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Remittances, financial development, and economic growth in African countries

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Abstract

This study examines the impact of remittances on economic growth in African countries, with a particular focus on the role of financial development. Unlike previous research, it adopts a two-step approach: first, it identifies the key growth determinants using Bayesian inference techniques; second, it estimates panel smooth transition regression (PSTR) models, incorporating these determinants as controls. The results indicate that remittances alone do not have a significant impact on economic growth. However, their positive effects are amplified in the presence of a well-functioning financial system. The study recommends that African policymakers prioritize financial sector reforms to fully harness the growth-enhancing potential of remittances.

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1 Introduction

Do remittances promote economic growth in recipient countries? This question has long divided economists, with no consensus emerging from empirical studies (Cazachevici et al., 2020). While some research highlights a direct positive effect of remittances on economic growth (Cooray, 2012; Nsiah and Fayissa, 2013; Imai et al., 2014), other studies point to a negative impact (Chami et al., 2005; Le, 2009; Singh et al., 2011; Nwosa and Akinbobola, 2016) or no significant effect at all (Rao and Hassan, 2012; Senbeta, 2013; Feeny et al., 2014; Konte, 2018). These divergent findings have prompted researchers such as Giuliano and Ruiz-Arranz (2009), Mundaca (2009), Barajas et al. (2009), Bettin and Zazzaro (2012), Nyamongo et al. (2012), Sobiech (2019) and Saidi (2024) to explore how financial development modulates the relationship between remittances and economic growth.

This line of inquiry has yielded contrasting conclusions. For instance, Giuliano and Ruiz-Arranz (2009) found that remittances enhance economic growth primarily in countries with poorly developed financial systems, where they alleviate credit constraints. Conversely, Nyamongo et al. (2012) provided evidence that remittances and financial development act as complements, with further financial development amplifying the positive effects of remittances on economic growth. In this context, well-functioning financial systems can channel remittances into long-term investments that foster sustainable economic growth (Mundaca, 2009). Despite the ongoing debate in the literature, international institutions consider remittances essential for financing development in recipient countries. For example, remittances were recognized as a potential funding source for achieving the Sustainable Development Goals (SDGs) during the UN Third International Conference on Financing for Development held in Addis Ababa in July 2015. Furthermore, the United Nations General Assembly adopted an International Day of Family Remittances (IDFR) in June 2018.[1]

This article contributes to the ongoing debate by re-examining the conditional relationship between remittances and economic growth, with a particular focus on the role of financial development. In other words, we analyzed how the effects of remittances on economic growth in African countries differ according to the level of financial development.

This study is particularly important given the unique economic challenges faced by the region. It is widely acknowledged that Africa is one of the poorest regions in the world, and remittances can serve as a key lever for development. However, African economies are often marked by underdeveloped financial markets, which significantly shape the way remittances interact with economic growth. Understanding these dynamics is essential for crafting policies that maximize the developmental benefits of remittances. Consequently, focusing on Africa provides valuable insights for countries seeking to harness remittances to address persistent challenges such as poverty.

This paper, closely related to the recent literature exploring the relationship between remittances and economic growth, makes several contributions to this field.

First, we apply recent Bayesian inference techniques to base our analysis on a bias-free growth model. Specifically, using the Weighted Average Least Squares (WALS) method developed by Magnus et al. (2010), we identify the main relevant determinants of economic growth. To the best of our knowledge, no prior studies have addressed the issue of uncertainty in the selection of control variables, risking the omission of key growth determinants. The wide range of growth determinants and possible model specifications can lead to contradictory conclusions (Magnus et al., 2010). Addressing

[1]For further details, see the resolution adopted at: http://undocs.org/A/RES/72/281

this uncertainty is crucial, as arbitrary selection of control variables may introduce estimation bias, undermining the reliability of policy implications (Brock and Durlauf, 2001). Additionally, we assess the potential dependency between these variables using the framework proposed by Doppelhofer and Weeks (2009). This allows us to identify determinants with complementary effects and those with substitutive effects on growth. This analysis is essential because the WALS method evaluates the relevance of variables individually, potentially overlooking the stronger explanatory power of certain variables when considered jointly. To refine the estimates, complementary determinants should be retained, while substitutes can be replaced by a single variable (Doppelhofer and Weeks, 2009; Ley and Steel, 2007).

Second, we rely on panel smooth transition regression (PSTR) models, which allow us to capture the heterogeneity of the remittance effect on economic growth as conditioned by financial development. Unlike previous studies that typically employ interaction terms, assuming a linear relationship between remittances and financial development in driving economic growth, the PSTR approach offers a more nuanced perspective. Specifically, it accounts for the possibility of non-linear and gradual transitions in the remittance-growth relationship, depending on the level of financial development. Our findings reveal that improvements in financial development do not exert a uniform influence on the marginal effect of remittances across its entire spectrum. Instead, the effect varies significantly, with distinct regimes emerging as financial development crosses specific threshold values.

Third, unlike previous studies, we conduct a country-level analysis to provide more granular insights. The PSTR method enables us to identify endogenous threshold values for financial development that mark shifts in the remittances-growth relationship across African countries. This approach allows us to classify countries based on whether their level of financial development is sufficient to harness the growth-enhancing potential of remittances. In particular, we identify which countries have attained the necessary financial maturity to benefit from remittances as a driver of economic growth, as well as those that have not. This distinction is critical for policymakers, as it highlights the need for targeted reforms in countries where financial development remains insufficient. Strengthening financial systems in these contexts could unlock the latent potential of remittances, transforming them into a more effective tool for promoting economic growth.

The remainder of the article is structured as follows: Section 2 outlines the empirical strategy. Section 3 presents the main results, followed by a discussion of their robustness in Section 4. Section 5 concludes the paper.

2 Empirical strategy

2.1 PSTR model

To assess the effects of remittances on economic growth as a function of financial development, we rely on a growth model expressed as follows:

$$y_{it} = \mu_i + \lambda_t + \beta_0 rem_{i,t-1} + \beta_1 rem_{i,t-1} g\left(findev_{i,t-1}; \gamma, c\right) + \alpha' X_{it} + \varepsilon_{it} \tag{1}$$

Where $i = 1, ..., N$ and $t = 1, ..., T$ denote the cross-sectional and time dimensions of the panel, respectively. μ_i and λ_t represent individual and time effects, respectively, and $\varepsilon_{i,t}$ are the error terms. y_{it} is the growth rate of GDP per capita. To address potential reverse causality, we use the first lag of remittances, $rem_{i,t-1}$, and the first lag of financial

development, $findev_{i,t-1}$. This approach is commonly employed to mitigate endogeneity issues in PSTR models (see, for example, Gonzalez et al. (2017) and Jude and Levieuge (2017), among others). $X_{i,t}$ is a matrix of economic growth determinants.

The continuous transition function $g(findev_{i,t-1})$, defined on [0,1], is expressed, following Gonzalez et al. (2017), as follows:

$$g\left(findex_{i,t-1};\gamma,c\right)=\left[1+\exp\left(-\gamma\prod_{j=1}^{m}\left(findex_{i,t-1}-c_j\right)\right)\right]^{-1} \tag{2}$$

with $\gamma>0$ and $c_1<c_2<\cdots<c_m$. γ is the slope of the transition function, and c represents the vector of location parameters such that $c=c_1,\ldots,c_m$, where m is the dimension of the vector.

The transition function $g(findev_{i,t-1})$ introduces smooth, non-linear transitions between regimes defined by the financial development variable. This means that instead of assuming a fixed or linear effect of remittances on growth, the PSTR model enables the relationship to change gradually depending on whether financial development is below or above certain threshold values. The coefficient β_0 represents the marginal effect of remittances on economic growth in the first regime, where financial development is low. The term $\beta_1 g(findev_{i,t-1};\gamma,c)$ captures the additional effect of remittances as financial development increases, transitioning into a second regime. For instance: When $g(findev_{i,t-1})\approx 0$, the growth effect of remittances is close to β_0, reflecting the first regime. When $g(findev_{i,t-1})\approx 1$, the growth effect becomes $\beta_0+\beta_1$, reflecting the second regime where financial development is high. This flexibility allows us to identify not only whether remittances influence economic growth, but also the conditions under which their impact is amplified or diminished.

The sensitivity of growth to remittances is formally expressed as:

$$\frac{\partial y_{i,t}}{\partial rem_{i,t-1}}=\beta_0+\beta_1 g(findev_{i,t-1};\gamma,c) \tag{3}$$

This expression highlights how the marginal effect of remittances evolves across the spectrum of financial development. The slope parameter γ controls the speed of transition between regimes, while the location parameters c_j determine the specific thresholds where the relationship between remittances and growth changes significantly. A high γ value indicates a sharp transition, suggesting distinct regimes, whereas a low γ implies a more gradual transition.

2.2 Selection of the main relevant growth determinants

2.2.1 WALS method

We rely on the WALS method proposed by Magnus et al. (2010) to select control variables. We use the WALS method for three reasons. First, it discriminates between variables of interest and potential control variables. Second, it is based on a more transparent concept of ignorance about the role of potential explanatory variables. Third, it relies on preliminary an orthogonal transformation of potential explanatory variables and their parameters, which greatly reduces the computational burden and allows for more accurate parameter estimation Magnus et al. (2010). The WALS method is based on an empirical growth model which is expressed as follows:[2]

[2]For a detailed discussion of the WALS method, see Magnus et al. (2010).

$$y = X\beta + \epsilon = X_1\beta_1 + X_2\beta_2 + \epsilon, \quad \epsilon \sim \mathcal{N}(0, \sigma^2) \tag{4}$$

where y is a vector representing the dependent variable, X_1 is a $(n \times k_1)$ matrix of interest variables, and X_2 is a $(n \times k_2)$ matrix of potential control variables. β_1 and β_2 are unknown parameter, and ϵ is a vector of Gaussian error terms.

The WALS method addresses uncertainty regarding the choice of explanatory variables by first estimating the parameters conditional on each model within the model space (2^k) and then computing the unconditional estimate as a weighted average of these conditional estimates.

In practice, the relevance of a variable in the explanation of y is given by the t-ratio, analogous to the Student's t-statistic in classical inference. A variable is important for explaining y if the absolute value of its t-ratio is greater than one, and it is considered fundamental if it is greater than two.

2.2.2 Doppelhofer and Weeks' "jointness" measure

Given that the WALS method focuses only on variables individually, we employ the "jointness" measure proposed by Doppelhofer and Weeks (2009) to differentiate determinants with complementary effects from those with substitute effects on growth. The jointness measure is defined as follows:

$$J_{jl} = \ln(\text{rpc}(j, l \mid y)) = \ln\left(\frac{p(j \cap l \mid y)}{p(j \cap \bar{l} \mid y)} \cdot \frac{p(\bar{j} \cap \bar{l} \mid y)}{p(\bar{j} \cap l \mid y)}\right) \tag{5}$$

Here, $p(j \cap l \mid y)$ represents the sum of the posterior probabilities of regression models where both X_j and X_l are included. Similarly, $p(\bar{j} \cap l \mid y)$ refers to the sum of the posterior probabilities of models where X_j is excluded and X_l is included. The terms $p(\bar{j} \cap \bar{l} \mid y)$ and $p(j \cap \bar{l} \mid y)$ are defined analogously.

The interpretation of the jointness measure is as follows: X_j and X_l are significant substitutes when $J_{jl} < -1$ and significant complements when $J_{jl} > 1$. If $-1 \leq J_{jl} \leq 1$, the variables are not significantly associated in explaining y.

2.3 Variables and data

We consider a heterogeneous, unbalanced panel of 41 African countries covering the period 1996–2019.[3] Economic growth is measured as the annual real growth rate of GDP per capita. Remittances are expressed as a percentage of GDP to capture their relative importance in national output.

Following the literature (Sobiech, 2019; Nyamongo et al., 2012), financial development is proxied by two indicators: private credit provided by deposit money banks and other financial institutions, and domestic credit to the private sector, both expressed as a percentage of GDP. These financial development indicators are particularly suitable for this study because they capture a critical constraint to financial development and economic growth in African countries: access to credit. In many African economies, limited access to formal credit markets inhibits entrepreneurial activity, productive investment, and broader economic expansion. By focusing on private credit provided by deposit money banks and domestic credit to the private sector, these indicators reflect

[3]The countries included in this study are listed in Table A1.

the extent to which financial institutions support economic activities, making them highly relevant for analyzing the role of remittances in fostering economic growth.

Regarding the control variables, the literature offers a wide array of possibilities. For instance, Dufrenot et al. (2010) identify 22 potential determinants of economic growth, while Sala-i Martin et al. (2004) highlight 67. Based on data availability, we retain 21 potential control variables, all of which, along with their sources, are detailed in Table A2.

3 Results

3.1 WALS estimates and "jointness" analysis

The results of the WALS method are presented in Table 1. We report only the Bayes factors, as they indicate both the relevance of variables and the sign of the estimated coefficients. In accordance with the specification of our growth equation, two groups of variables are distinguished: the variable of interest, remittances, and the set of potential control variables. Since economic growth is often measured as the rate of change of GDP, the initial GDP may be mechanically correlated with the error term, potentially introducing bias into the estimates. To assess whether its inclusion affects our results, it is excluded in a second step of the analysis.

Regarding our variable of interest, remittances, we find that remittances have no significant effect on economic growth. This result aligns with previous findings by Rao and Hassan (2012); Senbeta (2013); Feeny et al. (2014); Konte (2018).

As for the control variables, we observe that population growth, government expenditures, trade openness, life expectancy, and domestic investment exhibit strong evidence as key determinants of economic growth in African countries. Specifically, their Bayes factors consistently exceed the threshold of two, regardless of the specification retained. Furthermore, the signs of the Bayes factors, and therefore the associated coefficients, are consistent with existing literature.

The coefficient for initial GDP per capita is negative, indicating that countries with lower GDP per capita tend to grow faster, supporting the conditional convergence hypothesis. The coefficients for population growth and domestic investment are negative and positive, respectively, as predicted by Solow's growth model. Similarly, the negative coefficient for government expenditures reflects the government burden, as discussed by Barro (1991). Consistent with Mendoza (1997), we find a positive impact of terms of trade on economic growth. Finally, in line with Owoundi (2016), we observe a negative impact of life expectancy on economic growth in African countries.

INSERT TABLE (1) ABOUT HERE

These findings are further supported by the analysis of jointness relationships between variables, the results of which are reported in Table 2. This analysis reveals that only these main determinants exhibit mutual jointness relationships while also demonstrating significant complementary effects on economic growth.

INSERT TABLE (2) ABOUT HERE

3.2 PSTR estimates

Before estimating the effects of remittances on economic growth conditional on financial development, we test the null hypothesis of linearity and conduct the no remaining heterogeneity test. The former examines whether the effects of remittances on economic growth vary with financial development, while the latter, in addition to serving as a misspecification test, helps determine the number of transitions in the model (Gonzalez et al., 2017).

The results, reported in Table 3, indicate that the null hypothesis of linearity can be rejected. Moreover, they suggest that a two-regime PSTR model effectively captures all the heterogeneity in the remittance parameters, as the null hypothesis of no remaining heterogeneity is not rejected. These findings demonstrate that the impact of remittances on economic growth is nonlinear when financial development is used as the transition variable. This result holds regardless of the financial development measure employed. Accordingly, we proceed with estimating our nonlinear growth model using the PSTR specification, considering one threshold.

INSERT TABLE (3) ABOUT HERE

The parameter estimates are reported in Table 4.[4] Starting with the control variables, all explanatory variable parameters have the expected signs and are statistically significant, regardless of the retained specification. These results confirm the relevance of these determinants in explaining economic growth in African countries. Turning to our main variable of interest, remittances, we observe a strongly non-linear growth effect. Specifically, the impact of remittances on economic growth depends on financial development, with positive effects only materializing once a certain financial development threshold is surpassed. More precisely, the β_0 coefficient, associated with the linear component of the model (the first regime), which corresponds to underdeveloped financial systems, is negative but not statistically significant. In contrast, the results differ significantly in the second regime, corresponding to developed financial systems. In this case, the β_1 and $\beta_0 + \beta_1$ coefficients, associated with the non-linear component and the second regime, respectively, are positive and statistically significant.

This result, align with previous findings by Mundaca (2009), Nyamongo et al. (2012) or Saidi (2024), underscores the critical role of financial development in enabling the productive use of remittances for economic growth. In underdeveloped financial systems, the lack of efficient credit allocation mechanisms, limited access to formal banking services, and weak financial infrastructure may prevent remittances from being channeled into productive investments, such as business creation or capital accumulation. Instead, remittances in such contexts are often used for consumption or informal activities, which, while beneficial for short-term welfare, do not translate into sustained economic growth. Conversely, in developed financial systems, the presence of well-functioning financial institutions facilitates the mobilization of remittances into formal financial channels. This enables recipients to invest in long-term growth-enhancing projects, such as education, infrastructure, and entrepreneurship, amplifying the growth impact of remittances. The positive and significant coefficients in the second regime confirm that financial development acts as a catalyst, transforming remittances into a powerful tool for

[4]Fixed time effects are included in our econometric specifications to control for the evolution of countries' institutional environments. Our findings remain unchanged when fixed time effects and initial GDP per capita are excluded (see Table A3 in the appendices)

economic growth. This finding highlights the importance of prioritizing financial sector reforms to maximize the developmental potential of remittance flows.

INSERT TABLE (4) ABOUT HERE

Table 5 presents, for each country, the average estimated sensitivity of remittances to the average level of financial development over the period under consideration.[5] The results indicate that the average impact of remittances on economic growth varies significantly across countries and is positively correlated with the level of financial development. This relationship is further illustrated in Figure 1 and 2, which plot the country-level average sensitivity of remittances against the corresponding average level of financial development. Moreover, Table 5 highlights that only a subset of countries—Cabo Verde, Egypt, Kenya, Mauritius, Morocco, Namibia, South Africa, and Tunisia—exhibit a statistically significant positive impact of remittances on economic growth at the 5% significance level. These findings emphasize the importance of financial development in determining the growth-enhancing potential of remittances.

INSERT TABLE (5) ABOUT HERE

Figure 1 and 2 provide a detailed analysis of the effect of remittances on economic growth across countries by using historical financial development values and the identified threshold at which remittances have a positive and significant impact (at the 5% level). The findings reveal three distinct categories of countries based on their financial development and the corresponding impact of remittances.

INSERT Figure (1) ABOUT HERE

INSERT Figure (2) ABOUT HERE

Cabo Verde, Egypt, Kenya, Mauritius, Morocco, Namibia, South Africa, and Tunisia consistently exhibit a positive and statistically significant elasticity of economic growth with respect to remittances throughout the period under consideration. These countries have well-developed financial systems, characterized by effective credit allocation mechanisms, broader access to formal banking, and robust financial infrastructure. These features enable them to efficiently channel remittances into productive investments such as entrepreneurship, education, and infrastructure, thereby fostering sustained economic growth. For instance, Morocco and Egypt, as some of the largest recipients of remittances in Africa, have established financial policies that integrate remittance flows into formal financial channels, amplifying their developmental potential.

On the other end of the spectrum, countries such as Burundi, Cameroon, Comoros, Democratic Republic of Congo, Republic of Congo, Eswatini, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Lesotho, Madagascar, Malawi, Niger, Rwanda, Sierra Leone, Sudan, Tanzania, and Uganda consistently fall below the financial development threshold. As a result, remittances fail to generate any significant positive impact on economic growth in these nations. This is due to their underdeveloped financial systems, which are characterized by limited access to credit, weak institutional frameworks, and insufficient

[5]This analysis is conducted based on the results from column 2, i.e., a threshold of 16.25 for Private Credit by Deposit Money Banks and Other Financial Institutions, and column 3, i.e., 16.69 for Domestic Credit to the Private Sector.

banking penetration. Without adequate financial infrastructure, remittances are often diverted towards consumption or informal activities rather than productive investments, diluting their growth-enhancing potential. For these countries, prioritizing financial sector reforms—such as improving banking services, expanding credit access, and strengthening financial institutions—must precede any policy measures aimed at leveraging remittance flows for economic growth.

An interesting subset of countries, including Algeria, Angola, Benin, Botswana, Burkina Faso, Ivory Coast, Mali, Mozambique, Senegal, São Tomé and Príncipe, and Togo, have transitioned from the low to high regime during the period under study. These countries have made notable progress in improving their financial systems, which has allowed them to cross the threshold required for remittances to have a positive and significant impact on economic growth. The financial reforms and policy efforts undertaken—such as expanding access to banking, promoting financial literacy, and implementing regulatory improvements—have enhanced the ability of these economies to utilize remittance flows productively. For instance, Senegal has significantly improved its financial infrastructure in recent years, which has amplified the growth-enhancing effects of remittances.

4 Robustness check

To test the robustness of our results, we perform additional analyses. First, in the initial specification, financial development is considered as the threshold variable. However, since financial development may itself have a nonlinear influence on economic growth (Eggoh and Villieu, 2013), there is a risk of erroneously identifying switching remittance parameters (Fouquau et al., 2008; Ahamada and Coulibaly, 2011). To address this potential issue, we conduct an alternative specification in which financial development is also treated as a switching variable. The revised model incorporates the possibility of a nonlinear influence of financial development on economic growth and is defined as follows:

$$y_{it} = \mu_i + \lambda_t + \beta_{0,1} rem_{i,t-1} + \beta_{0,2} findev_{i,t-1} + [\beta_{1,1} rem_{i,t-1} + \beta_{1,2} findev_{i,t-1}]\, g\left(findev_{i,t-1}; \gamma, c\right) + \alpha' X_{it} + \varepsilon_{it} \quad (6)$$

Table 6 presents the estimated coefficients of the corresponding models. Consistent with our earlier findings, the results confirm that the positive effects of remittances on economic growth in African countries only materialize once a certain financial development threshold has been reached.

INSERT TABLE (6) ABOUT HERE

5 Conclusion

In conclusion, this analysis highlights the heterogeneity of remittance impacts across African countries, emphasizing the central role of financial development. For countries with underdeveloped financial systems, prioritizing financial reforms is imperative to unlock the potential of remittances. Meanwhile, countries that have transitioned to the high regime offer valuable lessons on the importance of sustained efforts to strengthen financial infrastructure. For countries already benefiting from remittance flows, further financial innovation and integration can enhance their impact, driving sustainable economic growth.

Table 1: WALS Estimation Results

	Variables	Private Credit		Domestic Credit	
		Bayes Factor		Bayes Factor	
Interest Variable	Remittances	0.03	0.49	0.25	0.05
Potential Control Variables	Initial GDP per capita	**-2.71**	-	**-2.73**	-
	Population growth	**-4.11**	**-3.27**	**-4.08**	**-3.22**
	Government expenditure	**-2.33**	**-2.77**	**-3.36**	**-2.80**
	Terms of trade	**3.07**	**2.42**	**3.10**	**2.44**
	Life expectancy	**-2.71**	**-2.66**	**-2.73**	**-2.67**
	Domestic investment	**1.99**	**2.33**	**2.01**	**2.36**
	Political stability	-1.58	-1.86	-1.54	-1.81
	Inflation	-0.94	-1.61	-0.88	-1.56
	Private expenditure	-0.39	1.48	0.37	1.49
	Internet	-0.50	-1.15	-0.64	-1.31
	Government effectiveness	1.69	1.36	1.61	1.29
	Financial development	-0.72	-0.32	-0.43	-0.39
	FDI	1.17	1.35	1.14	1.32
	Rule of law	0.77	0.84	0.84	0.87
	Trade openness	1.03	0.65	1.04	0.67
	Primary school enrolment	0.26	0.74	0.26	0.71
	Official development assistance	0.75	0.67	0.80	0.63
	Primary school enrolment GPI	-0.26	-0.52	-0.21	-0.47
	Military expenditure	1.13	0.30	1.17	0.33
	Area	0.20	0.39	0.15	0.34
	Voice and accountability	-0.16	-0.27	-0.18	-0.29
	Regulatory quality	0.32	0.25	0.23	0.20
	Control of corruption	-0.23	-0.18	-0.16	-0.15

Note: This table reports the Bayes factors. A variable is considered important for explaining economic growth if the absolute value of its Bayes factor is greater than 1. It is classified as fundamental or highly relevant if its Bayes factor exceeds 2.

Table 2: Jointness statistics (Doppelhofer-Weeks Measure)

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Population growth	-	**7.15**	**5.62**	**3.62**	**2.13**	0.15	0.98	-0.42	0.35	0.99	-1.53	-0.78	-1.38	-1.09	0.4	0.97	0.58	-0.18	-0.52	-1.04	0.98	1.02
2	Government expenditure		-	1.55	**3.33**	**2.79**	-1.05	0.52	-1.67	0.06	0.27	-0.04	0.51	0.16	0.10	0.28	0.81	0.66	-0.29	0.83	0.41	-1.11	**2.91**
3	Terms of trade			-	1.63	-0.02	-0.04	-0.60	0.13	-0.17	0.28	-0.00	0.35	0.58	-0.10	-0.00	-0.32	0.98	0.50	0.63	-0.15	0.35	**3.25**
4	Life expectancy				-	1.75	-1.79	0.16	-0.30	-0.21	0.29	-0.27	-0.39	0.59	-0.00	0.00	-0.60	0.94	-0.28	0.43	-0.07	-0.59	1.00
5	Domestic investment					-	-0.28	0.14	-1.97	-0.89	-0.18	-0.53	-0.63	-0.88	-0.01	0.00	-0.53	-0.08	0.33	0.21	-0.00	-0.83	0.41
6	Internet						-	0.03	-0.09	-0.06	-0.09	-0.08	-0.10	-0.24	0.02	-0.05	0.04	-0.40	0.26	-0.00	0.02	0.10	-1.38
7	Political Stability							-	0.08	0.12	0.01	-0.16	0.58	-0.19	-0.01	0.06	-0.16	0.28	-0.30	0.09	0.10	-0.05	0.18
8	FDI								-	0.24	0.19	0.08	-0.70	0.79	0.03	-0.09	-0.09	0.43	-0.22	-0.30	0.02	0.47	-0.37
9	Private expenditure									-	-0.01	-0.12	0.05	-0.09	0.12	0.13	0.06	-0.05	-0.01	0.12	0.04	-0.11	-1.00
10	Inflation										-	-0.10	0.00	0.11	0.06	0.02	0.06	0.09	-0.09	.01	-0.16	-0.22	0.31
11	Area											-	0.60	-0.18	-0.17	0.00	0.09	0.09	-0.01	-0.03	0.02	-0.27	-0.03
12	Trade openness												-	0.33	-0.03	-0.02	-0.23	0.65	-0.08	-0.41	0.04	0.00	1.00
13	Military expenditure													-	-0.08	0.03	0.21	0.24	0.11	0.14	-0.13	0.27	0.83
14	Primary school Enrolment														-	-0.05	-0.05	-0.02	0.07	-0.01	0.10	-0.02	-0.26
15	Primary school Enrolment GPI															-	0.00	-0.14	-0.16	0.12	-0.09	-0.02	-0.27
16	Control of Corruption																-	-1.59	-0.65	-0.78	-0.15	0.43	-0.00
17	Government Effectiveness																	-	**-2.15**	**-2.25**	-0.18	0.01	0.98
18	Regulatory Quality																		-	-1.03	-0.14	-0.19	0.77
19	Rule of Law																			-	0.08	0.18	0.52
20	Voice and Accountability																				-	0.00	0.05
21	Official development assistance																					-	0.55
22	Initial GDP per capita																						-

Note: two variables are significantly substitutable (respectively complementary) to explain economic growth when $\beta < 0$ (respectively $\beta > 0$). They are strongly significant substitutes (respectively complements) if $|\beta| > 2$, and they are not significantly associated if $\beta = 0$.

Table 3: LM and F Tests for Homogeneity and No Remaining Heterogeneity (p-values)

	Threshold Variable: Financial Development	
	LM Test	**F Test**
	H_0: Linearity vs H_1: PSTR Model	
Private credit by deposit money banks and other financial institutions	0.020	0.029
Domestic credit to the private sector	0.021	0.031
	H_0: PSTR Model ($m = 1$) vs H_1: PSTR Model ($m = 2$)	
Private credit by deposit money banks and other financial institutions	0.112	0.121
Domestic credit to the private sector	0.118	0.127

Table 4: PSTR Estimation Results

Variable		**Private Credit**		**Domestic Credit**	
Remittances	**Regime 1**	-0.056	-0.042	-0.068	-0.056
	β_0	(0.044)	(0.03)	(0.048)	(0.04)
	Non-linear part	0.116***	0.108**	0.133***	0.128**
	β_1	(0.04)	(0.042)	(0.05)	(0.051)
	Regime 2	0.0604***	0.066***	0.065***	0.071***
	$\beta_0 + \beta_1$	(0.013)	(0.015)	(0.014)	(0.016)
Location Parameter		16.25***	16.25***	16.69***	16.69***
		(3.6)	(3.28)	(5.5)	(5.05)
Slope Parameter		0.965***	0.11***	0.082***	0.09***
		(0.021)	(0.027)	(0.018)	(0.021)
Control Variables					
Initial GDP per capita		-0.519***	-	-0.51***	-
		(0.11)	-	(0.11)	-
Population growth		-0.119***	-0.104***	-0.116***	-0.101***
		(0.024)	(0.03)	(0.024)	(0.03)
Government expenditure		-0.018**	-0.023***	-0.019***	-0.023***
		(0.007)	(0.008)	(0.007)	(0.008)
Terms of trade		0.0018**	0.0019***	0.0017**	0.0018***
		(0.0008)	(0.00086)	(0.0008)	(0.0008)
Life expectancy		-0.0008	-0.005	-0.0001	-0.0043
		(0.007)	(0.008)	(0.007)	(0.008)
Domestic investment		0.0049*	0.0063**	0.0046*	0.006*
		(0.0027)	(0.003)	(0.0028)	(0.0029)

Note: Standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

Table 5: Individual average estimated impact

Country	**Private credit**		**Domestic credit**	
	Model I	**Model II**	**Model III**	**Model IV**
	Average	**Average elasticity**	**Average**	**Average elasticity**
Algeria	11.97	-0.010	12.76	-0.013
Angola	10.02	-0,015	11.43	-0.016
Benin	15.38	0.000	15.37	-0.005
Botswana	21.28	0.016	21.81	0.012
Burkina Faso	16.74	0.004	16.99	-0.001
Burundi	17.68	0,006	16.70	-0.002
Cabo Verde	**44.33**	**0.053**	**48.00**	**0.056**
Cameroon	9.54	-0.016	10.25	-0.019
Comoros	14.33	-0.003	8.87	-0.023
Congo, Dem. Rep.	2.69	-0.031	3.47	-0.035
Congo, Rep.	7.97	-0.020	8.38	-0.024
Ivory Coast	16.03	0.002	13.34	-0.011
Egypt, Arab Rep.	**37.42**	**0.047**	**40.97**	**0.049**
Eswatini	15.92	0.001	17.14	-0.001
Ethiopia	19.16	0.010	20.35	0.008
Gabon	9.80	-0.015	10.64	-0.018
Gambia	6.47	-0.023	10.10	-0.020
Ghana	10.58	-0.013	13.21	-0.011
Guinea	4.05	-0.029	5.28	-0.031
Guinea-Bissau	5.25	-0.026	6.47	-0.028
Kenya	**24.48**	**0.024**	**27.22**	**0.026**
Lesotho	11.95	-0.010	13.47	-0.011
Madagascar	9.95	-0.015	10.88	-0.018
Malawi	6.99	-0.022	8.79	-0.023
Mali	15.77	0.001	17.25	0.000
Mauritius	**72.53**	**0.060**	**76.05**	**0.064**
Morocco	**61.83**	**0.059**	**61.74**	**0.062**
Mozambique	16.43	0.003	17.95	0.002
Namibia	**46.85**	**0.055**	**48.25**	**0.056**
Niger	8.77	-0.018	9.14	-0.022
Nigeria	11.00	-0.012	11.76	-0.015
Rwanda	12.38	-0.009	13.48	-0.011
Senegal	17.96	0.007	18.51	0,003
Sierra Leone	3.66	-0.029	4.32	-0.033
South Africa	**130.06**	**0.060**	**137.03**	**0.065**
Sudan	17.42	0.005	24.18	0.018
São Tomé and Principe	17.42	0.005	24.18	0.018
Tanzania	8.32	-0.019	8.85	-0.023
Togo	20.50	0.014	22.81	0.015
Tunisia	**63.30**	**0.059**	**66.58**	**0.063**
Uganda	9.09	-0.017	10.75	-0.018

Figure 1: Elasticities of Growth with Respect to remittances conditional on financial development (Private credit by deposit money banks and other financial institutions as percent of GDP)

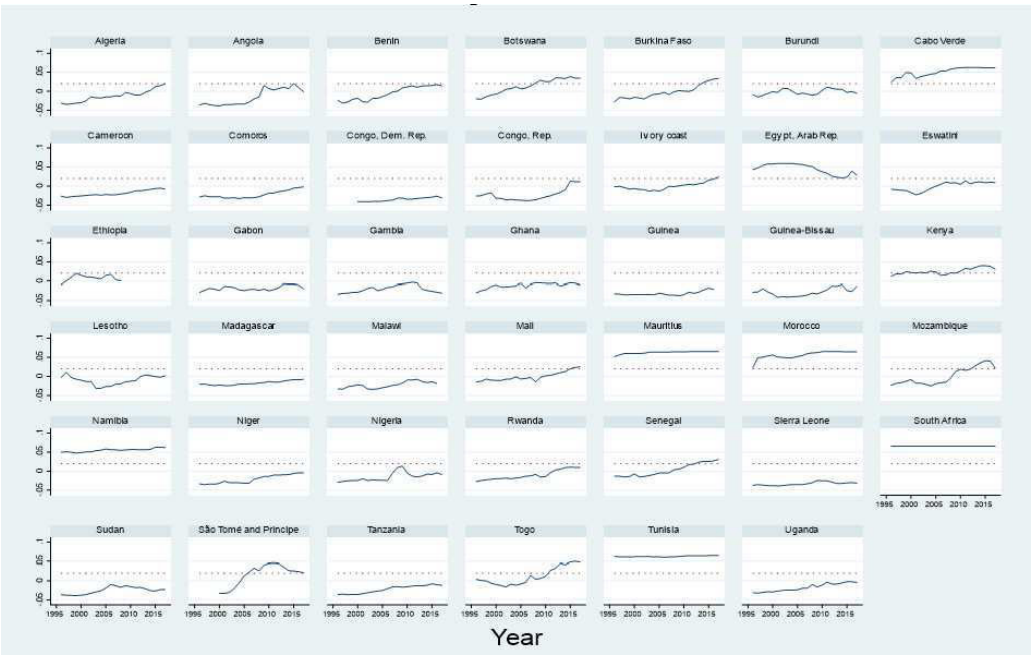

Figure 2: Elasticities of Growth with Respect to remittances Conditional on financial development (Domestic credit to the private sector as percent of GDP)

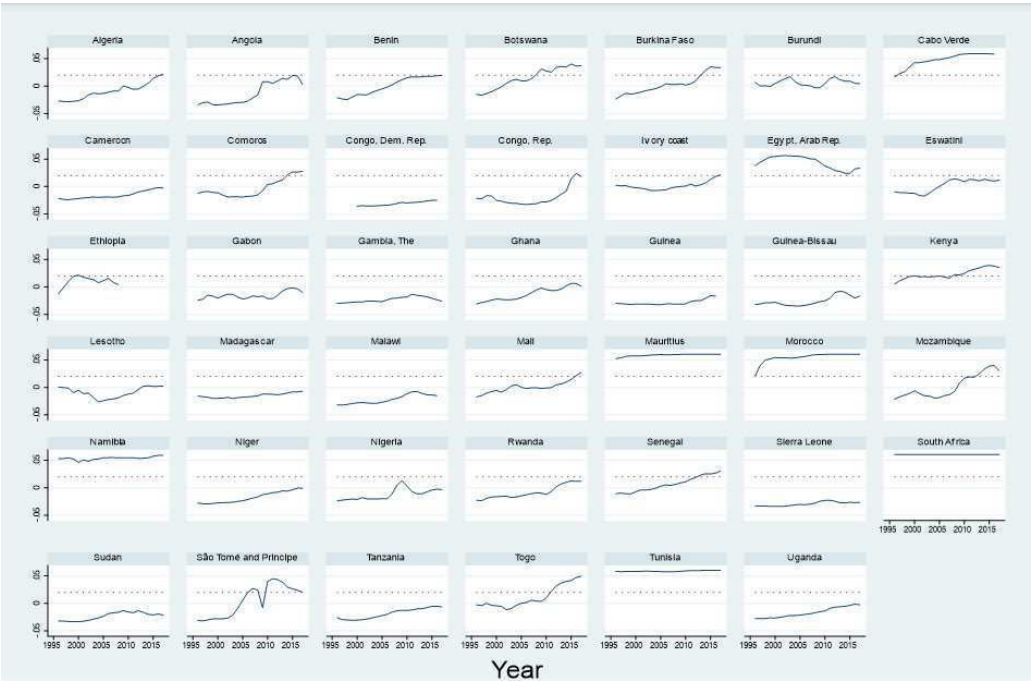

Table 6: PSTR estimations results: Robustness check

Variable		**Private credit**		**Domestic credit**	
		Model I	**Model II**	**Model III**	**Model IV**
Remittances	**Regime 1**	-0.04	-0.038	-0.051	-0.045
	β_{01}	(0.036)	(0.034)	(0.041)	(0.039)
	Non-linear part	0.0911***	0.089***	0.101**	0.103**
	β_{11}	(0.036)	(0.034)	(0.04)	(0.04)
	Regime 2	0.0457***	0.051***	0.048***	0.057***
	$\beta_{01}+\ \beta_{11}$	(0.009)	(0.0104)	(0.01)	(0.011)
Financial development	**Regime 1**	-0.037	-0.046	-0.019	-0.026
	β_{02}	(0.038)	(0.0042)	(0.02)	(0.0023)
	Non-linear part	0.035	0.0041	0.02	0.0025
	β_{12}	(0.026)	(0.003)	(0.018)	(0.0021)
	Regime 2	-0.0024	0.0041	0.0003	-0.001
	$\beta_{02}+\ \beta_{12}$	(0.0025)	(0.0026)	(0.0023)	(0.002)
Location parameter		16.25**	16.25**	16.69**	16.69**
		(7.73)	(7.21)	(7.5)	(6.91)
Slope parameter		0.115***	0.117***	0.109***	0.109***
		(0.03)	(0.035)	(0.033)	(0.03)
Control variables					
Initial GDP per capita		-0.443***	-	-0.494***	-
		(0.11)	-	(0.11)	-
Population growth		-0.12***	-0.112***	-0.116***	-0.105***
		(0.024)	(0.027)	(0.024)	(0.028)
Government expenditure		-0.0134**	-0.026***	-0.021**	-0.026***
		(0.006)	(0.009)	(0.0089)	(0.009)
Terms of trade		0.0022***	0.0023***	0.002**	0.0021**
		(0.0008)	(0.0008)	(0.0008)	(0.0008)
Life expectancy		-0.006	-0.0092	-0.001	-0.006*
		(0.0068)	(0.0074)	(0.007)	(0.008)
Domestic investment		0.006*	0.0076**	0.0053*	0.007**
		(0.0034)	(0.0031)	(0.003)	(0.0031)

Note: standard errors are in parentheses. ***, ** and * denote respectively significance at 1%, 5% and 10% levels.

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A Appendices

Table A1: Countries covered in the study

Country	**Economic Growth**	**Remittances**	**Private credit**	**Domestic credit**
Algeria	1.78	1.07	11.97	12.76
Angola	2.40	0.02	10.02	11.43
Benin	1.40	2.73	15.38	15.37
Botswana	2.59	0.47	21.28	21.81
Burkina Faso	2.73	2.12	16.74	16.99
Burundi	-0.47	1.09	17.68	16.70
Cabo Verde	4.35	12.31	44.33	48.00
Cameroon	1.55	0.52	9.54	10.25
Comoros	0.67	10.19	14.33	8.87
Congo, Dem. Rep.	0.36	1.61	2.69	3.47
Congo, Rep.	0.40	0.27	7.97	8.38
Ivory coast	0.69	1.09	16.03	13.34
Egypt, Arab Rep.	2.43	5.09	37.42	40.97
Eswatini	2.20	2.96	15.92	17.14
Ethiopia	5.02	1.08	19.16	20.35
Gabon	-0.97	0.10	9.80	10.64
Gambia	-0.006	10.38	6.47	10.10
Ghana	3.27	2.16	10.58	13.21
Guinea	1.94	0.77	4.05	5.28
Guinea-Bissau	-0.52	4.58	5.25	6.47
Kenya	1.45	2.24	24.48	27.22
Lesotho	2.85	39.65	11.95	13.47
Madagascar	0.18	2.07	9.95	10.88
Malawi	1.38	0.34	6.99	8.79
Mali	1.92	4.30	15.77	17.25
Mauritius	3.70	1.26	72.53	76.05
Morocco	2.66	6.60	61.83	61.74
Mozambique	4.56	1.06	16.43	17.95
Namibia	2.30	0.38	46.85	48.25
Niger	0.86	1.71	8.77	9.14
Nigeria	2.78	3.81	11.00	11.76
Rwanda	4.33	1.32	12.38	13.48
Senegal	1.84	6.95	17.96	18.51
Sierra Leone	2.18	1.53	3.66	4.32
South Africa	1.27	0.23	130.06	137.03
Sudan	3.81	2.92	17.42	24.18
São Tomé and Principe	2.69	2.92	17.42	24.18
Tanzania	3.16	0.39	8.32	8.85
Togo	0.90	6.93	20.50	22.81
Tunisia	2.56	4.31	63.30	66.58
Uganda	2.88	4.29	9.09	10.75

Table A2: Variable Descriptions

Variable	Description	Source
Dependent Variable		
Growth	Annual growth of GDP per capita in purchasing power parity 2017 US$	WDI
Interest Variables		
Remittances	Remittances as a share of GDP. Includes i) private transfers from migrant workers residing in the host country for more than a year to their home country, ii) migrants' transfers of net worth during migration, and iii) compensation of employees for migrants residing in the host country for less than a year.	GFDD
Private credit by deposit money banks and other financial institutions	Loans provided by commercial banks and other financial institutions as a share of GDP.	GFDD
Domestic credit to the private sector	Domestic loans to the private sector as a share of GDP.	GFDD
Control Variables		
Initial GDP per capita	Log of GDP per capita (PPP), in the first year of each five-year sub-period, expressed in constant 2017 US$.	WDI
Government expenditure	General government final consumption as a share of GDP.	WDI
Private expenditure	Private final consumption as a share of GDP.	WDI
Population growth	Annual growth rate of total population.	WDI
Domestic investment	Gross fixed capital formation as a share of GDP.	WDI
Trade openness	Total imports and exports as a share of GDP.	WDI
Inflation	Annual percentage change in the Consumer Price Index.	WDI
FDI	Net inflows of foreign direct investment as a percentage of GDP.	WDI
Terms of trade	Ratio of export to import prices.	WDI
Life expectancy	Life expectancy at birth.	WDI
Primary School Enrolment	Gross enrolment ratio, regardless of age, as a percentage of the population corresponding to the official school age.	WDI
Primary Enrolment GPI	Gender parity index for gross primary enrolment, ratio of girls to boys enrolled in public and private schools.	WDI
Military expenditure	Military expenditure as a percentage of GDP.	WDI
Area	Log of the country's total area in square kilometers.	WDI
Internet	Percentage of individuals using the Internet.	WDI
Official development assistance	Official development assistance as a percentage of GDP.	WDI
Government Effectiveness	Quality of public services, civil service independence, policy formulation, and implementation credibility.	WGI
Political Stability	Likelihood of political instability and/or politically motivated violence or terrorism.	WGI
Regulatory Quality	Ability to formulate and implement sound policies and regulations that promote private sector development.	WGI
Rule of Law	Confidence in the quality of contract enforcement, property rights, police, and courts.	WGI
Voice and Accountability	Freedom of expression, association, and media, and citizens' ability to select their government.	WGI
Control of Corruption	Extent to which public power is exercised for private gain, including corruption and state capture.	WGI

Table A3: PSTR estimations results (without temporal effects)

Variable		**Private credit**		**Domestic credit**	
		Model I	**Model II**	**Model III**	**Model IV**
Remittances	**Linear part**	-0.046	-0.034	-0.054	-0.04
	β_0	(0.031)	(0.029)	(0.036)	(0.034)
	Non-linear part	0.103***	0.091***	0.114**	0.103**
	β_1	(0.03)	(0.03)	(0.04)	(0.043)
	Regime 2	00.057***	0.057***	0.059***	0.06***
	$\beta_0 + \beta_1$	(0.014)	(0.011)	(0.014)	(0.014)
Location parameter		16.25***	16.25***	16.69***	16.69***
		(3.93)	(3.92)	(5.21)	(5.1)
Slope parameter		0.094***	0.098***	0.082***	0.086***
		(0.02)	(0.021)	(0.016)	(0.017)
Control variables					
Initial GDP per capita		-0.404***	-	-0.397***	-
		(0.118)	-	(0.118)	-
Population growth		-0.137***	-0.13***	-0.137***	-0.129***
		(0.021)	(0.028)	(0.02)	(0.029)
Government expenditure		-0.019**	-0.023**	-0.02**	-0.024**
		(0.0083)	(0.008)	(0.008)	(0.008)
Terms of trade		0.0022***	0.002**	0.0022***	0.0019**
		(0.0007)	(0.0008)	(0.0007)	(0.0008)
Life expectancy		-0.005	-0.016**	-0.0053	-0.0164***
		(0.007)	(0.006)	(0.008)	(0.0069)
Domestic investment		0.0053*	0.0064**	0.00511*	0.0062**
		(0.003)	(0.003)	(0.003)	(0.0030)

Note: standard errors are in parentheses. ***, ** and * denote respectively significance at 1%, 5% and 10% levels.