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Understanding Economic Growth in Ghana in Comparative Perspective

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Abstract

Ghana has experienced a decade of solid and exceptionally high growth. Between 2005 and 2015, income nearly doubled. This paper analyzes the factors driving this impressive growth performance, using tools such as structural change decompositions and growth regressions. For the comparative perspective, the paper compares Ghana with its structural and aspirational peers. The paper finds that the contribution of structural change to growth has been limited and attributes this to labor that was freed up in agriculture not being absorbed by high-productivity sectors. Looking at factors that drove growth since 2000, financial development and infrastructure had the most important impacts. A benchmark analysis suggests that those areas should remain the policy focus over the longer term, but that near-term priority should be given to stabilization policies.

Understanding Economic Growth in Ghana in Comparative Perspective

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Highlights:
- We investigate factors that have driven Ghana's recent growth performance in comparative perspective.
- Structural change provided relatively little impetus to aggregate productivity growth.
- Stabilization policies, infrastructure, and job creation in higher-productivity sectors offer viable sources of income gains.

1. Introduction

Historically one of the world's poorest countries, Ghana has experienced periods of stabilized and accelerated growth since 1990. As Figure 1A depicts, the 1990s were characterized by a stabilization of previously volatile growth. The average real per capita growth rate of 1.7 percent during that decade was only slightly below the 2 percent historical average which Summers and Pritchett (2014) calculated for all countries since 1950. Thereafter, growth picked up and remarkably accelerated after 2005, with annual p.c. GDP growth at 4.5 percent since.[1] This period, when the country escaped lower-income status, can be seen as a growth acceleration in the sense of Hausmann et al. (2005). However, regression to the mean and increased volatility of growth during that period are also evident.

Figure 1: GDP growth in comparison over time and regions

A. Real GDP p.c. growth in Ghana **B. Real GDP growth p.a. since 2005 in comparison**
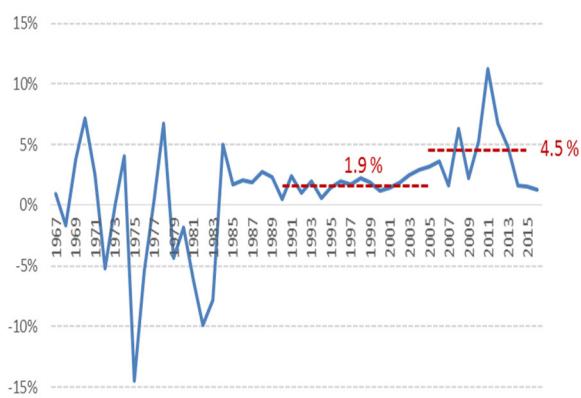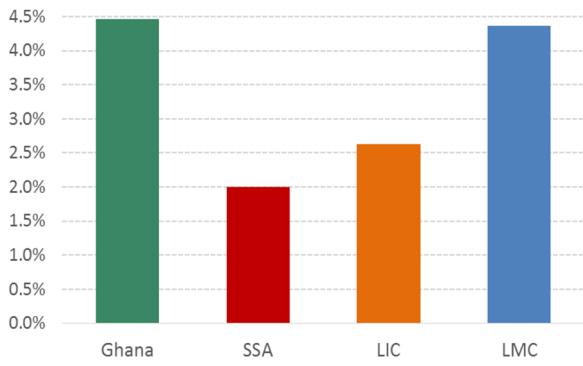
Source: own calculation based on WDI; SSA = Sub-Saharan Africa (excluding high income), LIC = low income countries; LMIC = lower middle income countries.

Comprehending Ghana's most recent growth performance is important beyond the country itself for several reasons. First, as Diao and McMillan (2015) argue, growth in Africa is not understood well. This has spurred macroeconomic studies of the region in comparative or country-level perspective (see Diao and McMillan, 2015; Moller and Wacker, 2017; Rodrik, 2018; and references therein). Second, within the region, Ghana's performance is outstanding: As Figure 1.B highlights, growth was considerably above the (non-high-income) Sub-Saharan African countries' average and also outperformed low-income and lower-middle-income countries, the latter only marginally though.[2] Third, given the prevalence of extreme poverty in several Sub-Saharan African countries, understanding the sources and drivers of growth in Ghana is instructive given its pro-poor nature. Ghana was generally at the forefront of poverty reduction in Africa since the 1990s: between 1991 and 2012, the headcount poverty rate (at $1.90) was reduced by about 34 percentage points. Looking at how growth since 2005 was distributed across the population, data from Ghana's Statistical Service (GSS, 2014) indicate that especially the bottom 15-20 percent of

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[1] Until 2015. All data are own calculations based on WDI data for GDP per capita in constant local currency.
[2] It is also noteworthy that Ghana is included in the reference group of 15 countries that are among the world's poorest and hence serve as a reference point for the international poverty line (Ravallion et al., 2009). While Ghana has the highest income of those countries, its 2005-2015 growth rate was the third-highest in this group (after Ethiopia, 7.7 percent, and Rwanda, 5.2 percent, and equal to Tajikistan, 4.5 percent).

the population over-proportionally benefitted. Having in mind that extreme poverty at $1.90 a day stood at 25.2 percent in 2005, growth was pro-poor in the sense of reducing poverty (Ravallion and Chen, 2003) and in terms of over-proportional income gains of the poor (Klasen, 2004).[3] And finally, Ghana's per capita income level back in 1970 was similar to countries such as Malaysia, the Republic of Korea, or Ecuador that subsequently outperformed Ghana by a large margin. From a growth and development perspective it is thus informative to analyze what those countries did differently and how this fits with Ghana's subsequent catch-up during the last decade.

In this paper, we thus analyze Ghana's recent growth performance using a variety of tools. After a descriptive overview in section 2, section 3 provides a comprehensive analysis of aggregate productivity developments due to within- and between-sector productivity dynamics. Such an exercise is important because in standard neoclassical growth models, in the absence of population growth, total factor productivity is the key 'proximate' source of growth in the long run, whereas productivity developments in Ghana have generally decelerated since the mid-2000s. This exercise hence sheds some light on the within- and between-sector contributions to this trend. Section 4 uses a panel growth regression model to decompose growth determinants in Ghana. This approach aims to identify the 'ultimate' drivers of growth, i.e. changes in policy variables that might influence growth through several proximate channels, including productivity.[4] Section 5 looks at the growth divergence between Ghana and other developing economies since 1970 and asks what countries that we group into "comparator countries" and "aspirational peers" have done or are doing differently in terms of different macroeconomic factors. Understanding potential growth constraints through such a benchmark exercise is also important because Ghana's most recent growth episode took place against the background of a fairly supportive external environment where several low and lower-middle income countries managed to grow at similar or even higher rates. It is thus important to understand the factors that potentially held and hold back growth in Ghana. A final section provides some discussion from a broader development and policy perspective and concludes.

Our key findings add to a vivid current debate on how to best conceptualize growth and its potential in Sub-Saharan Africa. They can be summarized as follows:
- *First*, within-sector productivity increases explain about 80 percent of recent aggregate productivity growth, leaving a limited contribution for structural change to increase aggregate productivity (by labor flowing towards higher-productivity sectors).
- *Second*, Ghana's pattern of structural change is remarkable, yet not unique, for the fact that most labor freed up by productivity increases in agriculture did not find higher-productivity employment opportunities elsewhere. In fact, the sector that has absorbed most laborers is 'wholesale and retail trade', with the economy's lowest productivity and disputable potential to boost sustained growth. This 'Janus-faced' nature of services generally supports the idea of Diao and McMillan (2015) that a clear division between agriculture, manufacturing, and services is of limited help for understanding growth in Africa.

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[3] However, overall income inequality (as measured by the Gini index) also rose, mildly but continuously, over the last two decades. Progress in poverty reduction could hence have been faster, even in the unlikely event that prudent redistribution came at the expense of slightly lower growth (see Schäfer, 2017).

[4] This is a rather optimistic interpretation concerning the capability of growth regressions; a more conservative interpretation is that we assess to what extent changes in policy variables that have strongly correlated with growth in many countries could explain Ghana's recent growth performance.

- *Third*, concerning determinants of growth after 2000, we find especially infrastructure and financial development and, to much lesser extent, schooling to be of relevance.
- *Fourth*, we find that the fundamental drivers of growth identified from our panel estimations cannot explain growth in Ghana after 2010—consistent with the notion that growth during that latter period was mostly cyclical and with our later finding that an insufficient macroeconomic stabilization framework is a potential roadblock for sustaining high growth rates. This adds to a wider debate about the countercyclical resilience of macroeconomic frameworks in Africa (Calderon and Boreux, 2016). Moller and Wacker (2017) have argued for the case of Ethiopia that economies at lower-income levels may use unorthodox macro policies if the costs of those policies are less than potential benefits they may create. Our findings for Ghana clearly indicate that this does not imply neglecting basic macroeconomic stabilization duties.
- *Fifth*, countries that outperformed Ghana since 1970 have made much stronger progress in terms of schooling, macroeconomic management, trade openness, and financial development—areas where key policy gaps for Ghana still exist today.

2. Some stylized facts of growth in Ghana

Looking at GDP from the demand side, most of its increase since 1990 was due to investment and public consumption. As panel A of Figure 2 highlights, real consumption of households in Ghana remained relatively constant since 1990. Consumption of the government and, especially, investment increased remarkably. Imports mostly exceeded exports, leading to an overall slightly negative contribution of net exports to aggregate demand. This pattern of domestic-demand-led growth is representative for most well-performing African economies over the last two decades (see Diao and McMillan, 2015).

Figure 2: Growth descriptives

A. Demand side composition of GDP p.c.   B. Sectoral composition of value added
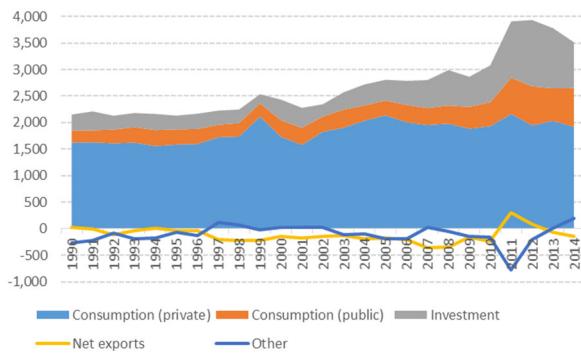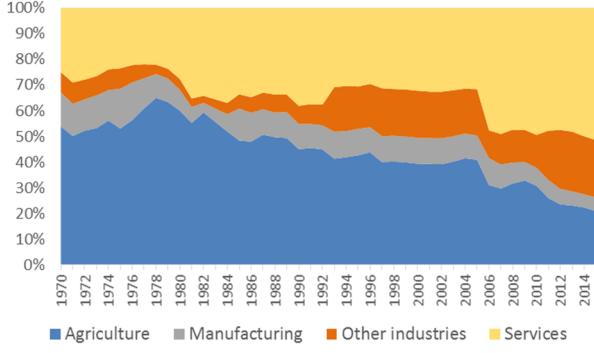
Figure 2: Growth descriptives (ctd.)

C. Sectoral contributions to value added growth
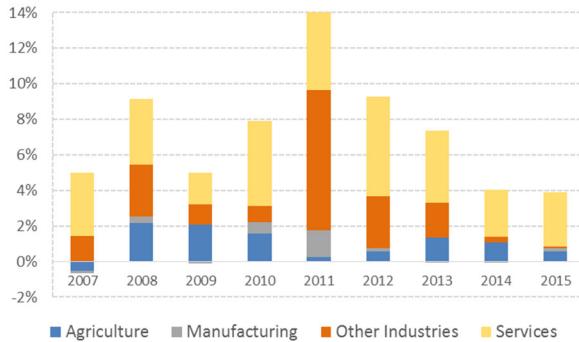
D. Value added per employee
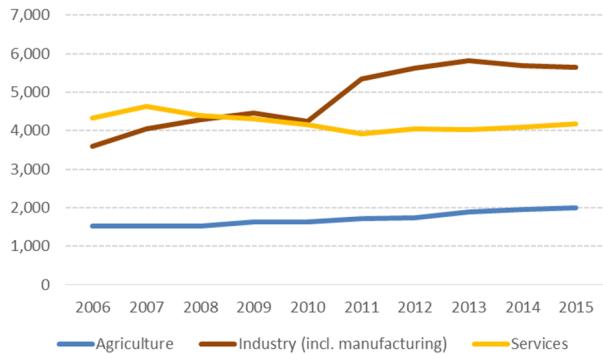
Source: A: PWT 9.0, B: own calculations based on WDI; C: own calculations based on WDI. D: own calculations based on WDI and ILO. Manufacturing includes ISIC-3 divisions 15-37, other industries are ISIC-3 divisions 10-45 without manufacturing (e.g. mining, construction, electricity, water, gas). Note that GDP growth need not match value added growth.

On the supply side, labor accumulation played a large role historically, but the recent growth episode was fostered by capital accumulation and productivity. This can be seen from our growth accounting exercise depicted in Figure 3 (and explained in detail in appendix B1). It shows that human capital accumulation (in terms of labor and education) has always had a positive effect on growth in Ghana (at least since 1970) and essentially was the only factor positively contributing to growth until 1990. Since then, the pattern of growth in Ghana (which also accelerated from the late 1980s, see Figure 1.A) remarkably changed in that productivity and increasingly capital accumulation started to positively contribute to growth. It remains to be seen whether this trend can be maintained in the aftermath of the most recent growth bust. Figure 3 also highlights the close connection between productivity and capital accumulation, with the latter following the former: by raising returns, productivity improvements provide additional incentives for investment, a point recently stressed by Araujo et al. (2017) in the context of Latin America and the Caribbean.

Figure 3: Growth accounting

A. Standard approach

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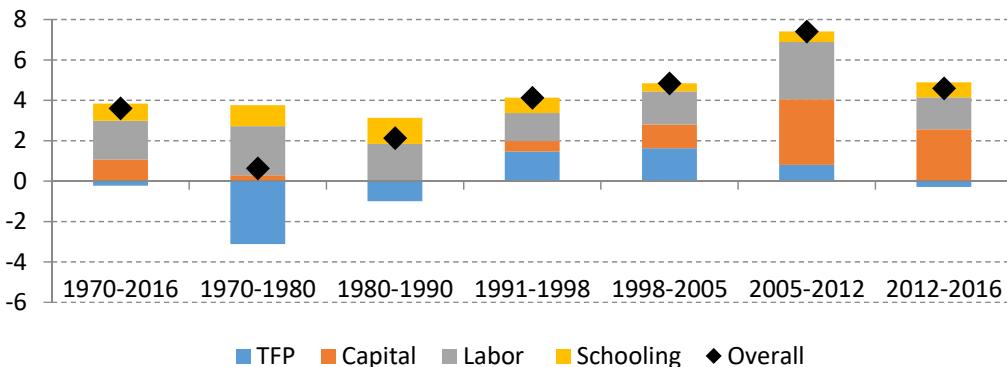
Figure 3: Growth accounting (ctd.)

B. Capital/output ratio approach
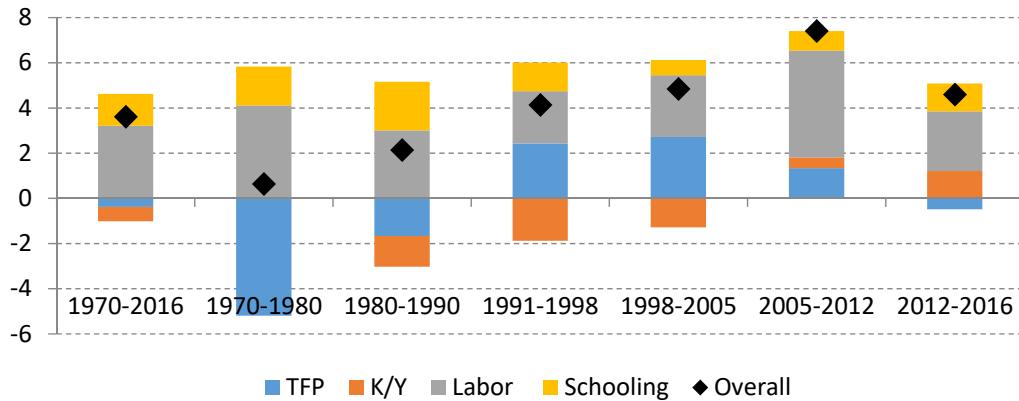
Source: own calculation based on PWT 9.0 and WDI. As the standard approach in the top panel may somewhat over-estimate the contribution of capital accumulation that is really due to productivity-induced capital deepening, we alternatively follow an approach by Klenow and Rodriguez-Clare (1997) in the lower panel that focuses on the capital/output ratio. As one can see, there is little qualitative difference between both approaches, only that the contribution of capital accumulation is qualitatively less in the latter case, as should be. See appendix B1 for details on the methodology and the data.

A sectoral perspective highlights the role of services and structural change: Figure 2.B depicts a typical pattern of structural change where the share of value added declines over time. Somewhat atypically, this was not accompanied by an increasing role for manufacturing, which remained remarkably stable. Labor instead moved straight into the services sector.[5] This is mirrored in Figure 2.C that shows a strong sectoral contribution of services to growth, while the contribution of manufacturing is barely visible for most years. It is important to understand, however, that the relevant growth contribution of services does not stem from productivity increases within the aggregate service sector. If anything, productivity in services was declining after 2005 (see Figure 2.D; the more detailed analysis in section 3 finds no productivity change). Services' relevant growth contribution rather stems from the fact that the overall size of the sector was large (a level effect) and growing (an effect of structural change).

By and large, one could expect this to be a favorable pattern of structural change, as labor productivity in services is about double as high as in agriculture (Figure 2.D). This aggregate picture, however, masks the productivity differences that exist within the services (and also industry) sector and the detailed changes in employment taking place. This motivates our more detailed analysis of structural change in section 3.

3. A detailed analysis of structural change

In this section, we have a more detailed look at patterns of structural change and recent literature of decomposing aggregate productivity changes into productivity changes that take place within

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[5] Note that a revision of the national account statistic was responsible for the considerable increase of the service sector in 2005/2006 as several communication and personal services, recreation services, and professional services were not included in GDP before the revision. Figure 2.B may thus quantitatively overstate the described trends which are nevertheless qualitatively present.

sectors and aggregate productivity changes that are the result of labor re-allocation between sectors with different productivity levels and trends (McMillan et al., 2014; de Vries et al., 2015).[6] We therefore rely on data from the Groningen Growth and Development Centre (GGDC) 10 Sector database (Timmer et al., 2015), with additional information on data and methodology provided in appendix B.2.

The more disaggregated GGDC data reveal that much of the increase in the service employment share since 1990 can be attributed to expanding market services. The strongest employment increase, especially after 2000, took place in the sector comprising wholesale and retail trade, hotels, and restaurants ('wrt', see Figure 4 and appendix Table A.1). Not only does this sector have the lowest labor productivity among the 10 sectors we analyze, but also when comparing this sector across 29 developing countries, as done in McMillan et al. (2014: Table 2), Ghana is the country with the lowest labor productivity within this sector. In our view, this suggests that high-productivity service sectors are not able to absorb most of the labor supply that is especially freed up by productivity increases in agriculture. This may be due to supply constraints (Ghana only ranks 120th in the Doing Business report) and/or because the freed-up labor supply does not have the skills to enter high-productivity services (Ghana ranks bottom in PISA scores) and hence end up in the insulated low-productivity sectors such as retail trade.[7] However, also highly productive service sectors such as transport or business services expanded employment.

To quantify the contribution of structural change to aggregate productivity growth, we use different methodologies to decompose the change in average labor productivity into different components, each with its own economic interpretation (McMillan et al. 2014; de Vries et al., 2015; McMillan et al. 2017; see appendix B2 for details on the methodology). In its basic form, the decomposition splits the change in aggregate labor productivity into a component that results from productivity growth within individual sectors (e.g., innovation) and changes that result from a shift of employers between sectors (e.g. from low-productivity to high-productivity sectors).

A key result of this exercise is that structural change cannot explain Ghana's most recent growth performance. Figure 4 plots the employment changes of 10 different sectors between 1990 and 2010 on the horizontal axis against the productivity of those sectors (relative to overall productivity) on the vertical axis. The size of each dot represents the overall importance of the respective sector (in terms of employment). Figure 4 details the above-mentioned employment dynamics: agriculture saw a drastic decline in employment, which is usually a precondition for labor to flow into above-productivity sectors. However, the sectors with the highest employment increases were trade services ('wrt') and "other" sectors ('oth'), both of which had the economy's lowest productivity. On a positive note, sectors with productivity highly above average also expanded so that in total a positive but very small effect of structural change on aggregate labor productivity remained. This is indicated by the solid regression line pointing out that, on average, sectors that saw an employment increase were those that had a relatively higher productivity.

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[6] See Osei and Jedwab (2016) for another case study. The studies of de Vries (2015) and McMillan et al. (2014) also include Ghana in their sample. The latter mentions that it was one of the relatively few countries where structural change towards higher-productivity sectors was taking place. Our analysis reveals, however, that this aspect was of very limited magnitude.

[7] For potential policies to promote growth-enhancing structural change, see Trenczek (2016).

However, a key result from Figure 4 is that structural change between sectors is not sufficient to explain Ghana's recent growth performance.

Figure 4: Employment and productivity dynamics in Ghana, 1990-2010

Correlation between sectoral productivity and change in employment shares in Ghana (1990–2010)
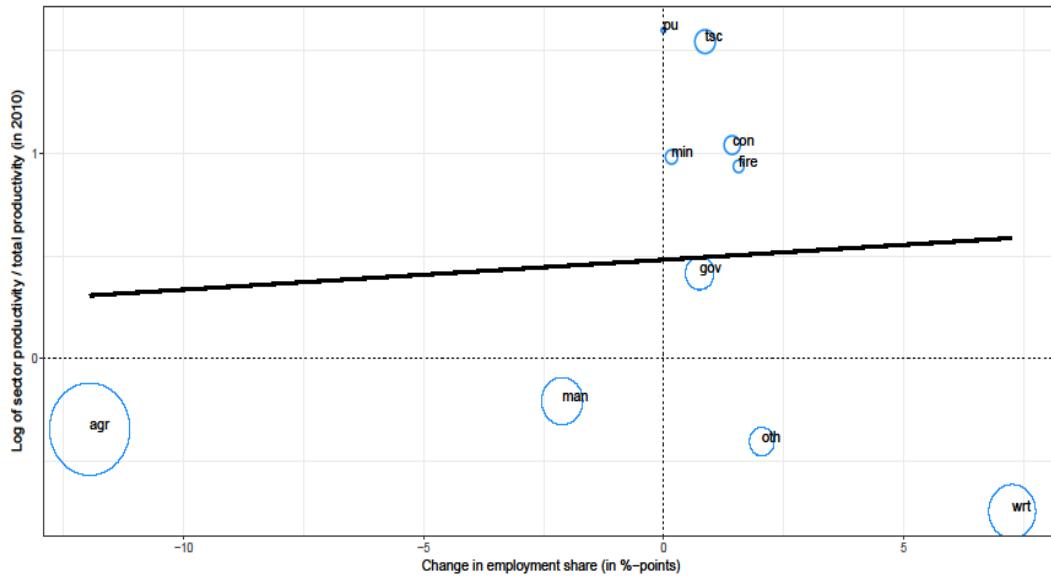
Note: agr = agriculture, min =mining, man = manufacturing, pu =public utilities, con = construction, wrt = trade service, tsc = transport services, fire = business services, gov = government services, oth = other services.

Over the last decades, the key contribution to aggregate labor productivity growth in Ghana rather came from productivity growth within sectors:[8] as Table 1 highlights, labor productivity increased by 0.5 percentage points annually during the period 1960-2010. Most of this effect is accounted for by increased value-added production per worker (80 percent). The contribution of structural change to productivity gains increased a bit since 1990, notably for the decade 1990-2000. However, productivity developments within sectors largely determine overall productivity changes in each sub-period.

Table 1: Within-sector and structural change components of productivity by periods (%), 1960–2010

Period	Productivity growth	Within-sector	Structural change
1960–2010	0.5	0.4	0.1
1970–1990	-3.8	-3.7	-0.1
1990–2010	2.9	2.4	0.5
1990–2000	3.2	2.8	0.5
2000–2010*	2.6	2.3	0.3

Source: Constructed from the Groningen Growth and Development Centre 10 Sector database (Timmer et al., 2015).
Note: Productivity growth is defined as the compound annual growth rate in average labor productivity (%). See appendix B2 for details on decomposition methodology

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[8] We can quantify the contribution of structural change to labor productivity growth using a set of decomposition formulas (McMillan et al. 2014; Vries et al., 2015; see appendix B.2 for details on the methodology). Essentially, the decomposition splits the change in aggregate labor productivity into a component that results from productivity growth *within* individual sectors (i.e., innovation) and changes that result from a shift of employers between sectors.

The key productivity improvements took place within agriculture. Table 2 disaggregates Ghana's pattern of structural change and productivity developments over the 1990-2010 period across the 10 sectors analyzed, using a modified decomposition formula suggested by Vries et al. (2015; see Appendix B2 for details). In the leftmost column we can observe that agriculture contributed more than half (1.4 of 2.4 percentage points) to productivity increases within sectors. The remaining within-sector productivity increases were essentially split between manufacturing (0.4 percent) and services (0.6 percent). Such productivity increases in agriculture are often seen as a precondition for industrialization and development. But growth-enhancing structural change can only take place if workers moving out from agriculture find higher-productivity job opportunities.

Table 2: Disaggregated productivity development patterns (1990-2010)

Sector	Total	Component due to:		
		Within	Structural change	
			Static	Dynamic
Agriculture		**1.36**	**0.00**	**0.00**
Industry		**0.42**	**0.17**	**0.05**
Mining		0.05	0.02	0.01
Manufacturing		0.22	0.00	0.00
Public utilities		0.06	0.00	0.00
Construction		0.09	0.16	0.04
Services		**0.59**	**0.56**	**-0.20**
Market services		0.37	0.47	-0.17
Trade services		0.14	-0.01	-0.12
Transport services		0.27	0.16	0.07
Business services		-0.04	0.31	-0.12
Non-market services		0.22	0.06	-0.03
Government services		0.19	0.03	0.01
Other services		0.03	0.03	-0.04
Total economy	**2.93**	**2.38**	**0.70**	**-0.15**

Source: Constructed from the Groningen Growth and Development Centre 10 Sector database (Timmer et al., 2015).
Note: Productivity growth is defined as the compound annual growth rate in average labor productivity (%). See appendix B2 for details on decomposition methodology. Growth-enhancing structural change occurs when labor moves into those sectors whose productivity is above-average in either productivity levels (static gains) or growth rates (dynamic gains).

The service sector absorbed most of the labor moving out of agriculture. The fact that productivity *levels* in the former are higher than in the latter contributed 0.56 percentage points to aggregate productivity growth, mostly driven by business and transportation services (table 2). Despite the relatively small increase in their employment shares, their productivity levels were quite above average (compare Figure 4). However, it seems that Ghana's service sector struggled with absorbing additional labor at levels of marginal productivity similar to existing workers. This can be seen from the dynamic term in Table 2 that captures different productivity *trends* rather than levels. Services' negative contribution of -0.20 percentage points to aggregate productivity growth indicates that while the sector had higher productivity levels than sectors that freed up labor, its increase of productivity over the 1990-2010 period was smaller. Especially trade services, that absorbed most laborers, do not enjoy scale economies and are likely to experience a strongly declining marginal productivity of labor (partially because they are not tradeable from an international perspective). This is reflected in their strongly negative 'dynamic' term. In a sense, these sectors are 'insulated' as they cannot easily integrate into value chains or provide forward

spillovers. Overall, this important sector did not contribute to aggregate productivity increases as small improvements within the sector were washed off by dynamic structural change effects.

Manufacturing, where prospects for scale economies are more promising, saw an employment decline and in Ghana historically suffers low productivity levels (see Figure 4) inter alia due to lagging technical efficiency of firms, firm dynamics, and a strong link between wage levels and firm size that weighs on international competitiveness (see Teal, 1999 and Davies and Kerr, 2018). The latter does not only constitute a problem in itself but also limits the potential for business services or what Diao and McMillan (2015) call 'in-between firms' to form linkages. This is illustrated by the fact that business services experienced negative within-sector and 'dynamic' productivity developments (table 2). After identifying key drivers of growth in the next section, we hence apply a benchmarking analysis in section 5 that might provide some indication about potential macroeconomic constraints.

4. Drivers of the recent growth performance

To better understand the nature of growth in the past two decades, we use insights from cross-country growth regressions to decompose growth determinants in Ghana. This methodology is based on recent studies by Araujo et al. (2016) and Moller and Wacker (2017). It essentially uses panel growth regressions for a sample of 126 countries (listed in Table B.5) over 5-year averages in the time period 1970-2010 and estimates the respective parameters using System GMM (Arellano and Bover, 1995; Blundell and Bond, 1998). Those parameters are then multiplied with developments of the explanatory variables in Ghana over several 5-year periods until 2015.[9] This allows us to predict growth based on the econometric growth model and identify the determinants that are most likely to have driven structural growth in Ghana over the respective period.

This approach is well-founded by growth theory and captures long-run drivers of growth. The setup of the econometric model can be shown to be a functional representation of the standard neoclassical growth model. Specifically, the lagged dependent variable ('persistence') captures the (smooth) transition of a country towards its own steady state while the remaining explanatory variables capture structural factors that are most-conventionally thought to drive growth in the long run, such as human capital accumulation or financial development. As Tables 3 and B.6 indicate, all parameter estimates of the model are in line with economic theory. It should be noted that this method aims to identify structural, not cyclical drivers of growth. This is especially achieved through 5-year averaging and the System GMM methodology which is careful not to confuse changes in a variable with a temporary shock. For example, temporary government consumption might help to cyclically bring up growth, especially in times of a severe output gap. However, structurally high government consumption (conditional on existing variables such as educational attainment) will most likely lead to distortions in the economy and lower potential output.

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[9] We use the exact model and parameters of Araujo et al. (2016) and Moller and Wacker (2017) but had to extend our sample until 2015. Technical and data details about the model and its extension to 2015 for Ghana can be found in appendix B3.

These drivers of growth are grouped into the categories of structural, stabilization, and external effects.[10] "Stabilization" variables contain inflation, banking crises and the real exchange rate,[11] capturing the idea that macroeconomic fluctuations can influence growth over an extended period. "Structural" variables capture a broad set of fundamental country characteristics. This includes secondary school enrollment as a proxy for human capital, a measure for trade openness (trade-to-GDP ratio adjusted for population), an institutional variable (polity2), private credit-to-GDP as a measure of financial development, fixed telephone lines per capita as a proxy for infrastructure, and government size measured by government consumption/GDP.[12] "External factors" are reflected in terms of trade and commodity prices, more specifically net barter terms of trade and the country-specific commodity export price index of Arezki and Brueckner (2012). Furthermore, global conditions will also be reflected in the time dummies (although they are not country-specific). The variables can also be inferred from Table 3 and are described in more detail in appendix Table B.4.

The model explains Ghana's past growth experience reasonably well: when looking at the two 5-year periods of the 2000s, the annualized average prediction error of the model is about 0.35 percentage points, as some overprediction in the earlier half is balanced by some underprediction in the latter half (see Table 3). This may be the case, for example, because growth policies in the earlier period did not immediately materialize in de facto growth but only with a delay of some years. Compared to the average annual growth rate of 3.1 percent, the prediction error is quite low and clearly outperforms other growth regression models for African economies, such as IMF (2013). A key deviation, however, arises for the early 2010s (the period between the average 2005-2010 and the average 2010-2015). As we will see, this is not per se a shortcoming of the model, which aims to capture drivers of potential output, but to a large degree driven by the cyclical nature of growth after 2010.

Growth was driven by structural improvements, particularly in infrastructure and financial development: as Table 3 highlights, our variables gauging infrastructure (telephone lines) and financial development (credit/GDP) improved markedly especially during the early 2000s, which explains most of Ghana's growth performance in the 2000s. For the latter half of the decade, this is also reflected in the persistence term, as initial improvements had a fading-out effect on the growth rate.

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[10] We again follow Loayza et al. (2005), Araujo et al. (2016), and Moller and Wacker (2017) in this regard.

[11] A decrease in the real exchange rate is equivalent to a currency depreciation. As the interpretation of the exchange rate variable is somewhat difficult in the cross-country context it should rather be seen as a control variable, i.e. controlling for the fact that an undervalued exchange rate might boost growth temporarily.

[12] Increases in government consumption / GDP (including increases of the public sector wage bill) are empirically associated with lower long-term economic growth. This is because this type of non-productive public spending would need to be financed either by distortionary taxation (Afonso and Furceri, 2010) or increased public borrowing, both of which are associated with lower growth in the long run. Growth-enhancing public spending, such as infrastructure development or education are already captured by other variables in the model, including lagged GDP.

Figure 5: Regression results: Key Growth Drivers in Ghana (Real GDP per Capita).
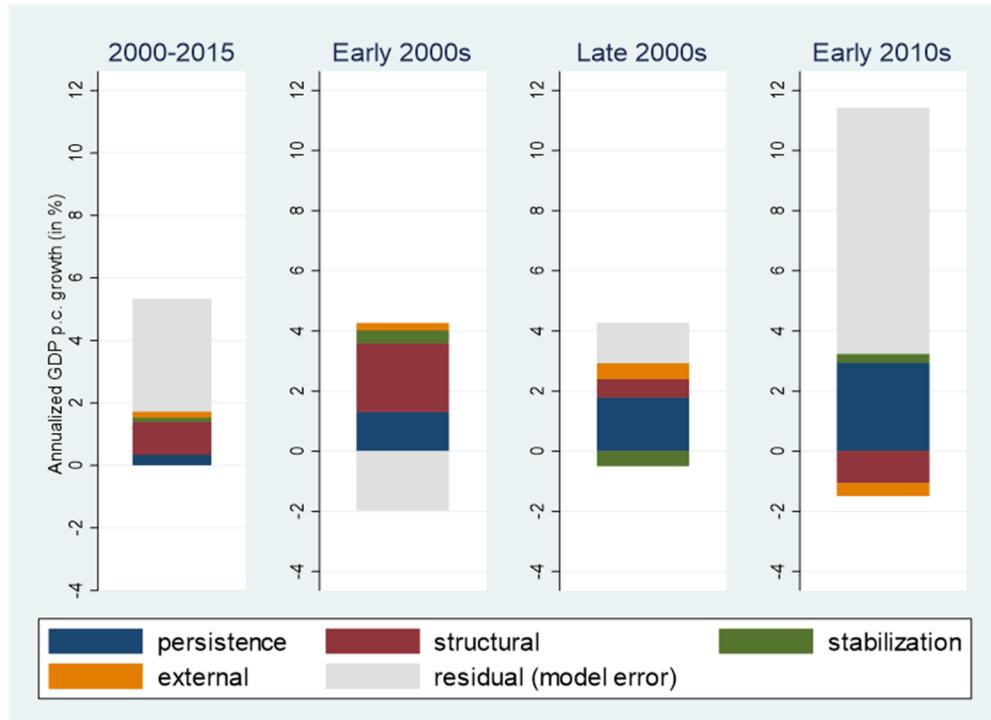
Source: see Table 3.

Improvements in the country's commodity exports' prices and associated terms of trade gains mildly supported growth over the full 2000-2015 period by 0.2 percent p.a., with the strongest impulse of half a percentage point p.a. during the late 2000s. Similarly, macroeconomic stabilization policies concerning inflation, the real exchange rate and financial stability (gauged by banking crises) overall added some, though little, to explain growth since 2000. These contributions are depicted in Table 3 and Figure 5.

Table 3: Parameter values, changes and predicted growth effects (real GDP per capita)

	parameter	2000-2015		early 2000s		late 2000s		early 2010s	
		change	*predicted effect*	*change*	*predicted effect*	*change*	*predicted effect*	*change*	*predicted effect*
Persistence	0.781	0.189	0.118	0.084	0.066	0.115	0.089	0.189	0.148
Structural:									
Δln(schooling)	0.018	0.508	0.016	0.056	0.001	0.245	0.004	0.207	0.004
Δln(credit/GDP)	0.074	0.565	0.072	0.264	0.020	0.104	0.008	0.196	0.015
Δln(trade/GDP)	0.082	0.086	0.012	-0.135	-0.011	0.222	0.018	0.000	0.000
Δln(govt C)	-0.262	0.142	-0.064	-0.082	0.021	-0.085	0.022	0.308	-0.081
Δln(tele lines)	0.141	0.346	0.084	0.627	0.088	-0.129	-0.018	-0.152	-0.021
Δln(institutions)	-0.003	0.379	-0.002	0.314	-0.001	0.065	0.000	0.000	0.000
Stabilization:									
Δln(inflation)	-0.011	0.145	-0.003	-0.016	0.000	0.253	-0.003	-0.092	0.001
Δln(exch rate)	-0.064	-0.076	0.008	-0.202	0.013	0.336	-0.021	-0.211	0.013
Δ bank crisis	-0.040	-0.200	0.014	-0.200	0.008	0.000	0.000	0.000	0.000
External:									
Δln(TOT change)	0.118	0.004	0.001	-0.017	-0.002	0.085	0.010	-0.064	-0.007
Δln(commodity prices)	10.482	0.002	0.028	0.001	0.013	0.002	0.017	-0.001	-0.014
predicted growth			0.312		0.216		0.126		0.057
annualized			**1.9%**		**4.3%**		**2.5%**		**1.1%**
actual growth			**5.3%**		**2.3%**		**3.8%**		**9.9%**

Source: Authors' calculation, obtained by inserting Ghana's values for the explanatory variables and using the regression coefficients of the baseline model presented. Note that results for the period 2000-2015 need not be consistent with the aggregation of the three included 5-year periods because the former uses the growth between the early 1980s and the late 1990s a lagged dependent variable in the persistence term which is not reflected in the 5-year intervals.

Observed growth rates since 2010 are largely cyclical and not justified by the policies captured by the model. This can be seen from the fact that the model generally predicts growth quite well but not for the period 2010-2015 (see rightmost panel in Figure 5). During this period, especially excessive government consumption held back structural growth drivers (see Table 3). It is important in this context to distinguish between actual output (a combination of potential output and cyclical factors) and long-run potential output. This is illustrated in Figure 6 which uses the standard Hodrick-Prescott filter to decompose actual GDP into an estimate of the trend of potential output (blue line) and cyclical fluctuations. Our econometric model, particularly the use of 5-year averages and of the System-GMM estimator, focuses on the determinants of long-run potential output. That is also why government consumption enters the model negatively: having already controlled for the growth-enhancing factors that public spending achieves (such as education and infrastructure), large public consumption puts a burden on output as the taxes needed to finance it act as a distortion to the economy. Figure 6 adds another important insight: actual output in the period after 2010 was way above potential. This is in line with fiscal spending only temporarily improving output and explains why our model 'underpredicts' growth so severely: because potential output (which the model is supposed to capture) by far did not grow as much as observed GDP. Especially the right panel of Figure 6 highlights that the cyclical deviation from the trend of potential output was enormously large during the most recent growth episode.

The initial boom during this period, peaking in 11.3 percent growth in 2011, mainly reflected increased prices of Ghana's main commodity exports, notably gold and cocoa, and the initiation of commercial oil production in 2011, together with a loose (and possibly election-driven) fiscal policy stance. The bust thereafter saw growth declining four consecutive years, down to 1.6 percent in 2015, and reflected a combination of declining commodity prices, energy rationing (partly due to reduced hydropower output in face of drought conditions), and a large fiscal crisis in 2013. Avoiding such boom-and-bust cycles is an important goal of stabilization policies, since such volatilities can themselves have negative impacts on long-term output.[13]

Figure 6: Cyclical and trend GDP p.c.

A.   **Real GDP p.c. against its trend potential**   B.   **Cyclical component of real p.a. GDP**
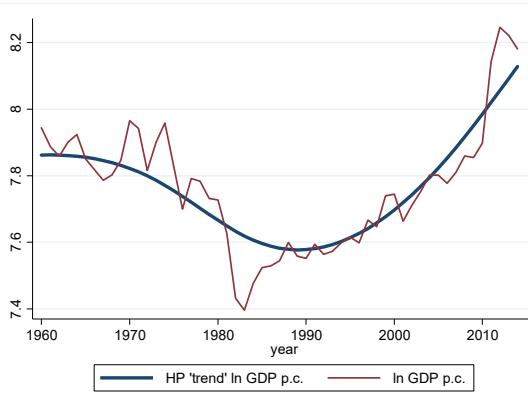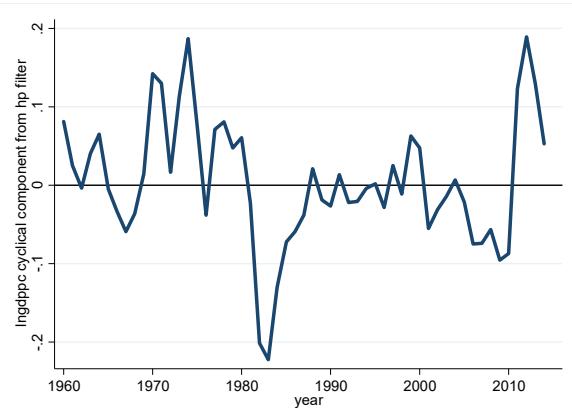
Source: own calculation based on annual data from PWT9.0. The smooth blue line in the left panel is an estimate of potential output (measured as log GDP p.c.) with cyclical fluctuations (red line) around it. The latter component is separately displayed in the right panel. A positive value here indicates that output is 'above potential'.

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[13] There is a vast literature addressing this relationship, staring with the seminal paper by Ramey and Ramey (1995).

Given the potential role of pro-cyclical policy and growth volatility in Ghana and the recent literature on macroeconomic frameworks in Sub-Saharan Africa (Calderon and Boreux, 2016), we also re-estimated the baseline model with the 5-year standard deviation of growth in the respective 5-year period as an additional explanatory variable.[14] According to our estimates, cyclical volatilities cost Ghana about 0.3 percent of growth p.a. over the whole 2000-2015 period, with the strongest drag on growth in the early 2010s (0.7 percent p.a.). This is in line with the magnitudes of cyclical volatilities documented in Figure 6 and supports our interpretation that the deviation of our growth model from the observed growth rate is mostly due to the cyclical nature of growth after 2010.

Overall, these results suggest that Ghana should revert to more conventional stabilization policies and prioritize structural reforms going forward. On the one hand, pro-cyclical fiscal spending and associated macroeconomic volatility have been a restraint to economic growth. Correspondingly, recent inflation developments also show a trajectory towards highly critical levels. While economies like the Ghanaian clearly do not need a level of price stability similar to most-industrialized countries, some modest improvement in macroeconomic stabilization and inflation containment would potentially lead to large benefits (see Kremer et al., 2013). On the other hand, potential output and its long-run drivers have developed much slower than actual GDP for other reasons as well. Hence, structural improvements are needed to increase potential output and sustain the recent growth performance. Given fiscal and political constraints, it is important to assess which reforms will potentially bring the highest output improvements or, put differently: which current areas are most constraining to growth of potential output. The next section will offer such an assessment.

5. The long-run challenges of economic growth: A comparative analysis

In this section, we compare Ghana to two groups of countries: a 'comparator' group and a group of 'aspirational peers'.[15] While the former are economies that are structurally similar to Ghana and stand at similar income levels, the latter have overtaken Ghana's income level at some point. We compare Ghana to these peer groups by a benchmarking exercise covering levels and historical trends in those key drivers of income and growth presented in section 4 and furthermore look in more detail at patterns of structural change in four countries from the group of aspirational peers. This exercise informs prioritizing policy and structural reforms in the context of fiscal constraints, as identified in the previous section, and also helps understanding Ghana's development from a comparative perspective.

Table 4: Benchmarking groups and levels of GDP p.c. (PPP)

Comparator group		Aspirational peers	
Myanmar	5,344	Republic of Korea	35,104
Nicaragua	4,453	Malaysia	23,158
Mauritania	3,409	Belarus	20,290
Kyrgyzstan	3,359	Algeria	12,812

[14] This somewhat alters other results of the model, see also the results in Araujo et al. (2016: Table B.20) who use the output gap and fluctuations around potential output as volatility measures. Results for the overall regression are available upon request. Note that our result of a growth drag of 0.3 percent hence cannot be simply subtracted from the prediction results of Table 3 and Figure 5.

[15] The countries selected as comparator and aspirational peers are identified using the same methodology of the parallel Systematic Country Diagnostics, which was carried out in 2017 and 2018 through the World Bank Group Country Team working on Ghana. See Annex 1 for details: World Bank 2018. However, we added, on a normative basis the Republic of Korea, Malaysia, and Vietnam to the group of aspirational peers, as they are prominent in the contemporaneous policy discourse in Ghana.

Comparator group		Aspirational peers	
Côte d'Ivoire	3,352	Colombia	12,599
Kenya	2,769	Dominican Republic	12,511
Cameroon	2,682	Peru	10,993
		Ecuador	10,968
Ghana	3,570	Jordan	10,456
		Paraguay	8,284
		Vietnam	5,353
Average (unweighted, w/o Ghana)	3,624	*Average (unweighted)*	*14,775*

Source for GDP and population data: PWT 9.0. Data is from 2014, the last year in PWT 9.0.

The potential of such an exercise for our wider understanding of development becomes evident from Figure 7: in 1970, none of the depicted countries (7/11 members of the group of aspirational peers listed in Table 4[16]) had a per capita GDP level (in PPPs) of more than 10 percent above Ghana's; the income level of Korea, Paraguay, and Vietnam was even 27, 30, and 72 percent below Ghana's, respectively. The subsequent growth performance of Korea and Malaysia was outstanding but also all other countries significantly outperformed Ghana over the following decades. They widened their income gap over Ghana during the 1970s, with the only exception of Vietnam that took over in the early 2000s.

Figure 7: Divergence of income levels since 1970
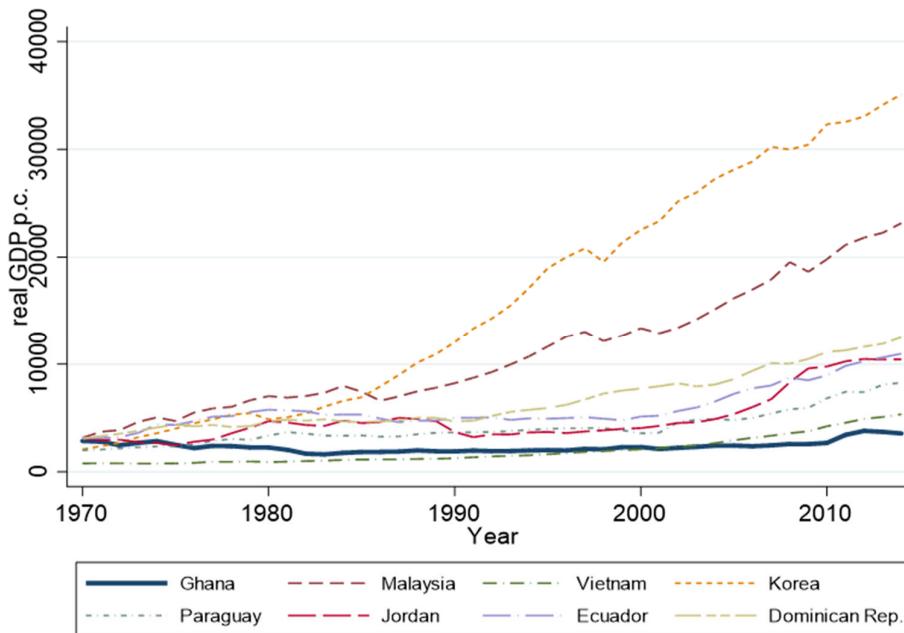
Source: own calculations based on PWT 9.0

What can explain this divergence in income levels? To help answer this key question of economic growth and development, we start with a comparison of long-run developments in key income drivers. More precisely, we look at the starting level (in the early 1970s) of those

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[16] 'Aspirational peers' are seen as good examples of development for Ghana. They were selected based on the following criteria: a) agrarian in 1990/92 (above world average), b) income level in 1990/92 (lower middle income: between USD 500 and 2,500), c) income level in 2016 (upper middle income: between USD 3,500 and 7,000), and d) poverty rate (USD1.90) about half of current Ghana (7 percent or lower). In addition, aspirational peers include Korea, Malaysia, and Vietnam, as they are often used as comparators in the policy discourse in Ghana.

variables in Ghana and the group of aspirational peers and their subsequent developments until the late 2010s.[17] The resulting graphs, combined in Figure 8, are essentially convergence plots for the respective variables. For example, the top left panel shows that sampled countries starting out with lower schooling levels in the early 1970s have, on average, seen faster improvements thereafter. Applying this exercise to the potential drivers of growth identified above gives us some candidates of explanatory variables that have contributed to the growth and income divergence over that time period.

From Figure 8 one can clearly see that all countries of the group of aspirational peers for which data are available outperformed Ghana in terms of increases of secondary school enrollment and reductions of inflation rates. The weak performance concerning inflation is particularly worrisome as Ghana already started out with high inflation rates in the early 1970s. Additionally, Ghana was one of the few countries in that group where government consumption has increased, not declined. Against the background that key public goods that governments should finance to spur growth (such as education or infrastructure) did not improve considerably over the investigated period, this is additional evidence for potential shortcomings in the macro framework that could be improved, for example, by more prudent monetary policy and a better prioritization of public investment spending. Finally, it is worth noticing that almost all of the sampled countries with strong growth performance have opened up more to trade than Ghana since the early 1970s. Finally, one can see convergence in real exchange rate valuations: countries that started out with overvalued exchange rates in the 1970s saw them decline over the following decades and vice versa, as economic theory suggests. One can also see that Ghana started with the most overvalued real exchange rate and hence also saw a strong subsequent decline. Falling behind the sampled countries with strong growth performance hence cannot be attributed to particularly unfavorable real exchange rate developments.[18]

In terms of financial development (top right panel of Figure 8), Ghana started out at a very low level to begin with but did not manage to catch up to other aspirational peers. Especially the fastest-growing economies of Korea and Malaysia saw credit/GDP increasing about twice as fast as Ghana. In terms of infrastructure, the analysis provides a mixed picture. Ghana started out with a comparably low level of telephone lines, which also developed slower than in other countries thereafter. Similarly, coverage of mobile phones was low in the late 1990s, but Ghana managed to catch up at reasonable speed in the decade thereafter. In terms of roads, Ghana started at an average level in the late 1980s and saw the fastest increase among the sampled countries in the two decades thereafter.

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[17] Reliance on the 2010 data allows us to use the data set from the growth regression exercise above. Besides consistency, this also avoids missing data points in more recent years whereas these years are unlikely to substantially change the depicted pattern. Note that for data such as roads and cell phone subscriptions we had to use later starting points since no (or not enough) data were available in the 1970s.

[18] We did not compare terms of trade changes, banking crises, and commodity price changes because those are cyclical 'shock' variables whereas all depicted variables are mainly 'level' variables. For example, a low *level* of schooling in 1970 could suggest a catchup in education over the following decades, reflected in higher *changes* of schooling. However, a banking crisis in the early 1970s or a positive terms of trade *change* in the early 1970s is not indicative of any changes in banking crises or accelerated/decelerated (=2nd differences) terms of trade developments in the subsequent decades. Inflation is a special case because even though it is no level variable in the strict sense (since it captures price changes), we view it as capturing the level, or stance, of macroeconomic inflation management.

Figure 8: Developments in key income drivers relative to aspirational peers since 1970
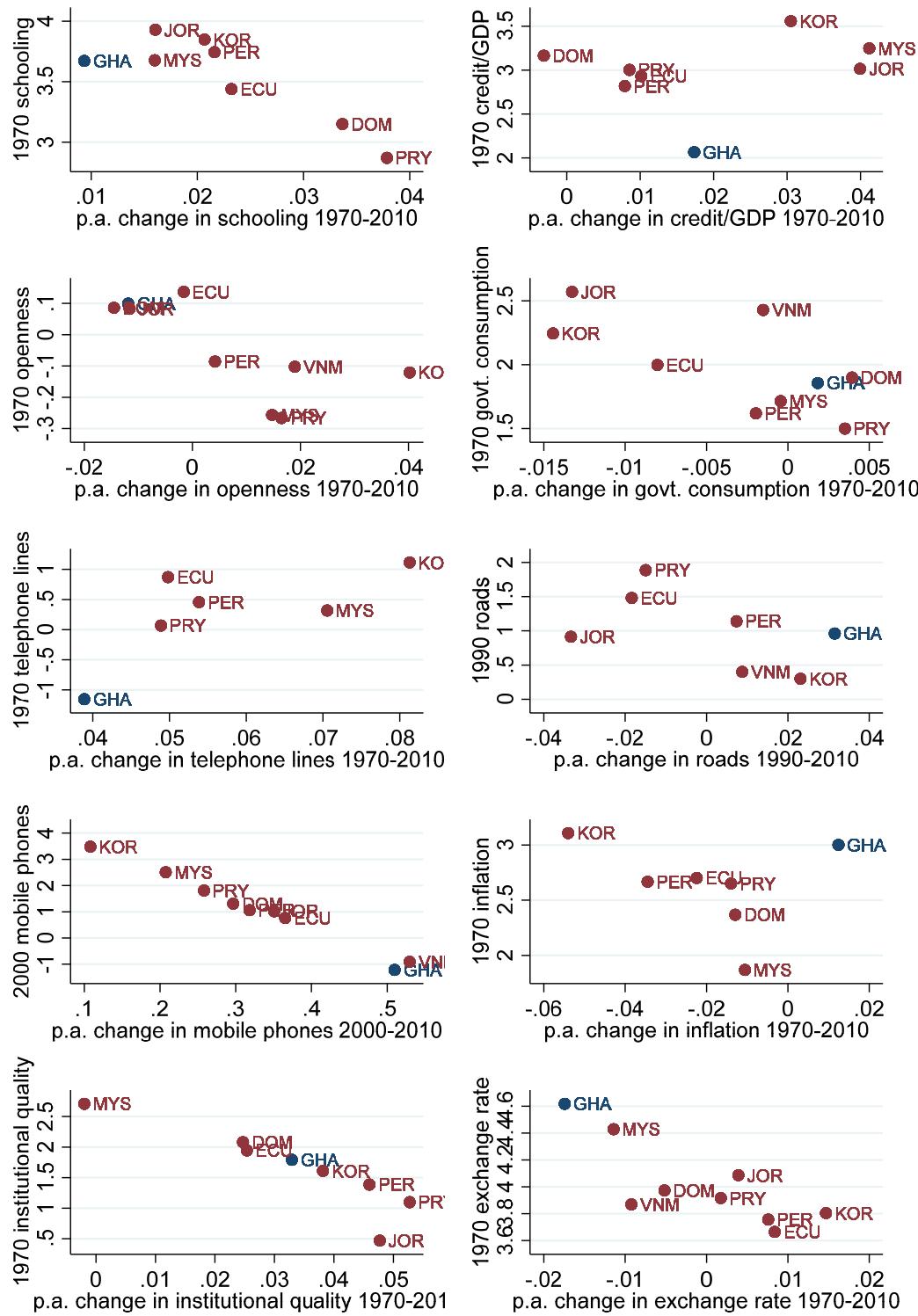
Next, we compare key variables in terms of quantiles that allow assessing distance to the frontier. For the variables in Figure 8 above, we compute Ghana's quantile within the two respective benchmark groups, 'aspirational peers' and 'comparator countries' which have been identified according to four criteria that would make a country relatively similar to Ghana.[19] That means, if Ghana performs best on the respective variable (within the comparison group) it gets a value of (close to) 1 and if it performs worst, a value of (close to) 0. A value of 0.5 would accordingly indicate that 50 percent of countries do better, whereas the other 50 percent do worse.[20] This exercise can inform us where policy gaps are particularly large compared to comparator countries and thus helps to prioritize reforms as large gaps usually entail that advancement in this dimensions is not particularly costly and that the existence of the gap might be a particularly binding constraint for further economic development.

The results are depicted in Figure 9. As one can see, roads and institutional quality (proxied by the polity2 index) do not seem to be areas of urgent need for policy action: Ghana comes close to the best performers in those categories, even if compared to the aspirational peers with a much higher income level. Key gaps, however, exist concerning inflation management and aspects of infrastructure, but also regarding schooling, trade openness, and financial development. From Figure 9 it is obvious that Ghana is considerably lagging behind in terms of inflation management and telephone lines: for both variables, it is the worst performer within both peer groups. The same is true for schooling and mobile phones within the group of aspirational peers, which have a much higher income level though. But Ghana also does worse than over half of the countries within the group of comparably similar countries in those two variables (right panel). Finally, Ghana falls short of more than 50 percent of countries in both peer groups concerning trade openness and levels of credit to GDP, a measure for financial development.[21]

Additional insights come from the results of the World Bank Enterprise Surveys. For the Ghana survey, business owners and top managers in 720 firms were interviewed from December 2012 through July 2014. Key data are presented in Figure 10 and compared to results from other Sub-Saharan African countries. Consistent with our benchmarking exercise, access to finance and key aspects of infrastructure are seen as major business constraint by firms—to an extent beyond the Sub-Sahara African average. This is especially true for electricity and water insufficiencies, while transportation seems to be less of an issue (consistent with our benchmarking exercise). The only deviation arises in the area of schooling, where our benchmarking exercise identifies a major gap whereas only 15.3 percent of surveyed firm managers see an inadequately educated labor force as a major business constraint. At the same time, Ghana ranks last in PISA scores for students' mathematics and science performance among 76 countries analyzed. Note, however, that surveys were conducted with existing enterprises only. With a broader educational background of its labor force, new firms may possibly have developed in more productive sectors.

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[19] These criteria were whether a country is/has: a) commodity exporter (World Bank DEC definition), b) agrarian (above world average), c) population between 3 million and 55 million, and d) income level (USD 900 to 2,200). This methodology is based on a World Bank tool called "Find My Friends" that allows to compare development data to identify common characteristics of countries.

[20] More precisely, we calculate quantiles by Hazen's rule, i.e. the quantile is given as Ghana's (inverse) rank (within the respective comparison group) minus 0.5, and then divided by the number of countries in the respective comparison group. Note, accordingly, that the best (worst) performer will not get a value exactly equal to 1 (0). We multiplied variables with a negative effect on growth (government consumption and inflation) with (-1) for the ease of interpretation.

[21] The shortcomings in Ghana's financial system are also investigated in Biekbe (2011).

Figure 9: Ghana's 'closeness to the frontier' to benchmarking countries
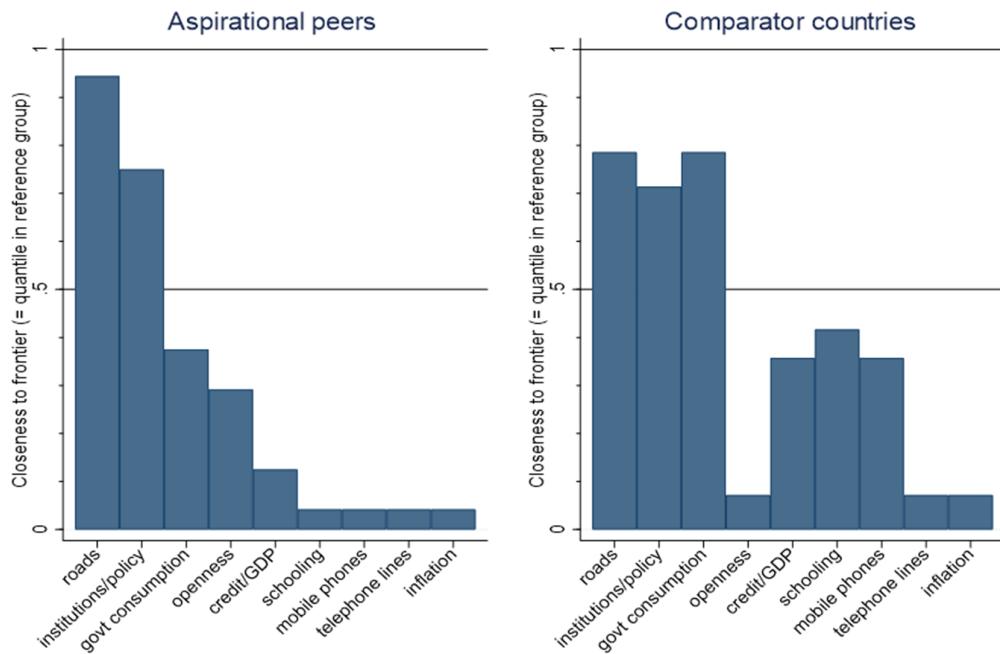
Note: 1 means that Ghana is leading in the respective group, and a value close to 0 means Ghana is achieving least in the respective policy dimension compared to respective benchmarking countries.

In summary, our results suggest that the most promising growth policies going forward are a policy mix of fixing the macroeconomic framework and broad-based progress in structural reforms. The growth costs of pro-cyclical macro policies and the lag of Ghana to comparator countries in this aspect has been well-documented in our analysis. Additionally, countries historically outperforming Ghana have advanced on several structural aspects (schooling, trade openness, financial development) at a faster pace. Together with the existing policy gaps identified, this highlights the need of such structural reforms for sustained growth. One area of reforms is to bring about a more stable macroeconomy through, for instance policies to contain the public sector wage bill to reduce the fiscal imprint of the public sector and allow more space in fiscal policy to respond to changing priorities and circumstances; and to unleash a more diverse economic structure, driven by the private sector, to remove resource-induced volatility and create job opportunities for the population. The latter requires a number of additional reforms to remove private sector constraints such as expanding access to finance, reforming land administration, and broadening the skills set of the population (World Bank, Systematic Country Diagnostics, 2018).

Figure 10: Firms' business constraints in Ghana and Sub-Saharan Africa
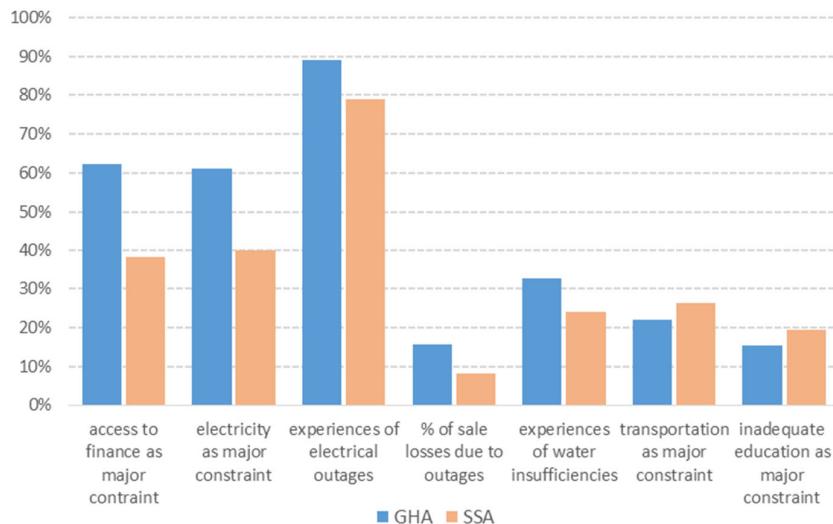
Source: World Bank Enterprise Surveys

An aggregate index for stabilization and structural policies supports the need for such a policy mix. This index is based on the idea in Araujo et al. (2016). For the structural policy index, it adds up the products of the unconditional parameter estimates and the log-levels of each of the following variables: schooling, credit/GDP, openness, government consumption, telephone lines, and mobile phone subscriptions.[22] The same is done for the structural policy variables (inflation, real exchange rate, and banking crisis). The results of each variable multiplied with their unconditional parameter estimate are predicted income levels for the realization of that variable (conditional on country fixed effects). Their sum is then normalized into the interval [0, 1] spanned by the aspirational peers and comparator countries and depicted in Figure 11. Note that this index does not simply add up performances or gaps across policies but weights them by their predicted relevance for growth (within each of the dimensions of stabilization and structural policy). For example, one can observe that Korea (KOR) achieves the highest possible level of the structural policy index. That means that Korea performs best in those structural policy variables that matter for growth. The red and blue dashed lines show the group averages for aspirational peers and comparator countries, respectively. As one can see, Ghana performs rather average in terms of structural policies among comparator countries but significantly falls short in terms of macroeconomic stabilization policies, where it shows the worst performance among both groups.

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[22] Averages of the 2005-10 data are used. Since telephone lines and mobile phones both capture infrastructure, each of them are weighted down by a factor of 1/2. Unfortunately, road data was missing for several peer countries which may somewhat enlarge the structural policy gap for Ghana (which has a relatively dense road coverage). Missing schooling data for Côte d'Ivoire have been interpolated with the growth rate of schooling from the previous period.

Figure 11: Stabilization vs. structural policy indices
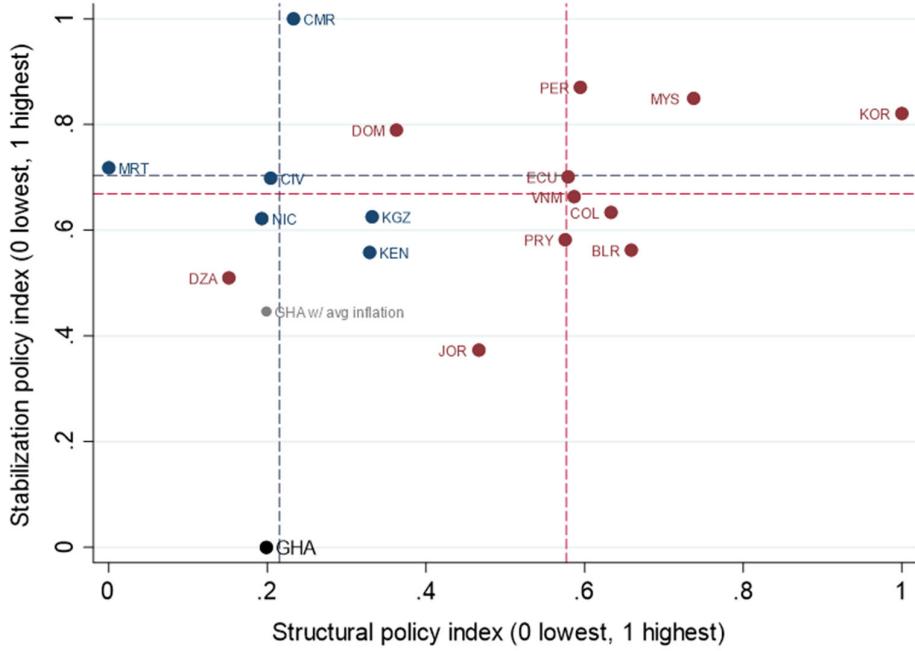
Looking at Figure 11 from a broad perspective reveals some relevant insights. First, most countries are not too far off their respective group midpoints of stabilization and structural policies whereas Ghana's low performance in stabilization policies puts it far away of the midpoint of comparators. Second, there is no significant difference in stabilization performance between Ghana's comparators and the aspirational group but quite some difference in structural policies. Third, the two countries with the highest income level (Korea and Malaysia) perform particularly well in terms of structural policies.[23] Taken together this re-iterates that Ghana needs to quickly fix its macroeconomic stabilization framework, which should be relatively easy to achieve, but for a further and sustained improvement in income levels, focus should gradually shift towards structural policies like some aspects of infrastructure and financial development. Figure 11 also highlights that improvement of stabilization policies is relatively easy to achieve: bringing down the inflation rate from an average 31 percent over the 2005-2010 period to the comparator group average of nearly 7 percent would bring Ghana considerably closer to the overall average of its comparator group (as indicated by the grey dot). While seemingly a large percentage improvement, an inflation rate of 7 percent is far from being over-ambitious.

One more finding underscores the importance of structural improvements in Ghana to sustain growth: the observation that simple gains from structural change are unlikely to materialize. Rodrik (2013a) has already emphasized that growth driven by structural transformation runs out of steam if not accompanied by improving fundamentals. For our analysis, we performed the same structural change exercises as in section 3 for those countries of the reference groups that are included in the GGDC 10-sector database. Results are reported in Table B.3. What stands out is the strong correlation between within-sector and overall productivity growth in virtually all countries and time periods. The contribution of structural change to productivity

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[23] Algeria (DZA), which is an outlier in terms of structural policies to the downside has below-average income within the group of aspirational peers and a sector of mineral products that accounts for about 95 percent of exports.

growth is overall positive (except for Malaysia), but quite small. Static gains are generally depressed by dynamic losses.[24] In no investigated country is there a single period when sectoral change on its own induced relevant aggregate productivity improvements. Fundamental improvements that boost productivity within sectors are hence once again most promising for sustained growth – especially in the case of Ghana because the exercise in section 3 revealed no high-productivity sector that is capable to absorb a huge amount of labor.

Finally, within-sector productivity developments are also a key explanation for the historical divergence between Ghana on the one hand and Korea and Malaysia on the other hand: while sectoral labor productivity grew rapidly in Korea and Malaysia, Ghana experienced a decrease in labor productivity within sectors of more than -1 percent in the period 1975-1990. Since then, within-sector productivity growth has been consistently above 2.3% and only modestly below the improvement of Korea and Malaysia.

6. Concluding remarks

In this paper, we analyzed the considerable growth performance in Ghana since 1990 that especially accelerated in the 2000s. We find that this period coincides with a positive turnaround in the contribution of productivity and capital accumulation to growth. Interestingly, we found that the contribution of structural change to the productivity performance is relatively limited, which stands in contrast to seminal studies in the literature (especially McMillan et al., 2014) but is consistent with our analysis of several peer countries. We attribute this to the fact that labor freed up in the agriculture sector due to productivity improvements did not find employment opportunities in higher productivity sectors on a large scale. While some high-productivity services such as business services and communication have grown and hence had positive effects on aggregate productivity, they could not absorb labor on a large scale; maybe due to their skill requirements, maybe because business services need linkages to demand from other sectors. On the other hand, the sector that absorbed most employment increases was wholesale and retail trade, the sector with the economy's lowest productivity, consistent with Rodrik's (2013b) reasoning that "economic activities that are good at absorbing advanced technologies are not necessarily good at absorbing labor." A key question for macroeconomic development strategies going forward is hence to understand how countries absorb labor freed up from productivity improvements within sectors, so that they do not end up in low-productivity sectors.

The 'Janus-faced' nature of high- vs. low-productivity services documented in the case of Ghana generally supports the idea of Diao and McMillan (2015) that a clear division between agriculture, manufacturing, and services is of limited help for understanding growth in Africa. However, we are less optimistic about the identified pattern of structural change in the particular case of Ghana. While productivity developments within sectors provide a somewhat positive picture, the large labor absorption by wholesale and retail trade is potentially problematic, as this sector is to a significant degree insulated and its ability for linkages with modern and exporting sectors is limited to narrow, usually less labor-intensive, activities that promote the formation of value chains ("supermarket revolution").[25] In terms of policy, there may be

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[24] This is not surprising from an economic perspective, as the declining marginal product of labor makes it unlikely that an above-average productivity sector will continue to experience above-average productivity growth when absorbing a lot of labor—especially when less developed financial markets prevent capital to quickly accumulate in such a sector.

[25] In this context, also see an earlier contribution by Breisinger et al. (2009) on Ghana, who argue that services can support rather than drive economy-wide growth and that considerable focus on the agriculture sector and its

potential for narrow productivity gains, e.g. by promoting foreign direct investment in retail. But, as Rodrik (2018: 16) put it, "achieving productivity gains along the entire retail sector is extremely difficult in view of the heterogeneity of organizational forms and the range of prerequisites across different segments."

Looking into the drivers of overall growth, we especially found financial development and infrastructure to be key drivers of Ghana's growth performance since 2000. This is consistent with the picture that extended periods of growth above the 2 percent historical average call for improvements in structural fundamentals and with the two best-performing economies in our comparative analysis, Korea and Malaysia, that also both saw considerable improvements in those variables.

Going forward, our analysis underscores the relation between short-run and long-run policies. In the short run, fixing the macroeconomic stabilization framework should be a priority given the recent boom-bust episode, our result that the most recent episode of growth (since 2010) was not justified by economic fundamentals, and large policy gaps compared to peer countries in this dimension. The need for further improvements of structural fundamentals to enjoy continued substantial growth rates in the longer run is supported by our benchmark exercise (and consistent with firm-level surveys) showing substantial gaps in some variables capturing structural factors, foremost financial development and aspects of infrastructure. The latter will also be important to foster regional and global trade integration. Improving access to finance, together with other reforms such as removing firms' business constraints and broadening skill levels, may support the development of new firms in less isolated and more productive areas than the traditional wholesale and retail trade sector, boosting growth-enhancing structural change.

Without prudent stabilization policies, necessary investments in many of those growth fundamentals are hard to finance. Additionally, there could be an important macro relation between the exchange rate regime and structural transformation, as moving away from the current overvaluation would also make the tradeable sector internationally more competitive and thus potentially offer job prospects in above-average productivity sectors where the marginal product of labor is not declining as much as in insulated service sectors. In our view, moving towards a consistent macro policy framework that aligns longer-term development aspirations with short-run challenges is hence of utmost importance for Ghana going forward and a challenge for Sub-Saharan African countries more broadly (see Calderon and Boreux, 2016). Moller and Wacker (2017) have documented for the case of Ethiopia that growth reduction through moderate heterodox macro policies may be overcompensated if they finance investment in areas with higher growth return. For the case of Ghana, we have documented the limits to such policies, as the costs of the post-2010 fiscal boom were relatively large while macroeconomic policies created few structural improvements that lifted the economy's long-term output potential.

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linkages should remain the mainstay of Ghanaian development. Also note that a modern wholesale and retail sector that is well-integrated with the rest of the economy is not ad odds with fast growth and structural transformation, as the example of Thailand shows (where the sector ranges at average economy-wide productivity).

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Appendix A

Table A.1 Sector composition (percentage of total employment), 1960–2010

Sector	1960	1970	1980	1990	2000	2010
Agriculture	**60.7**	**57.0**	**56.5**	**53.5**	**53.6**	**41.6**
Industry	**16.7**	**15.9**	**17.3**	**15.9**	**15.7**	**15.4**
Mining	1.9	1.0	0.6	0.9	1.8	1.1
Manufacturing	10.9	12.1	14.4	12.9	10.6	10.8
Public utilities	0.5	0.4	0.4	0.4	0.3	0.4
Construction	3.4	2.4	2.0	1.6	2.9	3.1
Services	**22.6**	**27.1**	**26.2**	**30.6**	**30.7**	**43.1**
Market Services	17.1	16.9	16.8	20.5	21.4	30.2
Wholesale and retail	14.2	13.8	14.4	17.1	17.0	24.3
Transport and storage	2.6	2.7	2.0	2.7	2.9	3.5
Finance and business services	0.3	0.3	0.4	0.7	1.4	2.3
Non-market Services	5.5	10.2	9.4	10.1	9.3	12.9
Government services	3.8	7.0	7.1	5.8	5.2	6.6
Other services	1.7	3.2	2.3	4.3	4.1	6.3

Table A.2 Labor productivity by broad sectors, different time periods

Sector	Relative labor productivity				Labor productivity compound annual growth rate (%)			
	1960	1990	2000	2010	1960-2010	1990 to 2010	1990 to 2000	2000 to 2010
Agriculture	**0.6**	**0.6**	**0.6**	**0.7**	**0.7**	**3.9**	**3.8**	**4.0**
Industry	**2.0**	**1.5**	**1.3**	**1.5**	**0.0**	**2.8**	**2.3**	**3.4**
Mining	3.5	3.2	1.6	2.7	0.0	1.9	-3.8	8.0
Manufacturing	1.3	1.0	1.0	0.8	0.0	1.9	3.7	0.0
Public utilities	0.6	5.0	5.3	5.0	4.9	2.9	3.8	2.0
Construction	3.9	3.5	1.8	2.8	0.0	1.8	-3.2	7.0
Services	**1.3**	**1.5**	**1.5**	**1.1**	**0.0**	**1.5**	**3.3**	**0.0**
Market Services	1.4	1.5	1.5	1.1	0.0	1.6	3.6	0.0
Wholesale and retail	0.9	0.6	0.7	0.5	-0.1	1.5	3.8	-0.1
Transport and storage	3.6	5.6	5.3	4.7	1.0	2.0	2.7	1.3
Finance and business services	6.0	6.0	4.0	2.5	-1.2	-1.3	-0.1	-2.0
Non-market Services	1.1	1.5	1.4	1.1	0.0	1.4	2.9	0.0
Government services	1.4	1.8	1.8	1.5	0.1	1.9	3.1	0.1
Other services	0.5	1.0	1.0	0.7	1.1	0.1	3.0	-1.2
Total economy	1	1	1	1	0.5	2.9	2.6	3.2

Appendix B

B1. Growth Accounting for Ghana: Methodology and data

Our growth accounting analysis is based on a standard Cobb-Douglas aggregate production function with constant returns to scale of the form

$$Y_t = A_t K_t^{\alpha}(Lh)_t^{1-\alpha}, \qquad (1)$$

where at period t, Y is GDP, K is the capital stock, L is the labor quantity, h is a labor quality adjustment, and A is factor-neutral technology, measuring total factor productivity (TFP). The coefficient α represents the output elasticity of capital.

We apply two growth accounting approaches. The first approach measures the contribution of changes in factor accumulation and TFP by taking the logarithm of Eq. (1) and differencing over i time periods. That is

$$\Delta \ln(Y_{t,t-i}) = \Delta \ln(A_{t,t-i}) + \alpha\Delta \ln(K_{t,t-i}) + (1-\alpha)\Delta \ln(Lh_{t,t-i}). \qquad (2)$$

We can extend Eq. (2) to

$$\Delta \ln(Y_{t,t-i}) = \Delta \ln(A_{t,t-i}) + \alpha\Delta \ln(K_{t,t-i}) + (1-\alpha)\Delta \ln(L_{t,t-i}) + (1-\alpha)\Delta \ln(h_{t,t-i})$$

to measure the individual contributions of changes in the labor input quantity and quality, respectively.

We have data on value added and factor inputs that are explained below. Regarding the parameter α, we follow a calibration approach and experiment with different capital shares around 0.4. The contribution of TFP to value added growth is then obtained as the residual:

$$\Delta \ln(Y_{t,t-i}) - \alpha\Delta \ln(K_{t,t-i}) - (1-\alpha)\Delta \ln(L_{t,t-i}) - (1-\alpha)\Delta \ln(h_{t,t-i}) = \Delta \ln(A_{t,t-i})$$

Several studies have criticized the approach above, as some of the accumulation of physical capital is in reality caused by growth in total factor productivity (e.g. Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999). To better control for productivity-induced capital deepening it is helpful to slightly modify the accounting approach. Specifically, dividing both sides of the production function by Y_t^{α} and solving for Y_t yields:

$$Y_t = A_t^{\frac{1}{1-\alpha}}\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}}(Lh)_t. \qquad (3)$$

Taking logs and differencing Eq. (3), we get

$$\Delta \ln(Y_{t,t-i}) = \frac{1}{1-\alpha}\Delta \ln(A_{t,t-i}) + \frac{\alpha}{1-\alpha}\Delta \ln\left(\frac{K_{t,t-i}}{Y_{t,t-i}}\right) + \Delta \ln(Lh_{t,t-i}) \qquad (4)$$

As can be seen in Eq. (4), the importance of TFP is now scaled up by a factor of $\frac{1}{1-\alpha} > 1$ compared to equation (2). Contrary to this, the capital stock needs to growth at a faster rate than GDP for capital to make a separate contribution to output growth in this modified version.

Data

Our primary data source for the growth accounting exercise is the Penn World Table version 9.0 (Feenstra et al., 2015). Particularly, we extract data on real GDP and the capital stock at constant national prices for Y. For labor quantity L, we use the numbers of persons engaged. The PWT 9.0 contain an index of human capital per worker based on the average years of

schooling linearly interpolated from Barro and Lee (2013), and an assumed rate of return for primary, secondary and tertiary education, as in Caselli (2005). As a robustness check, we construct an alternative human capital index, assuming a constant rate of return of 10 percent and using data on average years of schooling from the Cohen-Soto-Leker database.[26]

Some comments are in order: The PWT 9.0 contain data until 2014. To extend the data coverage up to 2016, we extrapolate the variables either based on own growth rates or available proxies. Specifically, the data on GDP is extended using data for the same variable from the World Development Indicator. The growth rates of both series are highly correlated (0.97) over an interval of several decades. The capital stock is extended using data on the investment rate from WDI and assuming a depreciation rate of 4 percent. To extend the labor quantity variable, we use data on the working-age population (WDI) and labor participation rates (ILO estimates). Finally, the human capital proxies are simply extrapolated.

B2. Analysis of structural change: Methodology and data

This paper analyzes the role of structural change for changes in average labor productivity using three different decomposition formulas. The objective of the decomposition exercise is to split changes in average labor productivity into different components, each with its own economic interpretation. In the simplest version, also used in McMillan et al. (2014), changes in labor productivity P are decomposed into two components:

$$\Delta P = \Delta PW + \Delta PS$$

where ΔPW is a change in aggregate labor productivity that results from productivity growth *within* individual sectors (i.e., innovation). The second term, ΔPS, is the *between* or *structural change* effect, which measures productivity changes that result from a shift of employers between sectors. More formally, we can decompose ΔP into

$$\Delta P = \sum_i (P_i^T - P_i^0) * S_i^0 + \sum_i (S_i^T - S_i^0) * P_i^T \qquad (1)$$

where S_i is the share of sector i in overall employment, P_i is the labor productivity level of sector i, and superscript 0 and T refer to the first and last year of a time interval. [27, 28]

Growth-enhancing structural change results when labor moves into those sectors whose productivity is either higher or growing. To what extent gains from a shift into higher productivity *level* sectors contribute to gains from structural change compared to gains resulting from a reallocation into sectors with higher productivity *growth* can be estimated using a second decomposition formula. Following Vries et al. (2015), labor productivity change can be split up into

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[26] The data can be downloaded at the department website of Daniel Cohen: https://www.parisschoolofeconomics.eu/en/cohen-daniel/international-educational-attainment-database/

[27] Instead of using the initial share in employment and final productivity level of the sector, an alternative approach is to use period averages as weights to make it more robust to outliers. Formally, $\Delta P = \sum_i (P_i^T - P_i^0) * \bar{S}_i^0 + \sum_i (S_i^T - S_i^0) * \bar{P}_i^T$. However, this formula has the drawback that the interpretation of the components is less straightforward and the extension into a static and a dynamic term not applicable.

[28] The split between within- and between-effects in Eq. (1) above relies on the assumption that marginal and average labor productivity in a sector are equal or, put otherwise, that labor productivity growth is independent of the changes in employment. Yet, by definition, a decline in the number of agricultural workers raises the average labor productivity level in agriculture, if marginal productivity is below average productivity. Eq. (1) will therefore understate the contribution from the reallocation effect, if the number of workers in agriculture diminish, as it attributes the increase in average productivity in sectors with decreasing labor to the within-effect. Indeed, although the agricultural share in employment decreased substantially in the past decades in all countries in the sample, this is not the case for the absolute numbers of workers. Accounting for the phenomenon of surplus labor or disguised employment in agriculture at early stages of development does not alter the results significantly.

$$\Delta P = \Delta PW + \Delta PSstatic + \Delta PSdynamic \qquad (2)$$

where ΔPW is again the within sector component. Equation (2) differentiates between a *static* structural change component and a *dynamic* structural change component, which are defined as:

$$\Delta PSstatic = \sum_i (S_i^T - S_i^0) * P_i^0$$
$$\Delta PSdynamic = \sum_i (P_i^T - P_i^0) * (S_i^T - S_i^0)$$

This modification allows to differentiate between two sources of productivity-enhancing structural change. First, gains that result from workers shifting to sectors with above-average productivity levels, captured in the static component. Aside from this, the reallocation of workers can also contribute positively to productivity changes if labor shifts, in sum, to sectors with above-average productivity growth. The change in productivity resulting from the joint effect of changes in employment shares and sectoral productivity is captured in the dynamic component. The dynamic component thus allows to capture depressing productivity growth rates that result, for example, from an expanding sector that might initially have high productivity levels but fails to employ additional workers at such high productivity levels.

Finally, we can study the contributions of individual sectors to aggregate labor productivity growth by decomposing productivity changes as

$$\Delta P = \sum_i (P_i^T - P_i^0) * S_i^0 + \sum_j^J (P_j^0 - \tilde{P}^0) * (S_j^T - S_j^0) + \sum_j^J [(P_j^T - P_j^0) - (\tilde{P}^T - \tilde{P}^0)](S_j^T - S_j^0), \quad (3)$$

where J is the set of expanding sectors, and K is the set of shrinking sectors, and average labor productivity of shrinking sectors at time 0 and T is given by

$$\tilde{P}^0 = [\sum_k^K (S_k^T - S_k^0) * P_k^0] / \sum_k^K (S_k^T - S_k^0)$$
$$\tilde{P}^T = [\sum_k^K (S_k^T - S_k^0) * P_k^T] / \sum_k^K (S_k^T - S_k^0)$$

The motivation for this final modification is that in the previous decomposition methods all expanding sectors contributed, by definition, positively to labor productivity, even if they are below average productivity levels or growth rates.

Data

We use data from: the GGDC 10-sector database (Timmer et al., 2015). The data set includes information on real value-added and employment in agriculture, four industrial sectors, three market services sectors, government services, and a final sector consisting of other services from 1960 until 2011 (see Table B.1). The GGDC10 covers 42 countries, including 11 African countries (see appendix Table B.2).[29]

To compare Ghana's pattern of growth-affecting structural change to other countries, ideally, sector value added should be deflated by multilateral purchasing power parities on the sector-level to account for variation in relative prices across tradable and non-tradable sectors (Inklaar and Timmer, 2014). Unfortunately, however, the GGDC10 does not include relative sector-level prices.[30] We therefore stick to a comparison of the components of productivity growth based on real value added (in constant national currency) from GGDC10.

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[29] For many, but not all, countries the time series start in the 1960s.

[30] For the year 2005, sector-level PPPs for the 11 African countries are integrated in the African Sector Database (Vries et al., 2015). For the same year, The Productivity Level Database provided by Groningen gives information on relative prices for 42 economies, but South Africa is the only African country. Unfortunately, both series differ in their methodology and cannot be combined.

Table B.1: Sector disaggregation for structural change analysis

Abbr	Sector Name	ISIC Rev3.1 description
Agr	Agriculture	Agriculture, Hunting and Forestry, Fishing
Min	Mining	Mining and Quarrying
Man	Manufacturing	Manufacturing
Pu	Public Utilities	Electricity, Gas and Water supply
Con	Construction	Construction
Wrt	Trade Service	Wholesale and Retail trade, Hotels and Restaurants, Repair of motor vehicles, motorcycles and personal and household goods
Tsc	Transport Services	Transport, Storage and Communications
Fire	Business Services	Financial Intermediation, Real Estate, Renting and Business Activities
Gov	Government Services	Public Administration and Defense, Education, Health and Social work
Oth	Other Services	Other Community, Social and Personal service activities Activities of Private Households

Table B.2 Overview: Structural Change Country Sample

Code	Countryiso3	Country	Region
1	ARG	Argentina	LAM
2	BOL	Bolivia	LAM
3	BRA	Brazil	LAM
4	CHL	Chile	LAM
5	COL	Colombia	LAM
6	CRI	Costa Rica	LAM
7	MEX	Mexico	LAM
8	PER	Peru	LAM
9	VEN	Venezuela, RB	LAM
10	HKG	Hong Kong SAR, China	Asia
11	IDN	Indonesia	Asia
12	IND	India	Asia
13	JPN	Japan	Asia
14	KOR	Korea, Rep.	Asia
15	MYS	Malaysia	Asia
16	PHL	Philippines	Asia
17	SGP	Singapore	Asia
18	THA	Thailand	Asia
19	TWN	Taiwan, China	Asia
20	BWA	Botswana	SSA
21	ETH	Ethiopia	SSA
22	GHA	Ghana	SSA
23	KEN	Kenya	SSA
24	MWI	Malawi	SSA
25	MUS	Mauritius	SSA
26	NGA	Nigeria	SSA
27	SEN	Senegal	SSA
28	TZA	Tanzania	SSA
29	ZAF	South Africa	SSA
30	ZMB	Zambia	SSA

31	MOR	Morocco	MENA
32	EGY	Egypt, Arab Rep.	MENA
33	DEW	West Germany	Europe
34	DNK	Denmark	Europe
35	ESP	Spain	Europe
36	FRA	France	Europe
37	GBR	United Kingdom	Europe
38	ITA	Italy	Europe
39	NLD	Netherlands	Europe
40	SWE	Sweden	Europe
41	USA	United States	North America

Table B.3: Patterns of growth-affecting structural change

Sector	Total CAGR	Component due to:		
		Within	Structural change	
			Static	Dynamic
Ghana				
1975-2010	**1.11**	**0.92**	**0.44**	**-0.25**
1975-1990	-1.27	-1.16	-0.03	-0.09
1990-2010	2.93	2.38	0.70	-0.15
1990-2000	3.25	2.79	0.77	-0.32
2000-2010	2.61	2.31	0.76	-0.46
Kenya				
1975-2010	**-0.17**	**-0.84**	**2.40**	**-1.73**
1975-1990	0.30	-0.56	1.48	-0.63
1990-2010	-0.51	-1.33	2.43	-1.61
1990-2000	-2.09	-3.59	4.23	-2.72
2000-2010	1.09	1.25	0.12	-0.28
Colombia				
1975-2010	**0.60**	**0.38**	**0.75**	**-0.53**
1975-1990	1.08	0.58	0.91	-0.41
1990-2010	0.25	0.01	0.56	-0.32
1990-2000	-0.61	-0.61	0.10	-0.10
2000-2010	1.12	0.68	0.98	-0.54
Peru				
1975-2010	**-0.34**	**-0.58**	**1.25**	**-1.01**
1975-1990	-3.07	-3.55	1.90	-1.43
1990-2010	1.76	1.44	0.54	-0.22
1990-2000	0.17	0.15	0.46	-0.44
2000-2010	3.38	2.83	0.88	-0.33
Korea, Rep.				
1975-2010	**3.73**	**3.28**	**1.78**	**-1.33**
1975-1990	4.44	2.28	2.37	-0.22
1990-2010	3.21	3.83	0.76	-1.38
1990-2000	4.00	4.37	0.80	-1.17
2000-2010	2.42	2.42	0.36	-0.36
Malaysia				
1975-2010	**3.14**	**3.80**	**-0.03**	**-0.64**
1975-1990	3.26	7.63	-0.34	-4.03

1990-2010	3.04	2.75	0.08	0.21
1990-2000	3.99	4.47	-0.19	-0.29
2000-2010	2.11	2.03	0.75	-0.68

Source: Constructed from the Groningen Growth and Development Centre 10 Sector database (Timmer et al., 2015).
Note: Productivity growth (%) is defined as the compound annual growth rate in average labor productivity based on constant national prices. See appendix B2 for details on decomposition methodology. Growth-enhancing structural change occurs when labor moves into those sectors whose productivity is above-average in either productivity levels (static gains) or growth rates (dynamic gains).

B3. Growth regressions: Methodology and data

Our analysis is based on previous studies investigating the determinants of growth in developing countries. We use an empirical growth model originally set up by Loayza *et al*. (2005) and improved by Brueckner (2013). These cross-country growth regression models were originally constructed to investigate the structural (as opposed to cyclical) drivers of growth in Latin America and the Caribbean (Araujo *et al.*, 2016). By applying the results of an existing cross-country regression model and its original parameter estimates, we preclude the possibility to get results that just fit Ghana's growth performance but are of little general validity.

Table B.4 Description of Variables

Variable	Description	Source
Growth Rate of GDP per capita	The change in the natural logarithm of real PPP GDP per capita between period t and t-1.	PWT 7.1
Schooling	The natural logarithm of the secondary school enrolment rate.	WDI (2013)
Private Credit/GDP	The natural logarithm of the ratio of domestic credit to the private sector divided by GDP. Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment.	WDI (2013)
Trade Openness	The natural logarithm of the ratio of exports plus imports over PPP GDP adjusted for countries' population size.	PWT 7.1
Telephone Lines	The natural logarithm of main telephone lines per capita. Telephone lines are fixed telephone lines that connect a subscriber's terminal equipment to the public switched telephone network and that have a port on a telephone exchange. Integrated services digital network channels and fixed wireless subscribers are included.	WDI (2013)
Mobile Phones	The natural logarithm of mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Post-paid and prepaid subscriptions are included.	WDI (2013)
Government Size	The logarithm of the ratio of government consumption expenditures over GDP.	PWT 7.1
Polity2	The polity2 score measures the degree of political constraints, political competition, and executive recruitment. It ranges between -10 to 10 with higher values denoting more democratic institutions.	Polity IV (2012)
CPI Inflation	The natural logarithm of 100+consumer price inflation rate. CPI inflation reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.	WDI (2013)
Real Exchange Rate	The natural logarithm of the GDP price level divided by the nominal exchange rate.	PWT 7.1
Banking Crisis	Indicator Variable that is unity in period t if the country experienced a banking crisis.	Reinhart and Rogoff (2011)
Terms of Trade Growth	The change in the natural logarithm of the net barter terms of trade index. The net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000.	WDI (2013)
ComPI Growth	The change in an international commodity export price index. The index is constructed as	Arezki and Brueckner (2012)

$$ComPI_{ct} = \prod_{i \in I} ComPrice_{it}^{\theta_{ic}}$$

where $ComPrice_{it}$ is the international price of commodity i in year t, and θ_{ic} is the average (time-invariant) value of exports of commodity i in the GDP of country c. Data on international commodity prices are from UNCTAD Commodity Statistics and data on the value of commodity exports are from the NBER-United Nations Trade Database (Feenstra *et al*., 2004). The commodities included in the index are aluminum, beef, coffee, cocoa, copper, cotton, gold, iron, maize, oil, rice, rubber, sugar, tea, tobacco, wheat, and wood.

Source: Brueckner (2013)

The underlying model expresses domestic income measured as the natural log of real PPP GDP per capita, lny_{ct} for country c in period t), as 'steady-state' function of key growth drivers, $X_{ct,}$:

$$lny_{ct} = \theta lny_{ct-1} + \Gamma ln(X)_{ct} + a_c + b_t + e_{ct} \qquad (1)$$

where a_c and b_t are country and time fixed effects, respectively; and e_{ct} is an error term that remains unexplained by the model (the residual, i.e. the difference between predicted and observed growth). Note that a time period t is the average over (non-overlapping) 5-year periods to smoothen short-run and cyclical effects. A detailed technical description of the growth drivers, including their original data sources, is presented in Table B.1. The data set used for estimation covers 126 countries for the 1970-2010 period (see online Table B.2 for country coverage).

For the analysis to include the 2010-2015 period, we applied the model results to updated data for Ghana. GDP data, government consumption, and openness were taken from PWT 9.0, data on credit to GDP, schooling telephone lines, inflation, the real exchange rate, and terms of trade were taken from WDI. Polity2 remained unchanged at a value of 8 and to our knowledge no major banking crisis took place during the early 2010s. Updating the commodity price index turned out to be more difficult. To construct the index, we took price data from the World Bank pink sheets of the following commodities (ranked by importance) and weighted them by their export share for Ghana in 1996: cocoa, gold, wood, aluminum, rubber, and eight other commodities with a weight below 1 percent. The resulting index saw an increase over all three investigated 5-year periods that was of similar size in the early 2010s as in the early 2000s (and about double as strong in the late 2000s). In accordance with those results, we opted to include a growth rate of the index for the early 2010s that was slightly above the one observed for the early 2000s. Note that since the index enters the levels equation in growth rates, its contribution to growth is negative in the last period (because the growth rate of the index declined).

Table B.5 List of Countries in Sample (ranked by 1995 Per Capita GDP, US$ PPP)

Congo, Dem. Rep.	328.4	Mauritania	1560.0	Thailand	5379.2	Ireland	19819.0
Mozambique	340.9	China, version 1	1591.5	Mauritius	5714.3	New Zealand	20250.0
Ethiopia	367.8	Pakistan	1643.4	Colombia	5765.0	Spain	20880.2
Zimbabwe	450. 7	Iraq	1718.7	Latvia	5861.0	Finland	21901.8
Malawi	503.3	Armenia	1748.0	Brazil	6255.1	Seychelles	22741.0
Niger	520.8	Angola	1823.3	Panama	6268.2	United Kingdom	23515.4
Burundi	556.4	Nicaragua	1845.4	Iran, Islamic Rep.	6453.5	Sweden	25155.3
Central African Republic	608.0	Georgia	1989.3	Bulgaria	6757.6	Italy	25334.9
Uganda	641.1	Djibouti	2012.0	Chile	6900.1	France	25992.4
Rwanda	643.7	Mongolia	2058.0	Turkey	6946.2	Canada	27285.9
Burkina Faso	647.2	Sri Lanka	2078.3	Malaysia	7275.9	Denmark	27397.4
Mali	681.6	Congo, Rep.	2117.7	Uruguay	7460.6	Australia	27801.2
Guinea	706.3	Morocco	2279.2	Lithuania	7643.0	Netherlands	28417.0
Tanzania	710.0	Philippines	2311.4	Estonia	7758.0	Austria	28454.6

Equatorial Guinea	733.2	Guyana	2425.2	Costa Rica	7769.0	United States	32256.4
Nepal	768.0	Azerbaijan	2477.2	Lebanon	7821.7	Norway	35624.2
Cambodia	790.1	Albania	2563.5	Poland	8006.9	Kuwait	40050.2
Chad	791.4	Indonesia	2582.0	Argentina	8054.5	Qatar	44696.4
Bangladesh	803.0	Bolivia	2837.7	Venezuela, RB	8894.7		
Madagascar	804.0	Egypt, Arab Rep.	2932.5	Croatia	9026.8		
Togo	825.5	Honduras	3006.7	Jamaica	9101.8		
Zambia	827.7	Jordan	3163.4	Russian Federation	92374		
Benin	1012.3	Paraguay	3513.1	Slovak Republic	9527.5		
Vietnam	1064.9	Fiji	3529.6	Mexico	9789.5		
Lao PDR	1080.2	Peru	4057.2	Hungary	11316.1		
Guinea-Bissau	1088.5	Tunisia	4353.5	Gabon	11802.6		
Nigeria	1097.5	Ukraine	4436.8	Korea, Rep.	14014.9		
Kenya	1114.2	Belarus	4468.6	Czech Republic	14041.4		
Senegal	1143.4	El Salvador	4484.4	Slovenia	14167.1		
Gambia, The	1207.9	Algeria	4687.9	Cyprus	14400.8		
Ghana	**1277.315**	Ecuador	4746.176	Oman	15129.8		
Côte d'Ivoire	1400.565	Guatemala	4826.791	Portugal	15922.2		
Tajikistan	1409.617	Kazakhstan	5218.543	Greece	17682.6		
India	1470.801	South Africa	5223.652	Libya	18526.2		
Yemen, Rep.	1477.545	Dominican Republic	5253.135	Bahrain	19686.0		
Cameroon	1523.098	Romania	5270.634	Israel	19758		

The model is estimated using System Generalized Method of Moments (GMM) with a limited set of internal instruments. More specifically the one first-differenced lag of the explanatory variables is used as an instrument for the explanatory variables in levels (see Arellano and Bover, 1995, and Blundell and Bond, 1998).[31] To contain the well-known problems associated with too many instruments (Roodman, 2009), the instrument set is limited to one lag. Regression results are reported in Table B.6.

Table B.6: Regression Baseline Results

VARIABLES	(1)	(2)	(3)	(4)
	log of GDP per capita (in PPP)			
Persistence	0.781***	0.784***	0.726***	0.746***
	(0.0569)	(0.0563)	(0.0491)	(0.0392)
ln(exch rate)	-0.0640	-0.0622	-0.0553*	-0.0172
	(0.0404)	(0.0392)	(0.0332)	(0.0355)
ln(schooling)	0.0178	0.0445	0.0104	-0.0266
	(0.0503)	(0.0502)	(0.0463)	(0.0452)
ln(credit/GDP)	0.0743**	0.0542*	0.0432*	0.0238
	(0.0311)	(0.0304)	(0.0221)	(0.0245)
ln(trade/GDP)	0.0824	0.0609	0.0916***	0.0968
	(0.0502)	(0.0490)	(0.0350)	(0.0584)
ln(govt C)	-0.262***	-0.259***	-0.215***	-0.127
	(0.0442)	(0.0423)	(0.0359)	(0.0810)

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[31] Commodity prices, terms of trade and time dummies are treated as exogenous. The one-step estimator is used as the two-step estimator is infeasible given the dimension of the data set. This also avoids severely downward biased standard errors associated with the two-step estimator (Blundell and Bond, 1998). See Brueckner (2013) for further details and discussions.

ln(tele lines)	0.141***	0.129***	0.0769***	0.0816***
	(0.0309)	(0.0297)	(0.0216)	(0.0261)
ln(inflation)	-0.0113	-0.0145	-0.00523	-0.0128
	(0.0118)	(0.0110)	(0.00886)	(0.0112)
Δln(TOT change)	0.118***	0.123***	0.116***	0.110***
	(0.0286)	(0.0277)	(0.0264)	(0.0339)
bank crisis	-0.0399	-0.0430	-0.0414	-0.0461*
	(0.0317)	(0.0314)	(0.0259)	(0.0236)
Δln(commodity prices)	10.48***	11.11***	7.507***	6.963
	(2.686)	(2.546)	(2.391)	(4.943)
ln(institutions)	-0.00265		0.00190	-0.00549
	(0.0330)		(0.0247)	(0.0255)
Constant	2.502***	2.829***	3.203***	2.469***
	(0.708)	(0.465)	(0.600)	(0.453)
Observations	464	502	464	464
Number of countries	126	141	126	126
Estimation	SysGMM	SysGMM	SysGMM	FE
Note:	Baseline	w/o Polity2	lags 1-3 as instruments	baseline as FE
No of instruments	153	166	171	
AB(1)	0.023	0.024	0.033	
AB(2)	0.102	0.045	0.062	
Sargan test	0.131	0.017	0.001	

Note: Based on Brueckner (2013). Standard errors in parentheses. ***, **, and * indicate statistical significance on the 1, 5, and 10 percent level, respectively. AB(1) and AB(2) is the p-value of the Arellano and Bond test for first and second order autocorrelation, respectively. Sargan test reports p-values.

Growth contributions over each time period can be calculated by first-differencing equation (1):

$$\Delta ln y_{ct} = \theta(\Delta\, ln y_{ct-1}) + \Gamma\Delta ln(X)_{ct} + \Delta b_t + \Delta e_{ct} \qquad (2)$$

as log-changes approximate growth rates of a variable. I.e. growth can be explained by a persistence effect $(\theta[\Delta\, ln y_{ct-1}])$, changes in the explanatory variables X, and a period-specific global shock (Δb_t).[32] Note that the country fixed effect cancels out because it is time-invariant.

For calculating Ghana's drivers of growth, we extend its explanatory variables by one 5-year period since the original data set contains average 5-year values across countries until 2010 only. Since not all of the 2015 data were available from sources fully consistent with the original data set, we added to the logged original series the log changes between the 2006-2010 averages and the 2011-2015 averages taken from PWT 9.0 (GDP, growth, trade openness, government size), WDI (schooling, credit/GDP, telephone lines, inflation, real exchange rate, terms of trade), and Polity IV (polity2). A commodity price index was calculated using data from Comtrade. Note that this extension does not affect the model estimation results as it was performed after estimation (and for Ghana only). The respective data for Ghana are reported in Table B.7.

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[32] Our calculation differs slightly from the one in Brueckner (2013) and Araujo *et al.* (2016) in two aspects. First, we do not use the actual lag of the growth rate for calculating the persistence effect from equation (2) but instead take the growth rate as predicted from the model because we think it performs better in the context of a growth acceleration in a low-income economy. When using actual growth rates, there is little difference to our baseline model over the 2000-2013 period and the model performs poorer in the early 2000s but better in the early 2010s. A more extensive discussion and results are available upon request. Second, we take second differences of external factors as they enter the estimated levels equation already in first differences. To calculate effects for the 2000-2013 period, we proceed as follows to accommodate dynamic effects: we calculate the changes over the full 15-year period and multiply them by the respective coefficient Γ times $(3+2\theta+\theta^2)/3$. This assumes that the change has been uniform over time and accommodates their dynamic effects. Similarly, the persistence effect is calculated as $(\theta+\theta^2+\theta^3)/3$ times the growth rate in the period prior to 2000.

Table B.7 Explanatory Variable Values for Ghana

Year	Late 1990s	Early 2000s	Late 2000s	Early 2010s
Log Real GDP per capita (PPP), US$	7.23655	7.35106	7.539918	8.035881
Real GDP per capita (PPP) growth (% p.a.)	0.016807	0.022902	0.037772	0.099193
Log Real Exchange Rate Index	3.873208	3.67143	4.007353	3.796767
Log CPI Inflation (annual, %)	3.199046	3.183496	3.436082	3.343985
Log Secondary enrolment (gross, %)	3.697654	3.753873	3.998497	4.205726
Log Private sector credit (% of GDP)	2.304435	2.568689	2.672925	2.869226
Log Trade openness	4.283606	4.148263	4.369898	4.369898
Log Government consumption (% of GDP)	2.086015	2.004482	1.919751	2.227817
Log Telephone lines (per person)	-0.29158	0.335734	0.20624	0.05459
Log Terms of trade growth	0.13267	0.11561	0.200588	0.136986
Banking crisis (1=yes, 0=no)	0.2	0	0	0
Commodity Price Index growth	-0.00037	0.00091	0.002547	0.0012
Polity 2	2.564949	2.879199	2.944439	2.944439