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Relationship between innovation, regional institutions and firm performance: Micro-evidence from Africa*

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The main aim of this paper is to examine empirically the extent to which firm-specific action, innovation, and an external factor, the quality of regional institution, affect firms' productivity. To this end, a firm-level dataset from 15 African countries was used and the three-step CDM approach was employed to estimate the relationship. The empirical results of the study highlight that firms that invest in R&D are more innovative and innovative firms are more productive, indicating the importance of innovation for firms' productivity. In addition, regional institutional quality has a significant positive effect on productivity, particularly for firms at low productivity distribution. Therefore, improving the quality of regional institutions, in addition to promoting R&D and innovation, is essential to enhance the productive capacity of firms in Africa. The present study contributes to the existing literature by providing new empirical evidence on the role of regional/local institutions on firm productivity for a region, Africa, which needs productivity enhancement the most. It is also recommended that further studies, similar to this one, should be carried out in order to better understand the topic in the context of African firms.

Keywords: innovation, productivity, regional institutions, CDM model, Africa

JEL Classification: L26, O31, D24

Introduction

After a long period of economic stagnation, African countries have registered rapid economic growth in the last two decades. Between 2000 and 2019, the average annual real GDP growth of African countries was 4.5%, about 50% higher than the world average, which was 3.1%. Despite the satisfactory growth rate, Africa confronted numerous formidable challenges. First, an average individual in Africa still received a per capita GDP six times lower than the world average in 2018.[1] Second, the growth pattern has not been even across countries. While countries such as Ethiopia, Rwanda and Tanzania have registered remarkable growth performance, the growth rate of others such as Zimbabwe, Burundi, and Central African Republic was nearly zero. Third, Africa still constitutes the largest percentage of the poor in the world. According to FAO (2017) report, a third of the African population is still extremely food insecure, which is four times higher than other parts of the world, and seven out of ten countries with the largest extreme poverty population are in Africa. It is with this reality that African countries set out an ambitious goal of a poverty-free Africa in 2030 and Agenda 2063.[2] The question of how these goals can be achieved and lift millions of Africans out of poverty has been the main concern of international organizations, policymakers, and the research community.

It has been acknowledged by the researchers that productivity growth at the firm level is not only essential for long-term economic growth and job creation but also for poverty reduction. For instance, UNCTAD (2015) suggested that enhancing the productivity of firms is one of the mechanisms through which developing countries can achieve sustainable industrial development and growth. Likewise, numerous theoretical and empirical studies have indicated that the contribution of total factor productivity (TFP) to economic growth is higher than the combined effect of factors of production (Beugelsdijk, Klasing, and Milionis 2018; Mohnen and Hall 2013). It is probably for this reason that recent growth theories mainly concentrated on the question of what explains productivity growth than the growth itself. Productivity growth can also contribute to poverty reduction. When goods are produced with more efficient technologies, prices of goods and services decline, the purchasing power of the poor increases; accordingly, the well-being of the people improves (Cirera and Cusolito 2019). Therefore, it can be stated that Africa's quest to meet the above-mentioned goals necessitates sustained improvement in the productive capacities of its firms. It has even been argued that policymakers in Africa should prioritize productivity-enhancing mechanisms rather than investment (Asongu and Acha-Anyi 2020).

Over the past three decades, several attempts have been made to search for factors that influence firms' productivity. Traditionally, it has been suggested that productivity growth originates from firms' specific action, innovation. In this regard, the endogenous growth theory of Romer (1990) suggested that the economic system in which a firm is operating determines incentives for involvement in innovative activities and that innovations in turn promote TFP. Ample studies have provided empirical support to Romer's work by confirming the critical role of innovation in enhancing productivity

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(Baumann and Kritikos 2016; Crespi and Pianta 2008; Crespi and Zuniga 2012; Crowley and McCann 2018; Geroski 1991; Hall and Sena 2017). This line of work also demonstrated the importance of policies that promote innovation like R&D expenditures and well-protected property rights.[3]

Despite the overwhelming consensus on the importance of innovation in the economic literature, empirical studies in developing countries have been unable to draw any firm conclusions regarding the magnitude of its impact (Benavente 2006; Goedhuys, Janz, and Mohnen 2008; Waheed 2017). Firms in developing countries, especially in Africa, operate in a different institutional and marketing environment (Avenyo et al. 2020; Saka-Helmhout 2020; Mlozi et al. 2018); therefore, it is likely that the nature of innovation and its link to productivity differs from developed countries. For instance, although firms do innovate, they encounter institutional and resource obstacles in translating the innovation output into productivity. Therefore, there is a need to conduct further empirical investigations using a large dataset from African countries.

Besides innovation, recent studies have revealed that higher level of productivity is also associated with higher-level institutional quality (Goedhuys and Srholec 2015; LiPuma, Newbert, and Doh 2013). In these studies, institutions are defined as the 'rules of the game' which shape incentive structure and accordingly peoples' behaviour and, in turn, determine how opportunities and resources will be allocated in an economy. These studies, however, distinctly focus on institutions at national level than at sub-national level, assuming that institutional quality is the same in various regions within a country. As evidenced by Bennett (2019), Lasagni, Nifo, and Vecchione (2015), and Lee and Lee (2018), each regional/local government formulates rules and regulations of transactions that exert influence on firms' performance. Compared to the importance given to institutions in the literature, there has been little empirical evidence as to whether and to what degree regional institutional quality affects firms' productivity.

It is against this background that the present study aims to address the following main research questions: (i) Are innovative firms more productive than non-innovators? If so, which type of innovation is more important? (ii) Does the quality of regional institutions impact firms' productivity? (iii) Does the return of innovation and regional institutions vary at different levels of productivity distribution? These research questions are important for several reasons. First, they are rarely discussed in the context of African countries. Second, answers to these questions allow us to compare the findings of studies on developed countries with developing countries and to decide whether generalization of these results to other parts of the world is appropriate. Third, the answers may provide insights that policymakers can use for strengthening the region's efforts to escape from low-productivity traps.

For this purpose, we used a firm-level data from the World Bank Enterprise Survey (WBES) of 15 African countries and the three-step CDM model to estimate the relationship. A regional institutional indicator is constructed for each region in our sample based on the perception of firms regarding corruption, regulatory quality, and rule of law. The results of our empirical investigation support the hypothesis that firms that invest in R&D are more innovative and innovative firms are more productive. Furthermore, in addition to innovation and other conventional factors, regional institutional quality significantly affects firms' performance, particularly for firms at low productivity distribution. Therefore, our empirical findings suggest that improving the quality of regional institutions, in addition to promoting R&D and innovation, is essential to enhance the productivity of firms in Africa.

The present paper contributes to the existing literature in several ways. First, although plenty of works have been carried out on the impact of innovation and institutions in recent decades, the number studies on Africa, the region which needs productivity enhancement the most, is still very limited. This paper aims at filling this gap by providing evidence for a larger set of African countries. Second, the present study contributes to the existing literature by providing new empirical evidence on the role of regional/local institutions on firm productivity. The vast majority of previous studies treat countries as homogeneous units and assume that quality of institutions is the same all over a country. However, most recent studies show that quality of institutions and accordingly productivity of the firms vary across a country (Bennett 2019; Lasagni, Nifo, and Vecchione 2015). To the best of our knowledge, this is the first study in the literature to investigate the nexus between regional institutions and productivity, by focusing on a sample of African firms. Therefore, this paper helps us to improve our understanding of this rarely examined issue. Third, by applying quintile regression for the productivity equation at the last stage of the analysis, we provide empirical evidence that the effect of regional institution varies across different productivity distribution.

The remainder of the paper organized as follows: Section two provides a review of literature on the topic while section three discusses the empirical methodology and data. Section four presents empirical results of the study and section five discusses the empirical results in line with the objective of the study. The final section concludes the study and provides policy recommendations.

Literature review

Innovation and firm productivity

The determinants of economic growth can be identified from either the demand-side or supply-side of the economy. Following the demand-side, determinants of economic growth are those variables that create GDP. Mathematically the components of GDP are given as $GDP = C + I + G + NX$, where C, I, G, and NX denote consumption, investment, government expenditures and net export, respectively. Thus, economic growth can be achieved by increasing these variables. Based on the supply-side of the economy, determinants of economic growth are derived from production function, and those that determine production (output) also determine growth. For instance, the Cobb–Douglas production function is given as $Y = f(K, L, A)$, where Y denotes output, K represents capital, L represents labour, and A denotes TFP. It would mean that the main factors that generate growth are production factors (L and K) and TFP. Needless to say, production function was augmented to include other variables, such as human capital, over the years.

The seminal work of Solow (1956) popularized the supply-side determinants of economic growth, and empirical analysis of the source of long-term growth became one of the widely studied topics in economics. In general – following Cobb–Douglas production function – growth can be achieved in either/both of the two ways: increase factor input, or increase output using the same level of input (Caselli 2005). The first alternative requires adding more resources, such as capital and labour to production, while the second is to improve the productive efficiency of the economy so that more goods and services can be produced without the need for extra inputs. Empirical studies, however, have found that output growth predominantly is explained by productivity growth or commonly known as 'Solow residual' or 'the economists' measure of ignorance' (Abramovitz 1993; Hall 2011). However, it was not until the rise of endogenous growth theory that this residual accounted in the analytical framework of growth theories, and mainly considered to be 'endogenous'. Recognizing the importance of productivity, the main focus of growth economists has been changed into investigating what determines productivity growth. Romer (1990) indicated that innovation, by increasing productivity, is one of the major sources of economic growth for countries and competitiveness for firms.

The effect of innovation is not only to innovative firms but also for the economy as a whole. Initially, innovative firms hold a monopoly power for a short period of time in which they accumulate monopoly profit. But because of the spillover effect in the market, innovation not only benefits the innovator but eventually to the entire industry as well (Stojčić and Hashi 2014). It is also likely that less innovative firms will exit from the market, and firms that can innovate enter into the market. At a country level, entry of efficient firms and exit of less efficient firms enhance the efficiency of the country's economy as a whole (Mohnen and Hall 2013; Rajapathirana and Hui 2017).

OECD (2018)'s Oslo Manual defines innovation as the introduction of new or significantly improved products, processes, organizational, and marketing methods. In light of this, innovation is classified into four types: product, process, marketing, and organizational innovation. The first two are deemed to be technological innovations while the latter non-technological innovations. Freeman and Perez (1988) suggested four taxonomies of innovation: (i) *incremental innovations:* – these type of innovation are often the result of learning-by-doing, not necessary by any deliberate R&D, and occur continuously; (ii) *radical innovations:* – unlike incremental, these types of innovations are the result of specific R&D activities in universities and laboratories and generates new products for use in the world; (iii) *change of* '*technology system*': – this type of innovation combine both radical and incremental innovation and affects larger firms; (iv) *technological revolution:* – this type of innovation transcends from new products and services and affects the entire economic system. It has been suggested that incremental innovation, more specifically the imitation of pre-existing products, is equally important to radical innovation for developing countries (Acemoglu, Aghion, and Zilibotti 2006; Ayyagari, Demirgüç-Kunt, and Maksimovic 2011; Fagerberg, Srholec, and Verspagen 2010). It was for this reason that the OECD (2018)'s Oslo Manual defines innovation in the broadest terms and 'new or improved' should mean 'new to the business' but not necessarily new to the market (Ayyagari, Demirgüç-Kunt, and Maksimovic 2011).

Regardless of its type, innovation requires considerable efforts and expenditures on R&D, tangible products, such as machinery or equipment, and non-tangible activities, such as on-the-job training (OJT). Firms spend in these innovative activities expecting to get a return in the future, in terms of productivity/profitability. Thus, innovative firms are expected to be more productive than non-innovator. Innovation leads to a rise in the value of firms' product (particularly product innovation), reduction of cost (specifically processes and organizational innovation), and differentiate firms' product from competitors (marketing innovation).

Integrating these relationships, Crepon, Duguet, and Mairessec (1998) developed an empirical model that comprises a recursive system of three equations: innovation input (R&D), innovation outcome, and productivity, commonly referred to as the CDM model. Using the French Community Innovation Survey (CIS), the authors concluded that firms that spend more on R&D are more innovative, and innovative firms are more productive. Following this pioneering paper, many empirical studies have been conducted, and the empirical results of these studies seem to support the hypothesis that firms engaged in R&D are more innovative and innovative firms are more productive than their counterparts, especially in developed countries. For instance, Griffith et al. (2006) found that spending on R&D has a significant positive impact on innovation, and innovation significantly affects productivity.[4] Similarly, Lööf and Heshmati (2006) conducted a sensitivity analysis and conclude that innovation significantly affects firms' productivity regardless of estimation methods, measures of productivity and types of innovation. Parisi, Schiantarelli, and Sembenelli (2006) also found a similar result for Italian firms, albeit the authors indicated that spending on R&D is more strongly associated with process innovation than product innovation, and process innovation has a larger impact on firms' productivity. In the same vein, Martin and Nguyen-Thi (2015) found a significant positive relationship between innovation and firm productivity using firm-level data of Luxemburg. In their comparative study between micro and larger firms, Baumann and Kritikos (2016) noted that micro firms do exhibit similar patterns as far as the relationship between R&D, innovation and productivity is concerned.

An empirical study by Stojčić and Hashi (2014) using firm-level data from 12 European countries also indicated that innovation, especially process and technological, significantly improves productivity. Using the micro-moments database for European countries, the empirical study of Bartelsman, van Leeuwen, and Polder (2017) also indicates that innovation enhances the aggregate productivity of firms even though its impact at the firm level is insignificant. In a nutshell, most of the previous studies that employed the CDM model to analyse the effect of innovation on productivity for the case of developed countries have produced similar results: innovation significantly and measurably affects productivity.

Contrary to the results of developed countries, existing studies on the case of developing countries have produced mixed findings. In this regard, three conclusions emerge from the empirical investigation on the impact of innovation on productivity. The first group of studies argued that although firms in developing countries do innovate, they encounter obstacles to translate the innovation output into productivity. For instance, in their empirical analysis on the effect of innovation on productivity using a firm-level data from Tanzania, Goedhuys, Janz, and Mohnen (2008) found that innovation, both product and process, is not a significant predictor of firm productivity. The authors suggested that Tanzanian firms were engaged in incremental innovation that did not have any significant impact on productivity and recommended that the government should improve the business environment so as to enhance the effect of innovation on productivity. The empirical results of Benavente (2006) also indicate that the productivity of Chilean firms is not determined by innovation and R&D. Similarly, Raffo, Lhuillery, and Miotti (2008) compared the effect of innovation on the productivity of selected developed countries, namely France, Spain, Switzerland, and developing countries including Brazil, Mexico, and Argentina. Their empirical results indicate that innovation positively and significantly affects firm productivity in all countries except Argentina. In their comparative study between South Sudan and Tanzania Molzi et al. (2018) found that innovativeness is related to performance only in Tanzania but not in South Sudan.

The second group of studies found empirical evidence consistent with the results of developed countries; i.e., innovation significantly affects productivity. For instance, Crespi, Tacsir, and Vargas (2016) conducted an empirical analysis using WBES and employed the CDM model for developing Latin American countries. Their empirical analysis indicates that innovation – both process and product – has a significant and positive impact on firm productivity. The third group of studies, on the other hand, revealed mixed results about the effect of different types of innovation on productivity. It has been argued that some types of innovation have a significant impact while others do not. For instance, in a recent study of Bangladesh firms, Waheed (2017) found that only process innovation affects labour productivity, not product innovation.

In short, despite the existence of conflicting results, the vast majority of empirical studies reported a positive relationship between innovation and productivity for developing countries, including those in Africa. Therefore, we hypothesize as follows:

> H1: Both types of innovations, i.e product & process, and technological innovation are positively related to firm productivity.

Institutions and firm productivity

The abovementioned studies have tended to focus on the nexus between internal factors, R&D and innovation, on productivity only. The influence of external factors, such as quality of institutions, has not been treated in much detail. However, macroeconomic studies have indicated that institutions, which are defined as the rule of the game, are one of the fundamental determinants of growth (Acemoglu, Johnson, and Robinson 2001, 2002; Égert 2016; Hall and Jones 1999; Lee and Kim 2009; Rodrik, Subramanian, and Trebbi 2004). It has been argued that institutional quality has both direct effects on growth through improving human capital and investment and indirectly through improving TFP (Dawson 1998). Recently, micro-level studies have also acknowledged the importance of institutional quality on firm productivity. For instance, Borghi, Del Bo, and Florio (2016) indicated that a higher quality of the institutional environment is associated with a higher level of firms' productivity in Europe. In another study, Goedhuys and Srholec (2015) examined the effect of national-level institutional quality on firm-level productivity using a multilevel modelling approach and found little effect of governance index on productivity. This study, however, distinctly focuses on institutions at the national level.

Other strands of studies relied on individual firm response to reveal the effect of institutions on productivity. For instance, Faruq, Webb, and Yi (2013) used an individual firm's perception of institutional quality and examined its relationship with firm-level productivity. Using a sample of firms from three African countries, namely Ghana, Kenya and Tanzania, the authors concluded that poor bureaucratic quality and corruption reduce firm productivity. Similarly, Bah and Fang (2015) examined the impact of aspects of the business environment, such as crime, regulations, and corruption on TFP of firms in selected Sub-Saharan African countries and found that a poor business environment negatively affects the TFP of firms.

In addition to national governments, sub-national or regional governments also formulate rules and regulations of transactions; thus, institutional quality varies from one region to the other even within a single country (Lee and Lee 2018; Tran et al. 2016). Since firms interact with other firms, households, and government officials during their operation, and most of these interactions occur at the regional level, it is argued that regional institutional quality also influences firms' performance. A recent study by Lasagni, Nifo, and Vecchione (2015), which is closer to the spirit of the present study, offers empirical evidence for this hypothesis using panel data of Italian firms. Their empirical findings, employing various estimation techniques, indicate that the quality of local institutions is, in fact, one of the principal sources of firms' productivity. In the same vein, Tran et al. (2016) found that a higher level of provincial corruption level is associated with a lower level of firm-level productivity, affirming the significance of the quality of sub-national institutions. A longitudinal study of Chinese firms by Lee and Lee (2018) also reports that 'private firms cannot prosper without sound [regional] institutions'. This view is supported by Bennett (2019) who indicates the importance of local economic freedom for the growth of firms in the USA.

Regions within a single country in Africa are more heterogeneous than other continents (Hussen and Çokgezen 2020), and this heterogeneity creates differences in the quality of regional institutions. This leads to the second hypothesis of the present study:

> H2: The quality of regional institutions is positively related to firm productivity.

Empirical methodology and data

Data

In order to investigate the impact of innovation and regional institutional quality on firm-level productivity, we used a firm-level dataset of 15 African countries from WBES. The World Bank collects firm-level data through surveys across the developing world once in three/four years rotation. The data collected through these surveys include information about the surveyed firms, such as age, size and ownership structure, as well as the perception of firms regarding access to finance, corruption, political instability, tax system, and business permit. This study used a sample of African countries for which most recent survey data, especially R&D expenditure data, is available. Thus, our sample includes data from 15 African countries. The breakdown of the sample firms for each country and regions/localities are presented in Table 1.[5]

Empirical methodology

To estimate the impact of innovativeness and institutional quality on productivity, we used an empirical model in which the first two are explanatory variables that influence the dependent variable productivity. However, rather than adopting this model directly, considering the endogeneity problem between productivity and innovation, we preferred to adopt the CDM approach. This model controls for causality and endogeneity; thus, it is regarded as a robust method of analyzing the link between innovation and productivity (Lööf, Mairesse, and Mohnen 2017). Over the past decade, several studies have employed this model to investigate the linkage both in developed (Griffith et al. 2006) and developing countries (Mohan, Strobl, and Watson 2016; Raffo, Lhuillery, and Miotti 2008).

The conceptual framework of the CDM model is that innovation is a process, which is conducted by firms with a particular set of innovative activities, mostly, but not limited to, R&D. These innovative activities produce certain outputs in terms of new or modified products and/or processes (for the firm or the market). Finally, the innovation outputs are not the end of the process but reflected in the performance of firms i.e. productivity. Thus, firms that have undertaken innovation are expected to perform better than non-innovators.

Accordingly, the relationship between R&D, innovation and productivity is modelled sequentially and estimated in three stages (see the upper panel of Figure 1). The CDM approach, however, overlooks an important external determinant of productivity i.e. regional institutional quality. Thus, we included institutional quality variable in the last stage of the model. The theoretical framework of the present study, which is the modified version of the CDM approach, is presented in Figure 1.

The empirical approach of the CDM model comprises a recursive system of three equations and is estimated in the three stages in which productivity is explained by innovation output and the latter by research investment. The first equation describes whether a firm undertakes R&D and if so, how much, as a function of firm and industry characteristics. The second equation describes the innovation outcomes as a function of R&D intensity and other firm-level characteristics. The R&D variable in the second equation is predicted from the first equation. Using predicted R&D, rather than the observed R&D expenditure, ensures that informal R&D effort that is often not reported is taken into account. It also addresses simultaneity problems that may arise between innovation and R&D. The third equation describes labour productivity as a function of innovation and regional institutional quality, in addition to other control variables. Similar to the second stage, the innovation variable in the third equation is also the predicted value from the second equation given the firm's characteristics. Detail explanation of the three stages of the CDM model is discussed below.

First stage: R&D decision and intensity

In this stage, firms' decision to engage in innovative activities, more specifically on R&D, and the amount of the investment (intensity of R&D) is analyzed. In WBES, firms were asked how much they had spent for R&D in the previous three years. We use this variable as a dependent variable to model innovation-decision and intensity equation as follows:

$$R\&D_i^* = X_i\beta + u_i \tag{1}$$

where $R\&D_i^*$ represents the latent unobserved variable (firms' innovative effort), X_i is the vector of determinants of the innovation effort, and u_i is the error term. Consistent with previous studies, the latent variable $R\&D_i^*$ is proxied by the log of R&D expenditure per worker.[6] Because some firms reported that they didn't spend on R&D, the dependent variable contains many zero observations. In such circumstances, the appropriate method of estimation is the generalized Tobit model.[7] Therefore, the generalized Tobit estimation was employed in this study to estimate the probability of spending in R&D and the intensity of the investment. As suggested by (Griffith et al. 2006; Lööf and Heshmati 2006; Stojčić and

Table 1: Sample country, region and year surveyed.

Survey year	Country	Region	Number of firms	
2016	Benin	Atlantique, Borgou, Mono, Ouém	42	150
		Littoral	108	
2016	Cameroon	Center	149	361
		Littoral	143	
		West	69	
2018	Chad	N'Djamena	153	153
2016	Côte d'Ivoire	Abidjan	268	361
		Rest of the Country	93	
2016	Egypt	Frontier	80	1814
		Greater Cairo	691	
		Middle and East Delta	338	
		Northern Upper Egypt	170	
		Southern Upper Egypt	126	
		Suez Region	120	
		West Delta	289	
2016	Eswatini	Eswatini	150	150
2015	Ethiopia	Addisababa	451	848
		Amhara	70	
		Dredawa	27	
		Oromia	138	
		Snnpr	53	
		Tigray	109	
2018	Gambia	Gambia	151	151
2016	Guinea	Conakry	150	150
2016	Lesotho	Lesotho	150	150
2017	Liberia	Margibi	31	151
	Liberia	Montserrado	106	
	Liberia	Nimba	14	
2016	Mali	Bamako	133	185
		Mopti, Ségou, Sikasso	52	
2017	Niger	Maradi	24	151
		Niamey	127	
2017	SierraLeone	Bo	20	152
		Bombali	21	
		Kenema	20	
		Western Urban	91	
2016	Togo	Lomé	117	150
		Plateaux, Centrale, Kara	33	
Total				**5077**

Hashi 2014) the predicted value of R&D is calculated for all firms, not only for those which report R&D expenditure.

In this respect, we assume that a firm decides to engage in innovative activities if its latent variable exceeds industry threshold c. Hence, the firm's decision

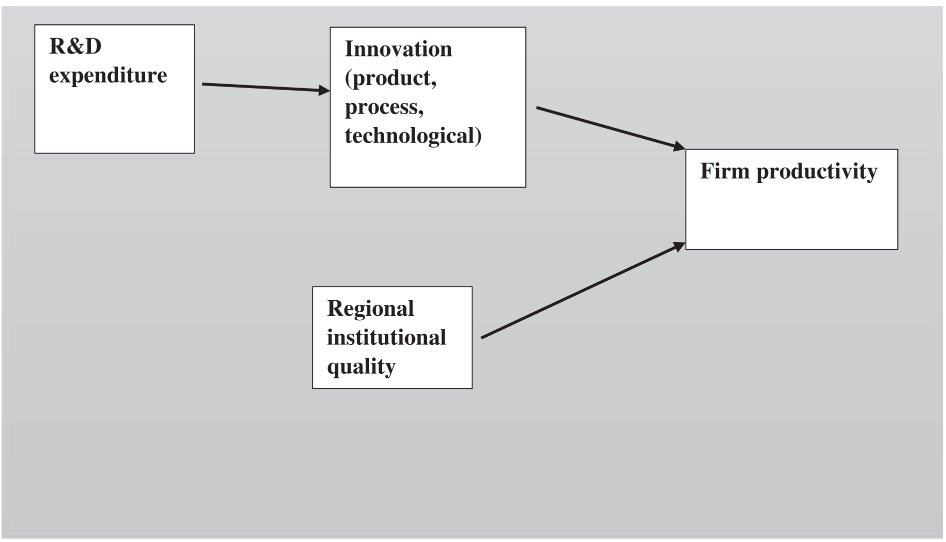

Figure 1: Theoretical framework of the study.

whether to engage in innovative activities i.e. R&D or not can be modelled as follows:

$$R\&D_i = \begin{cases} 1 \; if \; R\&D_i^* = X_i\beta + u_i > c, \\ 0 \; if \; R\&D_i^* = X_i\beta + u_i \leq c \end{cases} \tag{2}$$

where $R\&D_i$ is a dichotomous variable that takes the value 1 if the firm had conducted R&D investment and 0 otherwise. On the other hand, the intensity of R&D (R&DE) can be expressed as follows provided that the firm had spent on R&D:

$$R\&DE_i = \begin{cases} R\&DE_i^* = X_i\beta + e_i \; if \; R\&D_i = 1 \\ 0 \; if \; R\&D_i = 0 \end{cases} \tag{3}$$

Over the past two decades, there have been numerous studies that have examined this topic and identified various determinants of R&D decision and intensity. Although restricted by data availability, like most studies in this area, our choice of the independent variables is based on the previous literature (Cirera, Lage de Sousa, and Sabetti 2016; Crespi, Tacsir, and Vargas 2016; Hall, Lotti, and Mairesse 2009; Mairesse, Pierre, and Elisabeth 2005; Stojčić and Hashi 2014). Hence, the following four major determinants are considered in R&D equation. First, firm characteristics: – it includes variables such as Government ownership (*Gov*), foreign ownership (*For*), managerial experience (*Mang*), the age of the firm (*Age*) and part of a larger group (*Group*). Second, demand-pull factor (Cirera, Lage de Sousa, and Sabetti 2016): – it is proxied by a two-way trader (*Impoexpo*). Previous studies indicated that firms that are integrated into the international market (by exporting or importing) tend to spend more money than their counterparts. Third, a technology push factor, which puts pressure on firms to spend more on R&D in order to catch up to the ongoing technological improvement. This factor is captured by the dummy variable *Inter_quality* that takes the value 1 if the firm has internationally recognized quality assurance. Fourth, access to external knowledge which is proxied by a dummy variable (*Large_city*) that takes the value 1 if the firm is located in a city with more than one million population. It has been suggested that firms that are operating in big cities have easier access to knowledge than their counterparts in smaller settlements (Crespi, Tacsir, and Vargas 2016).[8] Finally, to account for country heterogeneity[9] and sectoral differences, we used both sector and country dummy as additional control variable.

Second stage: innovation outcome equation

It has been assumed that investment in R&D, together with other inputs, produces innovation outcomes. Therefore, in this stage, the impact of R&D on innovation outcomes is analyzed. Following recent studies on the topic, we consider three types of innovation: product innovation, process innovation, and technological innovation. Hence, the innovation output equation of the *i*th firm is given as:

$$In_i = \delta R\&DE_i^* + \gamma z_i + \varepsilon_i \tag{4}$$

where In_i is a dummy variable for innovation (product, process, technological innovation) being one for the firm that introduced an innovation, zero, if not; $R\&DE_i^*$ is the latent R&D variable predicted from equation 3, z_i is control variables that are believed to affect the probability of innovation, ε_i is the error term. As discussed by (Hall 2011; Hall, Lotti, and Mairesse 2009) the benefit of including the $R\&DE_i^*$ (the latent R&D intensity variable) than the observed R&D expenditure is twofold. First, it will account for informal R&D effort that is often not reported. Second, it also addresses simultaneity problems that may arise between innovation and R&D.[10] Similar to the R&D equation, the choice of control variables for the innovation outcome equation is also informed by previous studies in this realm (Ayyagari, Demirgüç-Kunt, and Maksimovic 2011; Cohen 2010; Hussen and Çokgezen 2019). These control variables include government ownership (*Gov*), foreign ownership (*For*), age of the firms (*Age*), internationalization of the firm (*Expo*), managerial experience (*Mang*), technological capability of the firm's owner/manager (*Email*), the human capital of the firms (*Highschool*), On-the Job-Training (*Training*) and two dummies i.e. *Medium* which takes the value 1 if the firm is medium size and *Large* if the firm is considered a large firm to measure the size of the firm. We also included both sector and country dummy to control for country heterogeneity and sectoral differences. Taking into consideration the dichotomous nature of the dependent variable, the probit estimation method is employed to estimate the parameters.

Third stage: productivity equation

In this stage, the impact of all three types of innovation on labour productivity is analyzed. The most widely used approach to conducting such kind of analysis is Cobb–Douglas production function, augmented with innovation. We further argue that the quality of regional/local institutions also affects the productivity of the firm; therefore, we introduce regional institutional quality as one of the potential inputs for firm's productivity, and labour productivity equation of the CDM models is given below:

$$y_i = \varphi_1 k_i + \varphi_2 l_i + \varphi_3 In_i + \varphi_4 reg_i + Z_i\pi + u_i \tag{5}$$

where y_i is the labour productivity of the *i*th firm. In previous literature, labour productivity has been measured in two ways: either by the value-added per worker or output per unit of labour input. Given the unavailability of data for value-added, we used the latter approach to measure productivity in this study. Therefore, it is measured by the log of annual sales per worker in US dollars.[11] k_i is the log of physical capital per worker measured by the log of the net book value of machinery, vehicles, and equipment per worker in the last fiscal year converted to US dollar using annual average exchange rates.

reg_i is the measure of institutional quality of the region in which the firm i is operating. WBES collects data using a stratified sampling methodology from developing countries. The strata are firm size, business sector, and geographic region within a country. Geographic regions within a country are selected based on administrative structure or considering which cities/regions collectively contain the majority of economic activity. For instance, Ethiopia follows a federal political structure where each region has autonomy regarding local administration and rules. Thus, the survey was conducted in the six administrative regions of the country, namely Oromia, Amhara, Southern Nations Nationalities and People, Tigray, Dire Dawa and Addis Ababa (Hussen and Çokgezen 2020). It should be noted that some of the countries in our sample are too small to be divided into regions. Therefore, the World Bank didn't divide these countries into regions during the survey. Thus, for countries such as Eswatini and Lesotho, region means the country itself.

Following (Barasa et al. 2017; Chadee and Roxas 2013; Hussen and Çokgezen 2020), regional institutional quality is measured by averaging firm's perception regarding rule of law, regulatory quality and corruption level of the region/locality where the firm is operating.[12] l_i is the log of the total number of workers and In_i is the proxy of innovation which indicates product, process or technological innovation. Since there is simultaneity between innovation and productivity, the predicted value of innovation from the innovation equation was used as an instrument. Moreover, following (Griffith et al. 2006; Musolesi and Huiban 2010), product, process and technological innovation indicators are included separately because of the substantial multicollinearity among these variables. To control for unobserved sectoral characteristics and cross-country heterogeneity in the sample, both sector dummies and country fixed effects are included, and the productivity equation was estimated using OLS and later quintile estimation method.

The variables used in this study are defined in Table 2.

Empirical results

As noted above, the empirical model of the study encompasses three different, but related, equations. Namely, (a) R&D and its determinants, (b) R&D and innovation, and (c) innovation, regional institution, and productivity. Thus, we discussed the estimation results of each equation in the subsequent sections.

R&D and its determinants

In the first stage of the CDM model, the firm's decision to spend on R&D and the intensity of its expenditure is estimated using the generalized Tobit model. The empirical results are reported in Table 3.

The first column presents the marginal coefficients of the probability of firms to invest in R&D (occurrence of R&D) while the second column presents the estimated coefficients of the intensity of R&D expenditure provided that the firms had decided to invest. In general, the empirical results indicate that government ownership, being both importer and exporter, the experience of firms' manager, belonging to a group, and having an international quality certificate significantly and positively affect both firms' propensity of spending in R&D and the intensity of R&D expenditure. More specifically, firms owned by the government are 26.8% more likely to spend on R&D compared to privately owned firms. This might be due to the fact that R&D is a costly activity that requires financial and human resources, and in Africa, where capital accumulation in the private sector is very low, only government companies can afford to spend on such resources than the private sector. Similarly, importing and exporting firms are 25.4% more likely to spend on R&D than their counterpart, indicating that demand-pull factors also determine the firm's decision. The empirical result also indicates that firms belonged to a group are 11% more likely to spend on R&D, indicating that belongingness to the group provides an opportunity for the firms to have additional financial and human resources for innovation input expenditure. A one percent increase in years of firms' manager experience also increases the probability to spend on R&D by 4.6%. Likewise, firms with international quality certificate are 20.6% more likely to engage in R&D than their counterpart.

R&D and innovation

In the second stage, the impact R&D on innovation output is estimated using the probit estimation method. The empirical results of the innovation equation (equation 4) are reported in Table 4.[13] Since we consider three types of innovations, the estimation results of each innovation equation are presented in a separate column. In order to address the problem of endogeneity related to R&D variable, the predicted value of R&D in the previous stage is used.

The first column of Table 4 presents the empirical results of product innovation. It indicates that spending on R&D significantly and measurably affects the propensity of product innovation even after controlling for other factors, simultaneity, country heterogeneity, and sectoral differences. It indicates that firms that spend on R&D have a higher probability of being innovative than non-spender, leading to the conclusion that firms have to spend more on R&D in order to produce new or significantly improved products and services. It is interesting to note that government-owned (*Gov*) firms are less innovative even though they tend to spend more in R&D, implying that such types of firms inefficiently spent the budget allocated for R&D. Counterintuitively, the coefficient of *Highschool*, which represents the percentage of workers with a high school diploma, is insignificant. It was expected that more educated employees would contribute to the innovation effort of the firms. Nonetheless, the insignificance, and surprisingly negative sign, of this variable could be explained by the fact that innovation in developing countries, particularly in Africa, is incremental that may not need an educated employee. As argued by recent empirical studies, such as van Uden, Knoben, and Vermeulen (2017), employee schooling may not be a significant determinant of firm innovation in developing countries but other forms, such as OJT, might be important for the innovativeness of firms.

Our empirical investigation also shows that foreign ownership, the age of the firms, exporting, and the size of the firms (proxied by dummy variable as Large firms and Medium firms) are insignificant. This result is in line with previous studies as these studies reported both in favour and against these variables with regard to the

Table 2: List of variables.

		Innovation variables	1st stage	2nd stage	3rd stage
Tech	Technological innovation	Dummy with value 1 if the firm introduced product or process innovation		* (dependent)	*(predicted)
Product	Product innovation	Dummy with value 1 if the firm introduced a product innovation		* (dependent)	*(predicted)
Process	Process innovation	Dummy with value 1 if the firm introduced a process innovation		* (dependent)	*(predicted)
	Performance variable				
Product_log	Labour productivity	Logarithm of sales per worker			* (dependent)
	Knowledge intensity				
R&D intensity		R&D expenditure per worker	* (dependent)	*(predicted)	
	Firms characteristics				
Gov	Government owned	Dummy with value 1 if the government has at least 10% ownership	*	*	
Age	Log (years) firm age	Survey year minus year of firm's establishment	*	*	
Highschool	Human capital of the firm	% of workers with high school degree		*	*
Training	Human capital	Dummy with value 1 if the firm provides on-job training		*	
Group	Part of a group	Dummy with value 1 if the firm is part of large group	*		
For	Foreign ownership	Dummy with value 1 the firm is at least 10% owned by foreigner	*	*	
Mang	Manager experience	Log of (years) experience of the manager in the sector of the firm	*	*	
lnCapital	Log(K/L)	$ Net book value of machinery vehicles, and equipment Per labour			*
Size_numlog	Employment	Log of full-time employee			*
Large	Measure of size	Dummy with value 1 if the firm is large		*	
Medium	Measure of size	Dummy with value 1 if the firm is medium		*	
Exporter	Exporter	(0/1) if the firms exports		*	
	Access to external knowledge				
Large_city	Large city	Dummy with value 1 if the firm is located in a city with more than one million population	*		
Email	Email	Dummy with value 1 if firm interact with customers and supplier via email		*	
	Demand Pull (market condition)				
Impoexpo	External market	Dummy with value 1 if the firm is both importer and exporter	*		
	Technology push factor				
Inter_quality	International quality certification	Dummy whether a firm has international recognized quality certification.	*		
	Enabling environments				
Regional_instiution	Measure of quality of regional institutions	Average of rule of law (crime, political instability, and the courts), regulatory quality (tax rate, tax administration, custom, business permit, and access to land), and corruption of each region			*

probability of innovation. Consistent with the literature, the estimated results show that OJT and the use of email to interact with buyers and customers significantly predict the probability of firms' innovation. It indicates that firms that provide OJT for their workers are 15% more likely to be product innovator while firms whose managers/owners are technological friendly i.e. communicate with customers and buyers through email are six percent more likely to be product innovator.

The second column of Table 4 reports the marginal coefficients of the process innovation equation. It indicates that R&D expenditure, unlike in the product innovation equation, do not have a significant impact on the probability of firms to engage in process innovation. This result, thus, suggests that process innovation does not depend on the amount of finance on R&D, probably because, as argued by Mohan, Strobl, and Watson (2016), 'imitation and technology acquisition may play a more important role than R&D investment' in the case of developing countries for process innovation. Except for government ownership and medium firms, the sign and the significance of other control variables are similar to the product innovation equation. More specifically, OJT and Email have a significant positive effect on the probability of process innovation while the impact of the experience of firms' manager is negative.

The third column of Table 4 presents the estimation result of the technological innovation equation and it

Table 3: Empirical results of innovation input equation.

	(Model 1) Innovation decision	(Model 2) Intensity of innovation
Gov	0.268***	0.659***
	(0.0926)	(0.226)
For	−0.0293	−0.0719
	(0.0460)	(0.113)
Age	0.0319	0.0782
	(0.0232)	(0.0570)
Impoexpo	0.254***	0.624***
	(0.0404)	(0.0971)
Mang	0.0464*	0.114*
	(0.0255)	(0.0627)
Group	0.114***	0.280***
	(0.0351)	(0.0862)
Large_city	0.0576	0.142
	(0.0422)	(0.104)
Inter_quality	0.206***	0.506***
	(0.0415)	(0.101)
N	3960	3960
Pseudo R2	0.06	–
Country dummy	yes	yes
Sector dummy	yes	yes

Standard errors in parentheses
*$p < .1$; **$p < .05$; ***$p < .01$

strongly suggests that R&D expenditure significantly predicts the probability of firms to engage in technological innovation, supporting the hypothesis that firms that spend on R&D are more innovative than non-spenders. Except for foreign ownership, which indicates that foreign-owned firms are more likely to engage in technological innovation than domestic owned firms, the significance and the sign of other control variables remain similar to our previous results of product and process innovation.

In a nutshell, the empirical results of the innovation equation suggest three points. First, R&D is a significant predictor of the propensity of firms' innovation in product and technological innovation but not process innovation. Second, once the endogeneity of the R&D variable is accounted for, firms' specific factors such as ownership, age, size, exporting, and even education level of employees are not a significant predictor of any type of innovation. Third, internal factors such as OJT and technological capability of the firm's owner/manager (*Email*) profoundly affect the innovativeness of firms in the sampled countries. This is good news for African firms that are small, young, and staffed with low educated employees. Our empirical investigation demonstrated that firm in Africa can improve their innovative capacity by training their employees, spending on R&D, and adopting information technology.

The impact of innovation and regional institutional quality on firm-level productivity

In the third stage of the CDM model, the impact of innovation and regional institutional quality on labour productivity of firms is estimated using the OLS estimation technique. Each of the innovation types is included separately in the productivity equation in order to tackle the multicollinearity problem. In addition, to address the possible endogeneity of innovation variables, the predicted values of each innovation type in the previous stage are used and the labour productivity equation is estimated. The empirical results are presented in Table 5 where the first column presents when product innovation enters into productivity estimation, the second process

Table 4: Estimation results for innovation output with predicted R&D.

	(Model 1) Product innovation	(Model 2) Process innovation	(Model 3) Technological innovation
R&D (hat)	0.0113***	0.00407	0.0123***
	(0.00408)	(0.00299)	(0.00447)
Gov	−0.147**	−0.00240	−0.0860
	(0.0596)	(0.0389)	(0.0627)
For	0.0341	0.0223	0.0397*
	(0.0211)	(0.0153)	(0.0235)
Age	0.00394	0.0115	0.00883
	(0.0109)	(0.00815)	(0.0120)
Exporter	0.0126	0.0248	0.0193
	(0.0252)	(0.0185)	(0.0276)
Mang	−0.0208*	−0.0171**	−0.0209
	(0.0118)	(0.00850)	(0.0131)
Email	0.0572***	0.0515***	0.0704***
	(0.0181)	(0.0139)	(0.0198)
Highschool	−0.0000606	−0.00182	0.0000881
	(0.00637)	(0.00486)	(0.00705)
Training	0.152***	0.0947***	0.162***
	(0.0159)	(0.0117)	(0.0177)
Medium firms	−0.0110	0.0205	−0.00678
	(0.0178)	(0.0135)	(0.0195)
Large firms	0.0253	0.0280	0.0366
	(0.0247)	(0.0182)	(0.0270)
N	3378	3369	3364
Pseudo R2	0.184	0.214	0.202
Country dummy	yes	yes	yes
Sector dummy	yes	yes	yes

Standard errors in parentheses
*$p < .1$; **$p < .05$; ***$p < .01$

innovation, and the third column technological innovation.

As shown in Table 5, all types of innovation, namely product, process, and technological innovation significantly affect the productivity of firms. Our empirical investigation indicates that product innovators are 1.4 times more productive than non-innovator while process and technological innovators are approximately 1.5 times more productive than non-innovator. This result corroborates to previous studies, such as (Cirera and Cusolito 2019; Crespi, Tacsir, and Vargas 2016; Hall, Lotti, and Mairesse 2009; Stojčić and Hashi 2014) to name a few, and suggest that there is a need to enhance the innovative capacity of firms in order to improve their productivity.

Regarding our variable of interest regional institutional quality, the empirical investigation confirms our initial hypothesis that firms located in a region where institutional quality is better are more productive than firms located in regions where institutional quality is poor. As can be seen from Table 5, the coefficients of regional institutional quality are positive and significant in all of the three models. These results would seem to suggest that better regional institutions enable firms to improve their productivity. On the contrary, firms located in a region where institutions are poor face risk and uncertainty, which in turn affect their productivity negatively.

Like previous studies in this realm, our empirical results further indicate that control variables which include labour (*Size_numlog*), human capital (*Highschool*), and capital intensity (*lnCapital*) significantly affect the productivity of firms in Africa.

Differences in returns to innovation and regional institutions

It is likely that the impact of innovation and regional institutions might differ on various productivity distributions. For instance, it might be the case that regional institutional quality is more important for firms at a lower level of productivity distribution than those at higher productivity distribution. Similarly, the impact of innovation on productivity could be heterogeneous for firms. Therefore, to analyze the effect of innovation and regional institutions on firm productivity at different levels of productivity distributions, we conducted a quantile regression at 25%, 50% and 75% levels and the empirical results for different types of innovations are reported in Table 6.

Section (a) of Table 6 reports the estimated coefficients of quantile regression when product innovation is included as an independent variable in the productivity equation. In this section, model 1 reports the estimation with 0.25 quintiles, the second column with 0.5 quintiles and the third column with 0.75 quintiles. Likewise, section (b) of Table 6 reports the quantile regression result of the productivity equation when process innovation is considered as an independent variable with similar quantiles. Finally, the last section (section c) reports the result of productivity equation when technological innovation is used as an independent variable.

As shown in the table, the significance and the sign of all variables, except the regional intuitional quality indicator, remain the same for different quintiles, albeit the magnitude varies. These results indicate that the quality of regional/local institutions is crucial for firms at the lower level of the productivity distribution. This implies that firms at lower productivity distribution benefit more from improving the regional institutional quality in terms of increased productivity.

To summarize, comparing the empirical results of the quantile regression models at different levels of productivity distribution, two inferences can be made. First, all types of innovation i.e. product, process, and technological innovation are significant determinants of firms' productivity at different productivity distribution. Second, the effect of regional institutions, however, varies depending on the productivity distribution. The quality of regional institutions is crucial especially for firms at lower productivity levels. As most African firms are low productive (Faruq 2019), it is necessary therefore to focus on improving the quality of institutions not only at the country level but also at the regional level, in addition to efforts to improve the innovative capacity of firms.

Discussion

Despite their outstanding economic performance over the last two decades, African countries have not significantly reduced poverty. As a consequence, Africa is still the poorest continent in the world. On the grounds of this, policymakers and economists alike have recently emphasized on policies and strategies that foster the standards of living in African countries. In this regard, most observers would agree that increasing material wellbeing is only possible by increasing productivity at various levels, in addition to the quantity and quality of production factors. While the importance of productivity is acknowledged, divergences still exist as to how productivity, especially at firm-level, be improved. This study is intended to contribute to this ongoing debate on the search for factors that influence firm productivity. In light of this, our empirical findings provide some insights and support our hypothesis to a greater extent.

First, results indicate that all types of innovation, namely product, process, and technological innovation have a positive and statistically significant effect on firms' productivity. It indicates that innovative firms are nearly 1.5 times more productive than non-innovator, implying the importance of engaging in innovative activities for enhancing the productive performance of firms in Africa. In this regard, the study produced results which corroborate the findings of a great deal of the previous work in this field (Cirera and Cusolito 2019; Crespi, Tacsir, and Vargas 2016; Hall, Lotti, and Mairesse 2009; Stojčić and Hashi 2014), albeit differs from some studies such as (Goedhuys, Janz, and Mohnen 2008).

If innovation, regardless of its type, is important for firms' productivity, why is that only certain firms are introducing new or significantly improved products and processes while others not? Our empirical evidence indicates that – in the second stage of innovation equation – it

Table 5: Estimation results for labour productivity with predicted innovation output (OLS regression).

	(Model 1)	(Model 2)	(Model 3)
Dependent variable: labour productivity			
Product_hat	1.346***		
	(0.360)		
Process_hat		1.537***	
		(0.408)	
Tech_hat			1.682***
			(0.364)
Regional_institution	0.356*	0.386*	0.359*
	(0.213)	(0.214)	(0.212)
lnCapital	0.222***	0.222***	0.218***
	(0.0167)	(0.0167)	(0.0167)
Highschool	0.112***	0.116***	0.109***
	(0.0347)	(0.0347)	(0.0347)
Size_numlog	0.108***	0.110***	0.0856***
	(0.0263)	(0.0260)	(0.0275)
cons	6.447***	6.561***	6.343***
	(0.247)	(0.244)	(0.250)
N	1299	1299	1299
adj. R^2	0.559	0.559	0.561
Country dummy	yes	yes	yes
Sector dummy	yes	yes	yes

Standard errors in parentheses
$^*p < .1$; $^{**}p < .05$; $^{***}p < .01$

is because innovation requires considerable efforts and expenditures not only on R&D but also on non-tangible activities such as OJT. Thus, firms that spend on R&D, provide training to their employees and adopt information technology are more likely to innovate. Our study thus underscores the importance of R&D, training employees and improving the capability of a manager (*Email*) to enhance the innovative capacity firms in Africa, which in turn increase firms' productivity. This finding of the current study is consistent not only with those of previous studies (Barasa et al. 2017; Hussen and Çokgezen 2020) but also the policy direction of African Union (AU). In recognition of the importance of R&D and other innovative activities for the overall development of the region, The AU has set a target of investment at least 1% of GDP to R&D (AUDA-NEPAD 2019). However, no country has achieved this target so far. Based on the UNESCO dataset, the regional average is only 0.4%. South Africa is the largest spender in Africa with a value of 0.82% of GDP while Madagascar, with a value of 0.01, is the lowest spender in R&D in 2018.[14]

Apart from spending on R&D, governments can support firms' R&D activities through various incentives mechanisms such as grants, procurement, tax incentives and direct performance of research etc., whose efficiencies vary considerably.[15] Many economists agree that the role of government is essential for the allocation of resources to innovative activities because relying on market forces in this regard will generate below the socially optimal level. Because of intangibility character of knowledge and its risky nature, in addition to the non-appropriability and public good, the market for innovation is known to fail. It is within this framework that governments around the world often provide various incentive mechanisms to firms. For instance, the European Union (EU) countries spent around 9.6% of its GDP to support firms in 2010 (Criscuolo et al. 2012). Role of government is even more important in developing countries in which private firms do not have sufficient funds to finance R&D investments. Therefore, governments of African countries who have very limited resources for R&D activities should choose the most efficient policy tools to allocate these limited resources. Results of our study provides a clue in this regard by demonstrating low performance of government owned firms which implies that funding R&D activities through private firms is more effective. Our findings, therefore, underscore the importance of investment in R&D activities both at macro-level and at the firm-level.

Second, we also find evidence that firms' productivity is influenced by the regional institutional environment and regional institutional quality matter more for firms at lower productivity levels. Entrepreneurs are unwilling to invest in risky innovative activities in a region where contract enforcement is unreliable, property rights are weakly defined, policies are unpredictable, and public administration is inefficient and corrupted. On the contrary, firms located in a region where institutions are good have incentives to spend on long-term investments that can increase their productivity. This has also been supported by a number of existing literature (Acemoglu and Robinson 2012; Agostino, Di Tommaso, Nifo, Rubini, & Trivieri, 2020; Bennett 2019; Ganau and Rodríguez-Pose 2019; Lasagni, Nifo, and Vecchione 2015; North and Thomas 1973; Tran et al. 2016) which conclude that better institutional structure promote investments and economic progress, in return.

On average institutional quality of African countries lags behind other parts of the world. A recent report by World Bank (2017) in this regard shows that average policy and institutional quality score of 38 SSA countries is 3.1 out of six and the scores of the individual countries vary widely across the region. With a score of 4.0, Rwanda leads all countries in the region; Senegal and

Table 6: Quintile regression estimation results.

	Dependent variable: labour productivity								
	(a) product innovation			(b) process innovation			(c) technological innovation		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Variables	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Product_hat	1.190**	1.163**	1.867***						
	(0.560)	(0.549)	(0.414)						
Process_hat				1.599***	1.250***	2.176***			
				(0.497)	(0.304)	(0.588)			
Tech_hat							1.386***	1.508**	1.975***
							(0.399)	(0.653)	(0.510)
Regional_institution	0.464**	0.345	0.491**	0.616***	0.358	0.415	0.544***	0.321	0.442
	(0.204)	(0.284)	(0.213)	(0.220)	(0.227)	(0.285)	(0.204)	(0.207)	(0.332)
lnCapital	0.253***	0.252***	0.215***	0.257***	0.251***	0.222***	0.253***	0.251***	0.213***
	(0.0295)	(0.0287)	(0.0285)	(0.0264)	(0.0274)	(0.0230)	(0.0255)	(0.0259)	(0.0223)
Highschool	0.152***	0.126***	0.0457	0.148*	0.129***	0.0556*	0.146**	0.109*	0.0452
	(0.0588)	(0.0429)	(0.0451)	(0.0759)	(0.0375)	(0.0293)	(0.0591)	(0.0565)	(0.0302)
Size_numlog	0.101***	0.127***	0.126***	0.0975***	0.120***	0.126***	0.0903***	0.100**	0.106**
	(0.0299)	(0.0337)	(0.0325)	(0.0341)	(0.0340)	(0.0268)	(0.0230)	(0.0428)	(0.0445)
cons	5.439***	6.260***	7.399***	5.489***	6.449***	7.488***	5.315***	6.345***	7.355***
	(0.307)	(0.459)	(0.308)	(0.196)	(0.507)	(0.298)	(0.487)	(0.338)	(0.327)
N	1299	1299	1299	1299	1299	1299	1299	1299	1299
Country dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes

Standard errors in parentheses
$*p < .1$; $**p < .05$; $***p < .01$

Kenya are among the top scoring countries with a score of 3.8. However, more than half (20) of the countries posts a relatively weak performance – that is, a score of 3.2 or lower. The data used in this study also indicate variations in institutional quality differences within the countries.

Our findings imply that it is essential for policymakers in Africa to improve the regional/local institutional environment in order to enhance the productive capacity of firms. Given the fact that most firms in Africa are less productive than their counterparts in other regions (Faruq 2019), it is imperative to improve the quality of institutions at the regional level that will improve productivity of firms. Giving priority and/or special emphasis to low scored regions in implementing this policy will help better in alleviating differences within a country and across the countries, and in turn, trigger overall development of the countries and the continent as a whole.

Conclusion and recommendation

Although African countries have registered remarkable economic growth in the last two decades, the growth of productivity is very low as compared to other parts of the world. In order to meet the goal of a poverty-free Africa by 2030 and Agenda 2060,[16] African countries need to concentrate on accelerating their growth pace. As evidenced by many theories and countless empirical studies, the major source of long-term growth is productivity growth. This can be realized by investing in R&D and innovative activities. Innovation is given much emphasize by economists and policymakers alike, but the link between innovation and productivity seems to be not established in developing countries. Moreover, although the institutional setting of the country is acknowledged to affect productivity, previous empirical studies have remained silent on the effect of regional/local institutional quality on firm productivity. It is against this backdrop that this study investigates the impact of innovation and regional institutional quality on African firms. To this end, we used WBES of firms from 15 African countries and the standard CDM model.

We draw three important conclusions from our empirical investigation. First, R&D significantly affects product and technological innovation, but not process innovation, indicating that firms that spend more on R&D tend to introduce new or significantly improved products. Process innovation, however, seems to be independent of R&D expenditure. Second, innovative firms are more productive. Firms that introduce product, process and technological innovation tend to be more productive, in terms of labour productivity, than their counterpart. Third, in addition to innovation and other conventional factors, regional institutional quality also affects firms' productivity, but its effect is profound for the firms at the lower productivity distribution.

Our empirical investigation suggests the following policy recommendations so as to enhance the innovative capacity and productivity of African firms. First, there is a need to support firms to spend more on R&D. Second, it is also essential to improve the regional/local institutional environment in order for firms to translate innovation into productivity. This could be realized by drafting and improving strong legal and regulatory framework that includes maintaining the rule of law, lowering corruption, and removing regulatory rigidities.

Although the present study makes several noteworthy contributions, several limitations need to be acknowledged. First, the study is limited by the lack of data for some variables; for instance, we used sales per person as a measure of productivity. It would have been interesting to analyze such types of studies using value-added as a measure of productivity. Second, as indicated by Crespi, Tacsir, and Vargas (2016) a better measure of an innovation effort is total innovation investment, which includes not only investment in R&D but on training, know-how, and technology transfer. However, the WBES doesn't provide information regarding investment on training and other innovation investment. Third, our innovation model-in the second stage – is follows a linear innovation model in which investments in basic research eventually result in the development, innovation, and diffusion of new products (so-called technology push). This model allows neither any feed-back mechanisms nor multi-directional information flows – such as input into R&D by manufacturers or marketers. Therefore, the direction of future studies is to employ system approach, rather than linear model, in which innovation is understood as the result of interaction between various economic and social processes. It is also suggested to use value-added to measure productivity and total innovation investment to measure innovation effort in future studies so as to provide a clearer picture on the impact of innovation and regional/local institutions on firms' productivity.

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Notes

1. Real GDP growth data is calculated based on data retrieved from IMF Data Mapper https://www.imf.org/external/datamapper/datasets/WEO/1.
2. The 2030 Agenda for Sustainable Development was adopted by all United Nations Member States in 2015 as a successor of Millennium Development Goals. Its first goal is zero poverty by 2030. Agenda 2060, on the other hand, is Africa's long-term vision for the next 50 years adopted by African leaders in 2015. It is a master plan for transforming Africa into the global powerhouse of the future by optimizing the use of Africa's resources for the benefit of the continent's people.
3. For instance, the Europe 2020 strategy, which was adopted by the European Council in 2010, sets R&D spending target of three percent of GDP for EU members to achieve its goal of smart, sustainable and inclusive growth (Andersson, Johansson, Karlsson, and Lööf 2012, 2).
4. Crepon et al. (1998) estimated the four equations jointly using asymptotic least square, but later studies used an instrumental variable method by using the predicted values. According to Mohnen and Hall (2013), the estimation results using either of the estimation methods produce similar results provided that endogeneity and selection bias is taken into account.

5. Sample countries are selected based on availability of R&D data. The WBES asks firms whether and how much they spend on R&D. Although data for Yes/No question is available for all countries, data for how much firms spend on R&D is only available for selected countries. It should be noted that some of the countries in our sample are too small to be divided into regions. Therefore, the World Bank didn't divide these countries into regions during the survey.
6. Since R&D expenditure is reported in local currency in the WBES, this variable is converted to US dollars using annual average exchange rates obtained from the IMF.
7. The generalized Tobit model has been used by a large number of empirical studies for innovation input equation, including Crespi and Zuniga (2012), Crespi, Tacsir, and Vargas (2016), Raffo, Lhuillery, and Miotti (2008).
8. Note that a detailed description of the measurement of each independent and dependent variable is provided in Table 2.
9. Mlozi et al. (2018) showed that impact of innovation on performance varies across the African countries because of the differences among them.
10. Cirera, Lage de Sousa, and Sabetti (2016) maintain that even though some firms did not report spending on R&D, they may carry out innovation output. Mohan, Strobl, and Watson (2016) also argue that innovation is a multidimensional and complex process, and R&D expenditure alone underestimates the true cost of innovation.
11. Since WBES collects monetary data using local currency, the total value of sales is converted to US dollars using annual average exchange rates obtained from the IMF to ensure the comparability of sales data for the sampled countries.
12. We have followed a similar approach as that of Hussen and Çokgezen (2020) to calculate the regional/local institutional quality level. For further detail on the measure, see Hussen and Çokgezen (2020).
13. The reported coefficients in the table are marginal coefficients.
14. See UNESCO Institute for Statistics (http://uis.unesco.org/) for more detail.
15. See for instance Guellec and van Pottelsberghe de la Potterie (2000), Nicolaides (2013), and Veugelers (2016).
16. https://au.int/en/agenda2063/overview.

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References

Abramovitz, M. 1993. "The Search for the Sources of Growth: Areas of Ignorance, Old and New." *The Journal of Economic History* 53 (2): 217–243. doi:10.1017/s0022050700012882.

Acemoglu, D., P. Aghion, and F. Zilibotti. 2006. "Distance to Frontier, Selection, and Economic Growth." *Journal of the European Economic Association* 4 (1): 37–74. doi:10.1162/jeea.2006.4.1.37.

Acemoglu, D., S. Johnson, and J. A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91 (5): 1369–1401. doi:10.1257/aer.91.5.1369.

Acemoglu, D., S. Johnson, and J. A. Robinson. 2002. "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution." *The Quarterly Journal of Economics* 117 (4): 1231–1294. doi:10.1162/003355302320935025.

Acemoglu, D., and J. Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*, New York, NY: Crown Publishing.

Agostino, M., M. R. Di Tommaso, A. Nifo, L. Rubini, and F. Trivieri. 2020. "Institutional quality and firms' productivity in European regions." Regional Studies, 54(9): 1275–1288. doi:10.1080/00343404.2020.1712689.

Andersson, M., B. Johansson, C. Karlsson, and H. Lööf, 2012. Innovation and growth: from R&D strategies of innovating firms to economy-wide technological change. Oxford: Oxford University Press.

Asongu, S. A., and P. N. Acha-Anyi. 2020. "Enhancing ICT for Productivity in Sub-Saharan Africa: Thresholds for Complementary Policies." *African Journal of Science, Technology, Innovation and Development* 0 (0): 1–15. doi:10.1080/20421338.2020.1732596.

AUDA-NEPAD. 2019. *African Innovation Outlook*. Johannesburg. www.nepad.org.

Avenyo, E.K., M. Konte, and P. Mohnen, 2020. "Product innovation and informal market competition in sub-Saharan Africa." Journal of Evolutionary Economics, pp.1–33. doi:10.1007/s00191-020-00688-2.

Ayyagari, M., A. Demirgüç-Kunt, and V. Maksimovic. 2011. "Firm Innovation in Emerging Markets: The Role of Finance, Governance, and Competition." *Journal of Financial and Quantitative Analysis* 46 (6): 1545–1580. doi:10.1017/S0022109011000378.

Bah, E. H., and L. Fang. 2015. "Impact of the Business Environment on Output and Productivity in Africa." *Journal of Development Economics* 114: 159–171. doi:10.1016/j.jdeveco.2015.01.001.

Barasa, L., J. Knoben, P. Vermeulen, P. Kimuyu, and B. Kinyanjui. 2017. "Institutions, Resources and Innovation in East Africa: A Firm Level Approach." *Research Policy* 46 (1): 280–291. doi:10.1016/j.respol.2016.11.008.

Bartelsman, E., G. van Leeuwen, and M. Polder. 2017. "CDM Using a Cross-Country Micro Moments Database." *Economics of Innovation and New Technology* 26 (1–2): 168–182. doi:10.1080/10438599.2016.1202517.

Baumann, J., and A. S. Kritikos. 2016. "The Link Between R&D, Innovation and Productivity: Are Micro Firms Different?" *Research Policy* 45 (6): 1263–1274. doi:10.1016/j.respol.2016.03.008.

Benavente, J. 2006. "The Role of Research and Innovation in Promoting Productivity in Chile." *Economics of Innovation and New Technology* 15 (4–5): 301–315. doi:10.1080/10438590500512794.

Bennett, D. L. 2019. "Local Economic Freedom and Creative Destruction in America." *Small Business Economics*, 1–21. doi:10.1007/s11187-019-00222-0.

Beugelsdijk, S., M. J. Klasing, and P. Milionis. 2018. "Regional Economic Development in Europe: The Role of Total Factor Productivity." *Regional Studies* 52 (4): 461–476. doi:10.1080/00343404.2017.1334118.

Borghi, E., C. Del Bo, and M. Florio. 2016. "Institutions and Firms' Productivity: Evidence from Electricity Distribution in the EU." *Oxford Bulletin of Economics and Statistics* 78 (2): 170–196. doi:10.1111/obes.12087.

Caselli, F. 2005. "Chapter 9 Accounting for Cross-Country Income Differences." In *Handbook of Economic Growth*. Elsevier. doi:10.1016/S1574-0684(05)01009-9.

Chadee, D., and B. Roxas. 2013. "Institutional Environment, Innovation Capacity and Firm Performance in Russia." *Critical Perspectives on International Business* 9 (1): 19–39. doi:10.1108/17422041311299923.

Cirera, X., and A. P. Cusolito. 2019. "Innovation Patterns and Their Effects on Firm-Level Productivity in South Asia." *Journal of Economics and Public Finance* 5 (3): 261. doi:10.22158/jepf.v5n3p261.

Cirera, X., F. Lage de Sousa, and L. Sabetti. 2016. *ICT Use, Innovation, and Productivity: Evidence from Sub-Saharan Africa*. Policy Research Working Paper Series No. 7868. The World Bank. doi:10.2139/ssrn.2866599.

Cohen, W. M. 2010. "Fifty Years of Empirical Studies of Innovative Activity and Performance." In *Handbook of the Economics of Innovation*. Vol. 1, 129–213. Elsevier B.V. doi:10.1016/S0169-7218(10)01004-X.

Crepon, B., E. Duguet, and J. Mairessec. 1998. "Research, Innovation and Productivity: An Econometric Analysis at the Firm Level." *Economics of Innovation and New Technology* 7 (2): 115–158. doi:10.1080/10438599800000031.

Crespi, F., and M. Pianta. 2008. "Demand and Innovation in Productivity Growth." *International Review of Applied Economics* 22 (6): 655–672. doi:10.1080/02692170802407429.

Crespi, G., E. Tacsir, and F. Vargas. 2016. "Innovation Dynamics and Productivity: Evidence for Latin America." In *Firm Innovation and Productivity in Latin America and the Caribbean: The Engine of Economic Development*, 37–71. Palgrave Macmillan. doi:10.1057/978-1-349-58151-1_2.

Crespi, G., and P. Zuniga. 2012. "Innovation and Productivity: Evidence from Six Latin American Countries." *World Development* 40 (2): 273–290. doi:10.1016/j.worlddev.2011.07.010.

Criscuolo, C., R. Martin, H. Overman, and J. Van Reenen. 2012. *The Causal Effects of an Industrial Policy*. NBER Working Paper No. 17842. doi:10.3386/w17842.

Crowley, F., and P. McCann. 2018. "Firm Innovation and Productivity in Europe: Evidence from Innovation-Driven and Transition-Driven Economies." *Applied Economics* 50 (11): 1203–1221. doi:10.1080/00036846.2017.1355543.

Dawson, J. W. 1998. "Institutions, Investment, and Growth: New Cross-Country and Panel Data Evidence." *Economic Inquiry* 36 (4): 603–619. doi:10.1111/j.1465-7295.1998.tb01739.x.

Égert, B. 2016. "Regulation, Institutions, and Productivity: New Macroeconomic Evidence from OECD Countries." In *American Economic Review*. Vol. 106, 109–113. American Economic Association. doi:10.1257/aer.p20161026.

Fagerberg, J., M. Srholec, and B. Verspagen. 2010. "Innovation and Economic Development." In *Handbook of the Economics of Innovation*, Vol. 2, edited by B. Hall and N. Rosenberg, 833–872. North Holland: Elsevier. doi:10.1016/S0169-7218(10)02004-6.

FAO. 2017. *The State of Food Security and Nutrition in the World (SOFI) Report I*. https://www.wfp.org/publications/2017-state-food-security-and-nutrition-world-sofi-report.

Faruq, H. A. 2019. "New Evidence on Why Many African Firms Perform Poorly." *The Manchester School* 87 (6): 848–874. doi:10.1111/manc.12271.

Faruq, H., M. Webb, and D. Yi. 2013. "Corruption, Bureaucracy and Firm Productivity in Africa." *Review of Development Economics* 17 (1): 117–129. doi:10.1111/rode.12019.

Freeman, C., and C. Perez. 1988. Structural crises of adjustment, business cycles and investment behaviour. In: Dosi, G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete, (Eds.), *Technical Change and Economic Theory*. Pinter, London, pp. 38–66.

Ganau, R, and A. Rodríguez-Pose. 2019. "Do high-quality local institutions shape labour productivity in Western European manufacturing firms?" *Papers in Regional Science* 98 (4): 1633–1666. https://doi.org/10.1111/pirs.12435

Geroski, P. A. 1991. "Innovation and the Sectoral Sources of UK Productivity Growth." *The Economic Journal* 101 (409): 1438. doi:10.2307/2234894.

Goedhuys, M., N. Janz, and P. Mohnen. 2008. "What Drives Productivity in Tanzanian Manufacturing Firms: Technology or Business Environment?" *The European Journal of Development Research* 20 (2): 199–218. doi:10.1080/09578810802060785.

Goedhuys, M., and M. Srholec. 2015. "Technological Capabilities, Institutions and Firm Productivity: A Multilevel Study." *The European Journal of Development Research* 27 (1): 122–139. doi:10.1057/ejdr.2014.32.

Griffith, R., E. Huergo, J. Mairesse, and B. Peters. 2006. "Innovation and Productivity Across Four European Countries." *NBER Working Paper* 1: 1–5. doi:10.1007/s13398-014-0173-7.2.

Guellec, D., and B. van Pottelsberghe de la Potterie. 2000. *The Impact of Public R&D Expenditure on Business R&D*. OECD Science, Technology and Industry Working Papers 2000/4. OECD Publishing. doi:10.1787/18151965.

Hall, B. 2011. *Innovation and Productiviy*. NBER Working Paper No. 17178.

Hall, R. E., and C. J. Jones. 1999. "Why Do Some Countries Produce So Much More Output Per Worker Than Others?" *The Quarterly Journal of Economics* 114 (1): 83–116. doi:10.1162/003355399555954.

Hall, B., F. Lotti, and J. Mairesse. 2009. "Innovation and Productivity in SMEs: Empirical Evidence for Italy." *Small Business Economics* 33 (1): 13–33. doi:10.1007/s11187-009-9184-8.

Hall, B., and V. Sena. 2017. "Appropriability Mechanisms, Innovation, and Productivity: Evidence from the UK." *Economics of Innovation and New Technology* 26 (1–2): 42–62. doi:10.1080/10438599.2016.1202513.

Hussen, M. S., and M. Çokgezen. 2019. "Analysis of Factors Affecting Firm Innovation: An Empirical Investigation for Ethiopian Firms." *Journal of African Business* 00 (00): 1–24. doi:10.1080/15228916.2019.1625020.

Hussen, M. S., and M. Çokgezen. 2020. "The Impact of Regional Institutional Quality on Firm Innovation: Evidence from Africa." *Innovation and Development* 0 (0): 1–22. doi:10.1080/2157930X.2020.1750143.

Lasagni, A., A. Nifo, and G. Vecchione. 2015. "Firm Productivity and Institutional Quality: Evidence from Italian Industry." *Journal of Regional Science* 55 (5): 774–800. doi:10.1111/jors.12203.

Lee, K., and B. Y. Kim. 2009. "Both Institutions and Policies Matter but Differently for Different Income Groups of Countries: Determinants of Long-Run Economic Growth Revisited." *World Development* 37 (3): 533–549. doi:10.1016/j.worlddev.2008.07.004.

Lee, H., and K. Lee. 2018. "Institutions Matter Differently Depending on the Ownership Types of Firms: Interacting Effects on Firm Productivity in China." *The Singapore Economic Review*, 1–24. doi:10.1142/S0217590818500224.

LiPuma, J. A., S. L. Newbert, and J. P. Doh. 2013. "The Effect of Institutional Quality on Firm Export Performance in Emerging Economies: A Contingency Model of Firm Age and Size." *Small Business Economics* 40 (4): 817–841. doi:10.1007/s11187-011-9395-7.

Lööf, H., and A. Heshmati. 2006. "On the Relationship Between Innovation and Performance: A Sensitivity Analysis." *Economics of Innovation and New Technology* 15 (4–5): 317–344. doi:10.1080/10438590500512810.

Lööf, H., J. Mairesse, and P. Mohnen. 2017. "CDM 20 Years After." *Economics of Innovation and New Technology* 26 (1–2): 1–5. doi:10.1080/10438599.2016.1202522.

Mairesse, J., M. Pierre, and K. Elisabeth. 2005. "The Importance of R&D and Innovation for Productivity: A Reexamination in Light of the French Innovation Survey." *Annales d'Économie et de Statistique* (79/80): 487. doi:10.2307/20777586.

Martin, L., and T. U. Nguyen-Thi. 2015. "The Relationship Between Innovation and Productivity Based on R&D and ICT Use." *Revue Économique* 66 (6): 1105–1130. doi:10.3917/reco.pr2.0048.

Mlozi S, O. Pesämaa, S. Jack, 2018. "Role of reciprocity and innovativeness on performance in a developing context: Empirical evidence from Africa." African Journal of Science, Technology, Innovation and Development. 10(1): 69–84. doi:10.1080/20421338.2017.1385133

Mohan, P., E. Strobl, and P. Watson. 2016. "Innovative Activity in the Caribbean: Drivers, Benefits, and Obstacles." In *Firm Innovation and Productivity in Latin America and the Caribbean: The Engine of Economic Development*, 73–101. Palgrave Macmillan. doi:10.1057/978-1-349-58151-1_3.

Mohnen, P., and B. Hall. 2013. "Innovation an Productivity: An Update." *Eurasian Business Review* 3 (1): 47–65. doi:10.14208/BF03353817.

Musolesi, A., and J. P. Huiban. 2010. "Innovation and Productivity in Knowledge Intensive Business Services." *Journal of Productivity Analysis* 34 (1): 63–81. doi:10.1007/s11123-009-0163-5.

Nicolaides, P. 2013. *The Economics of Subsidies for R&D: The Intrinsic Difficulty of Determining Optimum Subsidies and Implications for Reform of EU State Aid Rules on R&D*. Bruges European Economic Research Papers 26. European Economic Studies Department, College of Europe.

North, D. C., and R. P. Thomas. 1973. *The Rise of the Western World: A New Economic History*. Cambridge: Cambridge University Press.

OECD. 2018. "Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities." In *Handbook of Innovation Indicators and Measurement*. OECD. doi:10.1787/9789264304604-en.

Parisi, M. L., F. Schiantarelli, and A. Sembenelli. 2006. "Productivity, Innovation and R&D: Micro Evidence for Italy." *European Economic Review* 50 (8): 2037–2061. doi:10.1016/j.euroecorev.2005.08.002.

Raffo, J., S. Lhuillery, and L. Miotti. 2008. "Northern and Southern Innovativity: A Comparison Across European and Latin American Countries." *The European Journal of Development Research* 20 (2): 219–239. doi:10.1080/09578810802060777.

Rajapathirana, R. P. P. J. J., and Y. Hui. 2017. "Relationship Between Innovation Capability, Innovation Type, and Firm Performance." *Journal of Innovation & Knowledge* 3 (1): 44–55. doi:10.1016/j.jik.2017.06.002.

Rodrik, D., A. Subramanian, and F. Trebbi. 2004. "Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development." *Journal of Economic Growth* 9 (2): 131–165. doi:10.1023/B:JOEG.0000031425.72248.85.

Romer, P. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98 (5): S71–S102. doi:10.1086/261725.

Saka-Helmhout, A., M. Chappin, and P. Vermeulen. 2020. "Multiple paths to firm innovation in Sub-Saharan Africa: How informal institutions matter." Organization studies 41 (11): 1551-1575. doi:10.1177/0170840619882971.

Solow, R. M. 1956. "A Contribution to the Theory of Economic Growth." *The Quarterly Journal of Economics* 70 (1): 65. doi:10.2307/1884513.

Stojčić, N., and I. Hashi. 2014. "Firm Productivity and Type of Innovation : Evidence from the Community Innovation Survey 6." *Croatian Economic Survey* 16 (2): 121–146. doi:10.15179/ces.16.2.5.

Tran, T. Q., V. V. Huong, T. T. Doan, and D. H. Tran. 2016. "Corruption, Provincial Institutions and Manufacturing Firm Productivity: New Evidence from a Transitional Economy." *Estudios de Economía* 43 (2): 199–215. doi:10.15388/omee.2017.8.1.14200.

UNCTAD. 2015. "Broadening the Sources of Growth in Africa: The Role of Investment." *UNCTAD Working Paper* 14 (38): 1–4.

van Uden, A., J. Knoben, and P. Vermeulen. 2017. "Human Capital and Innovation in Sub-Saharan Countries: A Firm-Level Study." *Innovation* 19 (2): 103–124. doi:10.1080/14479338.2016.1237303.

Veugelers, R. 2016. "Getting the Most from Public R&D Spending in Times of Budgetary Austerity." Working Papers 13004. Bruegel.

Waheed, A. 2017. "Innovation and Firm-Level Productivity: Evidence from Bangladesh." *The Developing Economies* 55 (4): 290–314. doi:10.1111/deve.12152.

World Bank. 2017. *CPIA Africa, July 2017: Assessing Africa's Policies and Institutions*. Washington, DC: World Bank.