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External Debt, Labour Productivity Growth and Convergence: Evidence from Sub-Saharan Africa

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1. INTRODUCTION

IN the early 1990s, the majority of low-income countries (LICs) in sub-Saharan Africa (SSA) were experiencing excessive levels of external debt (ranging from 200 per cent to more than 1,500 per cent of exports) and debt-servicing obligations. A combination of factors had caused a dramatic rise in external liabilities since the mid-1970s. A lack of diversification in their export base made most LICs in the region vulnerable to adverse terms-of-trade shocks. In the hope of financing their development, these countries borrowed heavily abroad as commodity prices were booming but when world demand slumped in the early 1980s and then again in the early 1990s, their debt-servicing capacity was severely diminished. Furthermore, lack of sound macroeconomic policies and of careful management of the currency composition of debt coupled with political instability increased financing needs and failed to restore the capacity to service debt (Brooks et al., 1998).

When external indebtedness becomes excessive, and the repayment ability of a country is in doubt, the resulting debt overhang discourages domestic and foreign investment as the returns on such investments face a high marginal tax by external creditors (Krugman, 1988; Sachs, 1989). In turn, economic growth is adversely affected as the rate of physical capital accumulation slows down. Moreover, the growing debt-service burden may increase the government's interest bill and the budget deficit causing a rise in long-term interest rates. This crowds out the available credit for private investment (Gale and Orszag, 2003; Baldacci and Kumar, 2010) and decreases public funding for infrastructure, human capital and research and innovation (Agénor and Montiel, 1996; Calvo, 1998).

Both the debt overhang and the crowding-out effects appear to have affected SSA economies. For instance, the staggering rise in external liabilities in the early 1990s was accompanied by slow economic growth, while the increasing debt-service burden led to cuts in public spending on education and health services (Fosu, 2007; Quattri and Fosu, 2012). By the mid-1990s, it was increasingly clear that a bolder approach was needed to address excessive debt that was detrimental to the growth performance of SSA countries (Rogoff, 1992). In response, the World Bank and the International Monetary Fund (IMF)

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adopted the Heavily Indebted Poor Countries (HIPC) initiative in 1996,[1] which provided debt relief with the goal of reducing all public and publicly guaranteed (PPG) debt to sustainable levels and ensuring a permanent exit from repeated debt rescheduling (Fonchamnyo, 2009).[2]

This paper examines how external debt and debt service, both before and after the adoption of the debt relief initiatives, affected labour productivity growth and convergence in SSA. In particular, we use a non-parametric methodology to study the impact of external debt on the distribution of output per worker over the period 1970–2010. In addition, we model debt-weighted labour productivity growth as a discreet-time Markov process and estimate the transition probabilities across different ranges of output per worker relative to the sample mean. This allows us to detect and analyse the impact of external debt on intradistributional dynamics, and convergence tendencies in particular. In the second stage of the analysis, we employ various regression specifications to estimate the effects of debt and debt service on labour productivity growth and on the deviation from the mean output per worker. Lastly, we explore the role of the debt relief initiatives in mitigating the effects of debt on growth and convergence in SSA.

A number of recent studies have investigated the relationship between external debt and growth in developing countries. Pattillo et al. (2011) found this relationship to be non-linear and similar in form to a Laffer curve. They estimated that the marginal impact of debt on growth turns negative for debt levels above 25 per cent of gross domestic product (GDP) and 70 per cent of exports. Cordella et al. (2010) report similar findings but also show that in countries with bad policies and institutions, the threshold at which the effect of debt becomes negative is much lower (10 to 15 per cent of GDP).[3]

Furthermore, several papers evaluated the impact of the debt relief initiatives on growth (Hussain and Gunter, 2005; Fonchamnyo, 2009; Yang and Nyberg, 2009; Wamboye and Tochkov, 2014). They all agree that debt relief stimulated growth and reduced poverty in HIPCs. However, a narrow export base and the deterioration in the terms of trade coupled with weak policy and institutional frameworks seem to have eroded some of the beneficial effects of debt relief.

In contrast to previous studies, we focus on labour productivity growth rather than *per-capita* output growth.[4] In 1991, labour productivity in SSA was still above the levels of East Asia. But over the 1990s, it declined on average by 0.7 per cent every year, while that of East Asia increased dramatically by an annual rate of 7.6 per cent (International Labour Organisation, 2011). It is important to examine whether the rising levels of indebtedness during this period contributed to the deterioration of labour productivity in SSA. Over the 2000s, when debt relief was taking effect, output per worker in SSA recorded a positive albeit very low annual growth of 1.9 per cent (International Labour Organisation, 2011).

[1] The HIPC programme was restructured and enhanced in 1999 by lowering the thresholds requirements to allow more countries to qualify for debt relief. In 2005, The Multilateral Debt Relief Initiative (MDRI) was adopted as an extension of HIPC offering multilateral debt cancellation.

[2] Of the 36 countries included in the initiative since 1996, 33 are from SSA.

[3] The negative impact of bad institutions and policies on the growth effects of external debt is further supported by Imbs and Ranciere (2005).

[4] To the best of our knowledge, the only other study to examine the effect of public debt on labour productivity growth is by Kumar and Woo (2010). However, their sample includes only advanced and emerging economies, with South Africa being the only one from SSA.

The second major feature that distinguishes this paper from others is that it estimates the impact of external debt on convergence in labour productivity levels across SSA countries. Some studies find little evidence of income convergence in SSA (Ben Hammouda et al., 2009), while others detect certain convergence clubs (McCoskey, 2002). However, the impact of external debt and debt relief on convergence tendencies remains unclear. In contrast to previous convergence studies, we explore this issue using non-parametric methods that offer certain advantages over traditional techniques.

The rest of the paper is organised as follows. Sections 2 and 3 explain the methodology and data sources, respectively. Section 4 reports the results and Section 5 concludes.

2. METHODOLOGY

The methodology consists of a non-parametric and a parametric analysis. Following Quah (1996, 1997), the non-parametric analysis employs kernel density estimates to examine the shape of the distribution of labour productivity across SSA countries and the effects of external debt on its evolution over time. In addition, we use transition probability functions to investigate the impact of external debt on distributional dynamics and intradistributional mobility. The parametric analysis helps us quantify the effects of external debt on labour productivity dynamics while controlling for a number of other important variables.

a. Distribution Dynamics and Transition Probabilities

The first step of the analysis involves estimating a probability density function of output per worker using a kernel function. Let $X_1,\ldots,X_n$ be a sample of n independent and identically distributed (iid) observations on a random variable X.[5] The density value $f(x)$ at a given point x is estimated by the following kernel density estimator:

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - X_i}{h}\right), \tag{1}$$

where h denotes the bandwidth of the interval around x, and K is the kernel function.[6] The kernel estimator assigns a weight to each observation in the interval around x with the weight being inversely proportional to the distance between the observation and x. The density estimate consists of the vertical sum of frequencies at each observation. The resulting smooth curve allows us to visualise the shape of the distribution of output per worker and detect the presence of 'convergence clubs' represented by modes.

Next, we study the dynamics of the distribution and intradistributional mobility of SSA countries by estimating a transition probability matrix. Let Q_t denote the distribution of output per worker across countries at time t. The distribution at time $t+\tau$ is then described by:

$$Q_{t+\tau} = M \times Q_t, \tag{2}$$

where M is a finite discrete Markov transition matrix that contains a complete description of the distributional dynamics as it maps Q_t into $Q_{t+\tau}$. The transition matrix is given by

[5] We employ a conditional density estimator that relaxes the iid assumption.
[6] We use data-driven bandwidth selection (likelihood cross-validation) and a Gaussian kernel.

$$M = \begin{pmatrix} p_{ij} & \cdots & p_{iN} \\ \vdots & \ddots & \vdots \\ p_{Nj} & \cdots & p_{NN} \end{pmatrix}, \tag{3}$$

where p_{ij} with $i, j = 1,\ldots,N$ is the probability of a transition from an initial state i at time t to a state j at time $t+\tau$. The main diagonal of the matrix is an indicator of persistence because it consists of the probabilities that an observation remains in the same state in t and $t+\tau$.

Assuming that the transition probabilities from t to $t+\tau$ are time-invariant and independent of any previous transitions, the evolution of intradistributional mobility can be studied by iterating equation (2) z times. As $z\to\infty$, the iteration yields:

$$\lim_{z\to\infty} M_j^z = \delta_j > 0, \quad \sum \delta_j = 1. \tag{4}$$

The limiting probability distribution, δ_j, is the unconditional or ergodic distribution.[7] In other words, equation (4) describes the convergence to a steady-state distribution independent of the initial distribution. Accordingly, the ergodic distribution allows us to analyse the long-run tendencies of output per worker, assuming that the observed dynamics continue to hold.

b. Regression Model

In the parametric analysis, we estimate the effects of external debt on labour productivity growth and convergence in a sample of SSA countries using the baseline regression specification below:[8]

$$\begin{aligned}\Delta y_{it} = {} & \beta_0 + \beta_1 y_{it-\tau} + \beta_2 Debt_{it-\tau} + \beta_3 Debt_{it-\tau} * dhipc + \beta_4 Inv_{it-\tau} + \beta_5 Edu_{it-\tau} + \beta_6 Open_{it-\tau} \\ & + \beta_7 Infl_{it-\tau} + \beta_8 Gov_{it-\tau} + \beta_9 Inst_{it-\tau} + \beta_{10} Res_{it-\tau} + \beta_{11} dhipc + \eta_t + \upsilon_i + \varepsilon_{it},\end{aligned} \tag{5}$$

where y_{it} is the natural logarithm of real output per worker in country i at time t. Country-specific and time-fixed effects are denoted by υ_i and η_t, respectively, while ε_{it} is the standard error term. The dependent variable takes two forms. In the growth specification, Δy_{it}[9] stands for the average annual growth rate of output per worker in country i between the period $t-\tau$ and t, where τ takes the value of 3. In line with the growth literature, we average labour productivity growth across a 3-year non-overlapping period to control for the reverse causality bias and to minimise the effects of short-run cyclical fluctuations and outliers. Furthermore, by using 3-year averaged data, we are able to control for the timing of debt effects.

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[7] The ergodic distribution is unique if there is only one eigenvalue of M with modulus one.

[8] The regression model is derived using standard growth accounting in a neoclassical framework which we leave out to save space. Instead of trying to calculate total factor productivity (TFP) for SSA countries, which is bound to be an imprecise and biased measured given the lack of data, we choose to include explanatory variables in the model that can potentially affect TFP. A similar approach has been used in previous growth regressions for African countries (Sachs and Warner, 1997).

[9] Specifically: $\Delta y_{it} = y_{it} - y_{it\text{-}\tau}$, $y_{it} - y_{it\text{-}\tau} = \beta_1 y_{it-\tau} + X_{it-\tau}\beta + \eta_t + \upsilon_i + \varepsilon_{it}$, $y_{it} = (\beta_1 + 1) y_{it-\tau} + X_{it-\tau}\beta + \eta_t + \upsilon_i + \varepsilon_{it}$, $y_{it} = \delta_1 y_{it-\tau} + X_{it-\tau}\beta + \eta_t + \upsilon_i + \varepsilon_{it}$.
Therefore, $\beta_1 = \delta_1 - 1$. The average annual growth rate of output per worker between the years $t-\tau$ and t is calculated as $(y_{it} - y_{it-\tau})/\tau$.

In the convergence model, the dependent variable is the deviation of output per worker of country *i* from a benchmark in year *t*. Two benchmarks are used: (i) the average labour productivity across SSA countries; and (ii) the labour productivity level of South Africa, which had the highest output per worker across all years of the sample. These benchmarks allow us to study the distributional dynamics and convergence from different angles. Furthermore, from a policy perspective it is more relevant to assess whether an economy is catching up with the top performer in the region.

The major right-hand side variable of interest is external debt. Primarily, we focus on external PPG debt since it constitutes the bulk of SSA countries' external debt.[10] Debt stock is expressed as percentage of GDP, while debt service is expressed as percentage of exports. Given that the majority of the SSA countries in the sample participated in the debt relief initiatives which started in 1996, we also include an interaction term between the debt variable and a dummy variable, *dhipc*. This dummy variable takes four forms to capture different phases of the debt relief process:[11] (i) *d1996* measures the overall impact of the HIPC debt relief initiative and takes a value of 1 over the years 1996–2010, and 0 otherwise; (ii) *d1995* captures the effects prior to the start of the debt relief initiative and takes a value of 1 for the period before 1996, and 0 otherwise; (iii) *dcomp* controls for the effects of interim debt relief and assumes a value of 1 for the years from 1996 to the time a HIPC reaches its completion point, and 0 otherwise; and (iv) *dpost* captures the effects after full-scale debt relief has been provided and takes a value of 1 for the years beyond the completion point, and 0 otherwise. The coefficient of the interaction term is interpreted as the additional marginal effect of initial debt (or debt service) on labour productivity growth as a result of participating in the debt relief process. Furthermore, we enter these dummies as separate variables to measure the accruing benefits from implementing the conditions required in the two steps of the debt relief process, which are not taken into account by the interaction term.

To capture the idea that debt and other factors affected labour productivity growth over the following years, all independent variables in the growth regression model are initial values at the beginning of each 3-year period.[12] We follow closely the standard growth literature (Barro, 1991; Levine and Renelt, 1992; Sala-i-Martin et al., 2004) in selecting the core set of growth determinants, although our choice was constrained by data availability.

We include the initial level of output per worker to test for the presence of β-convergence (Barro and Sala-i-Martin, 1992) in labour productivity across SSA countries. Moreover, we take into account physical capital accumulation as one of the major determinants of labour productivity. Measured as the percentage share of gross fixed capital formation in real GDP per worker (*Inv*), it contributes to a higher capital–labour ratio, and thus to a higher output per worker. In addition, human capital accumulation, proxied by education (*Edu*), directly adds to labour productivity and indirectly leads to efficiency gains through more rapid

[10] In a parallel specification, we also evaluate the effects of total external debt. Since the results were very similar to those for PPG debt, we do not report them. However, they are available upon request.

[11] To receive full and irrevocable reduction in debt under the debt relief initiatives, a country must successfully complete a two-step process. The first step (decision point) requires an established track record of reform, sound policies and a strategy for poverty reduction. Upon completion, the country receives interim relief on debt service falling due. The second step (completion point) requires a further track record of good performance and the implementation of key reforms, including poverty reduction measures.

[12] This is not the case in the convergence specification, where the deviation from the benchmark in year *t* is regressed on the independent variables in year *t*.

adoption of technology. A country with high levels of human capital is more likely to attract investors, to have the capacity to absorb new ideas and to engage in research and innovations (Grossman and Helpman, 1991). The role of human capital constraints has featured prominently in the debate on SSA's inability to replicate East Asia's growth miracle (Pack and Paxson, 1999; Wolf, 2007).

Trade openness (*Open*) encourages competition on the global market, which in turn drives the export sector to adopt the latest technology and the most efficient practices of production, thereby increasing labour productivity (Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995; Dollar and Kraay, 2004). In addition, with increasing integration in the global economy, countries can achieve productivity gains through specialisation driven by comparative advantage. Success stories from the export-led growth of East Asian economies lend some support to this argument (Dollar, 1992).[13]

Our regression model further includes two policy variables. Monetary policy is proxied by the annual inflation rate (*Infl*), while fiscal policy is represented by government consumption spending (*Gov*).[14] High budget deficits and inflation have been found to have a negative effect both on capital accumulation and productivity growth (Fischer, 1993). As a fiscal policy instrument, government consumption expenditure can be used during economic downturns to stimulate aggregate demand and output. However, if the spending is politically motivated or results in corruption, it could have negative consequences on the medium and long-run productivity growth.

Besides economic variables, we also control for the effect of institutional factors proxied by a measure of governance (*Inst*). Previous studies have found good institutions to have positive effects on productivity growth (Beck et al., 2000; Bosworth and Collins, 2003). Furthermore, given the large share of natural resources in the exports of most SSA countries, we include a category of variables (*Res*) that examine the effects of fuel exports as well as exports of ores and metals on labour productivity growth and convergence.

The model in equation (5) exhibits a number of methodological issues. Endogeneity bias may arise due to the potential endogeneity of labour productivity growth determinants such as debt, investment, human capital and governance variables. On the other hand, it is possible that low productivity growth may cause high debts, while high debts may cause low productivity growth, or that both debt and productivity growth may be jointly determined by a third variable. In such instances, the model will suffer from reverse causality and simultaneity bias. Other biases that may affect the consistency of the estimates include the heterogeneity (omitted variable) bias and measurement error (in the independent variables).

The system GMM (SGMM) approach of Arellano and Bover (1995) and Blundell and Bond (1998) is used to control for the endogeneity bias, measurement bias, unobserved country fixed effects and heterogeneity bias. Relative to the difference GMM, SGMM is robust to weak instrument bias. It uses suitable lagged levels and lagged first differences of the regressors as their instruments. Additionally, all our samples meet Roodman's (2006) requirement of large N and small T when using GMM as the estimation technique. To minimise the number of GMM-style instruments used, we restrict the maximum lags of dependent and independent variables for use as instruments to one. In accordance with GMM

[13] On the link between current account sustainability and debt relief initiatives, see Edwards (2003).
[14] In more general terms, inflation can be interpreted as a measure of macroeconomic stability, while government consumption stands for the importance of government in the economy.

estimation techniques, the Sargan test of over-identifying restrictions and the Arellano-Bond test that the average autocovariance of residuals of order two is zero are reported. In all specifications, time dummies are included to remove universal time-related shocks from the errors (Roodman, 2006).

3. DATA

The analysis is conducted using two samples. The first covers 32 SSA countries (including 25 HIPCs) over the period 1970–2010, while the second covers 41 SSA countries (including 30 HIPCs) over the period 1984–2010.[15] Output per worker is expressed in purchasing power parity (PPP) terms and constant 2005 international dollars. Government consumption spending and investment spending are both measured as percentage of PPP converted GDP per worker at 2005 constant prices. Openness is expressed as trade volume (exports plus imports) as percentage of PPP converted GDP per worker at 2005 constant prices. All four aforementioned variables were collected from the Penn World Table version 7.1 (Heston et al., 2012).

Data on external debt stocks as percentage of GDP, debt service as percentage of exports, education (measured as the gross enrolment ratio for primary education), fuel exports and ores/metals exports (both measured as percentage of merchandise exports), and the annual inflation rate measured by CPI inflation (precisely as logarithm of (1 + inflation rate)) were obtained from the World Bank's World Development Indicators. The governance index that represents institutional factors was taken from the Polity IV Project (Marshall and Jaggers, 2011). The index is measured on a scale ranging from −10 to 10, with −10 indicating a strongly autocratic (political suppression) and 10 a strongly democratic (political freedom) political system.

The countries in the sample are listed in Table 1. The descriptive statistics for the variables of the growth regressions are shown in Table 2.

4. RESULTS

a. Distributional Analysis

The kernel density distributions of real output per worker for the SSA sample are shown in Figure 1. Each graph represents snapshots of the distribution in the initial, midpoint and final years of the sample period. The plots on the left show the distributions of the raw levels of labour productivity, whereas those on the right use real output per worker weighted by the inverse of external debt stocks as a share of GDP. In addition to the visual investigation of modes and convergence clubs from the graphs, we employ Silverman's (1981) test to formally identify the number of modes. In particular, we test the null hypothesis that the kernel density distribution is unimodal.[16]

In 1970, the probability mass is mostly concentrated around the mean, which is normalised to 100, while a few far smaller but distinctive modes are visible at higher levels of output per worker. This basic shape of the distributions does not change in the following decades, except

[15] Somalia and Sao Tome and Principe are the only HIPCs in SSA excluded from the sample.
[16] The results of the Silverman test are discussed but not shown to save space. They are available upon request.

TABLE 1
List of Countries in the 1984–2010 Sample Period and Corresponding HIPC Debt Relief Process Completion Point Year

Angola	Gabon	Niger (2004)
Benin (2003)	Gambia, The (2007)	Nigeria
Botswana	Ghana (2004)	Rwanda (2005)
Burkina Faso (2002)	Guinea (2012)	Senegal (2004)
Burundi (2009)	Guinea-Bissau (2010)	Sierra Leone (2006)
Cameroon	Kenya	South Africa
Cape Verde	Lesotho	Sudan[b]
Central African Republic (2009)	Liberia (2010)	Swaziland
Chad[a]	Madagascar (2004)	Tanzania (2001)
Comoros (2012)	Malawi (2006)	Togo (2010)
Congo, Dem. Rep. (2010)	Mali (2003)	Uganda (2000)
Congo, Republic of (2010)	Mauritania (2002)	Zambia (2005)
Cote d'Ivoire (2012)	Mauritius	Zimbabwe
Ethiopia (2004)	Mozambique (2001)	

Notes:
(i) Values in brackets represent the year a country reached its completion point, making it eligible to receive full and irrevocable reduction in debt available under the HIPCs and Multilateral Debt Relief Initiatives.
(ii) [a]Interim (between decision and completion points);
(iii) [b]Pre-decision point.

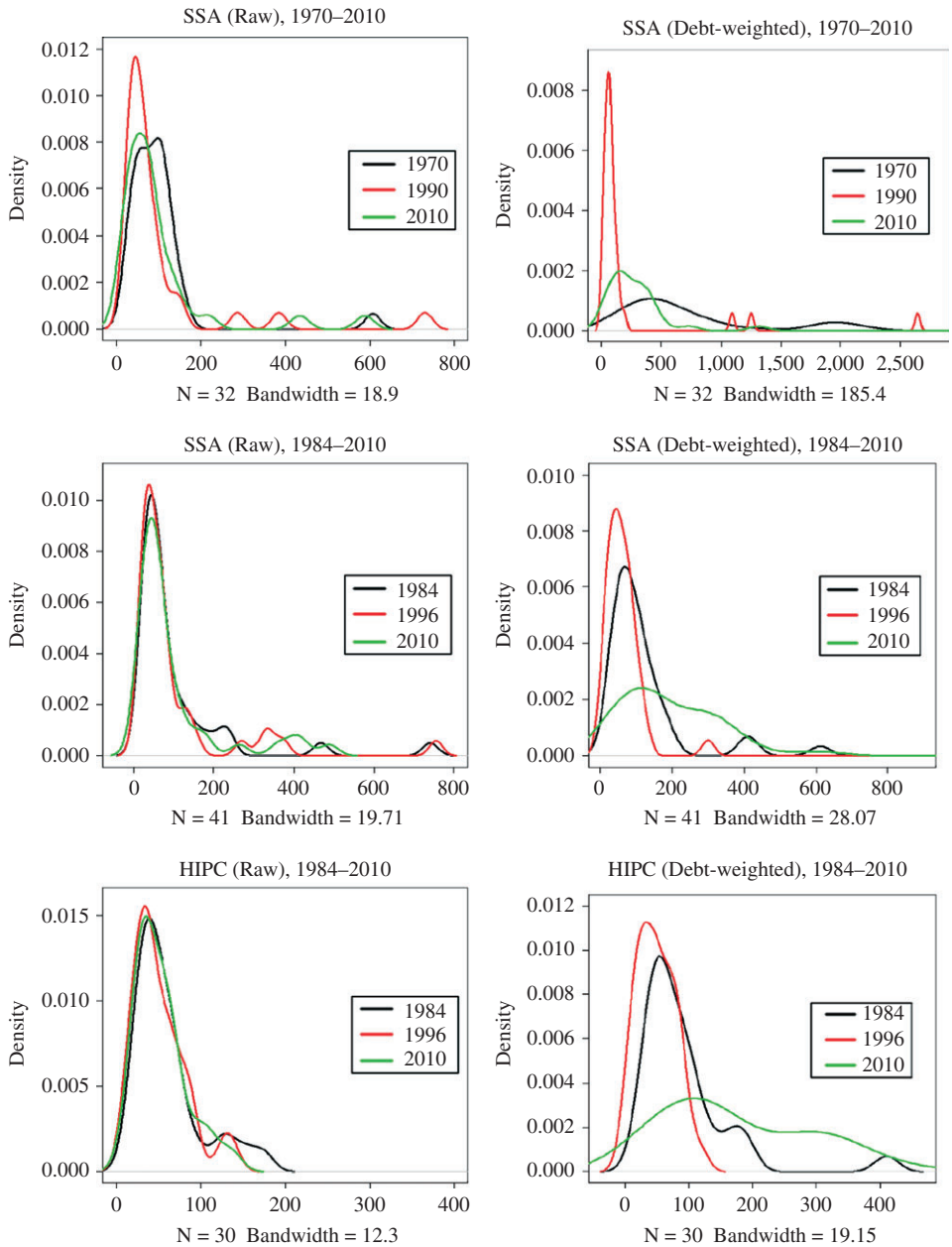
TABLE 2
Descriptive Statistics of the Regression Variables, 1984–2010

Variable	*Mean*	*Std. Dev*	*Min*	*Max*	*N*
Labor productivity growth (%)	0.620	5.130	−23.530	39.040	369
PPG debt stock (% of GDP)	78.500	72.340	1.870	690.830	369
Total debt stock (% of GDP)	101.400	131.150	3.230	1514.560	369
PPG debt service (% of exports)	12.430	10.440	0.000	72.980	369
Total debt service (% of exports)	17.440	20.780	0.490	319.630	369
Government consumption	13.080	9.630	1.370	58.640	369
Investment	18.600	12.070	0.720	63.180	369
Openness	62.000	33.610	7.590	182.130	369
Education	84.600	29.120	22.680	161.300	309
Governance (Polity2)	−0.98	6.01	−10	10	369
Inflation	41.420	304.220	−16.590	5399.530	369
Ores/metals exports	7.320	17.330	0.000	88.810	369
Fuel exports	6.780	20.170	0.000	98.940	369

Notes:
(i) Labour productivity growth is averaged over 3-year non-overlapping periods.
(ii) All independent variables are initial values at the beginning of each period.

that the peak at the bottom of the distribution becomes narrower and shifts decisively towards a level below the mean. This indicates that the majority of countries with initial average or below-average productivity have diverged from the mean. The divergence pattern is most obvious in 1990 when the tail of the distribution extends to higher levels of output per worker, while more countries than ever before assemble below the mean. Over the following

FIGURE 1
Kernel Density Distributions of Real Output per Worker for Sub-Saharan African Countries



two decades, this trend is reversed as the tail of the distribution becomes shorter again and the probability mass below the mean decreases. This pattern of divergence in the 1990s and convergence in the 2000s is confirmed in a larger sample of SSA countries over the period

1984–2010 (second row, Figure 1). The results of the Silverman test also concur by rejecting the null hypothesis that the distributions are unimodal.[17]

When external debt is taken into account, the aforementioned trends are amplified causing the shape of the labour productivity distribution to change dramatically over time. In particular, it appears that high levels of debt in the 1990s depressed labour productivity, preventing the majority of countries from catching up with the best performing economies, such as South Africa and Botswana. The higher concentration of probability mass at the bottom of the distribution for 1996 confirms this. Further support comes from the Silverman test that cannot reject the null hypothesis of a uni or bimodal distribution, but rejects the possibility of three modes, indicating a decrease in dispersion. In contrast, the period 1996–2010 is marked by strong convergence tendencies exemplified by the dramatic dispersion of the probability mass at the bottom of the distribution.[18] This suggests that lower levels of external debt since the late 1990s have helped many SSA economies achieve labour productivity gains.

The major beneficiaries of this process were the HIPC economies, as evident in the graphs at the bottom of Figure 1. The multimodal distribution of the weighted output per worker in the 1980s evolved over the following decade into a unimodal distribution that is almost entirely located below the mean.[19] The debt relief initiatives beginning in 1996 seem to have enabled participating SSA economies to converge towards higher levels of labour productivity.

b. Transition Probabilities

To gain a better understanding of the dynamics within the labour productivity distribution and how these are affected by debt, we employ Markov transition matrices, which report the probability of countries moving from one state associated with a certain level of output per worker to another over a period of five years.[20] For this purpose, we discretise the state space into six intervals chosen in such a way that each interval contains an approximately equal number of transitions.[21] The corresponding transition matrices are presented in Table 3. The value range for the initial state is given in each row, while the ranges for the states to which a region has transitioned after five years are reported in the columns.

The first matrix over the period 1970–2010 shows that the overwhelming number of transitions takes places across the states at or below the mean, which is set equal to 100. Moreover, while persistence is high (between 81 and 92 per cent) at both ends of the distribution, the countries in the middle of the distribution exhibit higher mobility with less than 73 per cent chance

[17] For the year 2010 in the 1970–2010 dataset and the year 1984 in the 1984–2010 dataset, the Silverman test shows that the null hypothesis for a unimodal distribution cannot be rejected. But in both cases, the null for two modes or less is rejected, while for three or less is not.

[18] Despite the overall convergence, there is divergence within the sample of countries that initially exhibited below-average labour productivity.

[19] The Silverman test rejects the null hypothesis of a unimodal distribution for 1984 but cannot reject it for 1996.

[20] We opt for 5-year periods to control for the effects of short-run fluctuations. The robustness of the results was tested using 3 and 10-year transitions but the qualitative conclusions of the study did not change. These results are not reported here but are available upon request.

[21] We would like to emphasise that our focus here is on the dynamics of productivity relative to the average. A country can achieve productivity gains in absolute terms, but still exhibit a deterioration in relative terms, because, for instance, most other countries in the sample recorded even larger gains. This should be taken into consideration, especially when a country with above-average productivity converges towards the mean.

TABLE 3
Markov Transition Matrices and Ergodic Distributions, 5-year Transitions

Raw levels of labour productivity, 1970–2010

State	*[11.8; 34.9)*	*[34.9; 46.2)*	[46.2; 64.5)	*[64.5; 79.7)*	*[79.7; 125.1)*	*[125.1; 1061.1]*	*n*
[11.8; 34.9)	**0.81**	**0.18**	**0.01**	0.00	0.00	0.00	192
[34.9; 46.2)	**0.21**	**0.56**	**0.23**	0.00	0.00	0.00	192
[46.2; 64.5)	**0.04**	**0.30**	**0.47**	**0.19**	0.00	0.00	192
[64.5; 79.7)	**0.02**	**0.01**	**0.17**	**0.73**	**0.07**	0.00	192
[79.7; 125.1)	0.00	0.00	**0.05**	**0.20**	**0.65**	**0.10**	192
[125.1; 1061.1]	0.00	0.00	0.00	0.00	**0.08**	**0.92**	192
Ergodic	0.33	0.26	0.17	0.15	0.04	0.05	1152

Debt-weighted levels of labour productivity, 1970–2010

State	*[0.7; 41.9)*	*[41.9; 72.4)*	*[72.4; 104.3)*	*[104.3; 180.2)*	*[180.2; 459.7)*	*[459.7; 10639.1]*	*n*
[0.7; 41.9)	**0.79**	**0.10**	**0.02**	**0.07**	**0.02**	0.00	192
[41.9; 72.4)	**0.22**	**0.41**	**0.16**	**0.15**	**0.06**	0.00	192
[72.4; 104.3)	**0.10**	**0.23**	**0.33**	**0.19**	**0.13**	**0.02**	192
[104.3; 180.2)	**0.01**	**0.20**	**0.30**	**0.26**	**0.18**	**0.05**	192
[108.2; 459.7)	0.00	**0.08**	**0.16**	**0.38**	**0.29**	**0.09**	192
[459.7;10639.1]	0.00	0.00	**0.01**	**0.09**	**0.31**	**0.59**	192
Ergodic	0.29	0.19	0.16	0.18	0.12	0.06	1152

Raw levels of labour productivity, 1984–2010

State	*[10.3; 28.8)*	*[28.8; 40.2)*	*[40.2; 58.7)*	*[58.7; 74.2)*	*[74.2; 130.5)*	*[130.5; 785.2]*	*n*
[10.3; 28.8)	**0.85**	**0.15**	0.00	0.00	0.00	0.00	150
[28.8; 40.2)	**0.18**	**0.65**	**0.17**	0.00	0.00	0.00	151
[40.2; 58.7)	**0.03**	**0.23**	**0.60**	**0.14**	0.00	0.00	150
[58.7; 74.2)	**0.01**	**0.01**	**0.16**	**0.77**	**0.05**	0.00	151
[74.2; 130.5)	0.00	0.00	0.00	**0.06**	**0.85**	**0.09**	150
[130.5; 785.2]	0.00	0.00	0.00	0.00	**0.09**	**0.91**	150
Ergodic	0.32	0.24	0.15	0.11	0.09	0.09	902

Debt-weighted levels of labour productivity, 1984–2010

State	*[0.6; 27.5)*	*[27.5; 45.6)*	*[45.6; 66.8)*	*[66.8; 93.3)*	*[93.3; 181.1)*	*[181.1; 9282.7]*	*n*
[0.6; 27.5)	**0.73**	**0.15**	**0.03**	**0.02**	**0.06**	**0.01**	150
[27.5; 45.6)	**0.26**	**0.38**	**0.17**	**0.05**	**0.09**	**0.05**	151
[45.6; 66.8)	**0.03**	**0.19**	**0.34**	**0.20**	**0.21**	**0.03**	150
[66.8; 93.3)	0.00	**0.07**	**0.19**	**0.30**	**0.28**	**0.16**	151
[93.3; 181.1)	0.00	**0.03**	**0.11**	**0.25**	**0.33**	**0.27**	150
[181.1; 9282.7]	0.00	0.00	0.00	**0.03**	**0.02**	**0.96**	150
Ergodic	0.02	0.03	0.04	0.07	0.07	0.77	902

Note:
Probabilities larger than zero are in bold.

of remaining in the initial state after a period of five years. The intradistributional dynamics show a clear tendency for divergence away from the mean and towards the bottom of the distribution. Those countries with initial productivity levels between 46 and 125 per cent of the mean have a significantly higher probability of moving towards lower levels of output per worker. The chance that these countries will experience a relative deterioration of productivity over five years is one and a half to three times higher than the probability of converging towards the mean levels. Most vulnerable to the divergence pattern appear to be countries with productivity levels between 46 and 65 per cent of the mean. The ergodic distribution at the bottom of the matrix suggests that if these divergence patterns remain constant in the long run, the productivity distribution would become extremely polarised between a large mode at the bottom and a minor mode at the very top. More than 90 per cent of sub-Saharan African countries would end up with output per worker levels below 80 per cent of the mean.

The second matrix that reports the intradistributional dynamics of output per worker weighted by the inverse of external debt as a share of GDP is different in two major aspects. First, when debt is taken into account, the mobility across states in the middle of the distribution increases significantly with the probability of remaining in the initial states over a 5-year period dropping to less than 30 per cent in some cases. Moreover, a decrease in external debt enables countries to move from the very bottom to the very top of the distribution within five years. As an extreme example, a country that had initially a debt-weighted productivity level of less than 42 per cent of the mean has a 2 per cent chance of achieving an output per worker equivalent to at least 180 per cent of the mean within half a decade. A second major feature of the debt-weighted matrix is the stronger convergence towards the mean and beyond, which results in an ergodic distribution with a very pronounced second mode at between 104 and 180 per cent of the mean.

The third matrix employs raw levels of output per worker for a larger sample of countries over the period 1984–2010 but it only confirms the patterns observable in the first matrix. The fourth matrix that again takes external debt into account is the most intriguing because it exhibits convergence towards the mean and beyond, which contrasts strongly with the divergence trend of the raw levels of productivity. The probability of moving towards higher levels of output per worker is now higher than experiencing a deterioration. For instance, the likelihood for countries with initial levels of between 66 and 93 per cent of mean productivity to move to the bottom of distribution is only 26 per cent as opposed to 44 per cent chance of converging to the top levels of output per worker. As the ergodic distribution at the bottom of the matrix indicates, if these convergence patterns hold in the long run, more than 70 per cent of countries would end up with the highest levels of output per worker, which is a mirror image of the polarised distribution of raw productivity levels.

In summary, the results of the non-parametric analysis suggest that external debt significantly affected the distributional dynamics of labour productivity. In particular, the strong divergence patterns that lead to polarisation of the distribution are reversed once output per worker is weighted by the inverse of external debt stocks. In other words, lower levels of debt are associated with improvements of labour productivity, thereby enabling countries with below-average levels to converge towards the mean and catch up with the best performing economies.

c. Growth Regressions

The non-parametric analysis has provided a strong indication that debt plays a major role in the dynamics of labour productivity relative to the mean. However, it has not allowed us to

control for the effects of other factors that might influence the shifts in the distribution of relative productivity over time. For this purpose, we employ a linear regression model with different specifications of the baseline equation (5) to estimate the effects of external PPG debt stock on annual labour productivity growth over 3-year non-overlapping periods during the 1984–2010 period. We report results for the full sample and HIPC subsample in Tables 4 (columns 1–4) and 5.

The results in Table 4 (columns 1–4) indicate that the debt effects are negative and statistically significant regardless of the model and sample specification. For every 1 per cent increase in the initial share of external PPG debt in GDP, annual growth in labour productivity drops by approximately 0.03 to 0.04 per cent in both the full sample and HIPC subsample over the consequent 3-year period.[22] This finding confirms the existence of a debt overhang and its negative effect on growth reported in previous studies on developing countries (Pattillo et al., 2011), African economies (Fosu, 1996) and labour productivity (Kumar and Woo, 2010).

As previously mentioned, the interaction term between PPG debt and *d1996* enables us to estimate the additional marginal effects of debt on labour productivity growth due to participation in the HIPCs debt relief initiatives. In columns 1 and 3 (Table 4), we observe a positive and significant coefficient of this interaction term implying that a 1 per cent increase in the initial share of PPG debt in GDP after 1996 enhanced annual productivity growth by 0.02 per cent over the subsequent three years in both the full sample and the HIPCs subsample. However, these additional marginal effects were not sufficiently strong to offset the overall negative impact of PPG debt observed above.

With reference to the unconditional debt relief process effects, Fonchamnyo (2009) reports a positive and significant dummy variable for the period after 1996 in real GDP *per capita* regressions for a sample of HIPCs. Our results in Table 4, columns 2 and 4, where *d1996* is entered separately, confirm this with respect to labour productivity growth, whereby HIPCs exhibit markedly stronger productivity growth after 1996 than the full sample, suggesting that debt relief process played a meaningful role.

In Table 5, we investigate the effects of the debt relief process in more detail by introducing three dummy variables. The first (*d1995*) stands for the period prior to the debt relief process. The second (*dcomp*) captures the intermediate period effects from 1996 to the year when a country reaches the completion point. The third (*dpost*) measures the post-completion-point effects after a country qualifies to receive full and irrevocable reduction in debt. Sceptics of the HIPC debt relief initiatives argue that once these countries qualify to receive full and irrevocable debt relief, the expected long-term economic effects may not be realised, since HIPCs do not suffer from a genuine debt overhang (Arslanalp and Henry, 2005) or in some cases, they are likely to revert to a borrowing spree to meet their domestic capital needs, making debt relief irrelevant. The dummy *dpost,* therefore, enables us to empirically evaluate such arguments. These dummy variables are entered as separate augments (column 1 and 3) and as interaction terms with PPG debt (columns 2 and 4).

The results in columns 1 and 3 of Table 5 confirm the debt overhang effects established in Table 4 (Columns 1–4) above. Also, we observe positive and significant coefficients of the

[22] Estimating the threshold at which the effect of debt on growth turns negative is beyond the scope of this paper. For more information, see Wamboye and Tochkov (2014) who address this issue using a sample of SSA countries.

TABLE 4
The Effects of Public and Publicly Guaranteed Debt Stock and Debt Service on Labour Productivity Growth in SSA, 1984–2010

	PPG Debt Stock				*PPG Debt Service*			
	Full Sample		*HIPCs*		*Full Sample*		*HIPCs*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Real GDP *per capita*	−13.090***	−13.510***	−9.576***	−9.927***	−12.220***	−13.560***	−9.597***	−9.896***
	(2.169)	(1.787)	(2.605)	(2.504)	(1.838)	(1.744)	(2.620)	(2.559)
PPG Debt	−0.041***	−0.033***	−0.040**	−0.028**	−0.016	0.027	−0.084	−0.021
	(0.006)	(0.006)	(0.016)	(0.013)	(0.024)	(0.017)	(0.060)	(0.044)
PPG debt × *d1996*	0.019***		0.024**		0.073***		0.098*	
	(0.003)		(0.011)		(0.016)		(0.055)	
d1996		2.882***		3.228***		2.182***		2.612**
		(0.281)		(1.103)		(0.322)		(1.077)
Gov. consumption	0.009	0.007	0.013	0.024	0.013	0.007	0.010	0.031
	(0.023)	(0.023)	(0.096)	(0.095)	(0.027)	(0.027)	(0.097)	(0.097)
Investment	0.101***	0.107***	0.234***	0.233***	0.110***	0.110***	0.230***	0.237***
	(0.025)	(0.017)	(0.051)	(0.050)	(0.019)	(0.017)	(0.052)	(0.052)
Openness	0.060***	0.050***	0.068**	0.065*	0.074***	0.067***	0.075**	0.076**
	(0.013)	(0.016)	(0.034)	(0.033)	(0.011)	(0.014)	(0.034)	(0.034)
Governance	0.074***	0.080***	0.056	0.059	0.022	0.028	0.014	0.021
	(0.025)	(0.027)	(0.088)	(0.087)	(0.028)	(0.027)	(0.088)	(0.086)
Inflation	−0.001**	−0.001**	0.0002	0.0004	−0.0003	−0.001	0.001	0.001
	(0.001)	(0.0004)	(0.003)	(0.003)	(0.001)	(0.001)	(0.003)	(0.003)
Education	0.045***	0.044***	0.057**	0.052**	0.054***	0.054***	0.067***	0.061***

TABLE 4 *Continued*

	PPG Debt Stock				*PPG Debt Service*			
	Full Sample		*HIPCs*		*Full Sample*		*HIPCs*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	(0.009)	(0.010)	(0.024)	(0.023)	(0.012)	(0.012)	(0.024)	(0.024)
Fuel	−0.007*	−0.010**	−0.029	−0.036	−0.010***	−0.009**	−0.050*	−0.043*
	(0.004)	(0.004)	(0.027)	(0.026)	(0.004)	(0.004)	(0.026)	(0.026)
Ores	0.045***	0.035***	0.038	0.030	0.055***	0.044***	0.044	0.033
	(0.006)	(0.005)	(0.028)	(0.028)	(0.004)	(0.005)	(0.028)	(0.029)
Constant	−0.687***	−0.977***	−1.168***	−1.361***	−0.475***	−0.618***	−0.995***	−1.116***
	(0.144)	(0.155)	(0.294)	(0.312)	(0.122)	(0.134)	(0.292)	(0.304)
Observations	209	209	157	157	209	209	157	157
Number of countries	38	38	27	27	38	38	27	27
Sargan Test (Prob >chi^2)	0.381	0.459	0.169	0.197	0.418	0.428	0.197	0.194
Arellano-Bond (Pr>z)	0.351	0.323	0.499	0.507	0.520	0.590	0.638	0.641

Notes:
(i) Labor productivity growth is averaged over 3-year non-overlapping periods.
(ii) Independent variables are measured as initial values at the beginning of the 3-year period.
(iii) Standard errors are in parentheses.
(iv) ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
(v) Arellano-Bond test that average autocovariance in residuals of order 2 is 0 has H0: no autocorrelation.
(vi) All values are based on a two-step estimator.

TABLE 5
Public and Publicly Guaranteed (PPG) External Debt Stock Effects on Labour Productivity Growth in SSA, Evaluated in the HIPC Debt Relief Initiative Framework, 1984–2010 (SGMM Estimation)

	Full Sample		*HIPCs*	
	(1)	*(2)*	*(3)*	*(4)*
Real GDP *per capita*	−14.470***	−12.950***	−11.000***	−9.880***
	(2.075)	(1.961)	(2.600)	(2.625)
PPG Debt Stock	−0.026***		−0.022*	
	(0.006)		(0.013)	
PPG Debt Stock × *d1995*		−0.039***		−0.045***
		(0.006)		(0.016)
PPG Debt Stock × *dcomp*		−0.023***		−0.020
		(0.005)		(0.013)
PPG debt stock × *dpost*		0.016**		0.010
		(0.007)		(0.024)
dcomp	2.162***		3.508***	
	(0.335)		(1.118)	
dpost	3.526***		5.292***	
	(0.535)		(1.745)	
Gov. Consumption	0.020	0.006	0.023	0.017
	(0.025)	(0.030)	(0.095)	(0.096)
Investment	0.090***	0.064**	0.216***	0.214***
	(0.019)	(0.030)	(0.051)	(0.052)
Openness	0.041**	0.052***	0.068**	0.063*
	(0.016)	(0.014)	(0.033)	(0.034)
Governance	0.063***	0.067**	0.053	0.056
	(0.023)	(0.029)	(0.087)	(0.087)
Inflation	−0.001**	−0.001***	−0.0001	−0.0001
	(0.001)	(0.0005)	(0.003)	(0.003)
Education	0.032***	0.033***	0.049**	0.052**
	(0.011)	(0.013)	(0.023)	(0.024)
Fuel	−0.008*	−0.009**	−0.034	−0.022
	(0.004)	(0.005)	(0.026)	(0.027)
Ores	0.039***	0.040***	0.025	0.031
	(0.006)	(0.008)	(0.028)	(0.028)
Constant	−0.724***	−0.617***	−1.471***	−1.207***
	(0.172)	(0.155)	(0.321)	(0.292)
Observations	209	209	157	157
Number of countries	38	38	27	27
Sargan Test (Prob >chi^2)	0.484	0.507	0.285	0.276
Arellano-Bond (Pr>z)	0.320	0.335	0.418	0.466

Notes:
(i) Labour productivity growth is averaged over 3-year non-overlapping periods.
(ii) Independent variables are measured as initial values at the beginning of the 3-year period.
(iii) Standard errors are in parentheses.
(iv) ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
(v) Arellano-Bond test that average autocovariance in residuals of order 2 is 0 has H0: no autocorrelation.
(vi) All values are based on a two-step estimator.

dcomp and *dpost* dummy variables, with the magnitudes of both coefficients almost two times larger in the HIPCs than in the full sample. Furthermore, growth is much more pronounced after the completion point than during the interim period. These findings offer further

evidence that the debt relief initiatives (HIPCs and Multilateral debt relief initiative) are likely to have played a positive role in sub-Saharan Africa.

We also estimate the conditional marginal effects of PPG debt through the interaction terms. The results in columns 2 and 4 of Table 5 reveal that PPG debt had a negative effect not only before 1996 but also during the interim period.[23] Once the completion point was achieved, the effect turned positive. In other words, while the interim relief measures were not sufficient to reverse the adverse impact of debt on growth, the full reduction in debt was successful in stimulating labour productivity growth as evidenced in the full sample. It is worth noting here that the negative marginal impact of PPG debt observed prior to 1996 was reduced significantly by 50 per cent once the debt relief process was initiated (during the interim period). Upon reaching the completion point and qualifying for the full debt relief, annual productivity growth of the beneficiary countries increased by 0.02 per cent over consequent 3-year periods for every 1 per cent increase in the initial share of PPG debt in GDP.

In the HIPC subsample (column 4), we continue to observe negative marginal effects of debt in the period prior to the debt relief process and the interim period, with positive effects after the completion point period.[24] However, these effects are significant only in the pre-debt relief process period. Notwithstanding, they are smaller than those observed in the full sample by roughly 50 per cent.

Generally, our findings documented in Tables 4 (columns 1–4) and 5 suggest that the conditions imposed by the World Bank and IMF for receiving full debt relief, such as implementing key reforms, maintaining a good performance in externally financed programmes and adopting a strategy for poverty reduction, have played a positive role in enhancing productivity growth above and beyond those accrued from the actual debt reduction.

The estimated coefficients of the control variables in the Tables 4 and 5 are largely consistent with the findings in the empirical growth literature (Barro, 1991; Levine and Renelt, 1992; Sala-i-Martin et al., 2004). The results provide evidence of β-convergence among SSA economies as the initial level of labour productivity is negatively correlated with consequent growth across all models. Initial levels of investment,[25] openness, good governance and education and are found to stimulate growth, while inflation has the expected negative effect but only in the full sample. Lastly, larger shares of ores and metals in merchandise exports have a growth-enhancing effect, while oil and other fuel exports impede growth.

[23] It is worth pointing out that the interaction terms of debt with the three dummy variables in columns 2 and 4 of Table 5 represent the full marginal effect of debt for the corresponding period, and not the additional marginal effect as in Table 4.

[24] The coefficient for the HIPC subsample in the period after the completion point is positive but lacks significance. The main reason is that we have relatively few data points because a large part of the HIPCs reached the completion point in the second half of the 2000s

[25] Previous studies have identified two main channels through which debt affects growth: physical capital accumulation and total factor productivity (TFP). The fact that the negative effect of external debt is robust even when we control for investment in the regression suggests that in the SSA sample this effect is more likely transmitted via TFP. This is in line with research showing that two-thirds of the effect of debt on growth in developing countries occurs through TFP (Pattillo et al., 2004).

d. Robustness Tests

We conducted a number of robustness checks and discuss some of the notable results here but abstain from reporting all the detailed estimates due to space limitations. For example, we estimated the regressions with annual productivity growth over 5-year periods as the dependent variable. The effects of initial PPG debt on growth were smaller in magnitude than for the 3-year periods but still significantly negative. Similarly, the additional marginal effects of debt after 1996 were positive as with the 3-year periods. Next, we replaced PPG debt with total debt, but this did not produce any major differences, which was expected, given that PPG debt constitutes the largest share of total debt in SSA. We also extended the sample period over the years 1970–2010 but this also did not change the main findings.[26] These results are available upon request.

Furthermore, we adopted a different measure of the impact of debt on growth by focusing on liquidity constraint effects of PPG debt (debt service effects) rather than debt overhang over the period 1984–2010. Similar to the baseline regression in Tables 4 (columns 1–4) and 5, labour productivity growth is averaged over 3-year non overlapping periods. Some of the results are presented in Table 4 (columns 5–8). Generally, we do not observe liquidity constraint effects across all sample and model specifications. However, the additional marginal effects of debt service on growth for the period after 1996 were consistently positive and significant. Specifically, for every 1 per cent increase in the share of initial PPG debt in GDP after 1996, annual productivity growth over the subsequent three years increased by 0.07 and 0.10 per cent for the full sample and the HIPCs subsample, respectively. The unconditional debt relief effects measured by the coefficient on the *d1996* dummy variable are consistent with those observed in the baseline regressions, emphasising the growth enhancing effects of the debt relief process in these countries.

e. Convergence Regressions

The next specification of the regression model, estimated using pooled OLS, focuses on the effect of external PPG debt stocks on convergence in output per worker. For this purpose, we use a sample of 32 economies (29 of them HIPCs) that exhibited below-average productivity for most of the period 1984–2010. The dependent variable in this model is defined as the (positive) deviation from the sample mean. The results in columns 1 and 2 of Table 6 indicate that an increase in the share of PPG debt in GDP leads to a growing distance from the sample mean. This divergence tendency is largely in line with the findings of the non-parametric analysis in Figure 1 (second row) and Table 3 (third matrix).

As reported in Section 4*c*, debt relief after 1996 was able to partially reduce the negative impact of the external debt burden on growth. In this model, it was also found to have led to convergence towards the mean as suggested by the negative sign of the interaction term measuring the marginal effect of debt after 1996. In other words, lower levels of external debt following the debt relief initiative have helped countries with below-average labour productivity

[26] We also introduced a quadratic term of the debt variable to test for non-linearities as has been done in previous studies but it was not significant. This can be explained by the fact that our analysis focused on the negative-slope section of the debt's 'Laffer curve' due to the excessive levels of debt in our sample. This concurs with Cordella et al. (2010) who also reported an insignificant quadratic term for countries with high levels of debt.

TABLE 6
Public and Publicly Guaranteed (PPG) External Debt Stock Effects on Convergence in Labour Productivity Levels within SSA, 1984–2010. (Pooled OLS Estimation)

Dependent Variable	*Productivity Deviations from Group Mean*		*Productivity Deviations from Best Performer (South Africa)*	
	Countries Below Group Mean			
	Full Sample (1)	*HIPCs (2)*	*Full Sample (3)*	*HIPCs (4)*
PPG debt stock	0.012***	0.007***	0.060***	0.004
	(0.003)	(0.002)	(0.020)	(0.007)
PPG debt stock × *d1996*	−0.004*	−0.002	−0.001*	−0.0003
	(0.002)	(0.002)	(0.0004)	(0.0002)
Gov. consumption (ln)	0.008	0.037**	0.031***	0.011
	(0.014)	(0.018)	(0.010)	(0.013)
Investment (ln)	−0.311*	−0.389**	−0.062**	−0.020**
	(0.160)	(0.154)	(0.027)	(0.009)
Openness (ln)	0.712***	1.175***	−0.078***	−0.015
	(0.231)	(0.312)	(0.019)	(0.012)
Ores (ln)	0.124***	0.093***	0.006**	0.005***
	(0.035)	(0.029)	(0.003)	(0.002)
Fuel (ln)	−0.308***	−0.296***	−0.009***	−0.017***
	(0.046)	(0.046)	(0.003)	(0.002)
Education (ln)	0.009***	0.005	0.020	0.011
	(0.003)	(0.003)	(0.016)	(0.012)
Governance	0.065***	0.114***	0.007***	0.006***
	(0.020)	(0.020)	(0.002)	(0.001)
Inflation	−0.006	−0.003	−0.0004	−0.00001
	(0.005)	(0.006)	(0.001)	(0.0004)
Constant	−0.070	−1.450	4.503***	4.469***
	−0.973	(1.29)	(0.111)	(0.107)
Observations	382	315	396	320
R-squared	0.336	0.410	0.184	0.422

Notes:
(i) Dependent variables are specified as follows: deviation of the productivity level from the sample mean (only countries with below-mean productivity are included) and deviation of the productivity level from that of South Africa.
(ii) Robust standard errors are in parentheses.
(iii) ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

to catch up with the mean level of output per worker. But this convergence effect is very weak, and its coefficient is not significant for the HIPC subsample. Accordingly, the overall effect of debt remained a contributing factor towards divergence from the mean, even after 1996.

One of the major findings of the non-parametric analysis was the convergence in the debt-weighted output per worker, especially after 1996. As shown in Figure 1 and Table 3, this convergence goes beyond the mean and towards higher levels of productivity. To explore this aspect further, we replace the sample mean with an alternative benchmark represented by the economy with the highest productivity level in the sample. Over the period 1984–2010, this happens to be South Africa. The dependent variable in the regression now becomes the deviation from the productivity level of South Africa, which is set equal to 100.

The results of this specification for 38 SSA economies are shown in columns 3 and 4 of Table 6. External debt is again found to be a driving force of divergence relative to the best performer in the full sample, but not in the HIPC subsample where its coefficient lacks significance. The interaction term for the years following 1996 exhibits again a negative sign. This confirms to a certain extent the convergence pattern after 1996 reported in the non-parametric analysis above, although the magnitude of the marginal effect after 1996 is not strong enough to reverse the divergence tendency. In the HIPC subsample, the interaction term is not significantly different from zero indicating that debt relief after 1996 did not have an effect on output per worker relative to South Africa's level.

The results in Table 6 further reveal that external debt is not the most important factor that drives the dynamics of labour productivity relative to the benchmark. Investment and oil exports appear to be the major contributors to convergence,[27] while governance and ores exports are mostly responsible for the growing disparities within the distribution. Openness leads to polarisation across countries but only relative to the mean. This is also the case for government consumption but only for the HIPC subsample.

5. CONCLUSION

Sub-Saharan Africa countries have long suffered from lagging productivity and excessive levels of external debt. The dramatic worsening of these trends over the early 1990s triggered the creation of the HIPC and MDRI programmes to provide debt reduction and restore growth in the region. This paper examined the impact of external debt and debt service on labour productivity growth and convergence before and after the debt relief initiatives using both parametric and non-parametric techniques. Our results confirm the existence of a debt overhang in SSA which is reflected in a consistently negative and significant effect of debt on growth across different model specifications. On the contrary, we do not find robust adverse effects of debt service on labour productivity growth. Moreover, the marginal external debt impact after 1996 (as measured by the interaction terms of debt with various dummy variables) was shown to be beneficial because it reduced the negative impact of external debt and debt service on growth in output per worker in the targeted countries. Notwithstanding, our results provide evidence of growth enhancing unconditional debt relief effects.

When indebtedness is taken into account, we detect strong divergence tendencies in labour productivity away from the mean and towards the bottom of the distribution over the 1980s and especially the early 1990s. Accordingly, external debt was found to be a robust determinant of divergence, albeit a less important one in magnitude than others, such as openness. In contrast, investment and the share of fuels in exports were the main driving forces behind convergence across SSA countries. Since the second half of the 1990s, countries with declining levels of external liabilities were increasingly able to converge towards higher levels of labour productivity. However, our results suggest that debt relief for the countries targeted by the debt relief initiatives was not strong enough to have a significant effect on convergence towards the top of the distribution.

[27] This is in line with the findings of Badunenko et al. (2010).

REFERENCES

Agénor, P. and P. Montiel (1996), Development Macroeconomics (Princeton, NJ: Princeton University Press).

Arellano, M. and O. Bover (1995), 'Another Look at the Instrumental Variables Estimation of Error-components Models', *Journal of Econometrics*, **68**, 1, 29–51.

Arslanalp, S. and B. Henry (2005), 'Is Debt Relief Efficient?', *The Journal of Finance*, LX **60**, 2, 1017–51.

Badunenko, O., D. J. Henderson and R. Houssa (2010), 'Explaining African Growth Performance: A Production-Frontier Approach', Working Paper 1013 (Namur: University of Namur).

Baldacci, E. and M. Kumar (2010), 'Fiscal Deficits, Public Debt and Sovereign Bond Yields', IMF Working Paper Nr. 10/184 (Washington, DC: International Monetary Fund).

Barro, R. (1991), 'Economic Growth in a Cross Section of Countries', *The Quarterly Journal of Economics*, **106**, 2, 407–43.

Barro, R. and X. Sala-i-Martin (1992), 'Convergence', *Journal of Political Economy*, **100**, 2, 223–51.

Barro, R. J. and X. Sala-i-Martin (1995), *Economic Growth* (New York: McGraw-Hill).

Beck, T., R. Levine and N. Loayza (2000), 'Finance and the Sources of Growth', *Journal of Financial Economics*, **58**, 1, 261–300.

Ben Hammouda, H., S. N. Karingi and M. S. Jallab (2009), 'Why Doesn't Regional Integration Improve Income Convergence in Africa?', *African Development Review*, **21**, 2, 291–330.

Blundell, R. and S. Bond (1998), 'Initial Conditions and Moment Restrictions in Dynamic Panel Data Models', *Journal of Econometrics*, **87**, 1, 115–43.

Bosworth, B. and S. Collins (2003), 'The Empirics of Growth: An Update', *Brookings Papers on Economic Activity*, **34**, 2, 113–206.

Brooks, R., M. Cortes, F. Fornasari, B. Ketchekmen, Y. Metzgen, R. Powell, S. Rizavi, D. Ross and K. Ross (1998), 'External Debt Histories of Ten Low-income Developing Countries: Lessons From Their Experiences', IMF Working Paper Series WP/98/72 (Washington, DC: IMF).

Calvo, G. A. (1998), 'Growth, Debt and Economic Transformation: The Capital Flight Problem', in F. Coricelli, M. di Matteo and F. Hahn (eds.), *New Theories in Growth and Development* (New York: St. Martin's Press).

Cordella, T., L. C. Ricci and M. Ruiz-Arranz (2010), 'Debt Overhang or Debt Irrelevance?', *IMF Staff Papers*, **57**, 1, 1–24.

Dollar, D. (1992), 'Outward-oriented Developing Economies Really Do Grow More Rapidly: Evidence From 95 LDCs, 1976–1985', *Economic Development and Cultural Change*, **40**, 3, 523–44.

Dollar, D. and A. Kraay (2004), 'Trade, Growth, and Poverty', *Economic Journal*, **114**, 493, F22–49.

Edwards, S. (2003), 'Debt Relief and the Current Account: An Analysis of the HIPC Initiative', *The World Economy*, **26**, 4, 513–31.

Fischer, S. (1993), 'The Role of Macroeconomic Factors in Growth', *Journal of Monetary Economics*, **32**, 3, 485–512.

Fonchamnyo, D. C. (2009), 'Debt Relief Incentives in Highly Indebted Poor Countries (HIPC): An Empirical Assessment', *International Advances in Economic Research*, **15**, 3, 322–35.

Fosu, A. K. (1996), 'The Impact of External Debt on Economic Growth in Sub-Saharan Africa', *Journal of Economic Development*, **21**, 1, 93–118.

Fosu, A. K. (2007), 'Fiscal Allocation for Education in Sub-Saharan Africa: Implications of the External Debt Service Constraint', *World Development*, **35**, 4, 702–13.

Gale, W. G. and P. Orszag (2003), 'The Economic Effects of Long-term Fiscal Discipline', Urban-Brookings Tax Policy Center Discussion Paper 8 (Washington, DC: Brookings Institution).

Grossman, G. and E. Helpman (1991), *Innovation and Growth in the Global Economy* (Cambridge, MA: MIT Press).

Heston, A., R. Summers and B. Aten (2012), Penn World Table Version 7.1 (Philadelphia, PA: Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania).

Hussain, N. and B. Gunter (2005), 'External Shocks and the HIPC Initiative: Impacts on Growth and Poverty in Africa', *African Development Review*, **17**, 3, 461–92.

Imbs, J. and R. Ranciere (2005), 'The Overhang Hangover', World Bank Policy Research Working Paper 3673 (Washington, DC: World Bank).

International Labor Organization (2011), *Towards Decent Work in sub-Saharan Africa – Monitoring MDG Employment Indicators* (Geneva: International Labor Organization).
Krugman, P. (1988), 'Financing vs. Forgiving a Debt Overhang: Some Analytical Issues', NBER Working Paper 2486 (Cambridge, MA: National Bureau of Economic Research).
Kumar, M. S. and J. Woo (2010), 'Public Debt and Growth', IMF Working Paper Nr. 10/174 (Washington, DC: International Monetary Fund).
Levine, R. and D. Renelt (1992), 'A Sensitivity Analysis of Cross-Country Growth Regressions', *American Economic Review*, **82**, 4, 942–63.
Marshall, M. G. and K. Jaggers (2011), *Polity IV Project: Political Regime Characteristics and Transitions, 1800–2010* (College Park, MD: Center for International Development and Conflict Management, University of Maryland).
McCoskey, S. K. (2002), 'Convergence in Sub-Saharan Africa: A Non-stationary Panel Approach', *Applied Economics*, **34**, 7, 819–29.
Pack, H. and C. Paxson (1999), 'Is African Manufacturing Skill-constrained?', Policy Research Working Paper 2212 (Washington, DC: World Bank).
Pattillo, C., H. Poirson and L. A. Ricci (2011), 'External Debt and Growth', *Review of Economics and Institutions*, **2**, 3, 30.
Pattilo, C., H. Poirson and L. A. Ricci (2004), 'What are the Channels Through Which External Debt Affects Growth?', IMF Working Paper No. 04/15 (Washington, DC: International Monetary Fund).
Quah, D. (1996), 'Empirics for Economic Growth and Convergence', *European Economic Review*, **40**, 6, 1353–75.
Quah, D. (1997), 'Empirics for Growth and Distribution: Stratification, Polarization and Convergence Clubs', *Journal of Economic Growth*, **2**, 1, 27–59.
Quattri, M. and A. K. Fosu (2012), 'On the Impact of External Debt and Aid on Public Expenditure Allocation in Sub-Saharan Africa After the Launch of the HIPC Initiative', UNU-WIDER Research Paper No. 42 (Helsinki: World Institute for Development Economic Research).
Rogoff, K. (1992), 'Dealing With Developing Country Debt in the 1990s', *The World Economy*, **15**, 4, 475–86.
Roodman, D. (2006), 'An Introduction to 'Difference' and 'System' GMM in STATA', Center for Global Development Working Paper Nr. 103 (Washington, DC: Center for Global Development).
Sachs, J. (1989), 'The Debt Overhang of Developing Countries', in G. A. Calvo, R. Findlay, P. Kouri and J. B. de Macedo (eds.), *Debt Stabilization and Development* (Oxford: Blackwell), 80–102.
Sachs, J. D. and A. M. Warner (1997), 'Sources of Slow Growth in African Economies', *Journal of African Economies*, **6**, 3, 335–76.
Sala-i-Martin, X., G. Doppelhofer and R. Miller (2004), 'Determinants of Long-term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach', *American Economic Review*, **94**, 4, 813–35.
Silverman, B. (1981), 'Using Kernel Density Estimates to Investigate Multimodality', *Journal of the Royal Statistical Society Ser. B*, **43**, 1, 97–99.
Wamboye, E. and K. Tochkov (2014), 'External Debt, Debt Relief Initiatives, and Economic Growth in Least Developed Countries', Texas Christian University Department of Economics Working Paper 14-03 (Fort Worth, TX: Texas Christian University).
Wolf, S. (2007), 'Encouraging Innovation for Productivity Growth in Africa', Africa Trade Policy Centre Work. Progress No. 54 (Addis Ababa: UNECA).
Yang, J. and D. Nyberg (2009), 'External Debt Sustainability in Hipc Completion Point Countries: An Update', IMF Working Papers 09/128 (Washington, DC: International Monetary Fund).