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THE LONG-RUN RELATIONSHIP BETWEEN FOREIGN AID AND LABOR PRODUCTIVITY IN SIERRA LEONE

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ABSTRACT

The Financing Gap Hypothesis (FGH) proposed that foreign aid is needed to fill a financing gap created by low savings in less developed countries (LDCs) relative to the large investments needed for promoting economic development and poverty alleviation. In the 1980s, using the failure of foreign aid to alleviate poverty in LDCs as evidence, a neoclassical counterrevolution in development economics rejected this hypothesis. In its stead, they pointed to poor governance and anti-market statist LDC policies, not inadequate financing, as for the causes of LDC poverty and underdevelopment. The ensuing debate generated a plethora of empirical studies of the aid-growth relationship, whose findings remain inconclusive. While unconditional aid-optimist studies found significantly positive aid-growth relationships, with or without "good" policies, conditional aid-optimists found aid positively impacting growth in only countries that have "good" policies. Meanwhile, aid-pessimist studies reported insignificant or significantly negative aid-growth relationships. However, this literature was mostly based on regression analysis of cross-sectional data. As such, they do not address individual country characteristics that impact the aid-growth relationship. Secondly, they assumed aid-exogeneity, although aid-endogeneity seems more plausible. This makes those regression findings susceptible to endogeneity bias. Thirdly, cross-sectional regression estimates provide a snapshot of the aid-growth relationship at a given point in time. However, economic growth and poverty alleviation are long-run phenomena, which require an understanding of the long-run equilibrium aid-growth relationship. Cointegration analysis estimates long-run equilibrium relationships. Hence, it is appropriate for studying the aid-growth relationship. It also addresses endogeneity bias by assuming that all variables are endogenous. Finally, unlike cross-sectional analysis, individual-country cointegration analysis addresses country-specific characteristics. Given the above advantages of cointegration analysis, this paper uses Johansen's maximum-likelihood (JML) cointegration procedure and three single-equation cointegration estimators to investigate the long-run relationship between labor productivity and foreign aid in Sierra Leone. All four estimators find a positive and significant long-run aid-growth relationship. They also find that total factor productivity (TFP) is the most dominant factor in explaining labor productivity in the country. Consequently, it recommends using aid to promote TFP growth.

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INTRODUCTION

Early development economists (Rostow 1960, for example) viewed economic growth and development synonymously with capital accumulation. Because poverty and low incomes in Less Developed Countries (LDCs) cause low savings and, therefore, low capital accumulation, they concluded that LDCs have a financing gap that only foreign aid can fill.[1] In the 1980s, a neoclassical counterrevolution in development economics cast doubt on this Financing Gap Hypothesis (FGH), arguing that, in spite of massive aid transfers to LDCS, especially in Sub-Saharan Africa (SSA), poverty has continued to grow because of poor governance and market-unfriendly statist policies of LDC governments. Therefore, for foreign aid to positively impact economic growth and poverty alleviation, they argued, it must be conditioned on good governance and macroeconomic policy reforms (Bourguignon and Sundberg 2007). The debate that followed this neoclassical critique made statistical estimation of the aid-growth relationship into a cottage industry. Unfortunately, the evidence produced by this literature is mixed. While some studies found positive aid-growth relationships (with or without good policies), others found it to be either significantly negative or insignificant.[2] Moyo (2009) used the findings of these latter studies to conclude that foreign aid has not only failed to alleviate poverty in Sub-Saharan Africa. Instead, it has promoted bad governance and corruption, both of which have increased the level and rate of poverty in the region. She thus recommended that aid be replaced with non-concessionary loans.[3]

Much of the empirical evidence on the aid-growth relationship has been based on cross-sectional regression models, whose key drawback is that they do not allow for country-specific characteristics and policy environments. This is especially important for Sub-Saharan Africa, whose many countries have often followed radically different economic policies. Additionally, being snapshots at a given time, cross-country regressions are incapable of addressing long-run equilibrium relations among variables. However, economic growth is a dynamic process. Therefore, the long-run equilibrium aid-growth relationship is more important to the aid-growth debate than the static (short-run) cross-sectional relationships on which the debate has been based. Ignoring the problem of aid endogeneity, which results from the fact that slow-growing countries tend to need and receive more aid than their fast-growing counterparts, is another weakness of much of the current literature. Because the explanatory variables in regression models are assumed to be exogenous, aid-endogeneity introduces bias into their results (Hansen and Tarp 2001).

Cointegration analysis addresses the above weaknesses in a number of ways. Firstly, it assumes that all the variables are endogenous, thus dealing with the aid-endogeneity issue. Secondly, it estimates long-run equilibrium relationships between the variables, which makes it ideal for studying long-run phenomena. Thirdly, country cointegration studies avoid the bias that country-specific characteristics pose for cross-sectional models. As such, they are most reliable for evaluating aid effectiveness (Riddell 2007). This paper uses four cointegration procedures to estimate the long-run relationship between foreign aid and labor productivity in Sierra Leone.[4] Unlike much of the existing literature, which have focused exclusively on real GDP growth, it seeks to explain labor productivity growth because it is the most important cause of improvements in living standards. Finally, it studies the aid-growth relationship in a very aid-dependent country.

The remainder of the paper is organized as follows. A brief survey of the empirical literature follows this introduction. Thereafter, the model and data used are described. This is followed by the empirical analysis and a discussion of its results. Finally, key conclusions from the empirical results and their policy implications are presented.

SURVEY OF THE LITERATURE

As already noted, the empirical evidence on the aid-growth relationship in LDCs is voluminous and mixed. Thus, reviewing it in its entirety is beyond the scope of this paper. Consequently, this survey focuses on four meta-analysis of this literature and a sample of empirical studies on SSA economies. The first meta-analysis, Tsikata (1998), found the plurality of the evidence suggesting an insignificant aid-growth relationship. Hansen and Tarp (2001) contrarily found the literature supportive of a positive aid-growth relationship. Meanwhile, Doucouliagos and Paldam (2008) countered Hansen and Tarp with a finding of an insignificant aid-growth relationship. The fourth meta-analysis, Mekasha and Tarp (2013), used the same 68 studies used by Doucouliagos and Paldam (2008) and reported a positive aid-growth relationship.

In the SSA region, the evidence has also been mixed, although the plurality points to a positive and significant aid-growth relationship. One of the earliest of these studies (Levy 1987) found aid being positively and significantly related to economic growth in the region. This was later confirmed by Loxley and Sackey (2008), Juseluis, Møller, and Tarp (2013), and Ndambendia and Njoupouognigni (2010), among others. Meanwhile, Mallik (2008) found a positive and significant aid-growth relationship in Togo and a negative and significant one in Central African Republic, Malawi, Mali, Niger, and Sierra Leone. In the Economic Community of West African States (ECOWAS), Sheu and Ismai (2016) found a significantly positive aid-growth relationship, contrary to Fiodendji and Elvo (2013) which found positive but insignificant aid-growth relationships in high aid-recipient ECOWAS countries and a negative and significant relationship in low aid-recipient ones. The study also found positive and significant aid-growth relationships in only countries that have good policies and institutions.

The country studies have been just as inconclusive. For example, Tuffour (2013) found a positive aid-growth relationship in Ghana while Appiah-Konado et al (2016) found the opposite. In Tanzania, Choong, Zeng, and Tiong (2010) and Rotarou and Ueta (2009) found a positive aid-growth relationship while Kabete (2008) found a negative one. Using ordinary least squares, Mbaku (1993) found an insignificant aid-growth relationship in Cameroon. However, a year later, applying cointegration analysis to the same data, he and his coauthors (Murthy, Ukpolo, and Mbaku 1994) found a positive and significant one.[5] Similarly, while Fasanya and Onakoya (2012) and Tombofa, Edoumiekumo, and Obudah (2013) found a positive aid-growth relationship in Nigeria, Kolawole (2013) and Mbah and Amassoma (2014) found it to be insignificant. In Ethiopia, Ejigu (2015) and Setargie (2015) found a positive aid-growth relationship while Girma (2014) found the opposite. Finally, in Sierra Leone, the country of interest here, contrary to Mallik (2008), Kargbo (2012) found a significantly positive aid-growth relationship.

THE EMPIRICAL MODEL AND DATA

Empirical Model

The model assumes a vector of non-stationary endogenous variables, $\mathbf{x}=[\mathbf{y}, \mathbf{TFP}, \mathbf{k}, \mathbf{a}]$; where $\mathbf{y}$ = output per worker, henceforth referred to as labor productivity, **TFP** = total factor productivity, $\mathbf{k}$ = fixed capital per worker, and $\mathbf{a}$ = aid per worker. Assuming p lags, the following vector-autoregressive (VAR) model can be formulated:

$$\mathbf{x}_t = A_1\mathbf{x}_{t-1} + A_2\mathbf{x}_{t-2} + \ldots + A_p\mathbf{x}_{t-p} + \mathbf{\Phi D}_t + \varepsilon_t; \quad (1)$$

where A_i = *nx1* vector of coefficients, $\mathbf{D}$ = *mx1* vector of deterministic terms (which can include a constant, trend, and dummy variables), $\mathbf{\Phi}$ = *nxm* matrix of coefficients and ε = *nx1* vector of NIID errors. Equation (1) can be rewritten as:

$$\Delta\mathbf{x}_t = \mathbf{\Pi x}_{t-1} + \mathbf{\Gamma}\Delta\mathbf{x}_{t-1} + \mathbf{\Phi} D_t + \boldsymbol{\varepsilon}_t; \quad (2)$$

where $\mathbf{\Pi}$ = *nxn* cointegrating matrix and $\mathbf{\Gamma}$ = *nxn* matrix of short-run adjustment coefficients. If $\mathbf{\Pi}$ has reduced rank ($r<n$), then there would exist two *nxr* coefficient matrices ($\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$) such that $\mathbf{\Pi} = \boldsymbol{\alpha\beta}'$ and $\boldsymbol{\beta}'\mathbf{x}_t$ is stationary.[6] In that case, the cointegrated VAR becomes:

$$\Delta\mathbf{x}_t = \boldsymbol{\alpha\beta}'\mathbf{x}_{t-1} + \mathbf{\Gamma}\Delta\mathbf{x}_{t-1} + \mathbf{\Phi} D_t + \boldsymbol{\varepsilon}_t. \quad (3)$$

Neoclassical production function theory holds that the coefficients of TFP and capital per-worker should be positive, with the former assumed equal to unity. The aid-growth debate hinges on the sign and significance of the estimated aid coefficient. When positive and significant, it supports the aid-optimist position. Otherwise, the aid-pessimist position is supported.

Data

Data availability and quality are major constraints to empirical research on developing countries. For this study, data on Sierra Leone's fixed capital stock and employment, which are from the *Extended Penn World Tables* (Marquetti 2011), are available for only the 1974-2008 period. This therefore determined the relevant period for the study. Data on foreign aid (defined here as net Official Development Assistance) are from the World Bank's *World Development Indicators* dataset. Total factor productivity (TFP), which is not observed, was estimated.[7] The variables were converted into per-worker terms and transformed into natural logs.

EMPIRICAL RESULTS

Johansen's Maximum-Likelihood (JML) Estimation

Johansen (1988) provides a one-step procedure for estimating the rank (r) of the cointegrating matrix, the cointegrating matrix (**β**), and the adjustment matrix (**α**). To implement it, one must first establish that the variables are non-stationary. However, conventional unit-roots tests tend to under-reject the null hypothesis of a unit root when the series have structural breaks (Perron 1990) or are characterized by non-linear dynamics (Choi and Moh 2007). The JML procedure avoids these problems by conditioning its stationarity test on the rank of the cointegrating matrix and the deterministic terms included in the VAR. Hence, to proceed, one must first determine the structure of the VAR—its deterministic terms (constant, dummy variables, trend, both or none), lag-length, and exogenous variables if any. Based on the Schwarz Information Criterion (SIC), a lag of 1 was chosen for the VAR. To account for the impact of the war, a transitory dummy (WAR = 1 for 1991-2001 and 0 otherwise) was also included. Finally, a restricted linear trend (T) was assumed in the cointegrating relationship.

TABLE 1. RANK DETERMINATION

Hypothesized Rank	Eigenvalue	Uncorrected Trace Estimate	Uncorrected Trace P-Value	Corrected Trace Estimate	Corrected Trace P-Value
0	0.8124	111.1468	0.0000	76.4334	0.0266
1	0.5963	55.9207	0.0126	26.4435	0.9160
2	0.3755	25.9837	0.1666	7.1753	0.9987
3	0.2714	10.4471	0.2477	1.9081	0.9919

Rank Determination

The JML trace test is biased in small samples (Gonzalo and Pitakaris 1999). To correct for this, Johansen (2002) developed a small-sample Bartlett correction, which is incorporated in Version 2 of Cointegration Analysis of Time Series (CATS).[8] Accordingly, CATS was used in the JML estimation process. Table 1 reports the (small-sample) corrected and uncorrected trace statistics and their probability values. Both tests reject the null hypothesis that the rank (*r*) of the cointegrating matrix is zero. The uncorrected trace test also rejects the null hypothesis of a rank of 1, while the corrected test fails to do so. Finally, both tests also reject the null hypothesis that the rank is 2. Hence, the corrected and uncorrected trace tests respectively identified one and two cointegrating relations. Because of the superiority of the corrected trace test, r = 1 was chosen, meaning that only one long-run equilibrium exists between the variables.

The Estimated Long-Run Equilibrium Relationship

With the chosen rank of one, the estimated cointegrating relation is as follows:

$$\hat{b}_{11} y_t - \hat{b}_{12} TFP_t - \hat{b}_{13} k_t - \hat{b}_{14} a_t - \hat{d}_{11} WAR - \hat{d}_{12} T = 0. \quad (4)$$

When normalized in terms of **y**, Equation (4) becomes:

$$y_t - \hat{\beta}_{12} TFP_t - \hat{\beta}_{13} k_t - \hat{\beta}_{14} a_t - \hat{\delta}_{11} WAR - \hat{\delta}_{12} T = 0; \quad (5)$$

TABLE 2. ESTIMATED COINTEGRATING RELATION

Vector	Log(y)	Log(TFP)	Log(k)	Log(a)	WAR	T
β′	1.0000	-0.6933	-0.1058	-0.0186	0.1052	0.0095
		(104.4163)[a]	(33.5576)[a]	(5.1460)[a]	(21.1484)[a]	(38.3385)[a]

Note: *Absolute value of t-statistics in parenthesis.* ***a*** *= statistical significance at the 0.01 level.*

FIGURE 1. ESTIMATED COINTEGRATING RELATIONS

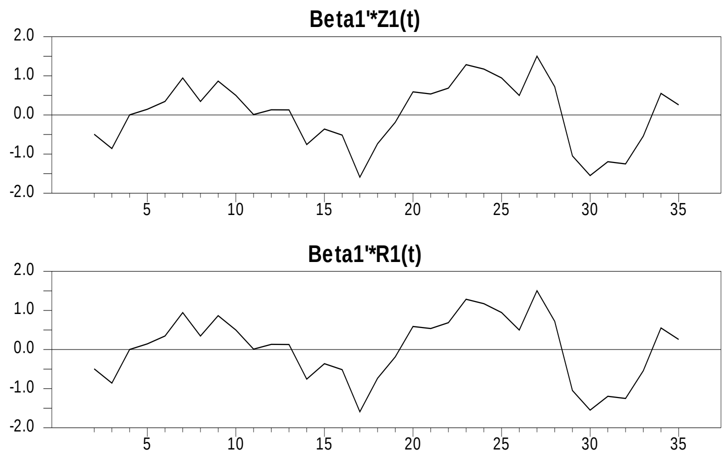


TABLE 3. STATIONARY TEST

Rank	DOF	Log(y)	Log(TFP)	Log(k)	Log(a)
1	3	14.9008	15.4266	14.8886	15.0268
		[0.0019]	[0.0015]	[0.0019]	[0.0018]
2	2	1.0301	1.2076	0.7685	0.7279
		[0.5975]	[0.5467]	[0.6810]	[0.6949]
3	1	0.7539	0.7933	0.7487	0.4697
		[0.3852]	[0.3731]	[0.3869]	[0.4931]

P-values are in brackets.

where $\hat{\beta}_{ij} = \frac{\hat{b}_{ij}}{\hat{b}_{11}}$ and $\delta_{ij} = \frac{\hat{d}_{ij}}{\hat{b}_{11}}$. Therefore, if an estimated coefficient in the normalized equation $(-\hat{\beta}_{ij})$ is positive, the relationship between **y** and the jth variable would be negative, and vice versa.

Table 2 reports the coefficients of the estimated normalized cointegrating relation. In parenthesis below each estimated coefficient is the absolute value of its t-statistic. Table 2 shows that all the estimated coefficients are significantly different from zero at the 0.01 level or better. As hypothesized by the neoclassical aggregate production theory, the estimated coefficients of TFP and the fixed capital stock are positive and significant, although the former is not equal to its hypothesized value of one. The estimated coefficient of aid per worker is also positive and significant, suggesting a positive long-run aid-growth relationship, which supports the unconditional aid-optimist position. Additionally, the war years had a negative transitory effect on labor productivity. Finally, there was a small negative trend in the estimated cointegrating relation.

Stationarity

Non-stationarity is the first of two prerequisites for cointegration. The second is that at least two of the endogenous variables in a cointegrated VAR must be integrated in the same order (Dennis 2006). Graphs of the estimated cointegrating relations can help to determine if these conditions are met. Accordingly, Figure 1 reports two graphs of the estimated cointegrating relation. The upper graph (labeled $\beta_1'Z1_t$) is the equilibrium error as a function of the deterministic components and short-run dynamics, while the lower one ($\beta_1'R_{1t}$) represents a clean disequilibrium error without short-run effects. If both graphs are similar, the variables are integrated in the same order. And if they seem stationary (meaning that they lack discernible trends), cointegration can be concluded (Dennis 2006). Figure 1 demonstrates that both conditions are satisfied. Formal stationarity tests, whose results are reported in Table 3, also confirm that, conditional on the deterministic terms in the VAR, the null hypothesis of stationarity can be rejected for all the variables at the chosen rank of 1. Figure 1 and Table 3 show that Engle and Granger's preconditions for cointegration (Engle and Granger 1987) are fulfilled.

TABLE 4. MULTIVARIATE RESIDUAL TESTS

Problem	Test	Lags	Statistic	DOF	P-Value
Normality	Jacque-Berra	--	12.5369	8	0.1288
Serial Correlation	Ljung-Box LM	1	17.2830	16	0.3675
		2	20.8486	16	0.1844
Heteroscedasticity	ARCH LM	1	109.0906	100	0.2511
		2	236.5417	200	0.0393

Residual Tests

The JML estimator assumes that the residuals are NIID. Table 4 reports diagnostic statistics for testing this assumption. They do not reject the null hypotheses that the residuals are normal and not serially correlated at lags 1 and 2. Similarly, the ARCH test for heteroscedasticity does not reject the null hypothesis of homoscedasticity at lag 1, but does so at lag 2. However, moderate ARCH effects do not affect the robustness of the JML estimator (Rahbek, Hansen, and Dennis, 2002).

Single-Equation Cointegration Analysis

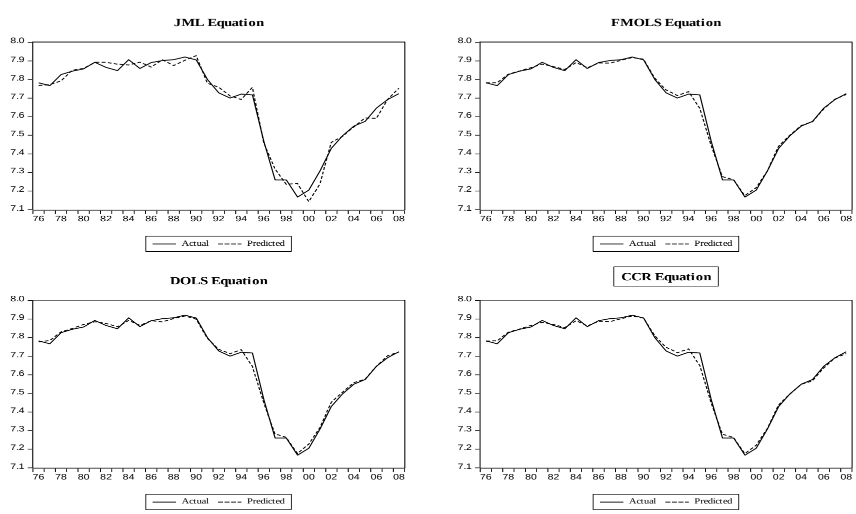
To check the robustness of the JML procedure, FMOLS, DOLS, and CCR estimators were also used to estimate the long-run relationship between the variables. Unlike the

TABLE 5. ESTIMATED COINTEGRATING EQUATIONS

Variable	**FMOLS**	**DOLS**	**CCR**	**JML**	**OLS**
Constant	-7.3805	-7.0323	-7.4011	--	-7.6747
	(29.9782)[a]	(25.1607)[a]	(33.0830)[a]		(22.5058)[a]
Log(TFP)	0.6960	0.6762	0.6961	0.6933	0.7088
	(54.8649)[a]	(47.2946)[a]	(59.3478)[a]	(104.4163)[a]	(40.3037)[a]
Log(k)	0.0709	0.0738	0.0717	0.1058	0.0745
	(12.4967)[a]	(7.8353)[a]	(14.3356)[a]	(33.5576)[a]	(9.6607)[a]
Log(a)	0.0183	0.0290	0.0211	0.0186	0.0172
	(3.0662)[a]	(3.3895)[a]	(2.9279)[a]	(5.1460)[a]	(2.2074)[b]
WAR	-0.0435	-0.0514	-0.0373	-0.1052	-0.0404
	(6.9297)[a]	(3.8210)[a]	(5.6719)[a]	(21.1484)[a]	(4.6783)[a]
T	-0.0110	-0.0110	-0.0112	-0.0095	-0.0109
	(32.3932)[a]	(17.5276)[a]	(25.4046)[a]	(38.3385)[a]	(23.1787)[a]
Regression Diagnostic Statistics					
Adjusted R^2	0.9945	0.9970	0.9943	--	0.9947
Std. Error	0.0170	0.0129	0.0172	--	0.0166
L-R Variance	0.0001	0.0001	0.0001	--	--
Cointegration Tests					
Hansen's Lc	0.5049	0.1685	0.4234	--	--
Park's H(p, q)	0.7455	0.0118	0.3767	--	--
E-G τ-Stat.	-5.3759[b]	-5.3759[b]	-5.3759[b]	--	--
E-G Z-Stat.	-31.1585[b]	-31.1585[b]	-31.1585[b]	--	--
P-O τ-Stat.	-5.4540[b]	-5.4540[b]	-5.4540[b]	--	--
P-O Z-Stat.	-28.7427[b]	-28.7427[b]	-28.7427[b]	--	--

[a]Significant at the 0.01 level; [b]Significant at the 0.05 level.

FIGURE 2. ACTUAL AND PREDICTED LABOR PRODUCTIVITY



JML estimator, which identifies the rank of the cointegrating matrix prior to estimating its parameters, the single-equation estimators assume non-stationarity and a rank of 1 prior to estimation. They then use stationarity tests to determine if those assumptions are reasonable. In this study, the Hansen Instability (Lc), Park H(p, q), Engle-Granger (τ and Z), and the Phillips-Ouliaris (τ and Z) tests were used to test for stationarity. They all failed to reject the hypothesis of non-stationarity.[9] The results for the FMOLS, DOLS, and CCR estimators are reported in Columns 2, 3, and 4 of Table 5. For comparison, the estimated JML (with signs reversed to make them comparable to the single-equation estimates) and OLS equations are reported in Columns 5 and 6 respectively. Table 5 shows that the estimated coefficients are very similar across the five equations. However, the t-statistics of the JML estimates are quite large relative to the other estimators. Additionally, except for the coefficient of aid per worker in the OLS equation, which is significant at the 0.05 level, all the coefficients are significant at a 0.01 level or better.

The predicted values of log of labor productivity $(\hat{y})$ from the four cointegrating relations are graphed alongside their actual values in Figures 2A, 2B, 2C, and 2D. Given the similarity of the estimated coefficients across the equations, it is not surprising that the graphs are very similar. Moreover, the fitted and actual values track each other very closely. However, it appears that the single-equation estimators provide a better fit than the JML estimator. This notwithstanding, the rest of the paper is based on the estimated JML equation because it has been shown to outperform the others in Monte Carlo tests (Gonzalo, 1994). According to that equation, a percentage increase in TFP raises labor productivity by 0.69 percent. This is significantly different from its expected value of 1 percent. Additionally, an approximately 0.11 percent increase in labor productivity results from a percentage increase in the stock of physical capital per worker. Meanwhile, a percentage increase in aid per worker raises labor productivity by 0.02 percent, which is disappointingly small from the viewpoint of the FGH. In other words, although the long-run aid-growth relationship in Sierra Leone is significantly positive, it has the least impact on the country's long-run labor productivity growth.

SUMMARY, CONCLUSIONS, AND POLICY IMPLICATIONS

This study finds that TFP and capital per-worker have positive and significant long-run relationships with labor productivity. Therefore, it validates the neoclassical aggregate production function in the case of Sierra Leone. It also finds foreign aid having a positive and significant long-term relationship with labor productivity growth, which supports the FGH. Therefore, it rejects Moyo's central argument that aid has negatively impacted economic growth in SSA. However, the very small impact of aid on productivity growth suggests that aid is not a panacea for the country's growth and development problems. The estimated sum of the long-run effects of TFP and capital per worker on labor productivity amounts to approximately 0.80. Under neoclassical assumptions, this means that approximately 80 percent of the rewards for labor-productivity growth in the country accrues to factor owners in the capital- and technology-intensive non-agricultural sector. However, as in most SSA economies, over two-thirds of Sierra Leoneans eke a living out of labor-intensive, low-productivity, rural agriculture. Therefore, one can infer that the distribution of the fruits of economic progress are quite heavily skewed in favor of factor owners in the formal sector, which explains the co-existence of economic growth with growing income inequality and rural poverty in the country.

The huge estimated impact of TFP on labor productivity also suggests that the effectiveness of foreign aid on the nation's living standard can be improved by using it to promote TFP growth in the country. Investments in the quality and quantity of the infrastructure (roads, energy, and telecommunication, especially) and human capital acquisition (education, health, and skill development) are consequently necessary. If such investments are skewed in favor of the rural sector, they would simultaneously promote rural TFP growth and raise rural incomes. In the long-run, this should reduce rural poverty, rural-urban income inequality, and rural-urban migration.

ENDNOTES

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[1] Non-existent and/or underdeveloped capital markets in LDCs made foreign private capital flows unlikely. Hence foreign aid was relied upon as the primary means for filling the financing gap.

[2] Arndt, Jones and Finn (2010), Burnside and Dollar (2000), Dalgaard, Hansen, and Tarp (2004), and Minoiu and Reddy (2010) are a sample of the aid-optimist literature while Boone (1996), Easterly (1999), Ram (2003), and Rajan and Subramanian (2008) represent the aid-pessimist genre.

[3] Although SSA governments have historically not used loans any more prudently than aid resources, Moyo argues that they will do so in order to finance their debt-service obligations.

[4] These are: The Johansen Maximum-Likelihood (JML) procedure, the Fully Modified OLS (FMOLS), the Dynamic OLS (DOLS), and Canonical Cointegration Regression (CCR) estimators.

[5] This buttresses the conclusion by Juseluis, Møller, and Tarp (2013) that methodological differences are partially responsible for the mixed findings of the empirical aid-growth literature.

[6] When r = 0, the variables are non-stationary, but not cointegrated. Hence when they are differenced enough to be stationary, OLS can be used to estimate their coefficients. And when r = n, the variables are stationary in levels, thus making OLS an ideal estimation procedure. Thus, it is only when $r<n$ that cointegration analysis is applicable.

[7] Using the JML approach, Kallon (2013) estimated 0.4477 as the elasticity of labor productivity with respect to fixed capital per-worker in Sierra Leone. Therefore, TFP was calculated as follows:

$$TFP_t = \frac{y_t}{k_t^{\hat{\lambda}_1}} = \frac{y_t}{k_t^{0.4477}}.$$

[8] CATS is a routine in Estima's Regression Analysis of Time Series (RATS) software.

[9] The null hypothesis of the Hansen and Parks tests is that the variables are non-stationary while that of the other tests is that they are stationary.

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