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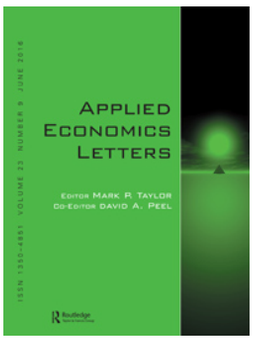

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Sectoral sources of sub-Saharan Africa's convergence

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ABSTRACT

From 1970 to 2010, sub-Saharan African's (SSA) labour productivity hovered at around 6% of the US level. This lacklustre performance, which remained stubbornly low despite the SSA's growth spurt that started in the mid-1990s, masks a great deal of variations across sectors and countries. Using a structural decomposition, we examine, for a representative sample of SSA countries, the sectoral sources that hold back their convergence to the US frontier. Our results suggest the presence of strong – and possibly long-lasting – headwinds that have wiped out the favourable effects of substantial, yet circumstantial, tailwinds. Headwinds, quantified by the unfavourable within- and reallocation-effects, are indicative of significant capital-deepening and technology gaps, both of which are extremely hard to bridge. The tailwinds, represented by favourable between-effects, result from the convergence of the SSA labour force to sectors where some US sectors have seen a slowdown of their productivity relative to that of the whole economy – a development unrelated to the fundamentals underlying the SSA economy. Although few exceptions emerged out of this general pattern, these results are indicative of a bleak outlook for the SSA economic performance at least in the medium run.

KEYWORDS

Convergence decomposition; productivity growth; structural change; sub-Saharan Africa

JEL CLASSIFICATION

N10; O47; O55; O57

I. Introduction

Sub-Saharan Africa (SSA) remains one of the poorest regions in the world. This region features an economic tragedy – a steady fall behind by any metric – that led to a human tragedy (e.g., poverty, diseases and high infant mortality), both of which have been abundantly documented (e.g., Easterly and Levine 1997; Artadi and Sala-i-Martin 2003). The resurgence of the SSA economy since the mid-1990s has overcome pessimistic expectations as growth projections have been revised to reflect a more sanguine pick-up in the economic pulse. Numerous factors have been identified as potential sources in the revival of the SSA economy, including improved macroeconomic conditions, a more favourable business climate marked with economic reforms and a desire to end armed conflicts (Sachs and Warner 1997).

Against this backdrop, we examine two sets of related questions: First, has the SSA's recent growth spurt translated into a gradual process of convergence to the world frontier represented by the US economy and, second, what are the sectoral origins of this convergence (or lack of thereof)? Using the newly developed Africa Sector Database (ASD), which tracks sectoral economic activity for 11 of the most representative SSA countries over the period 1970–2010, we perform a quantitative assessment on the relative importance of the within-, reallocation- and between-effects in the aggregate convergence.[1]

Our findings indicate that the within- and reallocation-effects have wiped out all of the favourable advances in the between-effect over the period 1970–2010 in the region. The unfavourable within-effect has more than doubled from period 1970–1990 to the period 1990–2010 in the SSA, a sharp contrast with the turnaround in the reallocation-effect and a further acceleration of the favourable between-effect. Our work builds on a set of recent contributions on convergence and structural transformation. Our article is similar in spirit and approach to Caselli and Tenreyro (2006), who performed a labour

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The views expressed herein are those of the authors and not necessarily those of the institutes they are affiliated to.

[1]This sample includes some landlocked, resource-scarce economies (Ethiopia and Malawi), some coastal, resource-scarce economies (Ghana, Kenya, Mauritius, Senegal and Tanzania) and some resource-rich countries (Botswana, Nigeria, South Africa and Zambia).

productivity convergence accounting exercise for Europe, identifying, along the way, the best prospects available for Eastern Europe to catch up with the level of the Western European frontier. Much like Eastern Europe, a large portion of the SSA labour force is trapped in an unproductive agricultural sector. For both economies, the within-effect is large, suggesting the presence of a huge gap attributable to capital-deepening and technical change.

Our article complements the recent work on the structural transformation of the SSA carried out by McMillan and Rodrik (2011), De Vries, Timmer, and De Vries (2013) and McMillan, Rodrik, and Verduzco-Gallo (2014). These studies employ a shift-share analysis at the country level for SSA economies and find that the structural change has been growth-reducing in the SSA since 1990s. While there is an obvious parallel between these studies and ours – tracing the sources of the aggregate productivity – there is a major difference, however, in terms of perspective. Our decomposition places the emphasis on 'level', which generally leads to a different interpretation from theirs, which is based on 'growth'. This article also complements our earlier work, which provides a broad-brush assessment on the relative performance of the SSA economy using the guidance offered by competing growth theories (see Harchaoui and Üngör 2015). It offers a higher level of resolution at the country level in an effort to identify any regularities on a cross-country basis that stem from the sectoral sources of convergence.

The remainder of this article is organized as follows. Section II describes the source data supporting the decomposition analysis of the SSA's relative labour productivity performance performed in Section III and Section IV concludes.

II. Data and summary statistics

Data

Our primary source is the ASD developed by the Groningen Growth and Development Centre (GGDC) (see De Vries, Timmer, and De Vries 2013).[2] This panel data tracks employment as well as current and constant price series of value added at national currencies (2005 prices) for 11 SSA economies and their constituent sectors over the period 1960–2010. The data are structured along 10 main sectors delineated on the basis of the International Standard Industrial Classification, Revision 3.1: (1) agriculture, (2) mining, (3) manufacturing, (4) utilities, (5) construction, (6) trade services, (7) transport services, (8) business services, (9) government services and (10) personal services. Due to the lack of separate employment data for government services and personal services for Zambia, we combine these two sectors into the non-market services sector, as in De Vries, Timmer, and De Vries (2013), making our analysis along the way based on nine sectors.

The ASD includes sector-specific purchasing power parities (PPPs) for the 2005 benchmark year for each of the 11 countries as well as the exchange rates for 2005. We convert the local currency value added at 2005 prices to international prices using the 2005 PPPs. A complete series on real value added in international prices has been extrapolated forward and backward using the growth rates of real value added by sector. Upon the construction of a time series for sectoral value added in 2005 international prices, the series were aggregated to the level of the whole economy for each country and across the 11 countries. Aggregate employment series were obtained as a straight sum across sectors to arrive at the national employment series and across countries to arrive at the SSA total. Finally, labour productivity in each sector for each country is computed as the ratio of each sector's PPP-adjusted real value added by the corresponding level of sectoral employment.

Because not all countries reported data since 1960, we start the sample period in 1970, the first year when the 11 countries offer a complete panel data set. Starting the sample period in 1970 does not alter our findings in any way, since the majority of countries were still under the colonial administration or were in a transition period towards the inception of a national development strategy.[3] The US sectoral data for the period 1970–2010 that offer the same structure as the ASD have been obtained from the 10-sector database, which covers the period 1950–2010.[4] The US data have been aggregated to

[2]http://www.rug.nl/research/ggdc/data/africa-sector-database
[3]Kenya, Malawi, Botswana and Mauritius became independent in 1963, 1964, 1966 and 1968, respectively.
[4]http://www.rug.nl/research/ggdc/data/10-sector-database

nine sectors and curtailed to the period 1970–2010 to match their ASD counterpart.

Summary statistics

Economic development involves structural transformation, which entails a gradual but steady deployment of employment away from agriculture towards industry and services propelled by an advance in productivity. Such a transformation remains limited in many SSA countries compared to that experienced by developed countries and other emerging economies (see Herrendorf, Rogerson, and Valentinyi 2014 for a comprehensive survey).

Table 1 reports sectoral employment shares in each economy and for the whole SSA economy for 1970, 1990 and 2010. Agriculture remains the dominant activity in terms of employment. For example, in

Table 1. Sectoral employment shares (%).

Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Trade	Transport	Business	Nonmarket
Botswana									
1970	82.5	1.1	1.5	0.2	1.7	1.5	1.2	1.3	9.2
1990	40.2	3.3	5.8	1.2	12.0	7.6	2.3	3.7	24.0
2010	38.6	1.5	6.6	0.6	2.8	19.7	3.2	7.1	20.0
Ethiopia									
1970	92.5	0.01	1.9	0.04	0.3	2.6	0.3	0.1	2.2
1990	89.4	0.1	1.8	0.1	0.3	3.7	0.4	0.1	4.2
2010	75.2	0.5	6.3	0.1	2.0	10.1	0.5	0.4	4.9
Ghana									
1970	57.0	1.0	12.1	0.4	2.4	13.8	2.7	0.3	10.2
1990	53.5	0.9	12.9	0.4	1.6	17.1	2.7	0.7	10.1
2010	41.6	1.1	10.8	0.4	3.1	24.3	3.5	2.3	12.9
Kenya									
1970	81.0	0.1	3.8	0.1	0.8	5.0	1.4	0.9	6.8
1990	71.2	0.1	5.3	0.3	1.4	8.4	1.5	1.0	10.8
2010	48.3	0.6	12.8	0.2	2.8	16.4	3.4	1.2	14.2
Malawi									
1970	86.7	0.2	3.1	0.2	2.0	1.9	0.9	0.1	4.8
1990	86.1	0.2	3.0	0.2	1.5	3.4	0.7	0.5	4.4
2010	65.2	0.1	4.4	0.3	4.5	13.0	2.2	0.7	9.4
Mauritius									
1970	37.3	0.1	10.6	1.6	7.8	7.7	5.8	1.1	27.9
1990	16.7	0.2	32.2	0.9	10.0	11.0	6.1	2.8	20.1
2010	7.2	0.2	19.1	1.0	10.0	21.5	8.3	9.5	23.2
Nigeria									
1970	65.6	0.3	12.8	0.1	0.8	14.7	0.6	0.1	5.1
1990	71.7	0.3	10.8	0.2	0.6	10.8	0.6	0.6	4.4
2010	58.9	0.2	4.0	0.2	1.6	18.3	3.1	2.7	11.0
Senegal									
1970	73.3	0.2	5.6	0.3	1.3	7.3	1.8	0.2	10.0
1990	65.8	0.1	5.8	0.7	1.6	13.5	2.1	0.2	10.1
2010	51.4	0.2	9.9	0.04	3.8	21.1	3.4	0.5	9.6
S. Africa									
1970	34.7	8.8	13.3	0.6	5.8	13.5	4.4	2.5	16.3
1990	21.5	8.8	14.7	1.0	5.7	17.6	5.0	4.9	20.9
2010	15.0	2.1	11.9	0.6	7.3	20.0	5.3	11.3	26.5
Tanzania									
1970	91.4	0.1	1.7	0.1	0.6	1.9	0.9	0.1	3.1
1990	86.1	0.4	1.4	0.1	0.8	5.4	0.8	0.2	4.8
2010	73.4	0.3	2.7	0.7	2.3	10.9	1.1	0.2	8.4
Zambia									
1970	62.8	3.9	3.1	0.6	3.9	4.1	2.7	1.4	17.7
1990	75.3	2.6	4.0	0.4	1.5	3.0	2.2	1.6	9.4
2010	72.8	2.4	3.3	0.3	1.5	10.2	1.9	1.1	6.5
SSA									
1970	70.6	1.4	8.3	0.2	1.5	9.4	1.3	0.5	6.6
1990	70.3	1.3	7.4	0.3	1.4	9.3	1.4	1.0	7.6
2010	58.3	0.6	6.6	0.3	2.7	15.7	2.5	2.4	11.0
US									
1970	3.2	0.7	22.2	0.7	5.3	21.0	6.0	9.2	31.7
1990	2.0	0.6	15.2	0.6	5.6	24.1	4.6	15.5	31.8
2010	1.5	0.5	8.7	0.4	5.1	24.1	4.0	18.1	37.6

some countries such as Ethiopia, Tanzania and Zambia, more than 70% of the workforce is trapped in agriculture, a sharp contrast with Mauritius and South Africa, where the proportion is lower and is reporting a rapid decline. Progress in reducing the agricultural employment share was slow (and almost negligible in some countries) between 1970 and 1990. For example, employment share in agriculture in Malawi was 86.1% in 1990, virtually unchanged since 1970.

The state of structural transformation in the SSA economy mirrors that of its constituent countries. In 2010, the relative employment size of agriculture was close to 60%, down from about 70% in 1970. The US agriculture reported the same relative importance back in 1810 (71.8%) and 1850 (59.9%).[5] While the SSA's decline in the relative importance of agriculture compares favourably to that of the nineteenth-century United States – the same order-of-magnitude decline during the same time span – it pales compared to the 42 percentage point decline reported by South Korea over the same period of 1970–2010.[6]

The SSA's slow progress in reducing the relative importance of employment in agriculture coincides with the virtual absence of industrialization propelled by a dynamic manufacturing sector. As a result, the SSA's structural transformation has experienced an atypical shift of employment to market and nonmarket services (see also Rodrik (2014) for this point). Mauritius remains an exception, with much of the agricultural employment moved to manufacturing, which, incidentally, also displays a hump-shaped pattern. Manufacturing employment share increased from 10.6% in 1970 to 32.2% in 1990, when it reached its peak before experiencing a steady decline to 19.1% in 2010.[7]

Table 2 shows the SSA's relative productivity level across sectors and for the whole economy in 1970, 1990 and 2010. Three sets of results stand out. First, the SSA's relative productivity performance represents only 6% of that of the US economy, suggesting the presence of a huge gap that does not seem to shrink despite the turnaround of the SSA economic growth that started in the second half of the 1990s. Second, the SSA's relative productivity level reveals large and persistent gaps ranging from 1% in agriculture to 42% for business services in 2010, a sharp deterioration from 1990, regarded by many observers as the period of 'renaissance' of the SSA economy (The Economist 2011). Mining and construction were the only sectors that improved their relative performance owing to favourable shocks experienced in the commodity markets since the 1990s.[8]

Third, the results feature an important regularity of economic development, i.e., large intersectoral productivity-level gaps, an indication of the extent of dualism that generally characterizes developing economies. These intersectoral gaps are indicative of allocative inefficiencies, particularly in traditional sectors such as agriculture. With this sector accounting for the bulk of the labour force, this gap makes its way into the aggregate economy, where developing nations lag behind the world frontier (see Rodrik 2011, 22). The relative productivity between the sectors with the highest and lowest productivities in the SSA (business services versus agriculture) was 236.4 in 1970, 221.2 in 1990 and 97.9 in 2010. However, the relative productivity between the sectors with the highest and lowest productivities in the United States (mining versus agriculture) was 21.6 in 1970 and 10.3 in 1990. In 2010, the relative productivity between the sectors with the highest and lowest productivities in the United States (mining versus construction) was 6.9. Clearly, this suggests that intersectoral relative gaps remain important in the SSA (14.3 = 97.9/6.9 in 2010 compared to 10.9 = 236.4/21.6 in 1970).

By and large, the majority of the SSA countries conform with these broad patterns, which translate into a large, relative productivity gap for the whole economy. Across the variety of the SSA's countries, few have performed exceptionally well and consistently over the four decades spanned by the data while the majority either continued to fall behind or, at best, remained stalled. For example, Botswana and Mauritius both had spurts of uninterrupted, above-average productivity performances and, by

[5]Historical data for the United States are from Dennis and İşcan (2009).
[6]The figures are 7% in 2010, down from 49% in 1970 (Timmer, De Vries, and De Vries 2014).
[7]This hump-shaped pattern in manufacturing employment shares is well-known for the developed world. The experience of Mauritius looks like the Korean one. In South Korea, manufacturing employment share increased from 13.6% in 1970 to 28.1% in 1988, and by 2010 it fell to 18.2% (Timmer, De Vries, and De Vries 2014).
[8]In countries like Ghana, Senegal and Tanzania, the levels of productivity in business services are extraordinarily large. This is due to the fact that employment is so low (relative to the value added figures) in these sectors so that they do not have major aggregate effects.

Table 2. Sectoral and aggregate labour productivity, relative to the United States (%).

Country	Agriculture	Mining	Manufacturing	Utilities	Construction	Trade	Transport	Business	Nonmarket	Whole Economy
Botswana										
1970	3.9	7.7	27.5	5.9	71.5	119.3	9.8	30.7	10.2	6.8
1990	3.9	39.9	27.4	5.7	25.9	56.6	18.0	73.1	25.0	25.1
2010	1.8	48.3	20.2	12.1	216.6	34.2	23.5	62.5	60.4	31.4
Ethiopia										
1970	2.5	2.8	3.6	12.6	23.0	12.0	12.0	39.0	6.3	1.3
1990	0.9	0.3	2.2	7.8	22.4	5.6	8.3	75.6	5.4	0.9
2010	0.5	0.2	0.6	6.5	10.8	3.0	9.6	42.5	20.7	1.8
Ghana										
1970	3.5	11.1	7.8	4.6	30.5	3.5	35.6	342.7	12.1	7.9
1990	1.5	4.3	3.5	6.8	15.6	3.1	17.0	207.6	13.6	6.3
2010	1.4	1.6	1.9	6.5	34.4	2.3	9.9	88.2	15.8	7.7
Kenya										
1970	4.5	2.7	10.9	10.7	35.4	15.5	23.6	50.6	26.6	5.4
1990	2.3	5.2	9.0	7.3	18.6	8.5	14.8	70.4	21.0	5.5
2010	1.0	0.4	1.5	6.5	12.4	2.9	5.0	44.3	12.6	3.7
Malawi										
1970	1.0	1.0	6.0	1.1	7.2	18.3	7.2	115.7	13.3	1.9
1990	0.4	1.3	4.0	1.2	10.3	10.0	6.4	89.0	16.3	2.2
2010	0.4	6.2	1.7	1.2	8.5	2.1	2.3	53.1	6.8	2.0
Mauritius										
1970	4.6	37.3	17.9	5.8	6.6	39.0	15.9	70.6	7.6	9.2
1990	10.3	28.4	10.1	13.5	10.3	40.1	16.8	32.2	19.9	13.8
2010	9.1	6.8	12.8	21.1	38.2	25.0	23.9	20.9	40.1	23.1
Nigeria										
1970	4.0	93.1	0.7	1.0	8.1	4.5	4.3	48.0	1.9	3.0
1990	1.6	138.9	1.3	0.8	12.6	6.6	3.6	77.8	4.4	4.1
2010	1.3	133.4	2.4	0.6	16.8	5.9	1.8	24.7	4.2	4.4
Senegal										
1970	8.2	5.9	25.5	12.8	8.4	37.2	46.8	390.7	24.4	9.1
1990	2.0	9.6	9.4	2.7	9.6	9.5	13.1	263.3	14.5	4.8
2010	1.2	2.8	3.0	49.3	13.8	3.9	10.7	132.5	15.9	4.6
S. Africa										
1970	8.3	6.1	55.2	15.9	13.4	44.5	40.0	102.1	32.6	25.8
1990	8.7	4.0	36.7	14.7	14.6	32.8	27.2	73.5	34.8	26.0
2010	5.3	10.0	24.9	19.9	25.7	23.5	29.3	46.4	33.5	28.1
Tanzania										
1970	2.4	3.6	18.8	4.2	30.0	33.1	19.9	103.9	9.8	2.2
1990	1.3	0.4	8.9	6.3	35.5	7.2	10.2	77.3	10.4	2.0
2010	0.9	3.6	4.7	0.9	26.3	3.9	7.9	131.9	9.2	2.5
Zambia										
1970	4.6	2.7	28.8	5.0	24.0	21.2	7.2	12.8	5.0	5.7
1990	1.7	1.7	12.0	11.5	26.0	36.2	4.7	18.9	10.0	3.9
2010	1.2	0.9	6.9	14.5	95.2	8.9	6.3	28.9	25.7	4.7
SSA										
1970	3.7	12.6	14.0	10.0	16.0	14.1	27.1	92.3	16.1	6.1
1990	1.6	14.1	10.7	8.8	16.4	12.6	17.5	79.8	18.3	6.0
2010	1.0	18.4	5.8	6.4	21.2	6.8	9.7	42.1	16.0	6.0

2010, their relative productivity levels were almost one-third and one-fourth of the US levels, respectively, compared to less than 10% four decades earlier.[9] An interesting aspect of Botswana's economy is the steady increase in the share of employment in manufacturing and market services, which defeats the symptoms of the Dutch disease.[10]

At the other end of the spectrum, Senegal, Kenya and Zambia, with a relative productivity performance considerably downgraded (by 49.3%, 31.9% and 17.7%, respectively), represent examples of tragedies in economic development. The performance of the remainder of the SSA countries does not offer any discernible pattern and, considering the wide margin

[9]In fact, the question, *How did Botswana and Mauritius managed to avoid the long and steady fall well below the frontier that features the development experience of the majority of other countries?*, has led to studies exploring the success stories of these two countries (see, e.g., Carroll and Carroll, 1997; Acemoglu, Johnson, and Robinson 2003; Frankel 2010).

[10]The Dutch disease is a process by which the boom in a natural resource sector results in shrinking nonresource tradables, making the economy prone to resource-specific shocks. Several studies have corroborated this result for Botswana (see Van Der Ploeg 2011 and the references therein).

of errors in the SSA data, it is safe to consider them as showing no noteworthy progress relative to the United States. The case of South Africa remains unique compared to other SSA countries. After a steady catching up to the level of US productivity, the shortfall in the advance of the South African economy caused the level of its productivity to fall back from a little less than one-third of the US level in 1980 to less than one-fourth in 2000. Fully one-fourth of the South African catch-up (from 25.8% in 1970 to 32.4% in 1980) over the period 1980–2000 has been lost due to the combined effects of international sanctions against apartheid and the challenging transition to a post-apartheid society (see Levy 1999; Rodrik 2008; respectively, for each of these arguments).

III. Tracing the sources of convergence

A decomposition à la Caselli and Tenreyro

We now pull together the disparate set of insights that were discussed and ask how much of the within-, reallocation- and between-effects explain the lack of convergence reported by the SSA economy. To this end, we use a decomposition of labour productivity developed by Caselli and Tenreyro (2006). The SSA productivity convergence to the United States takes the following general form:

$$\Delta \frac{y_t^{\mathrm{SSA}} - y_t^{\mathrm{US}}}{y_t^{\mathrm{US}}} = \frac{y_t^{\mathrm{SSA}} - y_t^{\mathrm{US}}}{y_t^{\mathrm{US}}} - \frac{y_{t-1}^{\mathrm{SSA}} - y_{t-1}^{\mathrm{US}}}{y_{t-1}^{\mathrm{US}}} \tag{1}$$

This measure can be decomposed into three channels as follows[11]:

$$\underbrace{\Delta \frac{y_t^{\mathrm{SSA}} - y_t^{\mathrm{US}}}{y_t^{\mathrm{US}}}}_{\substack{\text{Aggregate}\\ \text{convergence}}} = \underbrace{\sum_{j=1}^{J} \bar{a}_{j,t}^{\mathrm{SSA}} \Delta \left(\frac{y_{j,t}^{\mathrm{SSA}} - y_{j,t}^{\mathrm{US}}}{y_t^{\mathrm{US}}} \right)}_{\substack{\text{Within-sector}\\ \text{convergence}}} + \underbrace{\sum_{j=1}^{J} \overline{\left(\frac{y_{j,t}^{\mathrm{SSA}}}{y_t^{\mathrm{US}}}\right)} \Delta a_{j,t}^{\mathrm{SSA}} - \sum_{j=1}^{J} \overline{\left(\frac{y_{j,t}^{\mathrm{US}}}{y_t^{\mathrm{US}}} \right)} \Delta a_{j,t}^{\mathrm{US}}}_{\substack{\text{Labor reallocation}\\ \text{convergence}}} + \underbrace{\sum_{j=1}^{J} (\bar{a}_{j,t}^{\mathrm{SSA}} - \bar{a}_{j,t}^{\mathrm{US}}) \Delta \left(\frac{y_{j,t}^{\mathrm{US}}}{y_t^{\mathrm{US}}} \right)}_{\substack{\text{Between-sector}\\ \text{convergence}}} \tag{2}$$

where aggregate labour productivity of country $i(=\mathrm{SSA}, \mathrm{US})$ at time t constitutes a weighted sum of the $j = 1, 2, \ldots, J$ sectoral labour productivity levels, $y_t^i = \sum_{j=1}^{J} a_{j,t}^i y_{j,t}^i$, with $a_{j,t}^i$ representing the share of employment of sector j in the overall economy and the operators Δ and - are defined as: $\Delta x_{j,t} \equiv x_{j,t} - x_{j,t-1}$ and $\bar{x}_{j,t}^i \equiv \frac{x_{j,t}^i + x_{j,t-1}^i}{2}$.

The term *within-sector convergence* captures the productivity catch-up of each sector with the corresponding one in the United States weighted by the average employment share in that sector. The term *labour reallocation convergence* quantifies the part of convergence due to intersectoral labour movements weighted by the relative productivity of the sector. The term *between-sector convergence* measures the contribution to convergence of intersectoral productivity convergence (Caselli and Tenreyro 2006).

Table 3 quantifies how much of the convergence in the aggregate productivity is attributable to the within-, reallocation- and between-effects in absolute terms. The first striking observation is that the within-effect contributed in a significant way to dampening the convergence process, a result that stems from agriculture, which accounts for a large part of the workforce working inefficiently comparative to its US counterpart. Owing to this inefficient agricultural sector, reallocation does not constitute a source of growth and, if anything, contributes unfavourably to the convergence of aggregate productivity, albeit with a modest order-of-magnitude. The exceptions are represented by Botswana, Ghana, Mauritius and South Africa, where reallocation has positively contributed to the reduction in the productivity gap with the United States. In contrast, the between-effect plays a significant and favourable contribution to the aggregate convergence. This suggests a process of convergence of the productivity of the sectors where the SSA has a disproportionate share of the labour force to the productivity of the US sectors, which gets closer to that of the whole economy. The SSA countries comply with this broad pattern of between-effect outweighing those of within- or reallocation-effects.

[11]The detailed derivations are available in Caselli and Tenreyro (2006).

Table 3. Convergence decomposition, 1970–2010 (in absolute terms).

Country	Total	Within	Reallocation	Between	Country	Total	Within	Reallocation	Between
Botswana	0.25	−0.19	0.09	0.35	Nigeria	0.01	−0.38	−0.07	0.46
Ethiopia	0.01	−0.46	−0.08	0.54	Senegal	−0.05	−0.43	−0.06	0.45
Ghana	−0.002	−0.41	0.02	0.39	S. Africa	0.02	−0.14	0.07	0.09
Kenya	−0.02	−0.41	−0.06	0.45	Tanzania	0.003	−0.44	−0.07	0.52
Malawi	0.0008	−0.40	−0.07	0.47	Zambia	−0.01	−0.26	−0.12	0.36
Mauritius	0.14	−0.04	0.02	0.16	SSA	−0.001	−0.38	−0.06	0.44

1970–1990 versus 1990–2010

The period 1970–2010 blends together the period 1970–1990 of economic slump along with the subsequent revival period from 1990 to 2010. It is important to examine the shape that convergence has taken during each of these two periods to identify any discernible pattern. Again, following Caselli and Tenreyro (2006), the within-sector convergence during the s to τ period ($WSC_{s-\tau}$) is decomposed as:

$$WSC_{s-\tau} = \underbrace{\sum_{j=1}^{J} \bar{a}^{i}_{j,\tau}\, \Delta_{s'-\tau} \left(\frac{y^{i}_{j,t} - y^{US}_{j,t}}{y^{US}_{t}} \right)}_{WSC_{s'-\tau}} + \underbrace{\sum_{j=1}^{J} \bar{a}^{i}_{j,\tau}\, \Delta_{s-s'} \left(\frac{y^{i}_{j,t} - y^{US}_{j,t}}{y^{US}_{t}} \right)}_{WSC_{s-s'}},$$

where $\bar{a}^{i}_{j,\tau} \equiv \frac{a^{i}_{j,\tau} + a^{i}_{j,s}}{2}$. Here $s = 1970$, $s' = 1990$, and $\tau = 2010$. Then, labour reallocation convergence during s to τ ($LRC_{s-\tau}$) is decomposed as:

$$LRC_{s-\tau} = \underbrace{\sum_{j=1}^{J} \overline{\left(\frac{y^{i}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} \right)} \Delta_{s'-\tau} a^{i}_{j,\tau} - \sum_{j=1}^{J} \overline{\left(\frac{y^{\mathrm{US}}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} \right)} \Delta_{s'-\tau} a^{\mathrm{US}}_{j,\tau}}_{LRC_{s'-\tau}} + \underbrace{\sum_{j=1}^{J} \overline{\left(\frac{y^{i}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} \right)} \Delta_{s-s'} a^{i}_{j,s'} - \sum_{j=1}^{J} \overline{\left(\frac{y^{\mathrm{US}}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} \right)} \Delta_{s-s'} a^{\mathrm{US}}_{j,s'}}_{LRC_{s-s'}}$$

where $\overline{\left(\frac{y^{i}_{j,\tau}}{y^{\mathrm{US}}_{\tau}}\right)} \equiv \frac{1}{2}\left(\frac{y^{i}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} + \frac{y^{i}_{j,s}}{y^{\mathrm{US}}_{s}}\right)$. Finally, between-sector convergence during s and τ ($BSC_{s-\tau}$) is decomposed as:

$$BSC_{s-\tau} = \underbrace{\sum_{j=1}^{J} (\bar{a}^{i}_{j,\tau} - \bar{a}^{\mathrm{US}}_{j,\tau}) \Delta_{s'-\tau} \left(\frac{y^{\mathrm{US}}_{j,\tau}}{y^{\mathrm{US}}_{\tau}} \right)}_{BSC_{s'-\tau}} + \underbrace{\sum_{j=1}^{J} (\bar{a}^{i}_{j,\tau} - \bar{a}^{\mathrm{US}}_{j,\tau}) \Delta_{s-s'} \left(\frac{y^{\mathrm{US}}_{j,s'}}{y^{\mathrm{US}}_{s'}} \right)}_{BSC_{s-s'}}.$$

Table 4. Sources of convergence by sub-period (in absolute terms).

Country	1970–2010	1970–1990	1990–2010	Country	1970–2010	1970–1990	1990–2010
Panel A. Contribution of each sub-period to within-sector convergence							
Botswana	−0.19	−0.02	−0.17	Nigeria	−0.38	−0.10	−0.28
Ethiopia	−0.46	−0.14	−0.31	Senegal	−0.43	−0.17	−0.27
Ghana	−0.41	−0.15	−0.26	S. Africa	−0.14	−0.01	−0.13
Kenya	−0.41	−0.12	−0.29	Tanzania	−0.44	−0.14	−0.30
Malawi	−0.40	−0.12	−0.28	Zambia	−0.26	−0.04	−0.21
Mauritius	−0.04	−0.0002	−0.04	SSA	−0.38	−0.10	−0.27
Panel B. Contribution of each sub-period to labour reallocation convergence							
Botswana	0.09	0.19	−0.10	Nigeria	−0.07	−0.07	−0.01
Ethiopia	−0.08	−0.07	−0.01	Senegal	−0.06	−0.06	−0.001
Ghana	0.02	−0.05	0.07	S. Africa	0.07	−0.003	0.07
Kenya	−0.06	−0.06	−0.003	Tanzania	−0.07	−0.06	−0.01
Malawi	−0.07	−0.06	−0.01	Zambia	−0.12	−0.09	−0.03
Mauritius	0.02	−0.04	0.06	SSA	−0.06	−0.06	0.003
Panel C. Contribution of each sub-period to between-sector convergence							
Botswana	0.35	0.15	0.19	Nigeria	0.46	0.22	0.25
Ethiopia	0.54	0.25	0.30	Senegal	0.45	0.21	0.23
Ghana	0.39	0.18	0.21	S. Africa	0.09	0.01	0.08
Kenya	0.45	0.21	0.24	Tanzania	0.52	0.24	0.28
Malawi	0.47	0.22	0.25	Zambia	0.36	0.16	0.21
Mauritius	0.16	0.09	0.07	SSA	0.44	0.20	0.24

The results reported in the three panels of Table 4 refer to each of the sources underlying labour productivity convergence. Panel A in Table 4 shows the within-sector convergence for the whole period of 1970–2010 and the two sub-periods 1970–1990 and 1990–2010. The story about the importance of the within-effect discussed above remains unaltered. If anything, it appears that much of the significant negative within-effect observed during the period 1970–2010 in the SSA resulted from the period 1990–2010 (–27 percentage points), which was more than twice the order of magnitude reported during the period 1970–1990 (–10 percentage points) in the SSA. This suggests that the gap ascribed to the combined capital-deepening and total factor productivity has worsened during the period 1990–2010, a result that stems partly from a wide range of sectors except mining and construction, which account for a mere 3% of the economy in 2010. In addition to mining and construction, nonmarket services had positive within-sector effects for the SSA.

The contribution of the reallocation of labour to convergence displayed in Panel B reveals a

turnaround in the period 1990–2010, when this effect made a mild positive contribution (+0.3 percentage points), which contrasts with the moderately high negative contribution in the earlier period (–6 percentage points) in the SSA. While the SSA economies reported progress in the contribution of the reallocation effect, for some of them, the negative contribution of this effect dropped (e.g., Ethiopia, Malawi, Nigeria, Tanzania and Zambia) while, for others like Mauritius, Ghana and South Africa, the turnaround was quite substantial (almost +10 percentage points on average). Botswana was the only exception as the reallocation-effect contributed negatively to the convergence during the period 1990–2010 after a major positive contribution in the earlier period. This is due to the contribution of the construction sector in Botswana, which experienced a major boom during the period 1970–1990, following a major increase in urbanization (Green 2014).

Panel C completes the picture with the contribution of the between-sector, which further accelerated its contribution to the convergence during the period 1990–2010 (except for Mauritius). Business services and nonmarket services had positive between-effects in convergence due to the fact that these two sectors' productivity levels in the United States relative to the US aggregate productivity have been diminishing since 1970, and these two sectors' employment shares are higher in the United States in comparison with the SSA economy.

A counterfactual exercise

We follow McMillan, Rodrik, and Verduzco-Gallo (2014) and consider the following thought experiment. We assume that sectoral productivity levels in each SSA country remain unchanged while sectoral employment shares remain equal to those of the United States at each point in time between 1970 and 2010, i.e., $a^i_{j,t} = a^{US}_{j,t}$. This experiment may look unrealistic, since it assumes that the changes in sectoral employment shares are independent of sectoral productivity changes, which the literature on the structural transformation has proven otherwise (see Duarte and Restuccia 2010). Nevertheless, we think that this experiment can provide useful information for understanding the SSA experience and gaining additional insights to the results reported in section '1970–1990 versus 1990–2010'.

Table 5 provides an answer to the following question: what would the effect on aggregate labour be if the SSA economies would have had the same labour allocation as the United States? A comparison of Tables 2 and 5 shows that relative aggregate productivity would be higher for each SSA country: i.e., aggregate labour productivity in Ethiopia would be 21.6% in 2010, relative to the United States, instead of 1.8%. Poor countries like Ethiopia, Tanzania and Zambia report the highest benefits in terms of a faster catch-up. As emphasized before, agricultural employment shares are highest in these countries, and there would have been significant gains if the employment share in agriculture was less than 2% in 2010 instead of more than 70%.

Table 6 shows the quantitative magnitudes of the three sources of convergence between 1970 and 2010 under this counterfactual scenario. The between-sector convergence channel is turned off since $\bar{a}^i_{j,t} = \bar{a}^{US}_{j,t}$. Under this experiment, Mauritius is no

Table 5. Experiment: aggregate labour productivity, relative to the United States (%).

Country	1970	1980	1990	2000	2010	Country	1970	1980	1990	2000	2010
Botswana	33.5	61.0	43.2	43.6	54.0	Nigeria	17.6	40.5	30.6	20.7	14.4
Ethiopia	16.1	23.2	27.5	24.2	21.6	Senegal	110.5	97.5	88.0	72.0	53.3
Ghana	91.4	113.4	69.9	48.8	37.3	S. Africa	49.6	58.0	43.4	33.1	34.0
Kenya	28.5	30.2	31.8	18.0	20.1	Tanzania	37.3	31.7	31.4	40.2	51.1
Malawi	35.4	38.8	34.4	20.9	21.4	Zambia	13.1	16.4	16.7	18.1	22.4
Mauritius	28.2	26.9	24.1	27.5	25.7	SSA	33.7	42.0	34.8	26.3	22.2

Table 6. Experiment: convergence decomposition, 1970–2010 (in absolute terms).

Country	Total	Within	Reallocation	Between	Country	Total	Within	Reallocation	Between
Botswana	0.21	0.22	−0.02	0.00	Nigeria	−0.03	0.001	−0.033	0.00
Ethiopia	0.06	0.07	−0.01	0.00	Senegal	−0.57	−1.03	0.46	0.00
Ghana	−0.54	−0.91	0.37	0.00	S. Africa	−0.15	−0.19	0.03	0.00
Kenya	−0.08	−0.09	0.004	0.00	Tanzania	0.14	0.01	0.13	0.00
Malawi	−0.14	−0.22	0.08	0.00	Zambia	0.09	0.16	−0.07	0.00
Mauritius	−0.02	−0.02	−0.01	0.00	SSA	−0.12	−0.16	0.04	0.00

longer a success story. One reason for this result is that, under the counterfactual scenario, employment shares in the business services would be higher compared to the actual situation (i.e., 18.1% instead of 9.5% in 2010), and this sector's productivity has been declining in Mauritius (with an average annual growth rate of close to 3% between 1970 and 2010). Botswana has almost maintained its position, which is already enviable. It is important to contrast our results with those of the thought experiment performed by McMillan, Rodrik, and Verduzco-Gallo (2014). Differences with respect to the formula and sample of countries considered make any comparison, other than a qualitative one, virtually impossible. Nonetheless, a common finding between their study and ours is that the gains are larger, especially for the poor countries.

IV. Conclusions

The SSA economy was only 6% as efficient as the US economy in 2010, unchanged from 1990 and even 1970. The recent growth spurt did not contribute in any way to get the SSA economy closer to the US frontier. The absence of sectoral convergence is a broad-based phenomenon for the SSA economy. Convergence occurred in mining and construction (which maintains close ties with mining), a result driven from economies with major endowments in terms of natural resources, such as Botswana, Nigeria and South Africa. However, the share of these sectors is rather modest, implying that their productivity-enhancing aspect has a rather modest aggregate scope. A fundamental implication of this development is that the revival of the SSA economy results from a tide that propelled the commodity markets and not from a genuine process of structural transformation. Manufacturing which, in any typical process of structural transformation represents a major engine of growth, has seen its relative productivity steadily decline in most of the SSA regions.

All in all, the absence of convergence of the SSA economy to the US level results from a productivity-reducing within-effect reinforced by a milder reallocation-effect in the period 1970–1990. The subsequent period has seen a further reinforcement of the growth-reducing feature of the within-effect. The between-effect has shown a robust and increasing favourable change that mitigated the negative within- and reallocation-effects. The favourable between-effect is more a result of a slowdown of the productivity of business services and nonmarket services relative to the productivity of the whole US economy rather than fundamentals peculiar to the SSA economy. From this decomposition, it becomes clear that SSA is facing strong, and possibly long-lasting, headwinds contrasted by favourable, yet circumstantial, tailwinds. These headwinds, represented by capital-deepening effects and technical change, are the hardest to bridge and, in some sense, are not really good news for the outlook of the SSA economic performance.

Disclosure statement

No potential conflict of interest was reported by the authors.

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