

## Abstract

This study examines the nonlinear impact of remittances on financial development (FD) in Egypt over the period 1980-2019 while controlling for other key determinants of FD. The paper utilizes a recently developed comprehensive index of FD and uses an Autoregressive Distributed lag (ARDL) bounds testing approach to cointegration and a vector error-correction model to estimate the short- and long-run parameters of equilibrium dynamics. We find support for the complementarity hypothesis in the short run in which remittances have a statistically significant positive impact on FD. However, the results show that remittances have an inverted U-shaped impact on FD in the long run. In particular, remittances complement (substitute) FD below (above) a remittance-to-GDP ratio of 7.28 percent. This implies that in the long run remittances to Egypt hinder FD when received in large quantities. We also found that financial openness has a statistically significant positive impact on FD in the long run, while inflation impedes FD. Policies aimed at increasing the flows of remittances to Egypt should mitigate its potential adverse impact on financial development.

**Keywords:** ARDL; Bounds test; Egypt; Financial Development; Remittances; Threshold impact.

**JEL classification:** E44; F24; G20; C32.

## ملخص

تبحث هذه الدراسة في التأثير غير الخطي للتحويلات على التنمية المالية في مصر خلال الفترة 1980-2019 مع التحكم في المحددات الرئيسية الأخرى للتحويلات المالية. تستخدم الورقة فهرسًا شاملاً تم تطويره مؤخرًا للتنمية للتكامل المشترك ونموذج تصحيح الخطأ (ARDL) المالية ويستخدم نهج اختبار حدود الانحدار الذاتي الموزع المتجه لتقدير معلمات المدى القصير والطويل لديناميكيات التوازن. نجد دعمًا لفرضية التكامل على المدى القصير حيث يكون للتحويلات أثر إيجابي ذي دلالة إحصائية على التمويل المالي. ومع ذلك، تظهر النتائج أن على التنمية المالية على المدى الطويل. على وجه الخصوص، تكمل U التحويلات لها تأثير مقلوب على شكل حرف التحويلات (البديل) للتنمية المالية أدناه (أعلاه) التحويلات إلى-نسبة الناتج المحلي الإجمالي 7.28٪. وهذا يعني أن التحويلات المالية إلى مصر على المدى الطويل تعيق عملية التمويل عند استلامها بكميات كبيرة. وجدنا أيضًا أن الانفتاح المالي له تأثير إيجابي ذي دلالة إحصائية على التنمية المالية على المدى الطويل، في حين أن التضخم يعيق التنمية المالية. يجب أن تخفف السياسات التي تهدف إلى زيادة تدفقات التحويلات إلى مصر من تأثيرها السلبي المحتمل على التنمية المالية

## 1. Introduction

Remittances as a significant source of external finance, and financial development (FD), a multidimensional feature of a well-functioning financial system, have been consistently identified as key determinants of economic development. Understanding the nature of the relationship, complementarity/substitutability, between remittances and FD is of policy germaneness given the ample evidence on their role in promoting economic growth. Several studies found that the impact of remittances on economic growth is mediated by the level of financial development in the recipient country. For instance, Bettin & Zazzaro (2012) found that remittances promote economic growth only in countries with an efficient domestic banking system.

A growing literature has emerged to examine the impact of remittances on FD. Nonetheless, previous studies mostly assumed linearity in the impact of remittances on FD, which recent evidence has refuted (Akçay, 2020; Brown & Carmignani, 2015; Issahaku et al., 2017). It has been shown that failure to control for nonlinearity in a relationship could lead to biased estimates and unreliable inference and forecasts (Shin et al., 2014). Also, studies have shown that the macroeconomic impact of remittances could differ based on the size of remittances relative to GDP (Ruiz & Vargas-Silva, 2010). Based on this proposition, one could expect the impact of remittances on FD to vary depending on the size of the remittances received. In addition, the mixed findings of the previous studies regarding the direction of the impact of remittance on FD could indicate the existence of nonlinearities or threshold effects (Issahaku et al., 2017).

FD is a multidimensional concept that reflects various aspects that characterize a well-functioning financial system, including the depth (size and liquidity), access (ability to access financial services), efficiency (the ability of providing financial services at low cost) and stability. According to the World Bank (2020), FD occurs when financial instruments, markets, and intermediaries ease the effects of information about profitable investment opportunities, enforcement, and transactions costs and hence do a superior job at providing the main functions of the financial sector in the economy. Studies have shown that FD enhances economic growth, reduces poverty, and strengthens a country's resiliency through capital accumulation and technological progress (Beck et al., 2000; Bist, 2018; Valickova et al., 2013, 2015). FD also helps manage risks through

diversification by channeling funds, promoting information sharing, and improving resource allocation. In addition, FD fosters financial stability by helping to cushion the impact of shocks through deep and liquid financial systems via various financial instruments. By mobilizing unemployed funds, simplifying transactions, and attracting foreign investments, a well-developed financial system enhances the allocation of financial resources. Furthermore, developed financial institutions can make credit more accessible to the poor and vulnerable groups, reducing poverty and inequality, therefore enhancing development prospects and economic opportunity distribution (Donou-Adonsou & Sylwester, 2016). FD can also help small and medium-sized enterprises grow by providing them with access to finance

Similar to FD, there is considerable empirical evidence that if used efficiently, remittance inflows can increase the receiving country's welfare (Abduvaliev & Bustillo, 2020; Cazachevici et al., 2020). Remittances, for example, can boost economic growth by lowering output volatility, increasing physical and human capital investments (Dash, 2020), stabilizing the source of foreign currencies through countercyclical inflows, promoting financial sector development, and alleviating poverty among recipient households (Sharaf, 2014).

For decades, the Egyptian economy has been largely dependent on remittance inflows, as a source of foreign currency to finance its economic development needs. In 2021, official remittance inflows to Egypt reached an unprecedented level of 33 billion dollars, placing Egypt the fifth-largest recipient of remittances globally (*Migration and Development Brief*, 2021). Remittances are the largest source of foreign currency to Egypt, and they represent more than five times larger than revenues from the Suez Canal.

This paper contributes to the extant literature in two ways. Firstly, to the best of the authors' knowledge and to date, the current study is the first that examines the potential nonlinear impact of remittances on FD in Egypt. Secondly, this paper utilizes a recently developed comprehensive measure of FD, which captures the multidimensional aspects of the financial system. This index would overcome the shortcomings of the FD proxies used by earlier related studies.

The findings show that remittances have a statistically significant beneficial influence on FD in the short run while in the long run; remittances have an inverted U-shaped influence on FD.

The rest of the paper is organized as follows: Section 2 reviews the related literature. Section 3 presents the data and the empirical methodology. Section 4 presents the empirical results, which are then discussed in section 5, which also concludes the study.

## **2. Literature review**

Under the assumption of a linear relationship between remittances and FD, remittance inflows could have a positive or a negative influence on the recipient country's FD. On the one hand, according to the complementarity hypothesis, remittances positively affect FD. By expanding bank deposits, remittances augment access to credit and contribute to the stock market development (Aggarwal et al., 2011). On the other hand, the substitutability hypothesis asserts that remittances have a negative impact on FD because they act as an alternate source of funds other than credit, reducing demand for credit and thus impeding credit market development, particularly in recipient countries where the financial sector is less developed (Bettin et al., 2017).

Empirical evidence on the relationship between remittances and FD is inconclusive. While the findings of several studies support the complementarity hypothesis (e.g., Azizi, 2020; Kakhkharov & Rohde, 2020; Williams, 2016), other studies support the substitutability hypothesis (e.g., Bettin et al., 2017; Opperman & Adjasi, 2019). For example, Uddin & Sjö (2013) found that in the long run, remittances as a source of external finance are a substitute for using the domestic financial sector in Bangladesh during the period 1976–2011. In another study, using a two-step system GMM estimator over the period 2002–2014, Opperman & Adjasi (2019) found remittances a substitute for the formal banking system in sub-Saharan African countries. Using data on remittance flows to 109 developing countries during the period 1975–2007, Aggarwal et al. (2011) found a positive, significant, and robust link between remittances and FD as measured by the share of bank deposits and the ratio of bank credit to the private sector expressed as a percentage of GDP. In a panel study of 45 sub-

Saharan African countries, Williams (2016) found that remittances have a statistically significant positive impact on FD as measured by credit to the private sector to GDP ratio over 1970–2013. The author also found that democratic institutions do not mediate the effect of remittance on FD. In another cross-country study, Fromentin (2017) used two measures to proxy for FD, including domestic credit to the private sector and liquid liabilities of the financial system (M2), to analyze the dynamic impact of remittances on FD for emerging and developing countries over the period 1974-2014 by employing a Pooled Mean Group approach. The author found supportive evidence that remittances promote FD in the long and short runs, except for the low-income countries.

Using a dynamic panel GMM method, Kakhkharov & Rohde (2020) found evidence of a statistically significant robust positive nexus between remittances and FD in twenty-seven countries of the former Communist bloc during the period 1996 to 2013. In another panel study of 124 developing countries from 1990-2015, and using an instrumental variable-fixed effect model, Azizi (2020) found support for the complementary hypothesis in which remittances positively impact FD. The author used various measures for FD, including domestic credit to the private sector to GDP ratio, the ratio of bank deposits to GDP, credit to GDP, and the liquid liabilities to GDP. Using a panel cointegration approach, Basnet et al. (2021) examined the impact of worker remittances on financial sector development in five South Asian countries—Bangladesh, India, Nepal, Pakistan, and Sri Lanka for 1980–2017. The author found support for a positive and significant impact of remittances on credit to the private sector and liquid liabilities as a proxy for FD.

The empirical literature on the remittances-FD nexus is mostly dominated by panel/cross country studies, with few country-specific studies and implicitly assumes that this nexus is linear. For example, using an ARDL cointegration approach, Aslam & Sivarajasingham (2020) found that workers' remittances promote FD in Sri Lanka from 1975 to 2017. Recently, a growing number of studies have emerged to test the potential nonlinearity in the effect of remittances on FD. For instance, in a recent study, Kyobe et al. (2015) examined the relationship between remittance inflows and FD within a nonlinear framework in Jamaica from 1980 to 2017. Using the ARDL-bound testing approach to cointegration, the authors found support for the nonlinearity hypothesis in

which remittances substitute FD up to when remittances as a share of GDP reached a threshold point of 8.44 percent. After this threshold point, remittances start complementing FD. In another study, Akçay (2020) tested whether there is a nonlinear relationship between FD and remittances over the period 1980–2015 in Bangladesh. Using an ARDL model, the author found a robust nonlinear U-shaped relationship between FD and remittances, in which initially remittances hinder FD. However, after the threshold level, remittances enhance FD.

It is apparent from this brief review of the empirical literature that the impact of remittances on FD is a priori indeterminate. The mixed findings of the previous related studies could be attributed to the alternative econometric methodologies that are used, variations in the way FD is measured and differences in the periods under investigation. In addition, countries differ in terms of the stage of their economic development, institutional competency, economic structures, and applied macroeconomic policies. Hence, the nature of the impact of remittances on FD is expected to be country specific.

### **3. Data and methods**

This paper uses annual time series data over the period 1980–2019 to examine the potential nonlinear impact of remittance on FD in Egypt. The analyses also control for other determinants of FD, including inflation rate and financial openness. The data on FD is obtained from the financial development index database issued by the IMF, and the data on the other variables are drawn from the world development indicators. Several financial depth measures such as the ratio of private credit to GDP have been used in the empirical literature as proxies of FD. One limitation of such measures is that they neglect the complex multidimensional nature of FD. In the current study, we use a more comprehensive measure of financial development, the financial development index, which the IMF developed. This index captures the different aspects of the development of the financial system in terms of depth (size and liquidity), access (ability to access financial services), efficiency (ability to provide financial services at low cost) and stability. For more information about the composition of the financial development index, see Kyobe et al. (2015).

Table 1 presents descriptive statistics of the variables used in the empirical analysis, including the mean, standard deviation, minimum and maximum values.

**Insert Table 1 here**

**Insert Figure 1 here**

Figure 1 displays the evolution of personal remittance inflows as a percentage of GDP in Egypt over the period 1980 – 2020. It is evident from Figure 1 that remittance (as a % of GDP) have witnessed some degree of fluctuations over the study period, where it declined significantly from its highest level of 14.8% in the year 1992 to 3% in the year 2001, before rebounding back to reach 10.2% in 2018.

Following several earlier studies, such as (Akçay, 2020; Brown & Carmignani, 2015), we use the model presented in Equation (1) to examine the nonlinear impact of remittances on FD.

$$FD_t = \gamma_0 + \gamma_1 REM_t + \gamma_2 REM_t^2 + \gamma_3 INF_t + \gamma_4 FO_t + \varepsilon_t \quad (1)$$

Where  $FD_t$  is the financial development index,  $REM$  is the personal remittances received (as a % of GDP),  $INF_t$  is the annual rate of inflation,  $FO_t$  is the financial openness index. The potential nonlinear impact of remittances on FD is captured by including a quadratic remittance term among the explanatory variables. As evident in Equation (1), we also control for other key determinants of FD, including inflation rate and financial openness that are commonly used in the literature (Voghouei et al., 2011). High inflation rates are expected to have a detrimental effect on FD by creating uncertainty and lowering the real return on financial assets, which would discourage financial intermediation and the provision of credit. Also, high rates of inflation could induce banking crises. It has been shown that low and stable inflation helps achieve a deeper and more active financial sector (Bittencourt, 2011).

The existence of a long-run relationship, cointegration, between the variables in Equation (1) is tested using the bounds test for cointegration within an ARDL unrestricted error correction model. If cointegration exists between the variables, the analysis proceeds by estimating the long-run and short-run parameters of the equilibrium dynamics. The sign of the coefficients  $\gamma_1$  and  $\gamma_2$  indicate the nature of the remittance-FD nexus. If  $\gamma_1 > 0$  and  $\gamma_2 < 0$ , this would indicate an inverted U-shaped relationship

in which remittances positively impact FD up to a certain remittance threshold level, after which the impact becomes negative. In the case of an inverted U-shaped relation, the remittance threshold level that maximizes the effect of remittances on FD can be derived as in Equation (2).

$$\frac{\partial FD_t}{\partial REM_t} = \gamma_1 - 2\gamma_2 REM_t = 0 \rightarrow REM_{max} = \frac{\gamma_1}{2\gamma_2} \quad (2)$$

The model in Equation (1) can be presented in an ARDL framework as in Equation (3).

$$\begin{aligned} \Delta FD_t = & \gamma_1 + \sum_{i=1}^p \theta_{1i} \Delta FD_{t-i} + \sum_{i=1}^q \theta_{2i} \Delta REM_{t-i} + \sum_{i=1}^r \theta_{3i} \Delta REM_{t-i}^2 + \\ & \sum_{i=1}^s \theta_{4i} \Delta INF_{t-i} + \sum_{i=1}^t \theta_{5i} \Delta FO_{t-i} + \tau_1 FD_{t-1} + \tau_2 REM_{t-1} + \tau_3 REM_{t-1}^2 + \tau_4 INF_{t-1} + \\ & \tau_5 FO_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

In which  $\Delta$  is a first difference operator, p, q, r, s, t represent the optimal lag order determined based on any of the information criteria such as the Akaike information criterion (AIC), or the Schwarz information criterion (SBIC).

The error correction representation of the ARDL model presented in Equation (3) is exhibited in Equation (4).

$$\begin{aligned} \Delta FD_t = & \gamma_1 + \sum_{i=1}^p \theta_{1i} \Delta FD_{t-i} + \sum_{i=1}^q \theta_{2i} \Delta REM_{t-i} + \sum_{i=1}^r \theta_{3i} \Delta REM_{t-i}^2 + \\ & \sum_{i=1}^s \theta_{4i} \Delta INF_{t-i} + \sum_{i=1}^t \theta_{5i} \Delta FO_{t-i} + \phi ECT_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

The coefficient of the error-correction term  $\phi$ , reflects the speed of adjustment of FD, REM, REM<sup>2</sup>, INF, and FO to their long-run equilibrium, following any shock. This coefficient measures the proportion of the last period's disequilibrium corrected for in the current period. Dynamic stability requires this coefficient  $\phi$  to be negative and less than unity.

The ARDL bounds test uses an F-test for the joint significance of the coefficients of the lagged level variables in Equation (3) ( $H_0: \tau_1 = \tau_2 = \tau_3 = \tau_4 = \tau_5 = 0$ ) to test the existence of a long-run relationship between FD and personal remittances. Pesaran *et al.* (2001) provided lower and upper bound critical values for the F-statistic, as it does not



follow the standard F-distribution. Cointegration between the variables is established if the F- statistic exceeds the upper bound critical value.

The time series analyses routinely start with pre-testing all-time series for unit root to ensure non-spurious and time-invariant estimates. Also, although the bounds test for cointegration is not sensitive to the order of integration of the variables, it is only valid if none of the variables is integrated of an order greater than one. In this regard, we use two-unit root tests, the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) test and the Phillips–Perron (PP) test (Phillips & Perron, 1988). Three versions of both tests are used; one version allows for an intercept, and a second allows for an intercept and a deterministic trend, and a third version excludes both the intercept and the deterministic trend.

#### 4. Empirical results

Results of both the ADF and PP unit root tests of the variables in levels and first difference, reported in Table 2, show that all the variables are stationary at their first difference. This means that none of the variables is integrated of an order greater than one, which is a necessary condition for the validity of the cointegration bounds test.

**Insert Table 2 here**  
**Insert Table 3 here**

The Schwarz-Bayes information criterion (SBIC) is used to determine the optimal lag length of the ARDL model. The SBIC selected an ARDL (1,0,3,1,0) model. Table 3 presents the F-statistic of the ARDL bounds test for cointegration along with the 95% critical bounds. The results confirm the existence of a long-term relationship, cointegration, between FD, REM, REM<sup>2</sup>, FO, and INF since the F-statistic is greater than the upper bound of the critical value at the 5% significance level.

**Insert Table 4 here**

Table 4 presents the short-run and long-run coefficients of the estimated ARDL (1,0,3,1,0) model. The results show that the long-run coefficients of FO, INF, REM, and REM<sup>2</sup> are all statistically significant at the 1% significance level. In particular, estimates

of the long-run coefficients show that FO has a statistically significant long-run positive impact on FD, while the impact of INF on FD is negative. Of particular importance to the current study, results of the estimated long-run coefficients show that REM has an inverted U-shaped impact on FD. In particular, the coefficient of the linear term of remittance is positive (0.08), while the coefficient of the quadratic term of remittances is negative (-0.0036). The statistical significance of the coefficients of the linear and the quadratic terms of remittances suggests that the impact of remittances on FD in Egypt is nonlinear and has a tipping point. Based on the estimated model, this tipping point of the remittances-to-GDP ratio is estimated to be 7.28 percent. This means that remittances complement FD at any remittance-to-GDP ratio below 7.28 percent, while remittances substitute FD after a remittance-to-GDP ratio greater than 7.28 percent. This implies that remittance inflows hinder FD when received in large quantities. It should be noted that the estimated maximum point calculated from Equation (2) is within the data range of the analysis. Results of the estimated ARDL model show that remittances have a statistically significant positive impact on FD in the short run, which supports the complementarity hypothesis.

The estimated coefficient on the error-correction term is negative and is statistically significant, indicating the convergence in the variables' long-run dynamics. In particular, 25% of the last period's disequilibrium is corrected in the current period. This means that following a shock, it takes four years for FD, REM, FO, and INF to restore their long-run equilibrium relationship.

Several diagnostic tests, whose results are presented in panel (C) of Table 4, are conducted to check the validity of the estimated ARDL (1,0,3,1,0) model. These tests include the Lagrange multiplier (LM) test of residual serial correlation, Ramsey's RESET test for specification error, Jarque-Bera's normality test, and the Breusch-Pagan-Godfrey's heteroscedasticity test. These diagnostic tests show that the estimated ARDL (1,0,3,1,0) model does not suffer from heteroskedasticity, serial correlation, non-normality of the residuals, and specification error at the 5% significance level since all the p-values of the test statistics are greater than 5%. Results of the parameters stability diagnostics, displayed in Figure 2, which include the cumulative sum of recursive residuals (CUSUM) test and the cumulative sum of squares of recursive residuals (CUSUM of squares) test,

show that the estimated coefficients of the ARDL (1,0,3,1,0) model are stable at the 5% significance level.

**Insert Figure 2 here**

## **5. Discussion and conclusion**

In this study, we tested whether remittance inflows complement/substitute financial development (FD) in Egypt during the period 1980 to 2019 using a more comprehensive recent index for FD. Unlike most previous related studies, which implicitly assumed linearity in the remittances-FD nexus, the current study relaxed this assumption. It tested the existence of a nonlinear remittance impact on FD. The paper used an ARDL-bounds testing approach for cointegration, and the analyses controlled for other key determinants of FD, including inflation rate and financial openness.

The results show that the impact of remittances on FD is nonlinear and displays an inverted U-shape pattern in the long run. While in the short run, remittances have a statistically significant positive linear impact on FD. This indicates that the impact of remittances on FD is different in the long run when it is below or above a threshold level of remittances-to-GDP ratio, estimated to be 7.28 percent. In other words, remittances have a positive impact and hence complement FD at low remittance-to-GDP levels. In contrast, remittances have a negative impact at high levels and hence substitutes FD. These findings suggest that in Egypt, remittances promote FD only if received in small quantities in the long run.

These findings are in line with the findings of Esteves & Khoudour-Castéras (2011) and Issahaku et al. (2017), who identified an inverted U-shaped relationship between FD and remittances.

However, our findings are contrary to the findings of Akçay (2020), who found a nonlinear U-shaped relationship between FD and remittances over the period 1980–2015 in Bangladesh in which remittances substitute FD at low levels of remittances-to-GDP ratio while it complements FD when received in large quantities. Our findings also contradict the findings of Brown & Carmignani (2015), who used panel data on a large group of developing and emerging economies over the period 1970-2009, Brown & Carmignani (2015) and found that remittances exert a nonlinear U shaped impact on bank credit which is used as a proxy for FD. Brown & Carmignani (2015) estimated the

tipping point after which remittances complements FD to be a remittance-to-GDP ratio of 2.5%.

As for the other determinants of FD, our results reveal that financial openness has a statistically significant positive impact on FD in the long run. Several channels identified in the literature can explain this positive effect as mechanisms enabling financial openness to enhance financial system development. Financial openness can foster FD by increasing global competitiveness through the implementation of international standards and the fear of a "flight to quality" offered by foreign financial intermediaries. Furthermore, financial openness would allow foreign intermediaries to extend the local banking system through financial innovation, which would broaden the scope of financial services and credit availability at lower costs. Financial openness could also help improve the financial system's overall efficiency by crowding out inefficient financial institutions (Chinn & Ito, 2006). Moreover, financial openness is expected to stimulate the usage of various financial instruments and institutional reforms, hence fostering FD (Rajan & Zingales, 2003).

The results also show that inflation impedes FD. Being a source of macroeconomic instability, inflation creates uncertainty and discourages financial intermediation and the extension of credit by lowering the real return on money and financial assets (Huybens & Smith, 1999).

The fundamental conclusion of this study is that Egypt can no longer rely on remittance inflows to progress financial sector development once remittances as a proportion of GDP reach the threshold level. In this instance, Egypt may resort to other measures to encourage FD, such as improving capital markets, ensuring trade competitiveness, and developing a domestic investment structure favoring the banking industry. The adverse impact of remittances on FD at high remittance-to-GDP ratios may reflect Egypt's weak stock market quality. It has been demonstrated that developing-country stock markets are typically undercapitalized, illiquid, and volatile and are frequently grounded by inadequate infrastructure (Issahaku et al., 2017).

The government education and advertising programs that promote stock market financial literacy can increase migrants' involvement in the domestic stock market.

Regulatory authorities should ease stock market listing criteria and invest in infrastructure to promote stock market development (Issahaku et al., 2017).

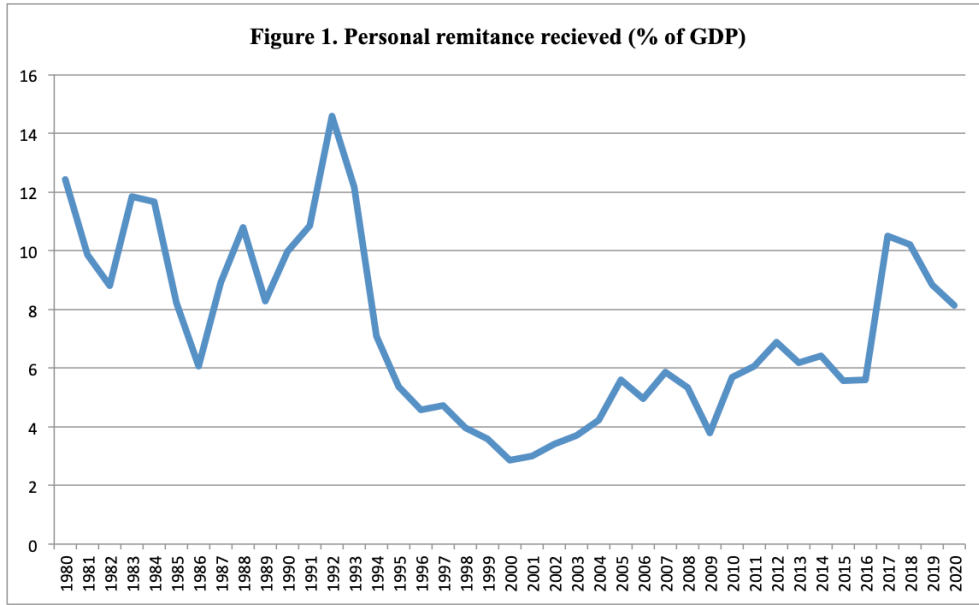
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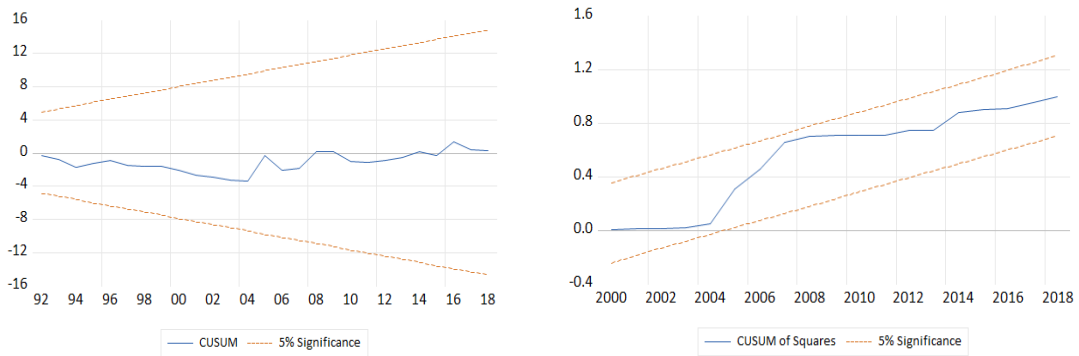
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Source: World Development Indicators (World Bank 2020)

**Figure 2: ARDL(1,0,3,1,0) model CUSUM and CUSUMSQ stability plots**





## List of Tables

**Table 1 summary statistics and data description**

Variable	Measurement	Source	Mean	S.D	Max	Min
Financial development (FD)	Financial development index	Svirydzhenka (2016)	0.29	0.06	0.45	0.20
Inflation rate (INF)	Annual growth rate of CPI	WDI issued by World Bank (2021)	0.11	0.05	0.25	0.02
Remittances (REM)	Personal remittances received (% of GDP)	WDI issued by World Bank (2021)	7.16	3.09	14.58	2.86
Financial openness (FO)	Capital account openness		64.58	13.48	90	36

**Table 2. Results of the ADF and PP unit root tests of variables in level and first difference**

	FD		REM		FO		INF	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP
<b>Unit root tests of variables in levels</b>								
Intercept	-1.80	-2.00	-2.29	-2.30	-1.53	-1.65	-2.83*	-2.73*
Trend and intercept	-1.69	-1.98	-1.87	-1.87	-1.68	-1.74	-2.87	-2.78
No trend and intercept	0.11	0.06	-1.04	-0.95	-0.49	-0.49	-0.25	-2.75
<b>Unit root tests of variables in first difference</b>								
Intercept	-5.22***	-5.18***	-5.58***	-5.96***	-6.60***	-6.59***	-8.80***	-8.80***
Trend and intercept	-5.14***	-5.10***	-5.59***	-8.38***	-6.61***	-6.62***	-8.68***	-8.68***
No trend and intercept	-5.28***	-5.25***	-5.66***	-6.14***	-6.69***	-6.66***	-8.90***	-8.90***

\* , \*\* , \*\*\* implies the rejection of the null hypothesis at the 10%, 5%, and 1% significance level, respectively. For both the ADF and PP tests, the null hypothesis is that the series is non-stationary.

**Table 3: Cointegration bounds test**

Dependant variable	Forcing variables	Specification	F-statistic	95% Critical bounds	
				I(0)	I(1)
$\Delta(FD)$	$FO, INF, REM, REM^2$	ARDL(1,0,3,1,0)	5.29**	3.07	4.44

The lower and upper bound critical values are obtained from Pesaran *et al.* (2001).

**Table 4: Estimated short-run and long-run parameters of the ARDL(1,0,3,1,0) model**

Panel (A)	Coefficient	Std. Error
<b>Short-run coefficients</b>		
$\Delta(INF)$	0.13	0.08
$\Delta(INF(-1))$	0.76***	0.14
$\Delta(INF(-2))$	0.31**	0.11
$\Delta(REM)$	0.014***	0.004
$ECT_{t-1}$	-0.25***	0.04
<b>Panel B</b>		
<b>Long run coefficients</b>		
FO	0.003***	0.000
INF	-2.42***	0.87
REM	0.08***	0.02
$REM^2$	-0.0036***	0.001
<b>Panel C: Diagnostic tests</b>		
Serial correlation	$F - statistic = 1.97$ P value (0.14)	
Heteroskedasticity	$F - statistic = 0.49$ P value (0.86)	
Functional form	F (2,25)=2.16 P value (0.14)	
Normality	Jarque-Bera = 4.24 P value (0.12)	