

A NOTE ON CAUSALITY RELATIONS AMONG ECONOMIC GROWTH, DEVELOPMENT ASSISTANCE AND TRADE OPENNESS IN LOW INCOME COUNTRIES

DÜŞÜK GELİRLİ ÜLKELERDE İKTİSADİ BÜYÜME, KALKINMA YARDIMLARI VE TİCARİ AÇIKLIK ARASINDAKİ NEDENSELLİK İLİŞKİLERİ ÜZERİNE BİR DEĞERLENDİRME

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Abstract

This article tests for causality relations among economic growth, official development assistance and openness-to-trade in low income countries. A recently developed Granger causality testing methodology based on Bayesian estimation of Seemingly Unrelated Regression (SUR) systems is employed in this study. Findings suggest a direct, unidirectional causality from official development assistance to economic growth in Chad, Madagascar, Democratic Republic of the Congo, the Gambia and Sierra Leone. In Chad and the Gambia, regression coefficients are found to be negative, suggesting a negative impact of foreign aid on economic growth. We therefore fail to provide clear-cut empirical evidence in support of aid effectiveness. Test results suggest unidirectional causality from openness-to-trade to economic growth in Chad, Democratic Republic of the Congo, the Gambia, Rwanda, Mali, Niger and Togo. In all these countries, except Democratic Republic of the Congo, the mean estimation beta is positive, providing some support for the trade-led growth hypothesis. For Chad, Rwanda, Malawi and Madagascar we find evidence for positive, unidirectional causality in reverse direction, that is, from economic growth to openness-to-trade. Finally, in Benin, Burkina Faso and Mali we find evidence that foreign aid inflows Granger-cause and enhance openness-to-trade.

Keywords: Development assistance, effectiveness of aid, openness to trade, economic growth, Granger causality, Bayesian estimation of Seemingly Unrelated Regression (SUR) models, low income countries.

JEL Classification: F14, F35, F43, O10

Özet

Bu makale düşük gelirli ülkelerde resmi kalkınma yardımları, ticari açıklık ve iktisadi büyüme arasındaki muhtemel nedensellik ilişkilerini inceliyor. Makalede, Görünürde İlişkisiz Bağlanımların Bayeşçi Tahminine dayalı bir nedensellik testi yaklaşımı kullanılarak 14 düşük gelirli ülkenin yer

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aldığı bir panelde değişkenler arasındaki tek ve çift yönlü nedensellik ilişkileri test ediliyor. Elde edilen test sonuçları Çad, Madagaskar, Kongo Demokratik Cumhuriyeti, Gambiya ve Sierra Leone'de resmi kalkınma yardımları ile iktisadi büyüme arasında anlamlı bir nedensellik ilişkisi bulunduğunu düşündürüyor. Çad ve Gambiya için regresyon katsayılarının negatif olması bu iki ülke örneğinde kalkınma yardımlarının büyümeyi olumsuz etkilediğine işaret ediyor. Çalışmada elde edilen bulgular Çad, Gambiya, Ruanda, Mali, Nijer ve Togo'da ticari açıklık ile iktisadi büyüme arasında tek yönlü nedensellik ilişkileri bulunduğunu, bu ülkelerde ticari açıklık arttıkça büyümenin olumlu yönde etkilendiğini gösteriyor. Diğer taraftan, çalışmada elde edilen bulgular Çad, Ruanda, Malavi ve Madagaskar'da büyümenin ticari açıklığı tetiklediğine işaret ediyor. Elde edilen test sonuçları kalkınma yardımları ile ticari açıklık arasında anlamlı nedensellik ilişkilerinin bulunduğunu; Benin, Burkina Faso ve Mali'de yardımların ticari açıklığı arttırdığını gösteriyor.

Anahtar Kelimeler: Resmi Kalkınma Yardımları, yardımların etkinliği, ticari açıklık, Granger nedensellik, Görünürde İlişkisiz Bağlanımların Bayeşçi tahmini, Düşük gelirli ülkeler

JEL Sınıflaması: F14, F35, F43, O10

1. Introduction

This article examines causality relations among economic growth, development assistance and openness to trade in low income countries. We employ a recent Granger-causality testing methodology developed in Tekin (2018) which is based on Bayesian estimation of SUR systems, the Markov Chain Monte Carlo (MCMC) method, and Gibbs sampling procedure.

The aim of the article is threefold. Firstly, it aims to revisit the so-called 'Aid-Growth' causality nexus, in an attempt to contribute to the aid effectiveness literature. Secondly, it aims to test for bidirectional causality relations between openness-to-trade and economic growth explicitly. In this respect, the present article connects with the empirical literature on the so-called 'Trade-Growth' causality nexus. The third aim of the article is to see whether foreign development assistance positively contributes to openness-to-trade in low income countries.

Foreign aid and trade liberalisation have long been on top of the international development policy agenda, from Millennium Declaration to Agenda 2030 for Sustainable Development. It can be said that trade has been seen as complementing development assistance since at least the second UNCTAD conference held in Delhi in 1968, which saw the emergence of the "Trade, not aid!" slogan. Trade liberalisation has been among standard policy prescriptions of international development assistance programmes. Low income countries have also been increasingly made subject to trade facilitation, aid-for-trade, and trade-capacity building programmes in the past few decades. Although development aid and openness-to-trade continue to be seen as major sources of real output growth in low income countries, empirical evidence remains somewhat mixed.

Today, there exists a huge and growing body of work on Aid-Growth causality relations. Existing empirical evidence on effectiveness of development aid, however, remains inconclusive. Despite all efforts, there still is a lack of evidence in aid effectiveness literature². Several studies reported

2 Temple, Jonathan R.W. (2010). Aid and Conditionality, Handbook of Development Economics, Ed. Rodrik, D. and

evidence for aid effectiveness in certain macroeconomic environments and under certain conditions³. Others, however, failed to confirm a significant relationship between development aid and economic growth⁴. Studies such as Bobba and Powell (2007), or Gong and Zou (2001), on the other hand, find that foreign aid might even have a negative, deteriorating impact on real income growth. The fact that there is no clear-cut positive relationship between development aid and economic growth can be because most studies “may be plagued by noise in the data, which makes it hard to establish any relationships even if they actually exist”⁵. Even with better data, and better handling of model misspecification and other regression problems, however, empirical literature on this issue only amounts to an “absence of evidence”⁶.

Similarly, there is a large empirical literature testing for Trade-Growth relations⁷. Similarly again, there is only weak evidence about positive impact of trade on economic growth in low income countries⁸. Studies such as Bahmani-Oskooee and Niroomand (1999) find a positive impact of trade on economic growth, while others such as Vamvakidis (2002), provide no support for such a positive relation.⁹ As of now, there exists no consensus on whether greater openness-to-trade stimulates economic growth. Recent researches, properly dealing with model misspecification, endogeneity, and country heterogeneity issues, tend to confirm that low income countries benefit less from openness to trade compared to higher income countries.¹⁰

This article consists of two sections. In the following section we present our testing methodology. In the next section we present the data and summarise findings of our estimations.

Rosenzweig, M., vol 5. London, Elsevier: 4415-4523.

- 3 Burnside, C., Dollar, D. (2000). Aid, Policies, and Growth, *American Economic Review*, 90(4): 847-868. Minoiu, C., Reddy, S. (2010). Development Aid and Economic Growth: A Positive Long-Run Relation, *The Quarterly Review of Economics and Finance*, 50(1): 27-39.
- 4 Easterly, W. et al. (2004). Aid, Policies, and Growth: Comment, *American Economic Review*, 94(3): 774-780.
- 5 Rajan, R. G., Subramanian, A. (2008: 660). Aid and Growth: What does the Cross-Country Evidence Really Show?, *Review of Economics and Statistics*, 90(4): 643-665.
- 6 Temple, 2010, 4448.
- 7 The effect of foreign aid on trade openness, on the other hand, remains relatively less scrutinized. On this issue, see, Tekin, R. B. (2012b). Development Aid, Openness to Trade and Economic Growth in Least Developed Countries: Bootstrap Panel Granger Causality Analysis, *Procedia-Social and Behavioral Sciences*, 62: 716-721.
- 8 Winters, L.A., Masters, A. (2013). Openness and Growth: Still an Open Question?. *Journal of International Development*, 25(8): 1061-1070. Sakyi et al. (2015) reports that for a group of 30 low income countries, they fail to provide support for a long-run cointegration relationship between growth and openness-to-trade. Sakyi et al. (2015). Trade Openness, Income Levels, and Economic Growth: The Case of Developing Countries, 1970–2009. *The Journal of International Trade & Economic Development: An International and Comparative Review*, 24(6): 860 – 882.
- 9 Other studies, such as Rigobon, R., Rodrik, D. (2005) find a significant negative impact of trade on economic growth. Rigobon, R., Rodrik, D. (2005). Rule of Law, Democracy, Openness, and Income: Estimating the Interrelationships. *Economics of Transition*, 13(3): 533-564. For a comprehensive review see Keho, Y. (2017). Keho, Y. (2017). The Impact of Trade Openness on Economic Growth: The Case of Cote d’Ivoire, *Cogent Economics & Finance*, 5(1): 1332820.
- 10 Winters, L.A., Masters, A. 2013, 1061.

2. Bayesian Analysis of Seemingly Unrelated Regression Systems

One advantage of Seemingly Unrelated Regression (SUR) systems is that unlike Vector Autoregression Regression (VAR) models they make it possible studying Granger-causality on each individual panel member separately.¹¹

A Seemingly Unrelated Regression system can be written in matrix forms as follows (see Ando and Zellner, 2010):

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

where $N(\boldsymbol{\mu}, \Sigma)$ is the normal distribution with mean $\boldsymbol{\mu} = (\mu_1, \dots, \mu_M)'$ and covariance matrix Σ , \otimes is the tensor product, Ω 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 ω_{ij} , $\mathbf{y}' = (y'_1, \dots, y'_m)$, $X = \text{diag}\{X_1, \dots, X_m\}$, $\boldsymbol{\beta}' = (\beta_1', \dots, \beta_m')$, $\mathbf{u}' = (\mathbf{u}_1', \dots, \mathbf{u}_m')$.

For estimating SUR systems one can employ the SUR estimator developed in Zellner (1962). For testing for Granger causality, however, one would need to solve for cross-sectional dependency and heterogeneity issues before drawing any meaningful inference.¹²

An alternative procedure that properly takes into account cross-sectional dependence and heterogeneity issues is proposed by Kónya (2006.) Kónya's procedure for testing Granger causality which is based on estimation of SUR systems and Wald tests with country specific bootstrap critical values has become quite popular in applied research in economics (see Kar et al. 2011, Tekin 2012a). Tekin (2018) proposed another alternative Granger causality testing procedure, again based on estimation of SUR systems, and which can properly deal with cross-sectional dependence and heterogeneity issues. Rather than using the SUR estimator and Wald tests with bootstrap critical values, this alternative approach employs Bayesian estimation for testing Granger causality. This approach, we believe, is particularly well-suited for testing Granger causality relations when there is a high degree of heterogeneity and strong likelihood of cross-sectional dependency in the panel at hand.¹³

11 Seemingly Unrelated Regression (SUR) models can be traced back to Zellner, A. (1962). SUR systems improve estimation efficiency, allow us to have heterogeneous slope coefficients, and properly account for the problem of cross-sectional dependence in panel data. In this respect they provide a highly valuable alternative for testing Granger causality. Zellner, A. (1962). An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias, *Journal of the American Statistical Association*, 57(298): 348-368.

12 See Pesaran et al. (1999) for heterogeneity issues. Pesaran et al. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, *Journal of the American Statistical Association*, 94(446): 621-634. See Hurlin, C. (2008) for Granger-causality testing in heterogeneous panels. Hurlin, C. (2008). Testing for Granger Non Causality in Heterogeneous Panels, Mimeo, Department of Economics: University of Orleans.

13 Cross-sectional dependency in panel data can be formally tested using the testing procedures proposed in Breusch, T., Pagan, A. (1980). The LM test and Its Applications to Model Specification in Econometrics, *Review of Economic Studies*, 47: 239-254 and Pesaran, M. (2004). General Diagnostic Tests for Cross Section Dependence in Panels, Cambridge Working Papers in Economics No. 0435 Faculty of Economics, University of Cambridge. One should, however, more than expect cross-sectional dependency a priori while working on low income countries. Low income countries do not only exhibit similar underdevelopment problems, but have also implemented similar

Zellner (1971) explains how SUR systems can be estimated within the context of Bayesian inference. Ando and Zellner (2010) show in detail how Bayesian inference can be used to obtain marginal posterior density functions and moments for individual SUR coefficients in alternative ways.¹⁴ One alternative, among others, is to employ a Markov Chain Monte Carlo (MCMC) methodology for Bayesian inference.

Below we provide a short exposition of Bayesian estimation of SUR models, the use of MCMC methodology and the Gibbs sampler. The exposition below strictly follows Griffiths (2003).

Let $f(\cdot)$ denote a generic probability density function. We can then write the likelihood function for β and Σ 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,

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

This matrix can then be written in the following form,

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

where $Y = (y_1, y_2, \dots, y_m)$ is a $(T \times M)$ matrix and $X^* = (X_1, X_2, \dots, X_m)$ is a $(T \times K)$ matrix while 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 can then be defined as follows:

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

Using Bayes' theorem we can now write the joint posterior probability density function for β and Σ as follows,

economic reforms, and trade and financial liberalisation programmes.

14 Griffiths, W.E. (2003) provides an excellent introduction to these alternatives, as well as the theoretical and applied literature on SUR systems. Griffiths, W.E. (2003). Bayesian Inference in the Seemingly Unrelated Regressions Model, Computer-Aided Econometrics, Ed. Giles, D. E. A. and Dekker, M. New York, CRC Press: 287-314.

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

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

The conditional posterior probability density function β given Σ 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 Σ given β 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 .¹⁵

We can now define the indicator function

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

Here, S gives us the feasible region defined by the inequality constraints.

We can now incorporate inequality restrictions into the following noninformative prior pdf¹⁶,

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

¹⁵ Griffiths, 2003.

¹⁶ Griffiths, 2003, 278.

Applying Bayes' Theorem we can write the joint posterior pdf as follows,

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

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 inverted-Wishart distribution defined 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 β_1 conditional on the remaining β_i can then be written as follows,

$$f(\beta_1 | y, \beta_2, \beta_3, \dots, \beta_M) \propto \left[v_1 + \frac{(\beta_1 - \hat{\beta}_1)' x_1' q_{(1), x_1} (\beta_1 - \hat{\beta}_1)}{\hat{\beta}_1^2} \right]^{-(K_1 + v_1)/2} I_s(\beta). \quad (20)$$

Gibbs Sampling with β and Σ

It is possible to get draws of β and Σ from their respective marginal posterior pdfs in several alternative ways. One way is to use an MCMC procedure known as Gibbs sampling.¹⁷

In Gibbs sampling in which case iterative draws are done from the conditional posterior pdfs.¹⁸ Letting $\Sigma^{(0)}$ to be the starting value for Σ , the l -th draw from the Gibbs sampler $(\beta^{(l)}, \Sigma^{(l)})$ can be obtained using in two steps:

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

Step 2. Draw Σ^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 $f(\Sigma | y)$.¹⁹ All the information we might need for inference and testing, such as the mean, median, standard deviations, quantiles, and posterior, or confidence intervals is given by the posterior distribution.²⁰

17 Rossi et al. (2005). Bayesian Statistics and Marketing. John Wiley & Sons.

18 Griffiths, 2003, 274.

19 Griffiths, 2003, 278-279.

20 Posterior probability distributions, as a direct measure of the degree of belief in hypothesis testing, provide us an invaluable alternative to frequentist P-values Ellison, A. M. (2004: 509). Ellison, A. M. (2004). Bayesian Inference in

3. Data and Estimation Results

This article scrutinizes Granger causality relations among official development assistance, defined as total official development assistance received as percentage of GDP [ODA], openness-to-trade defined as total merchandise trade as share of GDP [OPENNESS], and real GDP growth [GDP].

We employ annual data for 14 low income countries; namely, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Congo, Dem. Rep., the Gambia, Madagascar, Malawi, Mali, Niger, Rwanda, Sierra Leone, and Togo. The sample period is 1970 – 2017 for all countries. All data are taken from the World Bank World Development Indicators database.²¹

For testing for unidirectional and bidirectional pairwise causality relations we estimate two trivariate systems of seemingly unrelated regression equations. The first system takes real growth GDP as the dependent variable, and the two others, namely ODA and OPENNESS, as explanatory variables. The second system takes openness to trade OPENNESS as the dependent variable, and ODA and GDP as explanatory variables.

In each of these two systems, for mitigating the omitted variable bias, we include a linear time trend as a proxy variable.²² Granger-causality tests are very sensitive to the choice of the lag length. It is crucial to determine the optimal lag structure prior to estimation.²³ Following Tekin (2018), in each of the two systems of equations, we allow one lag for both the dependent and independent variables, without allowing them to vary across countries. We then estimate the two systems of Seemingly Unrelated Regressions adopting the Bayesian testing methodology explained in section 2 above.²⁴

Mean beta coefficients, as well as confidence intervals for the null hypothesis of non-Granger causality are provided in Table 1 and Table 2, presented below.²⁵

Ecology, *Ecology Letters*, 7(6): 509-520.

21 The data is available on <https://databank.worldbank.org/source/world-development-indicators>.

22 On this point see Tekin, R. B. (2012a: 872). Tekin, R. B. (2012a). Economic Growth, Exports and Foreign Direct Investment in Least Developed Countries: A Panel Granger Causality Analysis, *Economic modelling*, 29(3): 868-878.

23 See Kónya, L. (2006: 982-983). Kónya, L. (2006). Exports and Growth: Granger Causality Analysis on OECD Countries with a Panel Data Approach, *Economic Modelling*, 23(6): 978–992.

24 In our estimations, we employed R codes for Bayesian analysis of SUR models, and the Gibbs sampler, written by Peter Rossi, available in the following address <https://rdrr.io/cran/bayesm/man/rsurGibbs.html>

25 The length of burn-in period is selected as 200,000 in our estimations since convergence is already reached at around this size, and further repetition makes no gain.

Table 1: GDP = F (ODA, OPENNESS)

Countries	variable	mean betas	X1.	X5.	X10.	X50.	X90.	X95.	X99.
Benin	ODA	4,145	-3,519	-1,221	-0,021	4,150	8,307	9,504	11,777
Benin	OPENNESS	0,016	-0,126	-0,083	-0,061	0,016	0,093	0,115	0,158
Burkina Faso	ODA	1,694	-4,312	-2,532	-1,592	1,688	4,992	5,946	7,774
Burkina Faso	OPENNESS	0,069	-0,077	-0,033	-0,010	0,069	0,149	0,172	0,216
Burundi	ODA	3,041	-8,560	-5,106	-3,287	3,038	9,352	11,172	14,634
Burundi	OPENNESS	0,055	-0,207	-0,129	-0,088	0,055	0,199	0,240	0,320
Central African Republic	ODA	-2,969	-19,970	-14,969	-12,322	-2,956	6,376	9,018	13,979
Central African Republic	OPENNESS	0,187	-0,253	-0,122	-0,052	0,187	0,428	0,497	0,626
Chad	** ODA	-13,479	-30,971	-25,909	-23,180	-13,516	-3,732	-0,903	4,400
Chad	** OPENNESS	0,191	0,025	0,076	0,102	0,191	0,281	0,306	0,356
Congo, Dem. Rep.	* ODA	0,772	-0,502	-0,115	0,086	0,775	1,457	1,653	2,028
Congo, Dem. Rep.	* OPENNESS	-0,055	-0,153	-0,124	-0,108	-0,055	-0,002	0,013	0,043
Gambia, The	** ODA	-12,805	-29,665	-24,767	-22,148	-12,844	-3,424	-0,701	4,445
Gambia, The	* OPENNESS	0,028	-0,021	-0,006	0,002	0,028	0,054	0,062	0,076
Madagascar	*** ODA	7,084	0,567	2,546	3,579	7,102	10,569	11,560	13,442
Madagascar	OPENNESS	-0,029	-0,172	-0,129	-0,106	-0,028	0,049	0,071	0,113
Malawi	ODA	-0,542	-6,418	-4,677	-3,760	-0,554	2,692	3,638	5,449
Malawi	OPENNESS	0,094	-0,083	-0,031	-0,003	0,094	0,191	0,219	0,273
Mali	ODA	-3,472	-10,377	-8,286	-7,197	-3,447	0,223	1,265	3,228
Mali	*** OPENNESS	0,208	0,013	0,071	0,101	0,208	0,316	0,347	0,408
Niger	ODA	0,059	-11,103	-7,775	-6,036	0,062	6,137	7,858	11,174
Niger	** OPENNESS	0,156	-0,022	0,031	0,059	0,156	0,254	0,282	0,336
Rwanda	ODA	6,210	-6,289	-2,576	-0,613	6,220	13,016	14,963	18,645
Rwanda	** OPENNESS	0,355	-0,139	0,010	0,087	0,356	0,623	0,699	0,844
Sierra Leone	* ODA	6,223	-4,742	-1,468	0,247	6,227	12,185	13,888	17,135
Sierra Leone	OPENNESS	-0,064	-0,227	-0,177	-0,152	-0,064	0,023	0,048	0,095
Togo	ODA	-0,663	-14,483	-10,393	-8,242	-0,669	6,922	9,087	13,204
Togo	* OPENNESS	0,069	-0,056	-0,018	0,001	0,069	0,138	0,157	0,195

Standard growth theory suggests a positive causality relation between foreign aid and economic growth, simply because development aid adds to the recipient country's capital stock and accelerates growth.²⁶ Development aid, however, can also be negatively related to real output growth.²⁷ Development aid can even be harmful for assistance receiving countries as aid might crowd-out domestic savings by encouraging consumption, distorting relative prices, and deteriorating productivity. Therefore one might expect positive or negative estimation coefficients.

Estimation results for our first system, where GDP is the dependent and ODA and OPENNESS are the explanatory variables presented in Table 1 above. We fail to reject the null hypothesis of Granger non-causality in case of Chad (5 percent), Madagascar (1 percent), Democratic Republic of the Congo (10 percent), the Gambia (5 percent), and Sierra Leone (10 percent) at the confidence intervals given in parentheses. Here, it should be noted that the mean beta coefficient is found to be positive in all cases except Chad and the Gambia. We therefore conclude that in Madagascar, Democratic Republic of the Congo, and Sierra Leone development assistance contributes significantly (and Granger-causes) real income growth. In case of Chad and the Gambia, however, our test results suggest that foreign aid negatively affects economic growth. Our findings regarding effectiveness of foreign aid thus remain somewhat mixed and we fail to provide clear-cut, strong evidence in support of aid effectiveness.

26 Minoiu, C., Reddy, S. (2010).

27 Tekin (2012b), and references therein.

When studying openness to trade and real growth causality nexus, our test results suggest that OPENNESS is significant in Chad (1 percent), Rwanda (5 percent), Democratic Republic of the Congo (10 percent), the Gambia (10 percent), Mali (1 percent), Niger (5 percent), and Togo (10 percent). We fail to reject the null hypothesis of Granger non-causality for these countries at the confidence intervals stated in parentheses. It should however be noted that all mean estimation beta coefficients are positive in these countries, except Democratic Republic of the Congo. We therefore conclude that in Chad, Rwanda, the Gambia, Mali, Niger and Togo there is evidence of openness-to-trade enhancing and Granger-causing economic growth. In Democratic Republic of the Congo, on the other hand, our test results suggest a negative impact of openness-to-trade on real output growth.

Table 2 summarises results of the Bayesian analysis of the system where OPENNESS is the dependent and the other two variables are the independent variables.

Table 2: $OPENNESS = F(ODA, GDP)$

Countries	Variable	Mean Betas		1%	5%	10%	50%	90%	95%	99%
Benin	ODA	9.432	*	-5.688	-1.110	1.276	9.487	17.510	19.782	24.037
Benin	GDP	0.029		-0.699	-0.479	-0.364	0.030	0.421	0.533	0.750
Burkina Faso	ODA	6.581	**	-1.191	1.145	2.363	6.584	10.799	12.005	14.324
Burkina Faso	GDP	-0.348	**	-0.724	-0.611	-0.551	-0.347	-0.144	-0.086	0.026
Burundi	ODA	16.576		5.340	8.754	10.522	16.615	22.568	24.260	27.432
Burundi	GDP	0.069		-0.155	-0.088	-0.054	0.068	0.191	0.227	0.296
Central African Republic	ODA	-2.368		-12.586	-9.544	-7.936	-2.363	3.197	4.779	7.804
Central African Republic	GDP	-0.151	**	-0.340	-0.282	-0.253	-0.150	-0.050	-0.021	0.033
Chad	ODA	2.254		-16.734	-11.150	-8.196	2.251	12.679	15.661	21.187
Chad	GDP	0.307	**	-0.079	0.037	0.098	0.307	0.517	0.577	0.694
Congo, Dem. Rep.	ODA	1.036		-1.918	-1.033	-0.568	1.035	2.639	3.104	3.993
Congo, Dem. Rep.	GDP	-0.019		-0.554	-0.392	-0.308	-0.018	0.270	0.353	0.512
Gambia, The	ODA	-3.279		-25.337	-18.884	-15.432	-3.285	8.887	12.326	18.811
Gambia, The	GDP	0.431		-0.532	-0.241	-0.091	0.431	0.952	1.103	1.394
Madagascar	ODA	1.236		-8.224	-5.394	-3.909	1.245	6.366	7.832	10.634
Madagascar	GDP	0.422	**	-0.124	0.041	0.127	0.423	0.716	0.801	0.962
Malawi	ODA	4.008		-4.801	-2.156	-0.772	4.023	8.764	10.125	12.724
Malawi	GDP	0.602	***	0.221	0.335	0.394	0.601	0.810	0.872	0.990
Mali	ODA	5.008	*	-3.652	-1.037	0.322	5.011	9.688	11.028	13.575
Mali	GDP	0.004		-0.362	-0.252	-0.194	0.005	0.202	0.260	0.369
Niger	ODA	-5.968	*	-14.962	-12.307	-10.890	-5.971	-1.040	0.383	3.096
Niger	GDP	0.057		-0.204	-0.125	-0.083	0.057	0.198	0.239	0.317
Rwanda	ODA	2.618		-3.435	-1.617	-0.665	2.618	5.902	6.855	8.694
Rwanda	GDP	0.142	***	0.032	0.065	0.082	0.142	0.202	0.219	0.252
Sierra Leone	ODA	-1.443		-14.617	-10.718	-8.678	-1.461	5.793	7.872	11.825
Sierra Leone	GDP	0.053		-0.339	-0.222	-0.160	0.053	0.266	0.327	0.444
Togo	ODA	2.781		-14.496	-9.385	-6.704	2.800	12.253	14.961	20.063
Togo	GDP	0.241		-0.245	-0.098	-0.022	0.241	0.503	0.579	0.724

When testing for the Aid-Openness-to-trade causality nexus, we fail to reject the null of non-Granger causality in only 4 out of 14 countries; namely, Benin (10 percent), Burkina Faso (5 percent), Mali (10 percent), and Niger (10 percent). In all these cases except Niger, the mean

estimation beta is found to be positive. This finding suggests that there is a positive causality relation between the focussed variables. This result leads us believe that official development assistance positively affects and Granger-causes trade openness in these aid-recipient countries. In only one country in our sample (Niger), our test results suggest that development aid has a negative impact on trade openness.

Our estimation results provided in Table 2 further suggest that economic growth Granger-causes trade openness in 6 countries; namely, Rwanda (1 percent), Malawi (1 percent), Madagascar (5 percent), Chad (5 percent), Central African Republic (5 percent), and Burkina Faso (5 percent). In all of these countries with the exception of Central African Republic and Burkina Faso, the mean estimation coefficient was found to be positive, while for these two countries estimation coefficients were found to be negative. We therefore conclude that in Rwanda, Malawi, Madagascar, and Chad, economic growth contributes positively to (and Granger-causes) openness-to-trade. In Central African Republic and Burkina Faso, however, our test results suggest that there is a negative impact of growth on openness-to-trade.²⁸

4. Conclusion

This study tested for causality among development aid, openness to trade and economic growth in low income countries by making use of a recently developed Granger causality testing approach based on Bayesian inference of Seemingly Unrelated Regressions systems. This approach allows us to test for pairwise, one-period-ahead causality Granger relations in both directions where there are cross-sectional dependency and coefficient heterogeneity. Adopting this new procedure we aim to overcome some of the problems and biases in testing for causality relations oft-cited in the literature.

We failed to provide decisive empirical evidence in neither of the causality directions studied. Our findings clearly refute aid effectiveness in all low income countries in our panel, with the exception of Madagascar, Democratic Republic of the Congo and Sierra Leone. In these three low income countries there is evidence that foreign aid inflows positively contribute to economic growth. In case of two countries, however (Chad and the Gambia) we have found a statistically significant negative impact of foreign aid on real income growth. Our findings regarding aid effectiveness thus remain somewhat mixed, and we fail to provide clear-cut, strong evidence in support of aid effectiveness.

All in all, this study shows that even if we employ new, better testing methodology appropriately dealing with some of the problems of earlier studies, insignificant results still prevail. 'Absence of evidence' does definitely not mean 'evidence of absence' of a positive impact of foreign aid on economic growth, as Temple (2010: 4448) correctly noted. It might be that we simply fail to detect it.

28 Here it should be noted that in Chad and Rwanda causality works in both directions; that is, both trade-led growth and growth-led trade hypotheses seem to hold true in these two countries.

Regarding the impact of development aid on openness-to-trade this study provided an ambiguous result. In Benin, Burkina Faso and Mali, we find evidence that foreign aid positively contributes to trade openness. While in one case (Niger), development aid is found to have a negative impact on openness. Further research should deal with this issue in more depth.

Our findings on Trade-Growth causality relations also remain somewhat mixed. We find evidence for both the trade-led growth and growth-led trade hypotheses in a limited number of countries. We therefore conclude that in Chad, Rwanda, the Gambia, Mali, Niger and Togo there is some empirical evidence of openness-to-trade enhancing, and Granger-causing economic growth. In these countries openness-to-trade positively contributes to real income growth as suggested standard by growth theory. It should be noted that all mean estimation beta coefficients are found to be positive, with the exception of Democratic Republic of the Congo. In Democratic Republic of the Congo, our test results suggest that openness-to-trade negatively affects economic growth. We therefore conclude that openness-to-trade might well have a growth-deteriorating impact, as noted earlier by Vlastou (2010) and Tekin (2012b). Test results further suggest that there is some support for the growth-led trade hypothesis in a number of low income countries, namely, Rwanda, Malawi, Madagascar and Chad. In these countries economic growth contributes positively to openness to trade. In two countries, (Central African Republic and Burkina Faso) however, this study finds that real income growth is negatively affecting openness-to-trade.

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