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Services, Jobs, and Economic Development in Africa

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Abstract

This paper presents data and analyzes the structure of employment in thirteen African economies at the administrative unit level, with a focus on the role of services. We provide two novel pieces of evidence. First, we present a descriptive snapshot of changes in the composition of employment over time and across geographies. This reveals evidence of structural transformation towards services and service-related occupations at sub-national level and provides a fine-grained overview of who works in services and where and how this has changed over time. Second, we provide correlations between services and economic development, using per capita nightlight luminosity as a proxy. We document (a) a strong positive association between high skills services and economic development; (b) substantial heterogeneity across industries within services; and (c) a mediating role of market conditions and technology in the relation between services and economic development. Overall, our work highlights an important role of services activities for employment, skills and economic development in Africa.

Keywords

Services; economic development; structural transformation; growth; servicification; Africa; employment

Introduction[1]

Economic development is generally associated with a shift of the workforce from the agricultural to non-agricultural sectors, a process commonly referred to as structural transformation. A central feature of successful structural transformation of most economies in the 20th century involved a shift of workers from agriculture to manufacturing (Herrendorf, Rogerson, et al., 2014). This pattern of economic growth and development may be less applicable to lower-income countries today than it was in the past. An important stylized fact in this regard is that low-income developing countries are moving into services earlier and at a faster rate than was observed for East Asian economies in the 1970s and 1980s. The associated 'premature deindustrialization' (Dasgupta and Singh, 2007; Rodrik, 2016) is a potential source of concern insofar as it implies that low-income countries today cannot rely on an expanding manufacturing sector to create employment opportunities for relatively unskilled workers, drive economic growth and increase per capita incomes.

Arguments why structural transformation involving a rapid increase in services employment may be detrimental to the growth prospects of low-income countries include perceptions that services offer fewer prospects for sustained high productivity growth than manufacturing and less potential for positive spillover effects (innovation; inter-sectoral linkages; positive agglomeration externalities) or scope for scale economies. Other concerns are that services offer less potential to generate 'good jobs' for unskilled workers at the levels needed than manufacturing did in previous periods. Much of the research literature on the role of services in economic development has focused on the question whether services can realize the type of productivity growth observed in manufacturing. An expanding body of evidence documents that many types of services have experienced levels of productivity growth that are similar to, and sometimes exceed, what has been realized in agriculture and manufacturing. Less attention has been devoted to the question whether the shift to services in low-income countries is associated with the creation of jobs, the skill-intensity of services jobs, and where they are located. Because many services are relatively labor-intensive, involve both lower and higher skilled activities, and often are (and notwithstanding technological change likely will remain) less tradable than goods, there is the potential for job generation in services to be dispersed more widely across space (the territory of a given jurisdiction – locality, region, country) than manufacturing.

Our aim in this paper is to contribute to the emerging literature that analyzes structural transformation in low-income economies using micro data as opposed to a focus on broad sectoral shifts and aggregate indicators of output and employment at the country level. We present new data on the composition of jobs in services at the sub-national (administrative unit) level in a sample of thirteen African countries, describe how this has changed over time, and how employment in services correlates with indicators of economic development commonly used in the literature. We use the IPUMS International Database published by the Minnesota Population Center, extracting data for all African countries for which at least two censuses are available and that include information on the industry employing an individual.[2] The resulting dataset spans 56 million individuals covering 1,546 administrative units in the 13 African countries for either two or three census waves. The sample is representative of the Africa region. It includes both low-income countries whose GDP per capita is about US$1,000 (Malawi, Mozambique), middle income countries such as Mauritius; resource rich countries (Botswana, Zambia), more diversified economies (South Africa and Morocco), landlocked countries (Rwanda) and countries with sea borders and a strong tourism industry (Mauritius, Tanzania). Combined, the sample countries account for 31.1% and 44.1% of Africa's total population and GDP, respectively.[3]

1 A previous version of this paper was circulated under the title "Services and Economic Development in Africa". We are very grateful to Lorenzo Sileci for outstanding research assistance and to Richard Newfarmer and participants in the plenary section of the September 2021 STEG workshop for valuable comments. Financial support was provided by the International Growth Center (Project XXX-20086). This paper is complemented by an on-line appendix and a website providing tools for visualization of the micro-data on jobs in services discussed in this paper – see https://globalgovernanceprogramme.eui.eu/services-and-economic-development-in-africa/

2 This includes 12 industries that roughly concord to the services sectors in the International Standard Industrial Classification (ISIC).

3 Data sourced from the IMF WEO (April 2021 edition). Figures for GDP are based on the PPP values for the year 2019 (the last non-estimated figure), and 2015 for population (the latest non-estimated values).

We find that employment in trade (wholesale and retail) services is leading the shift towards services and that growth in services jobs is associated with a shift to higher skilled types of services, based on a classification that clusters specific services industries according to educational attainment of individuals and intensity of use of more complex types of occupations. Compared to manufacturing, services workers are on average more educated, engage in higher skilled occupations and are more likely to be female – 40% of employees are women, twice as large as in manufacturing. There has been a shift over time towards occupations related to the production of intangible value added and activities classified as higher skilled. This shift is observed across sectors, including manufacturing, with services more likely to develop in urban and densely populated areas and those with greater access to national and international markets.

Exploratory analysis of the relationship between services and proxies for economic development do not reveal an association between overall employment in services at the aggregate level and economic development. This masks significant heterogeneity within services and across administrative units. We document a strong positive (negative) association between high (low) skills services and economic development, with the positive association particularly strong in areas with low incidence of malaria, more natural resources, and good mobile phone coverage. These associations point to a mediating role of market conditions and technology in the relationship between services employment and economic development. Health services, public services, and, to a lesser extent, business services are positively associated with proxies for economic development, while transport and private household services have a negative association with development indicators.

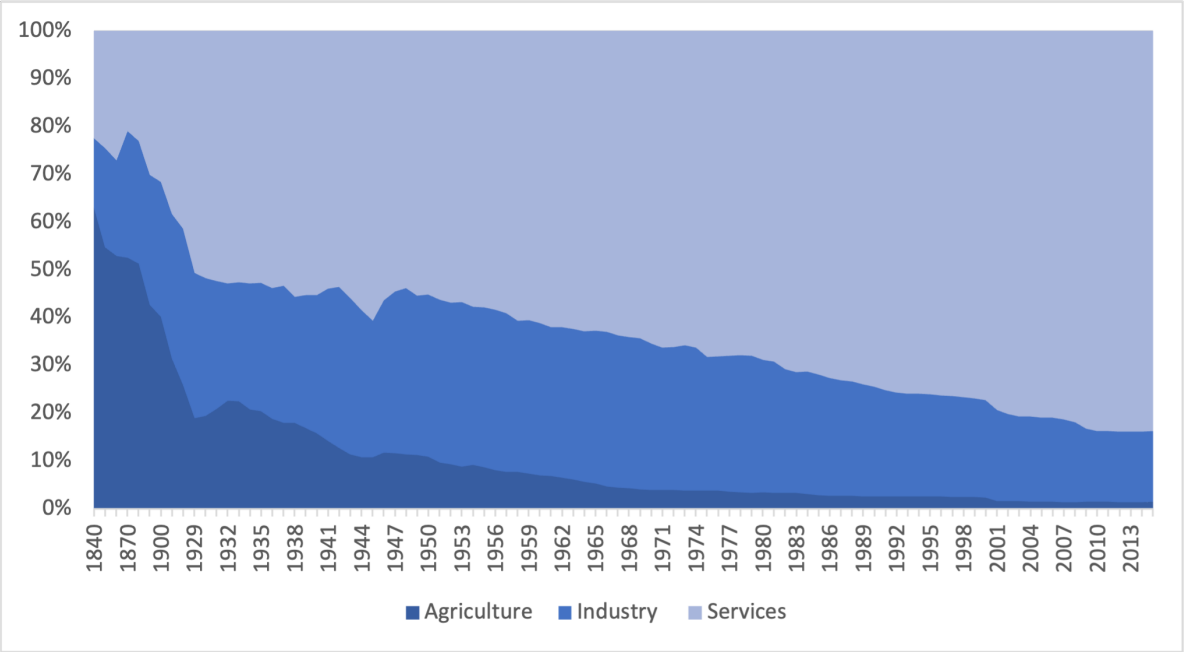
The remainder of this paper proceeds as follows. Section 1 briefly survey the related literature on structural transformation and drivers and implications of the shift to services. Section 2 discusses the data sources used and provides some descriptive statistics. Section 3 focuses on specific services sectors, assessing both graphically and by means of multivariate analyses employment changes across disaggregated services activities. Section 4 reports the results of exploratory analysis of the association between services and indicators of development. Section 5 concludes with suggestions for further research on the drivers and consequences of structural transformation driven by the shift towards services in low-income countries.

1. Services and economic development prospects of low-income countries

The conventional conceptualization of the structural transformation of an economy that underpins economic growth centers around sectoral reallocation of labor and capital to higher productivity activities, involving a steady reduction in agriculture-related employment, with workers absorbed by industry, mostly manufacturing (Kuznets, 1966; Kravis et al. 1983; Syrquin, 1988; Schettkat & Yocarini, 2006; Herrendorf et al. 2014). Figure 1 illustrates the pattern of declining agricultural employment over time as per capita income rises, with offsetting increases in employment shares of industry and services. A key feature of this process is that historically the rate of increase in manufacturing outpaces that of services for some time, after which the overall share of manufacturing peaks and the share of services expands further.

Two major drivers for structural transformation are often distinguished in the economic literature: technological change resulting in differential rates of sectoral total factor productivity growth and a demand effect reflected in differences in income elasticities for goods and services (Duarte and Restuccia, 2010). These drivers result in intra-sectoral reallocation of factors of production as well as inter-sectoral shifts. In practice, there will be significant change in economic activity and employment within sectors – e.g., a decline in personal household services and increases in market-based services activities with associated differential growth performance at the sub-sectoral level. The process of inter- and intra-sectoral reallocation has consequences for both growth and the distribution of income (poverty; inequality) and economic activity across locations within countries, depending on initial endowments, geographic attributes, infrastructure, and economic policy, among other factors.

Figure 1. Sectoral employment shares and economic growth: the US example



Note: Data cover employment in the US and is originally sourced from (Herrendorf et al., 2014)
Source: Authors' elaboration on Our World in Data

In recent decades, many low-income developing countries have experienced structural transformation without industrialization, in that a decline in the share of employment in agriculture is offset by a rise in employment in services, with a relatively constant or even declining share of manufacturing employment (Dasgupta and Singh, 2007). Rodrik (2016) provides cross-country evidence that the share of manufacturing employment (and value added) peaks at lower levels of per capita incomes when compared to the pattern observed in the past for countries that are high-income nations today. African countries are a prominent example, with manufacturing sectors dominated by relatively few large, export-oriented companies that have not created significant employment (most African firms are small and often informal).[4] Using micro data, Diao et al. (2019) also show that the structure of African economies has shifted more rapidly towards services than was the case for the present OECD countries during their industrial development phase and for East Asian economies in the 1970s and 1980s.

There is a vibrant and unsettled debate on whether and how low-income developing countries can rely on other engines of growth and job creation. Central questions in this regard concern the prospects for productivity growth in non-manufacturing activities[5] and the ability of services sectors to create jobs for relatively unskilled workers at scale in low-income countries where the type of export-led manufacturing strategy used by successful countries in the past is constrained. Recent work on Africa has emphasized the importance of non-manufacturing activities for both job generation and growth (Newfarmer et al., 2018). Thanks to revolutions in transport and technologies, industries 'without smokestacks', such as horticulture, agro-processing, tourism, e-commerce, digitally enabled business, health and education services, have the potential to drive sustainable demand for jobs, together with rising productivity, leveraging the increasing tradability of many services products (Dihel et al. 2016). Services are very heterogeneous in terms of skill intensity, tradability and scope for productivity growth. Some services offer great scope for the type of productivity dynamics that

4 For instance, Diao et al. (2021) find that manufacturing employment in Ethiopia and Tanzania is mostly determined by small and informal firms with stagnant productivity growth.

5 To some extent, distinguishing between services and manufacturing is misleading insofar as what matters is productivity growth performance (potential) and employment generation of different economic activities. Manufacturing may be – and increasingly is – services-intensive. Conversely, many services depend on manufactured inputs.

have characterized manufacturing, others do not (Balchin et al. 2016).[6] Arguments that services can play a role similar to manufacturing sector in past examples of successful development are based in part on the view that, due to the changes occurring in the organization of international production, the reduction in transport costs and opportunities offered by new technologies, the nature of services is changing dramatically. Many services activities are (increasingly) tradable, have experienced high productivity growth, and can achieve economies of scale (Gervais & Jensen, 2019; Loungani & Mishra, 2014; Nayyar et al. 2021).[7]

Sen (2019) argues that it is important to distinguish between business and nonbusiness services, both because of their different functions and because of the greater prospects for the former to affect productivity growth. Sen argues that in low-income countries growth must depend more on the nonbusiness service sector given their role as a major sector of employment outside agriculture and the limited prospects for manufacturing growth and associated business services. Fan et al. (2021), using data for India for the 1987-2011 period, develop a structural model that distinguishes between consumer and producer services, dividing services sectors in two categories depending on whether their output is absorbed more by consumer demand (e.g., hospitality) or by firms using services as inputs into production (e.g., business services). They investigate whether the rising share of services in the economy is a driver of growth (a source of rising productivity) or is the result of demand factors (the result of rising incomes). Their empirical analysis concludes that in India growth was services-led, driven by productivity improvements in consumer services such as retail and hospitality, which they find drove one-third of the aggregate growth rate. They also find that the distribution of the associated welfare benefits was highly skewed, with high-income households living in urban areas benefitting most. Gollin et al. (2016) highlight the potential role of consumer services in natural resource rich countries, pointing to examples of sub-Saharan African economies where urbanization has occurred without industrialization. They find a strong positive relationship between natural resource exports and urbanization in a sample of 116 developing nations over the period 1960–2010, documenting the rise of so-called 'consumption cities' with economies centered on non-tradable services in contrast to 'production cities' that are more dependent on manufacturing in countries that have industrialized.[8]

The extent to which manufacturing employment has peaked in Africa, or is in secular decline is a matter of debate. While the share of manufacturing in employment is low, some researchers argue there is both significant scope for African countries to increase the share of manufacturing in total employment and evidence suggesting that the shift to services is not necessarily associated with manufacturing employment peaking (e.g., Diao et al. 2017; Haraguchi et al. 2017; Mensah 2020; Nguimkeu and Zeufack 2019). Kruse et al. (2021) document that the manufacturing share of employment in Africa increased from an average of 7.2 percent in 2010 to 8.4 percent in 2018, reversing a de-industrialization trend of the decades before 2010 captured in earlier research. They add, however, that trends in manufacturing value added did not reverse, showing that much of this growth is associated with small and less-productive firms.

6 The extent to which the shift to services implies lower productivity growth potential is essentially an empirical question. Young (2014) finds that average productivity growth in services is similar to that in other sectors. Herrendorf et al. (2020) document for the US that this is associated with a large and rising share of services value added in investment expenditure, which has come to exceed the share of goods value-added in investment expenditure. Nayyar et al. (2021) compare productivity levels of services and manufacturing, showing that some of the most innovative services industries are more productive than manufacturing sectors.

7 Hsieh and Rossi-Hansberg (2021), for example, argue that the availability of a new menu of fixed-cost-intensive technologies in service sectors enables adopters to produce at lower marginal costs in a wide range of local markets. They note that in the US the entry of leading service firms into new local markets has led to substantial unmeasured productivity growth, particularly in small markets. ICT-based technologies together with the adoption of new management practices permit such services firms to scale up production over a large number of locations, driving productivity growth.

8 Eckert et al. (2020) investigate the drivers of urban biased growth in the US by identifying a cluster of "skilled, scalable" services based on each sector's reliance on high skilled-labor and ICT capital. This group includes professional, scientific and technical services; management services; information services and financial services. They show that US cities' comparative advantage in skilled services is a factor behind higher growth in urban areas. Similarly, Fang and Herrendorf (2021) show that removing frictions leading to the underdevelopment of high-skilled services would contribute to sizeable increases in per capita GDP.

While much of the literature on services and development has a focus on productivity, in this paper we focus primarily on the employment implications of structural transformation towards services in Africa and its potential consequences by undertaking an exploratory analysis of how the shift towards services co-varies with development indicators. While a focus on productivity and skill-intensity is central to understand the long-term implications of structural transformation, this might be at odds with developing strategies that maximize job opportunities for workers that move out of the agricultural sector. Understanding which industries and under which context are able to create jobs requires the compilation of granular data – the focus of this paper.

2. The data

We use three types of information: geolocalized employment data across sectors, including up to 12 services sectors; geolocalized indicators of economic development; and relevant features of the economic environment that could shape the relationship between services activities and economic development. This information is merged into one panel dataset, identified at the ADMIN-wave pair, covering 1,546 administrative units in 13 African countries: Benin, Botswana, Egypt, Ghana, Malawi, Mali, Mauritius, Morocco, Mozambique, Rwanda, South Africa, Tanzania and Zambia. The data span either two or three waves, depending on availability of census waves in the IPUMS International Database.[9] The final panel comprises 3,846 observations[10] and 55,976,623 individuals spanning the period 1982-2013. We describe the construction of the employment data from IPUMS below. The online Technical Appendix provides more detail on the construction of the database and on the other sources of data.

2. 1. Employment and Occupation Data

Employment data come from the IPUMS International Database (Minnesota Population Center, 2019). IPUMS reports information for a repeated cross-section of representative individuals, covering a variable fraction of a country's total population.[11] We aggregate individual-level information to the lowest available administrative designation for each country, in order to obtain a dataset defined at the ADMIN-wave level.[12] We only extract data for African countries for which at least two census waves report the "INDGEN" variable,[13] which provides a disaggregated sectoral employment classification, including up to 12 specific services industries.[14]

Given the abundance of temporal inconsistencies in the administrative designations in the IPUMS International Database, reflecting frequent redistricting by national authorities, we rely instead on the temporally and spatially consistent shapefiles provided by Alesina et al., (2021), to which we collapse all indicators included in our analyses. Figure 2 plots the 1,546 unique administrative units employed in the analysis, showing that these are broadly comparable in terms of surface area (larger administrative entities located in Morocco, Mali and Egypt correspond to mostly uninhabited and/or desert areas). As the Alesina et al. (2021) dataset does not include shapefiles for Mauritius we rely on the administrative designations provided by IPUMS International for this country. We calculate

9 Information on available waves and all variables is reported in the Online Technical Appendix. An online tool that provides graphs and maps on sectoral and occupational dynamics in Africa over available census waves in the IPUMS International database can be found at: https://globalgovernanceprogramme.eui.eu/services-and-economic-development-in-africa/

10 When including Mauritius. The number of observations is 3,727 when Mauritius is excluded in analyses using the spatial Gini coefficient and all Alesina et al., (2021) variables.

11 Coverage fractions and total number of surveyed individuals in each census wave are reported in the Online Technical Appendix.

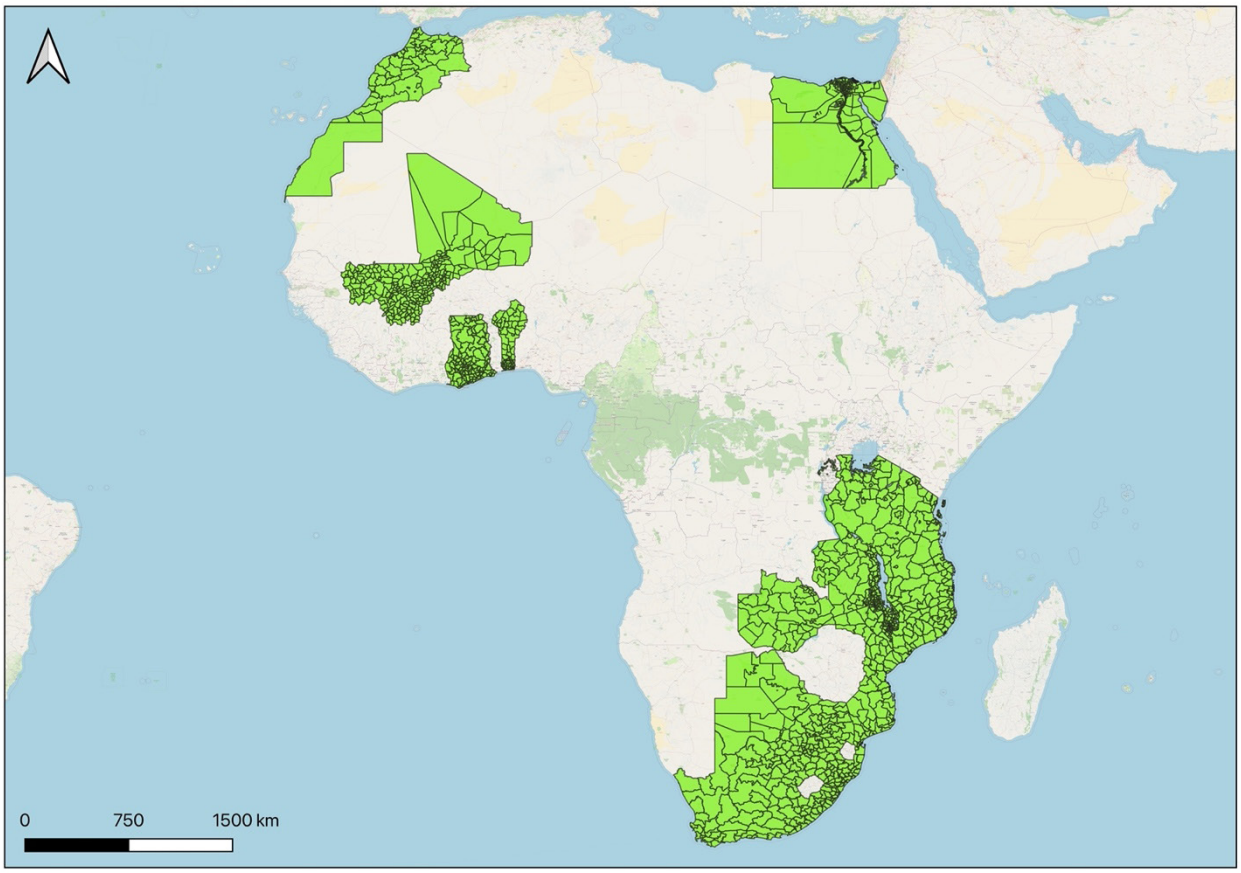
12 This operation amounts to aggregating data at the second administrative level for most countries, excluding Botswana, for which the sole administrative division available for aggregation is the first. The second-level administrative unit corresponds to Districts in a majority of cases, with the exception of Benin ("Communes"), Malawi ("Traditional Authorities"), Mali ("Circles"), Mauritius ("Municipal Wards/Village Council Areas"), Morocco and Rwanda ("Provinces").

13 The "INDGEN" variable refers to a disaggregated sectoral classification with 17 levels "roughly conforming to the International Standard Industrial Classification (ISIC)."

14 There is only one data point for sectoral employment in IPUMs for Burkina Faso, Cameroon, Guinea, Kenya, Lesotho, Senegal, Sierra Leone, South Sudan, Sudan, Uganda, and Zimbabwe, precluding us from including these African countries. We also exclude Liberia and Togo due to the very long time period between the two survey waves reported in the IPUMs dataset (1974 and 2008 for Liberia and 1970 and 2010 for Togo).

ADMIN-wave level sectoral shares for each of the 17 levels of the INDGEN variable,[15] weighting each individual-level observation by the survey weights provided by IPUMS International. This results in 17 distinct variables measuring the share of each sector in an administrative unit's total recorded sectoral employment.[16]

Figure 2. Administrative units for all countries included in the analysis



Source: Authors' elaboration on IPUMS and Alesina et al. (2021)

We repeat the same procedure for individual-level occupational characteristics, reported by IPUMS International under the "OCCISCO" variable. This variable includes 11 categories detailing the dwelling covered by each surveyed person within their occupational remit.[17] We thereby obtain 11 distinct occupational shares for each administrative unit, detailing the incidence of each dwelling on total employment. The OCCISCO variable is available in all included census waves, except for Rwanda's first census (1991).

15 The categories are: (1) Agriculture, fishing and forestry; (2) Mining and extraction; (3) Manufacturing; (4) Utilities (electricity, gas, water and waste management); (5) Construction; (6) Wholesale and retail trade; (7) Hospitality (hotels and restaurants); (8) Transportation, storage and communications; (9) Financial services and Insurance; (10) Public Administration and Defence; (11) Services, not specified; (12) Business services and real estate; (13) Education; (14) Health and social work; (15) Other services; (16) Private household services; (17) Other industry, not elsewhere classified. The "Other services" category includes the following: (a) miscellaneous personal and community services n.e.c., e.g. sanitary services and entertainment activities; (b) repairs not clearly for business functions and undifferentiated repairs; and (c) rental activities not of a business nature.

16 The IPUMS International Database includes "Not in Universe" (NIU) responses. In order not to distort the resulting sectoral shares, we decide to drop NIU observations from the dataset.

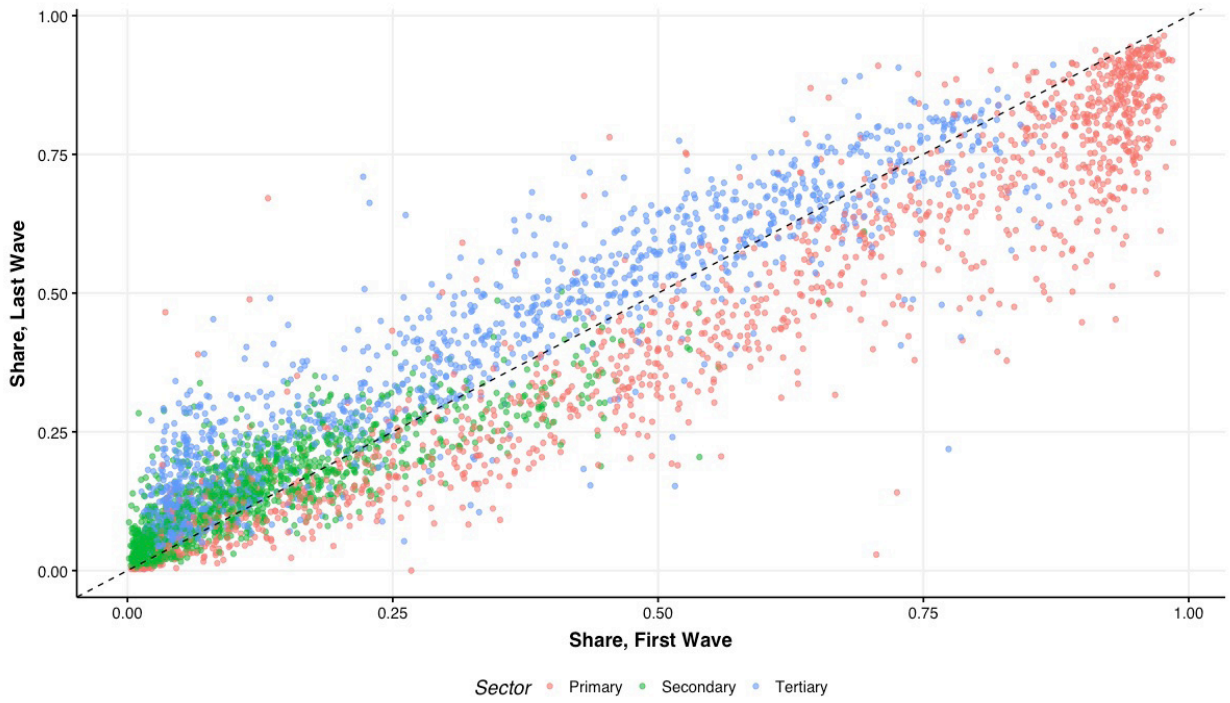
17 IPUMS codes occupations according to the major categories in the International Standard Classification of Occupations (ISCO) scheme for 1988. For someone with more than one job, the primary occupation is typically the one in which the person had spent the most time or earned the most money. The 11 categories are: (1) Legislators, senior officials and managers; (2) Professionals; (3) Technicians and associate professionals; (4) Clerks; (5) Service workers and shop and market sales; (6) Skilled agricultural and fishery workers; (7) Crafts and related trades workers; (8) Plant and machine operators and assemblers; (9) Elementary occupations; (10) Armed forces; (11) Other occupations, unspecified or not elsewhere classified.

3. Services in African Structural Transformation

The shift towards services noted in the literature discussed in Section 1 is evident in our sample of subnational units in Africa. Figure 3 plots decadal changes in employment shares across the three major sectors – primary, secondary and tertiary.[18] It shows that the drop in primary activities goes mostly hand in hand with an increase in services. Importantly, this pattern of services constituting a major source of employment growth is consistent across our sample, i.e. independent on the stage of development (e.g. Egypt vs. Malawi) or on the presence of natural resources (Botswana vs. Benin). The data also reveal that the share of the secondary sector generally increases during the period, with many instances in which employment shares in the secondary sector increase from an initial low base, offset by instances where administrative units with initially high shares of secondary sector employment experience a reduction in over time. Most of the instances where the share of industry increases are in the lower tail of the scatterplot. Conversely, administrative units where industry (the secondary sector) accounts for more than 25 percent of employment in the first wave often see a decline, consistent with Rodrik (2016). Appendix Figure C1 replicates the scatter plot for agriculture, manufacturing and services, showing a virtually identical picture as Figure 3.

The fact that we observe increases in the share of industrial employment in many administrative units suggests secondary sector activities demonstrate dynamism. Whether these activities can grow the share of industrial employment over time is of course an open question. An important research (and policy) question suggested by these descriptive data is what drives the growth in secondary activity at the lower end of the distribution, and whether and how it is distinct from the economic activities that are associated with instances of administrative units that report high shares of industrial employment in the first wave and lower shares in the second wave.[19]

Figure 3. Structural transformation at the sub-national level

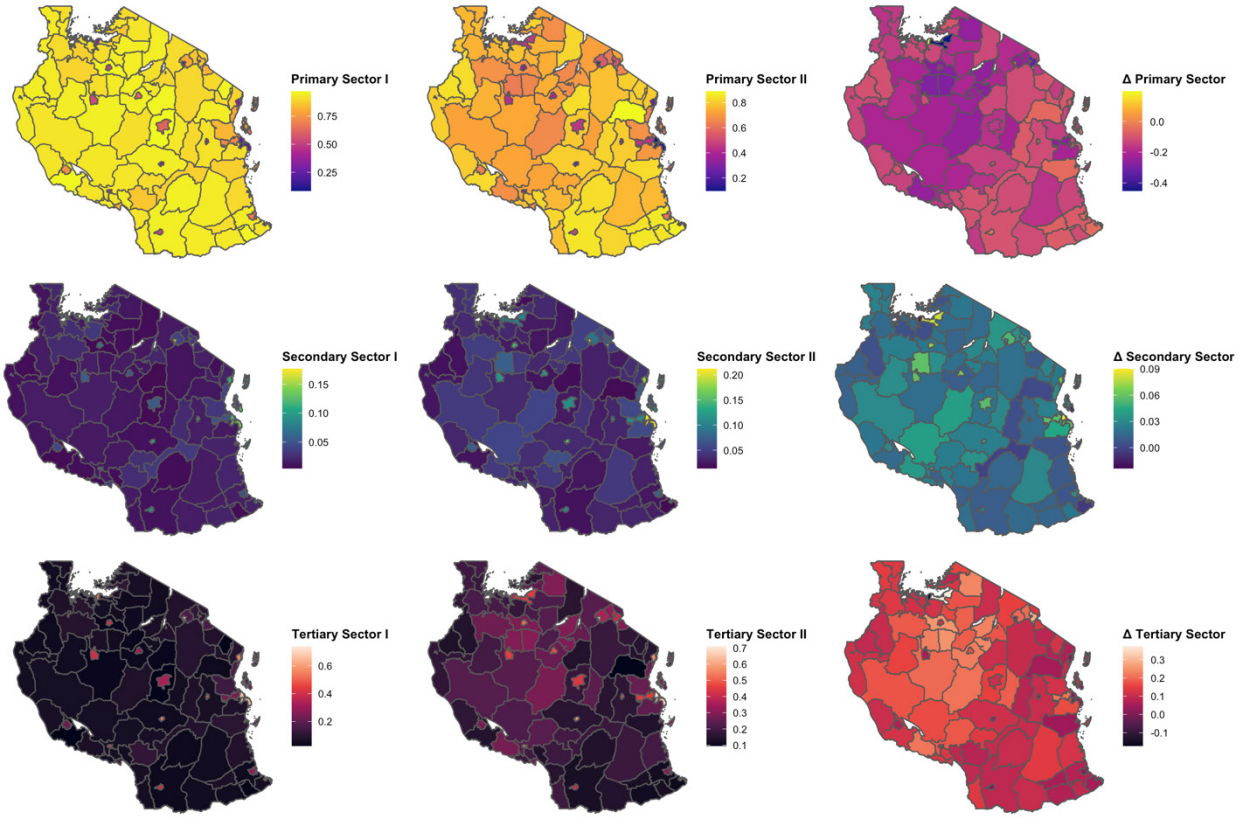


Note: Each dot represents an administrative unit that is observed over two successive waves of the census
Source: Authors' elaboration on IPUMS

18 Primary spans agriculture and mining; secondary includes utilities, manufacturing and construction; tertiary spans all services sectors.
19 These data pertain to shares and are not informative about the associated absolute levels of employment in a given sector of interest.

The online Appendix provides country specific maps plotting changes in sectoral employment over time. An illustration of these maps is provided in Figure 4, reporting data for Tanzania. It shows how structural change happened across administrative areas within the country over the decade spanning the two most recent population censuses (2002 and 2012). With the exception of a few areas, including the capital and other important cities, the rest of the country has been characterized by reductions in the share of agricultural employment that went together with an increase of employment within the services sectors. As is the case for the sample overall (Figure 3), there is also an increase in the share of the secondary sector.

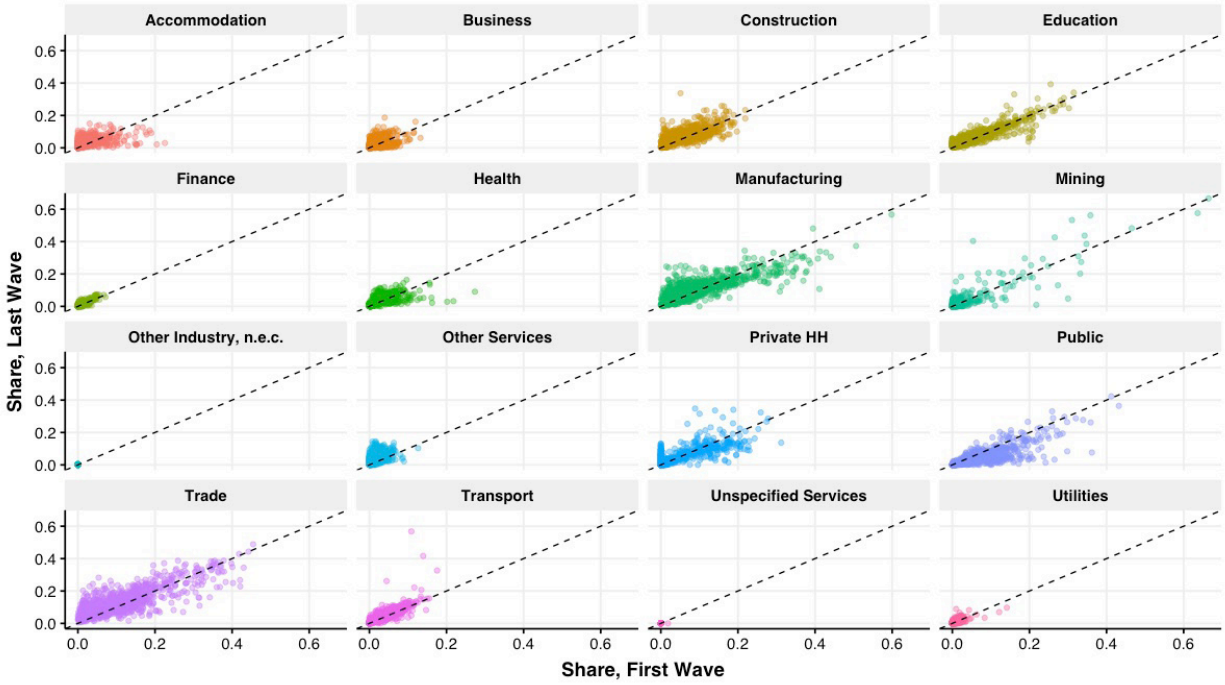
Figure 4. Sectoral dynamics in Tanzania between 2002 (I) and 2012 (II)



Note: the maps report administrative units' share of employment in the three main sectors. The first column reports maps covering the first (I) wave of the census (2002); the second column the next (II) wave; and the third column the difference between the two periods
Source: Author's elaboration using IPUMS

Figure 5 reports details for each of the 2-digit industries belonging to the services sector, in addition to other sectors for comparison. Again, all the graphs report information for the entire database and show changes that occurred in the most recent wave compared to the prior one. A few industries within services appear to explain the trends observed in the previous figure. This is most visible in the case of trade. Other services activities (e.g. business and financial services) also rise, but since they start from a very small base, their growth is more difficult to assess through visual inspection. Country-specific figures, reported in the online Appendix show interesting heterogeneity across sectors over time (e.g. a visible drop in public sector employment in Botswana, Tanzania and South Africa).

Figure 5. Structural transformation at the sub-national level: sector specific data



Note: Each dot represents an administrative unit that is observed over two successive waves of the census. Agricultural sector is excluded to allow a better visualization of smaller industries (given that all industries share the same values in the Y-axis)
Source: Authors' elaboration using IPUMS

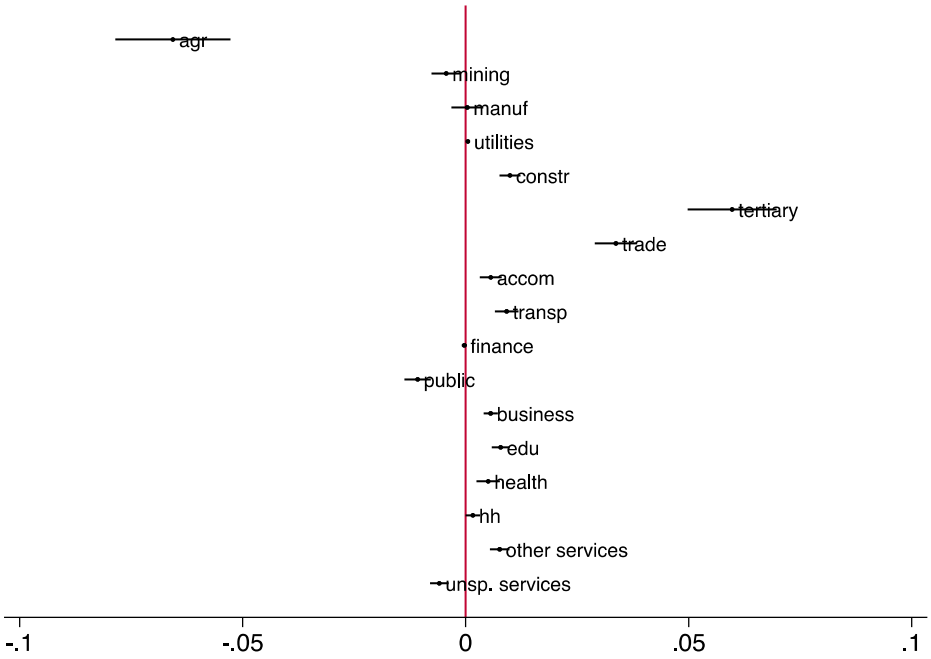
3. 1. Premature de-industrialization and the rise of services at the sub-national level

To get a better sense of the trends discussed above and the rate of change we replicate a specification proposed by Rodrik (2016) and adopted in other papers (e.g., Kruse et al. 2021), linking sectoral employment to time trends, as follows:

$$Emp\_share_{it} = \beta_0 + \beta_1 pop_{it} + \beta_2 pop_{it}^2 + \beta_3 ntl\_pc_{it} + \beta_4 ntl\_pc_{it}^2 + \theta_i D_i + \gamma_t post\_2000_t + \varepsilon_{it} \quad (1)$$

where the dependent variable is the employment share in agriculture, manufacturing and in all the industries comprising services. All regressions control for both demographic factors and income by means of the inclusion of (log) population and per capita night light and their squared terms, as well as for location *i* (administrative unit) fixed effects. The variable of interest is , which takes the value of 1 if the survey was run after 2000 and 0 otherwise. The estimated coefficient of this dummy gives us the size of the common shock to all sectors considered in the post-2000 period relative to pre-2000. Results are summarized in Figure 6, which reports the estimated using coefficients for all the regressions considered. Full results are reported in Appendix Tables A1 and A2. This exercise reveals the drop in agricultural employment has been substantial. On average, across all administrative units, agricultural shares of employment experienced a 6.6 percentage point (p.p.) decline compared to the pre-2000 period. While the changes in manufacturing have been substantially zero, the tertiary sector as a whole has shown an average increase of almost 6 p.p. Within the tertiary sector most industries grew compared to the previous decade. The trade sector records the greatest increase, while the relative size of the public sector shrinks.

Figure 6: Time trends across sectors



Note: Each point is the estimated, along with its 90% confidence interval, of different specifications based on equation (1)

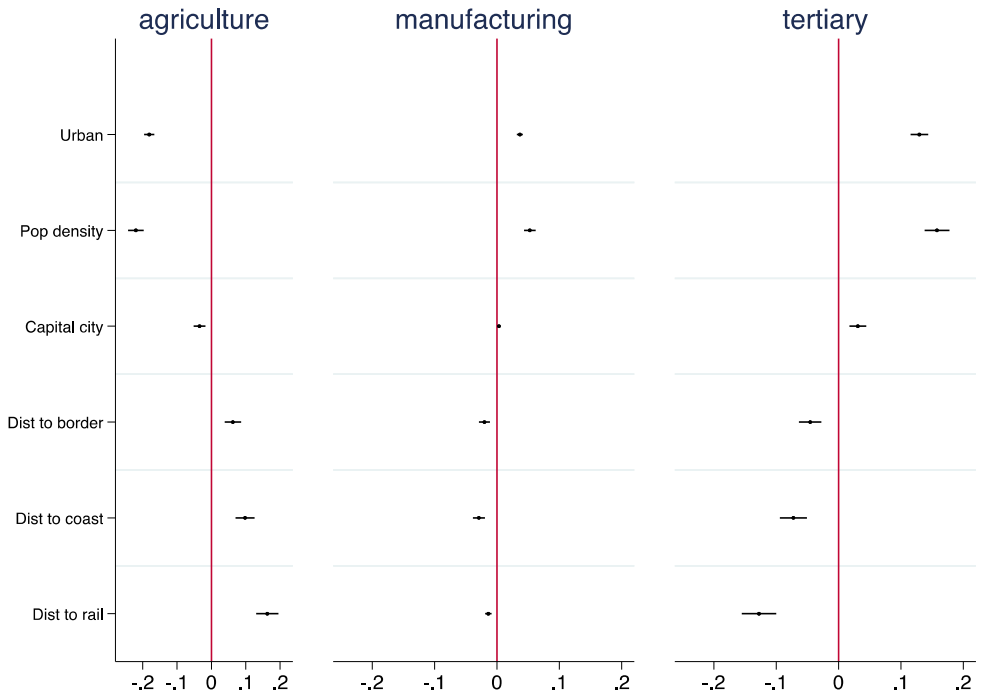
3. 2. Correlates of services employment

To explore whether the distribution of employment across sectors is correlated with specific characteristics of administrative areas, we exploit information on: (1) urbanization, measured as the share of the population living in urban areas; (2) population density; (3) a dummy indicating whether the area hosts the administrative capital of the country; and (4) the distance from the district centroid to the nearest border, coast and colonial railroad. Data on the first three variables are taken from the census data, while the distance measures are from Alesina et al. (2021). The technical Appendix provides detailed definitions of the variables considered, along with their summary statistics.

The variables we examine here mostly relate to historical and geographic factors identified by the existing literature as relevant drivers of African long run economic development (see Michalopoulos and Papaioannou, 2020, for a review). By shaping the direction of economic development, these factors might have determined the distribution of economic activities, and hence been linked with the contemporaneous size of certain types of services. The correlations presented below are useful indicators of potential drivers of services development, but the analysis does not imply anything about causal identification. Results, based on unconditional estimates accounting for country and wave fixed effects are summarized in Figures 7 and 8. Figure 7 plots the major differences across the three main sectors of the economy. Figure 8 reports results for specific services. All coefficients are standardized to facilitate comparison across the different estimations.

For each variable there is a (symmetric) difference between agriculture and the other sectors, which is more evident for services than for manufacturing. The characteristics of the administrative units appear to shape the distribution of economic activities within each country. Services (and, to a lesser extent, manufacturing) are more concentrated in urban areas, and in more densely populated parts of the country, including in particular areas in and around the capital city, where most administrative activities are concentrated.[20] Similarly, connectivity matters. Services employment is less likely to be high in areas far away from, in order of relevance: a border, a coast (where most of external trade happens) and a (colonial) railway. Surprisingly, these variables seem to matter less (though they keep the expected sign) for the location of manufacturing employment.

Figure 7. Correlates of sectoral employment

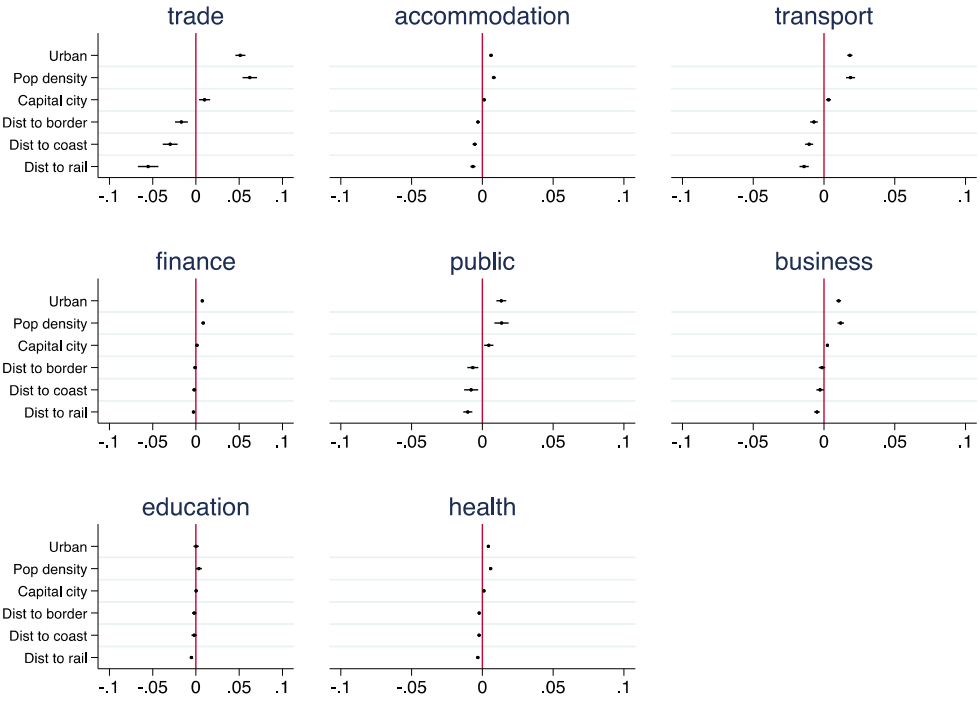


Note: Each point is the estimated coefficient, along with its 90% confidence interval, of a specification in which the outcome of interest (the share of employment in agriculture, manufacturing and services) is regressed against one of the following variables: urban (the share of urban population on total within each district); pop density (the ration of a district's population on its area); capital city (a dummy taking 1 if the district hosts the administrative capital of the country); dist to border (the log of the distance, in km, from a district's centroid to the closest border); dist to coast (the log of the distance, in km, from a district's centroid to the closest coast); dist to rail (the log of the distance, in km, from a district's centroid to the closest colonial railroad). All regressions include country and wave fixed effects, and standard errors are clustered at the district level.

Figure 9 reports the same correlations for specific services industries. Most of these industries tend to show the same pattern observed for the tertiary sector as a whole (Figure 8), but there is some heterogeneity that is worth highlighting. Trade and transport activities are most likely to cluster in more densely populated and urban areas, and in ones that are better connected. On the other hand, geography seems to matter less for public services such as health and education.

20 Public sector jobs in a capital city are on average more than two times larger than in other areas of the country.

Figure 8. Correlates of sectoral employment within services



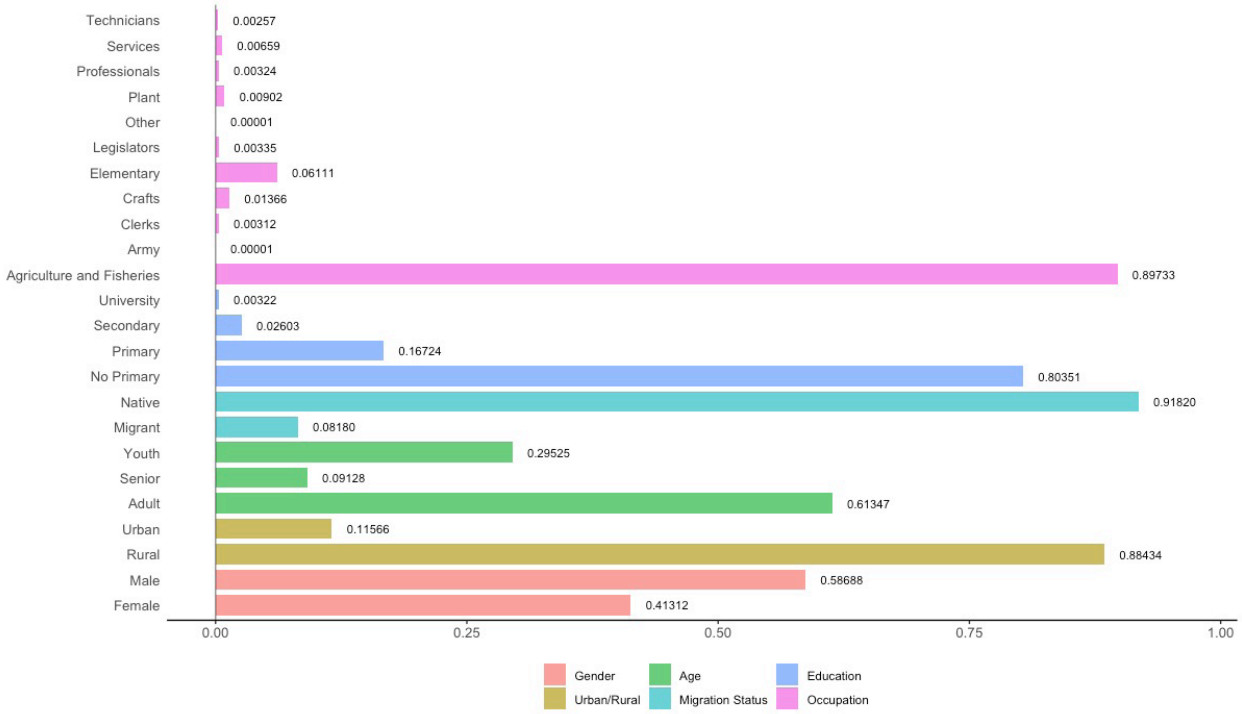
Note: Each point is the estimated coefficient, along with its 90% confidence interval, of a specification in which the outcome of interest (the share of employment in each of the services industries reported) is regressed against one of the following variables: urban (the share of urban population on total within each district); pop density (the ration of a district's population on its area); capital city (a dummy taking 1 if the district hosts the administrative capital of the country); dist to border (the log of the distance, in km, from a district's centroid to the closest border); dist to coast (the log of the distance, in km, from a district's centroid to the closest coast); dist to rail (the log of the distance, in km, from a district's centroid to the closest colonial railroad). All regressions include country and wave fixed effects, and standard errors are clustered at the district level. Regressions on undefined industries (other and unspecified services) are not included.

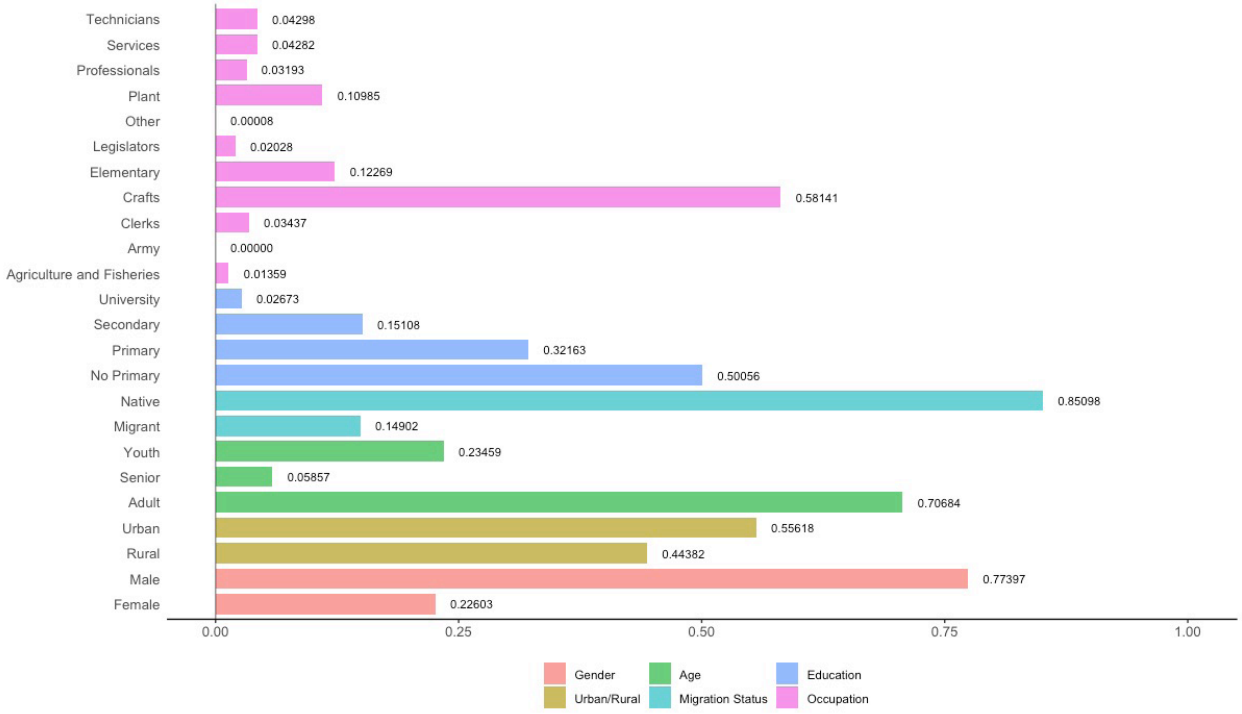
3. 3. Who works in services?

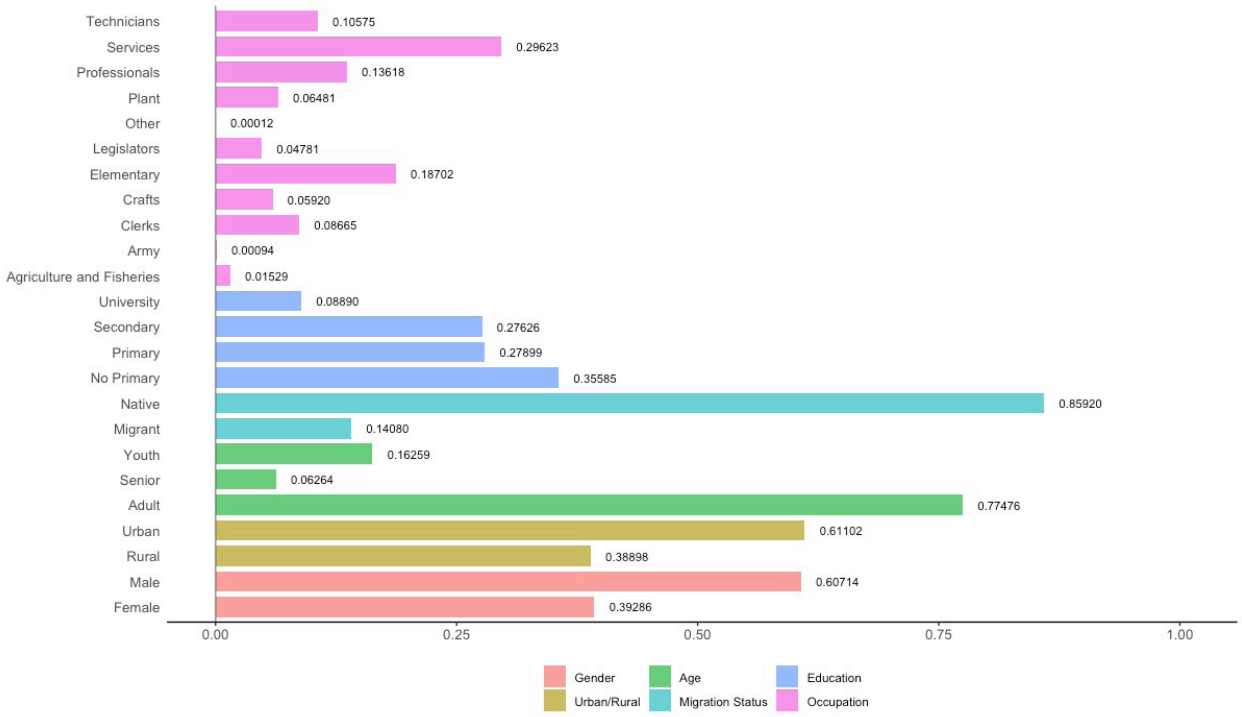
While services are important sources of employment in Africa, surprisingly little is known about their characteristics as well as their composition. For instance, previous research has shown that heterogeneity across services in terms of both skills and productivity plays a role in explaining cross-country differences in economic growth (Buera & Kaboski, 2012; Duarte & Restuccia, 2020). How much of this heterogeneity can be identified with the existing data, and how does it help to identify the potential contribution of sectors and industries to economic development?

This sub-section provides a snapshot based on the individual information available from IPUMS regarding the characteristics of people employed in services. We focus on the following characteristics: gender; urban/rural residence; age cohorts; migration status; education and occupation and collapse data over the latest two waves. Figure 9 summarizes the average values across all the countries included in our sample. Some patterns emerge with respect to the type of occupation (some of the more skilled ones are concentrated in the tertiary sector) and education. Regarding the latter, 8.9% of those employed in the services hold a university degree (2.8% in manufacturing) and 27.6% have a secondary school level (15.1% in manufacturing). Services employ a relatively higher share of women, some 40%, almost double that for the secondary sector. On the other hand, industry and services show relatively similar patterns in terms of the share of migrant workers employed (around 14% of the workers are internal migrants). Finally, younger cohorts of workers are less represented in services, compared to both the primary and secondary sectors.

Figure 9. Sectoral composition (%) by groups for primary (top panel); secondary (middle panel) and tertiary activities (bottom panel)







Source: Authors' elaboration on IPUMS

The online Appendix provides all the possible decompositions of the previous graphs by industries and country-industry pairs. As far as the industries within services are concerned, education, public administration, financial and business services employ a relatively large share of more highly educated individuals. Private household services, health and accommodation are female-dominated activities. Again, the majority of services industries employ a low share of youth or migrants.

3. 4. Occupations

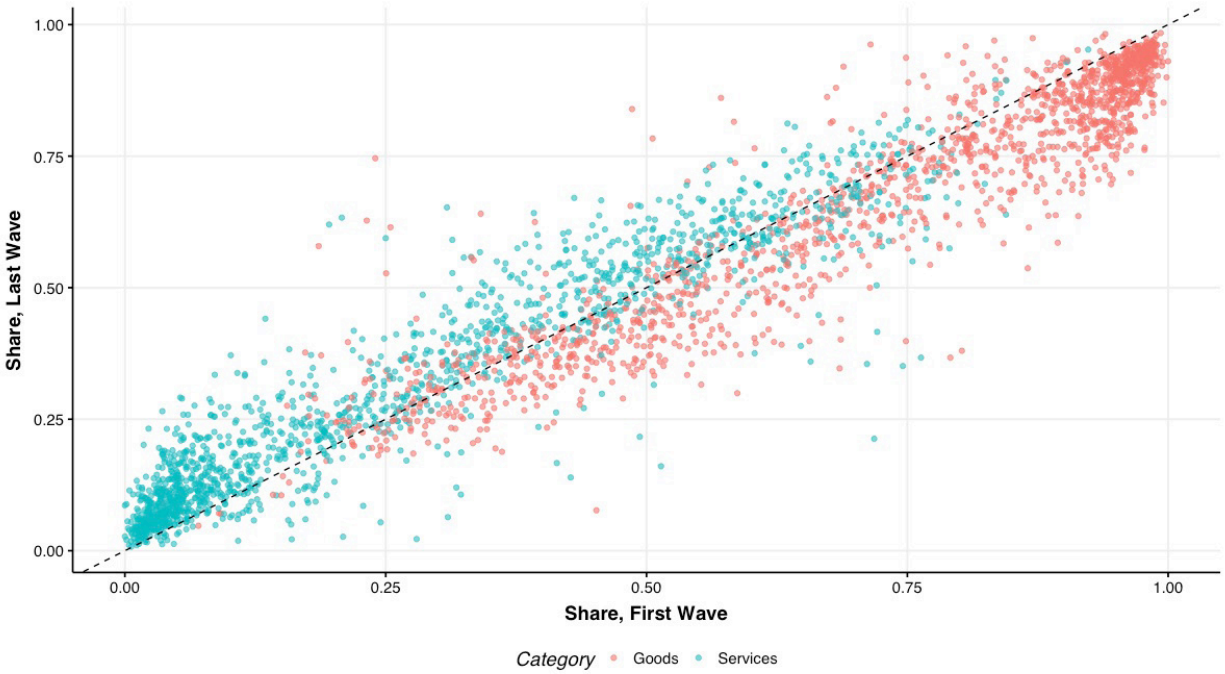
There is a rising emphasis on the role of occupations as opposed to industries or sectors in the literature on structural transformation (Lagakos & Shu, 2021). Industries are not necessarily precise categories. For instance, individuals formally employed in the manufacturing sector might perform services-related functions. There is evidence from developed countries of this potential misclassification (Berlingieri, 2014), and data shown in the previous section seem to confirm that this is an issue that can also be relevant in our sample of African countries (for instance, fig. 10 shows that some of the workers formally employed in the manufacturing sector are in fact performing service-related occupations as clerks, professionals or technicians, or craft workers in the services).

Duernecker and Herrendorf (2020) have proposed a distinction between categories of occupations that broadly map into the traditional distinction among the main economic sectors, although they are not necessarily attached to a specific sector. The categories are (1) *goods occupations*, which are related to the production of *tangible* value added; and (2) *services occupations*, which are related to the production of *intangible* value added. Employing census data for a large group of (developed and developing) countries, they show that the typical pattern of structural transformation (i.e. an increase in services as GDP per capita grows) holds also when using such classification. Given that they employ the same data we use in this report, we can replicate their exercise for our sample, and check whether results remain consistent.[21] Figure 10 shows that this is indeed the case. The shift towards intangible activities is evident for the last decades, and this pattern seems true for almost all the individual countries in our sample, with the exception of Benin and Mali. In these two countries,

21 In the sample, goods occupations include agriculture and industry (elementary, crafts and plant) occupations. Services occupations include the following: armed forces; clerks; elementary services; legislators; professionals; services; technicians.

while services are on the rise, goods occupations –especially those related to agriculture—have also kept going up over the last decade.

Figure 10. Structural transformation at the occupational level



Note: Each dot represents an administrative unit that is observed over two successive waves of the census
Source: Authors' elaboration on IPUMS

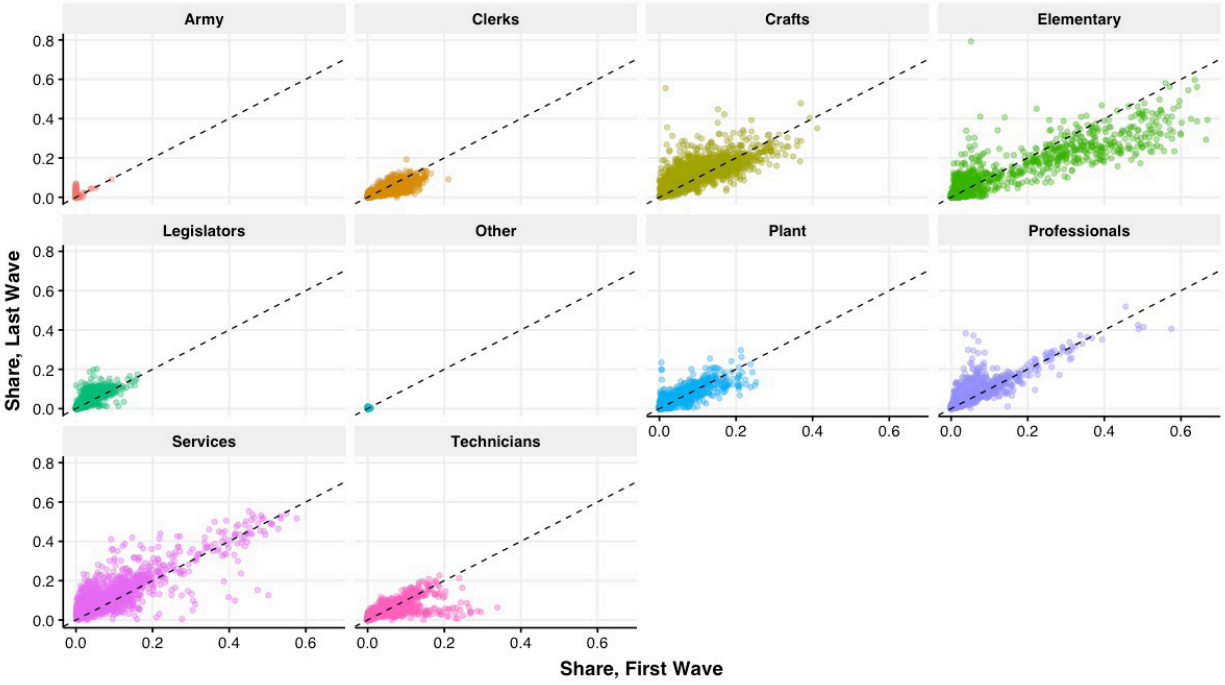
The results plotted in Figure 10 suggest that the increases in the shares of secondary sector employment registered by many administrative units reported in Figure 4 involve intangible (services) occupations. To check if this is the case, we run two exercises. First, we replicate Figure 10 with data relative to the manufacturing sector only.[22] Doing this allows us to observe more clearly that service occupations are growing the most in relative term during the most recent decade (see Figure C2 in Appendix C). Second, we run a simple regression in which we link changes in sectoral employment to changes in specific types of occupation. For the manufacturing sector, we find that a 1 percentage point increase in intangible occupations correlates with employment growth (see Table A3 in Appendix A), while this is not the case for tangible occupations.[23] This pattern would be consistent with the general trend towards servicification of economic activity in manufacturing (e.g., Beverelli et al. 2017). Insofar as this is the case, it may be one factor explaining the patterns of growing and declining shares of secondary sector employment observed across administrative units in the 13 countries in our sample. This is a question where further research using more granular information and firm-level data is needed.

Figure 11 plots changes in each occupation covered in our data for the whole sample of countries and over the last two decades. We observe a drop in elementary types of occupations, and a rise of those generally accounted for as high skilled, such as professionals, managers (the "legislators" category) and other services occupations.

22 Considering the whole sample, the share of services (goods) occupations among those employed in manufacturing is about 30% (70%).

23 Running the same regression on agriculture and services reveals that changes in employment shares are strongly correlated with the two types of occupations, tangible and intangible.

Figure 11. Occupation specific change



Note: Each dot represents an administrative unit that is observed over two successive waves of the census. The agri-fish occupation is excluded to allow a better visualization of smaller occupations (given that all share the same value in the Y-axis)
Source: Authors' elaboration on IPUMS

3. 5. Clustering services

Economic characteristics, such as tradability, potential productivity growth, economic spillovers, scalability, and skill intensity can vary substantially across services activities. The literature suggests several approaches to cluster individual services sectors in terms specific properties depending on the relevant application. Research on services and global value chains, including the spillover-effects of services trade policy to downstream industries that use services as intermediate inputs, focus on the group of so called "production" or "producer" services. This includes R&D, financial, business, transport, telecommunication and wholesale trade services, which are used as inputs in virtually all modern production processes (Beverelli et al., 2017). As we are interested in the relationship between services and economic development, we cluster services sectors in terms of employment characteristics which are both measurable in our data and relevant for economic development. These are: i) intensity in high skilled-labor, as captured by the share of employees with a university degree in a sector; and ii) intensity in complex occupations, measured through the share of legislators/senior officials/managers, professionals and technicians employed in each sector.[24]

24 The shares are computed at the level of the whole sample. Education categories in the data are identified using IPUMS classification and include: less than primary; primary; secondary; and university. Occupational categories listed by the IPUMS classification are: legislators, senior officials and managers; professionals; technicians and associate professionals; clerks; service workers, shop and market sales; skilled agriculture and fishery workers; crafts and related trade workers; plant and machine operators and assemblers; elementary occupations; armed forces; other occupations unspecified or not elsewhere classified. According to our definition, we consider as complex occupation legislators, senior officials and managers; professionals; and technicians and associate professionals.

Figure 12. Services sectors, skills and occupations

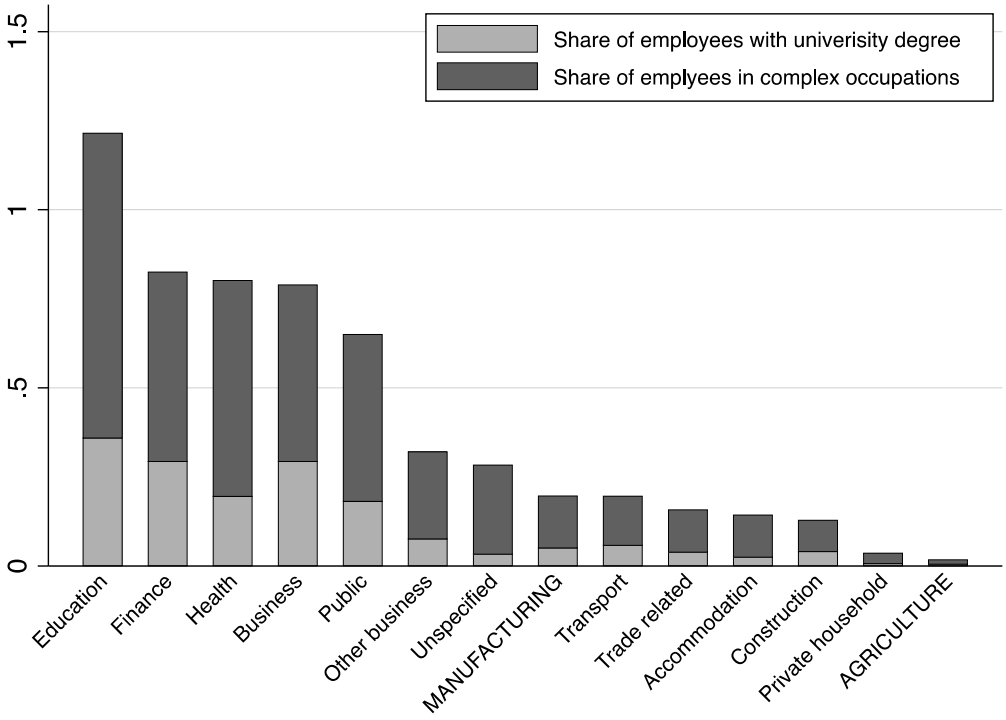


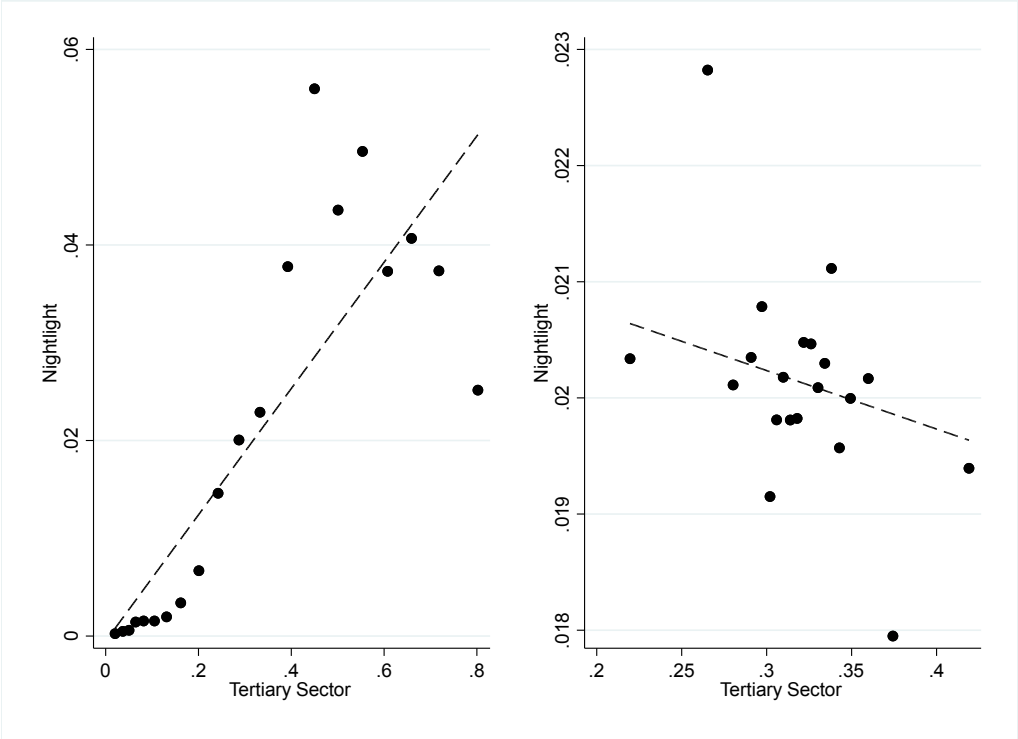
Figure 12 plots all services sectors identified in our database ranked in terms of the share of high skilled workers and complex occupations. The chart also reports the same figure for manufacturing and agriculture. We use manufacturing as a divide to identify two groups of services sectors: the cluster of "high skilled, complex occupation" (high skills) sectors, including education, finance, health, business, public services, other business and unspecified services; and the cluster of "low skilled, simple occupations" (low skills) sectors, including transport, trade related, accommodation, and private household services. According to our metric, seven services sectors rely more on skilled-labor and complex occupations than manufacturing. Agriculture has the lowest high skilled labor and complex occupation intensity. While our approach is somewhat discretionary, within the framework of our application it is fairly robust to alternative definitions of the ranking used to identify the two clusters.[25]

25 We computed 12 other rankings based on the following metrics: 1. share of employees with university degree; 2. share of employees with university or secondary degree; 3. share of complex occupations; 4. share of complex occupation including clerks; 5. share of employees in resident in urban areas (urban workers); 6. share of employees with university or secondary degree plus share of complex occupations; 7. share of employees with university or secondary degree plus share of complex occupations plus share of urban workers; 8. share of employees with university or secondary degree plus share of complex occupations including clerks; 9. share of employees with university or secondary degree plus share of complex occupations including clerks plus share of urban workers; 10. share of employees with university degree plus share of complex occupations plus share of urban workers; 11. share of employees with university degree plus share of complex occupations including clerks; 12. share of employees with university degree plus share of complex occupations including clerks plus share of urban workers. If we take the average score across all 13 rankings, the 7 high skills sectors correspond to the 7 highest ranked sectors according to the average ranking.

4. Services and development

Figure 13 shows correlations between nightlight *per capita*,[26] our proxy of economic growth, and the share of the tertiary sector, using binned scatterplot. The panel on the left is a barebones correlation, whereas the panel on the right accounts for ADMIN and wave fixed effects. The take away messages are clear-cut: 1) there is a strong positive association between growth and services across administrative units; and 2) there is a negative (weaker) correlation between growth and services within units.[27]

Figure 13. Correlation between nightlight and share of the tertiary sector



Note: binned scatterplot. The graph on the left shows a simple correlation. The graph on the right shows correlations accounting for ADMIN and wave fixed effects.

Our reduced form analysis is based on the following baseline model:

$$Nightlight_{it} = \alpha + \delta_i + \tau_t + \beta_1 Secondary\ Sector_{it} + \beta_2 Tertiary\ Sector_{it} + \beta_3 Z_{it} + \varepsilon_{it}, (2)$$

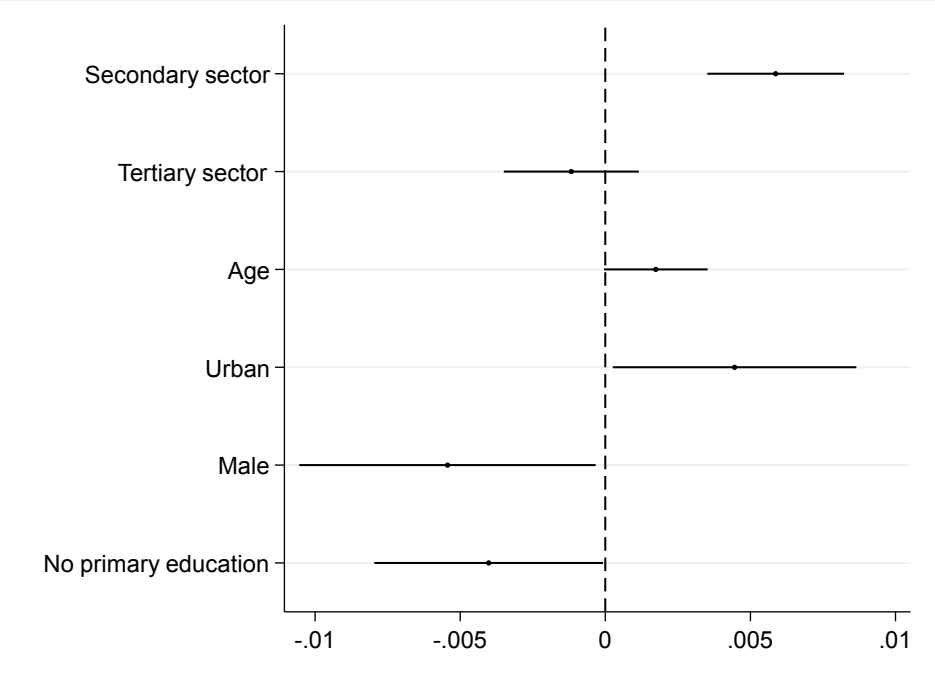
where nightlight per capita is the outcome, i.e. sum of nightlights in a ADMIN divided by its population. We observe this outcome in each ADMIN i and in each wave t. Secondary Sector and Tertiary Sector are share of worker employed in respectively industry and services in each ADMIN and in each wave. Thus, the share of workers employed in the primary sector is the baseline category in these regressions. Z is a matrix including our controls (share of people living in urban areas, share of male population, average age in an ADMIN, and share of people without primary education), δ and τ are ADMIN and wave fixed effects, and ε are the residuals.

26 Nightlight per capita are defined as the share of the admin level of nightlight density divided by population. For this exercise, data on night light are those using the DSMP satellite information, which allow to recover information for the earlier periods covered in our sample. For robustness, we have also run all regressions using the recently released data from Li et al. (2020).

27 In Appendix B, we report the same figures for the primary and secondary sector (Figures B1 and B2). There is always a negative (positive) correlation between nightlight and primary (secondary) sector with our without fixed effects.

We run OLS regressions weighted by ADMIN's population. We cluster the standard errors at the level of the ADMIN unit. For ease of comparison among covariates, we standardize all the right hand-side variables. We report here only the results of the baseline model. Appendix B reports all model specifications, i.e. with and without fixed effects as well as with and without controls (see Table B1). The estimation sample includes around 3,000 observations, depending on the model. Our unit of analysis is district-census wave. The results of this baseline model are reported in Figure 14. Overall, we find little evidence that the service sector as a whole is an engine of economic development in African countries.

Figure 14. Main results by sector



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,909 and the R^2 is 0.965. 90% C.I.

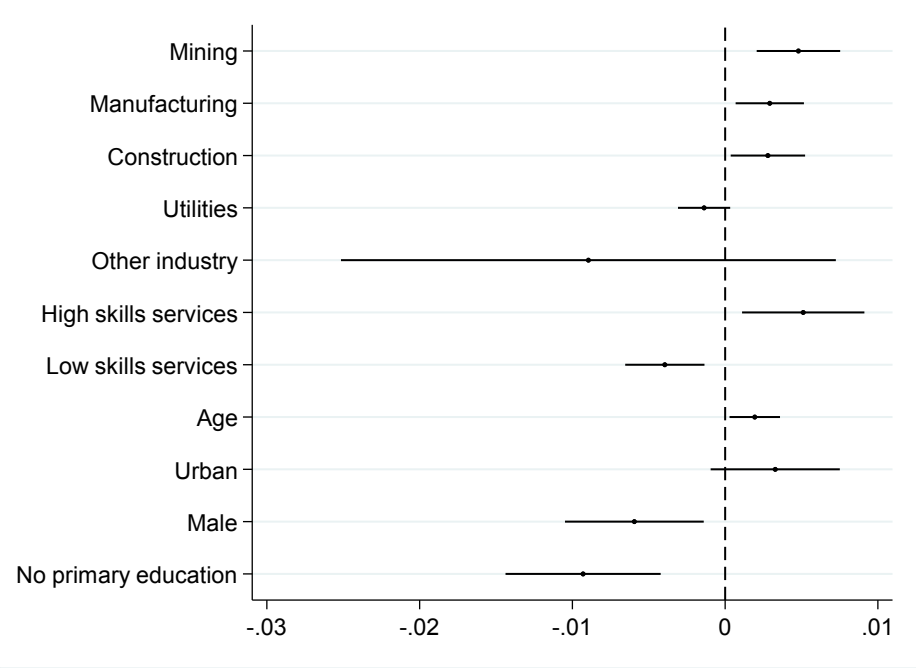
4.1. By macro service clusters

These foregoing findings may reflect the heterogeneity within the service sector. In what follows we therefore distinguish between high skills and low skills services, using the categorization developed above.

Our regressions show that there is a positive significant relationship between economic growth and the share of workers employed in high skills services (Figure 15). The magnitude of the positive correlation is in line and in fact larger than the magnitude of the positive correlation between nightlight and manufacturing. On the contrary, there is a negative significant association between economic growth and share of workers employed in low skills services. These results help understand the null effect of the baseline analysis[28].

28 Note that we account for the share of people with no primary education, which is negatively correlated with development. Thus, our macro service clusters are not a mere proxy of education in this model.

Figure 15. Main results: high skill services vs. low skill services



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,909 and the R^2 is 0.967. 90% C.I.

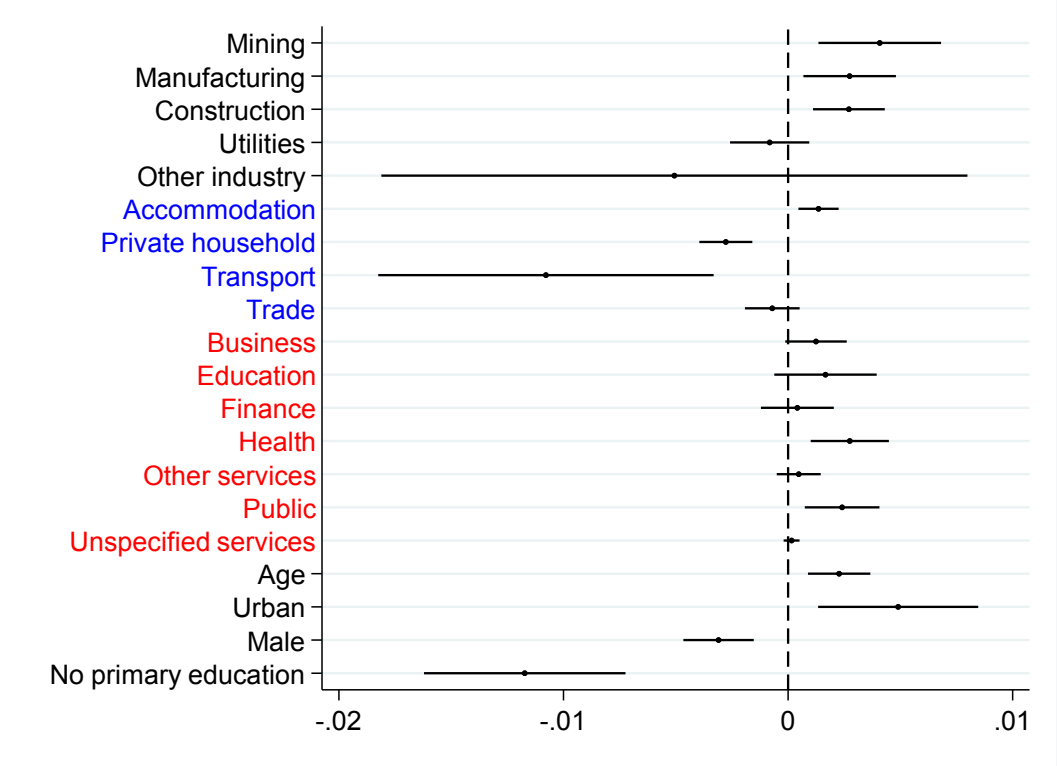
4. 2. By individual service industries

To determine which service industries are more associated with economic growth, we run our main model (2) including 2-digit industries. Figure 16 reports the results of this analysis. To ease the reading of the results, high skills services are highlighted in red, whereas low skills services are in blue. Strikingly, all the high skill service industries are positively associated with economic growth, though only health and public services are significant. Conversely, private household services, transportation, and trade, which are low skills services, are negatively correlated with growth, though only the first two variables are significant. Accommodation, which are also low skill, are an exception, being correlated positively with growth.

4. 3. Investigating heterogeneity across economic environments

The correlation of services and development may be affected by heterogeneity across economic environments. We are interested in three dimensions of this heterogeneity: 1) the mediating effect of (lack of) economic activities at the baseline, which we capture with the incidence of malaria; 2) the mediating effect of natural resources, which we capture with the presence of diamond mines and oil extraction; 3) the mediating effect of technology, proxied by mobile phone coverage.

Figure 16. Main results by industry

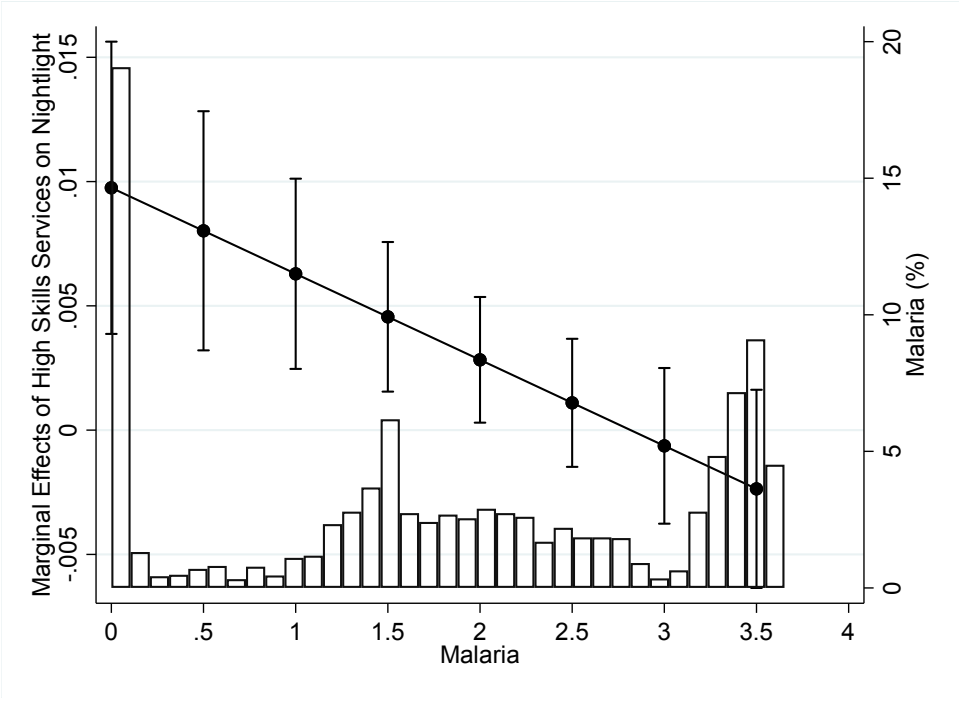


Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,909 and the R^2 is 0.972. 90% C.I.

To analyze this heterogeneity, we interact each mediating variable with share of high and low skills services as well as with the other industries, e.g., mining and manufacturing. We then run the same model specification as described in equation (2). To ease the interpretation of the interaction terms, we show the results graphically. We focus on the interaction between high skills services and mediating variables. We start with the incidence of malaria, where low values correlate with thriving economic activities (Acemoglu et al., 2001). Figure 17 reports the marginal effect of high skills services on nightlight *per capita* for different level of incidence of malaria. The positive correlation between high skills services and growth is only significant for low incidence of malaria. On the contrary, for incidence of malaria (roughly) above the mean, the correlation between high skills services and growth is no longer significant, i.e. the line of the marginal effect crosses the 0. In sum, we find convincing evidence that the presence of economic activities at the baseline mediates the positive association between high skills services and development.[29]

29 In separate regressions, not reported for reasons of space but available upon request, we show that the incidence of malaria does not mediate the effect of manufacturing on development.

Figure 17. High skills services and growth: Mediating effect of the incidence of malaria



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,829 and the R^2 is 0.970. 90% C.I.

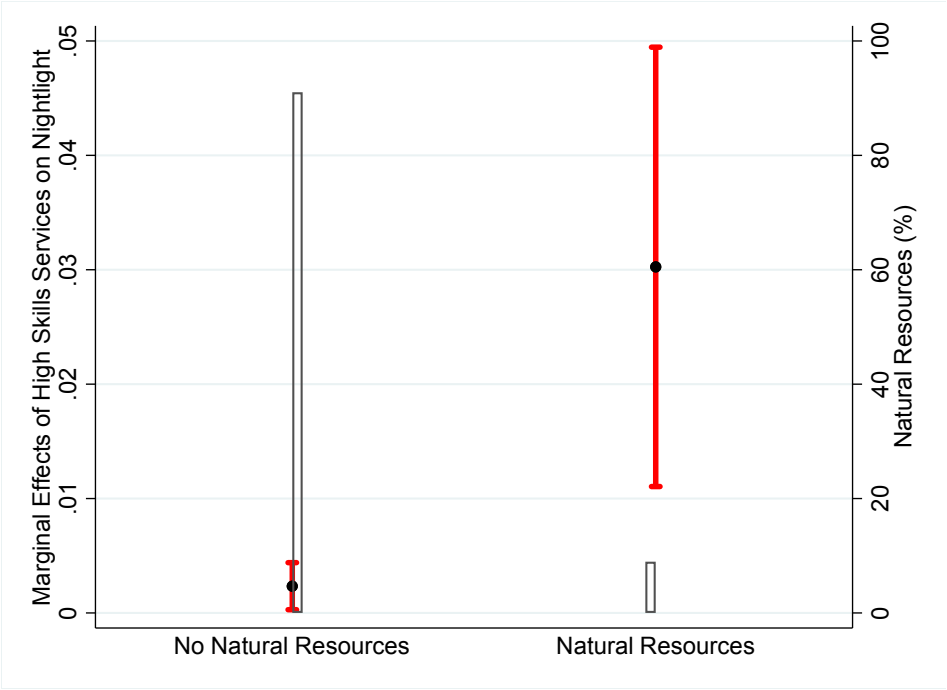
Turning to the mediating effect of natural resources, we interact high skills services with a dummy scoring one if there is at least one mine of diamond or of oil in the ADMIN unit. Figure 18 reports the marginal effect of high skills services on nightlight *per capita* for units with and without mines of diamond. While the positive correlation between high skills services and growth is significant in both regions with and without mines of diamond, the correlation is significantly stronger in regions with mines of diamond. This finding suggests that the presence of natural resources and related wealth provides the demand for the expansion of the high skills services, a result in line with Gollin et al. (2016).[30]

Finally, we look at the mediating effect technology. Specifically, we interact high skills services with mobile phone coverage (Manacorda and Tesei 2020). The rationale is that technology provides the supply for the expansion of service activities. Figure 19 reports the marginal effect of high skills services on nightlight *per capita* for different levels of mobile phone coverage. The positive correlation between high skills services and growth is only significant for high values (i.e. roughly above the mean) of mobile phone coverage, whereas is not significant for low values of mobile phone coverage. This finding points to technology being an important intervening variable to explain the positive association between some services activities and development.[31]

30 In separate regressions, not reported for reasons of space but available upon request, we show that natural resources do not mediate the effect of manufacturing on development.

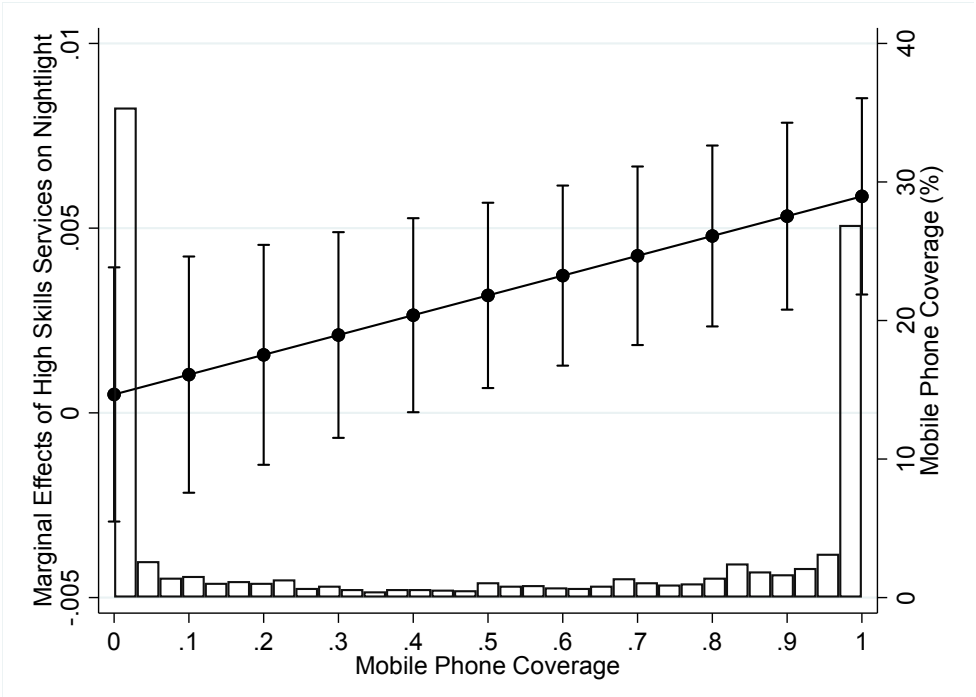
31 In separate regressions, available upon request, we show that technology also mediates the effect of manufacturing on development.

Figure 18. High skills services and growth: The mediating effect of natural resources



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,811 and the R^2 is 0.966. 90% C.I.

Figure 19. High skills services and growth: The mediating effect of technology



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 1,958 and the R^2 is 0.975. 90% C.I.

Conclusion

This paper contributes to the literature on structural transformation and economic development by providing detailed data on changes in the composition of employment over time at the administrative unit level for thirteen African countries. This reveals novel evidence of structural transformation towards services sectors and service-related occupations at sub-national level, providing a fine-grained picture of changes in sectoral employment shares and occupations. The data depict a clear shift towards services in all the countries in the sample. Across all the administrative units in our sample of countries there is a decline in the total share of employment in agriculture of six percentage points, offset by an equivalent increase in the share of employment in services sectors.

Although the overall share of secondary sector employment is stable, there is significant heterogeneity across sub-national units. The data reveal reductions in industrial employment shares in locations where such activity accounted for relatively high shares of total employment in the initial census year, but also numerous increases in areas where industry accounted for relatively low shares of total employment. There is weak evidence that manufacturing employment growth in these locations is associated with servicification, in the sense that employment in occupations associated with intangible outputs appears to grow in many regions where the share of employment in the secondary sector increases between two census waves.

Exploratory analysis of the relationship between services and economic development, using per capita nightlight luminosity as a proxy for growth, reveals no evidence that services as an aggregate are associated with economic development. There is however substantial heterogeneity across different services industries. Disaggregating the tertiary sector by skill intensity reveals that higher-skilled services are strongly associated with development. We distinguish between high and low skills services sectors by sorting services sectors by intensity of use of workers with a university degree and engaged in occupations that are more complex. Sectors that use these categories of workers more intensively than the average observed in manufacturing are classified as high skill. The strong positive association between high skill services sectors and development is mediated by geography, institutions and technology. Greater incidence of malaria, the presence of a mining facility and below average mobile phone coverage in an administrative unit reduces or undoes the significance of the positive association.

Overall, the data highlight an important role of services activities for job generation, skills accumulation and economic development in Africa. The patterns revealed by the data suggest the importance of exploiting the potential of microdata to study issues traditionally analyzed using aggregate or sectoral level information. With respect to services, as also suggested by Lagakos and Shu (2021), microdata can help—as showed descriptively in this paper —to associate their high heterogeneity to observable characteristics of workers and, potentially, firms.

Our findings suggest several areas on which future research could focus. One is to analyze the evolution within services across the sampled countries to understand better the relationship between high skills services and economic development. A corollary research question pertains to the role of services in explaining manufacturing employment dynamics, including analysis of the extent to which servicification is occurring in manufacturing. More broadly, insofar as high skills services are associated with development, future research to assess the drivers of demand for such services and possible complementarities between services activities would seem apposite. Complementing the census data with firm-level information at the administrative unit level is a necessary condition for developing a better understanding of the role services play in structural transformation and the prospects for increasing productivity and employment generation.

Another area for research suggested by the data concerns the distributional and poverty implications of the shift towards services. Existing research has shown that the type of structural transformation towards services matters to understand on development. Notably, the poverty-reducing effects

of growth in service activities that tend to develop early on (e.g. wholesale and retail trade and transportation services) have been found to be similar and sometimes greater than that associated with equal growth in agriculture or manufacturing sectors (Dorosh and Thurlow, 2018). Using sub-national data for developed and developing countries, Chatterjee and Giannone (2021) find that the development of highly productive types of services is associated with greater regional inequality.[32] Further research on such questions using micro data for African countries is important to understand better the implications of the shift to services and to identify policies that can help address adverse distributional consequences.

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APPENDIX A

Table A1. Full results by main sectors based on equation (1)

	(1)	(2)	(3)	(4)	(5)	(6)
	Agriculture	Mining	Manufacturing	Utilities	Construction	Tertiary
ntl_pc	-2.100***	0.198*	0.604***	0.00982	0.416***	0.881***
	(0.354)	(0.106)	(0.129)	(0.0151)	(0.0643)	(0.251)
ntl_pc^2	1.016***	-0.0535	-0.202*	0.0429***	-0.202***	-0.556***
	(0.321)	(0.0488)	(0.119)	(0.0112)	(0.0297)	(0.189)
pop	0.353***	0.0636	-0.0258	-0.0368***	-0.0758***	-0.314***
	(0.129)	(0.0697)	(0.0427)	(0.00591)	(0.0229)	(0.0890)
pop^2	-0.0190***	-0.00209	0.00192	0.00168***	0.00362***	0.0155***
	(0.00539)	(0.00281)	(0.00179)	(0.000256)	(0.000968)	(0.00374)
post_2000	-0.0656***	-0.00436***	0.000364	0.000494**	0.00993***	0.0597***
	(0.00657)	(0.00169)	(0.00182)	(0.000238)	(0.00120)	(0.00508)
Constant	-0.876	-0.442	0.0956	0.203***	0.415***	1.802***
	(0.780)	(0.427)	(0.254)	(0.0342)	(0.135)	(0.538)
Observations	3,135	3,135	3,135	3,135	3,135	3,135
R-squared	0.971	0.920	0.913	0.881	0.899	0.969

Notes: Estimates are based on equation (1). NTL_pc is the value of nighttime lights per capita. pop is the log of population. The squared term of both the former variables is included. Post_2000 is the variable of interest, a dummy taking 1 if the year of the census is successive to 2000. All regressions include district fixed effects. Robust standard errors in parenthesis. District. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Full results by industries within services based on equation (1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	trade	accommodation	transport	finance	public	business	education	health	private_hh	other_ services	unspec_ services
ntl_pc	-0.0465	0.430***	-0.0739	0.0608***	-0.145	-0.0843**	0.256***	0.148***	-0.219***	0.625***	-0.0792***
	(0.104)	(0.0654)	(0.255)	(0.0149)	(0.110)	(0.0371)	(0.0560)	(0.0435)	(0.0790)	(0.0874)	(0.0242)
ntl_pc^2	-0.0776	-0.162***	-0.215	-0.0228**	0.148*	0.0553***	-0.0416	-0.0990***	0.108**	-0.307***	0.0143
	(0.0615)	(0.0235)	(0.144)	(0.00950)	(0.0860)	(0.0191)	(0.0351)	(0.0273)	(0.0503)	(0.0617)	(0.0127)
pop	-0.206***	-0.0286	-0.0670***	-0.00998*	0.256***	-0.00127	0.0597***	-0.0951***	-0.0949***	-0.111***	0.0222
	(0.0585)	(0.0226)	(0.0259)	(0.00530)	(0.0361)	(0.0186)	(0.0217)	(0.0232)	(0.0240)	(0.0239)	(0.0358)
pop^2	0.00812***	0.00195**	0.00328***	0.000562***	-0.0115***	0.000198	-0.00201**	0.00441***	0.00456***	0.00585***	-0.00167
	(0.00251)	(0.000958)	(0.00104)	(0.000216)	(0.00159)	(0.000790)	(0.000933)	(0.000918)	(0.00107)	(0.00102)	(0.00162)
post_2000	0.0337***	0.00562***	0.00919***	-0.000309	-0.0108***	0.00561***	0.00784***	0.00505***	0.00162*	0.00762***	-0.00591***
	(0.00242)	(0.00126)	(0.00135)	(0.000292)	(0.00150)	(0.000809)	(0.00102)	(0.00134)	(0.000829)	(0.00111)	(0.00106)
Constant	1.371***	0.0721	0.357**	0.0444	-1.362***	-0.00209	-0.386***	0.519***	0.510***	0.499***	-0.0234
	(0.343)	(0.135)	(0.163)	(0.0326)	(0.205)	(0.109)	(0.127)	(0.144)	(0.135)	(0.141)	(0.197)
Observations	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135
R-squared	0.904	0.647	0.910	0.921	0.901	0.796	0.941	0.859	0.907	0.716	0.466

Notes: Estimates are based on equation (1). NTL_pc is the value of nighttime lights per capita. pop is the log of population. The squared term of both the former variables is included. Post_2000 is the variable of interest, a dummy taking 1 if the year of the census is successive to 2000. All regressions include district fixed effects. Robust standard errors in parenthesis. District. *** p<0.01, ** p<0.05, * p<0.1.

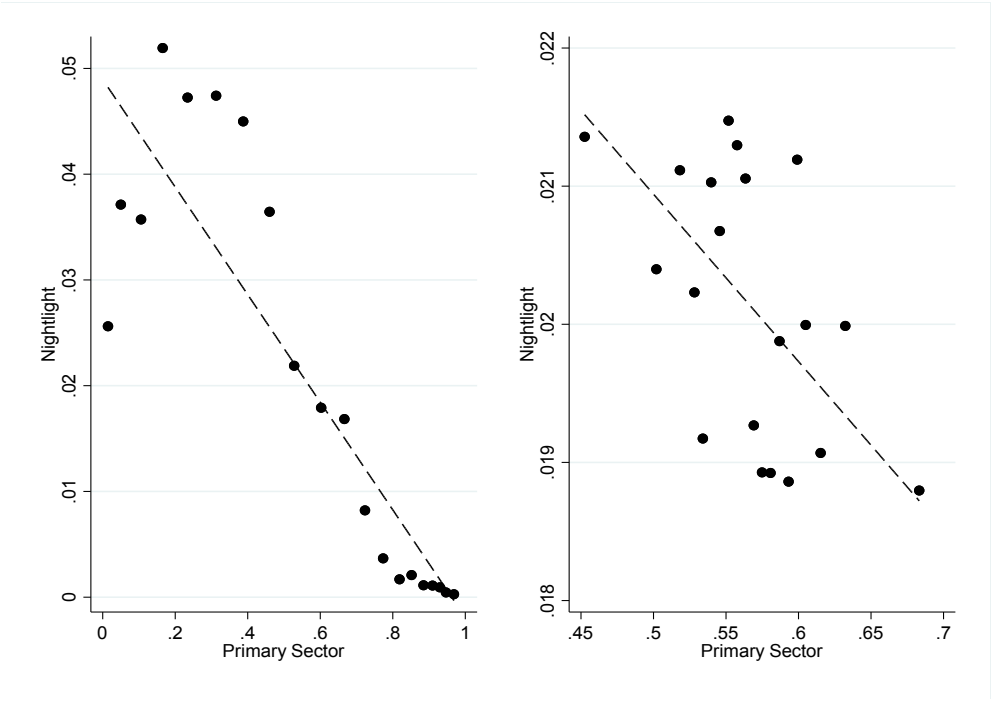
Table A3. Correlations between changes in sectoral employment and type of occupation

VARIABLES	(1) Agriculture	(2) Manufacturing	(3) Services
Goods (tangible) occupations	0.751***	0.180	-0.412**
	(0.245)	(0.129)	(0.186)
Services (intangible) occupations	-0.310	0.232*	0.523***
	(0.247)	(0.129)	(0.189)
Constant	-0.0396***	0.00844***	0.0211***
	(0.00204)	(0.00123)	(0.00125)
Observations	1,528	1,520	1,529
R-squared	0.712	0.210	0.867

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Notes: Each column reports a regression linking the first difference in the share of employment in one of the three sectors (agriculture, manufacturing, services) against the first difference in the share of workers classified into goods (tangible) or services (intangible) types of occupations according to the definition by Duernecker & Herrendorf (2020). The latter refers only to those employed within a specific sector. In order to compute the first difference in an homogenous manner, the estimation sample includes the two most recent waves for each country.

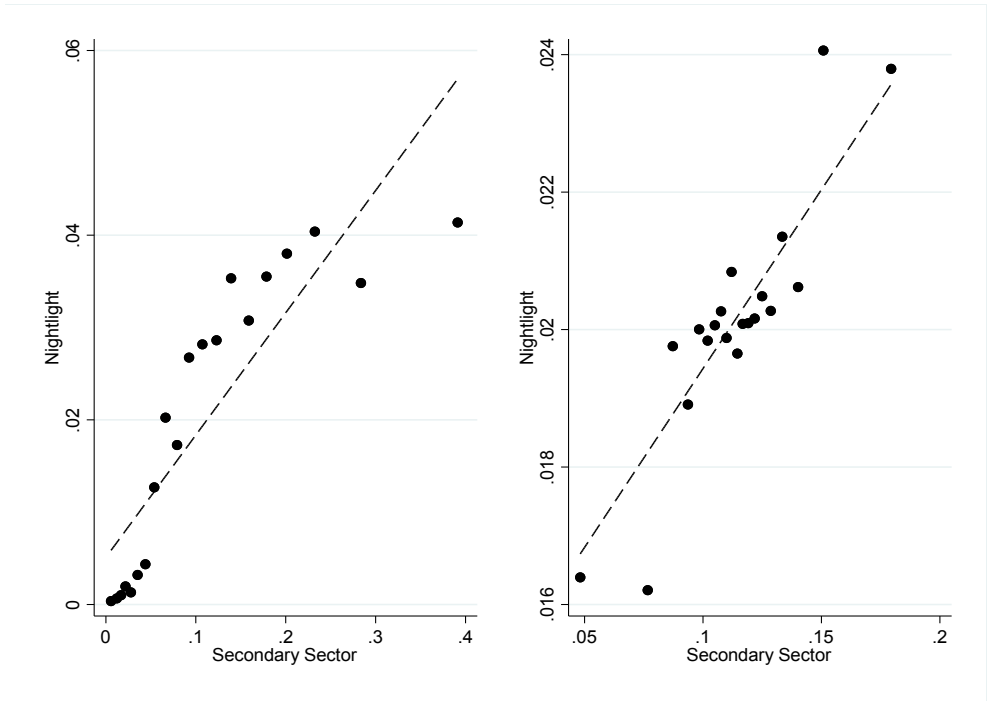
APPENDIX B

Figure B1. Correlation between nightlight and share of the primary sector



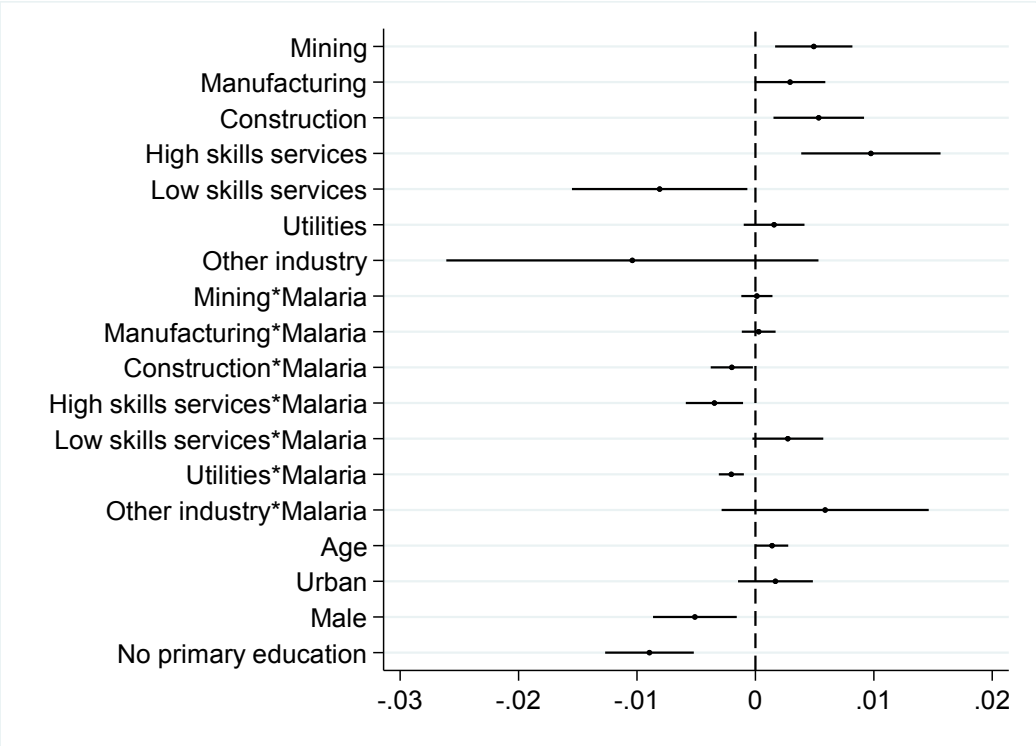
Note: binned scatterplot. The graph on the left shows a simple correlation. The graph of the right shows a correlation accounting for ADMIN and wave fixed effects.

Figure B2. Correlation between nightlight and share of the secondary sector



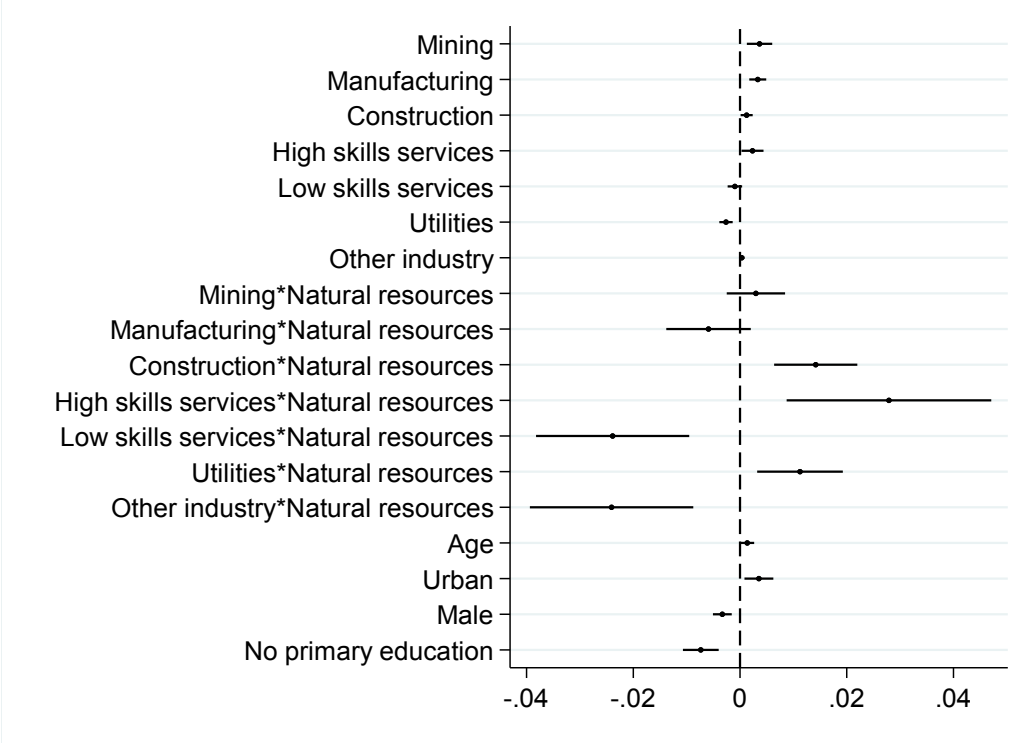
Note: binned scatterplot. The graph on the left shows a simple correlation. The graph of the right shows a correlation accounting for ADMIN and wave fixed effects.

Figure B3. High skills services and growth: The mediating effect of the incidence of malaria



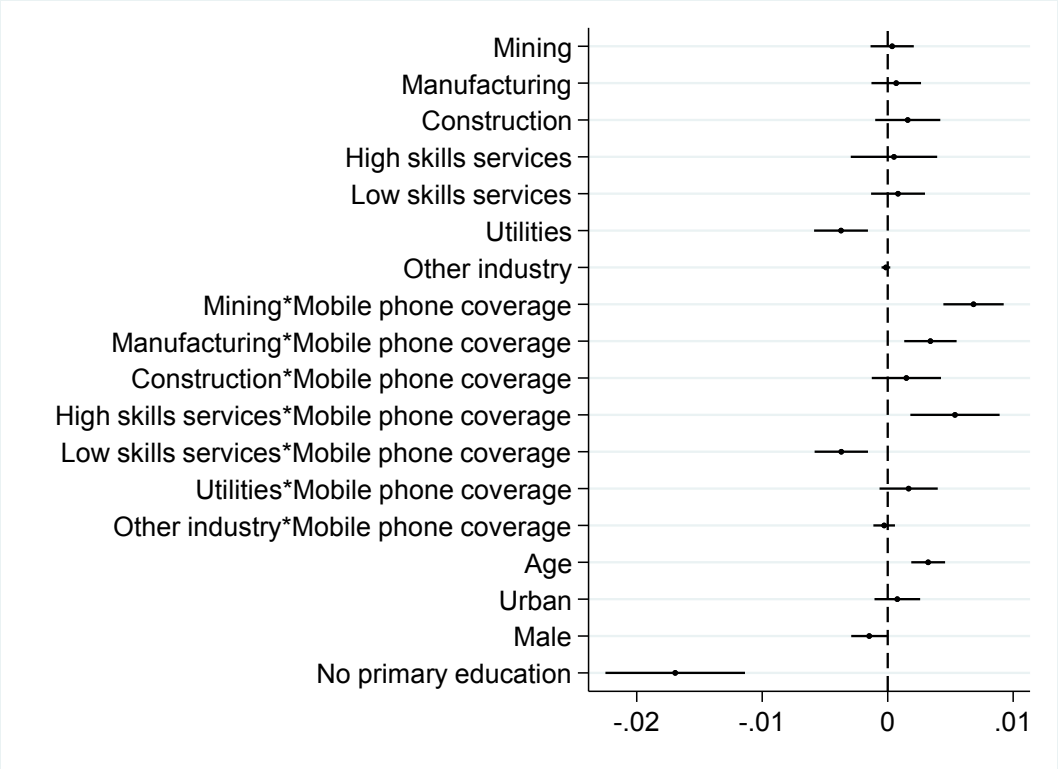
Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,829 and the R^2 is 0.970. 90% C.I.

Figure B4. High skills services and growth: The mediating effect of natural resources



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 2,811 and the R^2 is 0.966. 90% C.I.

Figure B5. High skills services and growth: The mediating effect of technology



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. The number of observations is 1,958 and the R^2 is 0.975. 90% C.I.

Table B1. Main analysis

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight per capita					
Secondary sector	-0.000	0.006***	0.005***	-0.002	0.006***	0.006***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Tertiary sector	0.010***	0.003**	-0.000	0.012***	-0.001	-0.001
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Constant	0.018***	0.019***	0.020***	0.017***	0.020***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.075	0.962	0.963	0.188	0.965	0.965

Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table B2. Macro service clust

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight per capita					
Mining	0.009***	0.004***	0.004***	-0.119***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.027)	(0.002)	(0.002)
Manufacturing	-0.001	0.004***	0.003***	0.010	0.003*	0.003**
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Construction	0.003***	0.004***	0.003*	0.113*	0.003*	0.003*
	(0.001)	(0.001)	(0.001)	(0.059)	(0.001)	(0.001)
Utilities	0.003	-0.000	-0.001	0.063	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.059)	(0.001)	(0.001)
Other industry	-0.000	0.000	-0.000	0.041	-0.009	-0.009
	(0.001)	(0.000)	(0.000)	(0.215)	(0.010)	(0.010)
High-skill services	0.011***	0.008***	0.007***	0.353***	0.005**	0.005**
	(0.002)	(0.003)	(0.003)	(0.072)	(0.002)	(0.002)
Low-skill services	-0.002	-0.002	-0.003	-0.090	-0.004**	-0.004**
	(0.001)	(0.002)	(0.002)	(0.061)	(0.002)	(0.002)
Constant	0.017***	0.018***	0.019***	0.519***	0.017***	0.015***
	(0.001)	(0.001)	(0.001)	(0.045)	(0.002)	(0.003)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.175	0.964	0.964	0.172	0.968	0.968

Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Table B3. Individual service industries

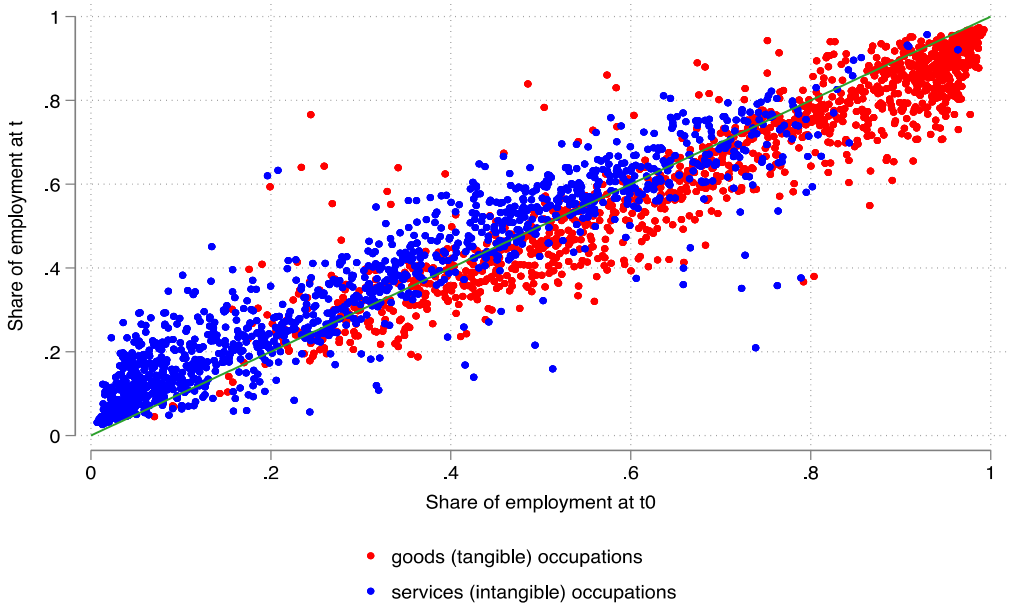
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight per capita					
Mining	0.008***	0.004**	0.003**	-0.096***	0.004**	0.004**
	(0.001)	(0.001)	(0.001)	(0.021)	(0.002)	(0.002)
Manufacturing	-0.003*	0.003***	0.003***	0.047	0.003**	0.003**
	(0.002)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Construction	0.002	0.003***	0.003***	0.116**	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Utilities	0.003*	-0.000	-0.001	0.013	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Other industry	-0.001	-0.001	-0.001	0.053	-0.005	-0.005
	(0.001)	(0.000)	(0.000)	(0.188)	(0.008)	(0.008)
Accommodation	0.001	0.002***	0.002***	0.095**	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.039)	(0.000)	(0.001)
Private household	0.004***	-0.002***	-0.002***	-0.243***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.038)	(0.001)	(0.001)
Transport	0.009***	-0.009*	-0.010**	-0.164***	-0.011**	-0.011**
	(0.003)	(0.005)	(0.005)	(0.060)	(0.005)	(0.005)
Trade	-0.011***	0.002**	-0.000	0.187***	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Business	0.005***	0.003**	0.002**	-0.026	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.051)	(0.001)	(0.001)
Education	-0.003*	0.002	0.001	0.251***	0.001	0.002
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Finance	-0.006***	0.001	0.001	-0.010	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.060)	(0.001)	(0.001)
Health	0.004***	0.004***	0.003***	0.102	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.063)	(0.001)	(0.001)
Other services	0.005***	0.002***	0.001	-0.151**	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.061)	(0.001)	(0.001)
Public	0.005***	0.002**	0.003***	0.191*	0.002**	0.002**
	(0.002)	(0.001)	(0.001)	(0.105)	(0.001)	(0.001)
Unspecified services	0.001***	0.001***	0.000*	-0.023	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.019)	(0.000)	(0.000)
Constant	0.018***	0.019***	0.021***	0.513***	0.018***	0.016***
	(0.001)	(0.001)	(0.001)	(0.037)	(0.002)	(0.002)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.256	0.968	0.969	0.230	0.972	0.972

Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADIMN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX C

Figure C1. Structural transformation at the sub-national level: Agriculture, manufacturing and services

Figure C2. Changes in type of occupations within the Manufacturing sector



Notes: Goods and Services occupations are constructed on the basis of the classification of Duernecker & Herrendorf (2020) and relative to those employed in the manufacturing sector only
Source: Author's elaboration on IPUMS.

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