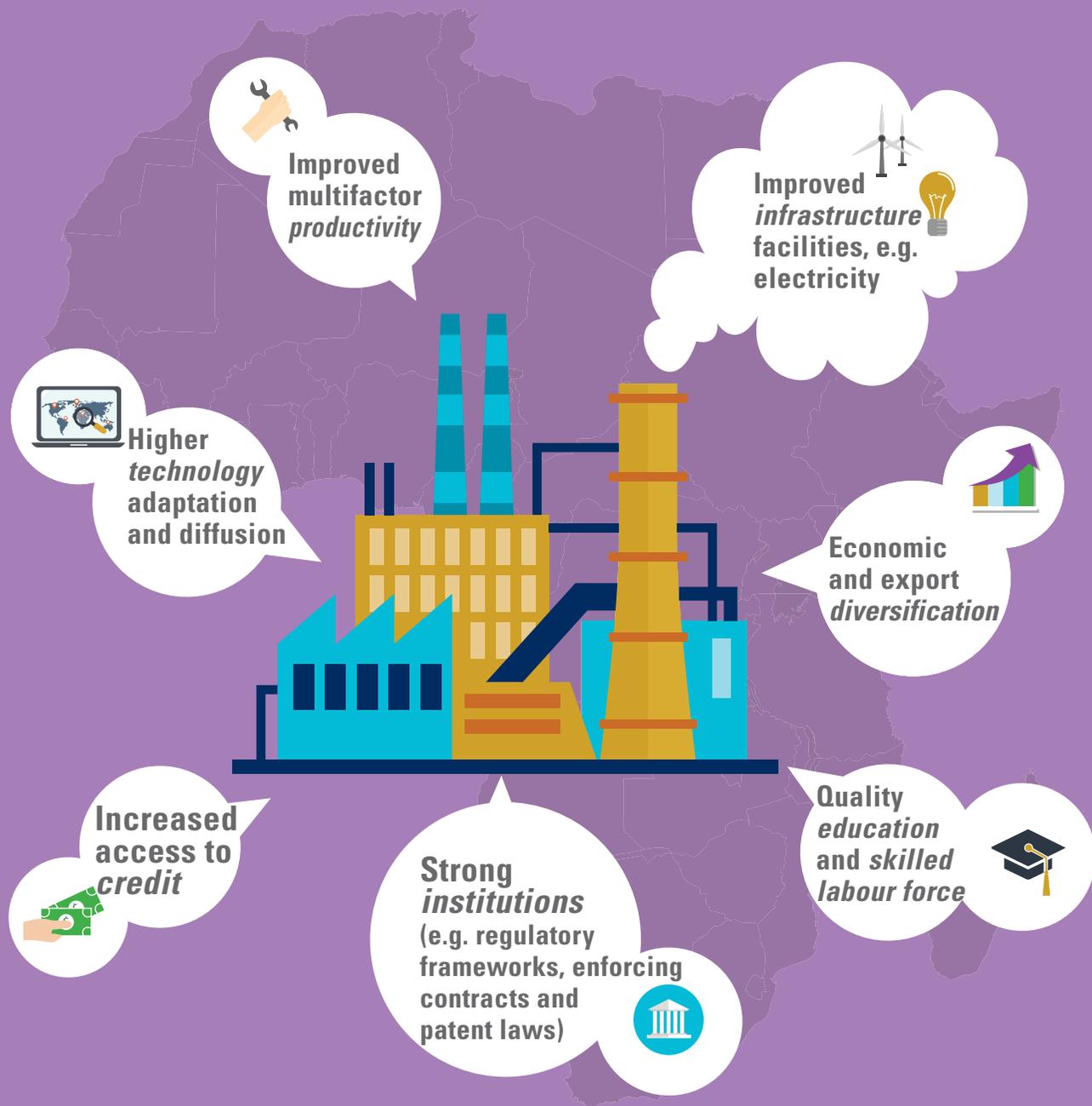


What accelerates African manufacturing performance?



5 Understanding the Determinants of Africa's Manufacturing Malaise

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5.1 Introduction

Since 2000, Africa has experienced high levels of economic growth. Between 2000 and 2015, sub-Saharan Africa grew at a rate of 5.04 per cent per annum (World Bank, 2016). However, a large portion of the population has not benefitted from this growth. In 2012, 42.7 per cent of SSA lived on less than US\$1.90 a day (Beegle et al., 2016). Africa's Gini coefficient in 2010 was 0.435 (Cornia, 2016).² The number of poor people increased from 280 million to 330 million in 2012 (World Bank, 2016). A survey of 35 African countries showed that there was "little evidence for systemic reduction of lived poverty" (Dulani, Mattes and Logan, 2013:1).

The persistence of poverty and inequality is primarily because of slow job growth, especially for youth (15–24 years). Between 2000 and 2008, the African working-age population (15–64 years) increased from 443 to 550 million, but only 73 million jobs were created over the same period (AfDB et al., 2012; ILO, 2011). Youth only obtained 16 million, or 22.0 per cent, of those jobs (ILO, 2011). The lack of jobs for this population has resulted in youth unemployment accounting for rate of 60.0 per cent of the total unemployed (AfDB et al., 2012). In a continent in which half the population is under 25 years of age (Brooks et al., 2014), economic transformation is required to take advantage of the youthful population.

To reduce poverty and inequality, the only option available to policymakers – at least in terms of industrial policy – is to create more jobs that are characterised by higher levels of productivity and remuneration (Söderbom and Teal, 2003). To increase aggregate productivity and income, a country must undergo structural transformation, that is, shift away from the low productivity agriculture sector toward higher productivity sectors (McMillan, Rodrik and Verduzco-Gallo, 2014). Economic growth is a prerequisite for creating better paying jobs, but without access to these jobs, poverty alleviation will be modest (Söderbom and Teal, 2003).

In the African context, most new, high-productivity jobs should ideally be in the manufacturing sector. It has two distinct advantages over other high-productivity sectors, such as mining or services. Manufacturing is one of the sectors that is both labour-intensive and export-oriented

¹ The authors would like to acknowledge research assistance provided by Catherine Pham and Adrienne Lees.

² This calculation is based on samples of 29 countries (Cornia, 2016), while Beegle, et al. (2016), based on 23 countries, computed a higher value – 0.56 for 2008.

(ibid.). The latter advantage is particularly relevant to Africa, as the continent's domestic markets are small and cannot sustain the high levels of growth required to reduce poverty and inequality.

However, recent experience in Africa suggests that despite strong economic growth over the past decade, the manufacturing sector has declined. Between 1981 and 1985, the average share of the manufacturing sector in Africa (excluding South Africa) was 14.7 per cent of GDP (World Bank, 2016). This declined to an average of 10.4 per cent of GDP between 2010 and 2014 (World Bank, 2016). Similarly, there was little change in manufacturing employment (World Bank, 2013). Rodrik (2014) and McMillan and Harttgen (2014) find that the main driver behind the 'African growth miracle' is the sizable expansion of the services sector. Essentially, the post-2000 period of growth in Africa witnessed the declining importance of agriculture and manufacturing and a significant increase in the importance of services.

Given that structural transformation is vital to sustained long-run economic growth and development, the evidence suggesting limited structural transformation remains a key cause for concern for Africa's development trajectory. The sustainability of Africa's long-run economic performance is important because it has an impact on the continent's ability to achieve key developmental objectives, such as poverty reduction, a more equitable distribution of income, enhanced human capital accumulation and improved infrastructure.

With the marginal performance of manufacturing in Africa in mind, this chapter explores which factors may be constraining the growth of manufacturing. If such growth is key to economic growth-enhancing structural transformation, then understanding the factors that are constraining this type of growth is of prime importance. The question regarding the constraints on manufacturing in Africa is approached by employing the *Atlas of Economic Complexity* analytical framework developed by Hausmann et al. (2011). First, we use this framework to examine evidence of structural transformation in Africa and then tailor it to provide insight into manufacturing performance across African countries. Second, we incorporate the 'economic complexity' and 'opportunity value' indices derived from the *Atlas of Economic Complexity* analytical framework into regression estimates that examine the factors constraining manufacturing performance.

This chapter is structured as follows: first, using the *Atlas of Economic Complexity* analytical framework, the extent of manufacturing-led structural transformation in Africa is examined; second, the methodology and data employed in the econometric analysis are outlined, followed by a discussion on the regression results; and finally, the chapter provides some policy implications resulting from the analysis.

5.2 Evidence of structural transformation in Africa

The analytical framework and empirical tools from the *Atlas of Economic Complexity* are used in this section first to examine the extent to which African countries have undergone structural transformation and then to draw on the intuition of this framework to understand the process of structural transformation. The shift to manufacturing activities is a key element of structural transformation. A better understanding of this process may thus offer insights into the drivers behind African manufacturing performance.³

³The *Atlas of Economic Complexity* was developed by a team of researchers at the Center for International Development (CID) at Harvard University. The CID published a book detailing the methodology and analytical framework underlying the *Atlas of Economic Complexity*, as well as key findings that can

5.2.1 The notion of economic complexity

Hausmann et al. (2011) argue that the process of economic development involves the accumulation of capabilities or productive knowledge that allow a country to produce a diversity of increasingly complex products. Hidalgo, Hausmann and Dasgupta (2009) describe these productive capabilities as non-tradable networks of collective know-how, such as logistics networks, finance networks, supply networks and knowledge networks. The notion of a country acquiring productive capabilities is encapsulated in the measure of 'economic complexity' developed by Hidalgo, Hausmann and Dasgupta (ibid.) and further discussed by Hausmann et al. (2011) in the *Atlas of Economic Complexity*.

The intuition behind this idea is described by Hausmann et al. (ibid.) using the game of Scrabble as an analogy. Each player is a country, each word that a player builds is a product and each letter from the alphabet represents a capability needed to produce a word (product). If a player (country) has many letters (capabilities), then she or he (it) can make more words (products). Hence, the diversity of the words (products) that a player (country) can make depends on the number of letters (capabilities) that she or he (it) has. The number of players (countries) that can make a word (product) provides information on the variety of letters (capabilities) needed to make a word (product). Long words (complex products) tend to be less ubiquitous since only a few players (countries) have the requisite letters (capabilities) needed to assemble them. Shorter words (less complex products) tend to be more ubiquitous since more players (countries) are likely to have the requisite letters (capabilities) needed to assemble them.

The measure of economic complexity developed by Hidalgo, Hausmann and Dasgupta (2009) corresponds to estimating the fraction of the alphabet a player possesses (a country's capabilities), using information on how many words a player can make (the number of products a country can produce) and determining how many other players can make those same words (how many other countries can produce those products). In this light, the process of economic development involves the accumulation of capabilities that allow a country to produce a greater diversity of increasingly complex products.

Hidalgo, Hausmann and Dasgupta (2009) exploit the bipartite network structure of trade, where countries are connected to the products they produce, in order to quantify the complexity of a country's economy. A country's measure of economic complexity is based on two components: the diversity of its export structure; the ubiquity of the products that it exports. The combination of these two measures and the use of an iterative calculation procedure, the Method of Reflections, generate quantitative measures of complexity. These two measures of complexity are the Economic Complexity Index (ECI) and the Product Complexity Index (PCI). The ECI is a measure of the productive capabilities specific to each country and the PCI is a measure of the productive capabilities required to produce each product.⁴ Box 5.1 presents a technical explanation on the measurement of economic complexity.

be drawn from this framework (Hausmann et al., 2011). Data can be accessed at: <http://atlas.media.mit.edu/en>. Formal discussions on the theory and intuition behind the *Atlas of Economic Complexity* can be found in Hidalgo, Hausmann and Dasgupta (2009) and Hausmann and Hidalgo (2011). Earlier publications linked to the evolution of the ideas behind the *Atlas of Economic Complexity* can be found in studies by Hausmann and Klinger (2006), Hausmann et al. (2007) and Hidalgo et al. (2007).

⁴ These measures are available on the Economic Complexity Observatory (Simoes and Hidalgo, 2011) website. Furthermore, an explanation on the derivation of these measures is available on this website and in greater depth in Hidalgo, Hausmann and Dasgupta (2009) and Hausmann and Hidalgo (2011).

BOX 5.1 Technical explanation for the measurement of economic complexity

Using bilateral trade data, M_{cp} is a matrix that is 1 if country c produces product p , and 0 otherwise. Diversity and ubiquity are measured by summing over the rows or columns of the matrix. Formally, this is defined as:

$$Diversity = k_{c,0} = \sum_p M_{cp}$$

$$Ubiquity = k_{c,0} = \sum_c M_{cp}$$

To generate a more accurate measure of the number of capabilities available in a country or required by a product, it is necessary to correct the information that diversity and ubiquity carry by using each one to correct for the other. For countries, this requires calculating the average ubiquity of the products that it exports, the average diversity of the countries that make these products that it exports and so forth. For products, this requires calculating the average density of the countries that make them and the average ubiquity of the other products that these countries make. This can be expressed as follows:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} \cdot k_{p,N-1}$$

$$k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp} \cdot k_{c,N-1}$$

Inserting the latter into the former, one obtains:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} \cdot k_{p,N-1} \frac{1}{k_{p,0}} \sum_c M_{cp} \cdot k_{c,N-2}$$

$$k_{c,N} = \sum_{c'} k_{c,N-2} \frac{\sum_p M_{cp} \cdot M_{c'p}}{k_{c,0} k_{p,0}}$$

Which can be rewritten as:

$$k_{c,N} = \sum_{c'} \tilde{M}_{cc'} k_{c',N-2}$$

This is satisfied when $k_{c,N} = k_{c,N-2} = 1$. This is the eigenvector of \tilde{M}_{cc} which is associated with the largest eigenvalue. The eigenvector associated with the second largest eigenvalue captures the largest amount of variance in the system and is the measure of economic complexity as defined by Hausmann et al. (2011).

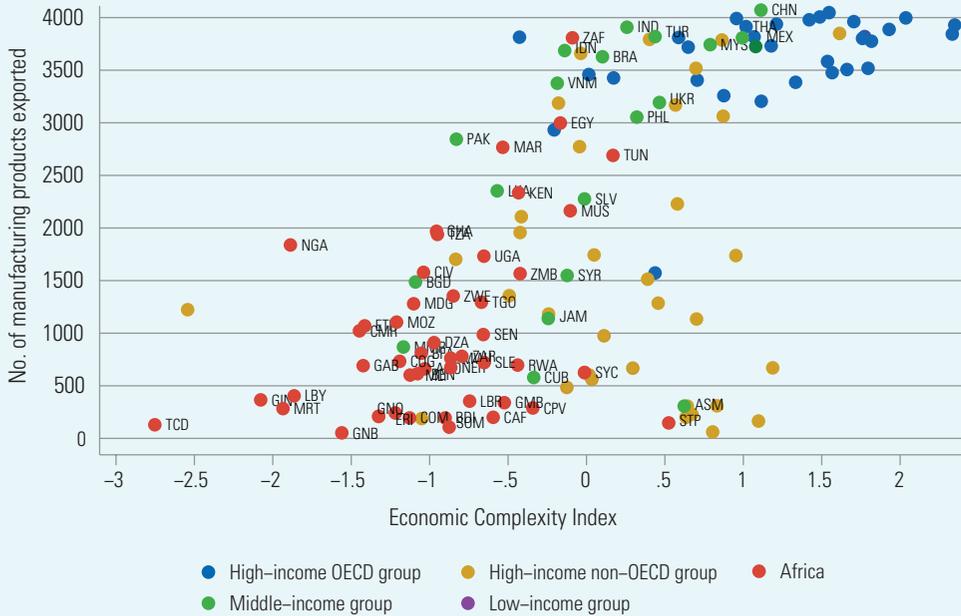
5.2.2 Economic complexity and manufacturing in Africa

Economic complexity, as measured in the ECI, is closely linked to a country's level of development and its future economic growth (Hausmann et al., 2011). In this light, it is interesting to consider the ranking of African countries relative to other countries, depicted in figure 5.1, showing the relationship between the log of GDP per capita and economic complexity across a sample of low-, middle- and high-income countries. As in Hausmann et al. (ibid.), a positive relationship between a country's productive capabilities and its level of economic development is evident, further emphasised by the grouping of countries according to level of economic development.

However, of more interest is the positioning of African countries – identified by the red markers. The clustering of red markers in the south-west corner of figure 5.1 indicates that African economies are

and Zambia (ZMB)⁵ – that have relatively high levels of economic complexity and substantial manufacturing sectors in relation to their African peers. It could be argued that these ‘manufacturing frontier economies’ have the potential to emerge as regional manufacturing hubs. Third, in relation to top-performing emerging market countries, such as China (CHN), Mexico (MEX), Malaysia (MYS), Turkey (TUR), Thailand (THA), Brazil (BRA) and India (IND), Africa’s top manufacturing exporters have lower levels of economic complexity, and hence lower levels of productive capabilities.

FIGURE 5.2 Economic complexity and number of manufactured products exported, 2013



Source: Own calculation using data from the Economic Complexity Observatory (Simoes and Hidalgo, 2011).

Notes: 1. Reduced sample of non-African middle-income countries. (For a full list of ISO codes, see Annex 5.2).

Nevertheless, despite some heterogeneity, the relatively low levels of economic complexity across African countries imply low levels of productive capabilities. This has implications for the ability of these economies to acquire more productive capabilities and shift to more complex manufacturing activities. This is explored using another analytical tool contained within the *Atlas of Economic Complexity*, the ‘product space’ analysis developed by Hausmann and Klinger (2006) and Hidalgo et al. (2007).

5.2.3 Considering the product space

Standard neoclassical trade theory suggests that a country’s productive structure, or pattern of specialization, is determined by the underlying characteristics of the country, such as factor

⁵ The ISO country code is indicated in brackets for each country.

endowments and technology. Changes to the productive structure are driven by accumulation of these underlying characteristics. For example, the Rybczynski theorem, derived from the Heckscher-Ohlin model, states that the accumulation of a factor endowment, such as capital, results in a shift in production toward more capital-intensive products. These models have little to say about whether shifts in a country's productive structure are influenced by its current productive structure. However, Hausmann and Klinger (2006) and Hidalgo et al. (2007) argue, using the product space analytical framework, that a country's current productive structure affects its future productive structure. Hence, the process of structural transformation is path-dependent.

The intuition behind the product space framework is explained by Hausmann et al. (2011) using the 'chicken and egg' problem. The accumulation of productive capabilities, which is associated with higher levels of economic development, is simultaneously aligned with the development of new industries that use this knowledge. If there is no demand for the new industry, then there is no incentive to accumulate the requisite productive capabilities. However, without the requisite productive capabilities, it is impossible to develop the new industry. Therefore, as Hausmann et al. (ibid.) argue, countries tend to move from products that they are currently producing to 'nearby' products. 'Nearby' products refer to products for which the required productive capabilities are similar to the productive capabilities embodied in the country's current productive structure. Thus, it is easier to shift from shirts to jackets than from shirts to catalytic converters. This suggests, crucially and of particular relevance to the African context, that the process of structural transformation is path-dependent.

Hausmann and Klinger (2006) investigated the hypothesis that countries diversify by moving into products that require similar productive capabilities to products that they already produce, and formulated the product space framework. The product space is a graphical depiction of the distance between products, where the distance is a measure of the difference in productive capabilities required to produce them.⁶ Products that are closer to one another require similar productive capabilities; it is thus easier for countries to move to nearby products. The distances and connections between products generate the structure of the product space. Further detail on analysing a product space graph is provided in box 5.2.

An important aspect of the 'product space' is the presence of a core and periphery. The core is comprised of relatively more proximate and connected products, typically manufactured products, while the periphery is comprised of relatively less proximate and connected products, typically primary products. This has implications for the process of structural transformation and the ability to shift to more complex manufactured products. If a country's productive structure is represented by a number of products within the core of the product space, then its ability to diversify into new products is made easier because there are many 'nearby' products that require productive capabilities similar to those it currently possesses. Conversely, if a country's productive structure is more peripheral, then its ability to diversify into products in the core of the 'product space' – typically manufacturing products – is limited because its productive capabilities are 'far' from those it requires to diversify.

⁶ Hausmann and Klinger (2006) and Hidalgo et al. (2007) calculate this distance by measuring the likelihood that a pair of products is co-exported. The probabilities that pairs of products are co-exported contains information on how similar these products are. If two products require similar productive capabilities, then this should be evident in a higher probability that a country exports both of these products.

BOX 5.2 Decoding the product space framework

To create the product space, Hidalgo et al. (2007) use product-level trade data at the four-digit level of the Harmonised System (HS) (1,241 product groups) and the Standard Industrial Trade Classification (SITC) (1,033 product groups). Each node represents a product. The size of the node is determined by its share of each respective country's total export trade. Nodes are linked based on the probability that a pair of products is exported by two or more of the same countries, with higher probabilities depicted by thicker and darker lines. A country is deemed to export a product if the revealed comparative advantage measure for that country-product combination is greater than or equal to unity (hence, it is a significant export within a country's export portfolio).

The links between products define the structure of the product space and hence the connectedness and distance between products. Products that are close together have similar productive knowledge and capability requirements. This implies that countries find it relatively easier to jump between these nearby products. Conversely, it is much harder to jump to products that are more distant from a country's current productive structure. The structure of the product space implies that the process of accumulating productive knowledge and shifting to new products is not haphazard but, rather, path-dependent. Therefore, products that a country currently produces influence the products that it is able to produce in the future.

The colour of each node represents product communities. These are groups of products that are more strongly connected to one another because they tend to be co-exported more frequently than products that exist outside of their community. This implies that products within a community require similar sets of productive capabilities.

Source: Hausmann et al. (2011) and Hausmann et al. (2014).

5.2.4 The product space and manufacturing in Africa

Using the product space tool on the Atlas of Economic Complexity website, it was possible to analyse the product spaces for a variety of African countries. For the purpose of brevity, figure 5.3 presents the product spaces for two African countries, Uganda and Ghana. These two countries represent two groups of African countries that vary with respect to the strength of their manufacturing sectors.⁷

Ghana represents the aggregate African product space, which is emblematic of a weak manufacturing sector that is evident in a large number of African countries. The productive structure of these African countries tends to be, on aggregate, peripheral. Further observation shows that this has not changed much over the period 1995–2013. These peripheral products are predominantly primary products (e.g. the large nodes for Ghana are gold, cocoa beans and petroleum), which provide insight into the overall levels of economic complexity, and hence productive capabilities inherent in Ghana (and the bulk share of African economies). Primary products are associated with lower levels of product complexity,

⁷ The authors are unable to present an 'African aggregate' product space and, due to space constraints, cannot include the product space for every African country. Thus, we show the product space for two countries that represent two groups of African countries evident in the data: first, countries with marginal manufacturing sectors, represented by Ghana; and second, countries with existing or emerging manufacturing sectors, represented by Uganda. A Working Paper version of this chapter provides product space graphs for a larger sample of African countries (see www.africa.undp.org/content/rba/en/home/library/working-papers/africa-s-manufacturing-malaise.html).

which translates into lower levels of economic complexity, as evident in figure 5.2. Relatedly, the peripheral character of their productive structures is matched by the paucity of manufactured products (i.e., very few occupied nodes in the core of the product space).

The peripheral nature of the productive structures of the aggregate African product space (represented by Ghana) has implications for structural transformation. Primary products found in the periphery of the product space are relatively distant from manufactured products found in the core of the product space. Intuitively, this indicates that the productive capabilities embodied in the production of relatively less complex primary products is distant from those capabilities required to produce manufactured products in the core of the product space. As such, the peripheral nature of the productive structures of this group of African economies suggests that it is difficult to diversify into new products, particularly relatively distant manufactured products.

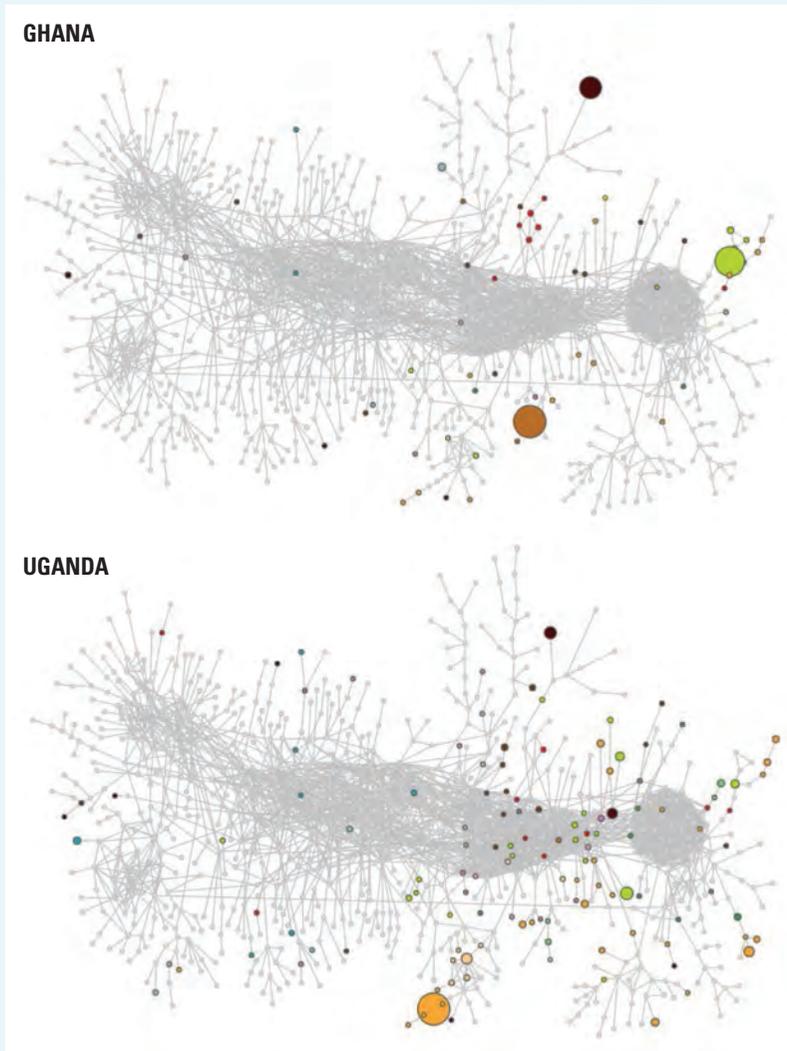
Although one could argue that the 'aggregate African' productive structure is peripheral, there is evidence of heterogeneity across African economies. For instance, the product space for Uganda, depicted in the bottom panel of figure 5.3, represents a 'manufacturing frontier economy'. Uganda is emblematic of a small number of African economies, such as Kenya, South Africa, Mauritius, Morocco, Tunisia and Egypt, with existent and emerging manufacturing sectors. In these economies, the number of occupied nodes within the core of the product space is higher.

Uganda provides an interesting example of how a country's existing productive structure influences its future productive structure. Figure 5.4 focuses on a section in the core of Uganda's product space and shows how its productive structure has evolved over the period 2005 to 2013. The nodes with the dashed circles represent products exported in 2005, with the yellow and red dashes representing continuing and dying products, respectively. The white lines show the products that are connected to the manufactured product of interest, HS1905 'Baked goods'.

In 2005, Uganda produced three products within this section of the core of its product space. Subsequently, in 2013 Uganda diversified to 12 other manufactured products, which are linked to HS1905 'Baked goods', the product it exported in 2005. This is a clear depiction of how countries diversify to 'nearby' products. The productive capabilities associated with 'Baked goods' was close enough to the productive capabilities required by these 12 nearby manufactured products. Thus, Uganda was able to diversify into a greater number of manufactured products. The implication of this pattern of diversification is that once a country accumulates the productive capabilities needed to produce a 'connected' product in the core of the product space, the path for subsequent diversification is much clearer.

The product space framework provides both a visual depiction of the connectedness of a country's export structure and a measure of this connectedness. Hausmann et al. (2011) provide a measure that captures the value of the new productive opportunities or connectedness associated with a country's current export structure, namely, the opportunity value index (see box 5.3). When the product is located in the highly connected core of the product space (associated with a higher opportunity value index), the process of shifting into new products and growing the complexity of an economy is relatively easier. Intuitively, this indicates that the productive capabilities implied by a country's current productive structure is relatively close to the productive capabilities required to shift production into new products. Conversely, being located in the less connected periphery (associated with a lower opportunity value) makes it relatively more difficult to shift into new products and increase the complexity of an economy. This indicates that the productive capabilities implied by a

FIGURE 5.3 Product space: Ghana compared to Uganda, 2013

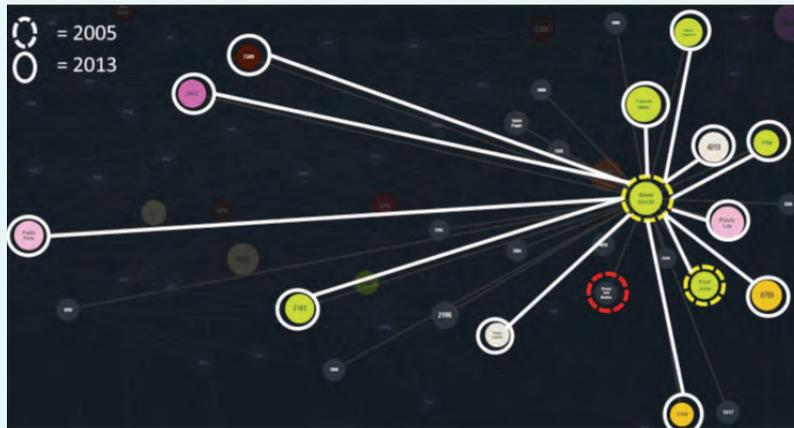


Source: CID (2014).

country's current productive structure are relatively distant from the productive capabilities required to shift production into new products.

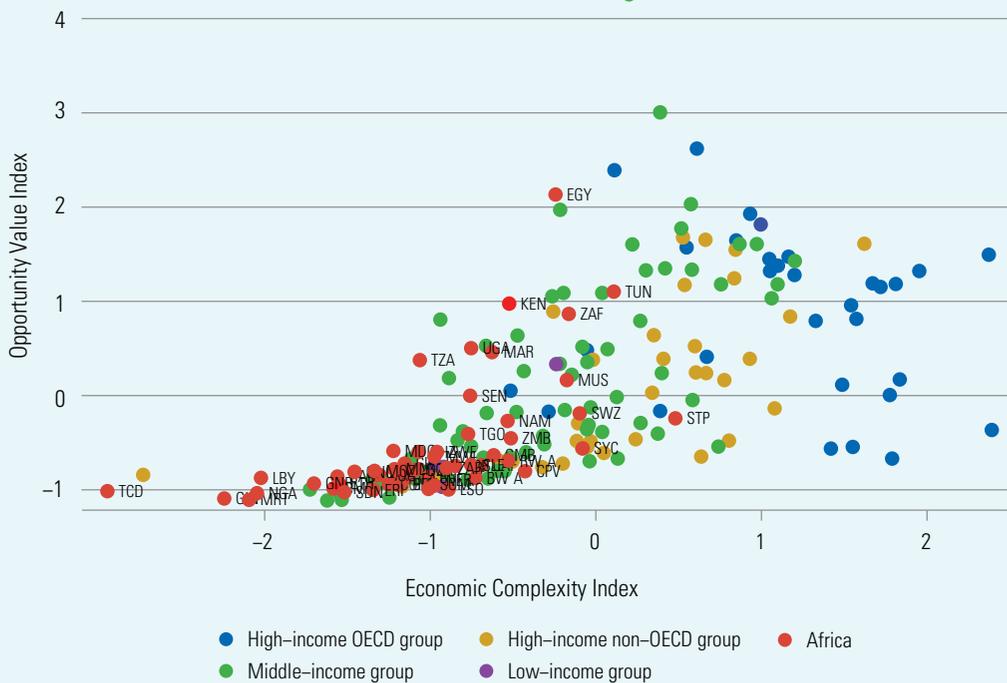
Figure 5.5 depicts the relationship between a country's opportunity value and economic complexity indices. It is evident that higher levels of economic complexity are associated with increased connectedness and greater potential for diversification, and hence structural transformation. However, further interrogation of this link between opportunity value and economic complexity suggests some nuance.

FIGURE 5.4 Uganda product space evolution, 2005-2013



Source: Harvard (2014).

FIGURE 5.5 Economic complexity and opportunity value, 2013



Source: Own calculation using data from the Economic Complexity Observatory (Simoes and Hidalgo, 2011).

Note: For the full list of ISO codes see Annex 5.2.

BOX 5.3 The opportunity value measure

It is worth further interrogating the notion of opportunity value and how it is measured in order to better understand its importance in the analysis in this chapter.

Empirically, Hausmann et al. (2011) find that countries move through the product space by developing products close to those that currently comprise their export portfolio. It is also evident that countries export a variety of products that comprise their export portfolio. Hence, their export portfolio is proximate to a range of other products that make up the product space. The similarity between two individual products and, as such, the similarity in terms of the productive knowledge (or capabilities) required in order to produce them, is labelled 'proximity'. However, Hausmann et al. (ibid.) are also interested in the aggregate 'proximity' between the products that comprise a country's current export portfolio and the products that it does not currently export, which they call 'distance'.

'Distance' is defined as the sum of proximities connecting a new product p to all the products that country c is not currently exporting. This is normalised by dividing distance by the sum of proximities between all products and product p . As such, 'distance' is the weighted proportion of products connected to good p that country c is not exporting, with the weights given by the proximities. Intuitively, the 'distance' measure implies that if country c exports most of the products connected to product p , then the distance will be short, or close to 0. Conversely, if country c only exports a small share of the products that are proximate to product p , then the gap will be large, or close to 1. This is formally represented by the following equation:

$$d_{c,p} = \frac{\sum_p (1 - M_{c,p'}) \phi_{p,p'}}{\sum_p \phi_{p,p'}}$$

Therefore, 'distance' indicates how far each product is, given a country's current export portfolio. Hausmann et al. (ibid.) go further and generate a measure of the opportunities implied by a country's position within the product space. This measure includes not only the distance ($d_{c,p}$) to products, but also their complexity. The rationale behind factoring in the complexity of the products that a country does not export is based on the idea that when a country produces products that are relatively complex, given their current level of income, they tend to grow faster.

A country's location within the product space has implications for the opportunities available to it in terms of diversification. For instance, some countries are located mainly in the periphery of the product space and, thus, located next to a few, poorly connected and relatively simple products, whereas other countries are located within the core of the product space, next to numerous highly connected and relatively complex products, and hence have a plethora of unexploited opportunities. Therefore, Hausmann et al. (ibid.) state that countries differ not only in terms of what they produce, but also in terms of their productive opportunities. The 'opportunity value' measure is the value of the options or unexploited products available to a country, given its current export portfolio. To quantify the 'opportunity value' of a country's unexploited export options, one can add the level of complexity of the products that it is not currently producing, weighted by the distance of these products from a country's current export portfolio. This is formally represented by the following equation:

$$\text{opportunity value}_c = \sum \frac{\phi_{p,p'}}{\sum_p \phi_{p,p'}} (1 - M_{c,p'}) \text{PCI}_{p'} - (1 - d_{c,p}) \text{PCI}_p$$

Where PCI is the product complexity index of product p . A higher opportunity value implies being in the vicinity of more products and/or products that are more complex.

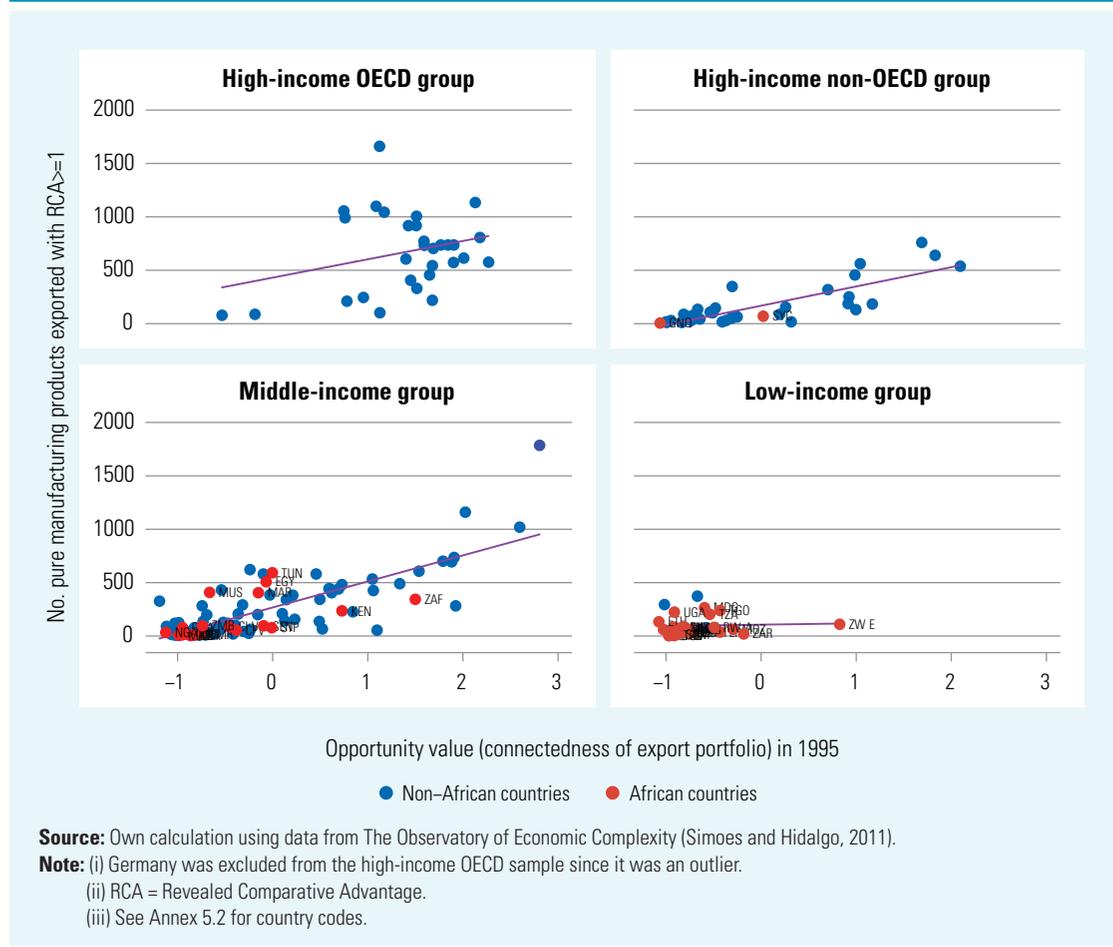
Source: Hausmann et al. (2011) and Hausmann et al. (2014).

Note: $M_{c,p'}=1$ if country c produces product p , and 0 otherwise.

Countries at lower levels of economic complexity, mainly African countries, have relatively disconnected productive structures. Their ability to diversify and undergo structural transformation is thus constrained. In essence, this suggests that these countries do not possess the productive capabilities needed to shift their production structure to more complex manufactured products. The peripheral nature of their product space does not afford them opportunities to diversify and grow in complexity. Second, in the case of some high-income OECD countries (blue markers), which already occupy large portions of the product space, opportunities for further diversification are low. Third, countries with intermediate levels of economic complexity exhibit varying levels of connectedness and thus exhibit varying levels of potential for further diversification.

Figure 5.5 does suggest a non-linear link between an economy's ability to diversify, and hence, undergo structural transformation and its level of economic complexity. To explore this further, the relationship between the connectedness of a country's export structure in an initial period, 1995, and the number of pure manufacturing products it exports in 2013 is examined. This relationship is examined across levels of development, which is already known to align closely to economic complexity, as depicted in figure 5.6. The key notion behind this analysis is to determine whether a country's initial export structure and the productive capabilities and connectedness associated with it has an impact on its

FIGURE 5.6 Opportunity value in 1995 pure manufactured exports ($RCA \geq 1$), 2013



ability to undergo structural transformation, particularly a shift toward more complex manufactured products.

From the African perspective, figure 5.6 offers some interesting insights. First, for low-income (predominantly African) economies, there is no correlation between the connectedness of their export structure in 1995 and the number of pure manufactured products that they produced in 2013. This suggests that the peripheral nature of their initial productive structure offers little opportunity for diversification into manufactured products.

However, in the middle-income country case, it is evident that a positive correlation exists between the connectedness of their export structure in 1995 and the number of pure manufactured products that they produced in 2013. This suggests that the initial export structures of these relatively more complex economies, some of which are African, allowed for subsequent diversification into manufactured products.

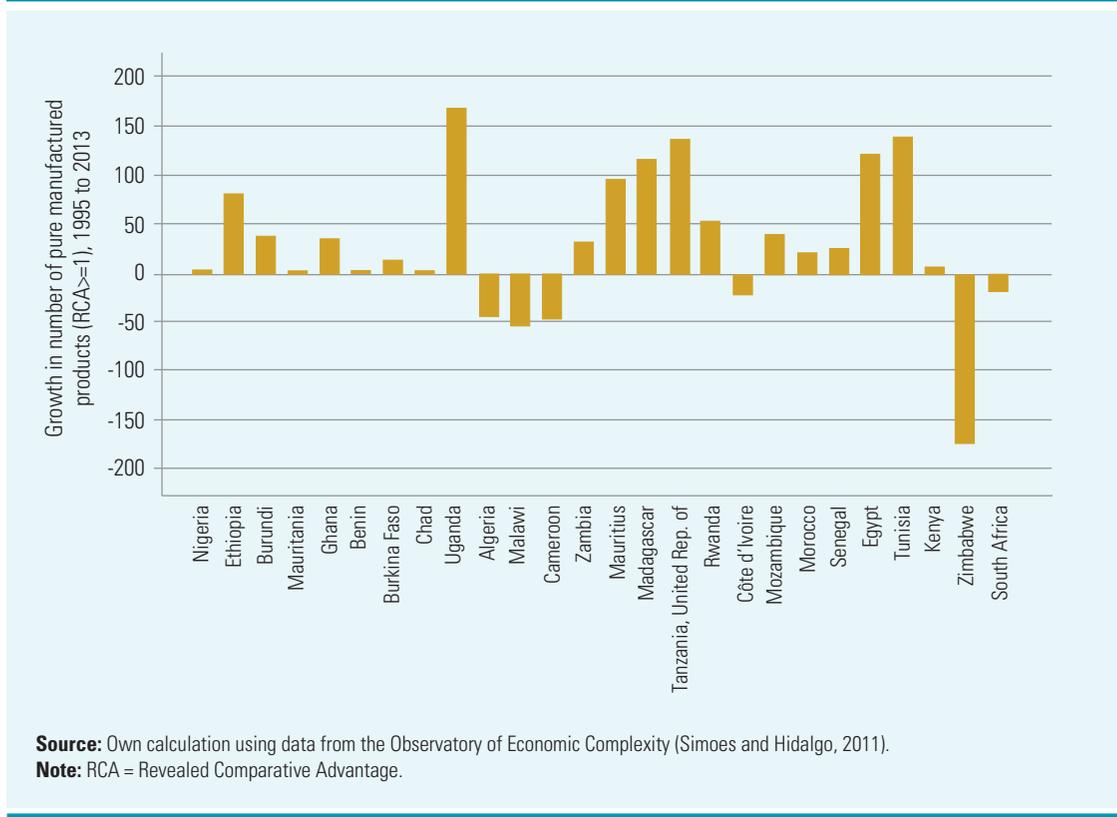
The low- and middle-income country cases in figure 5.6 suggest that a non-linear relationship exists between a country's opportunity value in an initial period, 1995, and the number of pure manufactured products it exports in a later period. One could argue that this suggests that the productive capabilities that embody the export portfolios of these low-income countries are distant from the productive capabilities required to produce more complex manufactured products in a later period. However, in the middle-income country case, it seems that an opportunity value threshold has been reached in terms of productive capabilities. Thus, the shift into more complex manufactured products is relatively easier. As such, the process of structural transformation — shifting to more complex manufactured products — is hindered by a country's existing productive capabilities.

Here, the link between a country's opportunity value index and its manufacturing performance, specifically in the African context, is investigated. Figure 5.7 shows how the growth in pure manufacturing over the 1995-2013 period across a sample of African countries is related to the opportunity value of these countries in 1995. It suggests a positive relationship, but with a number of qualifications. Countries with better-connected export portfolios in 1995 tended to experience greater entry into new pure manufacturing export markets (e.g. Tunisia, Egypt, United Republic of Tanzania, Madagascar and Mauritius). However, it is also evident that some countries with high opportunity value indices have underperformed, in particular, South Africa and Zimbabwe. This suggests that other factors (for example, political or policy related factors) may influence a country's pattern of structural transformation, despite what its initial export structure offers in terms of potential.

The Atlas of Economic Complexity toolkit and framework developed by Hausmann et al. (2011) and the analysis above suggest that the initial productive structure of an economy, and hence its initial level of productive capabilities have an impact on the number of manufactured products it produces and exports in later periods. This suggests that the process of structural transformation is a path-dependent process. The export structures of African economies, and hence what the Atlas variables reveal about the structure of these economies, points to their being characterised by low levels of economic complexity. The productive capabilities in these economies are limited and basic. The 'peripheral' nature of the product spaces of many African economies implies that the productive capabilities embodied in the export structures of these economies is distant from the productive capabilities required to shift to more complex manufactured products.

However, it is also evident that the African context is heterogeneous and that a number of African

FIGURE 5.7 Growth in number of pure manufactured products by country in terms of increasing opportunity value, 1995



countries have experienced growth in manufacturing over the past two decades. The analysis suggests that these African economies – for example, Uganda, United Republic of Tanzania, Madagascar, Mauritius, Tunisia and Egypt – had productive structures that embodied a sufficient level of productive capabilities to allow for a transition into more complex manufactured products. It also examines the extent to which the economic complexity and opportunity value indices explain variation in manufacturing performance across a sample of developed and developing countries, some of which are African. These indices make it possible to examine whether the productive capabilities of a country, for example, institutions, infrastructure and the business environment, explain its manufacturing performance.

5.3 Methodology and data description

This section outlines the econometric approach and details regarding the specifications estimated in Section 4. The various data used in the regression estimations are also described.⁸

⁸ A description of the dependent and explanatory variables used in the analysis and their sources are provided in Annex 5.1.

5.3.1 Econometric approach

To examine the factors that may be constraining the performance of manufacturing in Africa, the following econometric approach is employed. First, standard neoclassical variables will be analysed to determine whether they explain variation in manufacturing performance across a sample of both African and non-African countries over time. In this first set of specifications, country factor endowments that would feature in a standard production function are controlled for, such as capital per worker, technology and natural resource abundance.

Second, the analysis in Section 2 shows that countries with higher levels of economic complexity, and hence more productive capabilities, are more likely to have established manufacturing sectors. Furthermore, a country's ability to diversify into more complex manufactured products is greater the closer its current set of productive capabilities (embodied in its current production structure) are to those needed to produce these products. In the second set of specifications, the economic complexity and opportunity value indices developed by Hausmann et al. (2011) are included to control for the productive capabilities of a country.

Third, to tease out the African effect, a dummy variable controlling for African countries in the regressions was included. The initial estimations focused on a sample of African countries. The fixed effects estimator was used to examine the determinants of manufacturing performance. However, the initial estimations were problematic for two reasons: the data across African countries and over time resulted in a very small sample; and manufacturing performance across African countries tends to be at the bottom of the cross-country distribution. Thus, it seems that there is too little variation to work with in such a small sample. Therefore, to build a larger sample, non-African countries were included. Furthermore, to tease out the African effect, the African dummy variable was included and the random effects estimator employed; its cost is the inability to employ the fixed effects estimator and control for country and time fixed effects.

Finally, it is determined whether there is a non-linear relationship between a country's opportunity value index and its manufacturing performance. This is motivated by initial evidence in figure 5.6, which suggests that the link between a country's opportunity value index and its manufacturing performance varies by country income level. This is achieved by creating an interaction between the opportunity value index and a country income dummy variable.

5.3.2 Specification

The following reduced form equation is estimated by using the random effects estimator:

$$M_{ct} = \alpha_c + \beta_1 Neoclassical_{ct} + \beta_2 Africa_c + \beta_3 Productive\ structure_{ct} + \mu_{ct}$$

Where M_{ct} is a measure of manufacturing performance in country c in year t . The natural logarithm of the count of manufacturing products exported was chosen as a measure for manufacturing performance because it is consistent with the product space framework, where growth is measured by increased colonisation of the various nodes that comprise the product space.⁹ Furthermore, it can be argued that the export of manufactured products is a better measure of the strength of a country's

⁹It is important to note that when using the count of manufacturing products exported, export performance is defined as the diversification of a country's export structure.

manufacturing sector, as the ability to enter and compete in global markets indicates manufacturing proficiency.

$Neoclassical_{ct}$ denotes the neoclassical variables controlling for factor endowments in country c in year t . In the estimations reported below, the following factor endowments are controlled for: capital per worker, total factor productivity and natural resource abundance.

$Productive\ structure_{ct}$ denotes measures taken from the *Atlas of Economic Complexity* (Hausmann et al., 2011), in which the productive capabilities of an economy are controlled for. In particular, the economic complexity and opportunity value indices were used. $Africa_c$ is the dummy variable controlling for countries that are located in Africa.

Finally, μ_{ct} is the composite error term.

5.4 Estimating the determinants of Africa's manufacturing performance

This section analyses which factors may constrain the performance of the manufacturing sector in Africa within a multivariate context. To the extent that manufacturing sector growth is key to growth-enhancing structural transformation, then understanding the factors constraining growth in the sector is of prime importance. As described in Section 3, to analyse the factors that may constrain manufacturing performance in Africa, two broad specifications are examined, as discussed below.

5.4.1 Explaining manufacturing performance: The neoclassical specification

The estimates of the neoclassical specifications reported in table 5.1 make it possible to assess the extent to which endowments determine a country's manufacturing performance. In each of the specifications, employment, capital stock, technology and natural resource abundance are controlled for. The random effects estimation technique is employed to run regressions on an unbalanced panel of cross-country data for the period 1995-2013.

The positive and statistically significant coefficients for the log of capital per worker variable indicate that the more capital per worker in a country, the greater the number of manufactured products a country produces. This is expected, since manufacturing processes typically require relatively higher levels of capital per worker. This suggests that the extent to which financial capital markets restrict or enable firms to obtain access to credit market networks to finance physical capital investment may be an important constraint to manufacturing growth.

The estimated coefficients of the measures controlling for technology and natural resource abundance are both positive but not statistically significant across both specifications. This suggests that these two factor endowments, which typically feature in production function equations, do not explain variation in manufacturing performance across countries over time.

Interestingly, the dummy variable controlling for African countries is negative and statistically significant. This suggests that if there are two identical countries in terms of endowments and if one is African and the other is from another region, then the African country underperforms. It is likely that there are unobservable country characteristics that these specifications do not reveal. For example, there may be an 'African effect' with respect to foreign investor perceptions that results in less manufacturing-focused FDI inflows into African countries.

TABLE 5.1 Explaining manufacturing performance in Africa, 1995-2013: The neoclassical specification

Log of product count of total manufactured exports	
Log of fixed capital per worker	0.255*** [0.050]
Total factor productivity	0.131 [0.091]
Total natural resources rents (% of GDP)	0.002 [0.002]
Africa	-0.392* [0.219]
Constant	4.847*** [0.618]
Observations	1,750
Number of groups	104
R-squared	0.420

Notes:

1. Standard errors in brackets.
2. *** p<0.01, ** p<0.05, * p<0.1
3. 'Total natural resources rents' is used as a proxy for natural resource abundance in a country.
4. 'Africa' is a dummy variable controlling for whether a country is an African country.
5. 'Total factor productivity', the variable used to control for technology, is measured at current PPPs (USA=1).

5.4.2 Explaining manufacturing performance: The Atlas variable specification

Table 5.2 reports the results for the specification where the Atlas variables are investigated to determine whether they explain manufacturing performance across a sample of countries over the period 1995-2013.¹⁰ These specifications extend the neoclassical specification by including the opportunity value and economic complexity measures. Column 2 shows this estimation, while column three extends the analysis by teasing out whether evidence of non-linearity exists in terms of how the opportunity value influences manufacturing performance across income levels.¹¹ These specifications are estimated using the random effects estimator.

Consistent with the neoclassical specification, the estimated coefficient for the capital stock per worker variable is positive and statistically significant. Again, this indicates the importance of a country's endowment of physical capital in explaining its manufacturing performance.

Contrary to the estimates in the neoclassical specification, the total factor productivity variable that controls for the technology level in a country is now statistically significant and positive. This result makes sense since the production process behind manufacturing requires certain technologies, and countries best able to acquire them are best placed to develop their manufacturing sector. Lall (2000) disaggregates manufactures into low- medium- and high-technology products, and argues that the

¹⁰ The sample of countries is determined by data availability. The sample is comprised of 104 countries, 20 of which are the African countries of Benin, Burundi, Cameroon, Central African Republic, Côte d'Ivoire, Egypt, Kenya, Mauritania, Mauritius, Morocco, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, South Africa, United Republic of Tanzania, Togo, Tunisia and Zimbabwe.

¹¹ Similar results were obtained when the dependent variable measured pure manufactured exports.

economic success of the East Asian Tigers countries is partly explained by their ability to shift from low-technology manufactures to medium- and high-technology manufactures.

Shifting focus to the economic complexity index variable, the estimated coefficient is negative and not statistically significant. This may be driven by the fact that countries with the highest levels of economic complexity tend to be high-income countries. Although they typically possess an advanced manufacturing sector, high-income countries tend to shift to the services sector as they develop, while the manufacturing sector plays an increasingly lesser role. In particular, there is evidence that the size of the manufacturing sector in high-income countries shrinks in the face of significant growth in manufacturing in emerging markets, particularly China (e.g., Fontagné, Gaulier and Zignago, 2008).

TABLE 5.2 Explaining manufacturing performance over 1995-2013 period

	Log of product count of TM exports	Log of product count of TM exports
Log of fixed capital per worker	0.261*** [0.053]	0.247*** [0.056]
Total factor productivity	0.152* [0.085]	0.190** [0.085]
Total natural resources rents (% of GDP)	0.003 [0.002]	0.002 [0.002]
Africa	-0.272 [0.198]	-0.266 [0.180]
Economic complexity index	-0.026 [0.064]	-0.044 [0.056]
Opportunity value index	0.151*** [0.033]	
Opportunity value index * Low-income country dummy		0.361 [0.246]
Opportunity value index * Middle-income country dummy		0.227*** [0.060]
Opportunity value index * High-income OECD country dummy		0.095*** [0.024]
Opportunity value index * High-income non-OECD country dummy		0.139* [0.081]
Constant	4.670*** [0.631]	4.827*** [0.653]
Observations	1,750	1,750
Number of groups	104	104
R-squared	0.553	0.602

Notes:

1. Standard errors in brackets.
2. *** p<0.01, ** p<0.05, * p<0.1
3. 'Total natural resources rents' is used as a proxy for natural resource abundance in a country.
4. 'Africa' is a dummy variable controlling for whether a country is an African country.
5. 'Total factor productivity' is the variable used to control for technology and is measured at current PPPs (USA=1).
6. Atlas variable specification (Hausmann et al. 2011) was used for the estimation.
7. TM: total manufacturing.

The results in table 5.2 show that the opportunity value index is positive and statistically significant, thus indicating that the more connected a country's export structure, the better its manufacturing performance. This suggests that the productive capabilities of a country, embodied in its current export portfolio, are a key constraint to its manufacturing performance. The key notion behind this estimate is that countries whose productive capabilities are nearest to those needed to produce a greater range of manufactures are those with the best manufacturing performance.

Interestingly, once the connectedness of a country's export structure and its economic complexity are controlled for, the negative 'Africa effect' fades away.¹² This implies that once the productive capabilities of a country and the potential they offer in terms of ability to shift to increased manufacturing activity are controlled for, the manufacturing sectors in African countries do not underperform relative to those in countries from other regions. Therefore, if African countries were able to develop the appropriate productive capabilities needed for a dynamic manufacturing sector, manufacturing firms in these countries would be able to compete in the global market.¹³

From a policy standpoint, it is important to identify these productive capabilities. However, in light of the heterogeneity of African countries and the notion that Africa is not one big country, case study-type analyses would be the best approach to identify the specific constraints faced by manufacturing firms within individual African countries.

Finally, the estimates reported in column three of table 5.2 attempt to tease out whether the link between the connectedness of countries' export portfolios and their manufacturing performance is non-linear by income. The positive but not statistically significant coefficient for the variable that created an interaction between low-income country status and the opportunity value index suggests that connectedness of these countries does not affect their export performance. This may be because the manufacturing sectors in these countries are nearly non-existent.

The estimated coefficients for the interaction terms pertaining to middle-income, high-income OECD and high-income non-OECD countries are, clearly, all positive and statistically significant. This suggests that the connectedness of the export structures of these countries is positively related to their manufacturing performance.

Interestingly, it can be observed that the magnitude of the estimated coefficients increases as one moves from high-income OECD, to high-income non-OECD and to middle-income countries. The implication is that middle-income countries reap greater dividends in terms of improved manufacturing performance with respect to the connectedness of their export portfolios. Intuitively, this makes sense since middle-income countries with the requisite productive capabilities have greater scope to expand into new manufacturing products, and hence manufacturing growth (i.e., they start from a lower base and more 'easy wins'). Conversely, high-income countries have established manufacturing sectors. Thus, the scope for expansion into new manufacturing activities is limited.

¹² Given that the 'Africa dummy' is not statistically significant, this specification is run using the fixed effects estimator to control for country and year fixed effects. The results using the fixed effects estimator are consistent with those reported in table 5.2.

¹³ Hidalgo, Hausmann and Dasgupta (2009) describe these productive capabilities as non-tradable networks of collective know-how, such as logistics networks, finance networks, supply networks and knowledge networks. For example, a wine farmer needs to be able to access finance networks to fund the operation, supply networks to access inputs such as fertilizer, logistics networks to transport the product to the consumer, knowledge networks to refine wine-making techniques and obtain guidance on entering the international market, and so forth.

Furthermore, this result seems consistent with studies that examine the link between export diversification and economic development (Cadot, Carrère and Strauss-Kahn, 2011; Klinger and Lederman, 2011). Typically, these studies show that as countries develop, they diversify their export structures and produce more manufactured products. As countries reach higher levels of development, they shift to services and manufacturing growth levels off. In terms of the potential for manufacturing growth in African countries, this result offers solace since a small number of African countries have recently shifted to middle-income country status. These countries seem to show the most potential to grow their manufacturing sector.

5.5 Conclusions and policy recommendations

The above has essentially presented a view that structural transformation principally involves the steady diversification over time of a domestic economy into increasingly sophisticated forms of manufacturing activities and output. Therefore, understanding the factors that may be constraining this steady growth in manufacturing production is of key importance.

Using the analytical and empirical toolkit offered by the *Atlas of Economic Complexity*, it is shown that productive capabilities in Africa remain relatively low, which translates into low levels of economic development. The product space analysis shows that the export portfolios of African economies are peripheral, and thus dominated by primary products. The opportunity value index indicates that the peripheral nature of the African export portfolio has implications for the region's ability to transform itself structurally. It is clear that the productive capabilities embodied in the productive structure of a typical African economy are far from the productive capabilities required to shift production toward more complex manufacturing activities.

The econometric analysis suggests that factor endowments such as physical capital per worker impact positively on manufacturing performance. In contrast, it can be observed that being a country located in Africa has a negative effect on manufacturing performance and that this result is consistent across all specifications. The latter result suggests that even after controlling for a range of factors, there are unobservable variables that negatively affect Africa's manufacturing performance. However, once a country's economic complexity and the connectedness of its export structure are controlled for, the negative 'Africa effect' fades away.

With respect to opportunity value, a non-linear effect can be observed. Specifically, it can be observed that the positive effect increases in magnitude as one moves from high-income to middle-income countries. This suggests that middle-income countries have the most to gain from investing in their productive capabilities. However, there is no statistically significant effect in the case of low-income countries. This may be because no manufacturing sector exists in these countries; thus, their current productive capabilities inherent in their productive structure are too far from what is needed to easily diversify into manufacturing.

This analysis has shown that sustainable economic growth requires a country to diversify its export basket. Therefore, economic growth policies must focus on industries that produce relatively sophisticated products or ones that have the potential to produce more sophisticated products in the future (Zahler, et al., 2014). To identify such industries requires a detailed evaluation of the opportunities and challenges in each industry, undertaken without political interference or undue influence from vested interests (ibid.). Chile, for example, used the Boston Consulting Group, an

external, neutral party, to identify high potential growth industries (ibid.). From there, the government must engage with the private sector to determine the most suitable public inputs – infrastructure (e.g. electricity), institutions (e.g. strong patent law) or education – to facilitate an increase in the productive capabilities of the sector and, thereby, the sophistication of the products produced.

Ultimately, it is important to realize that there is no ‘magic bullet’ for Africa; rather, each country’s opportunities and challenges are more nuanced than presented in this study. It is likely that country-focused studies will yield more specific and desirable policy options.

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ANNEX 5.1 Variable descriptions and sources

Variable	Description	Source
Fixed capital per worker	The capital per worker variable is constructed using employment data and capital stock data (constant 2005 US dollars).	Penn World Table Version 8.1 (Feenstra et al., 2013)
Total factor productivity (TFP)	TFP is computed using current PPP US\$, capital stock, labour input data and labour share of income data.	See Feenstra et al., (2013) for more information.
Opportunity value index	This measures how many different products are near a country's current set of productive capabilities.	The Observatory of Economic Complexity (Simoes and Hidalgo, 2011)
Economic complexity index	This measures the distance between the productive capabilities embodied in a country's current export structure and the productive capabilities embodied in the products that it does not yet export.	
Total natural resources rents (% of GDP)	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents and forest rents.	World Bank Development Indicators
Count of manufacturing product exports	This measures the number of manufacturing products exported.	BACI International Trade Database at the product level

ANNEX 5.2 International Standards Organisation country codes

Country	ISO	Country	ISO	Country	ISO	Country	ISO
ALBANIA	ALB	ESTONIA	EST	LITHUANIA	LTU	SERBIA	SRB
ALGERIA	DZA	ETHIOPIA	ETH	MACEDONIA, FYR	MKD	SINGAPORE	SGP
ANGOLA	AGO	FINLAND	FIN	MADAGASCAR	MDG	SLOVAK REPUBLIC	SVK
ARGENTINA	ARG	FRANCE	FRA	MALAWI	MWI	SLOVENIA	SVN
AUSTRALIA	AUS	GABON	GAB	MALAYSIA	MYS	SOUTH AFRICA	ZAF
AUSTRIA	AUT	GEORGIA	GEO	MALI	MLI	SPAIN	ESP
AZERBAIJAN	AZE	GERMANY	DEU	MAURITANIA	MRT	SRI LANKA	LKA
BANGLADESH	BGD	GHANA	GHA	MAURITIUS	MUS	SUDAN	SDN
BELARUS	BLR	GREECE	GRC	MEXICO	MEX	SWEDEN	SWE
BELGIUM	BEL	GUATEMALA	GTM	MOLDOVA	MDA	SWITZERLAND	CHE
BOLIVIA	BOL	GUINEA	GIN	MONGOLIA	MNG	SYRIAN ARAB REPUBLIC	SYR
BOSNIA AND HERZEGOVINA	BIH	HONDURAS	HND	MOROCCO	MAR	TAJIKISTAN	TJK
BOTSWANA	BWA	HONG KONG SAR, CHINA	HKG	MOZAMBIQUE	MOZ	TANZANIA	TZA
BRAZIL	BRA	HUNGARY	HUN	NAMIBIA	NAM	THAILAND	THA
BULGARIA	BGR	INDIA	IND	NETHERLANDS	NLD	TRINIDAD AND TOBAGO	TTO
CAMBODIA	KHM	INDONESIA	IDN	NEW ZEALAND	NZL	TUNISIA	TUN
CAMEROON	CMR	IRAN, ISLAMIC REP.	IRN	NICARAGUA	NIC	TURKEY	TUR
CANADA	CAN	IRELAND	IRL	NIGERIA	NGA	TURKMENISTAN	TKM
CHILE	CHL	ISRAEL	ISR	NORWAY	NOR	UGANDA	UGA
CHINA	CHN	ITALY	ITA	OMAN	OMN	UKRAINE	UKR
COLOMBIA	COL	JAMAICA	JAM	PAKISTAN	PAK	UNITED ARAB EMIRATES	ARE
CONGO, REP.	COG	JAPAN	JPN	PANAMA	PAN	UNITED KINGDOM	GBR
COSTA RICA	CRI	JORDAN	JOR	PAPUA NEW GUINEA	PNG	UNITED STATES	USA
CÔTE D'IVOIRE	CIV	KAZAKHSTAN	KAZ	PARAGUAY	PRY	URUGUAY	URY
CROATIA	HRV	KENYA	KEN	PERU	PER	UZBEKISTAN	UZB
CUBA	CUB	KOREA, REP.	KOR	PHILIPPINES	PHL	VENEZUELA, BOL. REP.	VEN
CZECH REPUBLIC	CZE	KUWAIT	KWT	POLAND	POL	VIET NAM	VNM
DEMOCRATIC REPUBLIC OF THE CONGO	COD	KYRGYZ REPUBLIC	KGZ	PORTUGAL	PRT	YEMEN, REP.	YEM
DENMARK	DNK	LAO PDR	LAO	QATAR	QAT	ZAMBIA	ZMB
DOMINICAN REPUBLIC	DOM	LATVIA	LVA	ROMANIA	ROU	ZIMBABWE	ZWE
ECUADOR	ECU	LEBANON	LBN	RUSSIAN FEDERATION	RUS		
EGYPT, ARAB REP.	EGY	LIBERIA	LBR	SAUDI ARABIA	SAU		
EL SALVADOR	SLV	LIBYA	LBY	SENEGAL	SEN		