

# Economic Growth, Remittances and Foreign Direct Investment in Sub-Saharan Africa: A Panel Causality Analysis

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# **Economic Growth, Remittances and Foreign Direct Investment in Sub-Saharan Africa: A Panel Causality Analysis**

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**Abstract:** This paper investigates the causalities between economic growth, remittances and foreign direct investment in Sub-Saharan African (SSA) countries. To this end, we develop a panel Granger causality approach based on the seemingly unrelated regression system and Wald tests, with country-specific bootstrap critical values. Our methodology allows to evaluate simultaneously causality between remittances, foreign direct investment and economic growth, taking into account countries interdependence and heterogeneity. Using annual data over the period 1995-2023, we find that remittances impact economic growth only in Burkina Faso, whereas there is no impact of economic growth on remittances in any SSA countries. Moreover, foreign direct investment promotes economic growth in Niger and Sierra Leone, and economic growth favors foreign direct investment in Benin, Kenya and Mali. Our results also suggest that remittances and foreign direct investment are complementary financial flows notably in Niger, Mali and Togo.

**Keywords:** Foreign direct investment, Remittances, Economic growth, Causality, Sub-Saharan Africa.

**JEL Classification:** C33, F21, F24.

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## **Croissance économique, transfert de fonds et investissement direct étranger en Afrique subsaharienne : une analyse de la causalité en panel**

Résumé : Cet article examine les relations de causalité entre la croissance économique, les transferts de fonds des migrants et les investissements directs étrangers dans les pays d'Afrique subsaharienne. Pour cela, nous développons des tests de causalité en données de panel, fondés sur un système de régressions apparemment non liées et sur des tests de Wald, avec des valeurs critiques obtenues par *bootstrap* spécifiques à chaque pays. Notre méthodologie permet d'évaluer simultanément les relations de causalité entre les transferts de fonds, les investissements directs étrangers et la croissance économique, tout en tenant compte de l'interdépendance et de l'hétérogénéité entre les pays. À partir de données annuelles couvrant la période 1995-2023, nous constatons que les transferts de fonds ont un effet sur la croissance économique uniquement au Burkina Faso, tandis qu'aucun effet de la croissance économique sur les transferts de fonds n'est observé dans les pays d'Afrique subsaharienne étudiés. Par ailleurs, les investissements directs étrangers favorisent la croissance économique au Niger et en Sierra Leone, tandis que la croissance économique stimule les investissements directs étrangers au Bénin, au Kenya et au Mali. Nos résultats suggèrent également que les transferts de fonds et les investissements directs étrangers constituent des flux financiers complémentaires, notamment au Niger, au Mali et au Togo.

Mots-clés : Investissement direct à l'étranger, transfert de fonds, croissance économique, causalité, Afrique subsaharienne.

Classification JEL : C33, F21, F24.

## 1. Introduction

Promoting sources of funding that favor growth and reduce poverty, especially in Sub-Saharan African (SSA) countries, is a crucial development issue. In 2024, according to the World Bank, six Sub-Saharan African (SSA) countries are classified as low-income economies,<sup>3</sup> whereas ten as lower-middle income economies,<sup>4</sup> and only four as upper-middle income economies.<sup>5</sup> In this area of the world, private external sources of funding have increased considerably in recent decades: since 1995, foreign direct investment and remittances have multiplied, respectively, by 2.1 and 8.7, whereas GDP per capita has multiplied by only 0.4. Currently, these external private sources of funding represent nearly 5 percent of the GDP of SSA countries against less than 2 percent in 1995. Then, understanding in which way these two major external sources of funding jointly interact and contribute to growth is mainly useful for economic forecast and policies implementation. For example, international institutions promote global efforts to reduce the transaction costs of migrant remittances in order to boost official flows especially in Africa (UN, 2022). Yet, if remittances and foreign direct investment are complementary or substitutable, an increase in official remittances could induce an increase or a decrease in foreign direct investment and then induce a feedback impact on growth depending on inter-causality between foreign direct investment and growth. Then, proper global evaluations of development policies which notably intend to favor remittances, or foreign direct investment, has to identify inter-causalities between remittances and growth, between foreign direct investment and growth, as well as between remittances and foreign direct investment.

The aim of this paper is to understand how foreign direct investment and remittances interact and contribute to the economic growth of SSA countries taking into account simultaneously countries interdependence and heterogeneity. For this purpose, we developed a bootstrap panel Granger causality approach based on the Seemingly Unrelated Regression (SUR) system and Wald tests, with country-specific bootstrap critical values. Our methodology extends the seminal bivariate model proposed by Kónya (2006)<sup>6</sup> by notably including a third variable. To the best of our knowledge, the present contribution is the first that accounts for and estimates simultaneously all potential causalities between foreign direct investment, remittances, and economic growth, as well as both heterogeneity and cross-sectional dependence between

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<sup>3</sup> Burkina Faso, Madagascar, Mali, Niger, Sierra Leone and Togo. Low-income economies have a GNI per capita of \$1,145 or less.

<sup>4</sup> Benin, Cabo Verde, Cameroon, Côte d'Ivoire, Eswatini, Ghana, Kenya, Lesotho, Nigeria and Senegal. Lower-middle income economies have a GNI per capita between \$1,146 and \$4,515.

<sup>5</sup> Botswana, Gabon, Namibia and South Africa. Upper-middle income economies have a GNI per capita between \$4,516 and \$14,005.

<sup>6</sup> The seminal work of Kónya (2006) analyses Granger causality between exports and GDP in OECD countries.

countries. Hence, our methodological implementation allows us to extend the macroeconomic literature on these external funding sources and growth according to three main issues.

We simultaneously investigate potential inter-causalities between economic growth and each of both financial flows. Indeed, remittances, as foreign direct investment, potentially impact and are impacted by economic growth. For instance, a part of remittances can be invested in physical and human capital and, then, favors economic growth whereas altruism can motivate migrants to remit to alleviate the poverty of their relatives particularly during recession; foreign direct investment can boost growth through capital spillover and knowledge transfers, but can also be attracted by faster-growing markets. Then, whereas inter-causalities between economic growth and remittances or foreign direct investment have been investigated by previous research, the literature lack of studies which simultaneously estimate inter-causalities between economic growth and remittances as well as between economics growth and foreign direct investment.

Moreover, remittances and foreign direct investment are likely to impact and cause each other. For example, remittances can raise the productivity of foreign direct investment by financing complementary input as human capital, whereas remittances can crowd foreign direct investment if a part of remittances is invested in physical capital. Remittances and foreign direct investment also impact and are impacted by financial development. Yet, if remittances and foreign direct investment are likely to interact, as far as we know, the present contribution is the first which estimate properly inter-causalities between these both financial flows.

Finally, by controlling the presence of both cross-country heterogeneity and cross-sectional dependence, the present analysis investigates properly causalities in each SSA country taking into account interdependence between SSA countries. Indeed, SSA countries are notably characterized by deep trade links and high correlation of GDP and business cycles.<sup>7</sup>

To conduct the empirical analysis, we use annual data from 1995 to 2023 for 20 SSA countries. Our results confirm heterogeneity and cross-sectional dependence between the 20 SSA countries. We show that remittances impact economic growth only in Burkina Faso, whereas there is no impact of economic growth on remittances in any SSA countries. Moreover, foreign direct investment promotes economic growth in Niger and Sierra Leone, and economic growth favors foreign direct investment in Benin, Kenya and Mali. Our results also suggest that remittances and foreign direct investment are complementary financial flows notably in Niger, Mali and Togo.

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<sup>7</sup> See, for example, Fankem and Mbesa (2023). We also propose a complete and detailed statistical database to demonstrate these points. All results are available upon request from the authors.

The paper is organized as follows. Section 2 surveys and discusses the existing literature. Section 3 presents the econometric methodology. Section 4 describes the data. Section 5 reports and discusses the empirical results. Section 6 concludes with some suggestions for future works.

## **2. Literature review**

A large literature sets out to analyze the implications of foreign direct investment and remittances for developed and developing countries (Islamaj and Kose, 2022).<sup>8</sup> Nevertheless, most of the macroeconomic empirical literature tests bivariate causality relations between economic growth and foreign direct investment or remittances.

According to the OECD (2002) survey on foreign direct investment, 11 out of the 14 empirical studies which are documented conclude that foreign direct investment contributes to economic growth. Nevertheless, a major part of these studies is based on cross-country regressions and suffers from a simultaneity bias between foreign direct investment and economic growth. However, notably if foreign direct investment can favor growth through capital spillover, knowledge transfers or trade openness, foreign direct investment can also be attracted by faster-growing markets (de Mello, 1997), especially when financial markets are sufficiently developed (Lipsey, 2002). In order to control for simultaneity bias, Carkovic and Levine (2002) use a Generalized Method of Moments (GMM) panel estimator<sup>9</sup> and conclude that the impact of foreign direct investment on growth would not be significant. Nevertheless, they suppose causality from foreign direct investment to economic growth and do not evaluate the reverse causality. As bring to the fore by Hansen and Rand (2006), a recent strand of literature that focuses on Granger causality balances this result and concludes that if the impact of foreign direct investment on growth is highly heterogeneous across countries, the impact of foreign direct investment on growth is nevertheless on average significant. Regarding the SSA countries, which are partially present in Tekin's (2012) survey, foreign direct investment causes economic growth in Benin and Togo, and economic growth causes foreign direct investment in Burkina Faso, whereas any causality is brought to the fore in Central African Republic.<sup>10</sup>

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<sup>8</sup> See also, for example, Asiedu (2002), Akinlo (2004) or Baiashvili and Gattini (2020) for a literature review on foreign direct investment. See also, for example, Adams (2009), Yang (2011) or Bahadir et al. (2018) for a literature review on remittances.

<sup>9</sup> Following Arellano and Bover (1995) and Blundell and Bond (1998).

<sup>10</sup> Our study differs from Tekin (2012) by two majors points. Firstly, Tekin (2012) does not study the link between economic growth, remittances and foreign direct investment, but focuses on the link between economic growth, exports and foreign direct investment. Secondly, Tekin (2012) analyses this link for least developed countries, including, for example, Haiti, Liberia and Yemen, and not for SSA countries only.

In a meta-analysis on remittances and growth which surveys 95 studies, Cazachevici et al. (2020) show that 40% of these studies report a positive effect of remittances on growth, 40% report no effect, and 20% a negative native effect. Nevertheless, a major part of these evaluations which only considers a potential impact of remittances on growth suffers from a simultaneity bias. Indeed, causality between remittances and growth as well as causality between growth and remittances are both likely to be ambiguous (Yang, 2011).<sup>11</sup> On the one hand, altruism motivates migrants to remit income to their relatives in order to alleviate the poverty of those left behind, especially during recessions and a part of remittances can be invested in physical and human capital and, then, favors economic growth (Docquier and Rappoport, 2006). On the other hand, as pointed out by Chami et al. (2005), remittances can provide an incentive for beneficiaries to reduce their efforts in the labor market. Bahadir et al. (2018) developed a DSGE model with heterogeneous households. They show that the effects of remittances are inherently contractionary if they accrue to the wage earners, and expansionary when they accrue to the entrepreneurs. Hence, as both the causality from remittances to economic growth and the causality from economic growth to remittances are likely to be significant and of an ambiguous nature, correlations between remittances and growth estimated by a major part of the literature based on cross-section regressions cannot be rigorously interpreted in terms of causality. Cazachevici et al. (2020) show that studies ignoring this endogeneity issue find systematically a larger impact of remittances on economic growth. Ahamada and Coulibaly (2013) represent a notable exception. They adopt a panel Granger causality approach and conclude that there is no causality between remittances and growth in SSA countries, as they argue that remittances do not contribute to increase physical capital investment. The study of Ali et al. (2018) is also interesting. Following, as Ahamada and Coulibaly (2013), the seminal methodology developed by Kónya (2006), they investigate the causal relationship between economic growth and remittances among the top ten highest remittance recipient countries in the world. Their results show that there is a causality from remittances to economic growth for some countries (Honduras, Kyrgyz Republic, Lebanon and Moldova), and there is a causality from economic growth to remittances for other countries (Lesotho, Nepal, Samoa and Tajikistan). The only case for which there is a bidirectional causality is for Haiti where remittances cause economic growth and vice-versa.

While a large body of literature investigates the impact of remittances or foreign direct investment on economic growth, two notable contributions set out to estimate simultaneously

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<sup>11</sup> See also the seminal paper of Lucas and Stark (1985).

the impact of these both variables. Driffield and Jones (2013) use a 3SLS panel system estimator and find that, on average, both sources of foreign capital have a positive and significant impact on economic growth, but only when institutions are taken into account. Nevertheless, they assume a univocal causality from foreign capital (foreign direct investment, official development assistance and migrant remittances) to economic growth, and they do not estimate reversal causalities. Moreover, this contribution does not take into account potential interactions between foreign direct investment and remittances, or heterogeneity and cross-section dependence between countries. Nwaogu and Ryan (2015) adopt a dynamic spatial model but they also apply a de facto univocal causality from external capital flows to economic growth. They find that only foreign direct investment impact economic growth. Hence, these both contributions consider causality from remittances and from foreign direct investment to economic growth, but they do not evaluate causality from economic growth to foreign direct investment or to remittances and do not consider potential interactions between foreign direct investment and remittances.

The contribution of remittances and foreign direct investment to economic development depends on the nature of their relationship: if these flows are complementary or substitute, the final impact of each of these flows is fostered or weakened. Hence, the contribution of the two major financial flows to economic development depends on their interactions and on the channels of transmission, which connect them. Yet, a priori, each of this financial flow is likely to cause and to impact the other. Firstly, remittances and foreign direct investment can be connected through capital return: if remittances are invested in human or physical capital, remittances contribute to increase or decrease return in physical capital and then favor or crowd up foreign direct investment. Secondly, remittances increase disposable income which increase consumption and then boost the demand for capital and foreign direct investment (Garcia-Fuentes et al., 2016). Thirdly, remittances and foreign direct investment both impact and are impacted by financial development.<sup>12</sup> Concerning interactions between remittances and financial development, on the one hand, financial development can notably lower costs of transferring money (Freund and Spatafora, 2008) but migrants are also likely to be especially motivated to directly transfer money to their relatives when the credit market do not work properly (Giuliano and Ruiz-Arranz, 2009). On the other hand, remittances can reduce liquidity constraint and then credit demand but can also improve the demand for diverse financial products when they are firstly saved through banking deposits (Aggarwal et al., 2011).

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<sup>12</sup> See, for example, Azizi (2020) for a literature review on remittances and financial development. See, for example, Alfaro et al. (2003) for a literature review on foreign direct investment and financial development.

Concerning interactions between foreign direct investment and financial development, on the one hand, foreign firms are more likely to find locally efficient external source of finance in order to finance their foreign direct investment when the financial sector in the host country is sufficiently developed (Desbordes and Wei, 2017). On the other hand, foreign direct investment induces positive spillovers which are likely to promote financial development in the recipient countries (Alfaro et al., 2003). Empirical studies on interactions between remittances and foreign direct investment are scarce. Using a Panel Generalized Method of Moments, Garcia-Fuentes et al. (2016) and Amponsah et al. (2019) suggest that remittances have a positive effect on foreign direct investment but only for certain levels of GDP per capita for host country. Nevertheless, those studies suppose a univocal and indirect impact from remittances to foreign direct investment. It must then be pointed that empirical evaluation of inter-causalities between remittances and foreign direct investment is actually a very little explored issue.

The bootstrap panel Granger causality approach based on the SUR system and Wald tests, with country-specific bootstrap critical values, allows us to estimate simultaneously the impacts of foreign direct investment and remittances on growth, of growth on foreign direct investment and remittances, as well as interactions between foreign direct investment and remittances, taking into account both heterogeneity and cross-sectional dependence between countries.

### **3. Econometric methodology**

In panel data framework, three approaches can be used to test for Granger causality. The first one is based on the generalized method of moments (GMM) that estimates homogenous panel model by removing individual fixed effects. The second one, developed by Hurlin (2008) and Hurlin and Dumitrescu (2012), takes into account heterogeneity in the panel but does not account for heterogeneity problems in cross-sectional data.

The third approach proposed by Kónya (2006) allows the possibility to study both country-specific heterogeneity and cross-sectional dependence. This procedure is based on the estimation of Seemingly Unrelated Regression (SUR) systems and the calculations of Wald tests with country-specific bootstrap critical values and enables to test for Granger causality on each individual country separately. Two features of this testing approach are worth noting. First, computing bootstrap Wald critical does not need to have stationary series. As emphasized by Kónya (2006), the results of the bootstrap panel causality method unit root test, and cointegration test are all robust. This implies that not all variables need to be tested for stationary

series properties. Second, this robust feature of bootstrap panel causality arises from the generation of country-specific critical values from the bootstrapping method.

In this paper, we use and adapt to our framework the approach proposed by Kónya (2006), testing Granger causality in a panel data framework, taking into account both country-specific heterogeneity and cross-sectional dependence. We notably extend the seminal model developed by Kónya (2006) in order to introduce a third interactive variable. This procedure is based on the estimation of SUR systems and the calculations of Wald tests with country-specific bootstrap critical values. The SUR system on which the testing procedure is based includes three sets of equations that can be formulated as follow:

$$\left. \begin{aligned} gdp_{1,t} &= \alpha_{1,1} + \sum_{l=1}^{lgdp_1} \beta_{1,1,l} gdp_{1,t-l} + \sum_{l=1}^{lrem_1} \gamma_{1,1,l} rem_{1,t-l} + \sum_{l=1}^{lfdi_1} \varphi_{1,1,l} fdi_{1,t-l} + \varepsilon_{1,1,t} \\ &\vdots \\ gdp_{N,t} &= \alpha_{1,N} + \sum_{l=1}^{lgdp_1} \beta_{1,N,l} gdp_{N,t-l} + \sum_{l=1}^{lrem_1} \gamma_{1,N,l} rem_{N,t-l} + \sum_{l=1}^{lfdi_1} \varphi_{1,N,l} fdi_{N,t-l} + \varepsilon_{1,N,t} \end{aligned} \right\} (1)$$

$$\left. \begin{aligned} rem_{1,t} &= \alpha_{2,1} + \sum_{l=1}^{lgdp_2} \beta_{2,1,l} gdp_{1,t-l} + \sum_{l=1}^{lrem_2} \gamma_{2,1,l} rem_{1,t-l} + \sum_{l=1}^{lfdi_2} \varphi_{2,1,l} fdi_{1,t-l} + \varepsilon_{2,1,t} \\ &\vdots \\ rem_{N,t} &= \alpha_{2,N} + \sum_{l=1}^{lgdp_2} \beta_{2,N,l} gdp_{N,t-l} + \sum_{l=1}^{lrem_2} \gamma_{2,N,l} rem_{N,t-l} + \sum_{l=1}^{lfdi_2} \varphi_{2,N,l} fdi_{N,t-l} + \varepsilon_{2,N,t} \end{aligned} \right\} (2)$$

$$\left. \begin{aligned} fdi_{1,t} &= \alpha_{3,1} + \sum_{l=1}^{lgdp_3} \beta_{3,1,l} gdp_{1,t-l} + \sum_{l=1}^{lrem_3} \gamma_{3,1,l} rem_{1,t-l} + \sum_{l=1}^{lfdi_3} \varphi_{3,1,l} fdi_{1,t-l} + \varepsilon_{3,1,t} \\ &\vdots \\ fdi_{N,t} &= \alpha_{3,N} + \sum_{l=1}^{lgdp_3} \beta_{3,N,l} gdp_{N,t-l} + \sum_{l=1}^{lrem_3} \gamma_{3,N,l} rem_{N,t-l} + \sum_{l=1}^{lfdi_3} \varphi_{3,N,l} fdi_{N,t-l} + \varepsilon_{3,N,t} \end{aligned} \right\} (3)$$

Where  $gdp$  refers to the logarithm of the real GDP per capita,  $rem$  refers to the logarithm of the remittances per capita, and  $fdi$  refers to the logarithm of the foreign direct investment per capita.  $i$  is the number of countries ( $i = 1, \dots, N$ ),  $t$  is the time period ( $t = 1, \dots, T$ ), and  $l$  is the lag length.  $lgdp_j$ ,  $lrem_j$ , and  $lfdi_j$  are the maximal lag lengths for  $gdp$ ,  $rem$ , and  $fdi$  in equation  $j$  ( $j = 1, \dots, 3$ ). The error terms  $\varepsilon_{1,N,t}$ ,  $\varepsilon_{2,N,t}$ ,  $\varepsilon_{3,N,t}$  are supposed to be white noises and may be correlated with each other for a given country.

For each country  $i$ , alternative causal relations can be found. For example, there is one-way Granger causality from  $rem$  to  $gdp$  if not all  $\gamma_{1,i,l}$  are zero, but all  $\beta_{2,i,l}$  are zero; there is one-way Granger causality from  $gdp$  to  $rem$  if all  $\gamma_{1,i,l}$  are zero, but not all  $\beta_{2,i,l}$  are zero; there is a two-way Granger causality between  $rem$  and  $gdp$  if neither  $\gamma_{1,i,l}$  nor  $\beta_{2,i,l}$  is zero; and there is no Granger causality between  $rem$  and  $gdp$  if all  $\gamma_{1,i,l}$  and  $\beta_{2,i,l}$  are zero. This definition can easily be extended to causal relations between  $fdi$  and  $gdp$ , as well as between  $fdi$  and  $rem$ . Each equation has different predetermined variables. The only possible link among individual regressions is a contemporaneous correlation within the systems. In the absence of contemporaneous correlations across countries, each equation can be estimated one-by-one using the OLS procedure. However, this procedure is not efficient in the presence of contemporaneous correlations. To take into account contemporaneous correlations within the systems, an alternative consists of stacking the equations in each set and applying the SUR estimator proposed by Zellner (1962). In addition to the estimation of SUR systems, the panel Granger testing procedure relies on the calculation of Wald test statistics and country-specific bootstrap critical values.<sup>13</sup> Generating bootstrap Wald critical allows  $gdp$ ,  $rem$  and  $fdi$  to not be necessarily stationary. They can denote “the levels, the first difference or some higher difference, irrespectively of the time-series properties of these variables” (Kónya, 2006).

#### 4. Data

We use annual data from 1995 to 2023 for 20 SSA countries.<sup>14</sup> These countries are: Benin, Botswana, Burkina Faso, Cabo Verde, Cameroon, Côte d’Ivoire, Eswatini, Gabon, Ghana, Kenya, Lesotho, Madagascar, Mali, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa and Togo.<sup>15</sup> Data are collected from the World Bank database (*World Development Indicators*). The variables used in the study include the real GDP per capita, remittances per capita (defined as “workers’ remittances and compensation of employees”), and foreign direct investment per capita (defined as the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital, as shown in the balance of payments). All these variables are measured in constant 2015 US dollars.

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<sup>13</sup> Thanks to bootstrap critical values, this approach can deal with the shortcomings of small  $T$  samples (particularly in case of SSA countries where remittances are available only annually) and does not require pre-testing for unit roots and cointegration (Kónya, 2006).

<sup>14</sup> Detailed database used in the paper is available upon request from the authors.

<sup>15</sup> Initially, our sample was made of 30 SSA countries. However, 10 SSA countries were removed from the sample because of data availability issues. Moreover, on the sample period, some of these 10 SSA countries (the Central African Republic for example) are characterized by political instability and/or civil war. Furthermore, as we use bootstrap critical values, we need a balanced panel over the 1995-2023 period.

Tables 1 to 5 report the summary statistics for each SSA countries. From Table 1, we denote the significant heterogeneity of GDP per capita. Notably, the GDP per capita in Gabon, or in Botswana, is quite ten times higher than in Niger or Sierra Leone. The high GDP per capita for some countries can be explained by abundant oil and mining resources (Gabon for example), whereas countries as the Niger has faced political instability, notably after the economic crisis in 1997, which was induced by the fall in uranium prices.

INSERT TABLES 1 TO 3

Concerning foreign direct investment and remittances, the SSA countries are also characterized by a significant heterogeneity. Notably, remittances per capita are forty times higher in Cabo Verde and Lesotho than in Niger or in Cameroon (Table 2). For example, Cabo Verde exhibits a high tradition of emigration of their residents, especially to Portugal. As shown in Table 4, remittances represent an important source of income for several SSA countries. During the considered period, Lesotho is the highest recipient of remittances (39.22% of GDP), even if this part is decreasing along the period, while South Africa is the lowest recipient (0.23% of GDP). Foreign direct investment per capita is quite twenty times higher in Gabon or Namibia than in Burkina Faso or in Kenya (Table 3). Gabon, for example, receives an important inflow of foreign direct investment, mainly because of the investment of foreign multinational firms in domestic oil and gas fields. Table 5 indicates that foreign direct investment is also a significant part of income for many SSA countries. During the period considered, Cabo Verde has the most important part of foreign direct investment (6.42% of GDP), while Kenya has the lowest part (0.81% of GDP).<sup>16</sup> We can notice that, for many countries, the part of foreign direct investment (in % of GDP) is near the part of remittances (in % of GDP).

INSERT TABLES 4 AND 5

## 5. Empirical results and discussion

Before proceeding to estimation, optimal lag length must be determined because the results from the causality test are sensitive to the lag structure.<sup>17</sup> Ideally, the lag structure would vary

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<sup>16</sup> A complete statistical appendix is available upon request from the authors. This statistical appendix is a complement to our database.

<sup>17</sup> As indicated by Kónya (2006), this step is crucial because the causality test results may depend critically on the lag structure. In general, lag decisions may cause different estimation results (Kang, 1989; Pesaran, 2015).

across countries, variables, and equation systems. However, in a relatively large panel system, it induces a substantial computational burden. To overcome this problem, we allow maximal lags to differ across variables but to be the same across equations. We estimate the system for each possible pair of  $lgdp_1$ ,  $lrem_1$ ,  $lfdi_1$  and  $lgdp_2$ ,  $lrem_2$ ,  $lfdi_2$ , and  $lgdp_3$ ,  $lrem_3$ ,  $lfdi_3$ . We assume that 1 to 4 lags exist and then we choose the combinations that minimize the Schwarz Bayesian criterion.<sup>18</sup> The results suggest that the optimal number of lags is equal to one. Hence, we can interpret the sign of the coefficients as the sign of the Granger causality.

One of our main assumptions is the existence of cross-sectional dependency among the countries in the panel. Therefore, testing for cross-sectional dependence is crucial for selecting the most appropriate and efficient estimator. To test for cross-sectional dependency, we employ four different tests: the Lagrange multiplier test of Breusch and Pagan (1980),  $CD_{BP}$ , two cross-sectional dependence tests of Pesaran (2004, 2006), one based on the Lagrange multiplier ( $CD_{LM}$ ) and the other on the pairwise correlation coefficients ( $CD$ ). However, the  $CD$  test has lower power when the population average pair-wise correlations are zero, as demonstrated by Pesaran et al. (2008). For this reason, we use a fourth cross-sectional dependency test,  $LM_{adj}$ , proposed by Pesaran et al. (2008), who developed a bias-adjusted test that is a modified version of the LM test. Table 6 reports the results of these four cross-sectional dependence tests. Our results show that the null hypothesis of no cross-sectional dependence is rejected in all cases. These results confirm that strong economic links exist between the SSA countries. The cross-sectional dependency furthermore implies that examining the causality between remittances, foreign direct investment and economic growth in SSA countries requires accounting for this information in estimations of causality regressions. As a result, in the presence of cross-sectional dependency, the SUR method is more appropriate and will lead to more efficient estimations than the country-by-country pooled OLS method (Zellner, 1962). Thus, the estimation results obtained from the SUR model developed by Zellner (1962) are more reliable than those obtained from the country-specific OLS estimation.

#### INSERT TABLE 6

Another important point in the bootstrap panel causality approach is testing for cross-country heterogeneity. In order to test the hypothesis of slope coefficient homogeneity against the

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<sup>18</sup> Using an alternative information criterion, the Akaike information criterion, results are similar. Detailed results are available upon request from the authors.

alternative hypothesis, we apply the Wald principle, which is the familiar approach. The Wald principle is valid for cases where the cross-sectional dimension ( $N$ ) is relatively small and the time dimension ( $T$ ) of the panel is large, the explanatory variables are strictly exogenous, and the error variances are homoscedastic. Swamy (1970) developed the slope homogeneity test to detect cross-sectional heteroscedasticity (Pesaran and Yamagata, 2008). However, Wald and Swamy tests are applicable for panel data models where  $N$  is small relative to  $T$ . Pesaran and Yamagata (2008) proposed a standardized version of Swamy's test, the  $\Delta$  test, for testing slope homogeneity in large panels. The  $\Delta$  test is valid as  $(N, T) \rightarrow \infty$ , without any restrictions on the relative expansion rates of  $N$  and  $T$  when the errors terms are normally distributed. The small sample properties of the  $\Delta$  test can be improved under normally distributed errors by using a bias-adjusted version, the  $\Delta_{adj}$  test, of the Pesaran and Yamagata (2008) test. Table 7 reports the results from the slope homogeneity tests of Pesaran and Yamagata (2008). Both tests,  $\Delta$  test and  $\Delta_{adj}$  test, reject the null hypothesis of the slope homogeneity hypothesis. Thus, both reports support country-specific heterogeneity. The rejection of slope homogeneity implies that if the panel causality analysis imposes homogeneity restrictions on the variable of interest, there will be misleading inferences. Therefore, we have to take into account that causality between *GDP* and remittances or foreign direct investment may differ across the SSA countries. Finally, the existence of cross-sectional dependency and heterogeneity across the SSA countries supports our claim about the suitability of the bootstrap panel causality approach.

#### INSERT TABLE 7

The results of causality from GDP per capita to remittances per capita and from remittances per capita to GDP per capita are displayed, respectively, in Tables 8 and 9. These results show that there is no causality from remittances to growth, except in Burkina Faso, and no causality from growth to remittances in any country. Our results are similar to those of Ahamada and Coulibaly (2013) or Gachino (2025), which find no causality from remittances to growth, but are different from results of a large part previous studies which conclude in significant impacts. How to explain these differences? Firstly, as exposed in the literature review, studies which do not take into account simultaneity issue between growth and remittances generally conclude in a larger impact of remittances on growth. Secondly, assuming wrongly cross-sectional independence between countries of a panel can also induce misleading results as notably demonstrate by Bai and Kao (2006). Yet, our estimations validate cross-sectional dependence and take cross-

sectional dependence into account. Thirdly, assuming wrongly that the SSA countries are homogeneous particularly regarding remittances and growth links, as in Chami et al. (2005) or Singh et al. (2010), may also induce misleading results. Yet, we have brought to the fore that SSA countries are particularly heterogeneous concerning remittances (Tables 2 and 4) which notably implies that assuming homogeneity of migrants' behaviour is not a priori relevant. Fourthly, previous studies do not take into account foreign direct investment and then are likely to suffer from an omitted variable bias. Our results also suggest that remittances received in each SSA country are not globally explained by economic growth in home countries. Huang and Vargas-Silva (2006) find the same results for Latin and Caribbean American countries. Our results support then the argument that in a major part of SSA countries, remittances would not be significantly invested in human and physical productive and efficient capital.

#### INSERT TABLES 8 AND 9

The results of causality from GDP per capita to foreign direct investment per capita and from foreign direct investment per capita to GDP per capita are displayed, respectively, in Tables 10 and 11. In this case too, there is cross-sectional dependence in SSA countries for the link between foreign direct investment-growth (Table 6) and the assumption of heterogeneity is also validated (Tables 3 and 5), which implies that our results are more robust than studies supposing independence or homogeneity. For the causality from GDP per capita to foreign direct investment per capita, the causality is positive for Benin, Kenya and Mali and negative for Eswatini. Hence, as shown by de Mello (1997), foreign direct investment is more likely to be attracted by developing countries. For the causality from foreign direct investment per capita to GDP per capita, the causality is positive for Niger and Sierra Leone. In these countries, foreign direct investment favors economic growth, as brought to the fore by Bruno and Campos (2013). Our results suggest that the significance of the inter-actions between foreign direct investment and growth are heterogeneous between countries. They then sustain the argument that institutional factors, such as political stability, government effectiveness, lower corruption, voice and accountability of the rule of law, could mainly affect channel of transmissions between these both variables (Driffield and Jones, 2013; Rodríguez-Pose and Cols, 2017).

#### INSERT TABLES 10 AND 11

Tables 12 and 13 report, respectively, the results of Granger causality from remittances per capita to foreign direct investment per capita, and from foreign direct investment per capita to remittances per capita. The results show that, most of the countries, there is no causality from remittances per capita to foreign direct investment per capita except for Niger, for which the causality is positive. For the causality from foreign direct investment per capita to remittances per capita, there is a positive causality for Mali and Togo. Our results suggest that remittances and foreign direct investment tend to be complementary flows in certain countries. Here again, the significance of the inter-actions between foreign direct investment and remittances are heterogeneous between countries. If local institutional factors can also explain this heterogeneity, the level of local financial development can also be relevant as long as, as expose in the literature review, remittances and foreign development are both likely to impact and cause financial development.

INSERT TABLES 12 AND 13

Computing all these results, we can notice that for Niger, remittances per capita promote foreign direct investment per capita which promotes economic growth whereas for Mali economic growth promotes foreign direct investment per capita which promotes remittances per capita.

## **6. Conclusion**

This paper examines the causality between foreign direct investment, remittances, and economic growth in Sub-Saharan African (SSA) countries over the period of 1995-2023. For this purpose, we developed a panel Granger causality approach based on the SUR system and Wald tests, with country-specific bootstrap critical values. This approach enables to take into account simultaneously all potential causalities between foreign direct investment, remittances, and economic growth and to control the presence of both cross-sectional dependence and cross-country heterogeneity.

Empirical results indicate that SSA countries are strongly heterogeneous and interdependent. Moreover, they bring to the fore that there is a causality from remittances to economic growth only for Burkina Faso and no causality from economic growth to remittances for any SSA country. Concerning foreign direct investment, economic growth favors foreign direct investment in Benin, Kenya and Mali, whereas foreign direct investment promotes economic growth in Niger and Sierra Leone. Finally, our results show that remittances and foreign direct

investment are complementary financial flows notably in Niger, Mali and Togo. We can notably notice that for Niger, remittances per capita promote foreign direct investment per capita which promotes economic growth whereas for Mali economic growth promotes foreign direct investment per capita which promotes remittances per capita.

Our empirical study suggests that whereas causalities are likely to be positive when they are significant, the significance of the causalities is heterogeneous between SSA countries, regarding especially the causalities between economic growth and foreign direct investment and between remittances and foreign investment. These results induce two possible extensions of our contribution in order to better understand determinants of economic growth and to sustain policy recommendations. First, it would be useful to extend our methodology in order to introduce auxiliary institutional variables such as political stability, government effectiveness, voice and accountability of the rule of law, in order to investigate in which way efficiency of the transmissions channel between economic growth and both financial flows depend jointly on institutional factors. It would notably enable to evaluate if the lack of governance (Coon and Neumann, 2015) contributes to explain the relative disconnection between economic growth and external private financial flows. Second, as long as economic growth depend on financial development and remittances as foreign direct investment are likely to impact and cause financial development (Alfaro et al., 2003; Freund and Spatafora, 2008; Giuliano and Ruiz-Arranz, 2009; Gupta et al., 2009; Aggarwal et al., 2011; Desbordes and Wei, 2017), it would also be interesting to investigate more properly inter-causalities between economic growth, remittances, foreign direct investment and financial development. To this end, we could integrate financial development as fourth explanatory variable in our methodology.

Introducing a fourth variable, whether institutional or financial, would be also a challenging and innovative prospect for the econometric methodology.

## Tables

Table 1. Summary statistics of GDP per capita (constant 2015 US dollars)

| Countries     | Mean     | Max.     | Min.     | Std. dev. | Skewness | Kurtosis | J.-B.  |
|---------------|----------|----------|----------|-----------|----------|----------|--------|
| Benin         | 2805.37  | 3674.27  | 2258.62  | 382.75    | 0.68     | 2.62     | 2.38   |
| Botswana      | 13195.36 | 16857.55 | 9232.03  | 2487.10   | -0.02    | 1.55     | 2.53   |
| Burkina Faso  | 1700.69  | 2330.34  | 1079.10  | 372.24    | 0.10     | 1.81     | 1.77   |
| Cabo Verde    | 5390.61  | 7165.30  | 2544.28  | 1400.52   | -0.69    | 2.08     | 3.32   |
| Cameroon      | 3264.92  | 3863.87  | 2639.96  | 368.71    | -0.05    | 1.84     | 1.63   |
| Côte d'Ivoire | 4234.19  | 5790.43  | 3497.17  | 696.62    | 0.78     | 2.41     | 3.34   |
| Eswatini      | 7147.00  | 8732.33  | 5260.70  | 1259.81   | -0.23    | 1.47     | 3.06   |
| Gabon         | 15803.21 | 19512.79 | 13968.89 | 1527.59   | 1.24     | 3.52     | 7.73** |
| Ghana         | 3979.87  | 5873.19  | 2574.92  | 1133.94   | 0.27     | 1.53     | 2.97   |
| Kenya         | 3743.73  | 4841.32  | 3151.44  | 519.51    | 0.58     | 2.06     | 2.70   |
| Lesotho       | 2178.15  | 2779.61  | 1556.53  | 399.93    | -0.16    | 1.59     | 2.54   |
| Madagascar    | 1566.67  | 1700.70  | 1409.40  | 56.21     | -0.30    | 4.41     | 2.85   |
| Mali          | 1979.74  | 2327.37  | 1461.13  | 247.18    | -0.60    | 2.34     | 2.28   |
| Namibia       | 8480.42  | 10669.16 | 6316.31  | 1401.80   | -0.15    | 1.75     | 2.01   |
| Niger         | 1063.63  | 1272.21  | 931.49   | 106.03    | 0.54     | 1.83     | 3.06   |
| Nigeria       | 4324.74  | 5516.40  | 2901.78  | 944.16    | -0.41    | 1.59     | 3.21   |
| Senegal       | 2870.44  | 3734.12  | 2373.43  | 359.66    | 0.73     | 2.68     | 2.70   |
| Sierra Leone  | 1405.18  | 1987.07  | 955.30   | 287.81    | 0.22     | 1.99     | 1.46   |
| South Africa  | 11597.57 | 12894.13 | 9549.48  | 1178.95   | -0.53    | 1.70     | 3.40   |
| Togo          | 1818.69  | 2314.55  | 1516.86  | 223.74    | 0.64     | 2.32     | 2.54   |
| SSA           | 3379.11  | 3856.83  | 2675.32  | 432.22    | -0.42    | 1.52     | 3.49   |
| World         | 13804.99 | 17956.58 | 10045.63 | 2450.79   | 0.04     | 1.72     | 1.97   |

Notes: the sample period is from 1995 to 2023. Significant at 1% (\*\*\*), 5% (\*\*) and 10% (\*). Std. dev. is the Standard Deviation. J.-B. is the Jarque-Bera statistics. SSA is Sub-Saharan Africa.

Table 2. Summary statistics of remittances per capita (constant 2015 US dollars)

| Countries     | Mean   | Max.   | Min.   | Std. dev. | Skewness | Kurtosis | J.-B.    |
|---------------|--------|--------|--------|-----------|----------|----------|----------|
| Benin         | 19.16  | 32.55  | 9.49   | 5.56      | 0.64     | 2.90     | 1.96     |
| Botswana      | 27.41  | 79.44  | 8.60   | 18.88     | 1.32     | 3.67     | 9.02**   |
| Burkina Faso  | 13.17  | 23.21  | 4.28   | 6.80      | 0.25     | 1.41     | 3.35     |
| Cabo Verde    | 350.63 | 489.50 | 248.73 | 61.21     | 0.10     | 2.44     | 0.43     |
| Cameroon      | 8.21   | 16.33  | 1.29   | 4.80      | -0.22    | 1.76     | 2.08     |
| Côte d'Ivoire | 14.59  | 30.39  | 9.18   | 5.13      | 1.66     | 5.60     | 21.57*** |
| Eswatini      | 92.86  | 137.98 | 51.94  | 21.98     | -0.02    | 2.48     | 0.34     |
| Gabon         | 9.15   | 25.71  | 2.91   | 4.33      | 2.09     | 8.54     | 58.26*** |
| Ghana         | 44.98  | 178.91 | 1.57   | 52.19     | 0.86     | 2.58     | 3.83     |
| Kenya         | 26.86  | 59.96  | 2.07   | 17.46     | 0.43     | 2.26     | 1.57     |
| Lesotho       | 333.47 | 889.70 | 168.93 | 167.44    | 1.89     | 6.32     | 30.50*** |
| Madagascar    | 9.65   | 23.42  | 0.68   | 6.89      | -0.14    | 1.70     | 2.14     |
| Mali          | 32.17  | 55.34  | 9.20   | 16.31     | -0.03    | 1.39     | 3.13     |
| Namibia       | 19.22  | 40.61  | 5.38   | 11.18     | 0.47     | 1.92     | 2.47     |
| Niger         | 8.01   | 22.52  | 0.69   | 5.84      | 0.91     | 3.35     | 4.16     |
| Nigeria       | 78.78  | 140.71 | 3.60   | 53.68     | -0.34    | 1.40     | 3.63     |
| Senegal       | 97.27  | 157.43 | 22.93  | 46.75     | -0.55    | 1.66     | 3.66     |
| Sierra Leone  | 9.73   | 31.33  | 0.52   | 7.94      | 1.52     | 4.41     | 13.60*** |
| South Africa  | 13.41  | 23.47  | 2.68   | 5.29      | -0.11    | 2.56     | 0.29     |
| Togo          | 41.95  | 71.93  | 5.53   | 21.03     | -0.66    | 2.02     | 3.28     |
| SSA           | 28.40  | 43.66  | 7.09   | 14.40     | -0.56    | 1.47     | 4.36     |
| World         | 57.33  | 82.98  | 25.48  | 21.81     | -0.37    | 1.48     | 3.48     |

Notes: the sample period is from 1995 to 2023. Significant at 1% (\*\*\*), 5% (\*\*) and 10% (\*). Std. dev. is the Standard Deviation. J.-B. is the Jarque-Bera statistics. SSA is Sub-Saharan Africa.

Table 3. Summary statistics of FDI per capita (constant 2015 US dollars)

| Countries     | Mean   | Max.   | Min.    | Std. dev. | Skewness | Kurtosis | J.-B.     |
|---------------|--------|--------|---------|-----------|----------|----------|-----------|
| Benin         | 10.59  | 39.49  | -6.60   | 12.81     | 0.61     | 2.39     | 2.24      |
| Botswana      | 142.51 | 315.37 | -116.25 | 114.91    | 0.06     | 2.18     | 0.83      |
| Burkina Faso  | 6.63   | 29.22  | -4.33   | 8.64      | 1.21     | 3.39     | 7.30**    |
| Cabo Verde    | 193.88 | 482.92 | 23.94   | 113.23    | 0.79     | 3.61     | 3.44      |
| Cameroon      | 20.63  | 41.65  | -0.98   | 12.69     | -0.24    | 1.86     | 1.85      |
| Côte d'Ivoire | 26.98  | 70.89  | 12.10   | 12.69     | 1.79     | 6.18     | 27.63***  |
| Eswatini      | 58.51  | 226.59 | -75.80  | 66.88     | 0.13     | 3.06     | 0.09      |
| Gabon         | 307.68 | 706.13 | -387.07 | 303.04    | -0.57    | 2.48     | 1.88      |
| Ghana         | 62.58  | 134.79 | 3.84    | 50.71     | 0.15     | 1.28     | 3.67      |
| Kenya         | 9.70   | 35.40  | 0.22    | 10.07     | 1.19     | 3.24     | 6.87**    |
| Lesotho       | 21.95  | 54.99  | -8.98   | 15.52     | 0.16     | 2.89     | 0.14      |
| Madagascar    | 18.54  | 69.45  | 0.96    | 18.69     | 1.31     | 3.85     | 9.14**    |
| Mali          | 18.99  | 49.18  | -1.40   | 11.87     | 0.46     | 3.03     | 1.02      |
| Namibia       | 223.26 | 665.66 | -65.59  | 171.59    | 0.49     | 2.82     | 1.19      |
| Niger         | 18.61  | 65.70  | -0.24   | 18.83     | 0.85     | 2.68     | 3.59      |
| Nigeria       | 22.79  | 61.24  | -0.70   | 18.50     | 0.80     | 2.35     | 3.61      |
| Senegal       | 37.63  | 134.19 | 2.37    | 36.32     | 1.68     | 4.68     | 16.97***  |
| Sierra Leone  | 27.97  | 152.60 | 0.03    | 34.09     | 2.22     | 8.11     | 55.36***  |
| South Africa  | 100.56 | 594.42 | 15.11   | 112.35    | 3.07     | 13.99    | 191.35*** |
| Togo          | 12.82  | 116.41 | -21.65  | 24.42     | 2.59     | 12.37    | 138.67*** |
| SSA           | 30.45  | 53.54  | 8.23    | 13.67     | 0.26     | 1.83     | 1.98      |
| World         | 253.90 | 533.39 | 95.31   | 107.37    | 0.44     | 2.78     | 0.99      |

Notes: the sample period is from 1995 to 2023. Significant at 1% (\*\*\*), 5% (\*\*) and 10% (\*). Std. dev. is the Standard Deviation. J.-B. is the Jarque-Bera statistics. SSA is Sub-Saharan Africa.

Table 4. Remittances (in % of GDP) in SSA countries

| Countries     | 1995-2005 | 2005-2015 | 2015-2023 | 1995-2023 |
|---------------|-----------|-----------|-----------|-----------|
| Benin         | 2.52      | 2.04      | 1.48      | 2.05      |
| Botswana      | 0.69      | 0.44      | 0.28      | 0.47      |
| Burkina Faso  | 2.02      | 1.66      | 2.90      | 2.15      |
| Cabo Verde    | 15.39     | 10.21     | 13.40     | 12.95     |
| Cameroon      | 0.25      | 0.64      | 0.93      | 0.58      |
| Côte d'Ivoire | 0.77      | 0.83      | 0.79      | 0.80      |
| Eswatini      | 3.88      | 2.23      | 2.62      | 2.94      |
| Gabon         | 0.10      | 0.14      | 0.11      | 0.11      |
| Ghana         | 0.61      | 2.78      | 5.23      | 2.53      |
| Kenya         | 2.18      | 2.00      | 2.92      | 2.34      |
| Lesotho       | 63.42     | 27.05     | 21.41     | 39.22     |
| Madagascar    | 0.40      | 2.89      | 2.90      | 1.99      |
| Mali          | 3.13      | 5.05      | 5.81      | 4.59      |
| Namibia       | 0.27      | 0.46      | 0.53      | 0.42      |
| Niger         | 0.78      | 1.61      | 2.84      | 1.67      |
| Nigeria       | 1.92      | 5.56      | 4.67      | 3.85      |
| Senegal       | 4.09      | 8.82      | 10.36     | 7.52      |
| Sierra Leone  | 1.79      | 1.32      | 3.94      | 2.36      |
| South Africa  | 0.18      | 0.27      | 0.25      | 0.23      |
| Togo          | 3.99      | 9.22      | 7.23      | 6.66      |
| SSA           | 1.17      | 2.35      | 2.61      | 1.97      |
| World         | 0.40      | 0.64      | 0.75      | 0.58      |

Note: average over the period. SSA is Sub-Saharan Africa.

Table 5. FDI (in % of GDP) in SSA countries

| Countries     | 1995-2005 | 2005-2015 | 2015-2023 | 1995-2023 |
|---------------|-----------|-----------|-----------|-----------|
| Benin         | -0.06     | 1.23      | 1.58      | 0.89      |
| Botswana      | 2.80      | 2.87      | 1.47      | 2.36      |
| Burkina Faso  | 0.45      | 1.43      | 1.16      | 0.98      |
| Cabo Verde    | 4.96      | 8.39      | 5.95      | 6.42      |
| Cameroon      | 1.13      | 1.52      | 2.03      | 1.52      |
| Côte d'Ivoire | 1.68      | 1.15      | 1.58      | 1.48      |
| Eswatini      | 2.86      | 1.56      | 0.88      | 1.97      |
| Gabon         | 0.57      | 3.98      | 7.18      | 3.82      |
| Ghana         | 1.88      | 6.40      | 4.20      | 4.18      |
| Kenya         | 0.41      | 1.18      | 0.77      | 0.81      |
| Lesotho       | 3.11      | 2.66      | 1.45      | 2.42      |
| Madagascar    | 0.82      | 6.64      | 3.33      | 3.71      |
| Mali          | 2.04      | 2.97      | 3.27      | 2.76      |
| Namibia       | 3.93      | 6.63      | 4.76      | 5.04      |
| Niger         | 0.50      | 6.14      | 4.33      | 3.63      |
| Nigeria       | 1.47      | 1.85      | 0.49      | 1.29      |
| Senegal       | 1.30      | 2.04      | 5.68      | 2.90      |
| Sierra Leone  | 1.77      | 9.31      | 6.41      | 5.79      |
| South Africa  | 1.51      | 1.68      | 2.21      | 1.79      |
| Togo          | 2.16      | 4.59      | 0.55      | 2.38      |
| SSA           | 2.07      | 2.58      | 2.08      | 2.23      |
| World         | 2.47      | 3.34      | 2.25      | 2.66      |

Note: average over the period. SSA is Sub-Saharan Africa.

Table 6. Cross-sectional dependence tests

| Model         | CD <sub>BP</sub>                | LM <sub>adj</sub>               | CD <sub>LM</sub>                |
|---------------|---------------------------------|---------------------------------|---------------------------------|
| $(gdp, rem)'$ | 1033 <sup>***</sup><br>(0.000)  | 128.6 <sup>***</sup><br>(0.000) | 17.13 <sup>***</sup><br>(0.000) |
| $(gdp, fdi)'$ | 1736 <sup>***</sup><br>(0.000)  | 237.7 <sup>***</sup><br>(0.000) | 28.59 <sup>***</sup><br>(0.000) |
| $(rem, fdi)'$ | 670.3 <sup>***</sup><br>(0.000) | 72.98 <sup>***</sup><br>(0.000) | 9.66 <sup>***</sup><br>(0.000)  |

Notes:  $CD_{BP}$ ,  $CD_{LM}$  and  $LM_{adj}$ , are, respectively, the cross-sectional dependence tests of Breush and Pagan (1980), Pesaran (2004, 2006), and Pesaran et al. (2008).  $p$ -values are in parentheses. \*\*\*, \*\*, \*, indicate the rejection of the null hypothesis (no cross-sectional dependence) at 1%, 5%, 10% level of significance.

Table 7. Homogeneous tests

| Model         | $\Delta$ test                    | $\Delta$ adj                     |
|---------------|----------------------------------|----------------------------------|
| $(gdp, rem)'$ | 19.220 <sup>***</sup><br>(0.000) | 20.298 <sup>***</sup><br>(0.000) |
| $(gdp, fdi)'$ | 13.825 <sup>***</sup><br>(0.000) | 14.601 <sup>***</sup><br>(0.000) |
| $(rem, fdi)'$ | 10.332 <sup>***</sup><br>(0.000) | 10.912 <sup>***</sup><br>(0.000) |

Notes:  $\Delta$ test and  $\Delta$ adj are slope homogeneity tests of Pesaran and Yamagata (2008).  $p$ -values are in parentheses. \*\*\*, \*\*, \*, indicate the rejection of the null hypothesis (slope homogeneity) at 1%, 5%, 10% level of significance.

Table 8. Granger causality tests from *gdp* to *rem*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | -0.083                | 0.067           | 36.160                   | 19.209 | 13.094 |
| Botswana      | -0.617                | 2.826           | 30.843                   | 16.605 | 11.156 |
| Burkina Faso  | 0.353                 | 5.785           | 93.643                   | 54.386 | 40.156 |
| Cabo Verde    | 0.234                 | 16.009          | 49.566                   | 27.201 | 18.043 |
| Cameroon      | 1.398                 | 3.271           | 60.090                   | 29.752 | 20.004 |
| Côte d'Ivoire | 0.103                 | 0.236           | 50.417                   | 26.266 | 18.338 |
| Eswatini      | -0.094                | 0.234           | 35.158                   | 18.985 | 13.141 |
| Gabon         | -2.113                | 12.961          | 54.620                   | 26.537 | 17.776 |
| Ghana         | 2.551                 | 14.444          | 85.202                   | 42.179 | 30.361 |
| Kenya         | 3.035                 | 17.492          | 49.304                   | 25.770 | 17.936 |
| Lesotho       | -0.406                | 7.498           | 48.921                   | 26.125 | 18.130 |
| Madagascar    | 2.428                 | 4.369           | 70.796                   | 36.059 | 22.648 |
| Mali          | 0.606                 | 6.473           | 81.689                   | 44.119 | 31.588 |
| Namibia       | 1.165                 | 8.791           | 45.943                   | 25.030 | 16.906 |
| Niger         | 0.940                 | 1.192           | 73.864                   | 36.020 | 24.470 |
| Nigeria       | 1.028                 | 6.884           | 83.296                   | 44.152 | 30.414 |
| Senegal       | 0.666                 | 8.141           | 92.596                   | 52.367 | 37.307 |
| Sierra Leone  | 1.843                 | 8.061           | 39.083                   | 21.135 | 14.178 |
| South Africa  | -0.487                | 3.467           | 58.590                   | 28.686 | 19.997 |
| Togo          | -0.201                | 1.022           | 66.000                   | 33.284 | 22.584 |

Notes: The null hypothesis ( $H_0$ ) is *gdp* does not cause *rem*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

Table 9. Granger causality tests from *rem* to *gdp*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | -0.003                | 0.285           | 58.000                   | 30.666 | 20.947 |
| Botswana      | -0.012                | 3.173           | 70.135                   | 36.867 | 24.766 |
| Burkina Faso  | 0.014                 | 17.198*         | 42.047                   | 22.039 | 15.561 |
| Cabo Verde    | 0.025                 | 1.224           | 58.458                   | 28.786 | 18.757 |
| Cameroon      | 0.000                 | 0.014           | 57.501                   | 30.634 | 20.508 |
| Côte d'Ivoire | 0.053                 | 12.402          | 52.445                   | 24.970 | 16.817 |
| Eswatini      | -0.017                | 6.010           | 57.373                   | 30.815 | 21.029 |
| Gabon         | 0.019                 | 4.241           | 46.407                   | 24.191 | 15.493 |
| Ghana         | -0.007                | 3.016           | 68.631                   | 37.679 | 25.822 |
| Kenya         | 0.005                 | 7.378           | 75.991                   | 36.646 | 24.585 |
| Lesotho       | -0.011                | 1.690           | 70.041                   | 38.447 | 25.736 |
| Madagascar    | -0.002                | 0.263           | 37.888                   | 20.124 | 13.389 |
| Mali          | 0.006                 | 0.724           | 40.387                   | 21.844 | 15.003 |
| Namibia       | 0.011                 | 6.318           | 67.539                   | 35.222 | 24.075 |
| Niger         | 0.005                 | 0.676           | 57.720                   | 27.796 | 17.926 |
| Nigeria       | -0.002                | 0.126           | 80.043                   | 39.434 | 26.983 |
| Senegal       | -0.008                | 1.579           | 31.866                   | 16.931 | 11.284 |
| Sierra Leone  | -0.003                | 0.110           | 62.417                   | 31.888 | 20.344 |
| South Africa  | 0.022                 | 13.830          | 64.847                   | 33.248 | 23.302 |
| Togo          | 0.010                 | 2.311           | 43.596                   | 22.505 | 15.134 |

Notes: The null hypothesis ( $H_0$ ) is *rem* does not cause *gdp*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

Table 10. Granger causality tests from *gdp* to *fdi*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | 5.316                 | 15.225*         | 31.946                   | 17.585 | 11.562 |
| Botswana      | -0.361                | 0.267           | 30.211                   | 15.090 | 9.692  |
| Burkina Faso  | 2.954                 | 6.639           | 26.147                   | 13.349 | 9.131  |
| Cabo Verde    | 0.922                 | 9.588           | 42.081                   | 19.548 | 12.982 |
| Cameroon      | 5.846                 | 6.323           | 47.756                   | 23.951 | 16.040 |
| Côte d'Ivoire | 0.835                 | 5.786           | 47.241                   | 24.401 | 16.395 |
| Eswatini      | -1.991                | 7.920*          | 20.211                   | 10.370 | 7.169  |
| Gabon         | -4.770                | 5.656           | 37.414                   | 19.993 | 13.403 |
| Ghana         | -0.286                | 0.365           | 73.097                   | 38.108 | 27.097 |
| Kenya         | 6.117                 | 19.325*         | 41.956                   | 21.236 | 14.648 |
| Lesotho       | 0.805                 | 0.921           | 29.005                   | 15.019 | 10.248 |
| Madagascar    | 1.918                 | 1.572           | 77.499                   | 38.674 | 26.445 |
| Mali          | 3.572                 | 24.293*         | 57.404                   | 32.221 | 21.934 |
| Namibia       | -0.089                | 0.015           | 40.150                   | 20.928 | 14.271 |
| Niger         | -2.792                | 6.135           | 76.169                   | 44.384 | 30.613 |
| Nigeria       | -1.070                | 0.955           | 51.720                   | 26.105 | 17.633 |
| Senegal       | 5.476                 | 15.515          | 62.478                   | 32.741 | 22.566 |
| Sierra Leone  | 0.625                 | 0.337           | 55.455                   | 28.068 | 19.816 |
| South Africa  | -0.010                | 0.000           | 33.919                   | 18.503 | 12.555 |
| Togo          | -1.313                | 1.810           | 46.810                   | 25.237 | 17.314 |

Notes: The null hypothesis ( $H_0$ ) is *gdp* does not cause *fdi*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

Table 11. Granger causality tests from *fdi* to *gdp*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | 0.002                 | 1.715           | 73.739                   | 35.672 | 23.647 |
| Botswana      | -0.003                | 0.656           | 81.301                   | 42.001 | 27.880 |
| Burkina Faso  | -0.003                | 6.984           | 107.197                  | 48.375 | 31.750 |
| Cabo Verde    | 0.001                 | 0.007           | 58.999                   | 31.232 | 21.248 |
| Cameroon      | 0.004                 | 18.776          | 87.075                   | 41.039 | 27.997 |
| Côte d'Ivoire | -0.008                | 0.312           | 51.704                   | 24.627 | 16.496 |
| Eswatini      | -0.002                | 1.204           | 80.556                   | 40.930 | 26.716 |
| Gabon         | -0.004                | 0.907           | 59.977                   | 26.101 | 17.370 |
| Ghana         | 0.012                 | 18.325          | 62.517                   | 29.631 | 20.670 |
| Kenya         | -0.004                | 6.441           | 56.300                   | 30.332 | 20.755 |
| Lesotho       | 0.010                 | 15.485          | 74.729                   | 39.764 | 26.727 |
| Madagascar    | -0.009                | 3.692           | 71.701                   | 34.981 | 23.520 |
| Mali          | -0.007                | 3.182           | 60.865                   | 33.007 | 22.669 |
| Namibia       | 0.014                 | 18.191          | 81.373                   | 42.642 | 29.388 |
| Niger         | 0.014                 | 28.971**        | 34.900                   | 19.766 | 13.546 |
| Nigeria       | 0.008                 | 5.236           | 74.265                   | 37.268 | 26.191 |
| Senegal       | 0.011                 | 11.764          | 74.323                   | 39.179 | 25.809 |
| Sierra Leone  | 0.031                 | 29.084*         | 80.409                   | 37.068 | 23.901 |
| South Africa  | -0.003                | 2.860           | 96.766                   | 53.962 | 36.786 |
| Togo          | -0.016                | 14.748          | 61.862                   | 30.728 | 20.856 |

Notes: The null hypothesis ( $H_0$ ) is *fdi* does not cause *gdp*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

Table 12. Granger causality tests from *rem* to *fdi*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | 0.478                 | 2.055           | 64.566                   | 32.727 | 22.262 |
| Botswana      | 0.119                 | 0.742           | 72.436                   | 38.683 | 25.510 |
| Burkina Faso  | -0.093                | 0.058           | 43.263                   | 23.057 | 15.435 |
| Cabo Verde    | 0.632                 | 3.337           | 74.498                   | 38.322 | 26.590 |
| Cameroon      | 0.033                 | 0.015           | 59.525                   | 31.506 | 20.736 |
| Côte d'Ivoire | 0.053                 | 0.157           | 68.372                   | 32.225 | 21.710 |
| Eswatini      | -0.097                | 0.102           | 67.384                   | 36.188 | 24.051 |
| Gabon         | -0.084                | 0.033           | 64.107                   | 31.899 | 20.401 |
| Ghana         | 0.127                 | 4.240           | 93.386                   | 46.471 | 30.469 |
| Kenya         | -0.067                | 0.301           | 106.771                  | 47.992 | 30.861 |
| Lesotho       | 0.539                 | 2.331           | 51.925                   | 26.706 | 18.523 |
| Madagascar    | 0.217                 | 7.069           | 60.087                   | 29.529 | 19.973 |
| Mali          | 0.219                 | 1.890           | 62.832                   | 35.862 | 24.553 |
| Namibia       | 0.196                 | 1.321           | 66.059                   | 37.350 | 24.694 |
| Niger         | 0.701                 | 28.129*         | 71.025                   | 40.799 | 26.803 |
| Nigeria       | 0.229                 | 1.178           | 68.698                   | 35.992 | 23.427 |
| Senegal       | 0.204                 | 1.098           | 61.005                   | 32.141 | 21.730 |
| Sierra Leone  | 0.208                 | 1.842           | 104.646                  | 48.126 | 30.802 |
| South Africa  | 0.556                 | 2.406           | 55.672                   | 27.552 | 18.568 |
| Togo          | 0.371                 | 5.147           | 36.382                   | 19.351 | 13.336 |

Notes: The null hypothesis ( $H_0$ ) is *rem* does not cause *fdi*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

Table 13. Granger causality tests from *fdi* to *rem*

| Country       | Estimated coefficient | Wald statistics | Bootstrap critical value |        |        |
|---------------|-----------------------|-----------------|--------------------------|--------|--------|
|               |                       |                 | 1%                       | 5%     | 10%    |
| Benin         | -0.030                | 0.853           | 70.363                   | 33.483 | 22.441 |
| Botswana      | 0.022                 | 0.126           | 72.326                   | 36.808 | 25.091 |
| Burkina Faso  | 0.007                 | 0.248           | 90.848                   | 44.815 | 28.482 |
| Cabo Verde    | -0.038                | 3.132           | 67.943                   | 36.176 | 25.269 |
| Cameroon      | -0.033                | 1.097           | 73.084                   | 36.083 | 24.485 |
| Côte d'Ivoire | 0.056                 | 0.674           | 62.696                   | 31.946 | 20.041 |
| Eswatini      | 0.045                 | 1.877           | 55.687                   | 29.262 | 19.201 |
| Gabon         | -0.066                | 3.732           | 77.219                   | 33.007 | 19.965 |
| Ghana         | 0.262                 | 10.954          | 83.558                   | 40.518 | 25.806 |
| Kenya         | 0.125                 | 4.835           | 78.154                   | 37.552 | 24.968 |
| Lesotho       | 0.034                 | 2.256           | 74.229                   | 32.750 | 22.485 |
| Madagascar    | 0.244                 | 8.228           | 71.270                   | 37.298 | 26.951 |
| Mali          | 0.089                 | 23.706*         | 71.415                   | 33.954 | 22.916 |
| Namibia       | -0.001                | 0.000           | 67.414                   | 34.639 | 23.340 |
| Niger         | 0.138                 | 13.518          | 62.905                   | 33.913 | 24.487 |
| Nigeria       | 0.061                 | 1.891           | 109.921                  | 55.114 | 37.554 |
| Senegal       | -0.031                | 2.985           | 86.177                   | 42.244 | 28.095 |
| Sierra Leone  | -0.011                | 0.028           | 69.071                   | 31.592 | 21.082 |
| South Africa  | -0.040                | 5.266           | 71.837                   | 36.169 | 24.530 |
| Togo          | 0.134                 | 39.380**        | 67.624                   | 36.021 | 24.687 |

Notes: The null hypothesis ( $H_0$ ) is *fdi* does not cause *rem*. \*\*\*, \*\* and \* indicate the rejection of the null hypothesis at, respectively, 1%, 5% and 10% levels of significance. Bootstrap critical values are obtained from 10000 replications.

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