CHAPTER 7

Innovation in African Food Processing Enterprises: Patterns and Drivers

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Introduction

The need for industrial development in Africa has become more pressing than ever. Industrial development is key for structural transformation, which many African countries are struggling with, to sustain and deepen the observed solid economic growth of the last two decades (Newfarmer, Page, and Tarp 2019; Newman et al. 2016). It has also become a key strategy to tap into growing opportunities such as the high rates of urbanization, the growing labor force and its level of qualification, a high proportion of young people in the population structure, a growing domestic market, an increasing relative size of the middle class, the decrease in the severity of internal political confrontations and attenuation of intercountry armed conflicts, and the development of digital technologies (Ledeneva et al. 2020). Despite the wider narrative of "premature deindustrialization" associated with COVID-19,[1] recent data show that deindustrialization is not the common experience for the majority of African countries and industrial sectors (Lopes and te Velde 2021). This creates another opportunity to renew efforts and refocus policy to promote industrialization.

Industrialization is exceptionally crucial for African countries to create jobs. According to Brookings' 2017 Foresight Africa report, Africa south of the Sahara (SSA) had the world's highest unemployment rate (7.5 percent, compared with the global average of 5.7 percent) and lowest labor force participation rate (70.4 percent) in 2017 (Sow 2017; Bhorat, Naidoo, and Ewinyu 2017). The industrial sector is generally deemed more profitable than other sectors, and it has the capacity to employ large numbers of unskilled workers. However, it employs the smallest share of SSA's labor force. In most African countries, the manufacturing and services sectors employ an average of 46 percent of the working population, while the remaining 54 percent are still employed in the agricultural sector. Employment prospects in SSA are presently stagnating due to low overall productivity, attributed to the region's lack of economic diversification and innovation (Sow 2017).

An element central to boosting productivity in the industrial sector is increasing investment in knowledge capital and innovation activities at the firm level (Cirera and Cusolito 2019; Dohnert, Crespi, and Maffioli 2017; McMillan and Zeufack, 2022). These innovations are expected to affect firm performance in different ways. First, successful innovations are likely to increase firm-level total factor productivity by improving the capacity to transform factors of production into more and better products. Second, the increase in total factor productivity is expected to increase the marginal productivity of labor and, as a result, increase the quality (productivity) of jobs. Third, more productive firms are expected to push less productive firms out of the market, thereby increasing the overall efficiency of the economy. This will improve allocative efficiency. All of this, however, depends on the quality of the innovation and the ability of firms to translate innovation outcomes into improved firm performance (Cirera 2015). It also depends on the type of industries that matter for the specific context of Africa. According to Newfarmer, Page, and Tarp (2019), industrial sectors such as tourism, information and communications technologies (ICT), and other services, as well as the food processing and horticulture sectors, play a role analogous to the role played by manufacturing in East Asia.

In this chapter, we assess the pattern and drivers of firm-level innovation in the African food processing sector using a mix of methods that qualitatively explain concepts and conceptual relations, and quantitatively explore evidence using World Bank Enterprise Surveys (WBES) data. The chapter aims to incite policy and research discussion about enhancing firm-level innovation in the African food processing sector that could help to accelerate and deepen the growth of emerging food processing enterprises on the continent.

Definition and Measurement of Firm-Level Innovation

The definition and measurement of innovation has considerably evolved over the years (Hussen and Çokgezen 2020; González, Miles-Touya, and Pazó 2016; Dohnert, Crespi, and Maffioli 2017; Regasa et al. 2020). Generally, scholars agree that in the past, both the definition and scope of innovation were quite narrow (Trigo 2013; O'Brien 2016; Hussen and Çokgezen 2020). For many years, policy and academic research on firm-level innovations narrowly focused on modes of innovation driven by research and development (R&D) (Trigo 2013) and were also biased toward high-capability technological innovations (O'Brien 2016). This approach not only overlooked nontechnological innovations and the role played

1 The narrative on premature deindustrialization explains the adverse effect of COVID-19 on African industrialization, which is not yet mature enough to absorb shocks. It was a widely discussed presumption that COVID-19 would adversely affect the immature industries in Africa.

by nonformal R&D activities (such as experience, trainings, and the like) in innovative outcomes, but it also limited the understanding of innovative performance, especially among firms in the low-technology sectors (Trigo 2013; O'Brien 2016). According to O'Brien (2016), a bias toward high-capability technological innovation undermines other potentially significant impacts that could arise from low-capability innovations, such as low-novelty products or processes and those from organizational or marketing innovations. Furthermore, the narrow conceptualization in the past limited research on firm-level innovation to mostly the developed world (Hussen and Çokgezen 2019). Since innovation was largely understood as the introduction of a new product, and new products are mainly invented through formal R&D, the measurement of firm-level innovation focused mainly on the countries with the ability to finance R&D activities. However, as pointed out by Younas and Rehman (2021), the institutional advances of the firms in most developing countries fall outside these formal R&D models.

In recent years, however, there has been a revolution from this narrow conceptualization to a broader perspective that emphasizes the importance of other initiatives beyond R&D through which firms achieve innovation (González, Miles-Touya, and Pazó 2016; Trigo 2013; Hussen and Çokgezen 2020). This shift has been deemed important especially when assessing the innovation of firms in developing countries, where imitating preexisting products and processes is as important as creating original innovations (Hussen and Çokgezen 2020). Over time, therefore, the conceptualization of firm-level innovation has expanded, and it now captures the importance of imitation in these countries, representing innovations that could be new to a firm but not necessarily new in the market. This means that firms either imitate what is available in the market or invent through strategic investment in R&D. However, imitation could also depend on firms' ability to invest in human resources; depending on the knowledge intensity of the innovation, some innovations could be easier than others to imitate. In extreme cases, imitation is possible only through skill transfer from the original inventor. It also takes place through technology transfer from foreign companies through formal licensing agreements. Unfortunately, imitation creates gaps between an innovation and its private and social benefits, and it inhibits private investments in innovation (Sonobe and Otsuka 2006, 2011, 2014). In this case, innovation is often carried out by producer cooperatives to internalize its benefits in many dynamically growing industrial clusters (Hashino and Otsuka 2016). Imitation that takes place by buying new equipment that comes with embedded innovation may not affect the returns of the innovator and incentivize innovation.

Additionally, the broadened understanding of firm-level innovation has also shifted from its narrow focus on only product innovation to include other types of innovation, such as process, marketing, and organization methods (Hussen and Çokgezen 2020). Thus, a comprehensive measurement of innovation should include both imitation and invention in four types of innovations: ***product***, ***process***, ***marketing***, and ***organization*** innovations. However, in most empirical studies, firms' response on the adoption of new products or processes and firms' expenditure on R&D continue to be the most dominant measures of firm-level innovation, and hence these are referred to as "core" innovations (Cirera 2015). Marketing and organizational innovations are considered nontechnological innovations and are essential to optimize the gains from technological (product and process) innovations. Simple marketing and organizational practices, for example new packaging or introduction of *kaizen* (continuous improvement), help to accompany new products and processes and increase the benefits of these innovations. Therefore, in recent studies, the adoption of new marketing and organizational practices is used as a measure of innovation (Tadesse, Gachango, and Gwatidzo 2022). Other measures, though less applicable to the African context, include the number of applications for patents by firms (Fagerberg, Sholes, and Verspagen 2010; Fang 2019).

Others conceptualize innovation as a process that passes through from inputs to outputs of innovation. For example, the Global Innovation Index broadly classifies innovations as innovation inputs and innovation outputs to compare and rank countries, and hence it is less pertinent than some others to understand firm-level innovation (Aubert 2010). Similarly, the Oslo Manual of the Organisation for Economic Co-operation and Development (OECD) distinguishes two types of innovations: innovation inputs, such as investing in R&D, providing training to employees, and investing in fixed assets, and innovation outputs, such as the production of new products and processes for producing and delivering goods and services (OECD and Eurostat 2018).

Unlike that of other manufacturing industries, innovation in the food industry has been described as a complex process touching on different parts of the entire food system with a range of activities and institutions for

"development of new ingredients, formulation of new food products, improvement of methods of food preservation, and new ways of packaging" (Capitanio, Coppola, and Pascucci 2010, 3). In trying to understand the complex innovation process in the food industry, three key components need to be considered: (1) the production of totally new products or services, (2) the process of developing or modifying new products and services, and (3) the process of new product/service diffusion. Amidst this complexity, food firms are seen to display two distinct characteristics with respect to innovation: first, firms are process innovation–oriented, with equipment and capital goods investment taking the lead, and second, they innovate in an incremental manner, perhaps attributable to conservative consumer behavior (Capitanio, Coppola, and Pascucci 2010).

In line with the evolving broader definitions, Fagerberg, Sholes, and Verspagen defined innovation as "the attempt to try out new or improved products, processes, or ways to do things" (2010, 5). In this definition, implicitly, the following elements are critically important: (1) practical implementation of ideas or technologies, (2) newness or improvement of ideas or technologies, and (3) production of new or improved goods or services or improvement in delivering them. Therefore, we may alternatively define innovation as a practical use of ideas or technologies for the production or distribution of new or improved goods or services. The most formal and comprehensive definition is the one given by the OECD and Eurostat in a publication usually referred to as the Oslo Manual, which defines a business innovation as "a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (2018, 18).

Data

This paper applies a mixed-methods approach to explore the patterns and drivers of firm-level innovation in Africa's food processing sector. Whereas the conceptual analysis is guided by the existing dense literature in innovation at both the firm and the national levels, the empirical tests are carried out based on previous empirical work as well as descriptive analysis using the WBES data for African countries.

The WBES consists of several sets of data for many countries in the world, over multiple years. The survey covers two broadly defined sectors: manufacturing and service. We used the manufacturing survey data of African countries. The data include 47 countries in Africa and have been collected from different rounds across a total of 22,547 manufacturing enterprises since 2006. However, firm-level innovation data are available for a total 14,953 manufacturing firms in 37 countries, of which only 14 countries have both food and nonfood firms with innovation data. Table 7.1 lists these countries, the years of their surveys, and the number of samples from all manufacturing and food processing sectors. A total of 2,778 food processing firms have been surveyed

TABLE 7.1—NUMBER OF SAMPLE FIRMS WITH INNOVATION DATA AND USED FOR THE EMPIRICAL ANALYSIS IN THIS CHAPTER

Country	Years of survey	Sample size having innovation data	
		All manufacturing sectors	Food processing
Egypt	2103, 2016, 2020	5,187	969
Ethiopia	2011, 2015	704	89
Ghana	2013	377	57
Kenya	2013, 2018	869	306
Morocco	2013, 2019	650	168
Mozambique	2018	287	83
Nigeria	2014	1,416	183
Senegal	2014	249	126
South Africa	2020	344	47
Tanzania	2013	440	91
Tunisia	2013, 2020	695	195
Uganda	2013	378	118
Zambia	2013, 2019	544	136
Zimbabwe	2011, 2016	665	210
Total	**n.a.**	**12,805**	**2,778**

Source: Authors' estimation based on the data described in the methodology.
Note: n.a. = not applicable.

with innovation questions since 2011. Of the total 14 countries used for the analyses presented in this report, 6 have been surveyed for at least two years, and 1 (Egypt) for three years.

The specific number of samples might be different depending on the type of analysis. For example, the entire manufacturing sample is used to compare innovation levels between food and nonfood sectors, while only the 2,778 food processing sample firms are used to compare innovation levels across countries and over time and for all other analyses, including the role of innovation in trade and value addition, and the association of drivers with levels of innovation. The number of observations may be slightly lower for some of the analyses due to missing observations for a particular variable. It is important to note that these countries are not randomly selected to represent food processing firms in Africa. They are chosen based on data availability. Therefore, the results presented in this paper are case studies (results) and hence they help only to inform us on the likely importance of patterns, trends, and drivers of innovation in African food processing firms.

Patterns and Trends of Innovation in African Food Processing Firms

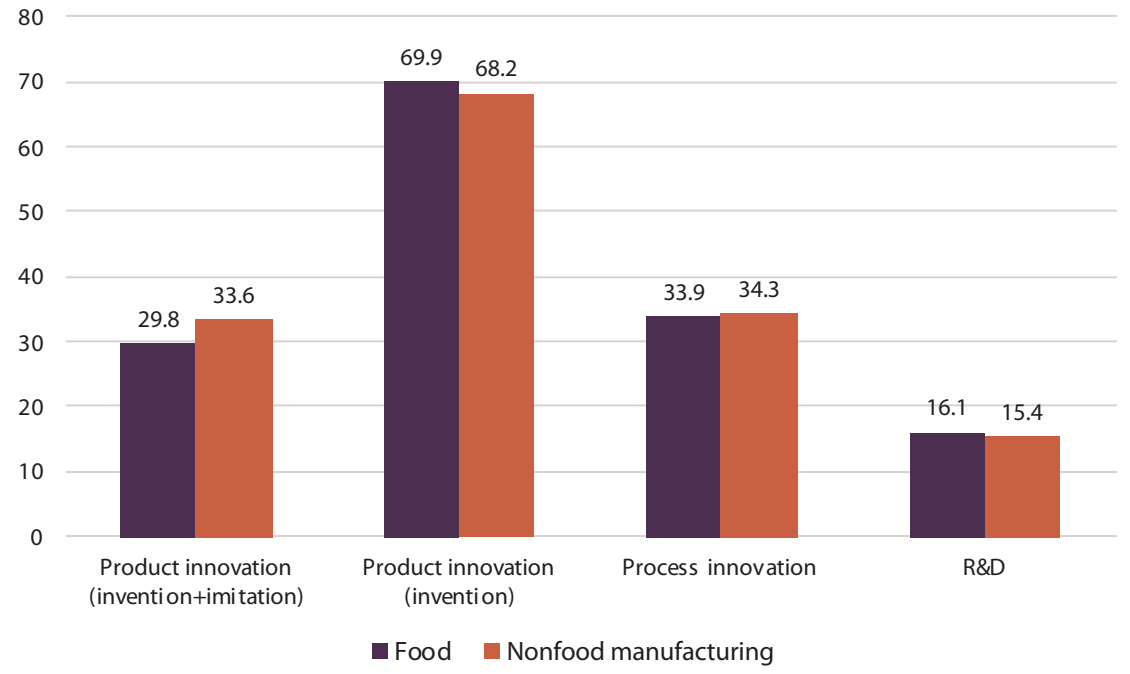
Patterns

Using the pooled data described above, we estimate the percentage of firms that adopted the four innovation indicators in the agrifood and nonfood manufacturing sectors (Figure 7.1). The four indicators are as follows:

1. Whether the firm has developed or adopted a product new to the firm in the last three years. This includes both imitation and invention of a product innovation, referred to as H1 in the WBES.
2. Whether the firm has developed a product new to the firm's market in the last three years. This includes only invention, referred to as H2 in the WBES.
3. Whether the firm has developed or adopted a process new to the firm in the last three years. This includes both imitation and invention of a process innovation, referred to as H5 in the WBES.
4. Whether the firm has invested in R&D, which is the major option for invention, referred to as H8 in the WBES.

The results, presented in Figure 7.1, indicate several lessons. First, the data on H2, representing the percentage of firms inventing new product innovations, are unexpectedly high compared with H1, which includes both inventing new innovations and adopting existing ones. By definition, the percentage of firms inventing new innovations (H2) should be less than the percentage of firms inventing or imitating (H1). However, the opposite is the case in the dataset. Moreover, the values for H2 are also exceptionally high compared with values

FIGURE 7.1—THE RATE OF INNOVATION IN FOOD AND NONFOOD PROCESSING FIRMS IN AFRICA



Source: Authors' estimation based on the data described in the methodology.

reported in other studies (such as Paus, Robinson, and Tregenna 2022). Therefore, all subsequent analyses are made based on H1 rather than H2.

Second, the difference between food and nonfood firms is not significant. Despite growing sector-specific opportunities for food processing firms in African markets, economywide constraints related to the business-enabling environment (for example, access to finance, support services, access to quality raw products and technologies, and so on) might have limited their ability to innovate to the extent that nonfood manufacturing firms have. Moreover, though food manufacturing firms invest a little more in R&D than do nonfood manufacturing firms, the actual level of innovation of food processing firms is slightly lower than that of nonfood processing firms. This is particularly the case for product innovation. The percentage of food processing firms that have adopted new products is 4 percentage points lower than that of nonfood manufacturing firms.

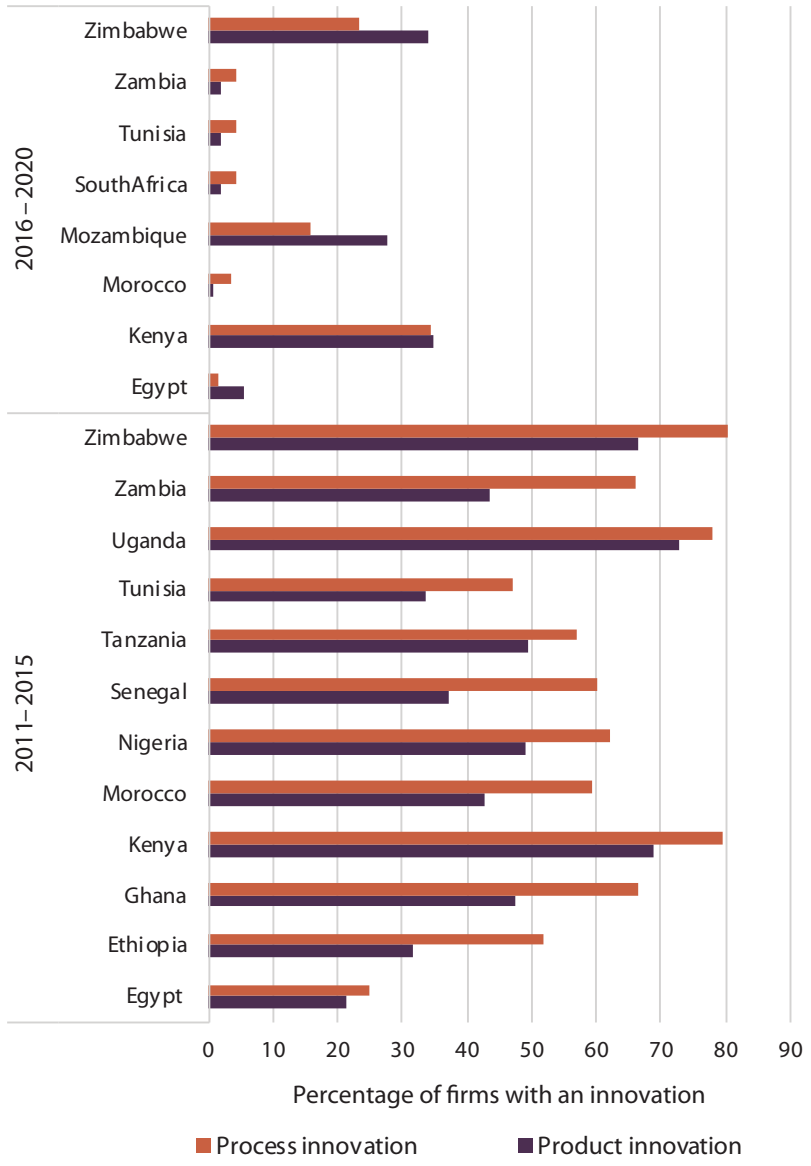
Third, the level of innovation in the African manufacturing sector is generally very low. Using H1, H5, and H8 as indicators, less than 35 percent of the firms have reported innovation and less than 20 percent of them have invested in R&D. These are formal firms, engaged in industrial food production to serve the rising African economies and middle-class consumers, and are expected to compete with global imports from Asia, Europe, and the United States. But they are not innovating enough to realize these expectations and opportunities. However, it should be noted that the level of firms' innovation varies across countries and sectors and over time.

Trends

Figure 7.2 shows the patterns of firms' innovation across 14 African countries, which are selected based merely on data availability and cover two periods of surveys. The figure presents the percentage of firms that adopted product and process innovations, as reported in the surveys conducted during the periods 2011–2015 and 2016–2020. The results show that the levels of both product and process innovations vary across countries and periods. Based on the first-period surveys, food processing firms in Kenya, Uganda, and Zimbabwe were more innovative than others. More than two-thirds of the firms in these countries reported the adoption of new products or processes—that is by far larger than the average of all firms' innovation, presented in Figure 7.1.

A more insightful observation from Figure 7.2 is that the level of innovation is declining markedly over time. Though the countries included in the two periods don't exactly match, we see a significant decline in the percentage of firms adopting

FIGURE 7.2—TRENDS IN INNOVATION IN AFRICAN FOOD PROCESSING FIRMS



Source: Authors' estimation based on the data described in the methodology.

new products and processes in the second period. A comparison of specific case countries reaffirms this assertion. For example, in all six countries (Egypt, Kenya, Morocco, Tunisia, Zambia, and Zimbabwe) for which we have two periods' data, the percentage of innovating firms has sharply declined. This is consistent with research by the African Center for Economic Transformation, which finds that the pace of technological upgrading has decreased in Africa each year since the early 2010s (Adhikary and Floyd 2021).

One possible reason for the declining of innovation over time could be the history of firms' entry. According to Sonobe and Otsuka (2011), when firms start new businesses, they adopt the best available innovation and then they keep using or producing the same innovation afterwards. Thus, the high rate of innovation in previous years, associated with the high level of economic growth witnessed in Africa, could be associated with the high rate of firms' entry in those years, and the lower rate of innovation in recent years could be associated with the lower rate of firms' entry in these years.

The Importance of Firm-Level Innovation in the Food Processing Sector

Innovations are key drivers of productivity and competitiveness (Cirera and Cusolito 2019; Dohnert, Crespi, and Maffioli 2017; McMillan and Zeufack, 2022). They help to improve value addition and expand markets. In this section we explore the role of product innovation for increasing the value added by processing firms and expanding markets through participation in international trade.

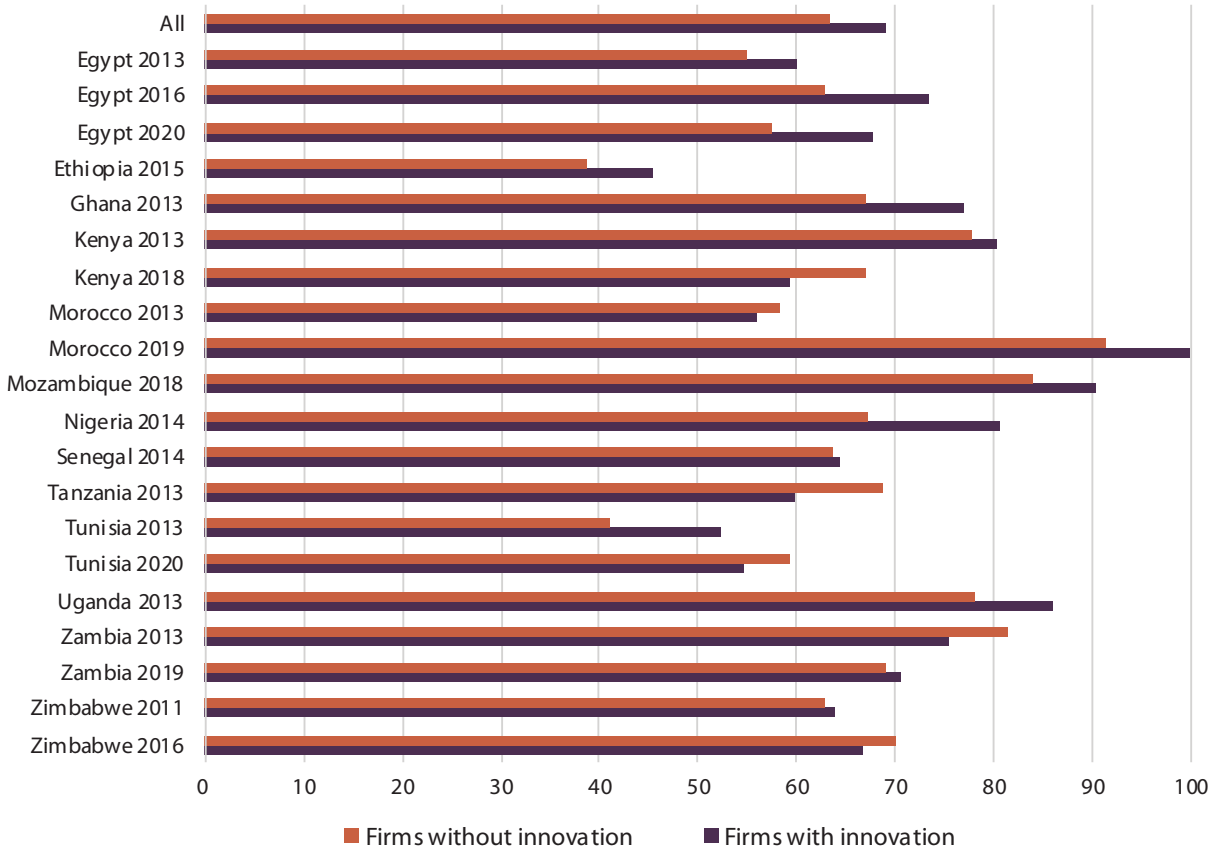
Firms' Value Addition

The role of innovation in firms' value addition is addressed here. The WBES includes questions related to total annual sales (TAS) and costs of raw materials and intermediate goods (CRI). Using these variables, the share of value addition (SVA) for a firm is calculated as

$$SVA_i = \frac{(TAS_i - CRI_i)}{TAS_i} 100$$

The average shares of value addition for firms with and without product innovations are shown in Figure 7.3. Of the 20 cases (by country and year), the average share of value addition is higher with innovation than without

FIGURE 7.3—THE AVERAGE SHARE OF VALUE ADDITION, PERCENTAGE



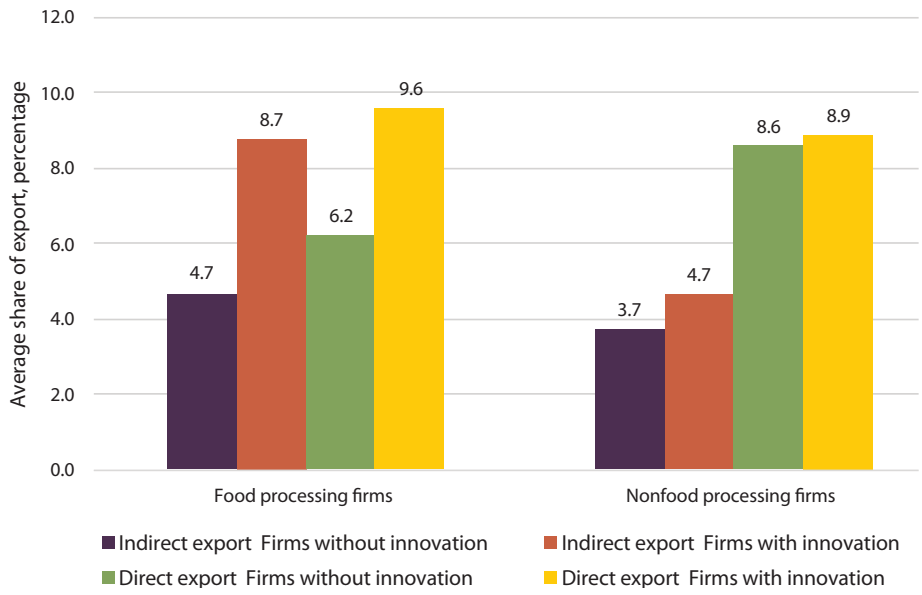
Source: Authors' estimation based on the data described in the methodology.

innovation in 14 cases. In total, firms with innovation add 5 percentage points more value than firms without innovation. In some countries, such as Egypt, Ghana, Nigeria, and Tunisia, the difference between the two exceeds 10 percentage points. In other countries, such as Ethiopia, Morocco, Mozambique, and Uganda, the differences range from 6 to 9 percentage points. All of these observations indicate the importance of firms' innovation for increasing value addition, which is usually positively associated with increased employment and competitiveness (Aiginger, Bärenthaler-Sieber, and Vogel 2013). The value addition effect of innovation may come either from a higher price premium or from a reduced cost of production for the new product.

Participation in Trade

To shed light on the impact of African food processing firms' innovation on trade competitiveness, we compare the average share of exports across food and nonfood firms (Figure 7.4). Firms export either directly or indirectly, the latter through contributing to the exports of other firms. The dataset has captured both possibilities. As shown in Figure 7.4, unlike the nonfood processing sector, the export share of firms with innovation is much higher than that of firms without innovation in the food processing sector. This is the case for both direct and indirect exports. While firms with innovation in the food processing sector exported 3.4 percentage points more than firms without innovation, firms with innovation in the nonfood processing sector exported only 0.3 percentage points more than firms without innovation. This finding suggests that firm-level innovation is more important in enhancing exports in the food processing sector than in the nonfood processing sector. Since most African countries' exports depend on agrifood products, it is not surprising to observe that innovation is critical for exports in this sector.

FIGURE 7.4—THE AVERAGE SHARE OF DIRECT AND INDIRECT EXPORT OF FIRMS WITH AND WITHOUT INNOVATION IN AFRICA

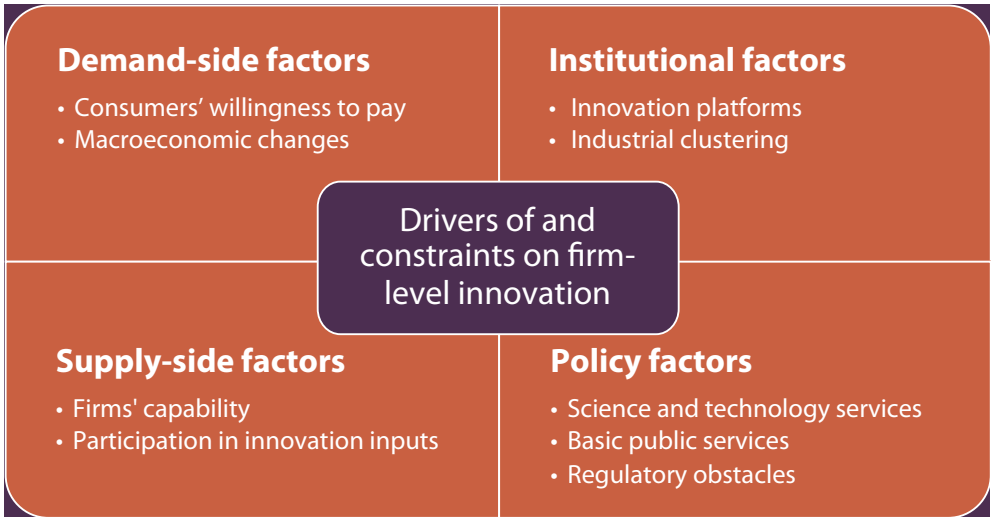


Source: Authors' estimation based on the data described in the methodology.

Drivers of and Constraints on Firms' Innovation

African firms face a variety of challenges that inhibit their innovativeness. Existing studies and practices define drivers of firms' innovation in less exhaustive ways, and hence they are unable to guide detailed and comprehensive analysis. The most widely used classification broadly categorizes drivers into internal and external factors (Hussen and Çokgezen 2020). Similarly, where innovation is looked at from a system perspective, drivers of innovation are distinguished based on whether they originate within or outside the firm's boundaries. More recent studies classify drivers as either firm capabilities or country characteristics (Paus, Robinson, and Tregenna 2022). Firm capabilities are represented by the firms' characteristics (size, age, ownership, and so on) as well as their participation in innovation inputs (investment in R&D, training, and assets), while the country characteristics are represented by macro-level performance indicators related to income level, GDP growth rate, investment ratio, and the like. Based on these and other dense conceptual and empirical literature (for example, Ayalew et al. 2020; Hussen and Çokgezen 2020) that looked at both internal and external factors as well as firm- and country-level factors, we propose a comprehensive typology that classifies innovation drivers into four broad categories (Figure 7.5). These categories capture internal as well as external factors, economywide as well as firm-level factors, and institutional as well as policy-level

FIGURE 7.5—DRIVERS OF AND CONSTRAINTS ON FIRMS' INNOVATION



Source: Authors.

factors. Three of the four categories are market-based drivers related to demand- and supply-side factors and the innovation system. The other category relates to government policy, which includes both public investments and regulations. Whereas the supply-side drivers mainly constitute factors internal to the firm, others constitute external factors.

Demand-side Factors

Demand-side drivers are economywide or country-level factors that create market opportunities for firms to invest and innovate. The demand for new products and services may arise from domestic or global consumers. However, since external trade in the African food processing sector is very limited, the demand for innovation should be derived from domestic consumers' demand for food quality, safety, convenience, and affordability. Therefore, the willingness of consumers to pay for these products and services is critical for firms to innovate. Consumers' willingness to pay (WTP) depends on several factors, including consumers' income and other macroeconomic structural changes, such as economic growth, urbanization, demography, literacy, and so on.

Consumer aversion to innovations in the industry could be a recipe for low consumer acceptance of innovation, and subsequently low WTP for innovation. Several empirical studies assessing the consumer WTP for innovations in the food processing sector exist. Food consumers are generally reluctant to accept substantially different new products, but acceptance depends on the product's attributes.

In Kenya, a study conducted to examine consumers' WTP for more advanced value addition in African indigenous vegetables also indicated that several socioeconomic factors and varietal attributes determine the WTP for value addition (Okello et al. 2015). Besides consumer age, gender, education, awareness of the selected value-addition techniques, and self-reported likelihood of purchasing value-added vegetables, WTP is affected by the vegetables' color, tenderness of leaves, and the washing off of soil.

Supply-side Factors

Supply-side drivers are firm-level factors related to firms' characteristics and business strategies. Characteristics such as the size of the firm, its age, leadership, and so on are critical drivers as they determine the capacity of the firm to innovate. Besides the firm's characteristics, its strategic choice to participate in innovation inputs (investment in R&D, training, technology transfers, building assets, and the like) is an important factor affecting its innovation.

Whether a firm is small or big, it sets strategies for producing and marketing its products and services. This strategic choice may create an opportunity or a challenge to innovate. Strategic choices that are important for innovation include investment in R&D, business openness, firms' specialization, and others. However, a firm's participation in innovation inputs is endogenous—that is, the probability of investing in R&D, using ICT, and so on may depend on the firm's characteristics (size, age, leadership, and others). Nevertheless, since innovation is a means to meet strategic objectives, participation in innovation inputs is critical for firms to innovate, second only to characteristics, which are widely discussed in many other studies.

Institutional Factors

With growing developments in innovation studies, a shift in the conceptualization of the drivers of firm-level innovation has been observed, with the current literature on firm-level innovations emphasizing the need to focus on the environment or system within which the firm operates. This has led to incorporating innovation drivers that are external, or outside the firm's boundaries. These drivers could be looked at from the perspective of the firm's interactions and collaborations with system or network actors and could be generally referred to as innovation systems that facilitate collaboration, learning, information sharing, and competition among firms and encourage them to either invent or imitate. They affect innovativeness through either reducing the cost of innovation or increasing the benefits of innovation. Innovation systems and industrial clustering are the two broadly defined institutional factors that are crucially important for driving firms' innovation.

The flow of technology and information among people, enterprises, and institutions is key for inventing as well as imitating innovations (Freeman 1995). Interactions between actors help to generate ideas and turn ideas into processes, products, or services. The easier the flow of information among consumers, traders, and other actors, the higher the probability that firms will understand the needs and demands of their potential customers. However, institutional platforms are needed for actors to meet or interact. Thus, the institutional structure of the economy, both formal and informal, has also been pointed to as a key driver of firm-level innovation (Hussen and Çokgezen 2020; Barasa et al. 2016). The innovation system is one of these institutional structures that would act as a system whereby actors interact to generate and share knowledge and experiences, and to create partnerships for innovation.

Edquist defined an innovation system as "a complexity of elements or components that work together, mutually condition and contract other complexes, each element having well-defined functions" (1997, 27). As there are diverse definitions of innovation systems, different types of innovation systems have also emerged over the years and include national, regional, and sectoral or technological innovation systems. A more practical and contemporary definition is given by the World Bank, which refers to the concept as a "network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect the system's behavior and performance" (World Bank 2006, 16).

All the definitions and theoretical explanations presented above imply the importance of networking and interactions for an effective innovation system. Therefore, an innovation system within the context of the food processing sector could be defined as the linkages (interactions) of processing enterprises with research centers, knowledge centers (such as universities and technical and vocational education and training institutions), raw material suppliers (such as farmers), product and service consumers, providers of services (such as banking, logistics, and so on), and quality and standards regulators. These interactions take place through innovation platforms, formal agreements with foreign companies for technology transfer, and (usually) industrial clusters and agro-industrial parks.

Industrial clustering helps not only innovation systems but also firms to be more innovative. According to Marshall (1920), industrial clusters have three advantages: (1) the ease of transaction among firms, (2) the development of a skilled labor market, and (3) the information spillover or the ease of imitation. All of these advantages affect firms' innovativeness in different ways. However, sometimes the direction of causality between industrial clustering and innovation becomes very subtle. Based on the works of Sonobe and Otsuka (2006, 2011, 2014), using roughly 20 case studies of industrial clusters in Asia and Africa, the association between clustering and innovation exhibits a sort of nonlinear relationship along industrial growth stages. These authors argued that industries usually pass through three stages: initiation, quantity expansion, and quality improvement.

At the initiation stage, when the industry is not yet set up, only innovative entrepreneurs start businesses in an industry. There is no cluster; only a few firms start to emerge as innovators. This is the stage in which demand is being created and hence only innovators appear in the industry, often referred as "pioneers." Hence, innovation happens without industrial clustering.

At the quantity expansion stage, firms are not yet clustered, and innovations are not very important to generate profit. Since the number of firms is few, new entrants can easily make a profit by producing the same product—that is, by imitating the products and services of the pioneers. This is the stage when clustering starts to emerge, but there is no innovation.

At the quality improvement stage, firms have to innovate to survive because this is the stage when the industry has a large number of firms and suppliers that drag profits down. Thus, firms must innovate to generate price premiums and profit for growth. If firms are able to innovate, the industry grows to the next stage. If firms fail to innovate, the industry remains stagnant. At this stage, the direction of causality between innovation and clustering is less clear. It is likely that they feed each other to maintain a well-developed and efficient industry.

On one hand, innovation helps to develop successful industrial clusters. Since the new, improved products are differentiated products, innovative firms must order product-specific parts and materials that have new ideas embedded in them. To protect new ideas, innovative firms must establish long-term subcontracts with dependable input suppliers, which will subsequently lead to the formation and growth of industrial clusters. On the other hand, clusters can help to encourage or discourage firms' innovation. Clustering affects innovation in different ways. First, the growing cluster leads to competition, and, amid limited industry profit, firms are subsequently forced to innovate. Second, clustering eases transactions between firms and leads to specialization. Specialization leads to innovation. Third, clustering leads to development of skilled labor markets, which creates opportunities for firms to access innovative workers. Fourth, clustering facilitates information spillover that leads to imitation. Imitation, however, may discourage innovation, and hence clustering may have negative effects on innovation (Sonobe and Otsuka 2011).

Through feedback between innovation and clustering, the industry continues to grow and maintains efficiency and competitiveness. Innovative firms will continue to form clusters. However, at this industrial growth stage the industrial cluster is characterized by vertical integrations of firms, each specialized with specific parts of a product (Sonobe and Otsuka 2011).

Policy Factors

Government policies are the fourth category of innovation drivers. Policies create incentives as well as disincentives for firms to innovate. Depending on their intentions and market friendliness, governments act on two types of policies, which might have varying effects on innovativeness. These are public services (investments) that aim to reduce transaction costs and promote firms' productivity and competitiveness, and government regulations that are critical to ensure that firms obtain the returns from and protection of their investments. Since public services aim at creating access for market services, they are more market friendly than regulatory policies, as the latter impose restrictions on markets. However, some regulatory policies (for instance, patent rights) could also improve market functioning, especially in areas where market failures are rampant. The effects of public services and regulations on firms' innovation are also different (Lundvall 2008).

Public services are soft and hard infrastructures that create a business-enabling environment for firms to innovate. Depending on the relevance for firms' innovation, they can be distinguished as services that have direct or indirect effects. Public services such as access to science and technology, innovation grants, access to skilled labor, and others are those that directly affect firms' innovativeness. The second type of public services are those indirectly related to innovation through creating access to services for the production and marketing of firms' inputs and outputs. Examples of public services that may indirectly affect firms' innovation include access to energy, finance, land, and so on. However, the importance of these public services is often overlooked in innovation analyses (Lundvall 2008).

Like public services, there are a number of regulatory policies that affect firms' innovation directly or indirectly. Regulations related to patent rights protection and licensing directly affect firms' investment to innovate. In areas where copying or imitation is widespread, firms may refrain from investing in R&D. Other regulations related to restriction of pricing and mark-ups, as well as labor regulations, indirectly limit firms' interest in efficiency and innovation. In areas where price mark-up is restricted, firms will have less incentive to invest in innovation. Likewise, in areas where firing and hiring of employees is structurally regulated, firms may not reward or punish employees based on their productivity and innovativeness (Cirera and Maloney 2017).

Public investment in science and technology that generates public knowledge and information is one of the critical policy instruments that many governments use to incentivize firms' innovation. Knowledge and information exchange is a key component of the innovation system approach, which stipulates the flow of knowledge and information as a key driver of the innovative process and outlines four types of such flows: interactions among business enterprises, interactions between enterprises and research and public institutions, diffusion of information and technology to enterprises, and movement

of personnel within and between private and public sectors. A combination of these knowledge and information flows in any industry is expected to result in high levels of technical collaboration, technology diffusion, and personnel mobility, thereby increasing the innovative capabilities of the firms in the system (OECD 1997). The seminal work of Cohen and Levinthal (1990) illustrated that knowledge accumulation increases the ability of firms to identify and integrate new ideas, as well as their ability to convert this knowledge into further innovations. One avenue for knowledge accumulation and dissemination is through public investment in science and technology.

A study by Cohen, Nelson, and Walsh (2002) assessed how public research influences the R&D of manufacturing firms in the United States. The study found that research findings from public institutions contribute to the development of new R&D projects in industry as well as completion of existing projects (demonstrating both novel and incremental innovation). The study further identified published papers and reports, public conferences and meetings, informal information exchange, and consultations as the key channels through which information flows between these two innovation system actors. A study by Toselli (2017) analyzed the determinants of product and process innovation in relation to knowledge sources for Spanish agrifood manufacturing firms, finding that associate firms have an elevated probability of engaging in process innovation because of knowledge spillover from parent companies. In the developing countries context, Gorgoni and Pietrobelli (2010) reported an increase in the probability of innovation in Chilean meat sector firms with an increase in knowledge flows.

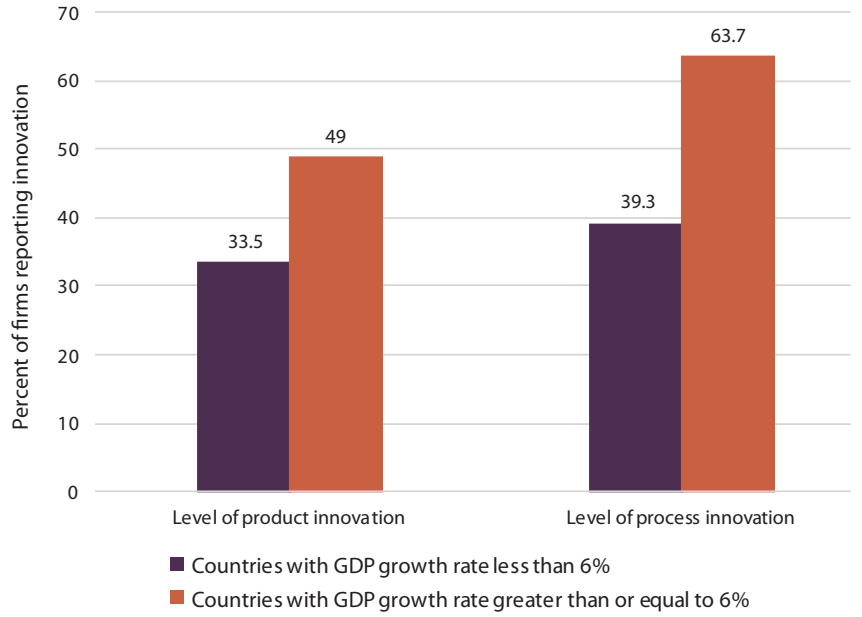
Empirical Evidence on Selected Drivers of Innovation

Economic Growth and Innovation

In addition to consumers' WTP, some macroeconomic structural changes, such as urbanization, demographic changes, economic growth, and others, may create opportunities for firms to innovate. Besides increasing consumers' WTP, such structural changes create additional demand for high-quality and convenient food products. Sustained economic growth, for example, may induce changes in food consumption behaviors and livelihoods that demand new products and services. This is particularly the case for food products whose major markets are domestic consumers. Our exploration of available firm-level innovation and national GDP growth data confirms the presence of an association between economic growth and firms' innovation in the African food processing sector (Figure 7.6).

Figure 7.6 presents the average economic growth rate and the level of firms' innovation in selected African countries. The average growth rate is estimated based on the five-year average growth rate of a country prior to the enterprise survey if firms respond to observed (lagged) income changes. The figure shows that those countries with higher economic growth in the past five years showed higher levels of firm-level innovation than countries with lower economic growth. On average, countries that had GDP growth rates of 6 percent or higher had 15- to 25-percentage-point higher shares of firms that adopted innovations than countries that had less than 6 percent growth rates. The difference is more

FIGURE 7.6—ECONOMIC GROWTH AND FIRM-LEVEL INNOVATION IN THE AFRICAN FOOD PROCESSING SECTOR



Source: Authors' estimation based on the data described in the methodology.

significant in process innovation than product innovation, consistent with the fact that unlike nonfood sectors, in the food processing sector, whenever consumers' income increases, the demand for new methods of delivery and services increases faster than the demand for new products. Hence firms implement process innovation at higher rates than product innovation.

Firms' Capability

Larger firms have been argued to be more innovative than smaller firms, as they benefit from economies of scale. Our data support this argument (Table 7.2). Larger firms are also likely to finance R&D and other complementary activities that could in turn increase their innovation performance. From a system perspective, larger firms are likely to have wider collaborations with other actors in the system, and because of increased interaction, increase their innovativeness (Tödtling, Lehner, and Kaufmann 2009). Some scholars have, however, suggested that these arguments may not hold for all firms, as the efficiency of firm-level innovation could be higher among smaller firms owing to their increased flexibility and reduced bureaucracy, among other factors (Hussen and Çokgezen 2020).

Regarding firms' age, older firms are expected to be more innovative than younger firms. It is expected that older firms have taken time to build their experience, knowledge, and entrepreneurial flexibility to a level where they are comfortable enough to take risks and make decisions to innovate (Hussen and Çokgezen 2020). This argument particularly holds where firms are involved in incremental innovation as opposed to novel innovations. Some scholars, such as Akcigit and Kerr, have, however, contested this argument, indicating that younger firms may be more innovative as they "enter the market with new technologies and apply exploratory R&D, mainly in the case of radical innovation" (2018, 33). The ownership structure of a firm has also been considered as a driving force for firm-level innovation, with some scholars arguing that government-owned firms are more likely to engage in innovative activities due to their access to resources, while others postulate that managers of government-owned firms lack motivation, a quality that could hinder them from seeing the need to engage in innovative activities (Lööf 2009).

Human capital has also been identified as a key driver of firm-level innovations in current industries, with the relevance of its endowment being emphasized even in cases where a firm is engaged in imitating, or implementing technologies and products that already exist somewhere else (Khatiwada and Arao 2020). Firms have various ways of acquiring human capital, the key ones being through formal education, in-firm training, and building up experience of workers within the firm. Studies have shown that simultaneously engaging in R&D and worker training significantly increases the likelihood of innovating (González, Miles-Touya, and Pazó 2016). Likewise, an increase in the proportion of skilled workers in a firm increases the likelihood of both process and product innovation, as shown in a study by Dohnert, Crespi, and Maffioli (2017).

For small food processing firms, as most African firms are, the characteristics of the top managers are also key drivers of innovation (Diederen, Meijl, and Wolters 2000). Data presented in Table 7.2 show the role of the gender and experience of the top manager for innovativeness. Firms with female and young managers are more innovative than firms with male and experienced managers.

Investing in R&D

There is little doubt on the role of R&D for innovation, though it is not the only option for innovating. Figure 7.7 shows the percentage of African food

TABLE 7.2—PERCENTAGE OF FIRMS THAT HAVE INNOVATED, ACROSS FIRM SIZE AND LEADERSHIP CHARACTERISTICS

	Product innovation	Process innovation
Firm size (number of employed people)		
Small (< 20)	21.7	28.3
Medium (20–99)	28.6	33.6
Large (100 and over)	48.3	45.6
Gender of top manager		
Female	32.4	37.1
Male	29.6	33.5
Experience of the manager		
10 years and less	34.3	40.3
More than 10 years	27.9	31.3

Source: Authors' estimation based on the data described in the methodology.

processing firms that have innovated with and without investment in R&D. More than two-thirds of the firms that invested in R&D have been able to innovate, while only one-fifth of the firms that did not invest in R&D were able to innovate. This finding is consistent with a recent study that demonstrated that in developing economies, capital investment and training are just as important to innovation activities as R&D spending (Paus, Robinson, and Tregenna 2022).

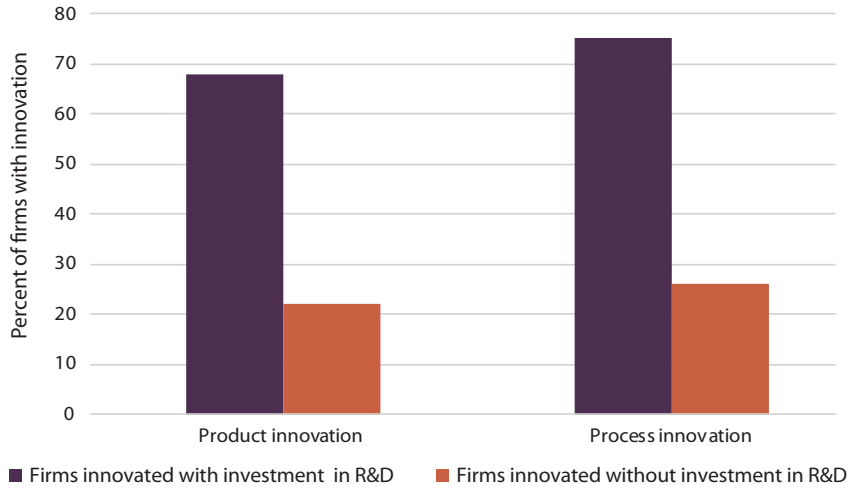
Investing in R&D seems more important for creating new products than it is for creating new processes. However, we noted two important perspectives. First, a significant number of firms (25 to 32 percent) that invested in R&D did not innovate any new product or process, implying that the investments have not yet been translated into innovations. This raises a concern about the productivity of R&D investments in the African food processing sector. Second, the percentage of firms investing in R&D has been declining over the years (Figure 7.7).

As shown in Figure 7.8, of all food processing firms surveyed during 2011–2015 in Africa, about 24 percent have invested in R&D, a much higher rate than that of the firms surveyed in 2016–2020. Africa-wide, the percentage of firms investing in R&D has declined by about 15 percentage points. The result is consistent across countries for which we have comparable datasets in the two periods. Of the six countries for which we have two periods' data, the percentage of firms investing in R&D has declined in all (Figure 7.8).

Technology Transfer from Foreign Companies

Despite several arguments for innovations in developing countries to be based on knowledge diffusion and absorption instead of investing in R&D, so as to reap the benefits of catching up through adoption and transfer of international technologies, our data show that the extent of technology transfer in the African food processing sector has remained very low. Of the 4,227 African food processing firms surveyed since 2006, only 13 percent have formal agreements for technology transfer with foreign companies. However, the data display a strong association between technology transfer and firms' innovation (Figure 7.9). Firms that have technology transfer agreements with foreign companies have a higher probability of innovation than firms without such an agreement. For instance, 56 percent of firms with

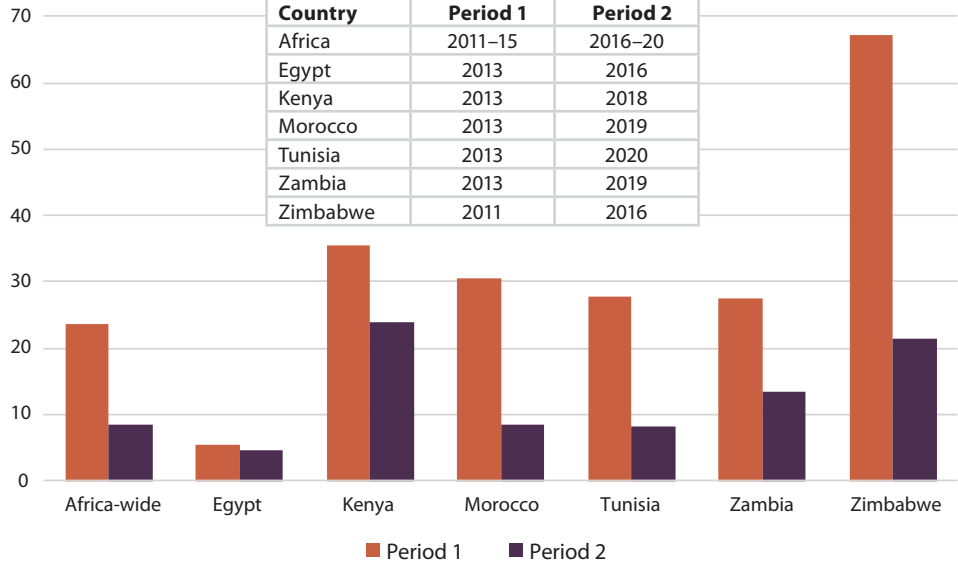
FIGURE 7.7—RATE OF INNOVATION WITH AND WITHOUT R&D



Source: Authors' estimation based on the data described in the methodology.

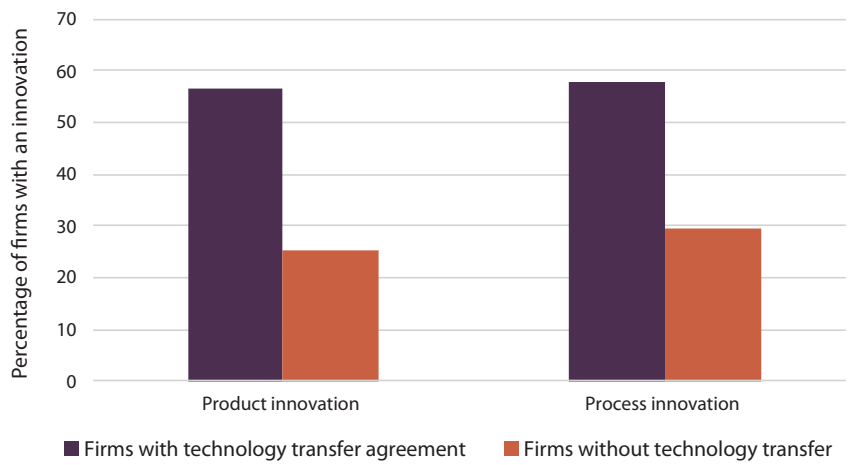
FIGURE 7.8—CHANGES IN PERCENTAGE OF FIRMS INVESTING IN R&D

Country	Period 1	Period 2
Africa	2011–15	2016–20
Egypt	2013	2016
Kenya	2013	2018
Morocco	2013	2019
Tunisia	2013	2020
Zambia	2013	2019
Zimbabwe	2011	2016



Source: Authors' estimation based on the data described in the methodology.
Note: Africa-wide includes other countries, which are listed in Table 7.1.

FIGURE 7.9— THE RATE OF INNOVATION WITH AND WITHOUT TECHNOLOGY TRANSFER



Source: Authors' estimation based on the data described in the methodology.

TABLE 7.3—MARGINAL EFFECTS OF INDUSTRIAL GROWTH STAGE ON FIRMS' INNOVATION IN AFRICAN MANUFACTURING AND SERVICE INDUSTRIES

Industrial growth stage (ref = initiation stage)	(1) Product innovation	(2) Process innovation	(3) R&D spending
Emerging stage (Quantity expansion stage)	0.027* (0.015)	0.022* (0.013)	0.015 (0.010)
Maturation stage Quality improvement stage)	0.059*** (0.017)	0.054*** (0.016)	0.006 (0.011)

Source: Saki and Tadesse (Forthcoming).

Note: Numbers in parentheses are standard errors. * and *** represent 0.1 and 0.01 levels of significance, respectively.

technology transfer agreements have innovated new products, which is twice the rate of firms without formal technology transfer agreements.

Vertical Coordination and Innovation

Firms' involvement in vertical supply chains is critical for innovation. It helps to ensure an adequate, high-quality, and timely supply of raw materials for food processing. Studies on the role of vertical coordination for innovation are scant. However, a few existing case studies indicate that though the linkages are critical for facilitating innovation, the level of enterprises' participation in these innovation platforms (linkages) is very low. Box 7.1 describes the performance and role of vertical coordination for innovation in the Ethiopian brewery industry. A series of studies conducted on the role of vertical coordination for breweries and malt barley producers indicate that there are options whereby the brewery companies can benefit through a quality input supply that helps them develop new products and brands (see Box 7.1).

Industrial Clustering

Empirical studies on the role of clusters suggest that the effect of clusters on firms' innovation is positive and significant. A study by Fang (2019) found that in the US manufacturing sector, the citation-weighted number of patent applications for firms in a cluster is 17.6 percent higher than that of firms outside of a cluster. A recent cross-country analysis in Africa indicated that most industries in Africa are at the emerging (quantity expansion) stage and thus continue to experience a rise in the number of firms (Saki and Tadesse, forthcoming). With respect to the relationship between innovation and industrial clusters, although a generally low level of innovation was observed in this study and there was no significant association between spending on R&D and industrial clusters, the findings showed that industrial clustering is an important driver of firms' product and process innovations in Africa (Saki and Tadesse, forthcoming). The study further indicated that firms in a mature (quality improvement stage) industry are more innovative than firms in the initiation and emerging (quantity expansion) industrial growth stages (Table 7.3). Table 7.3 shows that firms in the quality improvement stage have a 5.9-percentage-point higher probability of innovating than firms in the initiation industrial stage. The differences in firms' innovativeness between the emerging and initiation stages are barely significant.

BOX 7.1—VERTICAL COORDINATION AND INNOVATION IN THE ETHIOPIAN BREWERY INDUSTRY

Driven by rising incomes and urbanization, the market for beer in Ethiopia is booming. A series of studies conducted by Tefera and Bijman (2019, 2021) and Tefera, Bijaman, and Slingerland (2020) have indicated that the Ethiopian brewery industry is responding to the emerging high demand for beer through attracting multinational companies and innovating several institutional arrangements to secure improved and diversified beer production. The total beer consumption in the country has increased from 1 million hectoliters in 2003 to 11.7 million hectoliters in 2017, an annual growth rate of 20 percent (Tefera, Bijman, and Slingerland 2020). This has attracted many international brewing companies, including Heineken and Diageo (Meta-Abo), to invest in brewing and local sourcing of malt barley from smallholders using vertical coordination. Unlike the conventional direct contractual arrangements between farmers and producers, the vertical coordination model initiated by these companies is facilitated by producer organizations (POs), nongovernmental organizations (NGOs), and lead farmers who serve as intermediary actors between the breweries and malt barley producers. The intermediaries sign contracts with breweries to supply a specified quality of malt barley as well as with individual farmers to deliver malt barley that fulfills the quality requirements. They also facilitate input supply, provide technical assistance, and arrange logistics and aggregation of the produce. The farmers, in return, receive price premiums and improved seeds from the breweries.

The experience of these companies suggests that vertical coordination through contractual arrangements was very effective in meeting the supply of expected quantities with better-quality malt barley. While Heineken has managed to fully aggregate the contracted quantity, Diageo has collected more than 90 percent of its contracted malt barley supply (Tefera, Bijman, and Slingerland 2020). Contractual breach, which is a widely recognized problem of linking processing enterprises with growers in Africa, was not an issue in this case. The intermediation of POs, NGOs, and lead farmers might have contributed to the successful contractual system. Indeed, the impact of POs, specifically cooperatives, has been significant in promoting industrial innovations by linking producers with processors (Tefera and Bijman 2019). The vertical coordination has helped the brewery companies not only to reduce transaction costs but also to secure quality raw materials to produce quality and differentiated beers.

The reliable supply system through vertical coordination creates incentives for the breweries to invest in product and process innovations. Therefore, brewing enterprises engaged in vertical coordination have shown a higher chance of performing, in terms of innovation and other performance indicators, than enterprises that have not yet participated in the contractual vertical coordination system. Though causality cannot be claimed with these data, the two companies that have participated in the vertical coordination contracts have developed more brands than others. Both Heineken and Diageo have developed more than four brands each, while other companies developed only two or three brands. In terms of market shares, Heineken and Diageo account for 28 and 12 percent of the Ethiopian beer market, respectively (Tefera, Bijman, and Slingerland 2020).

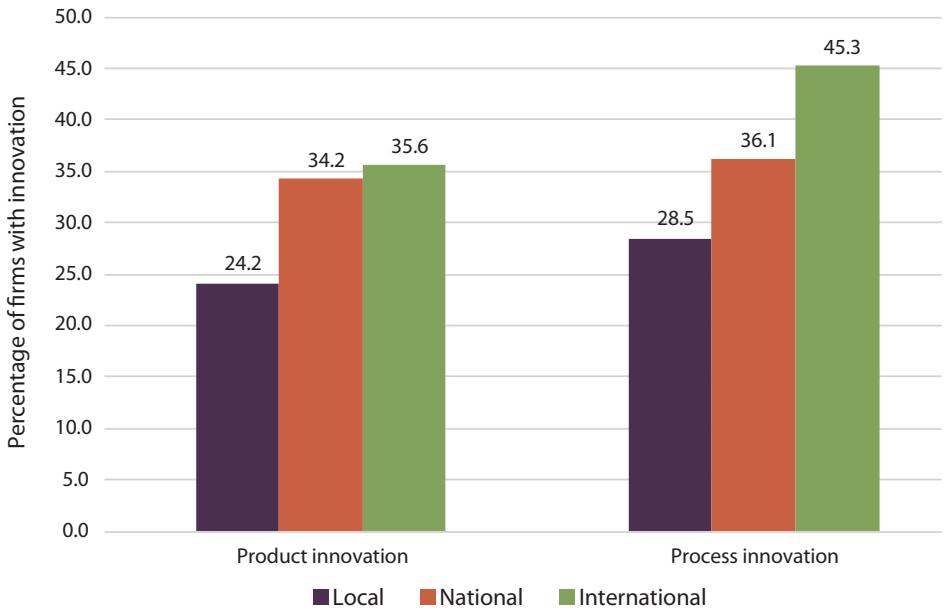
Contrary to popular belief, vertical coordination has also helped smallholder producers to significantly improve their malt barley production, intensification, commercialization, and quality (Tefera and Bijman 2021), which will further improve the innovativeness of the brewery companies in the long run. Therefore, vertical coordination with intermediaries in the Ethiopian brewery industry is a success that can be advocated and scaled up as the best and most innovative approach for reducing contractual breaches as well as expanding innovation in the African food processing sector.

Source: Compiled from Tefera, Bijaman, and Slingerland (2020), Tefera and Bijman (2019), and Tefera and Bijman (2021).

Market Competition

A firm's level of innovation can also be determined by the structure of the market from which it acquires its inputs and to which it sells its output (Hussen and Çokgezen 2020). The level and type of competition has been highlighted as a key factor when assessing the role of market structure in driving firm-level innovation. Competition and technological opportunities vary by product market and can directly influence decisions on innovation activities and investments (OECD and Eurostat 2018). Both the innovation system approach and the industrial clustering approach underline the importance of competition in motivating firms to innovate, generate price premiums, and survive in the industry. Using the type of market to which firms sell their main output, we explored the importance of competition for innovation.

FIGURE 7.10—THE RATE OF INNOVATION OF FIRMS SELLING IN LOCAL, NATIONAL, AND INTERNATIONAL MARKETS



Source: Authors' estimation based on the data described in the methodology.

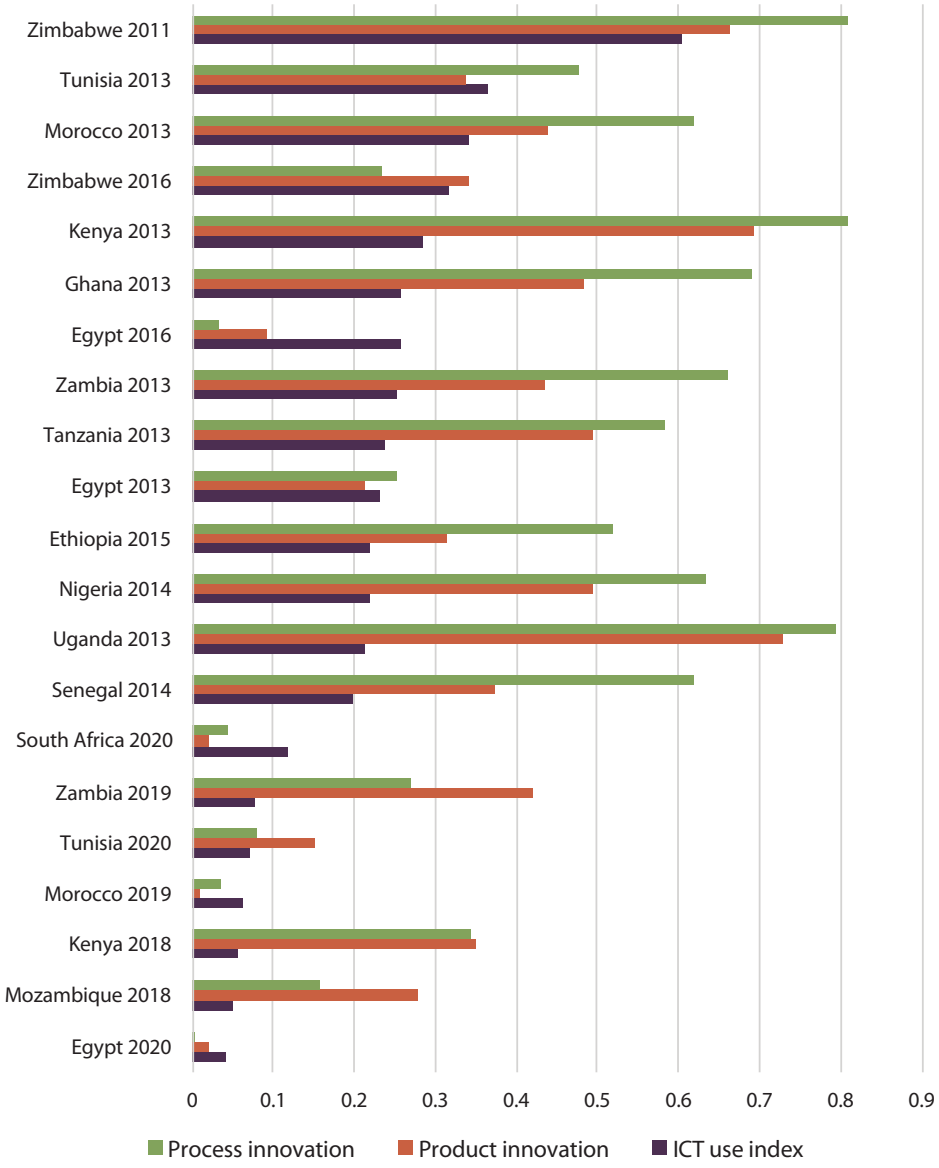
Figure 7.10 shows the percentage of firms that reported product and process innovation whose major markets for their products are local, national, or international. Assuming that international markets are more competitive than national and local markets, it seems that competition has indeed forced firms to innovate. However, the effect appears to be higher on process innovation than on product innovation (Figure 7.10). Firms that sell their products mainly in international markets innovate at rates that are 17 and 9 percentage points higher than firms that mainly sell in local and national markets, respectively. This is consistent with our expectation that process innovations are essential to be more competitive in larger international markets through reducing costs and improving efficiency. Consumers' WTP might be more important than the size of the market for product innovation.

ICT and the Innovation of Firms

A typical public service pertinent to innovation is access to ICT, which facilitates firms' innovation through easing communications, fostering the accumulation of knowledge, and creating innovation platforms. ICT is commonly considered an input for product innovation (Spiezia 2011). It helps firms interact with trade partners and solicit their needs as well as acquire knowledge for innovations. It also allows firms to invent ICT-based products and services. Innovations related to e-commerce platforms and delivery systems are easier if firms have access to reliable and low-cost ICT services. With these premises in mind, we explored the extent of ICT use by African food processing firms and its association with firms' ability to innovate.

Figure 7.11 shows the average ICT use index of food processing firms across countries in ascending order from left to right. The ICT use index is calculated based on seven firm-level indicators: (1) use of email, (2) owning a website, (3) access to broadband internet, (4) use of internet for purchasing, (5) use of internet to deliver services, (6) use of internet to do research and develop ideas, and (7) overall access to telecommunication services. All of these indicators take a value of 1 if the firm responded Yes to the question about access and 0 if the response was No. The total value of the index is normalized from 0 to 1, by dividing by 7.

FIGURE 7.11—ICT USE AND RATE OF FIRMS' INNOVATION



Source: Authors' estimation based on the data described in the methodology.

The result, in Figure 7.11, shows that the use of ICT by African food processing sectors is generally very low. The maximum value of the ICT use index is 0.8, which was reported in the Zimbabwe survey in 2011. Irrespective of the extent of firms' use of ICT, we compared how the ICT use is associated with firms' ability to innovate. The results suggest that as the ICT use index increases, the proportion of firms innovating increases (Figure 7.11). This suggests that though the level of ICT access and use by African firms is low, it plays a role in innovation, and public support is needed to enhance ICT services so as to encourage firms' innovativeness. Of the seven ICT services, access to broadband internet and overall access to telecommunication are key services that require the attention of the government more than the other indicators. The other indicators are partly associated with the internal capacity of the firms.

Access to Public Services and Firms' Innovation

Some public services affect firms' innovation indirectly through their production inputs and outputs. The basic argument is that firms' efforts to innovate and become efficient depend on the business-enabling environment. In many instances, in areas where the business-enabling environment is conducive, firms may tend to be innovative. However, in some instances, firms could also be innovative in areas where business obstacles are still significant. A recent study on the links between business obstacles (due to limited access to public services) and firm-level innovation in Africa has shown that the effect of access to public services depends on context and could be negative (Tadesse, Gachango, and Gwatidzo 2022).

Contrary to the authors' expectation, the econometric results suggest that firms that were affected by power outages were more likely to innovate. Both the incidence of power outages and firms' identification of access to electricity as a major obstacle have positive and significant effects on all three innovation indicators (Table 7.4). The same applies to those that consider access to finance to be a major obstacle. This has been interpreted as indicating that firms in Africa are innovating as a strategy to cope with business obstacles, rather than to enhance competitiveness (Tadesse, Gachango, and Gwatidzo

TABLE 7.4—EFFECT OF BUSINESS OBSTACLES (ENERGY, FINANCE, AND MARKET) ON THE LIKELIHOOD OF FIRMS TO INNOVATE

Business obstacle	Product innovation	Process innovation	Investment in R&D
Power outages, past year	0.486*** (0.054)	0.381*** (0.061)	0.303*** (0.078)
Number of power outages	0.002 (0.002)	0.000 (0.002)	0.002 (0.002)
Power outage duration	0.001 (0.001)	0.001 (0.001)	-0.004 (0.003)
Electricity as major obstacle	0.241*** (0.040)	0.247*** (0.043)	0.196*** (0.056)
Finance as major obstacle	0.067* (0.040)	0.118*** (0.043)	0.036 (0.056)
Secured government contract	0.319*** (0.047)	0.292*** (0.049)	0.374*** (0.063)

Source: Tadesse, Gachango, and Gwatidzo (2022).

Note: Business obstacles were estimated separately in each innovation regression model; they were not all entered simultaneously. However, other control variables related to firm characteristics were included in the models.

*, **, and *** represent 0.1, 0.05, and 0.01 levels of significance, respectively.

TABLE 7.5—RATE OF INNOVATION FOR FIRMS THAT REPORTED REGULATIONS AS MAJOR AND MINOR OBSTACLES

Extent of obstacle	% firms reporting product innovation			% firms reporting process innovation		
	Court system	Customs and trade regulations	Labor regulations	Court system	Customs and trade regulations	Labor regulations
Not an obstacle	30.40	28.00	30.11	31.07	29.29	30.53
Minor obstacle	39.11	36.52	37.70	38.82	36.88	37.00
Moderate obstacle	35.55	37.28	34.32	35.14	37.82	35.00
Major obstacle	33.39	41.11	33.86	31.97	37.90	32.27
Very severe obstacle	41.93	42.87	33.69	42.20	41.27	36.68

Source: Authors' estimation based on the data described in the methodology.

Note: The percentage shows the number of firms that reported innovation out of the number of firms that gave each response.

2022). Unfortunately, such innovations may not lead to competitiveness. They remain as adaptation options rather than as a long-term strategy for enhancing economywide efficiency and global competitiveness. Table 7.5 also shows that secured market access in the form of government contracts has shown strong and positive effects on firms' innovation. As argued above, secured demand for firms' products encourages firms to invest in innovation.

Regulations and Firms' Innovation

Besides public services, regulatory policies play a role in motivating or discouraging firms to innovate. For example, the effectiveness of the court system matters for firms to protect their inventions and appropriate the entire benefits. In many African countries, regulatory policies to protect patent rights are in place with clear legal provision for firms or individuals to privately own their inventions (Aubert 2010). However, the capacity of courts is very limited and unable to enforce such rights. Other regulatory policies such as trade, customer, and labor regulations could also discourage firms' interest in innovating. Table 7.5 presents the percentage of firms that have reported innovation across their responses on the extent of these regulatory obstacles. However, none of these obstacles seem detrimental for firms' innovation in the food processing sector: in general, the rate of innovation appears higher among firms that see regulations as larger obstacles (Table 7.5).

Conclusion and Policies for Enhancing Innovation

Within the context of the African agrifood processing sector, firm-level innovations should be defined to broadly encompass high (transformational and high-tech) and low (simple methods or redesigned products) technology innovations, invented and imitated innovations, and innovations for improving the firms' product, process, marketing, and organizational performance. However, even within this broader definition, the level of innovation measured by the numbers of firms that reported

innovation in the sector is generally low: only one-third of the sample firms reported any innovation. To make matters worse, the level of innovation is declining over time. However, the descriptive analysis reaffirms the importance of innovation for increasing firms' participation in global and regional trade and for increasing firms' value addition. All of these findings suggest the strong need for government intervention to create incentives and build an enabling environment.

As an attempt to identify priority areas for public interventions, the chapter examines drivers of and constraints on innovation. A conceptual framework that constitutes a broad range of drivers and economywide as well as firm-, market-, and policy-level factors is proposed and discussed. Existing evidence is reviewed, and available data are used to explore the empirical association of selected innovation drivers with firms' innovation. Based on these conceptual and empirical discussions, we learn that strengthening innovation systems that facilitate linkages, competition, and cooperation among firms and innovation system actors is very critical. Furthermore, building the financial capacity of emerging food processing firms, the majority of which are small and medium enterprises, is essential to enhance their access to foreign technology and allow them to invest in innovation. Technology transfer agreements, vertical coordination, and industrial clustering help facilitate interactions, learning, and cooperation among value chain actors, not only to generate new ideas but also to collectively invest in innovation development.

Infrastructural services such as ICT and energy supply services that directly and indirectly create incentives and reduce costs are also priority areas to guide firms' innovativeness and response to emerging opportunities. The expansion of low-cost ICT services appears to be very critical for product and process innovations, particularly for the food processing sector, as it entails several precautionary activities (packing, ensuring safety, delivering, tracing, and so on) that could be supported by digital platforms. Access to ICTs not only helps firms to interact with trade partners but also allows firms to invent ICT-based products and services. However, regulatory obstacles are not yet very determinantal for African food processing firms, as these firms are not yet inventing advanced innovations that demand regulatory protection.

In line with these findings, the following priority policy actions are proposed. First, African governments that would like to enhance the competitiveness and innovativeness of the food processing sector should prioritize strengthening the innovation system through vertical and horizontal integration in the form of foreign technology transfer, contract farming, and industrial clustering over innovation-related regulatory policies. Second, public investment for enhancing innovativeness in the food processing sector should focus on expanding low-cost ICT services that facilitate the adoption of product and process innovations, particularly for the food processing sector, as it requires several precautionary activities (packing, ensuring safety, delivering, tracing, and so on) that could be supported by digital platforms. Third, to enhance the effectiveness and inclusiveness of public capacity-building activities, they should target firms with female and young top managers, as well as small and medium enterprises, which have limited access to foreign technology and invest very little.