

What African Industrial Development Can Learn from East Asian Successes—The Role of Complexity and Economic Fitness

By Justin Lin, Masud Cader, and Luciano Pietronero

The path to becoming an advanced economy can be a difficult one that is fraught with obstacles, traps, and frequent reversals. Yet in the past half century several East Asian nations have completed the journey by increasing their “economic fitness”—implementing structural changes and leveraging their comparative advantages. Complexity and Economic Fitness is a methodology that measures the stage of an economy’s development and suggests feasible upgrades to more sophisticated production and diversity, which can lead to greater global competitiveness. This note highlights the East Asian lessons that African nations, and Ethiopia in particular, are putting to use. These include focusing on competitiveness in select industries, acquiring know-how from global leaders, seeking foreign partners and investment, and developing a national strategy to create the industries of the future. The application of these lessons is also of interest to private investors, as it can allow them to identify the economies utilizing Economic Fitness analyses and thus offer opportunities for growth and investment.

Since the 1970s, only seven emerging market economies—all of them in East Asia—have achieved substantial growth that has enabled them to move from low to middle and higher incomes.¹ Beginning in the 1950s and 1960s, today’s successful East Asian economies adopted an export-oriented development strategy based on labor-intensive manufacturing. Since then, these economies have moved up the industrial ladder, step by step, gradually accumulating development capital.

By leveraging and refining their underlying capabilities, these high-performing countries have sustained their growth by using their comparative advantage to upgrade industrially, diversify, and increase the competitiveness and complexity of their goods and services. Most of these

economies increased their competitiveness in complex industries by adopting a variety of policies and business strategies, including setting up clusters (industries that support mutual development, such as textile production and garment manufacturing), integrating into global value chains, automating, embracing services, increasing domestic consumption, and increasing trade beyond the Group of Seven countries.

Building on Strengths

Modern economic growth is a process of continuous structural transformation. This involves constant technological innovation in existing industries, the emergence of new, high value-added industries, and

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improvements to hard infrastructure such as power supply and road networks, as well as institutions (soft infrastructure). Economic structures, including the structure of technology and industry, determine labor productivity, and hard and soft infrastructure determines transaction costs that are endogenous to the endowment structure in an economy (e.g., land, capital, and labor with potential to create comparative advantage), which is present at any specific time and changeable over time.

Endowments, and their structure, determine the economy's total budget and relative factor prices at any specific time. These, in turn, determine which industries in the economy have comparative advantage. If all the industries in the economy are consistent with the economy's comparative advantage, the economy will have an appropriate industrial structure. Such a structure enables the economy to operate with the lowest factor costs for production in both the domestic and the international markets.

Therefore, as an economy's structure of factor endowments evolves from one level of development to another, the optimal industrial structure will evolve too. When the industries in an economy move from traditional resource-intensive or labor-intensive industries to modern capital-intensive industries, continuous improvement is required in hard infrastructure such as power, roads, and ports, as well as soft infrastructure such as financial institutions and the legal system. These improvements reduce transaction costs and transform the industries of an economy's comparative advantage into a competitive advantage.

Comparative Advantage

Traditionally, the goal of firms is profit maximization, which, all things being equal, is a function of the relative price of factor inputs. The criteria for a firm's selection of an industry is typically the relative price of capital, labor, and natural resources. The precondition for firms to follow the economy's comparative advantages in deciding whether to remain in or enter an industry is having a market system that provides price signals that reflect the relative scarcities of the factors of production in the endowment structure (land, labor, capital, and entrepreneurship).

In developing countries, which often lack a competitive market, the state must take steps to improve market institutions so that they create and protect competition in the product and factor markets. In the process of industrial upgrading, firms need to have information about production technologies and the market for their products.

Each firm will need to invest resources to collect and analyze information about technologies and the market for

Box 1 – What is Economic Fitness?

Economic Fitness (EF) is both a measure of a country's diversification and ability to produce complex goods on a globally competitive basis. Countries with the highest levels of EF have capabilities to produce a diverse portfolio of products, ability to upgrade into ever-increasing complex goods, tend to have more predictable long-term growth, and to attain good competitive position relative to other countries. Countries with low EF levels tend to suffer from poverty, low capabilities, less predictable growth, low value-addition, and trouble upgrading and diversifying faster than other countries.

Source: World Bank.

products. First movers that attempt to enter a new industry should be able to succeed if the industry is consistent with the country's new comparative advantage. However, they will fail if they have targeted an incompatible industry.

Successful industrial upgrading in an economy also requires new types of financial, legal, and other “soft” and “hard” infrastructure to facilitate production and market transactions in order to allow the economy to convert its advantages into growth. Improving hard and soft infrastructure requires coordination beyond the capability of individual firms.

Development is, therefore, a dynamic process marked with externalities, and one that requires coordination. Successful countries have followed their comparative advantages, as determined by their factor endowments, and in market economies, developed their industries with state facilitation. This has taken the form of both diversification and upgrading to ever-more complex production of goods and services, which is the measure of a country's Economic Fitness.²

Development through Economic Fitness

Since growth comes from continuous structural transformation, countries that grow sustainably will experience continuous innovation and become more competitive in producing increasingly unique goods and services. The capabilities that are given at any specific time in an economy—the economy's endowment—are required to produce high-quality, complex products, and will always be scarce. Globally, in each industry, only a few firms hold a dominant position. To achieve this, they will have leveraged capabilities in the economy and in their firms to move into related industries and successfully diversify their country's output. Capabilities are concentrated in some

countries in order to take full advantage of agglomeration economies. Effectively, this means that fitter economies produce more complex products, and they do so at scale.

If economic fitness captures the dynamics of growth through pursuing comparative advantages, it should be able to explain key dynamics of development, including:

1. Defining poverty and middle-income traps;³
2. Assessing the likely nature of future growth—e.g., fast (catch-up) growth;³
3. And predicting long-term gross domestic product (GDP) growth (i.e., the structural estimate of future growth).⁴

Production of complex goods involves the joint execution of a large number of highly specialized tasks. This requires both the presence of broad sets of advanced skills and the ability to combine them effectively.

Economic fitness provides a quantitative lens for examining development before ascribing any development philosophy to the drivers of growth. It provides a dynamic view that is based on transactional information about outputs. The profile of a country's trade specialization reflects the underlying capabilities that enable its economy to produce, using its existing skills efficiently, expanding to meet new production requirements, and adopting new technologies.

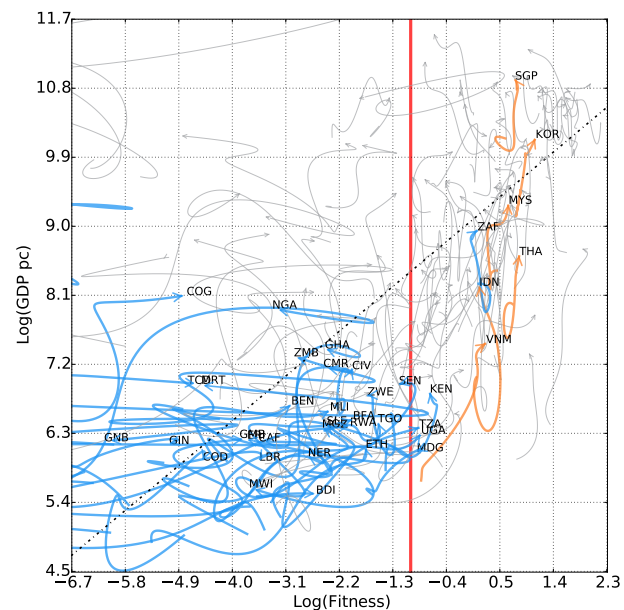


FIGURE 1 The Development Trajectories of Selected Sub-Saharan African (Blue), East Asian (Orange), and Other Countries (Grey)

Source: Matthieu Cristelli, University of Rome. Note: Very few countries have increased fitness to more than -0.5 on a sustained basis (e.g., Korea and Vietnam). In fact, most countries seem to lose fitness near 0, accompanied by lower and/or more volatile growth (e.g., Tanzania, Senegal, and Kenya).

Conventional measures of an economy's production possibilities do not explicitly consider its degree of flexibility and adaptability. However, if more complex economies are also endowed with a richer set of capabilities, then ignoring them would lead to misspecification in the underlying models, as the relevant explanatory variables would be omitted from the analysis.

Africa Set for Growth

Many development analysts expect Africa to achieve middle-income status sometime in the 2020s. Of the 54 African states in 2018, 24 were classified by the World Bank as low-income. In Africa, nine countries account for 75 percent of the continent's GDP, and only 400 companies have revenues exceeding \$1 billion. According to *WealthInsight*, there are 2,050 African multimillionaires—individuals whose net worth is over \$30 million (compared to 51,192 multimillionaires in North America, 48,245 in Asia, and 2,350 in Russia and the former Soviet Union states).

While most African countries have a population below 20 million, three countries are far more populous (Egypt, 90 million; Ethiopia, 100 million; and Nigeria, 190 million). There are great expectations that Africa's demographic dividend will result in consumer spending growth of 3.5 percent per year, driving it to \$6.7 trillion by 2030. McKinsey expects the continent's production will double to around \$1 trillion by 2030, almost half of it to meet domestic or regional needs. While these forecasts are expected to be affected by COVID-19, the underlying relative advantages and capabilities are likely to persist.

We Have Been Here Before

By the end of the 1960s, there were 17 newly independent African states, and their economic potential was widely believed to be enormous due to Western investment, international cooperation, and the ability to build on their colonial past. However, this foundation turned out to be insufficient, and most of these new nations started with economic fitness levels far below zero. With the exception of South Africa, this remains the case today. The low fitness levels in Africa contrast with those of the "Asian Tigers," which have fitness levels greater than zero (Figure 1, see the Republic of Korea (KOR)). This raises the question, what has differentiated Asia from Africa?

Across Africa, some countries are subject to commodity/natural resource price volatility (Nigeria, for example); some are fragile and prone to conflict and violence (such as the Democratic Republic of Congo); and some are vulnerable to macroeconomic problems (e.g., Mozambique). While situations vary, African countries (with the exception

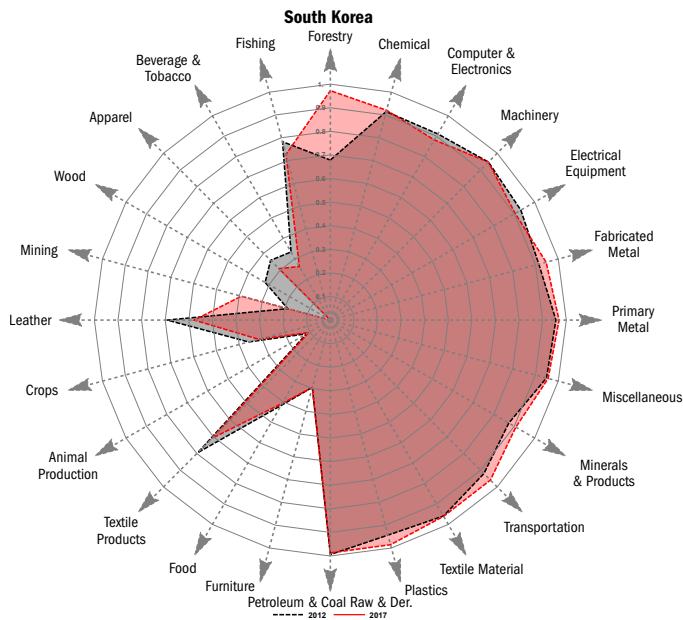


FIGURE 2 Korea Sector Fitness

Source: IFC. Note: The high level of competitiveness is concentrated in the complex sectors (the right side of each plot). Diversification across sectors is largely across the most complex sectors.

of South Africa) have one commonality—hitting the fitness boundary and losing diversification, complexity, and competitiveness just when it is critical for sustained growth. Almost all countries in Africa seem to systematically make a “U-turn” with fitness levels between -1 and 0 (Figure 1). That is, they never sustainably experience catch-up growth rates. The few countries that have jumped the poverty trap barrier required a focus on growth due to inputs and sustained investment during the transition period (white shaded area of Figure 3).

Learning from the Asian Tigers

In the 1960s and 1970s, the Asian Tiger economies were driven by agriculture and experienced a period of rapid growth to catch up to developed countries. This growth could have been the result of improved internal demand that jump-started industrialization (demand side growth), or from improved investment (supply side). Those who argue for demand side growth contend the industrialization of one sector increases the wages of a subpopulation of workers who then demand more products. This in turn drives growth in other sectors. Those who argue for supply side growth hold that the expansion cycle and high growth rates result from new and profitable facilities, from which revenue can be reinvested to create a virtuous cycle.

Patterns of sector fitness illustrate that the majority of Asian Tigers developed an appetite for diversification

(Figure 2). They strove to make use of their comparative advantages, which resulted in increased competitiveness, especially in complex sectors. This disproportionately increased fitness before rapid growth began—the “lateral exit”⁵ from low-income status to a path that helped avoid the low- and middle-income traps and enabled economies to reach sustained higher-income status (Figure 3).

With a population around 5.5 million and limited land, Singapore is dependent on external demand. This has resulted in a development focus on competitiveness. This in turn has meant developing human resources and creating infrastructure to sustainably grow external demand, while developing partnerships with sophisticated foreign entities. This evolution could only happen because the government of Singapore was viewed not as an agent for special interests, but as a trustee for its citizens.

Korea had similar objectives but differed substantially with regard to transferring knowledge. In the 1980s, the country’s large firms focused on adopting foreign technologies and know-how instead of conducting research and developing technology. However, foreign know-how has provided a foundation on which Korean firms have been able to innovate and build their own technological capabilities. Know-how comprised not just technical guidance, but also

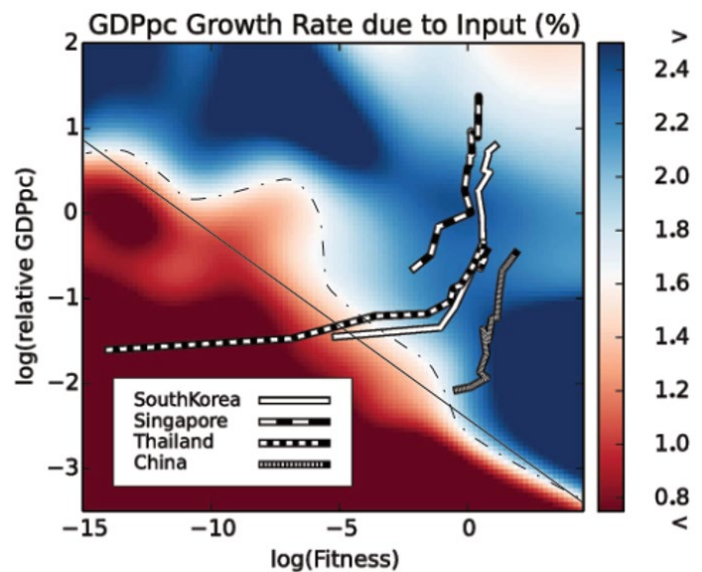


FIGURE 3 Korea and Thailand Illustrate the Lateral Escape from the Poverty Trap (Red)

Source: Pugliese et al. (2017). Many countries seem to get caught in a trap (white area) demarcated by the dotted spline fit or linear fit. Countries that transit the white area require around 25 percent increase of input capital (from less than 1.4 [red] to 1.8 [pale blue]) and high fitness to make the transition in a sustained manner. It is precisely at this line when risk perception is high and countries fall back into the trap of low relative wealth and lost capability.

on-site training, and learning from expatriate engineers who transferred knowledge while they worked. There were attempts in the 1960s to establish labor-intensive light-manufacturing industries, but these were not sufficiently profitable and did not provide adequate cashflow to finance dollar-denominated repayment for technology transfer. This pattern led Korea to adopt a strategy that encouraged backward integration so that intermediate goods (the inputs for higher value outputs) could be produced domestically. Eventually, in partnership with government and academia these firms had the capacity to pursue innovation-heavy production themselves by launching and deepening domestic research and development.

Whichever strategies were used for catch-up, low-fitness countries (those with poorly diversified economies) do not start the transition until they have reached an extremely high level of input capital.

Lion's Roar: The Case of Ethiopia's Industrialization

Ethiopia's industrial sector, including manufacturing, grew faster after 2005. The annual rate of growth of industrial output doubled to nearly 20 percent from 2015 to 2017, while manufacturing CAGR was 10 percent from 2005 to 2010, and 17.9 percent from 2015 to 2017. Despite such growth, the level of industrialization remained low. Value added in manufacturing reached only 6.4 percent of GDP by 2017.

Ethiopia is expected to grow much more. The International Monetary Fund forecasts growth of around 7.4 percent through 2024. Fitness is expected to increase by 7 percent per year to 2024, and a structural projection based on fitness predicts a growth rate of 7.3 percent that matches the IMF forecast.⁶ Over the first half of the 2020s, Ethiopia's growth rate is projected to be the highest in Africa and among low-income economies worldwide. Again, while growth rates for individual African countries and the region as a whole are expected to be affected by COVID-19, we continue to believe that Ethiopia remains one of the fastest growing countries in the region.⁷

Increasing fitness implies more diversification of the economy as well as greater competitiveness in the production of higher complexity goods and services in each sector.

Ethiopia's sector fitness (Figure 4) shows a loss of competitiveness in the most complex sectors (chemicals, machinery, and fabricated metals) from an already below-median global level of competitiveness. Similar fitness losses were experienced in simple sectors such as beverage production and mining. During Ethiopia's first Growth and Transformation Plan (GTP)—its five-year national

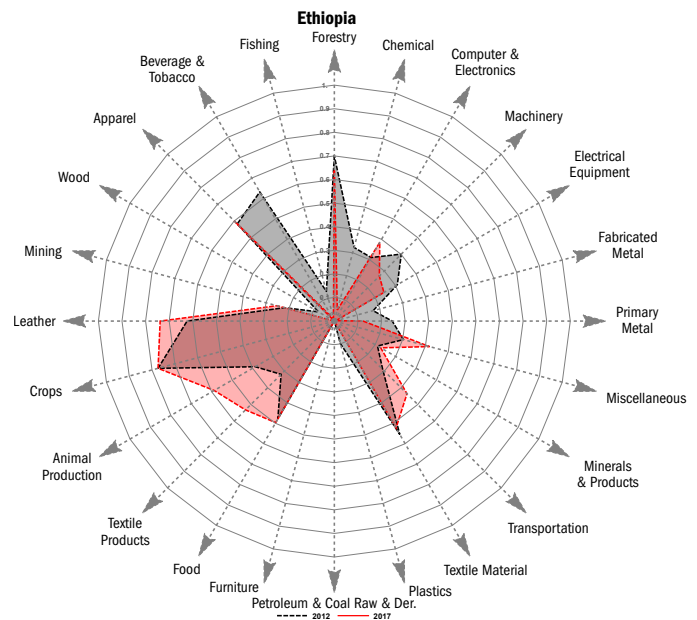


FIGURE 4 Ethiopia Sector Fitness Between 2012 and 2017

Source: IFC. Note: Most mid-complexity sectors maintained or grew their competitiveness. Sectors are arranged from the simplest (forestry) to the most complex (chemicals) in a counter-clockwise order. Red designates the most recent fitness level, and black is the level for 2012.

vision for growth that began in 2010—the country focused on competitiveness in crop, food, and textile production, and growth in animal production, leather, and textiles. In leather and crop production, Ethiopia now ranks near the top 20 percent of countries globally. The latter is largely due to the success of Ethiopia's cut flower industry, which sells to households in advanced European economies (Box 2). However, the competitiveness of Ethiopia's complex sectors has declined (with the exception of transportation equipment, which is due primarily to Ethiopian Airlines' maintenance and repair operations).

Ethiopian industries and firms are learning from global leaders that provide the same goods and services. However, the time needed to arrange the necessary transfer of know-how to local people may be longer than policymakers expect, and out of sync with reorienting the curriculum in domestic universities and vocational training centers.

Korea's development went through a similar phase and provides lessons on how to engage with sophisticated partners, which can facilitate the eventual transfer of know-how that increases domestic capabilities, complexity, and value-added. Ethiopia differs from Korea in that its private sector is not dominated by Chaebols (large family-owned conglomerates) that have sufficient absorptive capacity. Instead, the conditions in Ethiopia's private sector resemble the initial private sector conditions in China and Vietnam.

Box 2. Example of Country Comparative Advantage in Horticulture: Cut Flowers in Ethiopia

By 2015, Ethiopia produced 9 percent of global cut flower exports (up from less than 1 percent in 2005). The peak year for cut flower exports from Ethiopia was 2014 (\$749 million), but by 2017 Ethiopian exports of cut flowers fell to \$200 million. Over the same period, Kenya experienced a much smaller loss in the value of its cut flower exports, declining only from \$687 million to \$678 million.

Melese¹ found that after 2002 the government “provided generous investment incentives to both domestic and foreign investors, which included cheap land in water-abundant areas in close proximity to Bole International Airport, soft loans from the state-owned Development Bank of Ethiopia, income tax holidays, [a] loss rescheduling provision, and removal of tariffs and duties on capital goods, spare parts, and inputs.” These actions incentivized domestic flower producers’ entry—typically, as part of a diversified set of business

interests, but that caused “a lack of attention and commitment to further building their capabilities.” These capabilities include upgrading flower varieties and using better-adapted plant stock, providing appropriate shading structures/greenhouses, and using water-saving irrigation technology and environmentally-sustainable fertilizers and herbicides. Post-harvest, the capability improvements should target adopting cold-chain technologies; improving grading, inspection, packaging, labeling, and freight forwarding agents; and assuring commercial air cargo capacity, with the aim of reducing the time to reach foreign markets. In spite of strong government incentives and policy support, cut flower production feasibility remains relatively low in Ethiopia, in contrast with the country’s competitors. Kenya’s cut flower export feasibility is currently higher than Ethiopia’s in all but one category of cut flowers (fresh orchids).

Table 1. Feasibility of Cut Flower Products in Ethiopia and Kenya

	Dried/prepared cut flowers & buds	Fresh cut flowers & buds	Fresh carnations	Fresh chrysanthemums	Fresh orchids	Fresh roses
Ethiopia	0.33	0.13	0.06	0.05	0.04	0.11
Kenya	0.33	0.31	0.23	0.07	0.02	0.26

Note: Higher = more feasible.

¹ Melese, Ayelech T. 2019. “Constraints on the Ethiopian Floricultural Industry.” In: Cheru, Fantu, Christopher Cramer and Arkebe Oqubay. 2019. *The Oxford Handbook of the Ethiopian Economy*.

Ethiopia’s GTP II, the current national economic strategy for 2016 to 2020, calls for industrialization across several sectors and themes, with many having a high complexity focus (e.g., biotech, electronics, green technology).

GTP and GTP II, with their ambitious catch-up visions, are strategic efforts to channel growth through capital accumulation total factor productivity (TFP). Figure 3 shows that capital accumulation was a critical factor in the Asian Tigers’ catch-up, along with their greater level of fitness. As capital accumulation on its own will not enable a country to cross the poverty line, Ethiopia has identified Vietnam as its model, due largely to Vietnam’s success in transforming capital accumulation into sustained, high growth.

The Progress Score⁸ ranging from 0–1 represents the feasibility of Ethiopia becoming globally competitive in a sector or product, and indicates Ethiopia’s potential, beyond 2025, for the bio-science industries of the future.

Industries Beyond 2025

Industry 4.0, the ongoing transformation of manufacturing through digitalization, connectivity, and self-monitoring by machines,⁹ and Made in China 2025, a strategy to make China a dominant high-tech manufacturer in selected sectors,¹⁰ both promote what are likely to be the world’s industries of the future, including AI, bio-industry, and robotics. These are complex and strategic industries that require a great deal of coordinated effort, capability development, and risk-taking in order to deliver value.

With GTP II, Ethiopia has expressed its preference to develop several bio-industries (e.g., pharmaceuticals and biotechnology) as its industries of the future. The choice of these sectors has resulted in the development of a national strategy. Ethiopia’s ministers of health and industry stated in the preface to this strategy that “growth and development of the Ethiopian pharmaceutical manufacturing sector will be based on the ‘value chain’ approach, which is a

spectrum of progress from the exclusive import of finished pharmaceutical products to a research-based pharmaceutical industry.”¹¹ Essential to this approach is a phase that encourages foreign partners that can invest and increase the complexity of pharmaceutical outputs, while taking into account local conditions (e.g., forex availability and qualified domestic employees). This requires encouraging competitiveness so that appropriate import substitution can take place, competition can flourish, and learning and innovation create a virtuous cycle.

The pharmaceutical strategy in the GTP is summarized in a set of targets that include:

- Achieve full utilization of the existing capacity of local manufacturers of pharmaceuticals and medical supplies.
- Raise the share of the domestic market held by local manufacturers of pharmaceuticals and medical supplies to 50 percent.
- Increase the export earnings of local manufacturers of pharmaceuticals and medical supplies to \$20 million per year.

According to the mid-term report issued by Ethiopia’s National Planning Commission, “The export revenue earnings remained very low and stood at 3.1 million USD against the target of 54.8 million USD for the fiscal year. On the other hand, the plan to increase the domestic market share of the products of the pharmaceutical industry to 20 percent has been fully achieved.

Ethiopia’s Progress Scores demonstrate that sector development will continue to be difficult and will require further focus on input capital. The capabilities typically present in countries with high Progress Scores that have moved successfully and sustainably into pharmaceuticals and other bio-sciences are not yet present in Ethiopia at a suitable level of quality.

Creating Markets through Complexity Gain

Ethiopia has focused on catching up and becoming a middle-income country by 2025. As a result, the country has partnered with many experts to design an overall vision, as well as to specific vertical and horizontal industry strategies. However, the absorptive capacity of Ethiopia is finite. An assessment is needed of how projects are likely to contribute to country fitness (through an increase in complexity). Such an assessment should offer alternatives: “Will an investment in biomedical engineering or bio-agriculture unlock other more complex industries?” Complexity gain answers the question, “How likely is it that a project in a sector will unlock opportunities to upgrade to higher complexity

Probability of Developing Competitiveness in Bio Industry

Ethiopia and peer country chances of developing competitively within 10 years

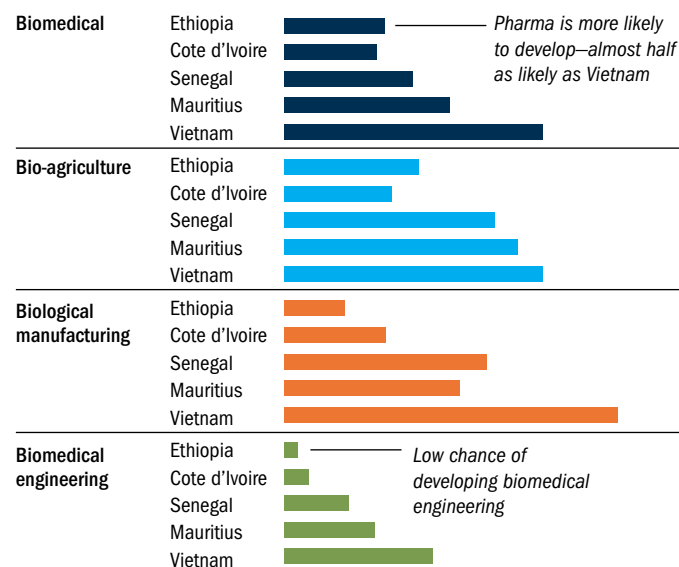


FIGURE 5 Progress Scores Compared for Several African Countries, and Relative to Their Aspirational Peer, Vietnam

Source: IFC. The Progress Score or feasibility of the biomedical industry, which includes pharmaceutical manufacturing, is nearly half as likely as Vietnam’s, but below that of Senegal and Mauritius. Across all the bio-industry sectors, bio-agriculture (the breeding of high-yielding, nutritious, less resource-intensive crops) is the most likely industry to develop.

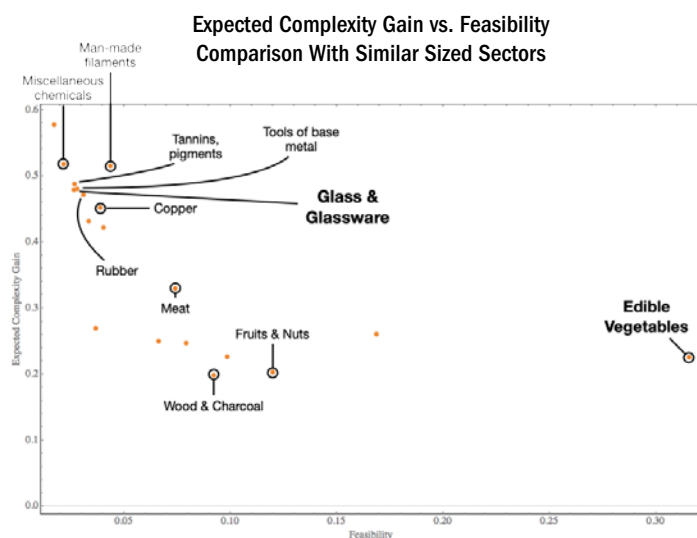


FIGURE 6 The Feasibility for Different Industries to Develop in Ethiopia Over the Current GTP II Strategy Period (to 2025), and the Complexity Gain/Unlocking Likely to Take Place

Source: IFC. Successful entry into glass ampules (within Glass & Glassware) would create the capabilities in Ethiopia to unlock other complex industries—over twice as much as the more feasible Edible Vegetables.

products in the future?” A high complexity gain means that the subject industry unlocks—or creates—markets, which are likely to catalyze others of higher complexity.

Will a proposed project to manufacture glass ampules in Ethiopia, which is currently not very feasible, unlock other opportunities to upgrade? Or would an investment in edible vegetable production create more opportunities? Figure 6 shows that investment in edible vegetables is very feasible, so much so that the private sector could operate reasonably in this sector. New edible vegetable projects are unlikely to require a great deal of assistance, and they will unlock a reasonable number of other industries (with a complexity gain of around 0.22). On the other hand, while a project to produce glass ampules is currently not feasible in Ethiopia (with less than a 5 percent chance), it would unlock pathways to higher complexity industries. The capabilities are not present for this sector to become competitive over the current strategy’s horizon (to 2025), and are unlikely to evolve naturally. They require extra care and market creation incentives to contribute sustainably to the GTP II strategy goals.

Conclusion

Creating a development strategy entails the prioritization and sequencing of sector development, which rewards the easing of economic constraints. Ethiopia is growing rapidly and has committed to evaluating strategies to reduce binding constraints, as well as boosting sector-specific opportunities to increase complexity. It is currently in a position on the fitness scale in which further input capital is necessary. Curtailing investment at this time would reduce the chances of Ethiopia catching up and exiting from the poverty trap.

Ethiopia has learned several policy lessons from the Asian Tigers. Fitness analytics (country fitness, sector fitness,

a country’s position on the fitness-income plane and its feasibility) provide an empirical and forward-looking quantitative perspective on opportunities, given Ethiopia’s current capability configuration, and the most likely ways that its capabilities can evolve. These metrics can help set priorities across myriad strategies and target the unlocking of opportunities in higher-complexity industries—the market creating complexity gain. Empirical evidence provided by the Fitness analytics support the philosophy of new structural economics. That is, that a country should develop its market based on its comparative advantages, and that the state should facilitate this so that the country can compete in the domestic market, as well as the international market, and accumulate capital and capabilities for further industrial upgrading and diversification.

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- ¹ China, Hong Kong, Korea, Singapore, Malaysia, Indonesia, and Thailand were identified as long-term performers, achieving above-global growth since the 1970s.
- ² Economic Fitness was introduced in 2012 by Andrea Tacchella and Luciano Pietronero. See Tacchella, A., M. Cristelli, G. Caldarelli, A. Gabrielli, and L. Pietronero. 2012. “A New Metrics for Countries’ Fitness and Products’ Complexity.” *Scientific Reports on Nature*. 2: 723.
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