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Trade Integration and Growth

Evidence from Sub-Saharan Africa

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Abstract

This paper examines the growth effects of different dimensions of international trade integration—notably, volume, diversification, and natural resource dependence—in Sub-Saharan Africa. First, the paper documents the recent trends in these foreign trade dimensions for the region and the traditional sources of growth. Second, it empirically estimates the impact of trade integration on growth per worker and the sources of growth; that is, growth of capital per worker and total factor productivity growth. To accomplish this task, the analysis uses a sample of non-overlapping five-year period observations for 173 countries from 1975 to 2014. The econometric evidence shows that increased trade openness, greater export production diversification, and reduced export dependence from natural resources will have a positive causal impact on economic growth. These effects will be mainly transmitted through faster capital accumulation or enhanced total factor productivity growth. Finally, the paper finds that, despite the progress exhibited in trade openness and diversification over the past decade, there are still potential benefits that can be accrued if countries were to deepen their integration to world trade.

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Trade Integration and Growth: Evidence from Sub-Saharan Africa

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1 Introduction

Over the past two decades, Sub-Saharan Africa (SSA) experienced a period of unprecedented economic activity growth in many countries of the region at a rate that exceeded 5 percent per annum. Annual average GDP growth for the region was 4.8 percent during the period 1996-2014. This period, labeled as *Africa Rising*, saw broad-based growth that benefitted all countries, regardless of their level of natural resource availability and even to some that lack it. The early narrative of *Africa Rising* attributed the region's faster growth to external tailwinds, progress in macroeconomic management and robust public investment. A favorable external environment characterized by high commodity prices, the emergence of China as an important trade and investment partner, and massive inflow of foreign capital, helped boost growth in the region. On the domestic front, improved macroeconomic frameworks delivered lower inflation and enabled economies to accommodate shocks (thanks partly to healthy fiscal and external positions). Moreover, growth was supported by a buoyant domestic demand as investment increased in both resource-intensive sectors (e.g. extractive industries) and non-resource sectors (e.g. telecommunications, finance, transportation, real estate and retail, among others).[1]

Historically, the growth path of African countries had been characterized by boom-bust cycles in economic activity triggered by sharp movements in the terms of trade, patterns of abundance and scarcity in foreign financing, and inadequate yet serendipitous beneficial macroeconomic management. The concentrated economic structure, pro-cyclical access to external borrowing, and the lack of policy space has typically left these countries not only vulnerable to sudden external disturbances but also unable to implement much needed countervailing policies.[2]

The acceleration of growth per capita in Sub-Saharan Africa over the past two decades has elicited questions about the strength and durability of economic growth in Sub-Saharan Africa in the event of external headwinds. How well prepared are regional policy makers to manage downside risks to growth? In this context, outward-oriented economic policies may help the region have access to larger markets and share risks internationally through trade in goods and services. Global trade trends affecting the macroeconomic scene have widened the set of shocks faced by economic agents and increased the degree of interconnectedness across countries. In fact, leveraging to the world economy through trade integration has deepened over the last three decades. World trade has grown almost twice as fast as world output thanks to countries' efforts to liberalize trade unilaterally and countries signing free trade and regional integration agreements.

Policies that foster international trade integration create growth opportunities, but they also entail risks. If inappropriately managed, opening the economy could expose the country to lower growth, and increase instability and inequality. Trade integration, under certain conditions, can lead to underutilized physical and human capital and, hence,

[1] See Calderón and Boreux (2016).
[2] See, for instance, Lledó, Yackovlev, and Gadenne (2011) and Calderon, Chuhan-Pole, and Lopez Monti (2017) for evidence on the procyclical bias of fiscal policy in Sub-Saharan Africa.

affect growth negatively. Market and institutional imperfections, concentration in extractive activities and specializing away from technologically advanced sectors can curtail the gains from trade (Chang et al. 2009). For instance, commodity exporters and countries with uninsured production risk are more unstable in the event of adverse terms of trade shocks (Malik and Temple 2009). In contrast, if trade integration is properly managed (i.e. greater outward orientation through linkages with more diverse partners and more diverse export products), it becomes a tool to share risks that emerge from international macroeconomic shocks, it facilitates the diffusion of technology and managerial practices, and it liberalizes the trade account to reduce anti-competitive practices of domestic firms, which raises the availability and quality of services provided by the domestic financial system.

This paper tests whether different aspects of international trade integration foster growth. One of the novel aspects of this paper is that we jointly test the growth effects of three different dimensions for trade integration: (a) the extent of trade openness —i.e. the amount of goods and services exchanged with other countries, (b) the degree of trade diversification (as captured by the Herfindahl index of exports) across markets and products, and (c) the importance of natural resources in the export basket. Our empirical analysis highlights the impact of an integral outward-oriented strategy for African countries grouped as resource rich (both oil and metal based) and non-resource rich. Besides estimating the growth effects from outwards-oriented strategies, we also assess the impact on the sources of growth; specifically, capital deepening and total factor productivity (TFP) growth. Ultimately, the regression estimates from growth and its sources are used to calculate: (a) potential growth gains of narrowing the gap on trade integration relative to selected regional benchmarks, and (b) within region growth gains from international trade integration over time.

According to the literature, trade may affect growth and productivity through five channels (Lederman 1996). First, if countries engage on trade, they can take full potential of their comparative advantages. In time, they lead to specialization and gains in Total Factor Productivity (TFP). Second, trade boosts the expansion of potential markets. With these in place, economies of scale can start at the firm level and increase productivity. Third, the back-and-forth interaction with foreign companies provides technological improvements and better managerial practices. Fourth, domestic firms diminish anti-competitive practices due to free trade. Finally, trade reduces the market's rent-seeking unproductive activities.

However, a few empirical studies explaining the effects of trade on growth have found contradictory results. Some discuss causal effects (Frankel & Romer 1999; Sachs & Warner 1999). Others argued that the effect of trade is influenced by incorrectly proxied variables (Rodriguez and Rodrik 2000). Moreover, institutional or policy outcomes could also have an impact on trade (Sachs and Warner 1995; Frankel and Romer 1999; Easterly, Islam and Stiglitz 2001). Besides the trade openness indicator, there are also aspects of international trade to consider, such as the level of diversification across markets and products, and the reliance on commodities in the export basket.

Countries with greater reliance on natural resource exports tend to display relatively low income per capita. There are, however, notable exceptions. For instance, Botswana has used revenues from diamond exports to invest in education and growth (Acemoglu, Johnson and Robinson 2003). Growth performance of countries with large natural resource exports is worse than that of countries without natural resources (Sachs and Warner 1995 1997; Sachs and Vial 2001). Natural resource dependence generally hinders growth, especially in countries with weak institutions (Mehlum, Moene and Torvik 2005). This negative relationship between natural resources and growth is at the heart of the "natural resource curse" hypothesis.[3]

Natural resource abundance poses several challenges in commodity-rich countries. For instance, it narrows the production base of the country —as non-resource sectors shrink due to competitiveness losses (i.e. Dutch Disease). It renders greater macroeconomic and financial volatility. It incentivizes rent-seeking activities that undermine governance and hinder the ability to build robust and growth-enabling institutions (Arezki et al. 2012). Addressing these challenges may help turn the resource curse into a blessing. In this context, commodity revenues can be used to build a physical and social infrastructure that might increase economic returns and encourage private investments in non-resource-based activities. For instance, Malaysia managed to defy Dutch disease and became a manufacturing hub through a combination of export-led growth, significant public infrastructure investment and import-substitution policies. The Government of Malaysia played an active role promoting diversification by supporting nascent manufacturing industries and aggressively sought foreign direct investment (FDI). Additionally, Malaysia became an oil exporter relatively late — the private sector was already strong in non-resource sectors prior to oil production and it maintained its dynamism even during the oil period (Ross 2017).

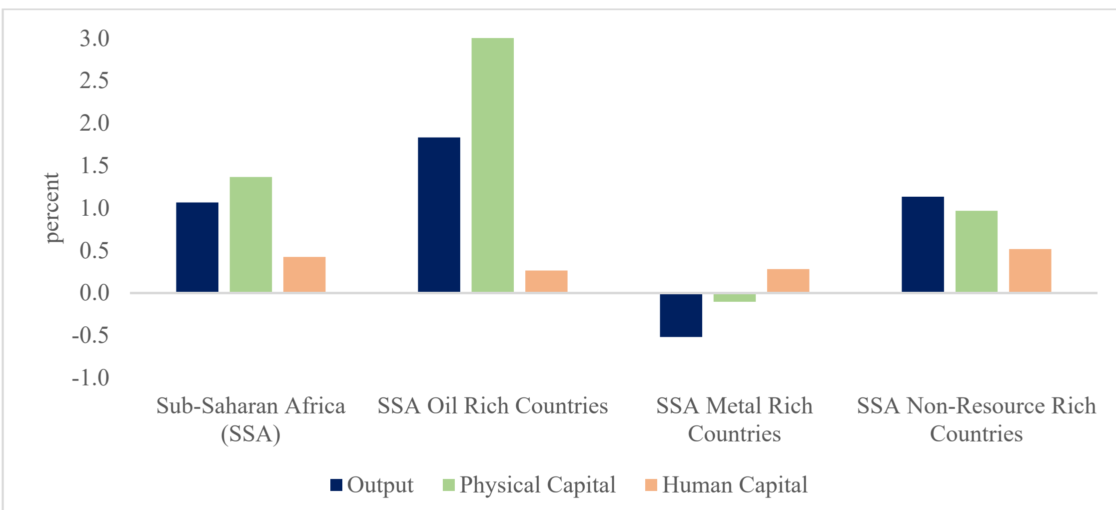
This paper is organized in five sections. In *Section 2* we describe the main stylized facts and the sources of growth for Sub-Saharan countries by groups for the 1961-2014 period. Inclusively, we compare their performance vis-à-vis to the whole region and inter-regional country groups classified according to their extent of natural resource abundance. In addition, the section conducts a Solow decomposition that accounts for the role of capital accumulation (physical and human) and the role of natural capital. *Section 3* describes the international trends on trade integration. *Section 4* presents the regression estimates of international trade integration on growth of real output per worker and sources of growth (i.e. capital per worker and total factor productivity growth) using the GMM-IV system estimation technique (Arellano and Bover 1995; Blundell and Bond 1998; Roodman 2009). The estimation results are then used to conduct an analysis to assess the impact of closing the trade gap with other selected regions (in trade openness, diversification and natural resources) on growth per worker and its sources, as well as their own evolution over time. *Section 5* provides some concluding remarks.

[3] It has been early documented that resource booms led to an expansion of consumption instead of greater investment (Hirschmann 1958).

2 Economic Growth in Sub-Saharan Africa

This section investigates the economic performance of Sub-Saharan Africa and its sources of growth during the period 1961-2014. Specifically, it reviews if economic growth in the region was driven by the accumulation of (human and physical) capital or by growth in total factor productivity (TFP). Before assessing the sources of growth, Figure 1 shows the annual average rate of growth of GDP per worker, physical capital per worker, and a human capital index for Sub-Saharan Africa as well as groups of countries in the region classified by their extent of natural resource abundance. Over the period 1961-2014, the average annual growth rate for Sub-Saharan Africa on physical capital was 1.37 percent, while that of human capital was 0.42 percent. Physical capital accumulates at a faster pace not only for the region as whole but also among all other country groups; namely, oil-rich countries (SSA-oil), metal-rich countries (SSA-metal) and non-resource rich countries (SSA-nrr). We should also point out that metal-rich countries in the region exhibit a small growth in human capital despite the fact that output and physical capital per worker contracts over the past half century. Oil rich countries in Sub-Saharan Africa, on the other hand, exhibit the largest growth rate of physical capital per worker (annual average rate of 3.31 percent), which is three times as fast as that of non-resource rich countries (0.97 percent).

Figure 1. Growth per worker of output, physical and human capital, 1961-2014

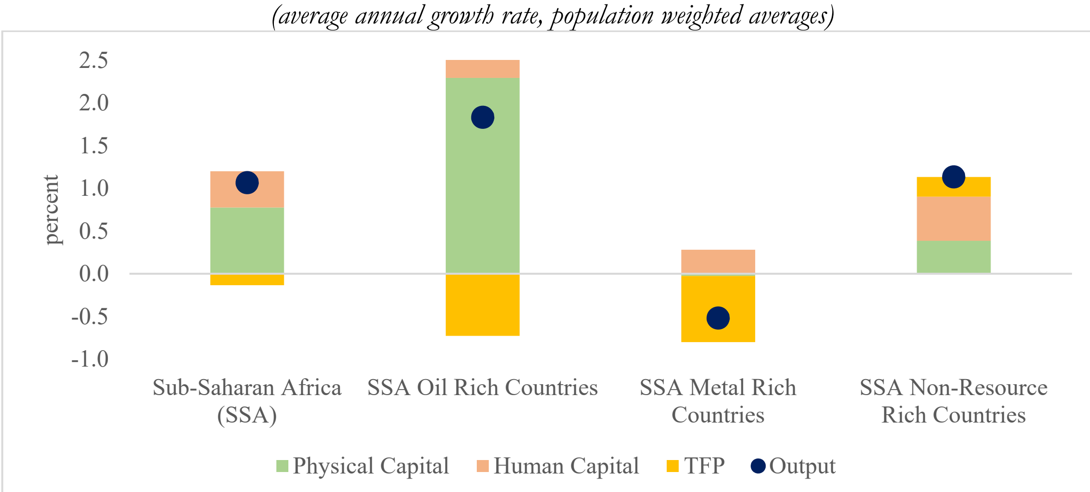


Notes: Averages are population weighted averages. The human capital index $H = exp(\phi(s_{it}))$ *is characterized by the relationship between human capital (H) and the years of schooling (s) as* $\phi(s_{it}) = \phi_i \cdot s_{it}$ *for each country i in period t —where the returns to education (*ϕ_i*) are heterogeneous across countries. The returns to education are measured from the estimation of Mincerian wage regressions on schooling. We use the Mincerian returns estimated by Montenegro and Patrinos (2014) and the total years of schooling for each country and year to construct the human capital index H. Source: Penn World Tables 9.0 (Feenstra, Inklaar and Timmer 2015).*

Figure 2 plots the sources of growth for the Sub-Saharan Africa region as well as the different groups according to the extent of natural resource abundance —that is, oil rich, minerals and metals rich, and non-resource rich countries during the period 1961-2014. The average annual growth rate of output per worker in the region (1.1 percent) is overwhelmingly explained by the accumulation of physical capital (which contributes with 0.8 percent) and followed by human capital (0.4 percent). The contribution of TFP growth to long-term growth in the region is negligible. Across the different country groups in the region, oil rich countries registered the largest rate of growth per worker (1.8 percent per year) and it was vastly attributed to the growth of the ratio of physical capital per worker (2.3 percent per year) and the contribution of TFP growth is negative. The latter result points to inefficiencies in the allocation of resources among oil rich countries. Countries in the region with abundant minerals and metals, in contrast, registered a contraction in output per worker during the period 1961-2014 (-0.5 percent per year). The contribution of physical capital accumulation is negligible for this group of countries while that of TFP growth is detrimental. Finally, non-resource rich countries in Sub-Saharan Africa registered a rate of per worker growth that is in line with the regional average (1.1 percent per year). However, the relative importance of the sources of growth is different from that of the region. Human capital and physical capital accumulation contribute to growth per capita with 0.5 and 0.4 percent per year, respectively. In contrast to the other group of countries in the region, the contribution of TFP growth among non-resource rich countries is positive (0.2 percent per year).

Figure 2. Source of Growth in Sub-Saharan Africa, 1961-2014

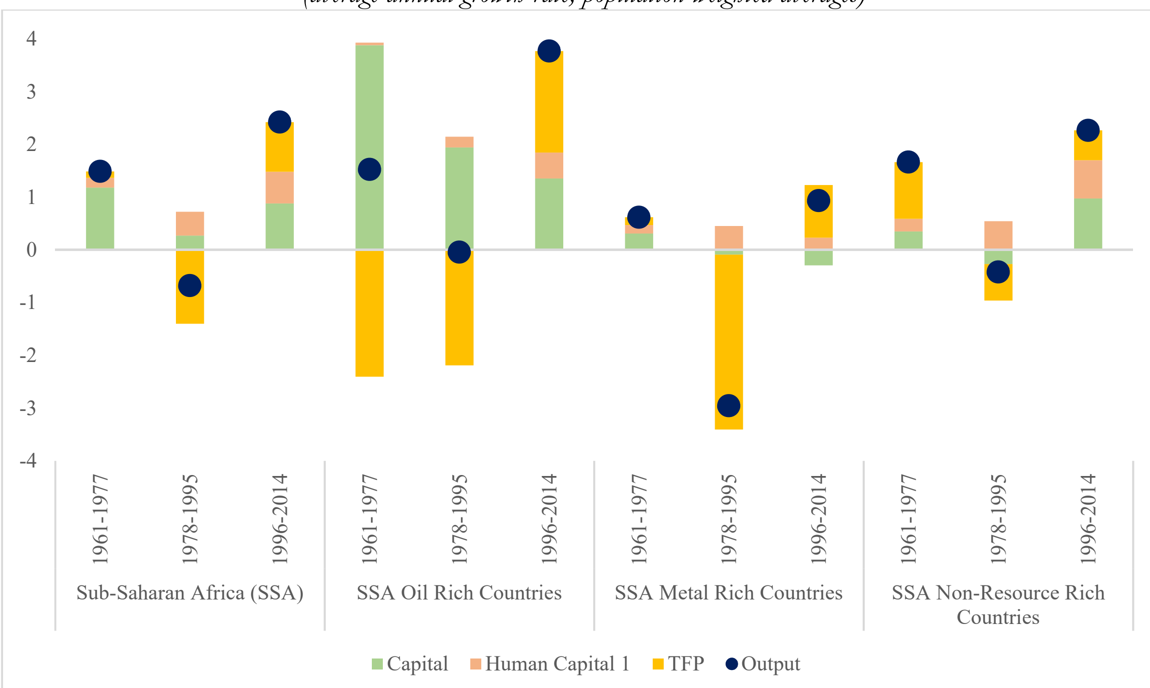
(average annual growth rate, population weighted averages)



Notes: Regional and sub-regional averages presented in this figure are population weighted averages. The human capital index $H = exp(\phi(s_{it}))$ *is characterized by the relationship between human capital (H) and the years of schooling (s) as* $\phi(s_{it}) = \phi_i \cdot s_{it}$ *for each country i in period t — where the returns to education* (ϕ_i) *are heterogeneous across countries. The returns to education are measured from the estimation of Mincerian wage regressions on schooling. We use the Mincerian returns estimated by Montenegro and Patrinos (2014) and the total years of schooling for each country and year to construct the human capital index H. Source: Penn World Tables 9.0 (Feenstra, Inklaar and Timmer 2015).*

Figure 2 displays the long-run average growth rate of output per capita as well as its sources (physical capital, human capita, and TFP) over the past half-century. However, it does not capture whether the contribution of the factors of production vis-à-vis TFP growth remained constant over time. The proneness to shocks affecting growth in the region over the medium-term justifies assessing the sources of growth in the region across different time periods; namely, 1961-1977, 1978 – 1995, and 1996-2014, respectively. Figure 3 depicts the dismal performance of the region (as well as that of resource and non-resource rich countries) during the period 1978-85, where not only growth per worker was negative but also the contribution of TFP was largely negative. The annual average growth rate of output per worker was -0.7 percent in the period 1978-95 while physical and human capital contributed to an increase in growth per worker of 0.3 and 0.4 percent per year, respectively. These numbers imply that these additional resources were combined inefficiently with the existing technology. In contrast, growth per worker in the region (as well as all country groups) accelerates during the period 1996-2014. The annual average growth rate of output per worker jumped from -0.7 percent in 1978-95 to 2.4 percent in 1996-2014. Factor accumulation contributes to growth per capita with 1.5 percent per year (0.9 percent by physical capital and 0.6 percent by human capital). In contrast to the other two periods, the contribution of TFP growth is economically significant (0.9 percent per year).

Figure 3. Source of Growth, 1961-2014: By sub-periods
(average annual growth rate, population weighted averages)



Note: The human capital index H is characterized by the relationship between h and s as $\phi(s_{it}) = \phi_i \cdot s_{it}$ for each country i in period t —where the returns to education are heterogeneous across countries. The second set of Mincerian returns are those estimated by Montenegro and Patrinos (2014). Source: The data has been collected from PWT 9.0 (Feenstra, Inklaar and Timmer 2015).

The swing in the growth rate per capita of the region over the three different periods is also observed across all country groups, and these fluctuations tend to be sharper among resource rich countries. Growth per worker of oil rich countries decelerates from 1.5 percent per year in 1960-77 to -0.1 percent per year in 1978-96. In both periods, physical capital accumulation contributes positively to growth per worker while TFP growth plays a detrimental role in the growth of labor productivity. Growth per worker then accelerated to an annual average rate of 3.8 percent in 1996-2014. Factor accumulation explained half of the growth per worker achieved during this period (1.4 percent attributed to physical capital accumulation and 0.5 percent to human capital) while the remainder was attributed to TFP growth.

In the case of countries that are abundant in metals and minerals, growth per worker was cut from an average annual rate of 0.6 percent in 1961-77 to -3 percent in 1978-96. The plunge in output per capita was driven not only by a reduced contribution of physical capital but also a sharp drop in TFP growth. During the period 1996-2014, growth per worker accelerated to 0.9 per year —with human capital and TFP growth contributing to this increase in the growth of labor productivity.[4] Finally, the growth rate of output per worker among non-resource rich countries contracted 0.4 percent per year during the 1978-95 period (down from 1.7 percent per year in 1960-77). Both physical capital and TFP growth contributed negatively to the deceleration in the growth rate of output per worker. During the period 1996-2014, growth per worker recovered to 2.3 percent per year for this group. About three-quarters of the observed growth per worker was attributed to the accumulation of physical capital and human capital (1 and 0.7 percent per year, respectively) while the remainder was explained by TFP growth (0.6 percent per year).

Considering that an important number of countries in the region are rich in natural resources, it is only logical to ask what the contribution of that factor of production to the sources of growth is. Figure 4 reports the growth decomposition during the period 1996 – 2014 that incorporates the stock of natural resource wealth as an additional input —specifically, another type of capital good. Recent methodological developments have allowed us to include natural capital in the measurement of TFP —which is particularly relevant for natural resource rich countries in the region. Growth accounting methodologies include natural resources as an additional factor of production (e.g. Brandt, Schreyer and Zipperer 2017, Monge-Naranjo, Sánchez, and Santaeulalia-Llopis 2017). Additionally, there is greater coverage and quality of the data on natural resources —especially, the value of the natural wealth associated to energy commodities (coal, petroleum, and natural gas), mineral ores and metals (Lange et al. 2018).

The data on the stock of natural capital in extractive industries (petroleum, natural gas, coal, minerals and metals) are available only for the period 1996-2014. Additionally, the inclusion of natural capital in the growth decomposition restricts the country coverage in Sub-Saharan Africa from 44 (Figure 3) to 37 (Figure 4) countries. However, the excluded countries are not representative in size relative to the entire group: the seven Sub-Saharan African countries without data on natural resource wealth amount to less than 0.5 percent of the region's population.

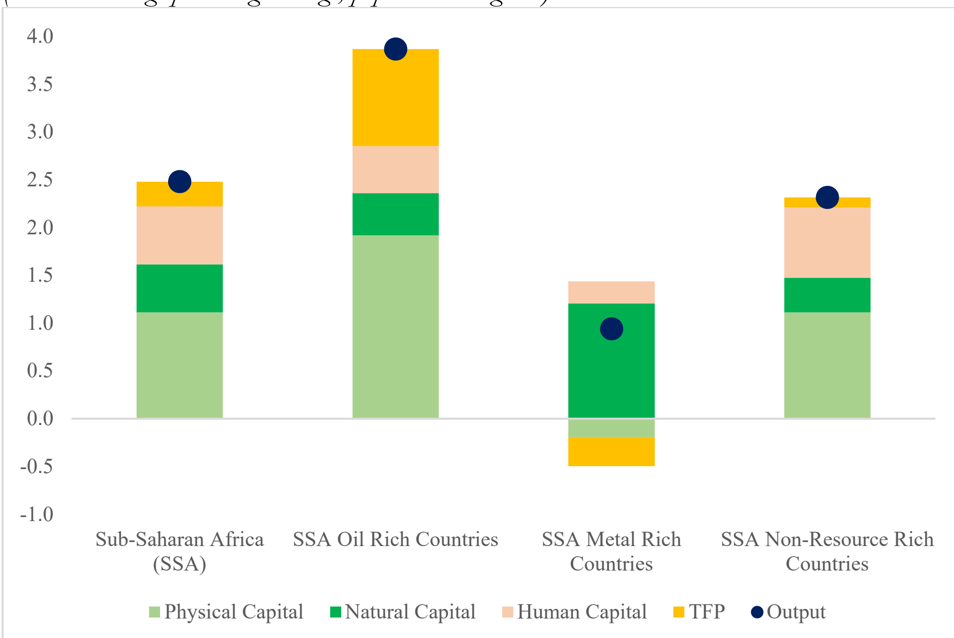
The decomposition of growth in real output per worker into physical capital, natural capital, human capital, and TFP growth is depicted in Figure 4. Natural capital is defined in this paper as the value of the capital associated to energy (petroleum, natural gas, hard and soft coal) and mineral resources. The data are collected from Lange et al. (2018). The accumulation of physical and human capital explains 70 percent of the observed growth per worker observed in Sub-Saharan Africa in the period 1996-2014 (1.1 and 0.6 percent per year, respectively) whereas natural capital explains about 20 percent (0.5 percent per year). Finally, TFP growth contributes with 10 percent of the observed growth per

[4] Two observations emerge from the analysis of Figure 3: (a) international commodity prices appear to be connected to the growth and productivity fortunes and misfortunes of both groups of resource rich countries. (b) We have to take the TFP growth calculations with caution as omitted variables (e.g. natural resource wealth for resource rich countries) may misrepresent the contribution of TFP to growth per worker.

worker in the region as a whole (0.3 percent per year). We argue that the contribution of natural capital is important in countries of the region that are abundant in energy commodities (for instance, Chad, Republic of Congo, Gabon, and Nigeria) and metals and mineral ores (say, Botswana, Democratic Republic of Congo, and Zambia).

Figure 4 Source of growth in Sub-Saharan Africa, 1996-2014: The role of natural resource wealth

(Annual average percentage change, population-weighted)



Source: The data has been collected from PWT 9.0 (Feenstra, Inklaar and Timmer 2015).

Figure 4 plots the growth decomposition that includes the role of natural capital for different country groups in the region. The contribution of natural capital, as expected, is greater among resource rich countries than among non-resource rich countries. During the period 1996-2014, oil rich countries grew at an annual average rate of 3.9 percent and natural capital explains about 10 percent of the observed growth (contributing with 0.4 percent per year). The contribution of natural capital to output per worker growth is significantly larger among countries in the region that are abundant in minerals and metals (with a contribution of about 1.2 percent per year). However, the contribution of TFP growth for this group becomes detrimental, thus indicating inefficiencies in the use of inputs. In sum, Figure 4 shows that if we do not account for the role of natural resources in the production function, the contribution of TFP to economic growth in resource abundant countries/regions might be over-estimated.

We have argued that total factor productivity (TFP) can be misstated if we do not account for the role of natural resources in the economy. The comparison of growth accounting exercises with and without natural capital as another input of production is depicted in Figure 5 —while holding constant the sample of countries remains constant across the different methodologies. This figure presents the contribution of a *composite* capital good that includes physical and natural capital: (i) it represents only the contribution of the physical capital stock from PWT 9.0 in the conventional decomposition, and (ii) it shows the contribution of the physical capital stock (from PWT 9.0) and natural capital (Lange et al. 2018) in the natural resource decomposition. The average annual rate of growth in output per worker for the common sample of 37 countries in Sub-Saharan African during the period 1996-2014 is approximately 2.4 percent.

Figure 5 reports the comparison of the growth decomposition across the different groups within the region when we exclude and include natural capital. The first column of each group shows the contribution of capital, and the second measures a composite value for capital, that includes both physical and natural capital. The second column for each group in figure 5, depicts the growth decomposition that includes accounting for natural capital in the physical capital share, named "composite capital". Both columns in each group include human capital, and TFP. The first column for Sub-Saharan Africa (traditional decomposition) shows that physical capital explains 36 percent of the observed growth in output per worker (0.88 percent per year) whereas that of TFP accounts for 39 percent (0.95 percent per year). The second column, on the other hand, shows that the composite stock of capital, which includes both physical and natural capital, contributes with 1.6 percent per year (about 65 percent of the observed growth per worker) while TFP grows at an annual rate of 0.25 percent (thus, explaining only 10 percent of growth per worker).

Figure 5. Contribution of TFP to output per worker growth in SSA, 1996-2014

(Annual average percentage change, population-weighted)

Source: The data has been collected from PWT 9.0 (Feenstra, Inklaar and Timmer 2015).

The estimation of the contribution of TFP to growth per worker is reduced sharply with the inclusion of natural capital among countries that are abundant in oil and rich in minerals and metals (Figure 5). For instance, TFP grows at an average annual rate of 1.9 percent per year among oil rich countries using the traditional decomposition, and this contribution is reduced to 1 percent per year when including natural capital as an additional input. In the case of countries abundant in minerals and metals, the contribution of TFP growth (1 percent per year) using the traditional method is wiped out when accounting for natural capital in the production function. In fact, its contribution becomes detrimental —as the TFP contracts at an annual rate of 0.3 percent. In sum, the contribution of physical and natural capital dominates the growth narrative of resource rich countries once we include natural capital in the production function.

3 Trade Integration in Sub-Saharan Africa

This section examines the evolution of international trade integration in Sub-Saharan Africa by calculating the volume and the patterns of trade of Sub-Saharan Africa as well as the role of natural resources in their foreign trade baskets. Specifically, it examines three different dimensions of international trade integration: (a) the volume of trade (as percentage of GDP), (b) trade diversification (as proxied by indices of product and market concentration), and (c) the importance of natural resources in the export sector (where natural resource exports are normalized by either the country's GDP or its total amount of exports).

Table 1. Trade measures for Sub-Saharan Africa

	Sub-Saharan Africa	Resource Rich		Non-Resource Rich
		Oil	Metal	
Trade Openness				
Percent of GDP				
1990 - 94	64	95	65	56
2010 - 14	77	94	93	70
Herfindahl Index				
Product Concentration				
1990 - 94	0.41	0.84	0.69	0.29
2010 - 14	0.30	0.67	0.46	0.21
Market Concentration				
1990 - 94	0.20	0.30	0.08	0.19
2010 - 14	0.20	0.15	0.28	0.18
Natural Resources				
Percent of GDP				
1990 - 94	17.0	46.9	26.8	9.8
2010 - 14	13.2	43.0	16.3	8.9
Percent of total exports				
1990 - 94	0.82	0.99	0.95	0.78
2010 - 14	0.73	0.89	0.71	0.72

Sources: WDI, and author's calculations using WITS, COMTRADE

3.1 Volume of trade

Trade openness is commonly measured by the volume of trade, defined as real exports plus imports, over GDP. Overall, the volume of trade has sharply increased in most selected regions from 1990-94 to 2010-14 —except for oil rich countries that already have a high volume of trade (about 94-95 percent in periods 1990-94 and 2010-14). Trade openness grew by 13 percentage points of GDP for the whole region over the past two decades. The growth of trade as a percentage of GDP among non-resource rich countries was comparable to the regional average whereas it was faster than average among countries that are abundant in minerals and metals (see Table 1).

3.2 Trade Diversification

Looking at the volume of trade is not sufficient to understand the linkages between international trade integration and growth. Looking beyond the volume of trade, we examine the degree of trade diversification, as proxied by the extent of trade concentration across products and across markets. Earlier evidence shows that high levels of diversification in export baskets may result in higher growth (Lederman and Maloney, 2007), and reduce risk to external shocks and output volatility (Haddad et al. 2010). Diversifying the export basket is an important element of the anti-poverty agenda as low-income countries tend to be specialized in few export products in highly volatile sectors (Cadot et al. 2013). Having said this, it is typically recommended for these countries to implement policies that diversify their export baskets and/or raise the productivity of the reduced product space through lower trade costs.

We use the Herfindahl index to compute the concentration of exports across products and markets. Here, lower values of our concentration measures can be interpreted as greater extent of export diversification. The Herfindahl index is computed as follows:

$$H = \sum_{i}^{n} \left(\frac{x_i}{\sum_i^n x_i} \right)^2$$

where x represents the amount of exports, the subscript i stands for a specific product (or market) and n is the total number of products (or markets). When a single export product (market) produces all the revenues, H=1, as opposed to H=0 when a large variety of products compose the revenues (Haddad et al. 2010; Lederman and Maloney 2012; Cadot et al. 2013). Higher (lower) values of the Herfindahl index, H, imply lower (higher) degree of export diversification. We use COMTRADE data on exports by product at a 4-digit disaggregated level from the SITC Revision 1.0 to compute Herfindahl indices of export product concentration. Bilateral data from COMTRADE are also used to compute Herfindahl indices of export market concentration.

Table 1 displays the evolution over time of the Herfindahl indices of export product and market concentration in the periods 1990-94 and 2010-14. In the period under analysis, the region's Herfindahl Index for export product concentration declined from 0.41 in 1990-94 to 0.3 in 2010-14 —thus, signaling an improvement in terms of trade diversification. In contrast, the region's Herfindahl index of export market concentration remained invariant.

Export product concentration declined over time for all country groups in Sub-Saharan Africa —although at different paces across the different groups. Countries that were abundant in minerals and metals experienced the largest decline in the Herfindahl index of product concentration: it dropped from 0.69 in 1990-94 to 0.46 in 2010-14. In the case of oil rich countries, the pace of decline was slightly slower than that of metal exporters, but the group maintained the largest degree of export product concentration by 2010-14 (0.67). Finally, non-resource rich countries exhibit the lowest degree of export product concentration in 2010-14 (0.21, down from 0.29 in 1990-94).

The evolution of export market concentration differs sharply across groups in Sub-Saharan Africa. The Herfindahl index of market concentration among non-resource rich countries remained almost invariant over time — as is also the case for the region as a whole. Export market concentration for oil rich countries declined sharply from 0.30 in 1990-94 to 0.15 in 2010-14 while that of countries abundant in minerals and metals increased from 0.08 in 1990-94 to 0.28 in 2010-14. Overall, oil rich countries tend to have a more diverse group of trading partners than minerals and metals-rich countries in 2010-14.

3.3 Natural Resources in Exports

There is no consensus in the literature about the effect of natural resources on growth —see for instance Havranek et al. (2016) for a meta-analysis of the long-term growth effects of natural resource richness. Before digging deeper and trying to understand the growth effects of natural resources, we explore the evolution of different indicators of trade in natural resources across regional country groups. The set of indicators of natural resource intensity in economic activity include natural resource exports as a share of GDP and natural resource exports as a share of total exports. For this information, we used the World Integrated Trade Solution (WITS) database on the SITC, Revision 1.0. Natural resource exports comprise the commodities in the SITC sections 0 – food and live animals, 1 – Beverages and tobacco, 2- Crude materials, inedible except fuels (excluding 22 – oil seeds, oil nuts and oil kernels), 3 – mineral fuels, lubricants and related materials, 4 – animal and vegetable oils and fats, and 68 no ferrous metals (Lederman and Maloney 2007). The value of these exports (in US dollars at current prices) is then normalized by either GDP or total merchandise exports.

3.3.1 Natural resource exports as a share of GDP

Natural resource exports as a percentage of GDP in the Sub-Saharan Africa region declined from 17 percent in 1990-94 to 13.2 percent in 2010-14. The decline in this ratio for oil rich countries is comparable to that of the region, although the share of natural resources in GDP is the largest across all country groups (about 43 percent in 2010-14). The share of natural resource exports in GDP for countries rich in minerals and metals had the largest decline (from 27 percent in 1990-94 to 16 percent in 2010-14). Finally, natural resource exports of non-resource rich countries remained stable over time at about 9 percent of GDP.

3.3.2 Natural resource exports as a share of total exports

Table 1 shows that the percent of natural resources in total merchandise exports decreased over time in all the country groups, yet not in any does the percentage go below 70 percent. For the entire region, the share of natural resource exports in total merchandise exports declined from 0.82 in 1990-94 to 0.73 in 2010-14. The share of natural resource exports in merchandise exports was above 0.95 in 1990-94 and it declined to 0.89 in 2000-14 for oil rich countries and to 0.71 for minerals and metals rich countries.

4 Impact of Trade on Growth and Productivity: A GMM Estimation

This paper seeks to estimate the growth effects of the different dimensions of foreign trade —that is, the extent of trade openness, the diversification of exports, and the importance of natural resources. We use a pooled data set of cross-country and time-series observations. We use an estimation method that is suited to panel data, deals with static or dynamic regression specifications, controls for unobserved time- and country-specific effects, and accounts for some endogeneity in the explanatory variables. This is the generalized method of moments (GMM-IV system estimator) for dynamic models of panel data developed by Arellano and Bover (1995) and Blundell and Bond (1998).

The method deals with unobserved time effects through the inclusion of period-specific intercepts. Dealing with unobserved country effects is not trivial, given that the model is dynamic and contains endogenous explanatory variables. The method therefore uses differencing and instrumentation to control for unobserved country-effects and likely endogeneity and reserve causality. Specifically, it allows relaxing the assumption of strong exogeneity of the explanatory variables by allowing the explanatory variables to be correlated with current and previous realizations of the error term. Parameter identification is achieved by assuming that future realizations of the error term do not affect current values of the explanatory variables, that the error term is serially uncorrelated, and that changes in the explanatory variables are uncorrelated with the unobserved country-specific effect. As Arellano and Bond (1991) and Arellano and Bover (1995) show, this set of assumptions generates moment conditions that allow the estimation of our parameters of interest.

4.1 Data and Sources

Our variable of interest is foreign trade and it is captured by its extent, diversification and the role of natural resources. The description of these different dimensions as well as the sources of data are presented in Section 3. In addition to trade as a structural factor, we consider a standard set of growth determinants following Loayza, Fajnzylber, and Calderon (2005); namely, drivers of growth that capture transitional convergence and other structural policies (education, governance, financial depth, government burden).[5]

Transitional convergence is one of the main implications of the neoclassical growth model. This factor depends on the initial positions of the economy, and states that, all things equal, poor countries would tend to grow faster than those in favorable conditions because of the decreasing marginal returns to factors of production. To account for this effect, we use the initial level of GDP per capita in the set of explanatory variables.

The group of structural factors that drive growth per worker mostly relates to economic policies or institutions. The first area is education. It proxies for human capital and it is usually measured by gross secondary school enrollment as estimated by Barro and Lee (2013). Sachs and Warner find that natural resources are linked to human capital – as the stock of human capital rises, the marginal effect of the stock of natural resources on income growth rises and becomes positive – they act as compliments. This factor plays a direct role on the endogenous growth literature and compliments other factors such as physical capital and natural resources (see Bravo-Ortega and De Gregorio 2002).

According to the literature, financial development is an important driver of growth at the country-, industry-, and firm-level. It is proxied by the ratio of private credit provided by financial institutions to GDP and it is the second indicator in our set of structural factors. Financial depth is supposed to facilitate risk diversification, help identify profitable investment and mobilize savings.[6]

Next, we look at the distortions that the government may impose on private sector activity, also known as government burden. To account for such, we use the ratio of government consumption to GDP. If government burden is high, taxes will be affected and thus will also be the private sector. Finally, the last structural factor considered in our analysis relates to governance. Institutional discipline and their effectiveness can also have an important effect on growth. For this variable we proxy by the principal component analysis of 4 measures from *International Country Risk Guide* (ICRG): prevalence of law and order, quality of bureaucracy, absence of corruption, and accountability of public officials.

As an indicator of stabilization policy, we include cyclical volatility in our set of growth determinants. It is proxied by the standard deviation of output. The expected effect on growth is negative when associated with economic uncertainty, whether this comes from political insecurity (Alesina et al 1996), macroeconomic instability (Judson & Orphanides 1996) or institutional weaknesses (Serven 2003; Rodrik 1991). Volatility increases in countries that are poor, institutionally underdeveloped, undergoing intermediate stages of financial development, or unable to conduct

[5] The descriptive statistics for the variables in our analysis are presented in Annex Table A.1.
[6] Manzano and Rigobón (2001) find that the negative effect of natural resources disappears when the growth regression includes the initial ratio of foreign debt to GDP.

countercyclical fiscal policies. However, it does not appear to depend on a country's level of international trade openness (Hnatkovska and Loayza 2005).

4.2 Econometric methodology: The GMM-IV system estimator

Our regression analysis is conducted on a panel data set of countries across the world. This poses some challenges. First, we many need to control for unobserved country- and time-specific effects. We can account for the presence of time-effects by including time-specific dummy variables in our regression. On the other hand, the common methods used to account for country-effects (i.e. "within-group" estimators) are inappropriate given the dynamic nature of the regression equation. Second, most explanatory variables are likely to be jointly endogenous with economic growth, and, thus, we need to control for the biases resulting from simultaneous or reverse causation.

We use the Generalized-Method-of-Moments (GMM) estimators developed for dynamic models of panel data that were introduced by Holtz-Eakin, Newey, and Rosen (1990), Arellano and Bond (1991), and Arellano and Bover (1995). Taking advantage of the panel data set, these estimators are based on, first, differencing regressions and/or instruments to control for unobserved effects, and, second, the use of previous observations of the explanatory variables as instruments (which are called "internal" instruments).

After accounting for time-specific effects, we use:

$$y_{i,t} = \alpha y_{i,t-1} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \tag{1}$$

To eliminate the country-specific effect, we take first-differences of equation (1),

$$y_{i,t} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \beta'\left(X_{i,t} - X_{i,t-1}\right) + \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right) \tag{2}$$

The use of instruments is required to deal with, first, the likely endogeneity of the explanatory variables, and, second, the problem that, by construction, the new error term, $\varepsilon_{i,t} - \varepsilon_{i,t-1}$, is correlated with the lagged dependent variable, $y_{i,t-1} - y_{i,t-2}$. Taking advantage of the panel nature of the data set, the instruments consist of previous observations of the explanatory and lagged dependent variables. Given that it relies on past values as instruments, this method only allows current and future values of the explanatory variables to be affected by the error term. Therefore, while relaxing the common assumption of strict exogeneity, our instrumental-variable method does not allow the *X* variables to be fully endogenous.

Under the assumptions that (a) the error term, ε, is not serially correlated, and (b) the explanatory variables, *X*, are weakly exogenous (i.e., the explanatory variables are assumed to be uncorrelated with future realizations of the error term), the GMM dynamic panel estimator uses the following moment conditions.

$$E\left[y_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s \geq 2; t = 3, \ldots, T \tag{3}$$

$$E\left[X_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s \geq 2; t = 3, \ldots, T \tag{4}$$

The GMM estimator based on these conditions is known as the *difference* estimator. Notwithstanding its advantages with respect to simpler panel data estimators, there are important statistical shortcomings with the difference estimator. For example, Alonso-Borrego and Arellano (1996) and Blundell and Bond (1998) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Instrument weakness influences the asymptotic and small-sample performance of the difference estimator. Asymptotically, the variance of the coefficients rises. In small samples, Monte Carlo experiments show that the weakness of the instruments can produce biased coefficients.[7]

To reduce the potential biases and imprecision associated with the usual difference estimator, we use a new estimator that combines in a *system* the regression in differences with the regression in levels (developed in Arellano and Bover, 1995, and Blundell and Bond, 1998). The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the *lagged differences* of the corresponding variables. These are appropriate instruments under the following additional assumption: although there may be correlation between the levels of the right-hand side variables and the country-specific effect in equation (2), there is no correlation between the *differences* of these variables and the country-specific effect. This assumption results from the following stationarity property,

$$\begin{aligned} &E[y_{i,t+p} \cdot \eta_i] = E[y_{i,t+q} \cdot \eta_i] \quad and \\ &E[X_{i,t+p} \cdot \eta_i] = E[X_{i,t+q} \cdot \eta_i] \quad for\ all\ p\ and\ q \end{aligned} \tag{5}$$

The additional moment conditions for the second part of the system (the regression in levels) are:[8]

$$E[\left(y_{i,t-1} - y_{i,t-2}\right) \cdot \left(\eta_i + \varepsilon_{i,t}\right)] = 0 \tag{6}$$

$$E[\left(X_{i,t-1} - X_{i,t-2}\right) \cdot \left(\eta_i + \varepsilon_{i,t}\right)] = 0 \tag{7}$$

and we use the moment conditions presented in equations (4), (5), (7), and (8) and employ a GMM procedure to generate consistent and efficient parameter estimates. These are given by the following formulas:

$$\hat{\theta} = (\overline{X}' Z \hat{\Omega}^{-1} Z' \overline{X})^{-1} \overline{X}' Z \hat{\Omega}^{-1} Z' \overline{y} \tag{8}$$

$$AVAR(\hat{\theta}) = (\overline{X}' Z \hat{\Omega}^{-1} Z' \overline{X})^{-1} \tag{9}$$

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[7] An additional problem with the simple *difference* estimator relates to measurement error: differencing may exacerbate the bias due to errors in variables by decreasing the signal-to-noise ratio (see Griliches and Hausman, 1986).

[8] Given that lagged levels are used as instruments in the differences specification, only the most recent difference is used as instrument in the levels specification. Using other lagged differences would result in redundant moment conditions (see Arellano and Bover, 1995).

where θ is the vector of parameters of interest (α, β), $\overline{y}$ is the dependent variable stacked first in differences and then in levels, $\overline{X}$ is the explanatory-variable matrix including the lagged dependent variable (y_{t-1}, X) stacked first in differences and then in levels, Z is the matrix of instruments derived from the moment conditions, and $\hat{\Omega}$ is a consistent estimate of the variance-covariance matrix of the moment conditions. [9]

The consistency of the GMM estimators depends on whether lagged values of the explanatory variables are valid instruments in the growth regression. We address this issue by considering a specification test suggested by Arellano and Bond (1991) and Arellano and Bover (1995). In the context of GMM, the overidentifying restrictions are commonly tested through the Hansen test. It tests the overall validity of the instruments analyses the sample analog of the moment conditions used in the estimation process. A rejection of the null hypothesis implies that the instruments are not satisfying the orthogonality conditions required (correlated with the variables, orthogonal to the error) for their employment and gives support to the model. In the *system* specification we test whether the differenced error term (that is, the residual of the regression in differences) is second-order serially correlated. First-order serial correlation of the differenced error term is expected even if the original error term (in levels) is uncorrelated, unless the latter follows a random walk. Second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving average process at least of order one. This would reject the appropriateness of the proposed instruments (and would call for higher-order lags to be used as instruments).

4.3 Trade and Economic Growth in CEMAC: Regression Analysis

This section discusses the empirical relationship between international trade integration and growth for an unbalanced panel data sample of 173 countries (of which, 45 countries are in Sub-Saharan Africa) from 1975 to 2014. The data are organized in non-overlapping five-year period averages. Our dependent variable is the average annual rate of growth of real output per worker over the five-year period. We first explore the relationship between our measures of trade and growth while controlling for a very parsimonious set of controls; namely, the (initial) level of income per capita (columns [1] through [5]) and the standard deviation of growth per worker (columns [1] and [5]).

Table 2 reports the GMM-IV estimation of our baseline equation. All columns report a negative and significant coefficient for the initial level of the real output per worker (in logs) in the five-year period. This indicates evidence of conditional convergence in real output per worker. Trade openness has a positive and significant effect on growth. When we account for the other dimensions of international trade integration —say, trade diversification and the

[9] In practice, Arellano and Bond (1991) suggest the following two-step procedure to obtain consistent and efficient GMM estimates. First, assume that the residuals, $\varepsilon_{i,t}$, are independent and homoskedastic both across countries and over time. This assumption corresponds to a specific weighting matrix that is used to produce first-step coefficient estimates. Then, construct a consistent estimate of the variance-covariance matrix of the moment conditions with the residuals obtained in the first step, and use this matrix to re-estimate the parameters of interest (i.e. second-step estimates). Asymptotically, the second-step estimates are superior to the first-step ones in so far as efficiency is concerned.

importance of natural resource exports— or growth volatility, the coefficient estimate of trade openness continues to be significant but becomes smaller.

Export market concentration (as proxied by the Herfindahl index of exports from a certain country to its trading partners) has a positive impact on growth. The sign of this coefficient estimate is different in nature to what we expected; however, it is not robust across the different specifications. Diversifying export destinations may not necessarily have a robust impact on economic growth. In contrast, export product concentration (measured by the Herfindahl index of export products) has an expected negative and significant effect on growth. The coefficient estimate of export product concentration remains slightly invariant to the inclusion of additional control variables in Table 2 (around -0.27 and -0.29). This finding implies that product diversification of exports would foster economic growth.

Table 2. Trade openness, diversification and growth: Baseline Specification
Dependent Variable: Growth of real GDP per worker (5-year averages)
Estimation method: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond 1998)

	[1]	[2]	[3]	[4]	[5]
Convergence					
Initial GDP per worker	-0.022***	-0.021***	-0.029***	-0.022***	-0.030***
(in logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Openness					
Exports and Imports	0.052***	0.041***	0.016**	0.039***	0.015**
(% of GDP, logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Diversification					
Market concentration	..	0.006	0.015***	0.007*	0.016***
(Herfindahl index)		*(-0.060)*	*(0.000)*	*(-0.019)*	*(0.000)*
Product concentration	..	-0.028***	-0.029***	-0.027***	-0.029***
(Herfindahl index)		*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Natural Resource Exports					
Natural resource exports	..	..	0.025***	..	0.028***
(% of GDP)			*(0.000)*		*(0.000)*
Natural resource exports	..	..	-0.0319***	..	-0.0338***
(% of total exports)			*(0.000)*		*(0.000)*
Volatility					
Growth volatility	..	..	..	-0.091*	-0.092*
(S.D. growth per worker)				*(-0.015)*	*(-0.01)*
Constant	0.02	0.01	0.120***	0.02	0.133***
	(-0.395)	*(-0.75)*	*(0.000)*	*(-0.158)*	*(0.000)*
Observations	1059	875	842	875	842
AR(1)	0.000	0.000	0.000	0.000	0.000
AR(2)	0.624	0.341	0.420	0.171	0.176
Hansen	0.012	0.072	0.428	0.135	0.448

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For both natural resource exports variables, we find a different impact on economic growth (as a percentage of GDP and natural resource exports as a percentage of total exports). The former explanatory variable has a positive and significant coefficient while the latter has a negative and significant coefficient. This finding largely suggests that: (a) the concentration of natural resource in total exports may hinder growth —to the extent that the export base is sensitive to international commodity prices and, hence, more volatile; and (b) natural resource sectors as part of economic activity may have an impact on growth not only through demand but also supply shocks —to the extent that their exploitation may lead to the build-up of infrastructure networks and other annex industries.

Table 3 reports our growth per worker regression estimates that control for the initial level of GDP per worker, our set of variables of interest (trade openness, trade diversification, and natural resources), and an augmented set of growth drivers including standard control variables —specifically, human capital (secondary enrolment), institutional quality (as proxied by the ICRG political risk index), financial depth (credit to the private sector), and government burden (government consumption). Columns [1], [3], [5], and [7] from Table 3 report different growth specifications that gradually include the additional control variables of growth per worker but exclude the intensity of natural resource exports. On the other hand, columns [2], [4], [6], and [8] add both indicators of natural resource exports normalized by GDP and total exports. Before we discuss the econometric findings for our variables of interest, we need to point out that we find evidence of conditional convergence —that is, countries with lower output per worker tend to growth faster, holding all other forcing variables constant. In addition, growth per worker is fostered by higher human capital, stronger institutions, lower government consumption, and lower growth volatility. The specification tests associated to the regressions in Table 3 (that is, second order correlation and Hansen tests) show little evidence against the validity of the moment conditions underlying the empirical specification.

The coefficient of trade openness remains positive and significant throughout all specifications of Table 3, and the estimates range from 0.007 (column [2]) to 0.021 (columns [3] and [5]). These findings impact that doubling trade openness may boost the growth of output per worker between 0.5 and 1.5 percentage points per year. Export market concentration does not show a systematic relationship with growth per worker: its sign and significance may change according to the estimated specification. Having said this, market concentration is positive and significant in most cases. Export product concentration, on the other hand, has a negative and statistically significant impact on growth per worker. That is, labor productivity growth is higher in countries with more diverse export baskets. Depending on the set of control variables, the coefficient estimates of export product concentration ranges from -0.01 to -0.18. Finally, the impact of natural resource exports on growth after controlling for an augmented set of growth determinants remains qualitatively similar to the findings in Table 2. Natural resource exports as a percentage of GDP has positive and significant impact on growth per worker with coefficients varying from 0.004 to 0.008. On the other hand, as a percentage of total exports, natural resource exports have a negative and significant effect on growth and the impact coefficient ranges from -0.015 to -0.023.

Table 3. Trade openness, diversification and growth: Augmented Specification
Dependent Variable: Growth of real GDP per worker (5-year averages)
Estimation method: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond 1998)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Convergence								
Initial GDP per worker	-0.024***	-0.025***	-0.019***	-0.022***	-0.018***	-0.020***	-0.017***	-0.019***
(in logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Openness								
Exports and Imports	0.019***	0.007***	0.021***	0.013***	0.021***	0.014***	0.020***	0.014***
(% of GDP, logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Diversification								
Market concentration	0.002***	0.011***	0.0002	0.006***	-0.002***	0.004***	-0.001	0.005***
(Herfindahl index)	*(0.000)*	*(0.000)*	*(-0.803)*	*(0.000)*	*(0.000)*	*(0.000)*	*(-0.143)*	*(0.000)*
Product concentration	-0.014***	-0.010***	-0.020***	-0.015***	-0.018***	-0.014***	-0.018***	-0.015***
(Herfindahl index)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Natural Resource Exports								
Natural resource exports	..	0.008***	..	0.006***	..	0.004***	..	0.005***
(% of GDP)		*(0.000)*		*(0.000)*		*(0.000)*		*(0.000)*
Natural resource exports	..	-0.023***	..	-0.019***	..	-0.016***	..	-0.015***
(% of total exports)		*(0.000)*		*(0.000)*		*(0.000)*		*(0.000)*
Additional Growth Drivers								
Secondary enrollment rate	0.006***	0.004***	0.004***	0.003***	0.004***	0.004***	0.004***	0.002*
(initial level, logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(-0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(-0.035)*
ICRG Political risk index	0.006***	0.005***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***
(principal components)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Credit to private sector	..	..	-0.013***	-0.011***	-0.012***	-0.011***	-0.011***	-0.011***
(% of GDP)			*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
General government consumption	..	..	..	..	-0.008***	-0.006***	-0.007***	-0.005**
(% of GDP)					*(0.000)*	*(-0.001)*	*(0.000)*	*(-0.003)*
Growth volatility	..	..	..	..	..	..	-0.086***	-0.102***
(S.D. growth per worker)							*(0.000)*	*(0.000)*
Constant	0.118***	0.178***	0.095***	0.155***	0.100***	0.151***	0.105***	0.146***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	624	613	616	606	611	601	611	601
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
AR(2)	0.721	0.472	0.880	0.638	0.851	0.570	0.483	0.252
Hansen	0.392	0.411	0.388	0.407	0.419	0.347	0.349	0.349

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We next examine the channels of transmission of integration trade integration on growth; that is, we assess the impact of the different indicators of trade volume, trade diversification, and natural resource exports on the sources of growth —namely, growth of physical capital per worker and total factor productivity (TFP) growth. Table 4 presents the impact of the international trade integration variables on growth per worker as well as on its sources (physical capital per worker growth and TFP per worker growth). Note that the specification of the regressions in Table 4 follows that of regressions [3] and [5] in Table 2. The first three columns of Table 4 reproduce the growth per worker regression from column [3] of Table 2 and estimates the same specification for growth in capital per worker and TFP growth. The remaining three columns of Table 4 repeat the same analysis for the specification in column [5] of Table 2. Note that the only difference in the estimation of columns [4]-[6] relative to columns [1]-[3] is the inclusion of growth volatility as an additional explanatory variable.

Table 4. Trade openness, diversification and growth: Baseline Specification
Dependent Variable: see columns (5-year averages)
Estimation method: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond 1998)

	Annual Average Growth of:			Annual Average Growth of:		
	Output per worker	Capital per worker	TFP(1)	Output per worker	Capital per worker	TFP(1)
	[1]	[2]	[3]	[4]	[5]	[6]
Convergence						
Initial GDP per worker	-0.029***	-0.021***	-0.018***	-0.030***	-0.023***	-0.019***
(in logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Openness						
Exports and Imports	0.016**	0.013**	0.006	0.015**	0.013**	0.007
(% of GDP, logs)	*(0.000)*	*(-0.004)*	*(-0.156)*	*(0.000)*	*(-0.004)*	*(-0.084)*
Trade Diversification						
Market concentration	0.015***	-0.002	0.021***	0.016***	-0.003	0.023***
(Herfindahl index)	*(0.000)*	*(-0.411)*	*(0.000)*	*(0.000)*	*(-0.269)*	*(0.000)*
Product concentration	-0.029***	-0.019***	-0.022***	-0.029***	-0.020***	-0.021***
(Herfindahl index)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Natural Resource Exports						
Natural resource exports	0.025***	0.021***	0.020***	0.028***	0.023***	0.021***
(% of GDP)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Natural resource exports	-0.032***	-0.021***	-0.023***	-0.034***	-0.025***	-0.023***
(% of total exports)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Volatility						
Growth volatility	..	..	..	-0.092*	0.217***	-0.192***
(S.D. growth per worker)				*(-0.010)*	*(0.000)*	*(0.000)*
Constant	0.120***	0.064**	0.086***	0.133***	0.065**	0.096***
	(0.000)	*(-0.003)*	*(0.000)*	*(0.000)*	*(-0.003)*	*(0.000)*
Observations	842	842	811	842	842	811
AR(1)	0.000	0.001	0.000	0.000	0.002	0.001
AR(2)	0.420	0.019	0.707	0.176	0.176	0.452
Hansen	0.428	0.040	0.215	0.448	0.069	0.420

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
(1) - refers to TFP as reported by the World Bank Group

The results from Table 4 indicate that the impact of the volume of trade (as proxied by exports and imports to GDP) affects output growth through physical capital accumulation rather than TFP growth. The coefficient estimate of trade openness in the physical capital equation is positive, significant, and equal to 0.013. This implies that doubling trade openness would increase the growth rate of capital per worker by 0.9 percentage points per year. In contrast, the volume of trade appears not to have a significant impact on TFP growth.

Export product concentration has a negative and significant relationship not only with growth per worker but also with the sources of growth per worker. The coefficient estimate of export product concentration in the TFP growth equation is slightly larger than the one in the capital accumulation equation. This finding implies that the impact of trade in product diversification on economic growth is transmitted through a faster accumulation of physical capital and an acceleration of TFP growth. Our estimates suggest that halving the extent of export product concentration may increase the growth rate of capital accumulation by 1.4 percentage points per year and that of TFP growth by 1.5 percentage points per year. On the other hand, export market concentration has a positive impact on growth per worker in the two selected regressions —see columns [1] and [4] of Table 4. When investigating its impact on the source of growth, we find that the positive effect is significant only through TFP growth whereas the impact through capital accumulation is statistically negligible. Finally, the impact of natural resources (as a percent of GDP and or total exports) on the sources of growth is similar to the one estimated for growth per worker in Table 2. Natural resource exports as a percentage of total exports has a negative and significant impact on both physical capital accumulation and TFP growth whereas natural resource exports as a percentage of GDP has a positive effect on both source of growth.

Table 5 estimates the impact of international trade integration on the sources of growth following the specification in columns [7] and [8] of Table 3. The first three columns of Table 5 reproduce the growth per worker regression from column [7] of Table 3 and estimates the same specification for growth in capital per worker and TFP growth. The remaining three columns of Table 5 repeat the same analysis for the specification in column [8] of Table 3. Again, the only difference in the estimation of columns [4]-[6] relative to columns [1]-[3] is the inclusion of natural resource exports as additional explanatory variables. Table 5 tests the robustness of our results in Table 4 to the inclusion of additional control variables. Before evaluating the impact of international trade integration on the sources growth, we should note that: (a) countries with lower level of output per worker tend to exhibit higher growth of both capital per worker and TFP growth, (b) education (as proxied by secondary enrollment rate) has a positive and significant impact on economic growth through the TFP channel, (c) growth-enhancing effects of improved institutional quality and lower government burden are transmitted through higher TFP growth, and (d) the impact on growth of cyclical volatility is more likely to be transmitted through lower domestic investment.

Some interesting findings emerge from Table 5. First, we find that the growth effects of trade openness are transmitted not only through faster capital accumulation but also higher TFP growth once we control for additional growth determinants. Note that when we control for the extent of natural resource exports, the impact of the volume of trade appears to be greater on TFP growth than on the growth of capital per worker. For instance, doubling the ratio of exports and imports to GDP is likely to increase the growth of capital per worker by 0.3 percentage points per year while it accelerates TFP growth by 0.7 percentage points per year. Second, export product concentration has a negative and significant impact not only on growth per worker but also on both sources of growth when we include additional growth determinants. This indicates that our findings from Table 4 are robust to additional explanatory variables. Halving the Herfindahl index of product concentration would increase the growth rate of physical capital accumulation by 1 percentage point per year while it would enhance TFP growth by 0.7 percentage point per year. In contrast, the relationship between export market concentration, growth and sources of growth is not robust. When controlling for the role of natural resources, our regressions show that market concentration has a positive impact on both physical capital accumulation and TFP growth. We should also note that the coefficient of product concentration (in absolute value) is higher than that of market concentration. Finally, natural resource exports as a share of total exports has a negative impact on both capital accumulation and TFP growth whereas the impact of natural resource exports as a share of GDP on the sources of growth is positive (although its impact is not significant in the TFP growth equation). Having said this, the bulk of the impact on growth is transmitted through faster capital accumulation.

Table 5. Trade openness, diversification and growth: Augmented Specification
Dependent Variable: Growth of real GDP per worker (5-year averages)
Estimation method: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond 1998)

	Annual Average Growth of:			Annual Average Growth of:		
	Output per worker	Capital per worker	TFP	Output per worker	Capital per worker	TFP
	[1]	[2]	[3]	[4]	[5]	[6]
Convergence						
Initial GDP per worker	-0.017***	-0.0073***	-0.011***	-0.019***	-0.010***	-0.011***
(in logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Trade Openness						
Exports and Imports	0.020***	0.015***	0.012***	0.014***	0.005*	0.010***
(% of GDP, logs)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(-0.022)*	*(0.000)*
Trade Diversification						
Market concentration	-0.001	0.003*	0.0006	0.005***	0.007***	0.003**
(Herfindahl index)	*(-0.143)*	*(-0.034)*	*(-0.317)*	*(0.000)*	*(0.000)*	*(-0.009)*
Product concentration	-0.018***	-0.020***	-0.011***	-0.015***	-0.015***	-0.010***
(Herfindahl index)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Natural Resource Exports						
Natural resource exports	..	..	..	0.005***	0.004**	-0.00005
(% of GDP)				*(0.000)*	(-0.003)	(-0.956)
Natural resource exports	..	..	..	-0.015***	-0.012***	-0.005**
(% of total exports)				*(0.000)*	*(0.000)*	(-0.002)
Additional Growth Drivers						
Secondary enrollment rate	0.004***	-0.002	0.002**	0.002*	-0.003*	0.002**
(initial level, logs)	*(0.000)*	*(-0.102)*	*(-0.003)*	*(-0.035)*	*(-0.044)*	*(-0.004)*
ICRG Political risk index	0.006***	0.0002	0.005***	0.006***	0.001*	0.005***
(principal components)	*(0.000)*	*(-0.470)*	*(0.000)*	*(0.000)*	*(-0.015)*	*(0.000)*
Credit to private sector	-0.011***	-0.007***	-0.009***	-0.011***	-0.006***	-0.009***
(% of GDP)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
General government consumption	-0.007***	0.002	-0.009***	-0.005**	0.009***	-0.011***
(% of GDP)	*(0.000)*	*(-0.306)*	*(0.000)*	*(-0.003)*	*(0.000)*	*(0.000)*
Growth volatility	-0.086***	0.019	-0.009	-0.102***	-0.068***	0.026*
(S.D. growth per worker)	*(0.000)*	*(-0.145)*	*(-0.393)*	*(0.000)*	*(0.000)*	*(-0.010)*
Constant	0.105***	0.015*	0.088***	0.146***	0.066***	0.101***
	(0.000)	*(-0.013)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	611	611	611	601	601	601
AR(1)	0.000	0.252	0.000	0.001	0.126	0.000
AR(2)	0.483	0.005	0.936	0.252	0.003	0.887
Hansen	0.349	0.43	0.319	0.349	0.369	0.32

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.4 Comparative Statics Analysis: Regional and International

We conduct a series of exercises to calculate the potential growth benefits of improving international trade integration in Sub-Saharan Africa. In this analysis, improving international trade integration involves expanding trade volumes, increasing export product diversification, and reducing the dependence on natural resources in the export basket. This implies the progress of trade indicators relative to a series of benchmarks for the region (as well as the different country groups classified by their extent of natural resource abundance). In the context of our analysis, the comparative static analysis consists of increasing the degree of trade openness (as proxied by exports and imports as percentage to GDP) and reducing both the export product concentration index (thus, raising export product diversification) and the dependence of natural resources in the export basket. The comparative analysis is conducted across two different dimensions: first, we compute the growth benefits of closing the gap at our latest observation in trade openness, export product diversification, and natural resource dependency for the whole region and country groups in Sub-Saharan Africa vis-à-vis select regional benchmarks. Second, we compute the growth benefits from improvements over time in trade openness, product diversification and dependence on natural resources. Note that in both cases, we compute the growth effects, the impact on physical capital accumulation, and TFP growth. Furthermore, the comparative statistical analysis is illustrative rather than conclusive because -among other simplifying assumptions- it is based on the implicit hypothesis that changes in trade do not lead to changes in any of the other growth determinants.

We will first look at the effects of narrowing the gaps in international trade integration on growth per capita, physical capital accumulation growth and TFP growth for a specific point in time, the most recent one available. To conduct this comparative exercise, we select appropriate benchmark countries/regions: (i) the country leader in Sub-Saharan Africa (SSA), (ii) the top quartile of the world excluding SSA (75th percentile), (iii) the country leader of middle-income country group, and (iv) the country leader among low-income economies.[10] To compute the growth benefits of closing the gap with a specific benchmark, we use the values[11] of the different dimensions of trade integration over the last five-year period (2010-14) and apply the following formula:

$$Growth\ benefit = \beta_{from\ regresion}(z_{benchmark} - z_{SSA\_region})$$

Table 6 reports the potential benefits on economic growth, physical capital, and TFP of improving trade openness in Sub-Saharan Africa (and country groups in the region classified by natural resources abundance) and narrowing the gap relative to other benchmarks. The first row reports the potential economic growth benefits of closing the gap in terms of trade openness. The implication of an additional unit of trade volume would impact growth by 0.0317 (result reported in Table 5 on column [4]), as shown in the second column of Table 6. Our calculations reveal that growth per worker in Sub-Saharan Africa would accelerate by 0.9 percentage points per year if the region closes the gap in trade volumes relative to the SSA leader. Note that the estimated gap for the region as a whole differs from the potential gains across country groups classified according to their degree of natural resource abundance. For instance, the largest potential growth benefits of rising trade volumes are likely to be accrued by non-resource rich

[10] Note that given that better outcomes imply lower product concentration and natural resources dependence, the benchmarks become: 1) SSA leader, 2) world excluding SSA (25th percentile), 4) middle-income country leader, and 5) low-income country leader.

[11] The values used are the results from the estimations calculated in regressions from Table 5 Columns [4] [5] and [6], for trade openness, concentration, and natural resource dependency, respectively.

countries (1.1 percentage points per year) while the smallest growth benefits are attained by oil rich countries in the region (0.6 percentage points per year).

Table 6. Comparative Statistics, Trade Openness
2010-2014

			SSA Leader	World Excl. SSA (75th percentile)	MIC Leader	LIC Leader
Growth	0.0137	SSA Average	0.86%	0.58%	1.02%	0.66%
		SSA oil RR	0.59%	0.31%	0.75%	0.38%
		SSA non-oil RR	0.76%	0.48%	0.93%	0.56%
		SSA non-RR	1.10%	0.82%	1.26%	0.90%
Capital	0.00544	SSA Average	0.34%	0.23%	0.41%	0.26%
		SSA oil RR	0.23%	0.12%	0.30%	0.15%
		SSA non-oil RR	0.30%	0.19%	0.37%	0.22%
		SSA non-RR	0.44%	0.32%	0.50%	0.36%
TFP	0.0102	SSA Average	0.64%	0.43%	0.76%	0.49%
		SSA oil RR	0.44%	0.23%	0.56%	0.29%
		SSA non-oil RR	0.57%	0.36%	0.69%	0.42%
		SSA non-RR	0.82%	0.61%	0.94%	0.67%

NOTE: The estimations are calculated based on the results from regressions in Table 5 Columns [4] [5] and [6].

Similarly, we look at the channels of transmission of closing the gap in trade volumes by assessing their benefit in terms of (potential) growth of physical capital per worker and total factor productivity (TFP) growth. The second panel in Table 6 shows the sensitivity of physical capital accumulation to trade openness (0.00544 as reported in column [5] of Table 5) and the third panel reports the sensitivity of TFP (0.0102 as in column [6] of Table 5). In all cases, the largest gains in physical capital accumulation and TFP growth from closing the trade openness gap vis-à-vis the SSA leader would be attained by the non-resource rich countries (0.44 and 0.82 percentage points per year). Again, oil abundant countries in the region register the smallest benefits in terms of capital accumulation and TFP growth. Finally, the potential gains in capital accumulation and TFP growth for the region as a whole vis-à-vis the leader in Sub-Saharan Africa amount to 0.34 and 0.64 percentage point per year.[12]

Next, we analyze the likely benefits of SSA and other country groups within the region in narrowing the gaps in international trade integration relative to the MIC leader. For instance, narrowing the trade openness gap of SSA relative to the MIC leader would improve economic growth by 1.02 percentage points, capital accumulation by 0.41 percentage points, and TFP by 0.76 percentage points. Oil rich countries in the region reap the smallest growth benefits in all three variables: growth, capital and TFP. The non-resource rich countries would have greater than average

[12]Note that closing the gap in international trade integration relative to the SSA leader would render greater potential benefits in terms of growth, capital accumulation and TFP growth than by closing the gap with respect to the top quartile of the rest of the world excluding SSA (75th percentile) and the LIC leader. For the sake of space, the results are reported in Table 6, but they are not discussed in the document.

(potential) benefits in terms of growth (1.26 percentage points), capital accumulation (0.41 percentage points), and TFP growth (0.94 percentage points).

Table 7 reports the (potential) gains of closing the gap of diversifying the export product basket in terms of growth, physical capital, and TPF compared to benchmark countries/regions (holding constant all other international trade integration dimensions). The coefficient estimates of product market concentration from the growth, physical capital accumulation and TFP growth are taken from the columns [4] [5] and [6] of Table 5. As expected, these coefficient estimates are negative —as lower concentration signals greater diversification. The higher the number, the more concentrated the products are. In this sense, if the Sub-Saharan Africa region were to close its gap in terms of export product market concentration to the regional lead (i.e. if its basket of products were to become more diverse), growth of output per worker would increase by 2.71 percentage points per year. In addition, their physical capital would expand by 2.76 percentage points annually and TFP growth would accelerate by 1.84 percentage points. However, the group that would attain the highest growth benefit from reaching the regional leader's figures would be the non-oil-resource rich countries (that is, countries that are abundant in metals and minerals). This group is probably the most laggard in terms of export product diversification. Specifically, if these countries were to diversify their export product basket more, their growth rate per worker would increase by 3.47 percentage points. In terms of physical capital accumulation, the average annual gains would be 3.97 percentage points while TFP growth accelerates by 2.64 percentage points annually. Finally, note that non-resource rich countries attain the lowest potential growth benefits (2.37 percentage points per year) from narrowing the gap in terms of export product diversification. The gains in physical capital accumulation and TFP growth are about 2.35 and 1.57 percent per year.

The potential benefits of the SSA region as a whole (or any of its different sub-groups classified according to their extent of natural resource abundance) relative to other (three) benchmarks again reveals that the largest gains would be by attaining the figures earned by the MIC leader (as suspected). If the SSA average country were to close its gap with the MIC leader, growth per worker would accelerate by 3.47 percentage points per leader (that is, 0.76 percentage points faster than scenario of closing the gap vis-à-vis the SSA leader). Physical accumulation and TFP growth would also be enhanced by 3.54 and 2.35 percentage points per year, respectively, if the gaps in product concentration were eliminated. Note that relative to the SSA leader scenario, these (potential) benefits imply an acceleration of the accumulation of physical capital and TFP growth of 0.78 percentage points and 0.51 percentage points, respectively.

Table 7. Comparative Statistics, Product Concentration
2010-2014

			SSA Leader	World Excl. SSA (75th percentile)	MIC Leader	LIC Leader
Growth	-0.0147	SSA Average	2.71%	2.42%	3.47%	2.37%
		SSA oil RR	2.42%	3.89%	4.94%	3.85%
		SSA non-oil RR	3.47%	3.60%	4.66%	3.56%
		SSA non-RR	2.37%	2.02%	3.07%	1.97%
Capital	-0.015	SSA Average	2.76%	2.46%	3.54%	2.42%
		SSA oil RR	4.26%	3.97%	5.04%	3.93%
		SSA non-oil RR	3.97%	3.68%	4.75%	3.64%
		SSA non-RR	2.35%	2.06%	3.13%	2.02%
TFP	-0.00998	SSA Average	1.84%	1.64%	2.35%	1.61%
		SSA oil RR	2.84%	2.64%	3.35%	2.61%
		SSA non-oil RR	2.64%	2.45%	3.16%	2.42%
		SSA non-RR	1.57%	1.37%	2.08%	1.34%

NOTE: The estimations are calculated based on the results from regressions in Table 5 Columns [4] [5] and [6].

Table 8 presents the potential increase in economic growth, physical capital growth and TFP growth if the gap in export dependence on natural resources gap were to close relative to the four benchmarks mentioned earlier. If the Sub-Saharan Africa region were to match the regional leader's share of natural resources exports in their overall export basket, growth would accelerate 2.81 percentage points, capital accumulation would be enhanced by 2.26 percentage points and TFP growth would rise by 0.97 percentage points. If we look at the potential gains of the different SSA groups relative to the regional leader, the oil resource rich countries would benefit the most from closing the gap with the benchmarks in terms of growth, capital accumulation, and TFP growth. Furthermore, narrowing the gap in terms of reducing the dependence on natural resources from the SSA average relative to the middle-income leader, which yields the higher benefits than those acquired from the SSA leader, would result in analogous potential growth gains. That is, about 3.9 percentage points per year of growth, 3.14 percentage points of physical capital growth and 1.34 percentage points of TFP growth.

Table 8. Comparative Statistics, Natural Resources (% of total exports)
2010-2014

			SSA Leader	World Excl. SSA (75th percentile)	MIC Leader	LIC Leader
Growth	-0.0154	SSA Average	2.81%	1.74%	3.90%	1.51%
		SSA oil RR	3.13%	2.07%	4.23%	1.84%
		SSA non-oil RR	2.85%	1.78%	3.94%	1.55%
		SSA non-RR	2.76%	1.70%	3.86%	1.47%
Capital	-0.0124	SSA Average	2.26%	1.40%	3.14%	1.22%
		SSA oil RR	2.52%	1.66%	3.41%	1.48%
		SSA non-oil RR	2.29%	1.43%	3.17%	1.25%
		SSA non-RR	2.23%	1.37%	3.11%	1.18%
TFP	-0.0053	SSA Average	0.97%	0.60%	1.34%	0.52%
		SSA oil RR	1.08%	0.71%	1.46%	0.63%
		SSA non-oil RR	0.98%	0.61%	1.36%	0.53%
		SSA non-RR	0.95%	0.58%	1.33%	0.51%

NOTE: The estimations are calculated based on the results from regressions in Table 5 Columns [4] [5] and [6].

Finally, we report the actual gains from improved international trade integration over at 10-year span (2010-14 vs. 2000-04) and 20-year span (2010-14 vs. 1990-94) in terms of growth of output per worker, growth of capital per worker and TFP growth. In the case of trade openness, growth of output per worker increased by 0.3 percentage points over the past 10 years whereas growth of capital per worker and TFP growth accelerated by 0.1 percentage points and 0.2 percentage points over the past decade. The largest growth per worker increase over the past decade is attained by minerals and metals rich countries in the region (0.3 percentage points per year) while the physical capital and TFP growth gains over time are similar to those of the regional average (0.2 and 0.1 percentage points, respectively). In contrast, the indicators of trade integration deteriorated over the past decade across oil rich countries. Hence, growth decelerated by 0.2 percent due to lower trade volumes, and it contracted by 0.1 and 0.15 due to greater product concentration and higher dependence of natural resource exports.

Table 9. Comparative Statistics, over time

2010-2014

		GROWTH		CAPITAL		TFP	
		10-year	**20-year**	**10-year**	**20-year**	**10-year**	**20-year**
Trade openness	SSA	0.29%	0.41%	0.11%	0.16%	0.21%	0.31%
	SSA oil	-0.20%	0.20%	-0.08%	0.08%	-0.15%	0.15%
	SSA metal	0.33%	0.35%	0.13%	0.14%	0.24%	0.26%
	SSA non-RR	0.22%	0.22%	0.09%	0.09%	0.16%	0.17%
	Developing excluding SSA	0.11%	0.36%	0.04%	0.14%	0.08%	0.26%
Product concentration	SSA	0.37%	0.63%	0.37%	0.64%	0.25%	0.43%
	SSA oil	0.35%	0.58%	0.36%	0.59%	0.24%	0.39%
	SSA metal	-0.09%	0.62%	-0.09%	0.63%	-0.06%	0.42%
	SSA non-RR	0.74%	0.80%	0.75%	0.82%	0.50%	0.54%
	Developing excluding SSA	-0.02%	0.05%	-0.02%	0.05%	-0.02%	0.03%
Natural Resource	SSA	0.02%	0.27%	0.02%	0.21%	0.01%	0.09%
	SSA oil	-0.01%	0.06%	0.00%	0.05%	0.00%	0.02%
	SSA metal	-0.09%	0.29%	-0.07%	0.24%	-0.03%	0.10%
	SSA non-RR	0.06%	0.17%	0.05%	0.14%	0.02%	0.06%
	Developing excluding SSA	-0.20%	0.02%	-0.16%	0.02%	-0.07%	0.01%

5 Conclusions and Policy Implications

This paper aims at understanding the relationship between international trade integration and growth by assessing the impact of different dimensions of trade integration —namely, trade openness, trade diversification, and export dependence on natural resources— with a special focus on the Sub-Saharan Africa region. Overall, we conclude with the following five takeaways:

First, the Solow decomposition shows that growth of output per worker over the long-term has been overwhelmingly attributed to factor accumulation —especially physical capital accumulation and, to a lesser extent, human capital. The contribution of human capital has been fairly constant in Sub-Saharan Africa regardless of the country groups under analysis. In contrast, the contribution of TFP growth to economic performance over the long-term is detrimental —and, negligible, at best. This may point to a severe misallocation of resources across countries in the region. The relative importance of the source of growth has changed over time, with the contribution of TFP growth becoming positive during the period 1996-2014. However, this contribution might be mis-represented due to the omission of natural capital as an additional input —especially when calculating the sources of growth for resource rich countries in Sub-Saharan Africa. Our calculations show that accounting for natural resource wealth in the production function will over-estimate the contribution of TFP to economic growth.

Second, the extent of international trade integration has increased in the region. Trade volumes have expanded, there is some progress in terms of export product and market diversification, and the dependence on natural resources has slightly declined over time. However, there are two caveats: (a) there is still ample room for improvement in the way that the region is inserted in world trade —particularly if one gauges the distance to the rest of the developing world not only in terms of trade policies but also trade facilitation. (b) Despite the changes observed in the region, there is great disparity in terms of levels and progress of trade integration within the region.

Third, our GMM-IV system estimations provide evidence of a causal relationship between growth and the different dimensions of international trade integration (trade openness, diversification, and the dependence on natural resources). In brief, our regression analysis shows that growth of output per worker is fostered by greater trade openness, lower export product concentration, and reduced dependence on natural resource exports. The finding that trade openness fosters growth is consistent with existing evidence —for instance, see Frankel and Romer (1999) and Chang et al. (2009). Furthermore, it has been argued that diversifying export products and export markets could be beneficial for growth (Lederman and Maloney 2007). We find that export product concentration has a negative and causal relationship with growth per worker. Market concentration, on the other hand, has a positive relationship with growth per worker —although it is not significant to the inclusion of additional controls. This finding implies that significant growth benefits are attained by diversifying the basket of export products rather than shipping goods to a greater number of export destinations. However, export market diversification may have an indirect effect on growth through reduced volatility (Haddad et al. 2010). Finally, we find that the weight of natural resources in the export basket has a negative impact on growth per worker whereas natural resources as a percentage of GDP has the opposite effect. This finding largely suggests that: (a) the concentration of natural resources in the overall export basket may hinder growth to the extent that the export base becomes volatile —that is, vulnerable to fluctuations in international commodity prices. (b) The natural resource sectors, as part of economic activity, may have an impact on growth not only through supply shocks but also demand (to the extent that their extraction leads to job generation in these industries as well as other annex industries).

Fourth, we explore the channels of transmission of greater trade integration by estimating the impact of the three dimensions of trade integration on the sources of growth —that is, growth of physical capital per worker, and total factor productivity (TFP) growth. The growth effects of international trade integration are transmitted through greater accumulation of capital per worker and higher TFP growth. Specifically, trade volumes influence output growth through physical capital accumulation. Trade diversification (especially, export product diversification) fosters growth through greater TFP growth rather than by a faster accumulation of physical capital. Lastly, natural resource exports appear to have an effect on output growth through both channels (physical capital accumulation and TFP growth).

Fifth, there is still significant progress to be made in trade integration and the associated potential growth benefits are economically important. Our comparative statics exercises show that narrowing the gaps in terms of trade openness, export diversification and export dependence of natural resources will render significant gains in growth per worker. Increasing trade openness, decreasing export product concentration and reducing the export dependence on natural resources will have an impact on growth and this impact can be transmitted through either faster capital accumulation or enhanced TFP growth. Narrowing the gaps relative to regional benchmarks shows, specifically, that trade diversification and natural resource dependence generate the largest potential growth gains, and those benefits are largely transmitted through faster capital accumulation. The bulk of the impact of trade openness on economic growth is transmitted through TFP growth. Additionally, looking at the growth effects of the evolution of trade integration over time shows that the largest benefits can be obtained by diversifying the export product basket.

Finally, this paper shows that assessing the impact of foreign trade on growth goes beyond looking at the nexus between trade openness and growth per worker. It also matters what kind of goods the country exports. This is particularly important for countries with abundant natural resources —as is the case of many Sub-Saharan African countries. These countries may typically deal with "*Dutch disease*" —a phenomenon that is characterized by natural-resource industries crowding out non-resource-based industries such as manufacturing (Matsuyama 1992, Sachs and Warner 1999). The inflow of reserves as a product of greater natural resource export revenues is also linked to currency appreciation and loss of competitiveness of non-resource-based activities. Additionally, countries that are abundant in natural resources tend to have lower quality of policies and institutions. It is key for these countries to develop institutions and policies that foster the transformation of the natural resource wealth into other types of reproducible capital (say, human capital and physical capital) and implement policies to promote non-resource activities.

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Annex I: Growth Accounting

Growth accounting analysis decomposes the growth in real output as the weighted average of the growth rate of factors of production —say, labor and capital— and a residual denoted as "*total factor productivity*" (TFP) growth. The latter component —also labeled as the *Solow residual*— represented the portion of economic growth that was not explained by factor accumulation. It was interpreted as a measure of technological change. According to the literature, large differences in real output per worker across countries are overwhelmingly attributed to differences in total factor productivity (TFP) rather than to differences in the stock of either physical or human capital —see, among others, Klenow and Rodriguez-Clare (1997), Hall and Jones (1999), Caselli (2005) and Hsieh and Klenow (2010).[13] The consensus in the literature points to 20 percent of country income differences explained by the accumulation of physical capital and 10-30 percent by human capital. Hence, differences in TFP may account for 50-70 percent of country income differences (Hsieh and Klenow 2010).

The production technology is depicted by the relationship between factors of production and output captured by the following production function (Hall and Jones 1999, Caselli 2005):

$$Y_t = A_t K_t^{\alpha} (hL)_t^{1-\alpha} \tag{I.1}$$

where *Y* is the country's GDP, *K* is the aggregate capital stock, and *hL* is the "quality adjusted" labor force —that is, the number of workers L multiplied by their average human capital *h*. Furthermore, α is the (constant) sensitivity of output with respect to capital, and *A* represents total factor productivity (TFP) or the efficiency with which factors of production are used. Furthermore, it is assumed that there are no adjustment costs in capital accumulation and that there is perfect competition in the markets for production factors, so that the latter are paid their social marginal products.

I.1 Traditional Solow Decomposition

We first express the production function, equation (I.1), in per-worker terms:

$$y_t = A_t k_t^{\alpha} h_t^{1-\alpha} \tag{I.2}$$

where *k* is the capital-labor ratio ($k = K/L$). If we define $\hat{x}_t = \frac{dx_t}{x_t}$, then TFP growth is:

$$\hat{A}_t = \hat{y}_t - \alpha \hat{k}_t - (1-\alpha)\hat{h}_t \tag{I.3}$$

The index of human capital, *h*, is constructed using the average years of schooling in the population over 25 years old (Barro and Lee 2013). Following Hall and Jones, the years of schooling are converted into a measure of *h* through the

[13] In a comprehensive survey, Caselli (2005) finds that factor accumulation cannot explain more than half of the differences in income per capita across countries.

formula $h = \phi(s_{it}) = \phi_i \cdot s_{it}$ for each country *i* in period *t*—where the returns to education are heterogeneous across countries. We use a set of Mincerian returns estimated by Montenegro and Patrinos (2014).[14]

I.2 Accounting for the accumulation of private and public capital stock

We decompose the stock of capital of the economy into the stocks of private and public capital (denoted by the sub-indexes *p* and *g*, respectively). The production function in (1) now becomes:

$$Y_t = A_t K_{pt}^{\alpha_p} K_{gt}^{\alpha_g} (h_t L_t)^{1-\alpha_p-\alpha_g} \tag{I.4}$$

where K_p and K_g represent the private and public capital stock, respectively. Again, TFP growth here can be expressed as:

$$\hat{A}_t = \hat{y}_t - \alpha_p(\hat{K}_{pt} - \hat{L}_t) - \alpha_g(\hat{K}_{gt} - \hat{L}_t) - (1 - \alpha_p - \alpha_g)\hat{h}_t \tag{I.5}$$

To compute the values for α_p and α_g, we follow the calibration implemented by Lowe, Papageorgiou and Perez-Sebastian (2012). The coefficients α_p and α_g cannot be directly derived from national income and product accounts data. However, the share of reproducible capital, $\alpha_g + \alpha_p$, can be calculated as 1-*labsh*, where *labsh* is the labor share reported in the Penn World Tables 9.0 (Feenstra, Inklaar and Timmer 2015).[15]

Estimating the composition of capital is not trivial. Following Lowe et al. (2012) we take estimates of the production function from the literature; notably, Kamps (2006) for advanced economies and Gupta et al. (2011) for low- and middle-income countries. The estimates are summarized in Table I.1.

Table I.1. Estimates of output elasticity to private and public capital

	Elasticities		Relative Share	
Sample	Private Capital [1]	Public Capital [2]	Private Capital [1]/([1]+[2])	Source
Low-Income Countries	0.23	0.25	0.48	Gupta et al. (2011)
Middle-Income Countries	0.29	0.17	0.63	Gupta et al. (2011)
Advanced Countries	0.26	0.22	0.54	Kamps (2006)

We use the estimates from Table I.1 to calibrate the relative income shares of private and public capital for advanced countries, middle- and low-income countries. The relative income share of private capital is computed as $\alpha_p/(\alpha_g + \alpha_p)$ and it is reported in the third column of Table I.1. The income shares for private and public capital —α_p and α_g, respectively— are then computed using the estimated relative income shares (which vary across groups) and the PWT 9.0 labor share (which varies across countries and over time).

[14] In both cases, whenever there are data on years of schooling and no data on returns for a specific country, we input the average returns on education of its corresponding region.

[15] Note that *labsh* is heterogeneous across countries and displays some time variation within each country.

I.3 Accounting for natural resource wealth

Assume that the technology used by natural resource rich countries can be specified as follows (Monge-Naranjo, Sánchez, and Santaeulalia-Llopis 2017):

$$Y_t = A_t\left(K_t^{\gamma} T_t^{1-\gamma}\right)^{\alpha} (h_t L_t)^{1-\alpha} \tag{I.6}$$

where K is the aggregate stock of capital, T represents the service flows of natural resources, and $\alpha(1-\gamma)$ is the natural resource share in GDP. The income share of natural resources uses data on the rents from natural resources. These data are collected from the World Bank's World Development Indicators (WDI). In this context, TFP growth is:

$$\hat{A}_t = \hat{y}_t - \alpha\gamma\left(\hat{K}_t - \hat{L}_t\right) - \{\alpha(1-\gamma)\}\left(\hat{T}_t - \hat{L}_t\right) - (1-\alpha)\hat{h}_t \tag{I.7}$$

Since α is calculated from the share of labor force in PWT 9.0 and $\alpha(1-\gamma)$ is proxied by the ratio of natural resource rents to GDP from WDI), we can implicitly compute γ.

If we assume a different specification —say, a natural-resource-augmented production function in the same spirit of equation (7):

$$Y_t = A_t K_t^{\alpha} T_t^{\gamma} (h_t L_t)^{1-\alpha-\gamma}$$

where α and γ represent the share of reproducible and natural capital in GDP. Let us again define TFP growth when we do not account for natural resources as $\hat{A}_t = \hat{y}_t - \alpha\hat{k}_t - (1-\alpha)\hat{h}_t$. Hence, TFP growth in the model that accounts for natural capital, $\hat{A}_t^{NR}$, is equal to:

$$\hat{A}_t^{NR} = \hat{A}_t + \gamma\left[\left(\alpha\hat{k}_t + (1-\alpha)\hat{h}_t\right) - \hat{T}_t\right] \tag{II.11}$$

where the difference between the traditional TFP growth —equation (3)— and the measure of TFP growth including natural capital —equation (12)— depends on the growth rate of the composite input index from the classical model (Solow Decomposition I) and the growth in the use of natural capital T as well as the share of natural capital rents in production —see Brandt, Schreyer, and Zipperer 2017).

Table A1. Descriptive Statistics

Full sample, 5-year averages

Variable	*Observations*	*Mean*	*Std. Dev.*	*Min*	*Max*
GDP per worker	1281	9.782	1.23	6.73	13.19
Growth rate of GDP per capita	1279	0.013	0.04	-0.38	0.26
Capital per worker	1281	10.840	1.44	5.91	14.30
Growth of capital (logs)	1279	0.020	0.04	-0.12	0.41
Growth of TFP (WB) /100	1214	0.001	0.03	-0.29	0.36
Trade openness	1291	4.157	0.61	-1.54	6.08
Herfindahl markets	1001	-1.915	0.67	-3.28	0.00
Herfindahl products	999	-2.130	1.18	-4.77	0.00
Natural resources, % of GDP	1024	2.115	1.05	-2.01	4.62
Natural resources, % of total exports	1054	-0.788	0.78	-3.69	0.21
Secondary enrollment	927	3.672	0.87	-0.29	4.61
ICRG Political Risk	1109	0.021	1.66	-3.40	3.36
Credit to private sector	1195	3.577	0.97	-2.55	5.82
Government consumption	1233	2.698	0.41	0.78	4.07
Volatility	1279	0.041	0.05	0.00	0.57