



## CAUSAL NEXUS AMONG EXPORTS, FOREIGN DIRECT INVESTMENT AND ECONOMIC GROWTH REVISITED: NEW EVIDENCE FROM SUB-SAHARAN AFRICA

İHRACAT, DOĞRUDAN YABANCI YATIRIMLAR VE İKTİSADİ BÜYÜME ARASINDAKİ NEDENSELLİK İLİŞKİSİNİ SAHRA ALTI AFRİKA ÖRNEĞİNDE YENİDEN DÜŞÜNMEK

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### Abstract

This paper investigates causality relations among exports, foreign direct investment and economic growth in Sub-Saharan Africa. A new panel-data causality testing approach is developed in the article, which is based on Bayesian estimation of Seemingly Unrelated Regression (SUR) systems. The study covers the period between 1970 and 2017 and tests for both unidirectional and bidirectional causality relations for a group of 13 Sub-Saharan African countries. Findings suggest a direct, one-period-ahead, unidirectional causality from exports to GDP growth in Burkina Faso, Madagascar, Nigeria, Rwanda, Senegal and Sierra Leone. Test results provide evidence of growth-led exports in Benin, Democratic Republic of the Congo, Kenya and Niger. This study also provides valuable insights into causality relations between FDI and economic growth, and exports and FDI pairs.

**Keywords:** Export-led growth, Growth-led exports, Foreign Direct Investment, Granger causality, Bayesian estimation of Seemingly Unrelated Regression (SUR) models, Sub-Saharan African countries.

**JEL Classification:** F14, F21, F43, O10, O11

### Öz

Bu makale Sahra-Altı Afrika ülkelerinde ihracat, doğrudan yabancı yatırımlar ve büyüme arasındaki muhtemel nedensellik ilişkilerini inceliyor. Makalede, Görünürde İlişkisiz Bağlanımların Bayesçi Tahminine dayalı yeni bir panel-veri nedensellik testi yaklaşımı geliştiriliyor. Makalede 13 Sahra-Altı Afrika ülkesinin 1970-2017 dönemine ait veriler kullanılarak, değişkenler arasındaki tek ve çift yönlü nedensellik ilişkileri test ediliyor. Elde edilen test sonuçları Burkina Faso, Madagaskar, Nijerya, Ruanda, Senegal ve Sierra Leone'de ihracata-dayalı büyüme yaşandığını düşündürüyor. Test sonuçları Benin, Kongo Demokratik Cumhuriyeti, Kenya ve Nijer'deyse büyümeye-dayalı ihracat hipotezini destekliyor. Makalede elde edilen bulguların doğrudan yabancı yatırımlar – büyüme ve ihracat – doğrudan yabancı yatırımlar arasındaki nedensellik ilişkilerine de belli ölçüde ışık tuttuğu söylenebilir.

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**Anahtar Kelimeler:** İhracata-dayalı büyüme, Büyüme-dayalı ihracat, Doğrudan Yabancı Yatırımlar, Granger Nedensellik, Görünürde İlişkisiz Bağlanımların Bayesçi Tahmini, Sahra-Altı Afrika Ülkeleri

**JEL Sınıflaması:** F14, F21, F43, O10, O11

## 1. Introduction

This paper examines possible causality relations among exports, (inward) foreign direct investment and economic growth, as they affect Sub-Saharan African countries. Understanding the causal nexus among these variables in Sub-Saharan Africa is important as it may help lessening severe economic and social problems in this part of the world. With a few exceptions such as South Africa, Kenya and Botswana, Sub-Saharan Africa is home to some of the poorest countries of the world, suffering from deeply-rooted and resistant underdevelopment problems, and stuck in modest, or low rates of economic growth.<sup>1</sup>

For many decades now, practically since the end of the Second World War, development assistance has been high on the international community's agenda. Extensive aid schemes and development assistance programmes have been pursued in underdeveloped areas, including the Sub-Saharan Africa, with the aim of encouraging sustainable economic growth and development. For this aim, the United Nations organized four major conferences on Least Developed Countries (LDCs) over the last four decades. Each of these successive UN Conferences initiated a "Programme of Actions" which served as the main framework of development assistance provided to Least Developed Countries.<sup>2</sup> In addition to financial aid flows, these UN programmes, and many other international development assistance schemes, recognise exports and foreign direct investment as major determinants of sustainable economic growth in the developing world. Trade and capital account liberalisation have thus become standard policy prescription of the international financial institutions, or donor agencies. Official development assistance, or foreign aid provided to Sub-Saharan African countries, or other less developed aid-recipients have come to be gradually made conditional on certain 'best practices' such as trade or capital account liberalisation. Sub-Saharan

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1 The United Nations Development Program lists 46 Sub-Saharan African countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Democratic Republic), Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Western Sahara, Zambia, and Zimbabwe. 33 of these Sub-Saharan countries are further enlisted as Least Developed Countries.

2 The first two UN Conferences on LDCs, organized in Paris in 1981, and 1990 respectively, initiated the first two "Programmes of Action" for improving the deteriorating conditions of this group of countries. The third UN Conference on LDCs was organized in Brussels in 2001 and initiated the "Brussels Declaration and Programme of Action for the LDCs" (BPoA) for the period from 2001 to 2010. The last Programme of Action for the LDCs is initiated in the Istanbul UN Conference on LDCs for the decade 2011 – 2020. See, <http://unohrrls.org/about-ldcs/istanbul-programme-of-action/>.

African economies have also increasingly been subject to trade facilitation and trade-capacity building schemes to enhance export-orientation. Donor-supported reforms to attract more FDI have also been quite widely implemented in most of Sub-Saharan Africa. Despite all these efforts, however, outcome of these structural reforms and liberalisation policies remain highly limited today.<sup>3</sup> Empirical evidence is not particularly strong, or supportive of the assumed linkages among economic growth, exports and foreign capital inflows.<sup>4</sup> Further empirical scrutiny of the causal nexus among export, FDI and economic growth in Sub-Saharan Africa thus is needed. This need is the primary motivation behind this study.

We can now state the objectives of this paper as threefold. The first objective of the study is to examine the ‘Exports – Growth’ nexus, explicitly testing for both the “export-led growth” and “growth-led exports” hypotheses. The second objective of the paper is to shed light on the ‘FDI – Growth’ causality relations. For this aim the paper explicitly tests for both unidirectional and bidirectional causality relations between this pair of variables. The third aim of this study is to address causality relations between Exports and FDI. The new panel-data causality testing methodology adopted in this paper allows us to address all these three sets of pairwise causality relations simultaneously.

## 2. Bayesian Analysis of Seemingly Unrelated Regression Systems

Seemingly Unrelated Regression (SUR) models go back to Zellner’s (1962) pioneering study combining several equations together in an attempt to improve estimation efficiency. Unlike Vector Autoregression Regression models, Seemingly Unrelated Regression (SUR) systems make it possible studying Granger-causality on each individual panel member separately. SUR systems thus allow us to have heterogeneous slope coefficients, and properly account for the problem of cross-sectional dependence in panel data. These advantages make this approach superior to other alternative approaches in several respects.

In matrix form, a typical Seemingly Unrelated Regression system can be written as follows (see Ando and Zellner, 2010):

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u}, \quad \mathbf{u} \sim N(\mathbf{0}, \boldsymbol{\Omega} \otimes \mathbf{I}), \quad (1)$$

In the expression above  $N(\boldsymbol{\mu}, \boldsymbol{\Sigma})$  denotes the normal distribution with mean  $\boldsymbol{\mu} = (\mu_1, \dots, \mu_m)'$  and covariance matrix  $\boldsymbol{\Sigma}$ , while  $\otimes$  is the tensor product,  $\boldsymbol{\Omega}$  is an  $m \times m$  matrix with the diagonal elements  $\{\omega_1^2, \dots, \omega_m^2\}$  and the off-diagonal  $ij$ th elements are  $\omega_{ij}$ ,  $\mathbf{y}' = (\mathbf{y}'_1, \dots, \mathbf{y}'_m)$ ,  $\mathbf{X} = \text{diag}\{X_1, \dots, X_m\}$ ,  $\boldsymbol{\beta}' = (\boldsymbol{\beta}'_1, \dots, \boldsymbol{\beta}'_m)$ ,  $\mathbf{u}' = (\mathbf{u}'_1, \dots, \mathbf{u}'_m)$ .

3 For a review of the theoretical and empirical literature on causality relations among exports, foreign direct investment and economic growth, see Tekin (2012) and references therein.

4 In Sub-Saharan Africa only a handful of countries such as Kenya, South Africa, Nigeria and Botswana are included in UN’s list of middle income developing countries. Despite continuing efforts, and many decades-long export-orientation and capital account liberalisation, today, underdevelopment and low economic growth performance persist in Sub-Saharan Africa.

Errors in each equation in the above system are homoscedastic and not auto-correlated; while contemporaneous correlation between corresponding errors in different equations is possible. Such systems can be estimated by using the SUR estimator proposed by Zellner (1962). However, one would need to solve for cross-sectional dependency and heterogeneity issues before drawing inference, or testing for Granger causality. Kónya (2006) proposed a new panel-data Granger causality testing procedure that provides a good alternative when homogeneity of slope parameters is unlikely. This approach, based on seemingly unrelated regression systems and Wald tests with country specific bootstrap critical values has recently become widely employed in empirical research in economics (see Kar et al. 2011, Tekin 2012).

In what follows we propose an alternative testing procedure. More specifically, rather than using the SUR estimator and Wald tests with bootstrap critical values, we opt in this study for Bayesian inference. This approach, we believe, is particularly well-suited for testing Granger non-causality in our case, given the strong likelihood of cross-sectional dependency of the data at hand, and the high degree of heterogeneity existing across Sub-Saharan Africa.<sup>5</sup>

Arnold Zellner of Chicago University did not only introduce the Seemingly Unrelated Regression systems and the SUR estimator, but also showed how such systems can be estimated within the context of Bayesian inference (see Zellner, 1971). Bayesian inference can be used to obtain marginal posterior density functions and moments for individual SUR coefficients in alternative ways (Ando and Zellner, 2010).<sup>6</sup> One such alternative is to employ a Markov Chain Monte Carlo (MCMC) methodology for Bayesian inference.

The following exposition of Bayesian estimation of SUR models, the use of MCMC methodology and the Gibbs sampler, strictly follows Griffith (2003).

Let  $f(\cdot)$  denote a generic probability density function. We can then write the likelihood function for  $\beta$  and  $\Sigma$  as follows,

$$f(y|\beta, \Sigma) = (2\pi)^{-MT/2} |\Sigma|^{-T/2} \exp\left\{-\frac{1}{2}(y - XB)'(\Sigma^{-1} \otimes I_T)(y - XB)\right\}. \quad (2)$$

This probability density function may also take the following form,

$$f(y|\beta, \Sigma) = (2\pi)^{-MT/2} |\Sigma|^{-T/2} \exp\left\{-\frac{1}{2}\text{tr}(A\Sigma^{-1})\right\}. \quad (3)$$

If we let A be a  $(M \times M)$  matrix whose  $(i, j)$ -th element can be written as,

$$[A]_{ij} = (y_i - X_i B_i)'(y_j - X_j B_j). \quad (4)$$

5 Cross-sectional dependency in panel data can be formally tested using the Breusch and Pagan (1980) and Pesaran (2004) testing procedures. One should, however, more than expect cross-sectional dependency a priori while working on Sub-Saharan African economies. Sub-Saharan African countries do not only exhibit similar underdevelopment problems, but have also implemented similar structural reforms, and trade and financial liberalisation programmes.

6 Griffiths (2003) provides an excellent introduction to these alternatives, as well as the theoretical and applied literature on SUR systems.

This matrix can also be expressed in the following form,

$$A = (Y - X^*B)'(Y - X^*B)A = (Y - X^*B)'(Y - X^*B) \quad (5)$$

where  $Y = (y_1, y_2, \dots, y_m)$  is a  $(T \times M)$  matrix and  $X^* = (X_1, X_2, \dots, X_m)$   $X^* = (X_1, X_2, \dots, X_m)$  is a  $(T \times K)$  matrix and B can be written in the following way,

$$B = \begin{bmatrix} \beta_1 & & & \\ & \beta_2 & & \\ & & \ddots & \\ & & & \beta_M \end{bmatrix}. \quad (6)$$

The non-informative prior is then given by

$$f(\beta, \Sigma) = f(\beta)f(\Sigma) \propto |\Sigma|^{-(M+1)/2}. \quad (7)$$

Using Bayes' theorem we can now write the joint posterior probability density function for  $\beta\beta$  and  $\Sigma\Sigma$  as follows,

$$(y - XB)'(\Sigma^{-1} \otimes I_T)(y - XB) = (y - X\hat{\beta})'(\Sigma^{-1} \otimes I_T)(y - X\hat{\beta}) + (\beta - \hat{\beta})'X'(\Sigma^{-1} \otimes I_T)X(\beta - \hat{\beta}) \quad (8)$$

$$\text{where } \hat{\beta} = [X'(\Sigma^{-1} \otimes I_T)X]^{-1}X'(\Sigma^{-1} \otimes I_T)y. \quad (9)$$

The conditional posterior probability density function  $\beta$  given  $\Sigma$  is the multivariate normal pdf can be written as follows,

$$f(\beta|\Sigma, y) \propto \exp\left\{-\frac{1}{2}(\beta - \hat{\beta})'X'(\Sigma^{-1} \otimes I_T)X(\beta - \hat{\beta})\right\}. \quad (10)$$

Where posterior mean is identical to the generalized least squares (SUR) estimator

$$E(\beta|y, \Sigma) = \hat{\beta} = [X'(\Sigma^{-1} \otimes I_T)X]^{-1}X'(\Sigma^{-1} \otimes I_T)y \quad (11)$$

and posterior covariance matrix being equal to

$$V(\beta|y, \Sigma) = [X'(\Sigma^{-1} \otimes I_T)X]^{-1}. \quad (12)$$

The covariance matrix estimator  $[X'(\hat{\Sigma}^{-1} \otimes I_T)X]^{-1}$  can be seen as the conditional covariance matrix from the same pdf.

Besides, the marginal posterior pdf  $f(\beta|y)$  can be shown as

$$f(\beta|y) = \int f(\beta, \Sigma|y)d\Sigma \propto |A|^{-T/2} \quad (13)$$

where the integral is taken by using the inverted Wishart distribution.

The conditional posterior pdf for  $\Sigma$  given  $\beta$  can be written as

$$F(\Sigma|\beta, y) \propto |\Sigma|^{-(T+M+1)/2} \exp\left\{-\frac{1}{2}\text{tr}(A\Sigma^{-1})\right\} \quad (14)$$

where the conditional posterior pdf has  $T$  degrees of freedom and parameter matrix  $A$  (see, Griffiths, 2003).

If we define the following indicator function

$$I_S(\beta) = \begin{cases} 1 & \text{for } \beta \in S \\ 0 & \text{for } \beta \notin S \end{cases} \quad (15)$$

where  $S$  denotes the feasible region defined by the inequality constraints, we can incorporate inequality restrictions into the following noninformative prior pdf (see Griffiths, 2003, p. 278),

$$f(\beta, \Sigma) \propto |\Sigma|^{-(M+1)/2} I_S(\beta). \quad (16)$$

$$f(\beta, \Sigma|y) \propto f(y|\beta, \Sigma)f(\beta, \Sigma) \propto |\Sigma|^{-(T+M+1)/2} \exp\left\{-\frac{1}{2}(y - XB)'(\Sigma^{-1} \otimes I_T)(y - XB)\right\} I_S(\beta) = |\Sigma|^{-(T+M+1)/2} \exp\left\{-\frac{1}{2}\text{tr}(A\Sigma^{-1})\right\} I_S(\beta) \quad (17)$$

The conditional posterior pdf for  $(\beta|\Sigma)$  can finally be written as follows,

$$f(\beta|\Sigma, y) \propto \exp\left\{-\frac{1}{2}(\beta - \hat{\beta})' X'(\Sigma^{-1} \otimes I_T)X(\beta - \hat{\beta})\right\} I_S(\beta). \quad (18)$$

Regarding the conditional posterior pdf,  $(\Sigma|y)$  is the same inverted-Wishart distribution as in equation (14).

The marginal posterior pdf for  $B$  can be written as follows,

$$f(\beta|y) \propto |A|^{-T/2} I_S(\beta). \quad (19)$$

The posterior pdf for  $\beta_1$  conditional on the remaining  $\beta_i$   $\beta_i$  can then be written as follows,

$$f(\beta_1|y, \beta_2, \beta_3, \dots, \beta_M) \propto \left[ v_1 + \frac{(\beta_1 - \hat{\beta}_1)' X_1' Q_{(-1)} X_1 (\beta_1 - \hat{\beta}_1)}{\hat{\sigma}_1^2} \right]^{-(K_1 + v_1)/2} I_S(\beta). \quad (20)$$

### Gibbs Sampling with $\beta$ and $\Sigma$

It is possible to get draws of  $\beta$  and  $\Sigma$  from their respective marginal posterior pdfs in several ways. One alternative is to use an MCMC procedure known as Gibbs sampling, in which case draws are made iteratively from the conditional posterior pdfs (see Griffith, 2003, pp.274).

Letting  $\Sigma^{(0)}$  to be the starting value for  $\Sigma$ , the  $l$ -th draw from the Gibbs sampler  $(\beta^{(l)}, \Sigma^{(l)})$   $(\beta^{(0)}, \Sigma^{(0)})$  can be obtained using in two steps:

Step 1. Draw  $\beta^l$  from  $f(\beta|\Sigma^{(l-1)}, y)$ .

Step 2. Draw  $\Sigma^l$  from  $f(\Sigma|\beta^{(l)}, y)$ .

As long as the two conditional posterior pdf's are normal and inverted Wishart respectively, we can employ the two steps procedure defined above. If we repeat this a sufficiently large number of times, the subsequent draws will converge to draws direct from the marginal posterior pdfs  $f(\beta|y)$  and  $f(\Sigma|y)$  (see Griffiths, 2003: 278-279).

The posterior distribution gives us all the information such as the mean, median, standard deviations, quantiles, and posterior, or confidence intervals we may need for statistical inference and hypothesis testing. Posterior probability distributions provide a valuable epistemological alternative to frequentist P-values, as a direct measure of the degree of belief in hypothesis testing (Ellison, 2005, p.509). For how Bayesian posteriors can be used for building Bayesian confidence, or credibility intervals for hypothesis testing (see Ellison, 2005, pp. 511 – 517, and Koch, 2007, pp. 207 – 215). For a general discussion of Bayesian inference and hypothesis testing based on MCMC and Gibbs sampling, also see Rossi, Allenby, and McCulloch, 2005.

### 3. Data and Estimation Results

This paper examines the possibility of pairwise Granger causality relations among real GDP growth (*GDP*), Exports as percentage of GDP (*EXP*), and net Foreign Direct Investment inflows (*FDI*) as percentage of GDP.

We employ annual data for 13 Sub-Saharan African countries; namely, Benin, Burkina Faso, Democratic Republic of the Congo, Kenya, Madagascar, Malawi, Mauritania, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, and South Africa. The selection of this sample was made due to data availability. The sample period is 1970 – 2017 for all countries. All data are taken from the World Bank World Development Indicators database.<sup>7</sup>

In an attempt to study unidirectional and bidirectional Granger causality in the SUR context we estimate three trivariate systems of equations. In each system, one of the three variables at hand is taken interchangeably as the dependent variable, and the two others are explanatory variables. In each of these, we also add a linear time trend as a proxy variable that might substitute for variables that are omitted from the original regression models. Our aim here is to mitigate the omitted variable bias (see Tekin, 2012: 872).

As correctly noted by Kónya (2006, p. 982-983), it is also crucial to determine the optimal lag structure prior to estimation, as Granger-causality tests are very sensitive to the choice of the lag length. Following Tekin (2012), in all of our systems of equations we allow one lag for both the dependent and independent variables, without allowing them to vary across countries.

We then estimate all the three systems of Seemingly Unrelated Regressions using the Bayesian approach explained above, which makes use of the MCMC procedure and the Gibbs sampler.<sup>8</sup> We

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<sup>7</sup> The data is available on <http://databank.worldbank.org/data/reports.aspx?source=World-Development-Indicators#>

<sup>8</sup> The R codes for Bayesian analysis of SUR models, and the Gibbs sampler, written by Peter Rossi, and provided in the following address, are greatly appreciated <https://rdrr.io/cran/bayesm/man/rsurGibbs.html>

chose 200,000 as the length of burn-in period since convergence is reached at around this size and further repetition makes no contribution. Estimation results, i.e. mean estimation coefficients, and confidence intervals for the null hypothesis of non-Granger causality are provided in Table 1, Table 2, and Table 3. In the Appendix we provide a visual summary of hypothesis tests conducted in each of these systems of equations.

### EXP-GDP Nexus

Bayesian analysis of the first SUR system, where *GDP* is the dependent and *EXP* and *FDI* are the explanatory variables, is summarised in Table 1. Findings presented in Table 1 suggest that exports Granger-cause economic growth in **Burkina Faso** (1 %), **Madagascar** (1 %), **Nigeria** (1%), **Rwanda** (5%), **Senegal** (10%), and **Sierra Leone** (1 %). We fail to reject the null hypothesis of non-Granger causality for these countries at the confidence intervals stated in parentheses. We therefore conclude that in these 6 Sub-Saharan African countries we have some evidence in support of the **export-led growth** hypothesis.

Table 2 summarises results of the Bayesian analysis of the system where *EXP* is the dependent and the other two variables are the independent variables. We fail to reject the null of non-Granger causality in only 4 out of 13 countries. This result suggests that GDP growth causes exports in these 4 Sub-Saharan countries; namely, **Benin** (5%), **Democratic Republic of the Congo** (10%), **Kenya** (5%), and **Niger** (5%). We therefore conclude that in these cases our causality tests are supportive of the **growth-led exports** hypothesis, which maintains that domestic economic growth dynamics are more relevant for explaining export growth.

It is remarkable that in none of these cases there is evidence for causality working in both directions. It should also be noted that in all of these cases there is evidence of significant causality, we find a positive estimation coefficient, that is, the mean and the median of regression betas are both positive. This finding suggests a positive causality relation between the two variables.

### FDI-GDP Nexus

We then concentrate on the next objective of the study; that is, testing for the so-called FDI-GDP causal nexus. Empirical results (see Table 1) suggest that FDI Granger-causes economic growth in **Benin**, **Burkina Faso**, **Democratic Republic of the Congo** (5%), **Madagascar** (10 %), **Mauritania** (1%), **Niger** (5%), **Senegal** (1%), and **Sierra Leone** (1%). In those cases we fail to reject the Granger non-causality hypothesis at the confidence intervals stated in parentheses. Testing for one-period-ahead unidirectional causality, therefore, this study provides support for the **growth-led FDI** hypothesis in 8 out of 13 Sub-Saharan African countries.

By focusing on results provided in Table 3, we can study causality relations in the opposite direction; that is, from *GDP* to *FDI*. In the case of **Madagascar** (10 percent), **Mauritania** (5%),



**Niger** (10%) and **South Africa** (5%) we fail to reject the hypothesis of Granger non-causality at the confidence intervals stated in parentheses. We therefore conclude that GDP growth Granger-causes net FDI inflows in these 4 Sub-Saharan African countries. Here, it must be noted that the sign of this coefficient is positive in all cases where there is a significant causality relation, but Mauritania. In Mauritania, both the mean and median regression beta is found to be negative, suggesting that economic growth in the previous year negatively affects net FDI inflows as share of GDP.<sup>9</sup>

It is highly remarkable that in only 2 cases, namely, in the case of **Sierra Leone** and **Burkina Faso**, we observe that economic growth is Granger-caused by both exports and net FDI inflows. In the remaining 11 Sub-Saharan African countries in our sample, test results suggest that GDP growth is Granger-caused by only one of the two independent variables.

**Table 1:**  $GDP = f(EXP, FDI)$

Country	Variable		1%	5%	10%	50%	90%	95%	99%
Benin	Export		-0.18193	-0.10075	-0.05911	0.085363	0.228577	0.269931	0.348133
Benin	FDI	**	-0.08431	0.158841	0.290358	0.733767	1.174741	1.300422	1.53954
Burkina Faso	Export	***	0.038021	0.104326	0.141183	0.264091	0.385525	0.421892	0.48759
Burkina Faso	FDI	**	-2.58677	-2.19234	-1.98211	-1.26625	-0.5542	-0.34156	0.060816
Congo Dem. Rep.	Export		-0.19983	-0.15102	-0.12444	-0.03356	0.058458	0.084389	0.135376
Congo Dem. Rep.	FDI	**	-0.05088	0.077054	0.144965	0.379789	0.613511	0.681004	0.810918
Kenya	Export		-0.20306	-0.13763	-0.10312	0.01653	0.136303	0.170304	0.23648
Kenya	FDI		-1.74565	-1.29804	-1.06649	-0.27747	0.515068	0.735823	1.180942
Madagascar	Export	***	0.008583	0.086831	0.126764	0.267595	0.408479	0.448842	0.526099
Madagascar	FDI	*	-0.60028	-0.48275	-0.42358	-0.21365	-0.0008	0.061773	0.180695
Malawi	Export		-0.23045	-0.14976	-0.10781	0.039941	0.190657	0.235078	0.317725
Malawi	FDI		-0.29544	-0.1344	-0.05225	0.232714	0.51901	0.601856	0.760201
Mauritania	Export		-0.13223	-0.09501	-0.07637	-0.0109	0.054671	0.07361	0.108944
Mauritania	FDI	***	0.115668	0.155389	0.176221	0.247996	0.31887	0.339324	0.379202
Niger	Export		-0.25087	-0.12022	-0.05165	0.184175	0.416196	0.483798	0.60827
Niger	FDI	**	-0.07569	0.050075	0.116621	0.344181	0.575871	0.643217	0.770923
Nigeria	Export	**	-0.01516	0.054435	0.091966	0.221284	0.349927	0.387521	0.458019
Nigeria	FDI		-0.90493	-0.58317	-0.41345	0.176507	0.773872	0.948438	1.276146
Rwanda	Export	**	-0.07591	0.212668	0.35693	0.865578	1.371926	1.514721	1.791917
Rwanda	FDI		-3.66131	-2.67591	-2.1573	-0.37171	1.420425	1.941183	2.949959
Senegal	Export	*	-0.09809	-0.02893	0.007818	0.135282	0.264861	0.301405	0.373288
Senegal	FDI	***	0.102662	0.368596	0.509427	1.001018	1.49618	1.643011	1.919966
Sierra Leone	Export	***	-0.76021	-0.67173	-0.62485	-0.46495	-0.30498	-0.25787	-0.16729
Sierra Leone	FDI	***	0.051067	0.142739	0.189692	0.355321	0.523894	0.573234	0.665869
South Africa	Export		-0.17983	-0.13037	-0.10457	-0.01569	0.072854	0.098348	0.146361
South Africa	FDI		-0.63077	-0.44772	-0.35745	-0.04252	0.275315	0.370445	0.553861

<sup>9</sup> Theoretically, FDI inflows might have a growth-decelerating impact on the recipient country in case of a substantial crowding-out, resulting in a negative link between FDI and economic growth in Least Developed Countries (Tekin, 2012; 870).

## EXP-FDI Nexus

Results provided in Table 2 allow us study causality relations from *FDI* to *EXP*. Empirical results show that in **Benin** (5%), **Mauritania** (5%), **Nigeria** (5%), and **South Africa** (5%), net, inward *FDI* Granger-causes exports at the confidence intervals given in parentheses. We therefore conclude that in those cases we have evidence for what can be termed as the **FDI-led exports** hypothesis.

Table 3 allows us to comment on the causality relations in the opposite direction; that is, to see whether Exports Granger-cause net *FDI* inflows. In the case of the following Sub-Saharan African countries we fail to reject the null hypothesis of Granger non-causality: **Burkina Faso** (1%), **Madagascar** (5%), **Malawi** (5%), **Nigeria** (10%), and **Rwanda** (10%). If we stick to 1 and 5 % confidence levels, we can claim evidence supportive of this reverse causality link in only 3 countries. It should be noted that the mean and median regression coefficients are positive in all these cases where we find evidence of significant causality between the exports and *FDI* pair.

**Table 2:**  $EXP = f(GDP, FDI)$

Country	Variable		1%	5%	10%	50%	90%	95%	99%
Benin	GDP	**	-0.0356	0.0337	0.0709	0.1968	0.3231	0.36	0.4292
Benin	FDI	***	0.3307	0.5072	0.5977	0.9027	1.2025	1.2893	1.4532
Burkina Faso	GDP		-0.2063	-0.1397	-0.1041	0.0183	0.1436	0.1801	0.2515
Burkina Faso	FDI		-1.2939	-0.8896	-0.6774	0.0566	0.8016	1.0206	1.4319
Congo Dem. Rep.	GDP	*	-0.112	-0.0075	0.0461	0.2325	0.418	0.4712	0.5728
Congo Dem. Rep.	FDI		-0.7995	-0.6024	-0.4982	-0.1431	0.2138	0.3162	0.5123
Kenya	GDP	**	-0.4376	-0.3661	-0.3281	-0.1976	-0.0648	-0.0265	0.0486
Kenya	FDI		-1.4907	-0.9971	-0.742	0.1351	1.014	1.2673	1.7692
Madagascar	GDP		-0.3723	-0.2893	-0.2454	-0.0934	0.0573	0.1008	0.1832
Madagascar	FDI		-0.5006	-0.3793	-0.3176	-0.1015	0.1159	0.1779	0.2989
Malawi	GDP		-0.2478	-0.1881	-0.1574	-0.0488	0.0599	0.0923	0.1529
Malawi	FDI		-0.3379	-0.1933	-0.1187	0.1433	0.4026	0.4769	0.6196
Mauritania	GDP		-0.5571	-0.4426	-0.3828	-0.1763	0.0294	0.0886	0.2003
Mauritania	FDI	**	-0.04	0.0221	0.0533	0.162	0.2709	0.3028	0.3637
Niger	GDP	**	-0.0021	0.0345	0.0535	0.119	0.1843	0.2035	0.2402
Niger	FDI		-0.1956	-0.1427	-0.114	-0.0166	0.0815	0.1098	0.1649
Nigeria	GDP		-0.2968	-0.2197	-0.1795	-0.0376	0.102	0.1428	0.2236
Nigeria	FDI	**	-0.0399	0.3192	0.5014	1.135	1.7706	1.9524	2.3119
Rwanda	GDP		-0.0441	-0.024	-0.0134	0.0231	0.0594	0.0698	0.0894
Rwanda	FDI		-0.5942	-0.3189	-0.1819	0.3049	0.7919	0.9309	1.2097
Senegal	GDP		-0.4425	-0.3528	-0.3071	-0.1462	0.0134	0.0589	0.1465
Senegal	FDI		-0.828	-0.5255	-0.3748	0.1548	0.6853	0.8375	1.1477
Sierra Leone	GDP		-0.1396	-0.0798	-0.0476	0.0627	0.1753	0.2076	0.2683
Sierra Leone	FDI		-0.2651	-0.1929	-0.1561	-0.0282	0.1006	0.1375	0.209
South Africa	GDP		-0.3834	-0.2693	-0.2095	-0.0036	0.2035	0.2629	0.38
South Africa	FDI	**	-0.2292	0.0117	0.1345	0.5541	0.9643	1.0837	1.3122

**Table 3:** FDI= f (GDP, EXP)

Country	Variable		1%	5%	10%	50%	90%	95%	99%
Benin	GDP		-0.0891	-0.0433	-0.0196	0.0624	0.1439	0.1673	0.2138
Benin	Export		-0.1510	-0.1172	-0.1002	-0.0410	0.0186	0.0358	0.0687
Burkina Fa	GDP		-0.0557	-0.0324	-0.0202	0.0210	0.0625	0.0745	0.0975
Burkina Fa	Export	***	0.0232	0.0500	0.0638	0.1121	0.1601	0.1737	0.2006
Congo Der	GDP		-0.1043	-0.0471	-0.0169	0.0854	0.1890	0.2193	0.2761
Congo Der	Export		-0.1425	-0.1038	-0.0839	-0.0129	0.0565	0.0767	0.1150
Kenya	GDP		-0.0645	-0.0449	-0.0349	0.0001	0.0349	0.0450	0.0650
Kenya	Export		-0.0644	-0.0445	-0.0341	0.0022	0.0383	0.0490	0.0690
Madagasc	GDP	*	-0.0536	-0.0153	0.0044	0.0734	0.1418	0.1620	0.2010
Madagasc	Export	**	-0.0245	0.0100	0.0278	0.0887	0.1488	0.1664	0.2002
Malawi	GDP		-0.1178	-0.0751	-0.0526	0.0236	0.1002	0.1225	0.1657
Malawi	Export	**	-0.0476	0.0066	0.0346	0.1310	0.2265	0.2531	0.3053
Mauritania	GDP	**	-0.8891	-0.7330	-0.6501	-0.3714	-0.0946	-0.0146	0.1441
Mauritania	Export		-0.3517	-0.2833	-0.2462	-0.1164	0.0150	0.0529	0.1249
Niger	GDP	*	-0.0338	-0.0046	0.0108	0.0637	0.1167	0.1321	0.1614
Niger	Export		-0.1669	-0.1134	-0.0851	0.0118	0.1084	0.1362	0.1899
Nigeria	GDP		-0.0377	-0.0142	-0.0020	0.0407	0.0837	0.0959	0.1194
Nigeria	Export	*	-0.0204	-0.0011	0.0092	0.0440	0.0791	0.0892	0.1087
Rwanda	GDP		-0.0251	-0.0181	-0.0144	-0.0017	0.0109	0.0146	0.0217
Rwanda	Export	*	-0.0378	-0.0095	0.0050	0.0559	0.1069	0.1220	0.1508
Senegal	GDP		-0.0841	-0.0534	-0.0376	0.0174	0.0722	0.0877	0.1185
Senegal	Export		-0.1055	-0.0777	-0.0631	-0.0124	0.0383	0.0531	0.0814
Sierra Leon	GDP		-0.2456	-0.1673	-0.1254	0.0170	0.1593	0.2014	0.2804
Sierra Leon	Export		-0.3281	-0.2461	-0.2027	-0.0537	0.0930	0.1359	0.2188
South Afric	GDP	**	-0.0449	0.0099	0.0388	0.1360	0.2329	0.2616	0.3162
South Afric	Export		-0.1354	-0.1021	-0.0853	-0.0261	0.0325	0.0491	0.0819

#### 4. Conclusion

This study employed a new Granger causality testing approach which is based on Bayesian inference of Seemingly Unrelated Regressions systems. This approach allows us to test for possible Granger causality relations in panels where there are cross-sectional dependency, and coefficient heterogeneity. Such Bayesian analysis of SUR systems based on the MCMC method and the Gibbs sampler allows us to test for pairwise, one-period-ahead causality relations in both directions. Bayesian estimation of SUR systems thus may provide a good alternative for testing Granger causality in panel data.

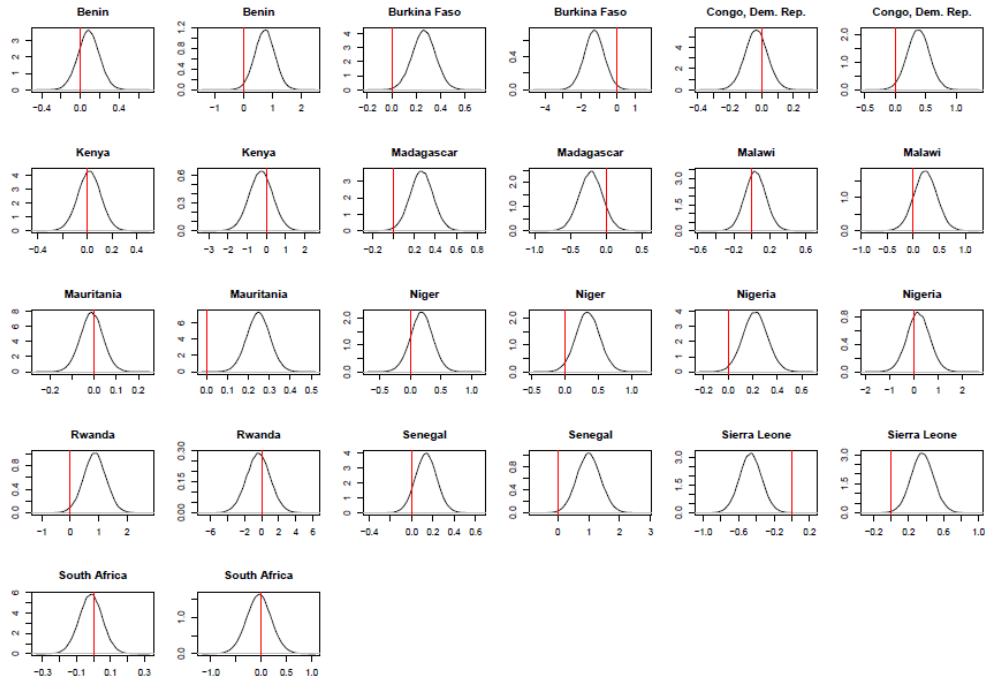
This study provide some new evidence on causal relations among exports, foreign direct investment, and economic growth in Sub-Saharan Africa. We provide some empirical support for both the export-led growth, and the growth led – exports hypotheses, which can't be rejected in the case 6, and 4 countries respectively. This study finds evidence in support of FDI-led economic growth in the case of 8 of the 13 Sub-Saharan African countries in the sample. Test results suggest

that causality in this FDI-economic growth pair works in the reverse direction, i.e., from GDP growth to FDI in 3 Sub-Saharan African countries. Test results on the last causal nexus studied, i.e., the so-called FDI and exports nexus, also designate a bidirectional causality relationship in conformance with the existing empirical literature. In 4 Sub-Saharan African countries test results suggest that we have Granger-causality from net FDI inflows to exports. In 5 Sub-Saharan countries, however, causality works in the reverse direction; that is, growth in exports Granger causes, and positively contribute to net foreign direct investment inflows.

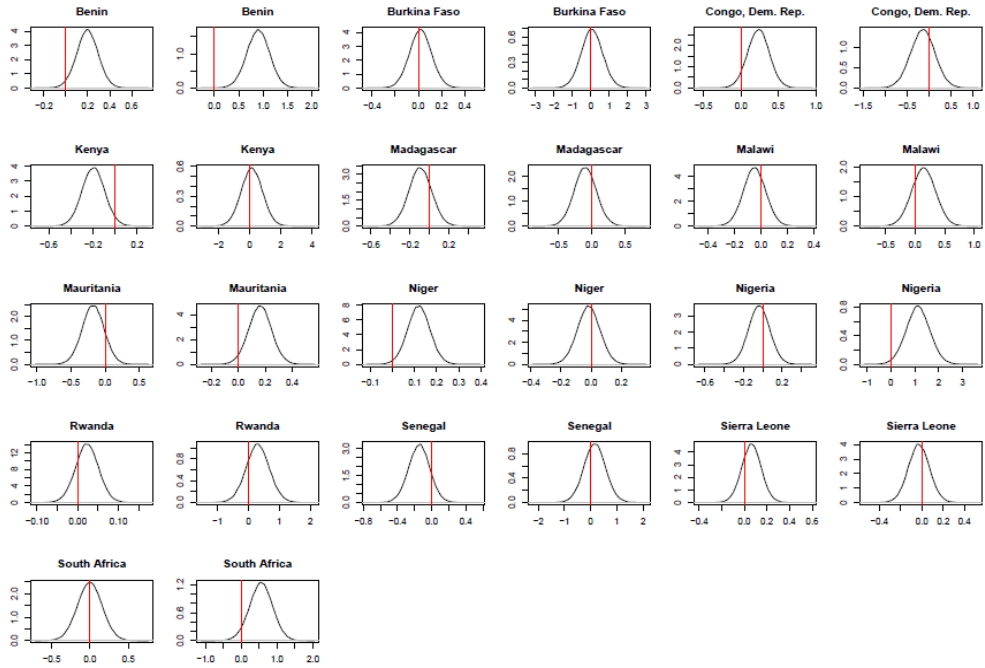
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**Appendix: Plots of regression betas GDP= f (EXP, FDI)**



Exports = f(GDP, FDI)



**FDI = f (GDP, EXP)**

