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ABSTRACT

Migration, Innovation, and Growth: An African Story?*

This chapter brings new evidence on innovation in Africa and its relationship with short-term labour mobility. Using data from 34 African countries over the period 2011- 2016 sourced from the World Bank's Enterprise Survey, we find that more than half of African firms have innovated in new product or process in the 3 years before the survey. Such high proportion may run counter to common perceptions of Africa as a region where innovation is lacklustre. The most innovative African countries are mainly located in East Africa, highlighting the dynamism of this area. Innovation there is typically about process, suggesting the existence of established productive units serving the region's market. The least innovative countries, which are characterised by innovation in products or services for local consumption, tend to be small in population and geographic size, except for one. The results also support the hypothesis that short– term labour mobility matters for innovation, making this a potentially effective channel for economic development alongside better-known activities such as investments in R&D, foreign direct investments, and trade. Short-term labour mobility thus emerges in Africa, too, as a prospective policy lever to generate new productive knowledge and promote sustainable economic growth.

JEL Classification: J61, O15, O33
Keywords: migration, labour mobility, business visits, innovation, Africa

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1. Introduction

Research on the sources of economic growth has traditionally highlighted the positive contribution of elements that are somewhat 'disembodied' like technological advances, investments in R&D, patents and routines at the core of firms' comparative advantage, institutional factors like openness to international trade, foreign direct investments, and financial capital. Embodied explanations, which instead centre on individual capabilities and activities, have received comparatively less attention. As an example, the relationship between peoples' interactions and the creation of new productivity-improving knowledge has been systematically investigated only in recent times.

Yet, embodied sources of growth could have a special place in research and policy-making in countries that are predominantly labour abundant, as they may offer complementary, or even alternative, paths to generate productivity and technological advances. In the context of Africa, several countries are relatively well endowed with young people labour mobility is relatively common, and income levels are low, though fast growing, vis-à-vis other parts of the world. This makes the continent an ideal case study as a place in which the relationship between innovation and mobility may be at work. Furthermore, as the 4th industrial revolution is heralded with migration at the core of global governance issues, the nature of the relationship between peoples' movements and productivity and innovation calls for in-depth analyses and understanding of its possible effects on, and potential uses in, the achievements of the Sustainable Development Goals (SDGs).

In this chapter, we study the link between short-term migration and innovation in Africa. In particular, we focus on the relationship between short-term forms of peoples' interactions, as proxied by international tourist arrivals per capita, and the introduction of new products, services or processes, as collected by innovation surveys. We aim to make three specific contributions. First, we wish to add to existing work, which focuses on the link between long-term or permanent migration and innovation, by extending the analysis to short-term movements. This is all the more important that Intra-African migration represents 80% of migration in Africa (AfDB, 2019) and consists mainly of circular and labor migration (Adepoju, 2008, Oucho, 1990). Short-term labour movements such as business visits are substantive channels through which new ideas and productive knowledge flow across borders (e.g. Andersen and Dalgaard, 2011), but they are not part of migration statistics, as their short-term nature accounts

them within 'tourist flows' in official data. Second, we explore the importance of peoples' interactions for introducing innovation as measured by new products, services and processes rather than patents, which tend to represent only a fraction of new knowledge generated (Kerr 2008; Agrawal, et al., 2006; Hovhannisyan and Keller, 2015). This approach reflects current standards to measure innovation (OECD's Oslo Manual). Third, we investigate innovation activities in Africa using recent and comprehensive firm-level data gathered by the World Bank's Enterprises Survey (WBES). In doing so we not only present novel results arising from this rich dataset, but complement existing analyses carried out in OECD and other high-income countries.

Our analysis shows that on average, 53.5% of African firms have been carrying out product or process innovation in the 3 years before the survey, a significant proportion, in line with rapid economic growth rates. Our study also provides support to the hypothesis that short-term labor movements have a substantial positive effect on the innovation activity of African firms.

The outline of the chapter is as follows. Section 2 discusses the concept of innovation through its definitions and measurements. Section 3 presents the background related to the relationship between innovation and migration. Section 4 presents the data. Section 5 presents the results. Section 6 summarises the link between innovation, migration and the SDGs. Section 7 concludes.

2. Innovation: Definitions, measurements, and figures

2.1 On the concept of innovation

The literature between migration and innovation mainly focuses on knowledge and technology diffusion. Diffusion is the step after an innovation arises, though it can spark further innovation as a spin-off effect. For example information about a new well-received item introduced in a particular geographic area (e.g. a tractor) could spread to other locales, resulting in the product's diffusion. Variants of the original product may be developed to better adapt it to new circumstances (e.g. different terrains), possibly leading to altogether new products (e.g. smaller or faster tractors).

Schumpeter's (1934) definition of 'innovation' as a cause of economic development and underlying force underpinning 'creative destruction' (a dynamic process where new technologies replace what is currently used) remains a fundamental reference in today's research. Schumpeter identifies innovation with the introduction

of new products or new methods of production, the opening of new markets, the development of new sources of supply for raw materials or other inputs, and the creation of new market structures in an industry. This approach is still at the base of the Oslo Manual (2005), the benchmark for innovation data collection developed by the OECD, which defines innovation as the implementation of a new or significantly improved product (good or service), or new process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

Despite the existence of an internationally agreed definition, measuring innovation is not a straightforward empirical exercise due to the broad nature and scope of the activities involved. Typically innovation is measured using variables related to its *outputs*, like enhanced firm profitability, number of new products (e.g. SPRU database), creation of patents, designs and trademarks, and improvements in total factor productivity (TFP), or its *inputs*, like the amount of resources devoted to R&D (see for example Bloom et al. 2016; Acs, Anselin and Varga, 2002; Hovhannisyan and Keller, 2015; Rogers, 1998).

However, as pointed out in the Oslo Manual (2005), while input and output variables *relate* to innovation, they only measure it imperfectly. First and foremost, they do not account for the essential activities that may have led to the innovation. For example, trials and failures in developing a new product generate skills, knowledge and experience, which may be essential to a later technological breakthrough. Yet, such interim learning process is not at all recognized by existing metrics due to the practical challenge of observing and reporting it.

Output measures such as patents are useful but they are only the observed tip of a large unmeasured 'iceberg' of intermediate efforts and attempts. In addition, many innovations are not patented because of complicated and lengthy registration processes involved. Protection then comes in the form of indirect barriers such as continuous product updates, trade secrets or other constraints to competition like the prohibition for some key workers to join a competitor firm for a minimum period after leaving the innovative firm.

Input measures, like expenditure in R&D or number of R&D employees are useful when institutional settings like accounting principles and taxation regimes are established, as they affect firms' internal organisation and reporting requirements. In addition, when the economy includes a large informal sector escaping official data

collection, R&D statistics may overly distort the actual level of innovation activity. This may be particularly problematic in the case of Africa where the share of informal employment is 72% of non-agricultural employment, the highest in the world (AfDB, 2019).

As an alternative to both patents and R&D data, knowledge diffusion is regarded as a suitable proxy of knowledge production. This approach relies on the assumption that knowledge exchanges lead eventually to the adoption of new or more productive technology, products or processes (Rapoport, 2018). Under this framework, international trade flows and peoples' mobility or interactions are valid indicators of knowledge transfers and exchanges. These are either incorporated in products and services when knowledge is disembodied (Bahar and Rapoport, 2018; Breschi and Lissoni, 2009; Jaffe et al., 1993; Keller, 2010; Hovhannisyan and Keller, 2015); or in peoples' skills when knowledge is embodied, especially in the case of temporary (Hovhannisyan and Keller, 2015; Andersen and Dalgaard, 2011; Piva et al, 2018); or through permanent movements of highly trained individuals like engineers or scientists (Bahar and Rapoport, 2018; Choudhury, 2016; Santos and Postel-Vinay, 2003; Hunt and Gauthier-Loiselle, 2010).

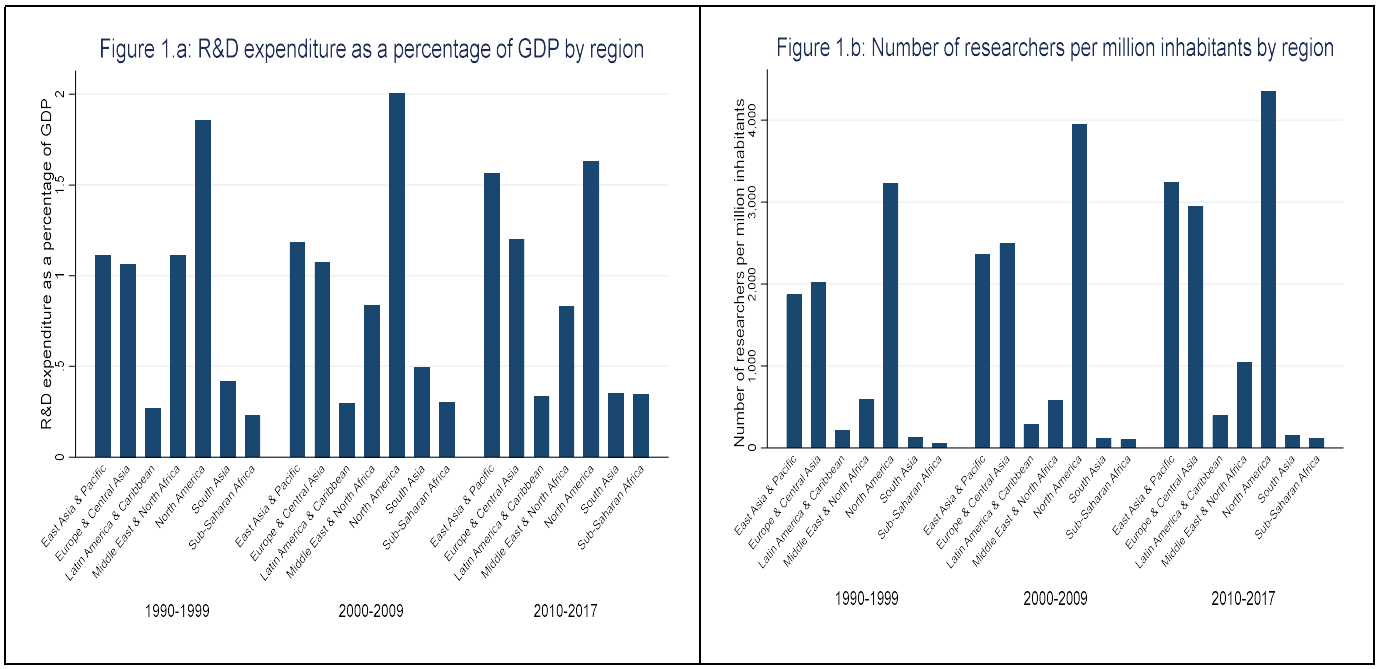
2.2 Facts and figures on R&D in Africa

Africa has witnessed an unsteady but slow upward trend in Research and Development (R&D), as measured by expenditure as a proportion of GDP and in PPP dollars, and the number of researchers in absolute term and per million inhabitants (figures 1.a and 1.b). UNESCO statistics show that the sub-Saharan Africa region's overall expenditure in R&D as a percentage of GDP rose from 0.23% in the 1990s[4] to 0.35% in the 2010s[5] (figure 1.a). Over the last decade, the highest average expenditure as a percentage of GDP was recorded in Kenya (0.79%), South Africa (0.75%), Senegal (0.65%), Tanzania (0.46%) and Ethiopia (0.42%)[6]. Only Kenya and South Africa are close to the 1% expenditure target (by 2020) set by the African Union. In contrast, the countries with the lowest share of R&D expenditure are Cabo Verde, Lesotho and Madagascar with values estimated at less than 0.08%. Sub-Saharan Africa's performances in R&D have been very distant from other regions such as North

[4] Data available from 1996
[5] Data from 2010 to 2016
[6] All rankings throughout the text are subject to data availability

America, East Asia & Pacific, and Europe & Central Asia. For instance, since 2010, Africa has spent on average only a quarter as much as North America and East Asia & Pacific (figure 1.a). However, in terms of expenditure over the last period, Africa's achievements have not been significantly different from those observed in South Asia, and Latin America & Caribbean. The average expenditure of each of these three regions ranges between 0.33 and 0.36 % of GDP (figure 1.a).

Figure1: Research and Development statistics in Africa and other regions

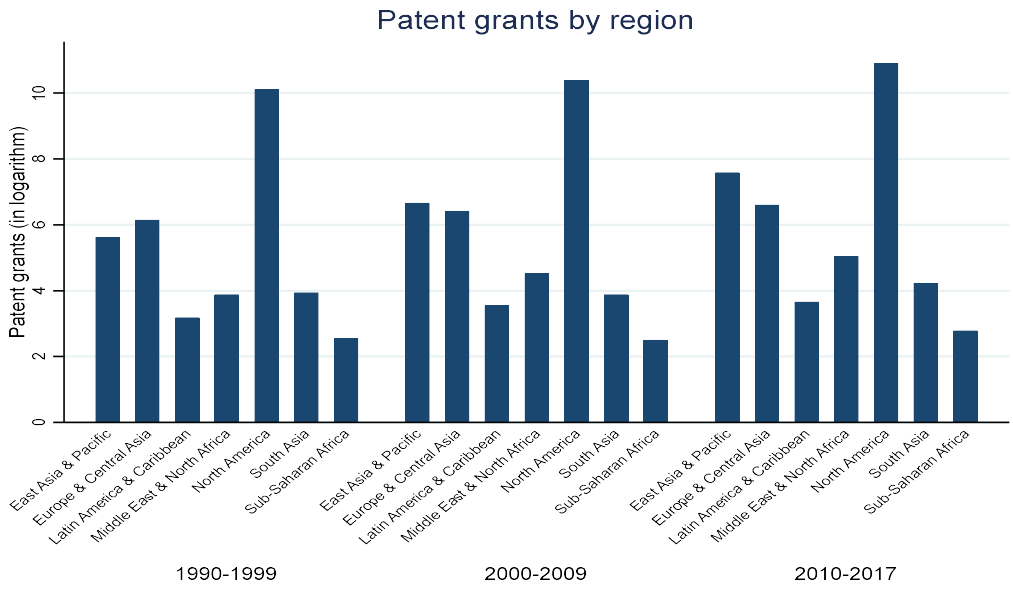


Source: Authors' computation using data from the UNESCO statistics

Since the work of Jaffe et al (1993), one common way to measure innovation has been to use patenting activities. A patent grant implies that the idea embodied in the patent represents a novel and useful contribution (an innovation) over the previous state of knowledge. Data on total patent grants by applicant's place of origin sourced from the World International Property Organization (WIPO) show that the average number of patents granted to Africa's residents has been quite unstable (figure 2). Over the period considered, Africa's inventors were granted on average 163 patents, with a peak in 2002 (509 patent grants). Patent grants are mainly driven by South Africa's resident inventors, which from 2010 to 2016 accounted for 1275 patents on average, far ahead Cote d'Ivoire, which comes second with only 306. With regard to patenting activities, Africa is lagging behind other regions of the world such as North America,

East Asia & Pacific, and Europe & Central Asia - the most innovative regions. Sub-Saharan Africa has witnessed the least patenting activities over the period 1990-2010.

Figure 2: Patents grants by region



Source: Authors' computation using data from the WIPO statistics

3. Background on migration, mobility and innovation

3.1 Determinants of innovation

The research summary provided by the Oslo Manual (OECD and Eurostat, 2005) suggests that innovation is determined by a number of factors. Some are technological, such as the strategic market position relative to competitors (Tirole, 1995), the level of uncertainty related to technology, markets, or product demand (Rosenberg, 1994). Others are institutional such as regulations or tax rules, and the ability of enterprises to appropriate the benefits stemming from their innovation activities, population size or the level of development measured by GDP (Hovhannisyan and Keller, 2015). Others relate to the characteristics of labour market like the level of education of those employed (Hunt and Gauthier-Loiselle, 2010), or are firm-specific decisions like R&D expenditures.

3.2 Migration and innovation

Migration, a priori, can positively or negatively affect innovation activity. The negative effect arises in theory when the migration of high skilled people generates a 'brain drain' in the country of origin depleting its stock of productive knowledge. However, empirical evidence suggests that migration has a positive impact on innovation, as labour movements establish the circulation of knowledge between sending and receiving countries through 'diaspora' networks (Rapoport 2018). The link between those moving in a new country and family and friends, or former colleagues, remaining in the place of origin is seldom lost.

Using data from 135 countries and 781 products from 1990 to 2010, Bahar and Rapoport (2018) show that the increase in the number of immigrants from a country exporting a certain product raises the likelihood of the receiving country to begin exporting that product in the next 10 years. A 10% increase in the immigrant stock from a country exporting a good is associated with a 2% increase in the probability of the receiving country to export the same good. It has also been demonstrated that compared to domestic firms, diaspora firms higher a higher likelihood to be exporters, to export more and towards more destinations (Boly et al., 2014).

This positive effect between migration and innovation has also been documented in the case of returning migrants (Santos and Postel-Vinay, 2003), as they tend to be more innovative, having learnt across various places, relative to local hires. Migrants in fact play the role of bridge from transferring knowledge from multinational enterprise headquarters to local employees (Choudhury, 2016).

3.3 Business visits and innovation

Unlike the case of migration, there is limited evidence about the effect of short-term labour movements on innovation. Notwithstanding the scarce literature, there is concordant support that short-term labour movements have a positive effect. Hovhannisyan and Keller (2015) show that business travel has a positive impact on countries' rate of innovation, as measured by the number of patents. Using data from the United States on patenting from 37 sectors in 34 developed and developing countries over the period 1993-2003, they find that 10% increase in visits in the US raises patenting in the places of origin by 0.2%. The technological content exchanged through visits is also important. Anderson (2007) shows that the inflows of business and professional visits have a positive effect on levels of per capita income in developing countries.

3.4 Channels of transmission

The mechanism through which temporary and permanent labour movements affect knowledge is the direct human interaction, as these foster mutual trust and thus the exchange of ideas and productive knowledge (Gambetta, 1988; Storper and Venables, 2004).

These exchanges reduce information asymmetries between what the interacting parties already know, leading to productivity shifts, especially when the interaction is carried out by highly educated individuals. This is well illustrated by Bahar and Rapoport (2018), who show that the positive relationship between migration and knowledge diffusion increases good specific productivity shift at a sectoral level. Labour movements can also increase the circulation and diffusion of knowledge through co-inventorship and R&D outsourcing, allowing collaboration between applicants of developed countries and inventors of developing countries (Miguelez, 2018; Agarwal et al., 2011; Kerr, 2008). This is particularly so in the case of tacit knowledge (Howells, 1996).

Productivity shift and the level of skills of workers also explain the positive effect of visits of shorter duration on innovation since significant knowledge flows occurs during short terms visits, such as conferences (Bathelt and Schuldt, 2008; Hammermesh, 2006). Another example from the art domain shows that travel enhances the value of painting of modern artists through human capital investment, knowledge spill-overs and inspiration acquired in the places visited (Hellmanzick, 2013). Evidence also exists about a positive relationship between short-term work-related travel and productivity (Andersen and Dalgaard, 2011; Dowrick and Tani, 2011). Business visits make a substantive contribution to productivity relative to other determinants. For instance, comparing the productivity impact of business visits to R&D expenditures using a panel of 16 sectors in 10 countries over the period 1998-2011, Piva et al (2016) show that labour mobility through business visits raise productivity by half as much as investing in R&D, a well-known and researched determinant of productivity and innovation.

4. Data and descriptive statistics

4.1 Data

To study the relationship between short-term migration and innovation we combine data from various sources. Innovation data are sourced from the WBES[7], a firm-level survey focusing on topics related to the business environment in which a country's private sector is evolving. It surveys business owners and top managers by sector, mainly focusing on cities and/or regions of major economic activities. We use a pooled cross-section covering 34 African countries during the period 2011 to 2016 from the aggregated WBES dataset, which does not include the country specific questions, allowing us to make firm-level comparisons across a large number of nations. The initial sample includes more than 37,000 firms. Questions cover, among others, innovation activities, R&D expenditures, personnel, location, ownership structure, relationship with institutions and suppliers, and whether the firm holds an internationally recognised quality certification.

We combine the WBES with country-level variables sourced from various data repositories. In particular we use information on the GDP growth rate, trade, population, migration, and tourism from the World Bank Development Indicators (WDI), FDI stock data from the United Nations Conference on Trade and Development (UNCTAD), informal employment statistics from the International Labor Organization (ILO), and institutional quality indicators about the rule of law from the World Governance Indicators database.

4.2 Descriptive statistics

4.2.1 Within-firm determinants of innovation

Table 1[8] describes the share of innovative firms across Africa, by country, based on our initial WBES sample. Innovation is sourced from two questions: "Have you introduced a new product or service in the past 3 years?" (Question h1); and "During the last 3 years, has the establishment introduced a new or a significantly improved process?" (Question h5). Unfortunately the WBES does not ask these questions in each country over the period covered, and some, like South Africa, are notable omissions in the table. [9]

[7] Source: http://www.enterprisesurveys.org

[8] Table 1 presents data for countries for which the information on new product and new process is available.

[9] Although the various Enterprise Surveys for African countries have data for some countries since 2002-2003, we focus on the period 2011-2016 because data related to the main interest variables are provided since 2011 (one exception is however Madagascar which has a survey in 2013 but which did not include those questions).

Notwithstanding this restriction, which reduces the number of responding firms to about 20,000, WBES data show that the average share of firms introducing new products or services, or either over the past three years is 53.5% - that is more than half of the sample[10]. In most cases, and this is noteworthy, innovation emerges from the introduction of both products and processes (column labeled C).

Table 1 ranks countries according to the share of innovative firms from highest to lowest. It is worth noting that the total share of innovative firms (first column) is highest in East African countries. The case of Rwanda is compelling: according to the Global Innovation Index, out of 126 countries, Rwanda went from 112th in 2013 to 99th in 2017, making it the best performing low-income country in the world. Similarly, the 2017-2018 Global competiveness ranked Rwanda 44th out of 137 countries in terms of innovation before many Asian and Latin American countries (Schawb, 2017; World Bank, 2019). Other East African countries are also experiencing a rapid economic and digital transformation. For example Africa is now the world leader in 'mobile money', and East African countries are leading this trend. In Kenya, Rwanda, Tanzania, Uganda, and Ghana, the only West African country of the list, there are more than 1000 mobile money accounts per 1000 adults, suggesting that money transfers are a common commodity and, probably, a substantive contributor to help funding private consumption and investments. In Kenya alone, M-Pesa, a financial services provider, earns more than $550 million annually in financial services revenues[11], a non-negligible amount for a country whose GDP reached $75 billion in 2017.

Table 1 also shows that the countries with the least innovative firms tend to be small in population and size, with the exception of one (Egypt). Innovation in these countries is predominantly due to the introduction of a new product or service (column labelled A) rather than process, supporting the hypothesis that small domestic market size and limited transport infrastructure may hinder the emergence of such countries as centres of production for a wider region.

4.2.2. *Short-term mobility and innovation*

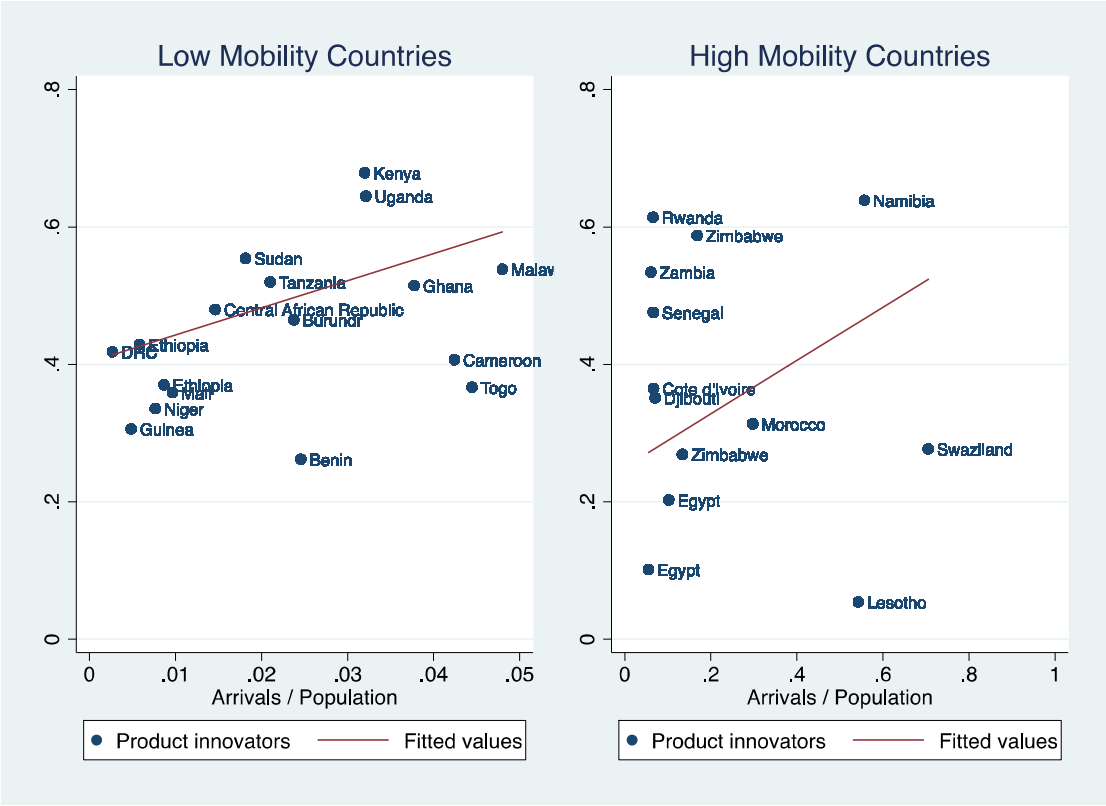
The relationship between short-term mobility and innovation at country level is initially explored in Figure 1, where the share of visitor arrivals per capita (horizontal axis) is

[10] We find that 53.5% of the firms surveyed in the WBES have introduced an innovation over the past three years (Table 1). This proportion rises to 75% in the working sample (Table 3), which restricts the observations to countries for which data on informal employment is available. Table 2 shows how data are trimmed based on available indicators.

[11] Source: McKinsey https://www.mckinsey.com/industries/financial-services/our-insights/mobile-financial-services-in-africa-winning-the-battle-for-the-customer.

juxtaposed to that of innovating firms (vertical axis). In particular, two graphs are presented, broadly splitting the share of tourist arrivals per capita in two groups of equal size, labelled as Low and high mobility countries respectively, to limit the influence of outliers of this variable, which include countries hosting world-famous historical or natural sites and wildlife sanctuaries, or having a small population. The graphs reflect country-year observations so countries with multiple WBES appear more than once. The data in Figure 1 are unconditional means, and therefore do not take into account the effect of other covariates. However, they support *a priori* the hypothesis of a positive relationship between short-term mobility and the share of innovating firms. The fitted lines have a positive slope, which becomes more pronounced for higher shares of visitors per capita. The underlying correlation coefficients are 0.5093 and 0.3218, respectively, for the graphs on the left and right in Figure 1.

Figure 1 The link between short-term mobility and new products and services

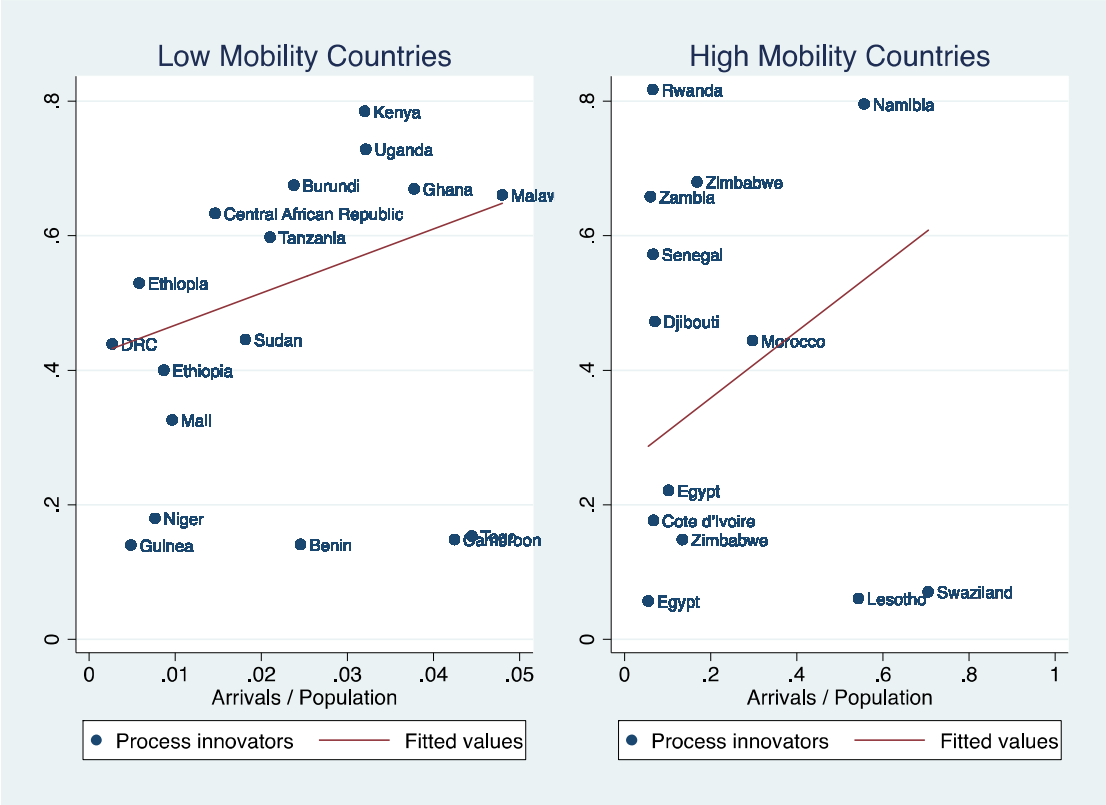


Source: WBES (various years): Question h1 "Have you introduced a new product or service in the past 3 years?" and WB indicators database (tourist arrivals, population). The vertical axis reports the share of innovating firms.

The possible existence of a positive relation between short-term mobility and the introduction of new products or services arises also when innovation is restricted to new processes, as depicted in Figure 2 (share of innovating firms on the vertical axis):

the relationship is positive and more pronounced for higher shares of visitors per capita, while the underlying correlation coefficients of the graphs on the left and right of Figure 1 are 0.3536 and 0.2949, respectively.

Figure 2 The link between short-term mobility and new processes

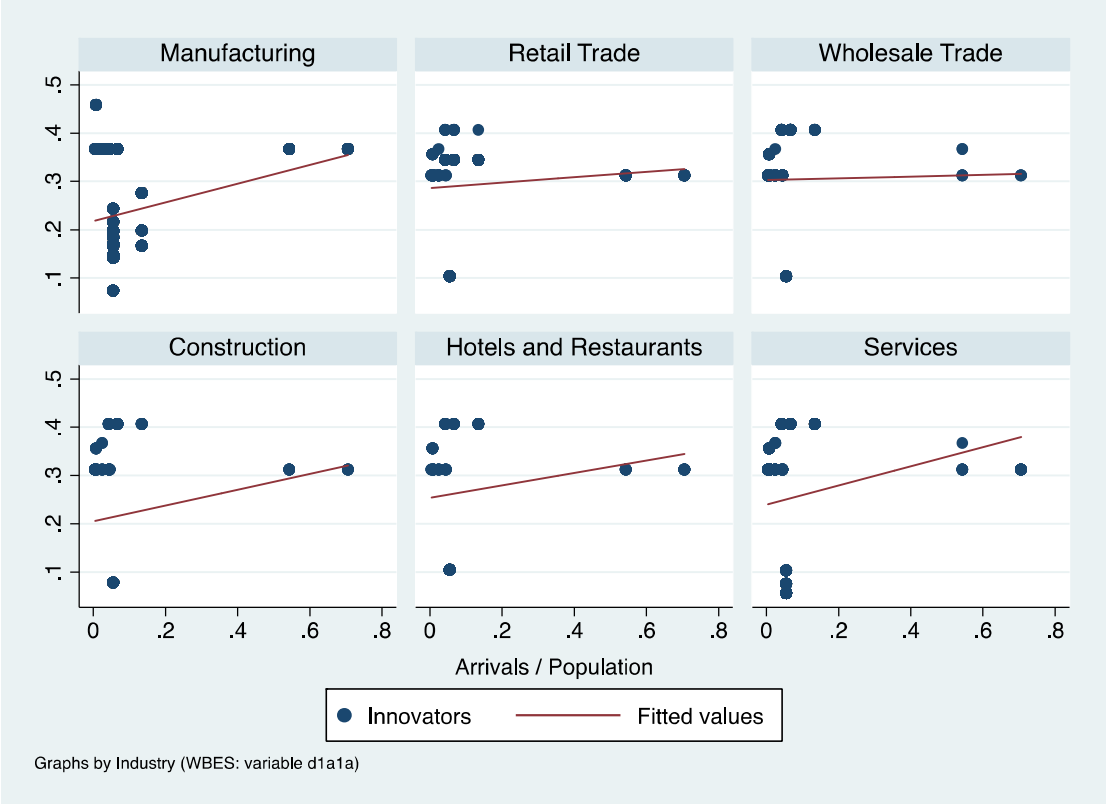


Source: Authors' computation using data from WBES (various years): Question h5 "During the last 3 years, has the establishment introduced a new or a significantly improved process?" and WB indicators database (tourist arrivals, population). The vertical axis reports the share of innovating firms.

The relationship between mobility and innovation also arises when the analysis is carried out at a sectoral level, as shown in Figure 3. Here the vertical axis reports the average share of innovating firms by industries using the WBES variable *stra_sector* (39 industries) while the horizontal axis reports the national average inflow of tourists per capita. Each plot in the scatter therefore represents a national industry/short-term arrivals combination. Figure 3 groups such combinations within the aggregate sector defined by the WBES variable *d1a1a*.

Figure 3 suggests that the positive relationship between mobility and innovation is not specific to an industry but seems to span across all sectors of the economy, with some variation. The link between mobility and innovation is more pronounced in industries that are more 'strategic' such as manufacturing (especially machinery within this sector) and services (particularly IT), as reflected by steeper fitted lines.

Figure 3 The link between short-term mobility and innovation, by industry



Source: Authors' computation using data from WBES (various years): new variables combining questions h1 ("Have you introduced a new product or service in the past 3 years?") and h5 ("During the last 3 years, has the establishment introduced a new or a significantly improved process?") by industry (variable stra_sector), and WB indicators database (tourist arrivals, population). The six aggregate industries presented correspond to the WBES variable d1a1a (Establishment's main product or service in the last year). The vertical axis reports the share of innovating firms.

These results support using a more formal approach to test the link between mobility and innovation, so that the influence of other relevant covariates can be properly taken into account. Doing so also enables us to quantify the strength of the relationship of interest.

4.2.3 Towards a quantitative analysis

As a prelude to the quantitative analysis, Table 2 shows the data trimming occurring as a result of information not being available for each country. The initial sample reduces to a working sample consisting of 12,147 firms, with employment data causing the largest drop in the number of usable observations. Within the working sample, Table 3 shows that on average, 75% of the firms have innovated over the past three years, equally split between those introducing a new product (37%) or process (38%). Since the number of observations in the working sample (Table 2) is smaller than the number of observations for all countries for which the innovation data is

available (Table 1), we prefer being conservative in our preliminary discussion by considering the 53.5% of firms which have been innovative over the past 3 years. In both cases, these shares are likely to underestimate the true degree of innovation in Africa, as the working sample does not cover large and advanced economies like South Africa.

Table 3 shows that 17 % of the firms in the working sample have invested in R&D during the year before the survey. The equivalent share for Israel, a well-known high-R&D country yet covered by WBES hence based on the same approach to data collection, is 30% - less than double, though Israel's GDP per capita is more than double the GDP per capita of the African countries considered. Table 3 also shows that 39% of the firms in the working sample are located in the capital city, where infrastructure is likely to be most advanced relatively to the rest of the country. Only 17% of them have an internationally recognised quality certification, partly because they are the domestic arms of a multinational company. More than half of the firm in the working sample are small ones, having less than 20 employees, 31% are medium size (21-99 employees) and 16% of firms are large size firms (100+ employees). This perhaps reflects the importance of the informal sector, where firms tend to be small, and which accounts for 76% of employment in the countries covered in the working sample (Table 3). With reference to peoples' interactions, annual tourist arrivals represent on average about 1% of the population. For comparative purposes, the corresponding figure for the United States in 2017 is 21% (World Tourism Organisation – World Bank[12]).

5. Migration, innovation and growth in Africa

5.1 Empirical framework

The relationship between innovation and short-term labour movements is estimated using a linear probability model, hence applying Ordinary Least Squares (OLS) to the model:

$$Innov_{ijt} = a_0 + X_{ijt}\beta + C_{jt}a_1 + a_2 ARR_{jt} + T_t a_3 + \varepsilon_{ijt} \qquad (1)$$

where $Innov_{ijt}$ is an innovation indicator of whether firm i in country j at time t has innovated a product, a process or both in the previous three years. The vector X_{ijt}

[12] https://data.worldbank.org/indicator/ST.INT.ARVL?locations=US

contains a set of firm-specific parameters that includes whether the firm has invested in R&D in the previous 12 months, its location in a capital city, its holding of an internationally recognised quality certification, and its size, as measured by the number of employees. Information on whether the firm has invested in R&D last year aims to capture efforts in improving services and processes. The location of the firm allows us to control for the differences that could exist in terms of availability of infrastructures, access to opportunities and disparities in level of development within a country. The ownership of international quality certification and the size of the firm typically affect the productivity level of the firm and its capacity to innovate.

The vector C_{jt} includes a set of country-specific controls that include GDP growth, lagged one year, a measure of institutional quality (the rule of law), and the share of informal employment in the economy. Including GDP growth aims to control for the changes in economic conditions of the country such as infrastructure creation. The lagged growth rate is more exogenous than the contemporaneous one. Indeed if economic growth at time t-1 can affect innovation at time t, it is very unlikely that innovation at time t affects GDP growth in the previous period. The level of governance in a country provides the legal setting to carry out transactions and is therefore a fundamental determinant of both economic activity and incentives to introduce new products or processes.

The variable ARR_{jt} is the key explanatory variable, the number of tourist arrivals per person in the country's population, which we use as a proxy for the intensity of interactions between those living in the destination country and the rest of the world. This data is from the World Development Indicators but is initially collected from the World Tourism Organization (WTO). We choose this variable as a proxy for short-term migration and temporary arrivals following the literature (e.g. Gambardella, Mariani and Torrisi, 2009; Andersen and Dalgaard, 2011). As highlighted by Andersen and Dalgaard (2011), the label tourist arrivals covers a wider reality since tourism is a subset of the arrival departures. This variable considered arrivals of people coming for no more than one consecutive year for business, leisure, and other purposes not related to an activity remunerated from within the place visited. We only consider arrivals since we are interested in the effect of the people flows in the innovation of the receiving countries, thereby considering only one aspect of the ways in which interactions can be actually carried out.

The variable T_t is a vector of year dummy variables. The error term, ε_{ijt}, is clustered by industry at country level, allowing observations to be correlated within industry-country combinations across Africa.

5.2 Results

Table 4 presents the results. The table includes four specifications to identify the baseline model and single out the contribution when additional channels of innovation-related interactions are included. The four sub-specifications differ in the measurement of the dependent variables, as representing only the introduction of a new product (model I) or a process (II) or both depending on whether innovation is still quantified as a dummy variable equal to zero if the firm did not innovate and 1 if the firm introduced either a new product or process (III) or a variable containing three categories: zero for no innovation, 1 for either new product or process, and 2 for both new product and process (IV). While models I-III are estimated by OLS, model IV is estimated by maximum likelihood (ordered probit), which is more efficient in catering for the non-linearity of the dependent variable.

All the estimates in Table 4 are marginal effects. Namely they indicate the change in the dependent variable from 'no innovation' to 'innovation in either product or process' (i.e. from 0 to 1) when the independent variable increases by a unit, maintaining unchanged the value of the other variables. Overall, the models explain about 20%-30% of the variation in innovation activity. This order of magnitude is comparable to existing innovation studies.

With reference to firm-level variables, specifications I-IV support that innovation for African firms responds to the same determinants as found in other parts of the world. New products (I) and processes (II), as well as innovation more broadly (III and IV) respond mostly to investments in R&D, a direct knowledge-producing activity. The coefficient of R&D is by far the most important both in terms of magnitude, accounting for over 30% of the probability of innovating in the following year, and statistical significance (p-value < .01). Innovation also positively relates to being located in a capital city, holding an internationally recognised quality certification, and being a medium-size or large firm.

With reference to the country-level controls, innovation positively correlates with lagged GDP growth and more certainty in the applications of laws. This coefficient is always positive and statistically significant (p-value < .01). The size of the estimate

in the case of new process is 3 times as high as in the case of new product and services, suggesting that new processes may involve technological and knowledge transfers that require adequate protection, as measured by the level of institutional quality in the country of destination. This explanatory variable is also the only one where the coefficient estimates for new product (model I) and processes (model II) differ substantively.

Another noteworthy result is the relevance of the informal sector in positively contributing to innovation activity: this result does not imply that informal activities ought to be incentivised because they lead to more innovation, but it suggests that informality is not a black box with no or negative value for the hosting economy. On the contrary, it may have a place in the formation of productive knowledge and in the introduction of new products and processes. This may be specific to Africa and other regions where informality accounts for such a high share of employment. More research on this topic is needed to understand the mechanisms through which such a result arises. These results are broadly consistent in highlighting that short-term mobility in Africa may act as a potential channel for knowledge exchanges and the generation of new productive knowledge.

These results hold even when we expand vector C_{jt} in model (1) to include additional country-specific explanatory variables controlling for other factor and commodity movements. We show this in Table 5, where we augment model (III) with country-specific variables capturing the openness to trade, as measured by imports plus exports as a share of GDP, the stock of Foreign Direct Investments as a share of GDP, and the share of migrants in the population[13]. The results confirm that innovation significantly benefits from previous investments in R&D, locational and firm-size advantages, and holding an internationally recognised certification. Innovation seems also more likely when the quality of the domestic institution is higher, regardless of the size of the informal sector.

With reference to factor movements, the results in Table 5 confirm what already found by previous studies: innovation is higher when economies are opened to FDI and migrants, while the coefficient associated with commodity trade is positive but

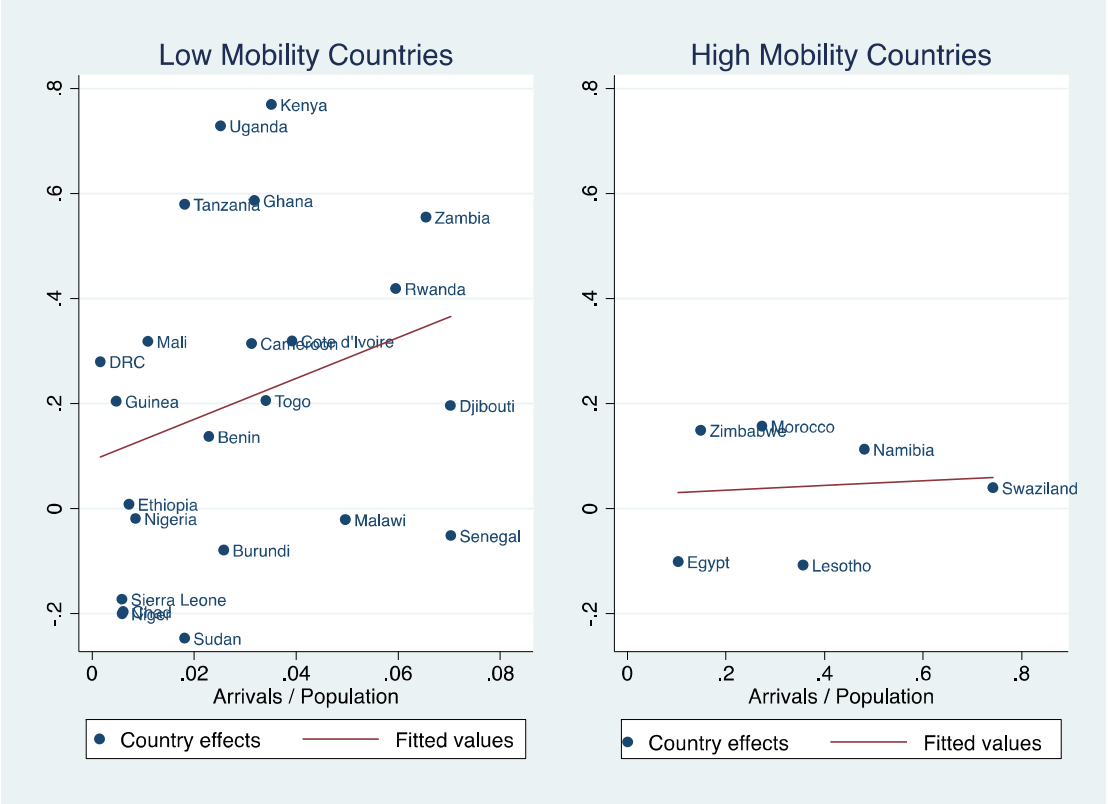
[13] The inclusion of a variable capturing trade openness aims to control for innovations occurring through the exchanges of goods (Rapoport, 2018). Similarly, using the stock of FDI as share of GDP accounts for innovation entering the country via foreign direct investments. Finally the share of migrants in the population accounts for innovation arising from long-term or permanent population movements as a distinct channel than short-term labour movements.

statistically no different from zero, perhaps due to opposite effects on innovation from imports and exports. With reference to short-term labour mobility, its relevance and effect on innovation is unchanged, strengthening the hypothesis that it may be viewed as a distinct source of productive knowledge. In fact, its point estimate increases as more factors movements are controlled for (fourth column, labelled Baseline + Trade + FDI + Migration).

The magnitude of the coefficients is quite large. One possible influencing factor is the small number of countries included in the working sample, which tends to inflate the size of the coefficients. At the same time, mixing individual- and group-level variables may be problematic if the 'large sample size' assumption required for consistent and efficient estimates is not be met (Bryan and Jenkins, 2015). If the ideal solution of collecting new firm-level data on interactions with the external environment is not possible, as in our case, the suggestion is to apply a two-step regression technique and produce a graphic representation of the relationship of interest. To verify the robustness of the results discussed we hence regress firm-level data on firm-level explanatory variables and a vector of country dummies (step 1), and then regress the estimated average country effects on other country-level explanatory variables (step 2)[14]. In other words, we apply OLS to model (1) with vector C_{jt} containing only country dummies. Then, the estimated coefficients $\widehat{C_{j-1}}$, (the average country effects on firms' innovation activity) are graphically linked to arrivals per capita[15]. The result, graphed in Figure 4, illustrates a positive relationship between average country effects on innovation and short-term mobility, especially for countries where arrivals per capital are not distorted by visits to world-known historical and natural attractions, as in the case of Egypt and Zimbabwe, or by the small population size, as in the case of Swaziland, Lesotho, and Namibia.

[14] The two-step approach is itself not without problems, as indicated by Bryan and Jenkins (2015).
[15] The second step regression includes lagged GDP growth, the share of informal employment, the share of migrants, openness to trade, the share of foreign FDI, and the number of tourist arrivals per country inhabitant. The coefficients of those variables are typically not statistically different from zero and hence are not reported.

Figure 4 Estimated country effects and peoples' interactions



The outliers (graph on the right) receive a much higher share of tourist per capita, making it more difficult to detect a clear relationship between country effects and mobility.

6. Discussion: Migration, innovation and the SDGs in Africa

The results provide support to the hypothesis that short-term mobility, as proxied by tourist arrivals per capita, are associated with higher innovation activity. This result adds support to one of mobility's established fundamental benefits: the exchange and formation of productive knowledge. As stated by goal 10.7 of the SDGs, within the goal of inequality reduction and aiming to facilitate safe, orderly, regular and responsible migration through better migration policies, labour movements matter, and our results show that both short and long term forms of movement carry important economic consequences. Their realization across countries could hence be viewed as a way to further enhance economic growth. According to the African Visa Openness Index report (2018), the free movement of people has still a way to go within the continent. In 2018, Africans need a visa to travel to 51% of other African countries. This figure was only marginally higher in the previous years (54% in 2017 and 55% in 2016).

In the context where the African Free Trade Area (AfCFTA), which aims at "creating a single continental market for goods for goods and services, with free movement of business persons and investments" and the Single African Air Transport Market launched in 2018, the Free Movement of persons remains a critical issue to facilitate knowledge exchanges across borders. As mobility does not require a permanent relocation of people, its encouragement can be used to overcome a small domestic market size or lacklustre innovation. Our results support the view that short-term labour mobility can contribute to achieve Goal 9 of the SDGs to "build resilience, promote inclusive and sustainable industrialization and foster innovation".

There are other objectives that can also be linked indirectly to the relationship between short-term labor mobility and innovation. These are poverty reduction (Goal 1), ensure quality education (Goal 4), promote productive employment and decent work (Goal 8), the promotion of peace, justice and strong institutions (Goal 16). The link to the goal of poverty reduction is quite straightforward since innovation is one of the motor of economic growth and short-term visits seem to act as a channel to new productive knowledge in Africa too, as found for other countries.

This chapter also provides some support to the hypothesis that innovation can occur even when the informal sector is the predominant sector of employment, and the proportion of high-skilled workers is much lower than other parts of the world. However, as the informal sector typically does not provide good jobs or jobs that are safe, attached to decent salaries and working conditions, there are substantial benefits to be gained at the national level if workers transit from the informal to the formal sector, perhaps via larger firms, whose formation could too be encouraged with targeted policies.

As innovation matters more than ever in the Fourth industrial revolution, the risk of skills mismatch where the curriculum in the education systems do not necessarily matches the skill needs could be partly alleviated by promoting short-term migration and the associated circulation of knowledge and ideas. Our results show that the rule of law matters, and that poor governance can be both an obstacle to innovation and to people mobility: this needs to be reviewed.

Given the key contribution of R&D to long run growth and development, Africa can intensify its efforts to shape a better comparative advantage with respect to the other regions. We provide some evidence that labor mobility could play a role, and hence encourage the development of policies that create connectivity, alongside encourage

additional research focusing on the transmission channels that underpin the relationship between short-term migration and innovation.

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Table 1 Share of innovating firms across Africa from highest to lowest share

Country	Innovating Firms				Did not innovate	N
	Total (A + B + C)	*Product only (A)*	*Process only (B)*	*Both (C)*		
	(%)	*(%)*	*(%)*	*(%)*	(%)	
Rwanda	87.6	*5.8*	*26.1*	*55.6*	12.4	241
Kenya	85.1	*6.2*	*16.6*	*61.8*	15.4	759
Namibia	81.8	*2.3*	*17.3*	*62.2*	18.2	556
Uganda	76.9	*4.0*	*11.9*	*61.0*	23.1	748
Mauritania	75.8	*6.7*	*20.1*	*49.0*	24.2	149
Zambia	74.2	*8.5*	*20.9*	*44.8*	25.8	698
Malawi	74.0	*7.9*	*19.5*	*46.5*	26.0	507
Central African R	73.3	*10.0*	*25.3*	*38.0*	26.7	150
Burundi	73.2	*5.7*	*26.8*	*40.8*	26.8	157
Ghana	71.7	*4.6*	*20.6*	*46.5*	28.3	710
Nigeria	67.6	*4.2*	*17.5*	*45.6*	32.7	2,571
Tanzania	67.1	*7.4*	*14.9*	*44.8*	32.9	784
South Sudan	66.0	*24.4*	*16.9*	*24.8*	34.0	718
Senegal	65.3	*8.4*	*17.9*	*39.2*	34.5	592
Sudan	59.0	*14.4*	*5.0*	*39.6*	41.0	637
Ethiopia	54.2	*8.6*	*14.6*	*31.0*	45.8	1,481
Dem Rep Congo	53.2	*9.1*	*11.2*	*32.8*	46.9	525
Zimbabwe	53.1	*11.1*	*9.7*	*31.7*	47.4	1,195
Djibouti	51.0	*3.9*	*16.9*	*30.2*	49.0	255
Morocco	50.9	*5.9*	*18.6*	*25.7*	49.9	393
Gambia	50.0	*29.3*	*2.7*	*18.0*	50.0	150
Mali	47.8	*15.2*	*12.0*	*20.7*	52.2	184
Liberia	47.0	*22.5*	*2.0*	*22.5*	53.0	151
Cameroon	43.8	*28.1*	*3.4*	*11.5*	57.0	349
Chad	42.8	*27.0*	*5.9*	*9.9*	57.2	152
Cote d'Ivoire	41.4	*23.7*	*5.7*	*12.0*	58.6	350
Togo	39.3	*24.0*	*2.7*	*12.7*	60.7	150
Niger	38.3	*20.1*	*4.7*	*13.4*	61.7	149
Sierra Leone	34.9	*15.8*	*0.7*	*18.4*	65.1	152
Guinea	32.9	*18.6*	*3.6*	*10.7*	67.1	140
Benin	30.9	*16.8*	*4.7*	*9.4*	69.1	149
Swaziland	27.1	*20.0*	*1.4*	*5.7*	72.9	140
Egypt	24.2	*7.7*	*7.1*	*8.7*	76.6	4,678
Lesotho	9.0	*2.8*	*3.4*	*2.8*	91.0	145
TOTAL	53.5	*9.4*	*12.6*	*31.4*	46.5	20,865

Source: World Bank - Enterprise Survey. A: question h1 ("Have you introduced a new product or service in the past 3 years?"). B: question h5 ("During the last 3 years, has the establishment introduced a new or a significantly improved process?").

Table 2 Data trimming

Item	N
Number of firms in Enterprise Survey	37,107
With valid responses on innovation of either product or process	20,865
With valid controls at firm level	20,214
With valid governance for rule of law [+]	19,920
With valid GDP growth data [++]	19,672
With valid informal employment data [+++]	12,297
With valid tourist arrival data [++]	12,147

Sources: [+] Worldwide Governance Indicators, [++] World Development Indicators, [+++] ILO

Table 3 Data summary – working sample

Variable	Mean	Standard Deviation
Has innovated in past 3 years	0.75	0.86
Has innovated product or service	0.37	0.48
Has innovated process	0.38	0.49
Firm-level controls		
Has invested in R&D in last year	0.17	0.37
Is located in capital city	0.39	0.49
Has internationally recognised quality certification	0.17	0.38
Firm is medium size (20-99 employees)	0.31	0.46
Firm is large size (100+ employees)	0.16	0.37
Country-level controls		
GDP growth (lagged) [+]	.052	.039
Governance indicator – rule of law [++]	-0.59	0.45
Informal employment as % of employment [+++]	0.76	0.16
Tourist arrivals as % of population [+]	.095	.122
N	**12,147**	

Source: World Bank - Enterprise Survey, [+] Worldwide Governance Indicators, [++] World Development Indicators, [+++] ILO.

Table 4 Results

MODEL	**I**	**II**	**III**	**IV**
Dependent variable	**New product** OLS	**New process** OLS	**Innovation** OLS	**Innovation** ML (oprobit)+
Explanatory variables				
Invested in R&D last year	.331***	.315***	.647***	.054***
	(.014)	(.016)	(.027)	(.004)
Located in capital city	.052**	.038***	.090***	.009***
	(.014)	(.013)	(.025)	(.002)
Recognised certification	.076***	.080***	.156***	.015***
	(.014)	(.012)	(.022)	(.002)
Medium-size firm	.038***	.050***	.088***	.008***
	(.011)	(.013)	(.020)	(.002)
Large firm	.057***	.034***	.092***	.010***
	(.014)	(.013)	(.022)	(.002)
Country controls				
GDP growth lagged	.418	.846***	1.26**	.075*
	(.299)	(.282)	(.512)	(.045)
Rule of law	.059***	.188***	.246***	.015***
	(.019)	(.015)	(.029)	(.002)
Informal employment	.806***	.771***	1.58***	.158***
	(.054)	(.053)	(.096)	(.013)
Tourist arrivals / population	.421***	.357***	.779***	.092***
	(.063)	(.069)	(.119)	(.011)
Constant	-.515***	-.563***	-1.07***	
	(.055)	(.053)	(.093)	
Year dummies	Yes	Yes	Yes	Yes
Nr clusters (country*industry)	452	452	452	452
Adjusted R^2 (pseudo R^2 for ML)	.2129	.3247	.3310	.1866
Wald chi2				2,056.94
N	12,146	12,146	12,146	12,146

Note: +Marginal effects for innovation of either product or process relative to no innovation. The reference group for the firm size is small firm. Robust standard errors in parentheses. The symbols ***, **, * indicate significance level at the 1, 5, 10 per cent level, respectively.

Table 5 Robustness tests

MODEL	**Baseline III in Table 4**	**Baseline + Trade**	**Baseline + Trade + FDI**	**Baseline + Trade + FDI + Migration**
Dependent variable	Innovation OLS	Innovation OLS	Innovation OLS	Innovation OLS
Explanatory variables				
Invested in R&D last year	.647*** (.027)	.647*** (.028)	.639*** (.027)	.635*** (.028)
Located in capital city	.090*** (.025)	.088*** (.025)	.079*** (.025)	.074*** (.025)
Recognised certification	.156*** (.022)	.156*** (.022)	.149*** (.022)	.152*** (.022)
Medium-size firm	.088*** (.020)	.088*** (.020)	.091*** (.020)	.090*** (.020)
Large firm	.092*** (.022)	.092*** (.022)	.098*** (.022)	.100*** (.022)
Country controls				
GDP growth lagged	1.26** (.512)	.980* (.590)	-.141 (.659)	.868 (.851)
Rule of law	.246*** (.029)	.239*** (.030)	.214*** (.029)	.165*** (.037)
Informal employment	1.58*** (.096)	1.52*** (.131)	1.70*** (.138)	1.62*** (.148)
Tourist arrivals / population	.779*** (.119)	.638*** (.232)	.792*** (.229)	.906*** (.233)
Trade as % GDP		.100 (.130)	.120 (.128)	.045 (.132)
FDI as % GDP			.745*** (.221)	.851*** (.243)
Migrant share				.552** (.279)
Constant	-1.07*** (.093)	-1.06*** (.099)	-1.77*** (.241)	-1.86*** (.255)
Year dummies	Yes	Yes	Yes	Yes
Nr clusters (country*industry)	452	452	452	452
Adjusted R^2	.3310	.3311	.3327	.3334
N	12,146	12,146	12,146	12,146

Notes: regression based on model (1) augmented by additional international channels of interactions influencing the innovation activities of domestic firms.