significant role in boosting gross domestic product (GDP) per capita. The transformation is attributed to ICT's ability to reshape transaction processes through electronic commerce, enhance the flexibility of banking operations, and improve communication methods.

The concept of remittance flow refers to the transfer of money from foreign workers to individuals in their home countries [3]. These funds sent by migrants constitute one of the largest financial inflows to developing countries and compete with international aid as a significant source of income. Remittances are particularly crucial for labor-exporting countries, and as countries have become more financially open and economically liberalized, government restrictions on remittances have eased [4]. This has led to an increase in various forms of foreign exchange transfers by overseas migrants, supplementing traditional methods of international remittances. The definition of international remittances has expanded beyond just family-level transfers, and now governments and international economic organizations compile data according to the Balance of Payments Manual 6th edition framework. As of 2015, remittance flows to low- and middle-income countries (LMICs), excluding China, exceeded foreign direct investment (FDI), making them the largest source of foreign exchange earnings in LMICs. The paragraph also provides statistics on global remittance flows, with a total of $689 billion worldwide in 2018, with $529 billion going to developing countries [5].

Exchange rates hold significant importance in the context of remittances [6]. These rates determine the actual value of remittances received by individuals in their home countries. When exchange rates are favorable, meaning the local currency is stronger relative to the sender's currency, recipients receive more money in their local currency, potentially improving their standard of living [7]. Conversely, unfavorable exchange rates can result in reduced remittance values, impacting recipients' financial well-being. Exchange rates also affect the cost to the sender, with unfavorable rates leading to higher fees or less advantageous conversion rates when transferring money. Additionally, fluctuations in exchange rates can influence the decision to send remittances and the amount sent, affecting the economic stability of both the sender and recipient countries [8].

In the context of remittances, the significance of political stability is vital Ajide and Alimi [9]. A politically stable environment in the sender's home country can foster confidence and security among migrants, encouraging them to send more remittances to their families and investments back home [10]. Conversely, political instability may lead to increased emigration, as people seek safety and economic opportunities abroad, indirectly contributing to higher remittance flows [11]. Moreover, political stability can influence government policies and regulations related to remittances, impacting the ease and cost of sending money. Stable governments are more likely to create favorable remittance environments. In recipient countries, political stability can contribute to economic growth and stability, indirectly affecting remittances as recipients may have more disposable income. Trust in financial institutions and formal banking channels also tends to be higher in politically stable environments, reducing reliance on informal and riskier methods. Ultimately, political stability's impact on remittances is multifaceted and underscores its importance in shaping the financial well-being of both individuals and economies [12].

Employment plays a pivotal role in the sphere of remittances, with profound significance for both sending and receiving countries [13]. For migrant workers, employment abroad provides the essential income necessary to send remittances back to their home countries, offering crucial financial support to their families. These remittances often cover essential expenses like education, healthcare, and housing, and they can serve as a lifeline to lift families out of poverty. Moreover, employment opportunities for family members overseas enable investments in local businesses, property, and education, contributing to economic development in the sending countries. On a larger scale, remittances can be a substantial source of foreign exchange earnings, helping to stabilize local currencies and enhance economic stability. However, employment-related risks and challenges, such as job insecurity or economic downturns in host countries, can also impact remittance flows, highlighting the intricate connection between employment and the financial well-being of individuals and economies alike [14].

The inflation rate holds notable significance in the context of remittances, impacting both sending and receiving countries [15]. High inflation in the recipient country can lead to a reduction in the real value of remittances, as the purchasing power of the funds sent diminishes over time [16]. This can affect the standard of living of recipient households and make it challenging to cover rising costs. Conversely, when the sender's home country experiences high inflation, it may motivate migrants to send more remittances to help their families cope with increased expenses. Moreover, inflation can influence exchange rates, potentially affecting the value of remittances received. It also shapes investment decisions, prompting individuals to seek alternative forms of investment to preserve their savings' real value [17].

The main objective of this paper is to analyze the impact of digitalization, exchange rate, political stability, employment, and inflation rate on remittance in the short and long run in three South Asian countries, India, Pakistan, and Bangladesh. The data is collected from the World Development Indicators (WDI) from 2003 to 2022. This study uses panel data to estimate the impact of digitalization, exchange rate, political stability, employment, and inflation rate on remittance. The main reason for using panel data is that it measures the impact across a group rather than individual units. Moreover, panel data reduces noise coming from individual time series [18]; therefore, heteroscedasticity is not an issue in panel data analysis [19]. This study focuses on heterogeneous panel data modeling, also known as panel-ARDL. To detect and quantify co-movement between variables at different timescales, this study employs the continuous wavelet transform (CWT) approach [20]. Through this approach, the study aims to offer robust recommendations capable of effectively improving remittances through digitalization and exchange rates, and promoting political stability, employment, and inflation rate sustainability without disproportionately affecting other critical aspects.

The study has the potential to significantly enhance financial inclusion in developing countries, particularly in South Asia, including India, Pakistan, and Bangladesh. By accurately examining the impacts of digitalization, exchange rates, political stability, employment, and inflation rates on remittances over both short and long periods, the study provides a comprehensive understanding of the driving forces behind remittance flows. Employing advanced statistical techniques and panel data analysis, this research offers data-driven insights and robust recommendations. These insights can help policymakers design tailored strategies to promote financial inclusion effectively, reduce financial exclusion, and create an enabling environment for remittance-based financial participation.

This article consists of five sections. It begins with an introduction, followed by a literature review. Methodologies are discussed in the third section. Subsequently, the results and discussions are presented, leading to the fifth section, which encompasses the conclusions and policy implications.

2. Literature Review

In 2018, more than 200 million migrant laborers globally sent a substantial $689 billion back to their countries of origin, with approximately $529 billion directed toward developing nations [5]. This remarkable financial inflow highlights the immense economic impact of remittances. As the world becomes increasingly interconnected through globalization, the process of sending money across borders has become faster and more efficient. This has allowed laborers, particularly those from developing countries, to leverage the income gap between their host nations, often developed countries, and their home countries. By remitting a portion of their earnings to their families and communities back home, these migrant workers contribute significantly to their home country's economy.

The process of digitalization in financial services plays a pivotal role in enhancing accessibility, potentially leading to a positive impact on remittances [21]. Remittances have been widely established as a primary source of financial inflow for developing countries, surpassing the significance of official aid and foreign direct investment, as substantiated by studies such as those by Alvarez et al. [22], Ratha [23] and Tabit and Moussir [24]. Further empirical evidence, provided by Bettin et al. [25] indicates that the volume of remittances tends to increase in correspondence with a greater density of internet users. Therefore, it underscores how the improvement in access to financial services resulting from digitalization presents an opportunity to reduce costs, as noted by Rodima-Taylor and Grimes [26]. Additionally, it has the potential to enhance financial inclusion by diverting informal remittance flows towards formal channels, as discussed by Emara and Zhang [27]. Guermond [28] illustrates this effect by demonstrating how the digitalization of remittances in Ghana has contributed to the advancement of digital financial inclusion. Moreover, Ratha and Shaw [29] indicated that the costs associated with South-South remittances tend to be high due to limited competition in both sending and receiving countries' remittance markets. Transactional costs are a crucial factor influencing the willingness of workers to send remittances, as indicated by Ahmed and Martínez-Zarzoso [30] in their study on remittance flows to Pakistan from 23 host countries. Schiopu and Siegfried [31] similarly, it was found that remittances increased when remittance costs were lower, emphasizing the importance of cost reduction. Freund and Spatafora [32] expanded on this notion, noting that countries with high transaction costs tend to experience larger volumes of informal remittance flows. They further explained that the increase in remittances in Latin America since 1995 can be attributed to the greater utilization of formal channels over informal ones, driven by the development of FinTech and reduced costs in the financial sector. Based on the above literature, the hypothesis is:

H_1: *There is a long-run and short-run impact of digitalization on remittance in South Asian countries.*

Numerous studies have explored the relationship between exchange rate fluctuations and remittances. For example, Chami et al. [33] found that exchange rate volatility can deter remittances in the short term, as migrants may delay or reduce transfers when they anticipate unfavorable exchange rate movements. Similarly, Yang [34] observed that increased exchange rate volatility in receiving countries can lead to reduced remittance flows. Furthermore, exchange rate regimes can also impact remittance flows, as Kandilov et al. [35] found that countries with flexible exchange rate systems tend to experience larger remittance inflows compared to those with fixed exchange rate systems. The flexibility of exchange rates allows remittances to adjust more effectively to economic conditions in both the host and recipient countries. In developing

countries, exchange rate movements can have significant effects on remittance behavior. For instance, Faini et al. [36] found that depreciation of the recipient country's currency can lead to an increase in remittances as migrants seek to take advantage of favorable exchange rates, thus boosting the inflow of foreign currency. Some studies examine the impact of exchange rate pass-through on remittance flows. Mitra and Murayama [37] found that a higher degree of exchange rate pass-through, where changes in exchange rates directly affect domestic prices, can lead to increased remittances as migrants seek to offset the rising cost of living in their home countries. The literature suggests that exchange rates play a crucial role in shaping remittance behavior. Exchange rate volatility, regime flexibility, and pass-through effects can all influence the volume and direction of remittance flows in both developed and developing countries. Based on the above literature, the hypothesis is:

H_2: *There is a long-run and short-run impact of the exchange rate on remittance in South Asian countries.*

Research has consistently highlighted the positive relationship between political stability and remittance flows. For instance, Adams Jr and Cuecuecha [38] found that higher levels of political stability in the recipient country are associated with increased remittances. Political stability fosters confidence in the safety of investments and encourages migrants to send more money back home. Conversely, political instability and conflict have been shown to have a detrimental effect on remittance flows. McKenzie and Rapoport [39] found that political instability in the home country of migrants can lead to a reduction in remittances. Conflict and instability create uncertainty, making migrants hesitant to send money to regions experiencing turmoil. Studies have also explored the impact of political transitions on remittances. Hanson and Woodruff [40] found that remittances may increase during periods of political transition as migrants contribute to economic stability and recovery in their home countries. Some research suggests that political stability can serve as a moderating factor in the relationship between other variables and remittances. For instance, Böhme and Thiele [41] found that the positive impact of political stability on remittances is stronger in countries with higher income inequality. Studies demonstrate that political stability plays a crucial role in shaping remittance behavior. Stable political environments enhance confidence and encourage migrants to send more money home, contributing to economic stability and development. Thus, based on the above literature, the hypothesis is:

H_3: *There is a long-run and short-run impact of Political stability on remittance in South Asian countries.*

Employment abroad has consistently been identified as a primary driver of remittances. Migrants who secure employment opportunities in foreign countries often send a portion of their earnings back to their home countries to support their families and contribute to their economies. Amuedo-Dorantes and Pozo [42] found that remittances are positively associated with employment among migrants. Labor market conditions in both host and home countries can significantly influence remittance behavior. For example, Bollard et al. [43] studied remittances in the Pacific region and found that labor migration patterns and remittances are closely linked to employment opportunities and income levels in both sending and receiving countries. Research has also explored the impact of employment on remittance flows in developing countries. McKenzie and Rapoport [39] found that improvements in labor market conditions in sending countries can lead to increased remittance flows. When job opportunities and income levels rise, migrants may be more inclined to send money back to their home countries. The stability of employment and income levels in host countries is crucial to influencing remittance behavior. Durand et al. [44] highlighted that migrants are more likely to send remittances when they have stable employment and higher income prospects in their host countries. Literature suggests the fundamental role of employment in driving remittance flows. Migrant workers who secure employment opportunities in foreign countries often serve as a vital source of financial support for their families and contribute significantly to their home country's economy through remittances. Labor market dynamics, job opportunities, and income levels in both sending and receiving countries all play pivotal roles in shaping remittance behavior. Thus, based on the above literature, the hypothesis is:

H_4: *There is a long-run and short-run impact of employment on remittance in South Asian countries.*

Several studies have explored the relationship between the inflation rate and remittances in developing countries. Chami et al. [33] found that a higher inflation rate in the recipient country tends to reduce the real value of remittances, which can affect the purchasing power of recipients. As a result, remittances may not fully cover rising living costs when inflation is high. The relationship between inflation and exchange rates can also impact remittance behavior. Cerrutti and Pessino [45] examined this relationship and found that high inflation rates can lead to exchange rate depreciation, which can, in turn, affect the value of remittances when converted to the local currency. Conversely, some studies suggest that high inflation rates in the sender's home country may motivate migrants to send more remittances. As the cost of living rises, migrants may increase their remittances to help their families cope with increased expenses [34]. Furthermore, remittances can serve as a hedge against the negative effects of inflation in recipient countries. When inflation erodes the value of local currency, remittances received in foreign currency can help households maintain their purchasing power. Gani [46] found that remittances can act as an inflation buffer in countries with high inflation rates. High inflation rates can also influence the investment choices of remittance recipients. Research by Beja Jr and Yap Jr [47] suggests that in the face of inflation, remittance-receiving households may choose to invest in assets that offer protection against rising prices, such as real estate, rather than immediately consuming remittances. Studies suggest that the inflation rate can have various impacts on remittance behavior. High inflation in the recipient country may reduce the real value of remittances, affecting the ability of recipients to cover rising living costs. The relationship between inflation, exchange rates, and investment decisions can all influence the volume and direction of remittance flows. Therefore, based on the above literature, the hypothesis is:

H_5: *There is a long-run and short-run impact of employment on remittance in South Asian countries.*

3. Research Methodology

This study uses panel data to estimate the impact of digitalization, exchange rates, political stability, employment, and inflation rates on remittances in the short and long term in three South Asian countries: India, Pakistan, and Bangladesh.

$$REMi_t = \alpha_0 + \beta_1 DGT_{it} + \beta_2 EXC_{it} + \beta_3 PST_{it} + \beta_4 EMP_{it} + \beta_5 INF_{it} + \varepsilon_{it}$$

Where REM indicates the remittance of a country and is defined as the supply of funds from citizens of a country living abroad, macroeconomic indicators consist of exchange rate (EXC), employment (EMP), and inflation (INF). Macro-institutional variables consist of political stability (PST). Digitalization (DGT) is measured by the number of mobile phone users per hundred. The main reason for using panel data is that it measures the impact on a group rather than individual units. Moreover, panel data reduces the problem of heteroscedasticity, and the issue of the non-availability of long-term data is particularly relevant for developing countries and repeated cross-sectional observations. This study is strictly based on a heterogeneous panel data technique known as panel-ARDL. This is an econometric technique for estimating and assessing the long-run and short-run relationships between variables. The integration of lagged values of both the dependent and independent variables is possible with ARDL, capturing the dynamic nature of economic interactions [48]. This is critical for researching variables that display persistence and dependency. Because of its capacity to handle co-integration, dynamic connections, endogeneity, and non-stationarity, ARDL is useful in econometrics [49].

The simplified ARDL (p, q, q, …, q) model is specified as:

$$Y_{it} = \sum_{j=1}^{p} \delta_i Y_{i,t-j} + \sum_{j=0}^{q} \beta' X_{i,t-j} + \varphi_i + \varepsilon_{it} \tag{1}$$

Where Yit is the dependent variable, $(X'_{it})'$ is a vector that is permitted AR (0) or AR(1) or cointegrated, δ_I id represents the coefficient of the lagged dependent variables called scalars; β_{ij} are the coefficients for the independent variables; φ_i shows the unit-specific fixed effect; I, …, N; t=1, 2, 3, …, T; p, q are optimal lag orders; ε_{it} shows the residual term.

The revised ARDL (p, q, q, q, …, q) error correction model is specified as

$$\Delta Y_{it} = \theta_i [Y_{it-1} - \lambda' X_{it}] + \sum_{j=1}^{p-1} \xi_{ij} \Delta Y_{it-j} + \sum_{j=1}^{p-1} \beta_{ij} \Delta X_{it-j} + \varphi_i + \varepsilon_{it} \tag{[(2)}$$

Where θ_i is the – (1- δ_i) shows the group-specific speed of adjustment coefficient (expected that θ_i<0), λ'_I is the vector of long-run relationships, ECT is [Y_{it-1}- $\lambda' X_{i,t}$] is the error correction term representing the long-run information in the model, term and ξ_{it} and β'_{ij} are the short-run dynamic coefficients.

Based on the above model, *y* is remittance, a dependent variable including both the lag and difference values for short-run and long-term estimations. While *x* shows the set of independent variables, including macroeconomic factors, macro institutional factors, and digitalization, with their lags and difference values.

To detect and quantify co-movement connecting variables at different timescales, this study uses the continuous wavelet transform (CWT) approach [50]. Wavelet coherence is a statistical approach for analyzing the coherence between two time and cross-section panels with varying scales or frequencies [51]. Because of its capacity to provide insights into time-varying relationships and patterns between two variables, the wavelet coherence model has grown in popularity across various domains. Wavelet coherence enables the investigation of correlations between two time series at different scales or frequencies [52]. This is essential for understanding how the relationship between variables changes over time and across different frequency components. Many real-world phenomena demonstrate changing, dynamic relationships. The wavelet coherence model can illustrate how the strength and type of a relationship between two variables change over time, allowing dynamic patterns to be identified [53].

The CWT approach contains both frequency and time components, having zero mean. The major advantage of CWT is that it can be characterized by localizing CWT in time (Δt) and in frequency ($\Delta\omega$), or in both. Wavelet has two properties - scaling and shifting - that can be modified to create "daughter" wavelets. The continuous wavelet transform (CWT) is defined as the integral over all time of the signal multiplied by scaled, shifted versions of the wavelet function ψ (*scale, position, time*):

$$C(scale, position) = \int_{-\infty}^{\infty} x_t \psi (scale, position, t) dt$$

In the context of CWT analysis, let C represent the wavelet coefficient and t denote time. To analyze both high and low frequencies of a signal, the wavelet transform employs a fundamental function known as the mother wavelet, which is subjected to scaling and shifting. Scaling a wavelet involves expanding or compressing it, while shifting entails advancing or delaying it. In this paper, we rely on the versatile approach mentioned, specifically in the form of wavelet coherence. Wavelet coherence quantifies the coherence between two time series within a bivariate model.

The macroeconomic variables are used as dependent and independent variables, and the data is collected from the WDI database by the World Bank for the period of 2003 to 2022.

4. Result and Discussion

4. 1. Pre-estimation Results

For empirical analysis, the study employs the panel ARDL dynamic method to investigate the impact of digitalization, exchange rate, political stability, employment, and inflation rate on remittance in the short and long run in three South Asian countries: India, Pakistan, and Bangladesh. Furthermore, statistical assessments with a theoretical and conceptual discussion of the results are adopted to address the research hypotheses. In addition to the empirical outcomes, the study includes descriptive statistics of the variables used and a diagnostic test for the best-fit models.

Table 1.
Descriptive Statistics.

Variable	Variable Name	Obs.	Mean	Std. Dev.	Min	Max
REM	Personal remittances, received (% of GDP)	60	5.276298	2.303556	2.601088	10.58793
DGT	Internet users per 100 inhabitants	60	13.25873	12.2033	0.1638777	49.21456
EXC	Exchange rate	60	74.96249	38.3025	39.4	192.45
PST	Political Stability and Absence of Violence/Terrorism: Estimate	60	-1.533945	0.603783	-2.810035	-0.5686082
EMP	Employment to population ratio, 15+, total (%) (modeled ILO estimate)	60	50.91795	3.467239	43.253	56.019
INF	Inflation, GDP deflator (annual% %)	60	7.065428	4.000682	0.9221633	27.85074

Sources: World Development Indicators (WDI).

Table 1 shows that personal remittances as a percentage of GDP (REM) have a mean of 5.28% with a relatively low standard deviation of 2.30%, indicating moderate variation. Internet users per 100 inhabitants (DGT) exhibit greater variability, with a mean of 13.26 and a substantial standard deviation of 12.20. Exchange rates (EXC) have a mean of 74.96 and a notable standard deviation of 38.30, suggesting a wide range of exchange rate values. Political stability (PST) is characterized by a mean of -1.53 and a relatively low standard deviation of 0.60, suggesting limited variation. The employment-to-population ratio (EMP) averages at 50.92%, with a standard deviation of 3.47, indicating relatively stable employment patterns. Finally, inflation (INF) displays a mean of 7.07% and a standard deviation of 4.00%, signifying some variability in annual inflation rates.

Table 2.
Metrix Correlation.

Variables	PST	EMP	INF	DGT	EXC
PST	1.0000				
EMP	-0.0259	1.0000			
INF	-0.2739	0.0542	1.0000		
DGT	0.3931	-0.2916	-0.0673	1.0000	
EXC	-0.5955	-0.0504	0.1715	0.0664	1.0000

The correlation matrix provides insight into the relationships between several variables in Table 2, including political stability (PST), employment-to-population ratio (EMP), inflation (INF), internet users per 100 inhabitants (DGT), and exchange rate (EXC). Each variable's correlation with itself is 1, as expected. Notably, there is a moderate negative correlation between PST and INF, implying that as political stability increases, inflation tends to decrease. Additionally, PST exhibits a strong negative correlation with EXC, indicating that as political stability rises, the exchange rate tends to decline. Conversely, there is a moderately positive correlation between PST and DGT, suggesting that increased political stability corresponds to higher internet usage. In contrast, EMP and INF display only weak correlations with other variables, indicating a lack of strong linear relationships.

Table 3.
Unit Root Test.

Variable	I (0)	1st Difference
REM	Non-Stationary	Stationary
DGT	stationary	N/A
EXC	Non-stationary	Stationary
PST	Non-stationary	Stationary
EMP	stationary	N/A
INF	Non-stationary	Stationary

The above Table 3 shows that REM, EXC, INF, and PST are at a stationary level; however, DGT and EMP are first-differenced, so the result of the unit root test provides the level of confidence for the application of panel ARDL for estimation [54, 55]. After conducting the unit root test, the selection of the optimal lag is based on the most common lag for each variable and is used to represent the lags in the model, such as (1, 0, 0, 0), to avoid issues related to degrees of freedom. Following the selection of the optimal lag, Padroni's cointegration test is applied to identify long-run cointegration among the variables [56, 57]. Cointegration is established based on the statistical significance of the long-run coefficients and the error correction term.

Table 4.
Cointegration.

Test Stats.	Panel	Group
v	0.2487	.
rho	0.8618	1.586
t	-1.241	-1.412
adf	5.068	6.332

In the above two sets of cointegration results, the study finds that the long-run relationship among the variables used for estimation, as the null hypothesis of no-cointegration, is rejected at the 1% level for panel and group statistics.

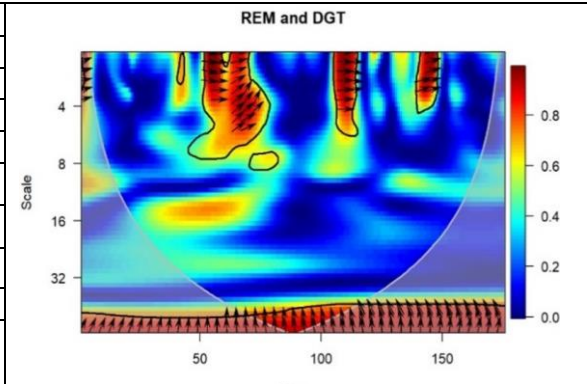### 4.2. Post-estimation Results

Before proceeding to estimation, the study employs Hausman test criteria for the selection of PMG or MG estimation. The rule of thumb depends on the probability value; if the p-value of the Hausman test is greater than 5% level of significance, PMG is the most suitable for estimation. The study applies the above criteria. Furthermore, two different sets of regressors are used in each estimation to avoid the issue of degrees of freedom.

Table 5.
Impact of Digitalization on Remittance.

D.REM	Coef.	Std. Error	z	P>|z|
LR				
DGT	0.7855321	1.889998	0.42	0.678
ECT	-0.3336256	0.1111137	-3.00	0.003
SR				
DGT (D1)	-0.8575504	0.9396518	-0.91	0.361
_cons	0.5621053	0.93444	0.60	0.547
Pooled Mean Group Estimation: Error				
Number of obs. = 60				
Number of groups = 3				

Table 5 shows the coefficient of Digitalization (DGT) is insignificant in the long run as well as in the short run. However, the coefficient of ECT is significant, indicating that some impact of an adjustment exists with the change in the structural policy of the country. The result can be examined through wavelet coherence analysis, which indicates that in the short run, the effect of DGT is in-phase (positively correlated) with REM, showing that REM follows the changes in DGT, which means DGT plays a leading role in the short run. However, in the long run, the findings are inconclusive. The insignificance of the coefficient of Digitalization (DGT) in both the short run and long run suggests that, within the context of the study or analysis, there is no robust statistical evidence to support the idea that Digitalization directly impacts REM (Remittances). The result opposes the empirical evidence, provided by Bettin et al. [25] which indicates that the volume of remittances tends to increase in correspondence with a greater density of internet users. There may be several factors that could contribute to this result, including the complexity of the relationship between digitalization and remittances, potential issues with causality, the size of the sample, model specification, endogeneity, time lags, and the presence of omitted variables.

However, the result also introduces a new dimension with the wavelet coherence analysis, which indicates that in the short run, Digitalization (DGT) and remittances (REM) are positively correlated (in-phase), suggesting that changes in digitalization lead to corresponding changes in remittances in the short term. The result aligns with some findings in previous research that have explored the relationship between technology adoption and remittance flows. For instance, a study by Xing et al. [58] found that an increase in digital financial services, which can be associated with digitalization, was linked to a short-term surge in remittances in certain countries. This is consistent with the notion that as digitalization becomes more accessible, it can facilitate remittance transactions and lead to short-term increases in remittance inflows. However, it is important to note that the long-term relationship between digitalization and remittances remains insignificant, as indicated in the results. This suggests that while digitalization may influence short-term fluctuations in remittance flows, its overall impact on remittances may be limited over extended periods.

Table 6.
Impact of Exchange Rate on Remittance.

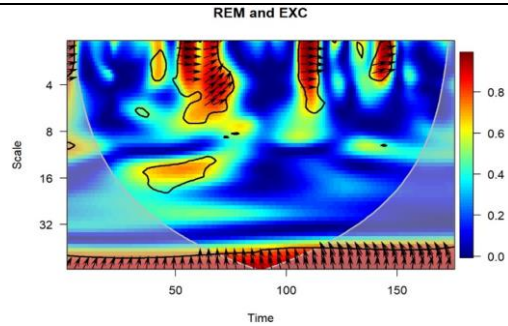| D.REM	Coef.	Std. Error	z	P>|z|
LR				
EXC	0.0311278	0.0060447	5.15	0.000
ECT	-0.3112824	0.1316278	-2.36	0.018
SR				
EXC (D1)	0.0841079	0.0794501	1.06	0.290
_cons	0.4939047	0.12177	4.06	0.000
Pooled Mean Group Estimation: Error				
Number of obs. = 60				
Number of groups = 3				

REM and EXC

Table 6 shows the coefficient of exchange rate (EXC) significant in the long run as well as in the short run. The coefficient of ECT is significant and identifies the impact of an adjustment that exists with the change in the monetary policy of the country. The result is further elaborated through wavelet coherence analysis, which indicates that in the short run, the effect of EXC is in-phase (positively correlated) with REM, and furthermore, REM follows the changes in EXC, which means EXC plays a leading role in the short run. However, in the long run, the finding is insignificant.

This result suggests that changes in the exchange rate have both short-term and long-term impacts on remittances (REM). Previous literature has often discussed the significance of exchange rates in influencing remittances. For example, a study by Chami et al. [33] found that exchange rate movements can affect the value of remittances, and this relationship can persist over time. This result implies that there is a long-term relationship between exchange rates and remittances that adjusts over time, possibly due to changes in monetary policies. Previous research has discussed the role of macroeconomic policies, including monetary policies, in influencing both exchange rates and remittances. The ECT signifies that deviations from the long-term equilibrium between exchange rates and remittances are corrected over time.

The result from the wavelet coherence analysis, which shows that in the short run the effect of the exchange rate (EXC) is positively correlated (in-phase) with remittances (REM), and that REM follows the changes in EXC, suggests a dynamic and short-term relationship. This finding aligns with the study of Mohapatra and Ratha [59] who found evidence that exchange rate movements can significantly affect remittance flows in the short run. Changes in exchange rates can influence the timing and amount of remittances sent by migrants. This is consistent with the idea that, in the short run, fluctuations in exchange rates can lead to adjustments in remittance behavior, as migrants respond to changing economic conditions and exchange rate movements. However, the result also notes that, in the long run, the relationship between EXC and REM becomes insignificant. This aligns with the notion that, while short-term fluctuations in exchange rates may lead to adjustments in remittance behavior, the long-term determinants of remittances are influenced by a wider range of factors, such as economic development, migration patterns, and institutional factors. Therefore, the effect of exchange rates on remittances may diminish or become less significant when considering a longer time horizon.

Table 7.
Impact of Political Stability on Remittance.

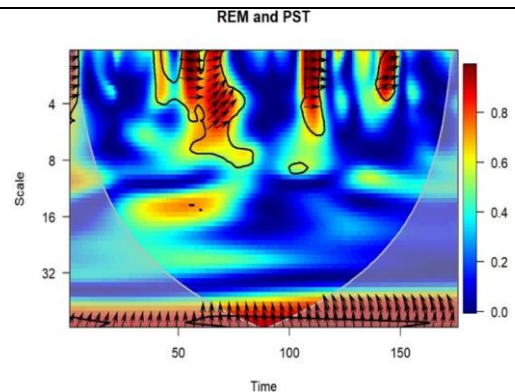| D.REM	Coef.	Std. Err	z	P>|z|
LR				
PST	-0.5875862	0.6285871	-0.93	0.350
ECT	-0.2987765	0.1611351	-1.85	0.064
SR				
PST (D1)	0.7368227	0.8047337	0.92	0.360
_cons	1.0963	0.2637096	4.16	0.000
Pooled Mean Group Estimation: Error				
Number of obs. = 60				
Number of groups = 3				

REM and PST

Table 7 shows that the coefficient of political stability, a measure of institutional quality (PST), is insignificant in both the short run and the long run. The coefficient of ECT is significant at the 10% significance level, indicating that an impact of adjustment exists with changes in macro-institutional policy in the country. The result is further elaborated through wavelet coherence analysis, which indicates that in the short run, the effect of PST is in-phase (positively correlated) with REM, and furthermore, REM follows the changes in PST, meaning PST plays a leading role in the short run. However, in the long run, the finding is insignificant.

The finding that PST is insignificant in both the short and long run is consistent with some previous research. It suggests that, within the context of the study, political stability may not directly impact remittances in a statistically significant way. This aligns with studies of Adams Jr and Cuecuecha [38], which found that political stability alone might not be a primary driver of remittance flows. The significant ECT suggests that changes in macro-institutional policy in the

country can lead to adjustments in the relationship between political stability (PST) and remittances (REM). This corresponds to prior research highlighting the role of policy changes in influencing remittance behavior. For instance, Amuedo-Dorantes and Pozo [42] discussed how changes in immigration and labor market policies can affect remittance flows.

The wavelet coherence analysis reveals a positive correlation (in-phase) between PST and REM in the short term, suggesting that during shorter time intervals, changes in political stability can lead to corresponding changes in remittances. This short-term positive correlation aligns with the study of Gubert [60] who found that improvements in political stability and governance in countries of origin can result in increased remittance inflows. The finding of insignificance in the long run suggests that the impact of political stability on remittances may diminish or become less clear over extended periods. This observation corresponds with studies of Docquier and Rapoport [61] which emphasizes that while political and institutional factors can influence remittance decisions, they may not have a sustained effect in the long term, with other factors coming into play.

Table 8.
Impact of Employment on Remittance.

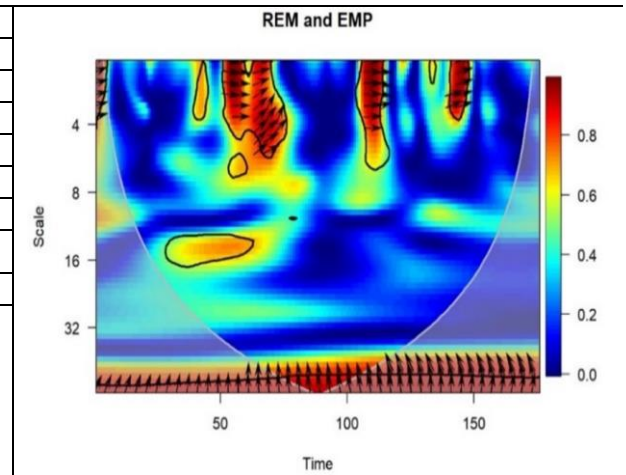| D.REM	Coef.	Std. Err	z	P>|z|
LR				
EMP	-0.5875862	0.6285871	-0.93	0.350
ECT	-0.2987765	0.1611351	-1.85	0.064
SR				
EMP (D1)	0.7368227	0.8047337	0.92	0.360
_cons	1.0963	0.2637096	4.16	0.000
Pooled Mean Group Estimation: Error				
Number of obs = 60				
Number of groups = 3				

Table 8 shows the coefficient of employment (EMP) is insignificant in both the short run and the long run. The coefficient of ECT is significant at the 10% significance level, indicating that an impact of adjustment exists with changes in macroeconomic policy in the country. The results are further elaborated through wavelet coherence analysis, which indicates that in the short run, the effect of EMP is in-phase (positively correlated) with REM, and furthermore, REM follows changes in EMP, suggesting that EMP plays a leading role in the short run. However, in the long run, the findings are insignificant.

The finding that employment (EMP) is insignificant in both the short run and the long run regarding its direct impact on remittances aligns with some previous research. This suggests that, within the context of the study, employment status alone may not have a statistically significant effect on remittance behavior. This finding resonates with studies of Yang [62], which found that while employment abroad is a common reason for remittances, its direct impact may not always be statistically significant. The significant Error Correction Term (ECT) suggests that changes in macroeconomic policy in the country can lead to adjustments in the relationship between employment (EMP) and remittances (REM). This corresponds to previous research emphasizing the role of economic policies, such as exchange rate policies and labor market regulations, in influencing remittance behavior. For example, Ratha and Shaw [29] discussed how labor market policies can affect remittance flows.

The wavelet coherence analysis finding of a positive correlation (in-phase) between EMP and REM in the short run, indicating that changes in employment have an immediate impact on remittances, aligns with the study of Gammeltoft [63] who have shown that variations in employment status and income abroad can lead to immediate adjustments in remittance behavior, particularly when migrants experience changes in job opportunities. The finding of insignificance in the long run suggests that, while employment plays a leading role in short-term remittance decisions, its influence may diminish or become less clear over extended periods. This observation is consistent with research by De Haas [64], which highlights that employment alone might not be the sole determinant of remittance behavior in the long term. Factors such as social networks and migration intentions can also influence remittances.

Table 9.
Impact of Inflation on Remittance.

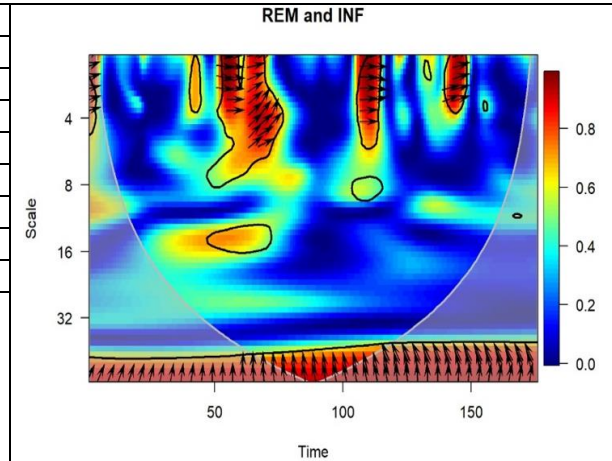| D.REM	Coef.	Std. Err	z	P>|z|
LR				
INF	0.6993839	0.2790278	2.51	0.012
ECT	-0.2645125	0.2043838	-1.29	0.196
SR				
INF (D1)	-0.3448403	0.1327932	-2.60	0.009
_cons	0.7199542	0.3165593	2.27	0.023
Pooled Mean Group Estimation: Error				
Number of obs. = 60				
Number of groups = 3				

Table 9 shows that the coefficient of inflation (INF) is significant in the short run as well as in the long run. The coefficient of ECT is insignificant, indicating that no impact of adjustment exists with changes in macroeconomic policy in the country. The results are further elaborated through wavelet coherence analysis, which indicates that in the short run, the effect of INF is in-phase (positively correlated) with REM, and furthermore, REM follows the changes in EMP INF, which means INF plays a leading role in the short run. However, in the long run, the findings are insignificant.

The finding that inflation (INF) is significant in both the short run and the long run, implying that it has a direct and lasting impact on remittances, aligns with some previous research. Inflation can erode the value of remittances, affecting the purchasing power of recipients in the home country. This is consistent with studies of Adams Jr and Cuecuecha [38], which discussed the impact of inflation on the real value of remittances. The results indicating the insignificance of the Error Correction Term (ECT) suggest that changes in macroeconomic policy may not lead to immediate adjustments in the relationship between inflation (INF) and remittances (REM).

The wavelet coherence finding of a positive correlation (in-phase) between INF and REM in the short run, indicating that changes in inflation have an immediate impact on remittances, aligns with prior research. Studies of Cebula and Chevlin [65] have shown that remittances can be influenced by inflation, especially when migrants and recipients seek to preserve the real value of remittance transfers during periods of rising prices. The finding of insignificance in the long run suggests that while inflation may play a leading role in short-term remittance decisions, its sustained influence on remittances may wane over extended periods. This observation corresponds to research by Chami and Barajas (2013), which emphasized that remittance behavior can be driven by various factors, including economic stability, employment conditions, and exchange rates, with the impact of inflation potentially diminishing over time.

5. Conclusion and Policy Implications

The study aimed to examine how digitalization, exchange rates, political stability, employment, and inflation rates have influenced remittances in the short and long term across three South Asian countries: India, Pakistan, and Bangladesh, from 2003 to 2022. Using panel ARDL and wavelet techniques, the study found the influence of key economic and institutional factors on remittances (REM) in both the short and long run. Digitalization (DGT) is found to be insignificant in both time horizons, suggesting no direct and lasting impact on REM. However, in the short term, DGT demonstrates a positive correlation with REM, indicating a potential short-term role. Exchange rate (EXC) emerges as a significant driver, impacting REM in both the short and long run, with short-term wavelet coherence analysis confirming its leading role in the short run. Political stability (PST) appears to be less influential, as its coefficient remains insignificant in both time frames, though it exhibits a short-term correlation with REM. Similarly, employment (EMP) shows insignificance in both the short and long run, but it demonstrates a short-term leading role in the wavelet. In contrast, inflation (INF) significantly affects REM in both time frames, with short-term analysis confirming its short-term leading role. The policy implications drawn from these results suggest a nuanced approach to enhancing and managing remittance flows. Digitalization's short-term influence on remittances highlights the importance of facilitating digital payment channels, particularly during economic crises. Exchange rate stability is crucial for predictable remittance inflows, emphasizing the need for exchange rate management policies. Political stability, while not a long-term driver, indicates that efforts to maintain stability can support remittance flows in times of uncertainty. The short-term correlation between employment and remittances underscores the significance of policies promoting employment opportunities for migrants abroad. Inflation's impact in both the short and long run calls for inflation control measures. In general, the results highlight the role of financial inclusion in remittances. While digitalization offers short-term benefits, exchange rate stability and inflation protection are crucial for long-term remittance resilience. Policies should prioritize digital access, transparent exchange rates, and inflation-protected financial products to empower recipients. Financial inclusion measures also enhance economic stability amid short-term fluctuations tied to political stability and employment changes.

References

[1] S. H. Lee, J. Levendis, and L. Gutierrez, "Telecommunications and economic growth: An empirical analysis of sub-Saharan Africa," *Applied Economics,* vol. 44, no. 4, pp. 461-469, 2012. https://doi.org/10.1080/00036846.2010.508730

[2] Š. Bojnec and I. Fertő, "Broadband availability and economic growth," *Industrial Management & Data Systems,* vol. 112, no. 9, pp. 1292-1306, 2012. https://doi.org/10.1108/02635571211278938

[3] C. M. Buch and A. Kuckulenz, "Worker remittances and capital flows to developing countries," *International Migration,* vol. 48, no. 5, pp. 89-117, 2010.

[4] S. E. Mohamed, "Workers' remittances and growth in MENA labor exporting countries," International Network for Economic Research Working Paper No. 10, 2009.

[5] World Bank, "Remittances to developing countries decline for second consecutive year," Press Release No. 2017/218/DEC, 2017.

[6] H. Lopez, M. Bussolo, and L. Molina, "Remittances and the real exchange rate," World Bank Policy Research Working Paper No. 4213, 2007.

[7] S. Bracking, "Sending money home: Are remittances always beneficial to those who stay behind?," *Journal of International Development: The Journal of the Development Studies Association,* vol. 15, no. 5, pp. 633-644, 2003.

[8] J. Ahmed, M. Mughal, and I. Martínez-Zarzoso, "Sending money home: Transaction cost and remittances to developing countries," *The World Economy,* vol. 44, no. 8, pp. 2433-2459, 2021.

[9] K. B. Ajide and O. Y. Alimi, "Political instability and migrants' remittances into sub-Saharan Africa region," *GeoJournal,* vol. 84, no. 6, pp. 1657-1675, 2019.

[10] Ö. Bilgili, "Economic integration to send money back home?," *Journal of Immigrant & Refugee Studies,* vol. 13, no. 4, pp. 379-400, 2015.

[11] N. Williams and M. S. Pradhan, "Political conflict and migration: How has violence and political instability affected migration patterns in Nepal?," 2008.

[12] D. Hordofa, "Impacts of external factors on Ethiopia's economic growth: Insights on foreign direct investment, remittances, exchange rates, and imports," *Heliyon,* vol. 9, no. 12, p. e22847, 2023.

[13] A. Shera and D. Meyer, "Remittances and their impact on economic growth," *Periodica Polytechnica Social and Management Sciences,* vol. 21, no. 1, pp. 3-19, 2013.

[14] M. Van Klaveren and K. Tijdens, "Job insecurity in times of relocation and crisis: Workers in multinational enterprises and domestic firms compared," presented at the Paper 31st International Labour Process Conference (ILPC), New Brunswick, March (pp. 18-20), 2013.

[15] D. A. Singer, "Migrant remittances and exchange rate regimes in the developing world," *American Political Science Review,* vol. 104, no. 2, pp. 307-323, 2010.

[16] C. P. Ball, C. Lopez, and J. Reyes, "Remittances, inflation and exchange rate regimes in small open economies 1," *The World Economy,* vol. 36, no. 4, pp. 487-507, 2013.

[17] P. K. Narayan, S. Narayan, and S. Mishra, "Do remittances induce inflation? Fresh evidence from developing countries," *Southern Economic Journal,* vol. 77, no. 4, pp. 914-933, 2011.

[18] Y. Chen, A. Prati, J. Montgomery, and R. Garnett, "A multi-task gaussian process model for inferring time-varying treatment effects in panel data," presented at the International Conference on Artificial Intelligence and Statistics (pp. 4068-4088). PMLR, 2023.

[19] X. Sun, H. Wang, and S. Mei, "Highway performance prediction model of International Roughness Index based on panel data analysis in subtropical monsoon climate," *Construction and Building Materials,* vol. 366, p. 130232, 2023.

[20] J. Aladwani, "Wavelet coherence and continuous wavelet transform: Implementation and application to the relationship between exchange rate and oil price for importing and exporting countries," *International Journal of Energy Economics and Policy,* vol. 13, no. 4, pp. 531-541, 2023.

[21] A. Nyanhete, "The role of international mobile remittances in promoting financial inclusion and development," *European Journal of Sustainable Development,* vol. 6, no. 2, pp. 256-256, 2017.

[22] S. P. Alvarez, P. Briod, O. Ferrari, and U. Rieder, "Remittances: How reliable are the data?," *Migration Policy Practice,* vol. 5, no. 2, pp. 42–46, 2015.

[23] D. Ratha, "Workers' remittances : An important development finance," World Development, 2003.

[24] S. Tabit and C.-E. Moussir, "Macroeconomic determinants of migrants' remittances: Evidence from a panel of developing countries," *International Journal of Business and Social Research,* vol. 6, no. 7, pp. 1-11, 2016. https://doi.org/10.18533/ijbsr.v6i7.969

[25] G. Bettin, A. F. Presbitero, and N. L. Spatafora, "Remittances and vulnerability in developing countries," *The World Bank Economic Review,* vol. 31, no. 1, pp. 1-23, 2017. https://doi.org/10.1093/wber/lhv053

[26] D. Rodima-Taylor and W. W. Grimes, "International remittance rails as infrastructures: Embeddedness, innovation and financial access in developing economies," *Review of International Political Economy,* vol. 26, no. 5, pp. 839-862, 2019. https://doi.org/10.1080/09692290.2019.1607766

[27] N. Emara and Y. Zhang, "The non-linear impact of digitization on remittances inflow: Evidence from the BRICS," *Telecommunications Policy,* vol. 45, no. 4, p. 102112, 2021. https://doi.org/10.1016/j.telpol.2021.102112

[28] V. Guermond, "Whose money? Digital remittances, mobile money and fintech in Ghana," *Journal of Cultural Economy,* vol. 15, no. 4, pp. 436-451, 2022. https://doi.org/10.1080/17530350.2021.2018347

[29] D. Ratha and W. Shaw, "South-South migration and remittances," *World Bank Working Paper,* vol. 105, pp. 1–10, 2007.

[30] J. Ahmed and I. Martínez-Zarzoso, "Do transfer costs matter for foreign remittances? A gravity model approach," *Economics,* vol. 10, no. 1, p. 20160004, 2016. https://doi.org/10.5018/economics-ejournal.ja.2016-4

[31] I. Schiopu and N. Siegfried, "Determinants of workers' remittances: Evidence from the European neighbouring region," ECB Working Paper No. 688, 2006.

[32] C. Freund and N. Spatafora, "Remittances, transaction costs, and informality," *Journal of Development Economics,* vol. 86, no. 2, pp. 356-366, 2008. https://doi.org/10.1016/j.jdeveco.2007.09.002

[33] R. Chami, C. Fullenkamp, and S. Jahjah, "Are immigrant remittance flows a source of capital for development?," *IMF Staff Papers,* vol. 52, no. 1, pp. 55-81, 2005.

[34] D. Yang, "Migrant remittances," *Journal of Economic Perspectives,* vol. 25, no. 3, pp. 129-152, 2011. https://doi.org/10.1257/jep.25.3.129

[35] A. M. Kandilov, A. Leblebicioğlu, and N. Petkova, "Interactions between legal and illegal immigration: Evidence from Russia's Quota system," *Journal of Economic Behavior & Organization,* vol. 73, no. 1, pp. 116-135, 2010.

[36] R. Faini, D. A. Jaeger, and D. N. Weil, "The returns to migration: The role of educational attainment," *World Bank Economic Review,* vol. 21, no. 2, pp. 227-246, 2007.

[37] A. Mitra and M. Murayama, "Exchange rate pass-through and inflation targeting in emerging market economies," *Journal of International Money and Finance,* vol. 51, pp. 82-103, 2015.

[38] R. H. Adams Jr and A. Cuecuecha, "Remittances, household expenditure and investment in Guatemala," *World Development,* vol. 38, no. 11, pp. 1626-1641, 2010.

[39] D. McKenzie and H. Rapoport, "Self-selection patterns in Mexico-US migration: The role of migration networks," *Review of Economics and Statistics,* vol. 92, no. 4, pp. 811-821, 2010.

[40] G. H. Hanson and C. Woodruff, *Emigration and educational attainment in Mexico. In Mexican immigration to the United States*. Chicago, IL: University of Chicago Press, 2003.

[41] M. H. Böhme and R. Thiele, "Does income inequality affect the strength of the link between income and migration?," *Zeitschrift für Wirtschaftsgeographie,* vol. 59, no. 3-4, pp. 151-165, 2015.

[42] C. Amuedo-Dorantes and S. Pozo, "Workers' remittances and the real exchange rate: a paradox of gifts," *World Development,* vol. 32, no. 8, pp. 1407-1417, 2004.

[43] A. Bollard, D. McKenzie, M. Morten, and H. Rapoport, *Remittances and the braindrain: Evidence from Microdata for Sub-Saharan Africa. In C. Ozden & M. Schiff (Eds.), Handbook on the economics of international migration*. Cheltenham, UK: Edward Elgar Publishing, 2011.

[44] J. Durand, W. Kandel, E. A. Parrado, and D. S. Massey, "International migration and development in Mexican communities," *Demography,* vol. 33, no. 2, pp. 249-264, 1996.

[45] M. Cerrutti and C. Pessino, "Inflation and nominalization: Exploring a negative relationship," *Journal of Development Economics,* vol. 92, no. 2, pp. 182-185, 2010.

[46] A. Gani, "Workers' remittances and economic growth: The role of output volatility," *Economics Letters,* vol. 104, no. 2, pp. 85-88, 2009.

[47] E. L. Beja Jr and D. B. Yap Jr, "What drives households to remit? Evidence from the 2007 survey on overseas Filipinos," *Asian Economic Journal,* vol. 25, no. 2, pp. 197-221, 2011.

[48] E. Nkoro and A. K. Uko, "Autoregressive distributed lag (ARDL) cointegration technique: Application and interpretation," *Journal of Statistical and Econometric Methods,* vol. 5, no. 4, pp. 63-91, 2016.

[49] M. Rahman and A. Islam, "Some dynamic macroeconomic perspectives for India's economic growth: Applications of linear ARDL bounds testing for co-integration and VECM," *Journal of Financial Economic Policy,* vol. 12, no. 4, pp. 641-658, 2020.

[50] Z. Jiang and S.-M. Yoon, "Dynamic co-movement between oil and stock markets in oil-importing and oil-exporting countries: Two types of wavelet analysis," *Energy Economics,* vol. 90, p. 104835, 2020. https://doi.org/10.1016/j.eneco.2020.104835

[51] A. Orhan, D. Kirikkaleli, and F. Ayhan, "Analysis of wavelet coherence: Service sector index and economic growth in an emerging market," *Sustainability,* vol. 11, no. 23, p. 6684, 2019. https://doi.org/10.3390/su11236684

[52] A. Grinsted, J. C. Moore, and S. Jevrejeva, "Application of the cross wavelet transform and wavelet coherence to geophysical time series," *Nonlinear Processes in Geophysics,* vol. 11, no. 5/6, pp. 561-566, 2004. https://doi.org/10.5194/npg-11-561-2004

[53] Z. Ye, C. Hu, L. He, G. Ouyang, and F. Wen, "The dynamic time-frequency relationship between international oil prices and investor sentiment in China: A wavelet coherence analysis," *The Energy Journal,* vol. 41, no. 5, pp. 251-270, 2020.

[54] M. H. Pesaran, Y. Shin, and R. P. Smith, "Pooled estimation of long-run relationships in dynamic heterogeneous panels," *The Econometrics Journal,* vol. 3, no. 2, pp. 1-31, 1997.

[55] S. Yamarik, M. El-Shagi, and G. Yamashiro, "Does inequality lead to credit growth? Testing the Rajan hypothesis using state-level data," *Economics Letters,* vol. 148, pp. 63-67, 2016.

[56] P. Pedroni, "Critical values for cointegration tests in heterogeneous panels with multiple regressors," *Oxford Bulletin of Economics and Statistics,* vol. 61, no. S1, pp. 653-670, 1999.

[57] P. Pedroni, "Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis," *Econometric Theory,* vol. 20, no. 3, pp. 597-625, 2004.

[58] Y. Xing, Y. B. Foo, and P. Leung, "Mobile money and remittances: The case of m-pesa and Sub-Saharan Africa," *Information Systems Research,* vol. 29, no. 4, pp. 995-1011, 2018.

[59] S. Mohapatra and D. Ratha, *Impact of the global financial crisis on migration and remittances. In R. C. Feenstra & A. M. Taylor (Eds.), Globalization in an age of crisis*. Chicago, IL: University of Chicago Press, 2010.

[60] F. Gubert, "Do migrants insure those who stay behind? Evidence from the Kayes area (Western Mali)," *oxford Development Studies,* vol. 30, no. 3, pp. 267-287, 2002.

[61] F. Docquier and H. Rapoport, "Migrants' remittances and economic development," *Nordic Journal of Political Economy,* vol. 37, p. 4, 2012.

[62] D. Yang, "International migration, remittances and household investment: Evidence from Philippine migrants' exchange rate shocks," *The Economic Journal,* vol. 118, no. 528, pp. 591-630, 2008.

[63] P. Gammeltoft, "Remittances and other financial flows to developing countries," *International Migration,* vol. 40, no. 5, pp. 181-211, 2002.

[64] H. De Haas, "Remittances, migration and social development: A conceptual review of the literature," *Social Policy and Society,* vol. 6, no. 4, pp. 481-492, 2007.

[65] R. J. Cebula and L. K. Chevlin, "A note on international remittances and the real income of the recipient economy," *Journal of International Economics,* vol. 11, no. 1, pp. 151-155, 1981.