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The Symmetric and Asymmetric Effect of Remittances on Financial Development: Evidence from South Africa

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Abstract: Investigating the remittance-financial development relationship is an ongoing endeavor among economists and policy makers. Building and improving on the existing work, this study considers the possibility that the relation between remittances and financial development is potentially asymmetric. This study applies the linear ARDL and captures the possibility of an asymmetrical relationship by applying the non-linear Autoregressive Model (NARDL). Using NARDL, an attempt is made to estimate the short-run and long-run asymmetric responses of financial development through positive and negative partial sum decompositions of changes in remittances. To assess the robustness of the ARDL and NARDL estimates, a battery of long-run robustness tests were employed, including the linear and nonlinear versions of the fully modified ordinary least squares (FMOLS). Annual data series from 1980 to 2017, derived from the World Development Indicators, Fred Economic data and Penn World Tables were used for this study. The ARDL results reveal a positive and significant impact of remittances on financial development, whereas NARDL estimations suggest a both positive and negative shock of remittances on financial development in the long run: a percentage (%) increase in the remittances brings about 0.121568 percent increase in financial development, whereas a one-percent decrease in remittances produces a 0.33363 percent decrease in financial development.

Keywords: remittances; financial development; domestic credit

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1. Introduction

Remittances are monies sent by migrants (through a mobile transfer or bank) to their countries/communities of origin. Despite the COVID-19 pandemic, remittances remained buoyant in 2020. The amount of remittance flows to developing regions (including low- and middle-income nations) was as high as $540 billion in 2020 (Bidawi et al. 2022). Interestingly, the decrease in remittances associated with COVID-19 pandemic was smaller than the decrease experienced during the 2009 global financial crisis. Given the mounting prominence of remittances, it is natural to ask about the impact that they have on the welfare of the remittance-receiving communities. The remittance-welfare nexus is well established in this field. The investigation transcends various fields, including poverty (Bertoli and Marchetta 2014; Azam et al. 2016), education (Adams and Cuecuecha 2010; Bredl 2011), labor supply (Jadotte and Ramos 2016) and health (De and Ratha 2012). A growing body of literature suggests that remittances contribute to financial development in developing countries such as South Africa (Gupta et al. 2007; Chowdhury 2016; Cooray 2012; Kakhkharov and Rohde 2019; Shahzad et al. 2014).

Figure 1 depicts not only the growth in remittances but the growth in financial development (with domestic credit as proxy), which is indicative of a positive complementary relationship between remittances and domestic credit. From 1980 to 1985 remittances remained unstable, reaching their lowest level from 1986 to 1989 due to the state of emergency and Soweto uprising (Cowell 1986). In 1994 South Africa transitioned to a new democratic government and a new constitution for the Republic of South Africa was unveiled in 1996. South Africa's domestic credit grew more as remittances increased. In the early 2000s, a government intervention required all banks to sign the Financial Sector Charter and provide a basic savings and transmission account, known as Mzansi, for the poorest, including those without a regular income (James 2014). From May 2004, up until the 2010 Soccer World Cup both remittances and domestic credit rose in South Africa. Investigating the effect of remittances on finance is important for South Africa because the country still struggles with issues of high levels of unemployment, income inequality and poor financial inclusion across different racial groups. Despite the existence of financial services in South Africa, these services remain inaccessible to the excluded and underserved. Amuedo-Dorantes (2014) highlights the micro- and macro-economic level benefits of remittances. At a micro-economic level for households and individuals, the main benefit of remittance flows is that it assists to stabilize income. Remittances can help unbanked households in impoverished rural regions through easing credit limitation and facilities asset accumulation, business investment and the promotion of financial literacy. At a macro-economic level, the resilience and countercyclical nature of remittance flows, both of which promote economic stability and have shown to help prevent sudden current account reversals during periods of economic instability, improve a country's credit rating, and facilitate the inflow of new investments, Amuedo-Dorantes (2014). Misati et al. (2019) state that more receivers and senders of remittances stimulates a greater demand for financial systems and encourages greater interaction with financial institutions and financial products, thus expanding financial development. Thus, the aim of this study is to investigate not only the symmetric effects of remittances on financial development, but also shed light on the asymmetric short and long run effects of remittances. Specifically, the investigation is on whether or not remittances might have both a negative and positive effect on financial development, and to identify the most predominating effects. The remainder of this paper is structured as follows: Section 2 provides the literature review, Section 3 discusses the methodology, including data and modelling. Section 4 discusses the results, while Section 5 provides the conclusion and policy implications.

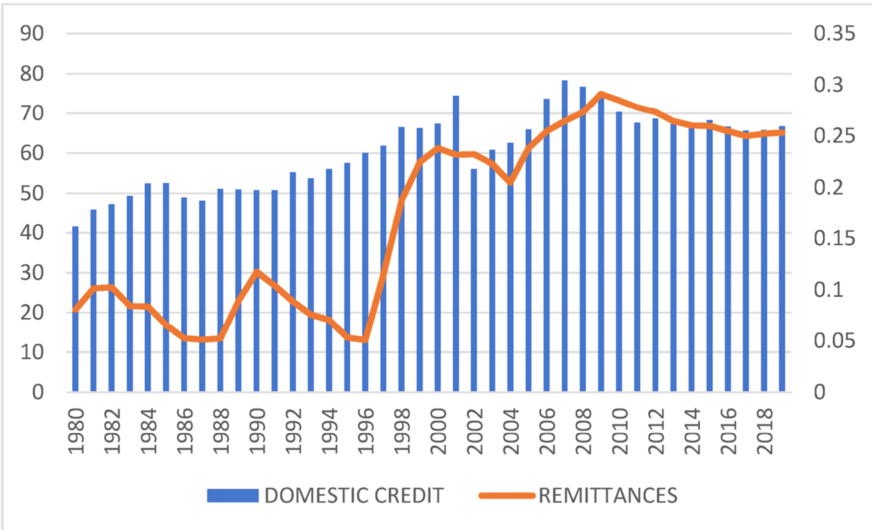

Figure 1. Trends in remittances and financial development in South Africa. Source: World Bank, 2019.

2. Literature Review

The relationship between financial development and remittances is premised on two key hypotheses: complementarity and substitutability. The premise for the complementarity hypothesis is that, like any substantial external financial source, official remittance inflows that come through the banking sector should in principle enhance financial development for the receiving communities/households, especially in developing nations (Aggarwal et al. 2011).

However, this premise is not universally shared among scholars in this field. Some scholars take the view that remittances are a substitute for credit in that they act as an alternative for credit, thereby lessening their financial constraints—remittances might therefore lead to a decrease in the demand for credit, which in turn impacts negatively on credit market development, especially for poor countries (Bettin et al. 2009).

On the empirical front, many empirical studies have been conducted on the financial development-remittances nexus. These studies can be conveniently clustered into two groups. The first group captures a linear relationship between financial development and remittances (see Freund and Spatafora 2008; Santos and Kvangraven 2017; Gupta et al. 2007; Bindu et al. 2021; Azizi 2020; Chowdhury 2016; Bettin et al. 2009; Adekunle et al. 2020; Saydaliyev et al. 2020; Bjuggren et al. 2010; Bhattacharya et al. 2018; Karikari et al. 2016; Aggarwal et al. 2011; Coulibaly 2015; Opperman and Adjasi 2019; Bandura et al. 2019). The second group establishes a non-linear link between remittances and financial development (Das and McFarlane 2021; Pesaran et al. 2001; Issahaku et al. 2017; Fromentin 2017, 2018; Mehta et al. 2021; Faheem et al. 2019). There are other studies in the emerging economies that have attempted to treat similar concepts, but ones not directly related to this study (Kovacova et al. 2022; Kovacova and George 2021).

Studies which find a linear relationship include Gupta et al. (2007) who, using the 1975 through 2004 data, examined the impact of remittances on poverty and financial development in 44 countries in sub-Saharan Africa. Applying a three-stage least-squares technique the authors found evidence to suggest that remittances reduce poverty and promote financial development. Based on these results, they conclude that "formalizing such flows can serve as an effective access point for "unbanked" individuals and households, and that the effective use of such flows can mitigate the costs of skilled out-migration in Sub-Saharan Africa."

Similar findings that indicate the positive influence of remittances on financial development in developing countries were found by Azizi (2020) in a panel data study of 124 developing countries during the period 1990 to 2015. Using the fixed-effect model, the results indicate a 10% increase in remittance-to-GDP ratio increased domestic credit to the private sector by 1.7%, also increasing bank credit with 1.9% and 1.2% in bank deposits. Karikari et al. (2016) also analyzed remittance inflows from 50 developing countries in Africa from 1990 to 2011. Upon applying the fixed-effects and random effect estimations as well as the vector error correction model methods on the panel data, the results showed that remittances boost aspects of financial growth to some extent. According to their study, a better financial system fosters remittance receipts, which facilitates financial growth in the short term, while the development of the financial sector can help to improve the predisposition to send money through official channels in the long run. A study by Bindu et al. (2021) found a 1% rise in remittances results in a 4.5% increase in bank deposits.

Many other studies also find that remittances enhance financial development: Misati et al. (2019) for Kenya; Oke et al. (2011) for the case of Nigeria; Sibindi (2014) for the case of Lesotho; Masuduzzaman (2014) for the case of Bangladesh; Fromentin (2018) for 32 Latin American and Caribbean countries; Chowdhury (2016) for developing countries; Cooray (2012) for non-OECD. Unsurprisingly, some studies find a negative relationship between remittances and financial development. Calderón et al. (2007), for example, observed that remittances can hinder credit demands and thus have a reducing impact on credit demand markets.

The relationship between remittances and financial development is partly influenced or conditional on other factors that may affect this relationship. For example, recent studies have shown that countries with fairly strong institutions motivate banks to expand credit, whereas countries with weaker institutions may discourage banks from lending money, especially to risky borrowers, due to severe asymmetric information problems. For example, Saydaliyev et al. (2020) used data between 2011 and 2018, and a dynamic panel data technique to study the influence of remittance inflows on financial inclusion with a special focus on high remittance-receiving developing nations. Their findings revealed that remittances that promote financial inclusion are linked to higher institutional quality. Reaching a similar conclusion, Bhattacharya et al. (2018), applied dynamic system-generalized method of moments which showed that emerging nations have lower elasticity values than industrialized countries. Their findings are consistent across nations, highlighting the need to improve institutional setups to enhance remittance inflows.

Using unobserved dynamic factor model based on 46 countries for the period of 1996 through to 2016, Kim (2021) studied the effect remittances on financial development by accounting for the potential impact that institutional quality might have on the financial development. Upon employing the panel data models (such as fixed and random effects) and instrumental variable models, the author observed that financial development is positively associated with both institutional quality and remittances. The analysis support the hypothesis that institutional quality enhances the impact of remittances on financial development, when institutions are not be interfered by the authorities. Though many empirical studies have found a linear effect of financial development and remittances having a negative or positive relationship, other empirical evidence shows a non-linear relationship between remittances and financial development.

Akcay (2020) used time-series data from 1980 to 2015, which displayed a normal U-shape in both the short and long run. To put it more succinctly, remittances depress financial development at first, but subsequently improve it, demonstrating rising returns, indicative of the complementarity hypothesis. Akcay's (2020) study is consistent with work of Pesaran et al. (2001) who, using time-series data covering the period 1980–2015 and applying the autoregressive distributed lag bounds testing approach, observed a U-shape short and long run between and remittances and financial development.

In Bangladesh, a non-linear link between financial development and remittances was observed from 1980 to 2015. The findings indicate a non-linear U-shaped link between financial development and remittances, which supports the complementary theory in both the long and short term (Akcay 2020). Similarly, Das and McFarlane (2021) discovered that the relationship between remittances and financial development is a U-shape function of remittances. When remittances increased, there was initially a negative impact on financial development until a threshold point was reached and the impact on financial development became positive. There is long list of empirical work that either finds the U-shaped relationship, e.g., Brown et al. (2013) for the case of developing and emerging economies, or an inverted U-shaped relationship as demonstrated by Esteves and Khoudour-Castéras (2011) for eight European countries as well as Sharaf and Shahen (2022) for the case of Shahen Egypt.

Faheem et al. (2019) researched the effect migrant remittances had on financial development in Pakistan. The study used period data from 1976 to 2018 and employed the linear ARDL and NARDL models. The ARDL results showed that, in the short run and long run, financial growth leads to rises of 0.5% and 0.6% for every 1% increase in remittance inflows. The NARDL long run results showed a more substantial effect negative changes of remittances had on financial development, and a 1% drop in remittances resulted in a 62% drop in financial development.

Mehta et al. (2021) used data from 1975 to 2019. The NARDL revealed that the positive and negative shocks in remittances inflows were positively related to financial development, which was measured by bank-based indices, stock-based indices, and the financial development index.

It is apparent from the empirical evidence in the literature that there is no definite conclusion that remittances have a positive or negative impact on financial development. The literature provides mixed results, indicating that the relationship between remittances and financial development requires more research as the relationship differs across countries. Thus, the aim of this study is to contribute by investigating, not only the symmetric effects of remittances on financial development, but also the asymmetric short- and long-run effects of remittances. Secondly, to the best of the author's knowledge, this is the first study that investigates the effect of remittances on financial development in South Africa. To investigate the linear and non-linear impact of remittances on financial development in South Africa, this study employs the ARDL and NARDL for the 1980–2018.

3. Methodology

3.1. Data and Modeling

As noted earlier, the main aim of this study is to empirically investigate not only the symmetric effects of remittances on financial development, but also to shed light on the asymmetric short and long run effects of remittances. Drawing on the previous studies (which provided an overview of the theoretical and empirical considerations), an empirical analysis is produced to shed light on the research question. Specifically, this section describes the data and variables used, theoretical model/model specifications, symmetric and asymmetric models and descriptive analysis.

3.2. Data and Variables

The study employs data that covers 38 years, spanning from 1980 to 2018. Our data starts in 1980 because comparable figures on some variables are not available prior to 1980. The data is obtained from various sources: World Bank Development Indicators, Penn World Tables 9.1 and Fred Economic data for which data is available and complete. Drawing from the studies in this field (Bindu et al. 2021; Karikari et al. 2016; Saydaliyev et al. 2020; Das and McFarlane 2021; Azizi 2020; Aggarwal et al. 2011) the following variables were used: financial development, remittances, population, inflation, gross capital formation and total factor productivity. The first four variables were obtained from the World Bank Development Indicators and the last two come from Penn World Tables 9.1 and Fred Economic data, respectively. Table 1 presents all the information about the variables used in the analysis, including the sources of the data.

Table 1. Variables used in the analysis.

Variables	Description	Source of Data	Unit of Measurement
	Dependent variable		
FC	Financial development	World Bank Development Indicators	Rands
	Independent variable		
REM	Remittances	World Bank Development Indicators 2021	percentage of GDP
	Control variables		
TFP	Total factor productivity	Fred Economic data	Units:Index 2017 = 1
POP	Population	World Bank Development Indicators 2021	Millions
GFC	Gross capital formation	Penn Table 9.1	At current PPP's
INF	Inflation	World Bank Development Indicators 2021	Annual percentage

As can be seen in Table 1, financial development is the dependent variable of interest and is proxied by domestic credit to the private sector by banks as a percentage of GDP. Domestic credit is a standard measure that was used here, following many studies in this field, to proxy for financial development (see, Aggarwal et al. 2011; Azizi 2020). This measure is preferred to other measures of financial development (for instance Money Supply M2) because of its ability to capture the major role of 'financial intermediaries' directing deposits from surplus units to deficit units (Biyase and Chisadza 2023). The independent variable of interest for the analysis is remittances and is measured as personal remittances, received (% of GDP). The choice of control variables in this study is steered by the above-mentioned existing studies in this field. These include total factor productivity, inflation, population, and gross capital formation. Inflation is included as a control variable following studies that have found evidence to suggest that inflation interferes with individuals' decision-making process in terms of nominal magnitudes and is likely to discourage financial intermediation (Aggarwal et al. 2011). Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. Total factor productivity is measured for each country comparative to the U.S. (TFP level at current PPPs, U.S. = 1).

Gross formation capital obtained from the Penn World Table is a percentage share of GDP at current purchasing power parities. Inflation is measured by the consumer price index as an annual percentage.

3.3. The Autoregressive Distributed Lag Model: Symmetric Model

The study applies the linear ARDL and captures the possibility of an asymmetric relationship by applying the non-linear autoregressive model (NARDL) advanced by Shin et al. (2014). Although the ARDL approach may at first glance appear somewhat complicated to non-econometricians/economists, it is not difficult once you understand the key steps involved in implementing it. These steps include the specification of ARDL model, ensuring that variables in questions are either I(0) or I(1) or both but not above I(1) process as this will nullify the entire model, formulating the error-correction model and, last but not least, deciding on the fitting lag structure for the model by adopting some information criteria ('such as Akaike information criterion (AIC), Schwarz (Bayes) criterion (SC), Hannan-Quinn information criterion'). Some of the advantages of ARDL mentioned by Nkoro and Uko (2016) is that ARDL allows for underlying variables that are I(0), I(1), or a mix of the two; secondly the ARDL model has a large enough number of lags and thirdly, the error correction model (ECM) may be generated from ARDL using a simple linear transformation that combines short and long run adjustments. One of the other benefits of ARDL that Latif et al. (2015) state is that the ARDL test is more robust and works better with small sample sizes of data, which is appropriate for this study. The ARDL model order is enhanced appropriately to allow for current correlation among the stochastic parts of the data producing processes that are used in estimation (Shrestha and Bhatta 2018).

The empirical specification used is the model first proposed by Pesaran et al. (2001); the symmetric ARDL model is expressed in the equation below

$$\begin{aligned}\Delta LFC_t = \; & \varphi_0 + \varnothing_1 LFC_{t-1} + \varnothing_2 lTFP_{t-1} + \varnothing_3 lRem_{t-1} \\ & + \varnothing_4 lPop_{t-1} + \varnothing_5 Inf\_cpi_{t-1} + \varnothing_6 lGFC_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta lFC_{t-i} \\ & + \sum_{i=1}^{n} \beta_{2i} \Delta lTFP_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta lRemit_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta lPop_{t-i} \\ & + \sum_{i=1}^{n} \beta_{5i} \Delta lInf\_cpi_{t-i} + \sum_{i=1}^{n} \beta_{6i} \Delta lnGCF_{t-i} + \varepsilon_t\end{aligned} \tag{1}$$

where: *FC* denotes Financial Development; *TFP* represents Total Factor Productivity; *Remitt* is Remittances; *Pop* is Population; *GFC* denotes Capital formation; *Inf* is Inflation; ε is error term. Prior to applying the bounds test the optimal lag length was determined for each of the explanatory variables by using the AIC. The next step was to run an ARDL bounds tests, as the F-test statistic indicates, if there is a long run relationship between the variables. We reject the null hypothesis of no long-run relationship between variables $\varnothing_1 = \varnothing_2 = \varnothing_3 = \varnothing_4 = \varnothing_5 = \varnothing_6 = 0$ if the upper bound value is lower than the F-statistic.

Otherwise, we fail to reject the null hypothesis that there is a long-run relationship between variables $\varnothing_1 \neq \varnothing_2 \neq \varnothing_3 \neq \varnothing_4 \neq \varnothing_5 \neq \varnothing_6 \neq 0$ if the lower-bound value is above the F-statistic value. The error correction model (ECM) in Equation (2) is used to determine the short run relationship.

$$\begin{aligned}\Delta LFC_t = \; & \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lFC_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta lTFP_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta lRemit_{t-i} \\ & + \sum_{i=1}^{n} \beta_{4i} \Delta lPop_{t-i} + \sum_{i=1}^{n} \beta_{5i} \Delta Inf_{t-i} + \sum_{i=1}^{n} \beta_{6i} \Delta lnGCF_{t-i} \\ & + u_{1t}\end{aligned} \tag{2}$$

If the ECM_{t-1} coefficient is negative and significant, this would indicate that any short-term disequilibrium between the dependent and independent variables would eventually move back to the long run equilibrium.

3.4. The Nonlinear Autoregressive Distributed Lag Model: Asymmetric Model

The NARDL model (an augmented version of ARDL model) was also used for this analysis. The reason for using NARDL model, is that it allows for asymmetry with respect to positive and negative changes in the explanatory variable in short run and long run. Thus, remittances is decomposed to allow the testing of asymmetric effect of remittances on financial development. The decomposition of remittances (denoted by *lRemit*) into positive and negative sum is expressed in Equation (3)

$$\begin{aligned} lRemitt_t^+ &= \sum_{j=1}^{t} \Delta lRemit_j^+ = \sum_{j=1}^{t} \max(\Delta lRemit_j^+ 0) \\ lRemitt_t^- &= \sum_{j=1}^{t} \Delta lRemit_j^- = \sum_{j=1}^{t} \min(\Delta lRemit_j^- 0) \end{aligned} \tag{3}$$

The NARDL model is expressed by replacing $lRemit$ in Equation (3) by positive and negative variables.

$$\begin{aligned} \Delta LFC_t = \; & \varphi_0 + \varnothing_1 LFC_{t-1} + \theta_2 lTFP_{t-1} + \theta_3 lPop_{t-1} + \theta_4 Inf_{t-1} + \theta_5 lGFC_{t-1} \\ & + \theta_6 lRemit_{t-1}^+ + \theta_7 lRemit_{t-1}^- + \sum_{i=1}^{n} \beta_{1i} \Delta lFC_{t-i} \\ & + \sum_{i=1}^{n} \beta_{2i} \Delta lTFP_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta lPop_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta Inf_{t-i} \\ & + \sum_{i=1}^{n} \beta_{5i} \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \beta_{6i} \Delta lRemit_{t-1}^+ + \sum_{i=1}^{n} \beta_{7i} \Delta lRemit_{t-1}^- \\ & + \varepsilon_t \end{aligned} \tag{4}$$

The NARDL cointegration model expressed in Equation (4) consists of both the long run and short run. Using the NARDL estimation technique, the F statistic and critical values will provide an indication of the existence of long run or short run asymmetric connections that may exist between remittances and financial development.

Lastly, a series of diagnostics tests were done to test the validity of the models. The Breusch-Godfrey test was applied to test for autocorrelation in the errors of the regression model, Breusch-Pagan-Godfrey tested homoscedastic elements, and the Jarque-Bera (JB) test JB test was used for normality. The BDS test was also used as a diagnostic tool to detect non-linear series, while the robustness of the models was tested using the FMOLS (fully modified ordinary least squared) test.

4. Empirical Analysis

4.1. Data Description and Sources

Table 2 shows a summary of the statistics used in the dataset in which all variables in the dataset are continuous. This is seen by the range of maximum and minimum values. Financial development had a maximum value of 78.2 and a minimum of value 41.50, population ranges from 29.760 to 56.717, inflation falls within −0.692 to 18.655, GFC remains within 0.137 to 0.309, REM is located within 0.051 to 0.291 while TFP ranges from 0.533 to 0.890.

Table 2. Summary statistics.

Variables	Mean/%	Std Dev	Min	Max	Skewness	Kurtosis	Observations
LFC	60.731	9.732	41.503	78.294	−0.064	1.941	37
LREM	0.169	0.089	0.051	0.291	−0.062	1.261	38
LPOP	43.829	8.038	29.760	56.717	−0.157	1.823	38
INF	9.006	4.657	−0.692	18.655	0.242	2.143	38
LGFC	0.187	0.041	0.137	0.309	1.058	3.937	38
LTFP	0.732	0.094	0.533	0.890	−0.527	2.630	38

The BDS test (see Table A1) statistics provide evidence to suggest that the series are not identically and independently distributed, thereby ascertaining the existence of asymmetries. Thus, it is appropriate to the use NARDL approach for the analysis of the asymmetric effect of remittances on financial development in South Africa.

4.2. Results and Discussion

4.2.1. Unit Root Test Estimates

Unit root tests are done to ensure that none of the variables are integrated of order two. In the event that variables used are integrated of order two the F-statistic is no longer valid (Pesaran et al. 2001 and Jalil and Feridun 2011). Tables A2 and A3 indicate whether the variables used are stationary at level with constant and trend, as well as without constant and trend. At level both unit roots tests of the ADF and PP indicated that some of the variables are significant. Since only a few variables chosen were not stationary at level, all the variables were tested to see if they were integrated at order one. The results summarized in Tables A2 and A3 show there is a mixture of stationarity since some variables are stationary at level I(0), while others are stationary at first difference I(1).

4.2.2. ARDL Results

ARDL Bounds Test for Co-Integration

After establishing the order of co-integration, the bounds test was then run to test if there was a long run relationship existing amongst the variables. In Table 3 the bounds test F-values with a value of 7.574437 is higher than the critical values and is significant. The null hypothesis is that there is no level relationship between the variables, and the alternative is that there exists a long relationship between the variables. Based on the critical values being lower than the F-value the null hypothesis can be rejected. This concludes the evidence of a long run relationship between financial development and other explanatory variables.

Table 3. ARDL Bounds Test Statistics.

F-statistic	7.574437	k-5
Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.50%	2.96	4.18
1%	3.41	4.68

4.2.3. ARDL Long-Run and Short-Run Results

In Table 4 the long run estimates indicate LREM has a p-value of 0.0645 > 0.05 indicating there is no long run relationship with LFD compared with the other variables that have p-values less than 0.05. The other variables POP, INF, TFP and GCF indicate a long run relationship with FD. A 1% increase in POP leads to a 2.04% increase in FD as the need for credit grows, consistent with the findings of The National Treasury (2019). A growing population has a need of financial inclusivity. A 1% increase in INF results in FD increasing with 0.02%, which is indicative of increasing velocity in money. Higher inflation rates cause people to utilize bought transactional services instead of cash holdings, thus increasing money supply and the ability of the financial sector to expand their credit facility (Asongu 2014). However, when GCF increases, FD decreases with 0.22% indicating a negative relationship. This is to be expected, as the relationship between GCF and FD is a substitutable one. A 1% increase in TFP increases DCF by 0.93% and is significant at 5%. Through the improvement in the levels of TFP, this encourages more foreign direct investment in the country, thus enhancing financial integration and expansion of financial services (Rahman and Inaba 2020). The optimal lag length for each variable was based on the results on the Akaike Information Criteria (AIC). AIC assesses the quality of each model in relation to the other models. As a result, AIC serves as a tool for model selection (Menegaki 2021).

Table 4. ARDL long-run and short-run results.

Variable	Coefficient	Standard Error	t-Statistic	Probability
Panel A Long-run results				
LREM	0.058403	0.029658	1.969181	0.0645
LPOP	2.045231	0.216308	9.455185	0.000
INF	0.013874	0.005743	2.415735	0.0266
LGCF	−0.223402	0.056891	−3.92682	0.001
LTFP	0.939035	0.172996	5.428065	0.000
Panel B Short-run Results				
C	−2.373733	0.310666	−7.64079	0.000
D(LREM)	−0.073135	0.030162	−2.4247	0.0261
D(LREM(-1))	−0.077342	0.038537	−2.00692	0.06
D(LPOP)	−32.8389	10.28407	−3.19318	0.005
D(LPOP(-1))	36.56715	9.971682	3.667099	0.0018
D(INF_CPI)	−0.009252	0.002801	−3.30335	0.004
D(INF_CPI(-1))	−0.021737	0.004197	−5.17879	0.0001
D(INF_CPI(-2))	−0.011452	0.003183	−3.59756	0.0021
D(LTFP)	0.346052	0.233003	1.48518	0.1548
CointEq(-1) *	−1.255174	0.164712	−7.62041	0
R-squared	0.808285	Mean dependent var		0.016432
Adjusted R-squared	0.733266	S.D. dependent var		0.062943
S.E. of regression	0.032508	Akaike info criterion		−3.769628
Sum squared resid	0.024305	Schwarz criterion		−3.316141
Log likelihood	72.19886	Hannan-Quinn criter.		−3.617043
F-statistic	10.77443	Durbin-Watson stat		2.340748
Prob(F-statistic)	0.000002			

* *p*-value incompatible with t-Bounds distribution.

The error correction model in panel B of Table 4 shows the negative coefficient of −1.255174 which is statistically significant at 5%, implying that the system adjusts to its equilibrium with a speed of 125%, in the presence of other mentioned variables.

Diagnostic tests were also conducted to test the validity of the model, while the Breusch-Godfrey and Breusch-Pagan-Godfrey diagnostic (See Tables A4 and A5) tests were done to test serial correlation and heteroscedasticity. The tests in Table A4 indicates there is no serial correlation in the model as the null hypothesis is not rejected—the Prob.Chi square is 0.1152. Table A5 results shows that Prob.Chi square is 0.2421, therefore the model is homoscedastic.

4.2.4. Robustness Checks Results

The estimated ARDL model's structural stability is further evaluated using the FMOLS. The results of fully modified ordinary least squares regression in Table 5 provides some robustness check. The explanatory variables such as REM, POP and TPF are positively significant with the same expected sign, with the exception of INF which is insignificant. FMOLS also results reveal a significant and positive effect remittances have on financial development.

Table 5. Method: Fully Modified Least Squares (FMOLS).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LREM	0.075884	0.019677	3.856501	0.0005
LPOP	1.5873	0.044135	35.96426	0.000
INF_CPI	0.003678	0.005214	0.705339	0.4859
LGCF	−0.250081	0.052906	−4.726897	0.000
LTFP	0.687947	0.118991	5.78149	0.000
R-squared	0.955895	Mean dependent var		4.9033
Adjusted R-squared	0.950204	S.D. dependent var		0.289957
S.E. of regression	0.064704	Sum squared resid		0.129785
Long-run variance	0.003604			

A 1% increase in the level of remittances results in a 0.07% increase in financial development. The positive relationship in the long run is explained by remittances providing a stimulus for domestic credit, thereby boosting the amount of money that banks can mobilize and encourage lending. The population coefficient is also positive and significant at a 1% level, increasing financial development by 1.58% at a 5% significance level. Gross capital formation is negative and significant, indicating that a 1% increase in gross capital formation decreases domestic credit by 0.25%. The coefficient of TFP is positive and significant at 5%: a 1% increase in TFP increasing domestic credit with 0.68%.

The ARDL regression's cumulative sums (CUSUM) of the recursive residuals and CUSUM squared plots reveal that the plots are inside the 95% confidence band graphs, indicating that the ARDL models are stable. The CUSUM and CUSUM of squares graphs depicted in Figures 2 and 3 are inside the critical limits and show statistical significance at a level of 5%.

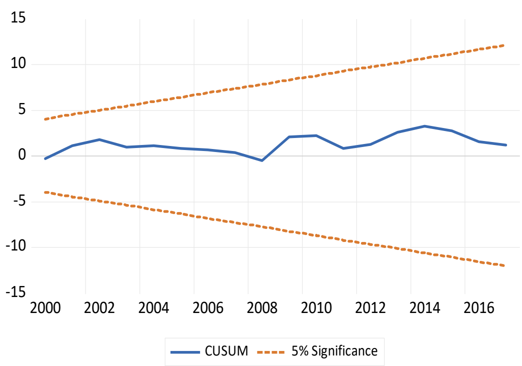

Figure 2. CUSUM test for the linear ARDL model.

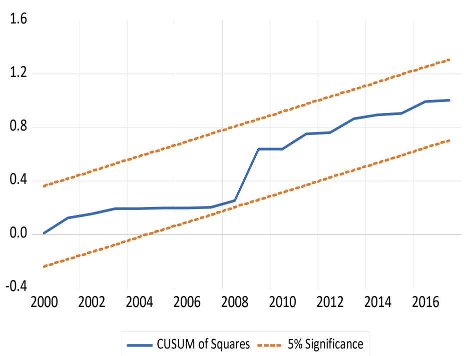

Figure 3. COSUMQ test for the linear ARDL model.

4.3. NARDL Results

4.3.1. NARDL Bounds Test for Co-Integration

In Table 6, the asymmetrical model results for co-integration bounds test indicates the F-statistic value of 5.07 is greater than the upper bound level at 1% and 5% significance level, therefore showing evidence of a long relationship and co-integration between the variables.

Table 6. NARDL Bounds Test Statistics.

F-statistic	5.070620	k-6
Significance	I0 Bound	I1 Bound
10%	2.33	3.25
5%	2.63	3.62
2.5%	2.9	3.94
1%	3.27	4.39

4.3.2. NARDL Long-Run and Short-Run Results

Table 7 Panel A shows the results of the NARDL regression and separates the reaction of remittances as negative and positive effects on financial development. The results suggest that positive and negative shocks in remittances bring about a statistically significant positive and negative changes in financial development in the long run, with varying magnitudes. A positive shock in remittances (0.12) has a positive and significant impact on financial development in South Africa. These findings imply a 1% increase in LREM_POS, increases financial development by 0.12%, while a negative shock in remittances implies that a 1% decrease in remittances will lead to a 0.33% decrease in financial development. The long run estimates do not just highlight the importance of remittances that positively expand financial development in South Africa, but also highlight that a negative shock on remittances has an even greater negative effect on financial development. The long run estimation results are consistent with the findings of Aggarwal et al. (2011) and Fromentin and Leon (2019). Aggarwal et al. (2011) and Fromentin and Leon (2019) who assert that due to increasingly steady earnings and a decrease in information asymmetry, lenders may be more motivated to extend loans to beneficiaries. The negative relationship between remittances and financial development can be explained by substitutability hypothesis whereby remittances serve as a credit alternative by easing liquidity restrictions. The opposing viewpoint according to Fromentin and Leon (2019) is that remittances may encourage the availability of credit for both receivers and non-recipients. From the viewpoint of the demand-side perspective, borrowers may be less hesitant to request a loan as a result of advancements in financial literacy or altered views of banks. Therefore, policymakers should encourage the positive inflow of remittances and retaining the flow in the long run as this will enable the financial sector to expand financial inclusivity in the country. The other explanatory variables POP, INF and GCF were statistically insignificant in the long run. Only TFP (1.15) is positively significant at 5% and has a long run causal effect on financial development, which can be explained by banks improving services and offering new products, therefore enhancing financial inclusivity within the population.

In Table 7 Panel B, the short run results of remittances appear to be insignificant with both D(LREM_POS) and D(LREM_POS (-1)) p-values > 0.05. The error correction term (ECT) of 1.13 is negative, indicating evidence of a long run which is reverting back to equilibrium and is significant at 1%, therefore long run causal relationship can be inferred. The adjustment term shows reversion to long run equilibrium is at an adjustment speed of 113%.

Table 7. NARDL long-run and short-run results.

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Probability**
Panel A Long-run results				
LREM_POS	0.121568	0.040307	3.016028	0.0074
LREM_NEG	−0.33363	0.14936	−2.2337	0.0384
LPOP	−0.98723	1.486436	−0.66416	0.515
INF_CPI	0.002813	0.006871	0.409394	0.6871
LGCF	−1.89250	0.126439	1.496765	0.1518
LTFP	1.159701	0.345576	3.355851	0.0035
@TREND	0.032419	0.021664	−1.496459	0.1519
Panel B Short-run Results				
Variable	Coefficient	Std. Error	t-Statistic	Probability
C	8.159689	1.087428	7.50366	0.000
D(LREM_POS)	−0.036718	0.035901	−1.02276	0.32
D(LREM_POS(-1))	−0.065882	0.039798	−1.65539	0.1152
D(LPOP)	−5.151249	9.515979	−0.54133	0.5949
D(LPOP(-1))	25.01076	9.573189	2.612584	0.0176
D(INF_CPI)	−0.010948	0.002789	−3.92589	0.001
D(INF_CPI(-1))	−0.00886	0.002929	−3.02542	0.0073
D(LTFP)	0.325553	0.240239		0.1921
CointEq(-1) *	−1.12608	0.150024		0.000
R-squared	0.771766	Mean dependent var		0.016457
Adjusted R-squared	0.698731	S.D. dependent var		0.061982
S.E. of regression	0.034021	Akaike info criterion		−3.70176
Sum squared resid	0.028935	Schwarz criterion		−3.29772
Log likelihood	71.92994	Hannan-Quinn criter.		−3.56397
F-statistic	10.56709	Durbin-Watson stat		2.431065
Prob(F-statistic)	0.000002			

* *p*-value incompatible with t-Bounds distribution.

4.3.3. Robustness Checks Results

Table 8 shows the FMOLS in which the negative shocks and positive shocks of LREM in the asymmetric structure are significant at a level of 5%, in the long run.

Table 8. Method: Fully Modified Least Squares (FMOLS).

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LREM_POS	0.061376	0.030026	2.044089	0.0501
LREM_NEG	−0.181298	0.082849	−2.188286	0.0369
LPOP	1.017495	0.404712	2.514122	0.0177
INF_CPI	0.000821	0.00392	0.209538	0.8355
LGCF	0.015516	0.074198	0.209109	0.8358
LTFP	0.676911	0.148646	4.553838	0.0001
C	0.669041	1.209981	0.552935	0.5845
R-squared	0.963992	Mean dependent var		4.9033
Adjusted R-squared	0.956542	S.D. dependent var		0.289957
S.E. of regression	0.060447	Sum squared resid		0.10596
Long-run variance	0.002009			

LTPF and LPOP coefficients remain positive and significant in the long run. The individual FMOLS results of the effect of remittances, both positive and negative, are both significant and highlight bi-directional causality. The positive shocks allow for more credit to be provided in the economy once remittances are received. Mbaye (2015) states a negative relationship between remittances and credit market is expected if the variables act as substitutes due to imperfections within the credit market. Secondly, due to the fact that loans drive investment, a village's lack of access to credit markets may have a detrimental impact on its level of development, resulting in an increase in remittances through increased migratory movements.

Figures 4 and 5 show the nonlinear ARDL parameters are relatively stable. The CUSUM and CUSUM Squared test demonstrates full stability.

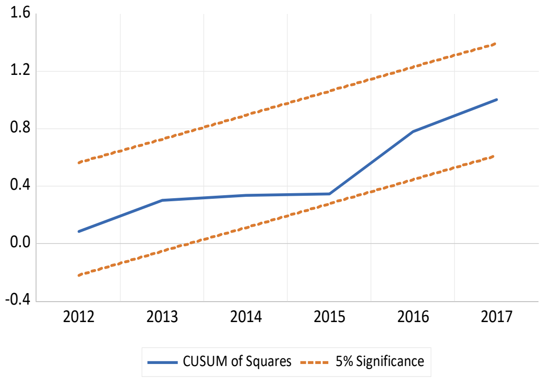

Figure 4. CUSUM test for the nonlinear ARDL model.

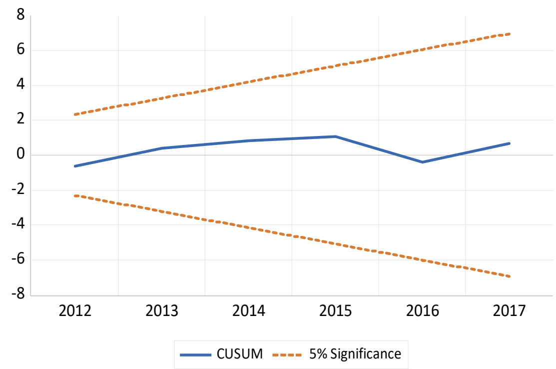

Figure 5. COSUMQ test for the nonlinear ARDL model.

5. Conclusions

This paper focused on the symmetric and asymmetric effect of remittances on financial development. For the analysis, domestic credit by the financial sector was used as a proxy for financial development. The study employed the linear ARDL and captured the possibility of an asymmetrical relationship by applying the non-linear autoregressive model (NARDL). The study used NARDL to estimate the short-run and long-run asymmetric responses of the financial development through positive and negative partial sum decompositions of changes in remittances. To assess the robustness of the ARDL and NARDL estimates, a battery of long-run robustness tests, including the linear and nonlinear versions of the fully modified ordinary least squares (FMOLS), were implemented. Annual data series from 1980 to 2017 derived from the World Development Indicators, Fred Economic data and Penn World Tables were used for this study. The ARDL results reveal a positive and insignificant impact of remittances on financial development whereas NARDL estimations suggest positive and negative shock of remittances on financial development in the long run: a percentage (%) increase in the remittances brings about 0.121568 percent increase in the financial development, whereas a 1 percent decrease in remittances produces a 0.33363 percent decrease in financial development.

There is a scope within future research on issues relating to financial reforms in South Africa to analyze the effect of remittances on financial development. The limitations of this study are that it does not account for the effects of institutional interaction on financial development, nor does it consider structural changes.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. BDS Test for non-linearity.

	BDS Statistics				
Series	**Dimension 2**	**Dimension 3**	**Dimension 4**	**Dimension 5**	**Dimension 6**
LnRem	0.135338 ***	0.204693 ***	0.249206 ***	0.269476 ***	0.274459 ***
LnPop	0.205432 ***	0.348046 ***	0.448461 ***	0.521418 ***	0.575820 ***
Inflation	0.114317 ***	0.197423 ***	0.252863 ***	0.289751 ***	0.303947 ***
LnGCF	0.140990 ***	0.235039 ***	0.285269 ***	0.309245 ***	0.315260 ***
LnTFP	0.146173 ***	0.220791 ***	0.249368 ***	0.238413 ***	0.185790 ***

Notes: (***) Significant at the 1%. indicating the rejection of the null hypothesis of the residuals being (iid) at 10%, 5% and 1%, respectively.

Table A2. Unit root ADF test at level and first difference.

		PP unit root test table at level					
		LDCF	LREM	LPOP	INF_CPI	LGCF	LTFP
With Constant	t-Statistic	−1.7065	−1.2079	−7.0597	−3.0559	−2.7913	0.7922
	Prob.	0.4193	0.6639	0.0000	0.0389	0.0693	0.9926
		no	no	***	**	*	no
With Constant & Trend	t-Statistic	−0.697	−2.3048	−1.8057	−3.9463	−2.3116	−1.0191
	Prob.	0.9655	0.4235	0.6817	0.0198	0.4176	0.9289
		no	no	no	**	no	no
Without Constant & Trend	t-Statistic	2.0883	−0.9872	7.7670	−1.538	−1.1012	3.0164
	Prob.	0.9897	0.2856	1.0000	0.1149	0.2406	0.9990
		no	no	no	no	no	no
		At first difference					
		d(LDCF)	d(LREM)	d(LPOP)	d(INF_CPI)	d(LGCF)	d(LTFP)
With Constant	t-Statistic	−8.214	−5.0064	−1.3025	−8.7359	−6.4003	−3.0368
	Prob.	0.0000	0.0001	0.6178	0.0000	0.0000	0.0409
		***	***	no	***	***	**
With Constant & Trend	t-Statistic	−8.8832	−4.9385	−1.471	−8.5618	−7.0016	−2.9851
	Prob.	0.0000	0.0011	0.8211	0.0000	0.0000	0.1501
		***	***	no	***	***	no
Without Constant & Trend	t-Statistic	−7.3256	−5.0671	−1.9968	−8.4845	−6.2735	−2.6743
	Prob.	0.0000	0.0000	0.0452	0.0000	0.0000	0.0089
		***	***	**	***	***	***

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant.

Table A3. Unit root ADF test at level and first difference.

		ADF unit root test table at level					
		LDCF	LREM	LPOP	INF_CPI	LGCF	LTFP
With Constant	t-Statistic	−1.2929	−1.5417	−3.1827	−3.1528	−2.7721	0.0224
	Prob.	0.6211	0.5042	0.0318	0.0312	0.0721	0.9544
		no	no	**	**	*	no
With Constant & Trend	t-Statistic	−1.0131	−3.0839	−3.9101	−3.947	−2.4111	−1.1161
	Prob.	0.9291	0.1217	0.0225	0.0197	0.3682	0.9118
		no	no	**	**	no	no
Without Constant & Trend	t-Statistic	1.7484	−1.0157	1.0651	−1.5363	−1.063	1.8810
	Prob.	0.9783	0.2741	0.9214	0.1153	0.2547	0.9837
		no	no	no	no	no	no
		At first difference					
		d(LDCF)	d(LREM)	d(LPOP)	d(INF_CPI)	d(LGCF)	d(LTFP)
With Constant	t-Statistic	−7.8083	−5.2273	−1.4502	−7.8037	−6.4003	−3.975
	Prob.	0.0000	0.0001	0.5454	0.0000	0.0000	0.0041
		***	***	no	***	***	***
With Constant & Trend	t-Statistic	−8.0064	−5.1741	−3.5426	−7.6944	−6.8141	−4.0057
	Prob.	0.0000	0.0006	0.0527	0.0000	0.0000	0.0177
		***	***	*	***	***	**
Without Constant & Trend	t-Statistic	−7.3256	−5.2017	−1.3909	−7.8273	−6.2815	−3.2618
	Prob.	0.0000	0.0000	0.1496	0.0000	0.0000	0.0018
		***	***	no	***	***	***

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. (no): Not Significant.

Table A4. Breusch-Godfrey Serial Correlation LM Test.

F-statistic	1.382535	Prob. F(1,17)	0.2559
Obs*R-squared	2.481903	Prob. Chi-Sq(1)	0.1152

Table A5. Heteroskedasticity Test: Breusch-Pagan-Godfrey.

F-statistic	1.411643	Prob. F(14,18)	0.2427
Obs*R-squared	17.27032	Prob. Chi-Sq(14)	0.2421
Scaled explained SS	5.126397	Prob. Chi-Sq(14)	0.984

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