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Innovation, informality, and firms' growth in low-income countries

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PRELIMINARY DRAFT

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Abstract

Despite the high profile of the issue in current policy formulations in low-income countries (LICs), there is little empirical evidence on innovativeness and firm performance in formal and informal establishments. This paper aims to fill this gap in the literature using a revised Crépon-Duguet-Mairesse (CDM) structural model to analyse data from a unique innovation survey of 500 manufacturing firms in Ghana. We found that innovation positively impact the labour productivity of firms, and learning instead of technical based innovations are the significant factor. The effect is significantly greater for informal establishments. We suggest that on the one hand innovation is a factor that developing informal firms may push them to the formal economy. On the other hand, surviving of some informal firms may be linked to their ability to innovate.

1. Introduction

The economic growth of low-income countries (LICs) is a product of ideas, skills, capital, and the organization of society and firms. It has not been different in the economic history of current developed countries, where main industrial revolutions were all linked to an application and spread of an innovation – steam power, electricity, and informatics – resulting in a remarkable increase in the total productivity, changes in the society, and ultimately in the wealth and welfare of nations. The past also shows that the real impact of technologies and knowledge is when those are diffused and adopted by a large range of actors, within a country and in other countries as well. Yet, hosting countries not only have to face financial constraints to acquire the technology, but developing an absorptive capacity (knowledge and skills) able to adopt and possibly reproduce such technologies is often a greater barriers to overcome (Cohen and Levinthal, 1989). The steam engine is a demonstrative example: it was invented in United Kingdom at the end of the 18th century, but its diffusion to other countries took decades. Even if the Chinese empire came across to this technology during the First Opium War (1839-1842), its potential impact were not fully realized at first, and then took two decades to overcome the knowledge and skills gaps (mainly in term of technical drawing and machine tools) for the Chinese to adopt and produce steam engines (Wang, 2010). The first steam engine built in China was manufactured in 1869, almost hundred years after its invention in United Kingdom. At that time, the second industrial revolution was in its infancy in Europe and the streets of the European capitals were soon starting lighting up with electric street lighting.

In the macroeconomic literature it is widely recognised that innovation is a major driver of economic growth (Grossman and Helpman, 1991). As extensively documented in Fagerberg et al. (2010), two factors have been identified as critical factors in the endogenous economic growth models: adoption of technologies developed elsewhere and indigenous innovative capacity. However, the technology diffusion to and adoption by developing countries is costly and conditional to factors that support the process (Keller, 2004). It relies on substantial and well-directed technological efforts (Lall, 1992) as well as sufficient human and financial resources and absorptive capacity in firms and industries (Cohen and Levinthal, 1989; Keller, 1996). As highlighted in Fu and Gong (2011), it also requires appropriate institutions and policies to guide incentives and facilitate the process, in addition to strong local capabilities to identify the right technology and appropriate transfer mechanism, and to absorb and make adaptations according to local economic, social, technical and environmental conditions. Trade (import and export) and foreign direct investments can become important sources of growth for catching-up countries.

The macro-level evidence is supported by empirical studies that strongly suggest that the level of technological innovation contributes significantly to economic performance, particularly at the firm and industry level (see for example Kleinknecht and Mohnen, 2002).

Firms' growth is seen as a learning process in which firms that are able to adopt and create technologies and knowledge grow and survive; while firms that do not innovate decline and fail (Jovanovic, 1982). This is particularly relevant in the context of LICs in which the learning process is the major factor enabling innovation activities in firms (Bell and Pavitt, 1992; Lall, 1992). Low income countries face severe constraints and, as argued by Lundvall et al. (2010), technological capabilities in these countries are more than research and development (R&D). In such environments, learning based innovations – such as adoption or adaptation of both technological and no-technological innovations – are significant factors for the industrial development.

The richness of data on innovation in emerging and developed countries has allowed researchers to implement econometric approach, such as the widely used Crépon-Duguet-Mairesse (CDM) structural model (Crepon et al., 1998), in which firm performance are a function of product and/or process innovation, which in turn are explained by R&D and other innovation expenditures. In the context of developing income countries, the lack of data at longitudinal level and the fact that for the vast majority of firms R&D activities are only a marginal determinant in innovation activities have posed several challenges in modelling innovation and growth. Nonetheless, in the recent years an increasing number of empirical studies have analysed the role of innovation in LICs firms, both exploring its determinants (Goedhuys, 2007; Robson et al., 2009) and the impact it has on various firm performance indicators (Gebreeyesus, 2009; Goedhuys et al., 2008, 2014). Most of the latter studies focus on product and process innovation and their impact on productivity. However, as argued by various scholars (Bloom et al., 2013; Bruhn et al., 2010; Mano et al., 2012) in the current state of firm development of LICs it is important to recognize the impact of a range of innovations, including management and marketing innovations, of which the impact could go further than an improvement in productivity.

In analysing the contribution of innovation on firm's performance, it is important to recognize the structural peculiarities of most of the developing countries, where a dual-economy system coexists and beside formal registered firms, an informal sector is active. In a recent survey on informality and development, La Porta and Shleifer (2014) provide five stylized facts of the informal economy in developing countries. The informal sector employs a large proportion of workers and tends to escape taxation and controls from the authorities. Moreover, it is characterized by small and inefficient firms, which are ran by poorly educated entrepreneurs and as a consequence its productivity is very low. Capturing the magnitude and impact of the informal sector is problematic because of its intrinsic nature, but it has been estimated that the weighted average size of the shadow economy (as a percentage of GDP in the period 1999-2007) in Sub-Saharan Africa around 40 per cent (Schneider et al., 2011) and up to 80 per cent of non-agricultural employment (Chen et al., 1999). The different firms' capabilities of formal and informal sectors are likely to shape the innovation adoption and diffusion. For example, formal establishments may have the human and capital resources to

collaborate in innovation activities with other firms, research and development institutions, or, for larger firms, with foreign institutions (Oyelaran-Oyeyinka et al., 1996). Instead, informal firms unlikely have strong capabilities and therefore may be more likely to innovate from entrepreneurs' initiatives and in response of specific constraints given by the context in which operate (Robson et al., 2009).

According to received wisdom, whether the role of innovation in firms' growth located in developed countries is largely documented, its impact on developing countries is still partially understood. Difficulties related to data availability and how to measure innovation have limited empirical studies on the link between innovation and firms' growth in LICs. This paper aims to fill this gap investigating the role of innovation in the performance of Ghanaian manufacturing firms. Because of the development level of the institutions and education system, Ghana provides a potential fertile soil for innovation in the context of developing countries making this a relevant case study. However, it also shares many of its structural characteristics with other LICs. In the past thirty years, Ghana has undertaken a series of structural reforms aimed to strengthen the role of private sector firms as a pillar of economic growth. In 2010 the Industrial Policy was set within the context of Ghana's long-term strategic vision of achieving middle income status by 2020, through the transformation of the country into an industry-driven economy. Remarkably, the Industrial Policy acknowledged the role of innovation and put in place policies aimed to increase the overall level of science, technology, research and development for innovation in industry. However, despite policy reforms the majority of firms are still small and embedded in the informal sector, and larger firms are constrained by finance, managerial, and technical skills. In this study we used data from an innovation survey that was designed to investigate the innovation activities of firms in a granular way, capturing the conventional and unstructured way firms of different nature, sizes, and absorptive capacities typically innovate. Adopting a reduced form of the CDM structural model we are able to capture the dynamics of innovation activities and the impact those have on formal and informal firms' growth.

Despite the high profile of the issue in current policy formulations in low-income countries (LICs), there is little empirical evidence on innovativeness and firm performance in formal and informal establishments and under severe institutional and resource constraints. This paper aims to fill this gap in the literature analysing data from a unique innovation survey of 500 manufacturing firms in Ghana. Two main research questions motivate this study:

1. Is there innovation in LICs, specifically in the informal sector? If yes, which kind of innovation?

2. How innovation affect firm's growth? Are there difference between formal and informal?

Our results show that innovation positively impact the labour productivity of firms, and learning instead of technical based innovations are the significant factor. The effect is significantly greater for informal establishments. We suggest that on the one hand innovation is a factor that developing informal firms may push them to the formal economy. On the other hand, surviving of some informal firms may be linked to their ability to innovate.

The remaining of the paper is structured as follows. Section 2 provides the literature review, while Section 3 reports the model and the estimation strategy. This is followed by the description of the data at hand with a focus on the nature of innovation we find and how formal and informal firms differ. Section 5 reports and discussed the results. Finally, Section 6 concludes.

2. Literature review

Until the a decade ago, innovation in the private sector in LICs was the focus of only a handful of study every year (Zanello et al., 2013). Until then, innovation was often associated with patents or ground-breaking discoveries. Those are the results of costly, risky and lengthy processes which require intense knowledge and capital investment to create something "new". The Oslo Manual has been a standard reference for surveys of innovation in advanced economies and, from its third edition, in developing countries. Its definition of innovation as "[…] the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005: 46) highlights two important features. First, innovation can take a multitude of forms (product innovations, process innovations, marketing innovations, and managerial and organisational innovations). Second, innovation can be developed by an original idea but also emerges from diffusion, absorption, or imitation of the new methods that are observed. Because of that it could simply be new to the firm and have impact on productivity and employment.

The recognized growing role of innovation in developing countries has opened a new sub-fields of research at the intersection of innovation and management studies and development studies. The so-called inclusive innovation focuses on the impact of innovation on the people living in the lowest income groups (Chataway et al., 2013). In particular, it refers to the production or delivery of new products and services for and/or by those people that so far were largely excluded by markets. At the same time the constrained ingenuity and resilience of the people living on the poverty line have been recognized as an incubator for local innovation. This focus on 'frugal innovation' (Bhatti and Ventresca, 2012) introduces further considerations to understand the sources and impact of innovation in LICs. In order to access effectively new markets, companies may need to re-think the production and delivery of goods, often re-engineering products in order to reduce the complexity and cost of

production. The innovation process could involve reverse diffusion (Govindarajan and Ramamurti, 2011), when an innovation is adopted first in LICs before spreading to advanced industrial economies, reverse engineering, jugaad (Gulati, 2010), in case the innovation involves arrangement or work-around and is born out of lack of resources improvised, or design thinking processes, in which consumers are involved in the design of a product or services.

2.1 Innovation and firms' growth in low income countries

Fagerberg et al. (2010) review the literature and provide large and strong evidence on how worldwide countries that are more active in innovation have higher productivity and income than the less-innovative ones. Many scholars have argued that in developed economies the growth of firms depends on their ability to learn about their environment, and to link changes in their strategy choices to the changing of that environment. (Geroski, 1989; Klepper, 1996). This is even more relevant in LICs, where infrastructures are often poor, markets tend to be underdeveloped, and potential local customers have limited disposable income. In such environment micro, small, and medium size firms – many of them working in the informal sector – are particularly vulnerable because of the limited absorptive capacity and restricted access to financial and knowledge resources. Firms located in LICs that are able to successfully undertake innovation activities will survive and the innovating firms that are able to make the best use of the resources available have potential to be leading the market.

In the recent years there have been an increasing number of studies that have explored in more detail the role of innovation in LICs firms. Most of these studies have looked at the impact of product or process innovations on various performance outcomes. A survey of SMEs combined with in-depth case studies found a positive association between innovativeness in small firms in the Tanzanian manufacturing sector and growth (Mahemba and Bruijn, 2003). More recently, Gebreeyesus (2009) investigated the role of innovation in Ethiopian SMEs, and found a strong evidence that innovators grow faster than non-innovators. In this case, the effect of innovation is measured on employment growth. Again, using a rich dataset of SMEs operating in Sri Lanka, De Mel et al. (2009) find an association between innovation and profits.

Overall, the emerging evidence from literature suggests a positive impact of innovation on firms' performance measured as either profit and employment growth. However, recent studies on the role of innovation on firms' productivity found a much weaker impact. Goedhuys and colleagues (2008, 2014) focused on the importance of various sources of technological knowledge on firm's productivity. Analysing data from Tanzania, they found that firm productivity is not enhanced by R&D, neither product nor process innovation, but business environment seems to play a more relevant role. Those conclusions suggest that the

relationship between R&D, innovation, and productivity in developing countries is weaker than the evidence we have from developed countries. In a subsequent work in which three sectors and five countries (including Tanzania, and Bangladesh) are considered, they conclude that knowledge that raises productivity is highly sector specific, rather than country specific. Specifically, in developing countries firms working in the food processing sector that imported or licensed machinery and equipment are more productive. Such evidence did not emerge in other sectors.

In the context of developing countries is useful to differentiate innovations between technological and non-technological innovations (often defined as the introduction of new organisational methods or new marketing methods). Although these are highly interconnected (the commercialisation of product innovations often requires new marketing methods, and new production technique need to be supported by changes in organisation), the factors that drive the different types of innovation are likely to be different. A decade ago, Hausman (2005) highlighted how much of the existing research had examined product and process innovations and neglected non-technological innovation, such as new management practices. Since then, management and managerial skills have received increased attention as a factor explaining differences in firms' performance in developing countries with evidence spanning various geographical areas (Bloom et al., 2013; Drexler et al., 2014; Karlan and Valdivia, 2011; Mano et al., 2012). Moreover we found some qualitative and narrative evidence of the benefit of market innovations on firms, mainly in the informal sector (Hall et al., 2012; Ramani et al., 2012).

2.2 Informality, innovation, and firms' growth

Exploring the different ways in which formal and informal firms innovate and the impact this has on the growth of the firm is critical given the relevance of the informal sector in the whole economy. In addition, there is increasing evidence that the cure for informality is economic growth, as reported in La Porta and Shleifer (2014), and therefore innovation could play a key role in such transformation. Although we have a fair knowledge of the characteristics the informal sector, there is not a single widely-accepted definition of informal firms. As reviewed in Benjamin and Mbaye (2014), scholars have used different criteria based on firm size, registration status, employer social-security contributions, legal form of organization; and character (sincerity) of financial accounts. However, consensus has emerged on the fact that there are degrees of formality and informality along a continuum rather than mutually distinct sectors (Trebilcock, 2005). Therefore, using a single indicator is likely to capture only partially the nature of the firm. Using various indicators to capture the informal sector, La Porta and Shleifer (2008) found that it accounts for 30-40 per cent of total economic activity in the poorest countries, and an higher share of employment.

Limited empirical evidence is available specifically on the role of innovation and firms' growth in the informal sector of developing countries (De Mel et al., 2009; Gebreeyesus, 2009). However, few studies explore the determinants of innovation adoption, often including firms' characteristics, such as firm size and education level of entrepreneurs. Firm's size, which is meant to capture the scale of operations and it has been recognized as one of the defined characteristics of informal establishments, has been identified as a barrier to innovation in various studies (De Mel et al., 2009; Gebreeyesus, 2009; Robson et al., 2009). The level of education of entrepreneurs is regarded as an important, although not a sufficient, condition to innovation. Bradley et al. (2012) advocate that capital is not a "silver bullet", and education and human capital are the major constraints of innovation in Kenyan small firms. The lack of resources in the education system in many LICs make the non-formal training the main source for learning, together with "learning by doing" (Oyelaran-Oyeyinka and Lal, 2006).

Most of the literature looks at observable indicators (e.g. firm size, age, education of workers and entrepreneur), however soft skills may be as much as important in the process of adoption and impact of innovation. In this regard, the ingenuity and the constraints-self on which the poorest lives can be rich soil for innovation (Prahalad, 2012). These are not only an unexplored vast market segment that has pushed international and local firms to build affordable and sustainable products, but are actively exploiting small scale business activities. The transmission of knowledge and the dynamics in which the informal sectors adopt and create innovation are different than formal sector. Informal firms may heavily rely on learning adoption of technologies and being far from the technological frontier impact may be more significant. Moreover the success of informal businesses may be determined by not only the skills but also the acumen of entrepreneurs (De Mel et al., 2009). The role of the entrepreneur in small enterprises is more evident in every strategical aspect, including innovation activities (Donckels and Fröhlich, 1991).

3. The innovation model: Econometric specification and estimation

The innovations found in LICs are shaped by the context to an extent that those can take multiple forms and determinants. A recent literature review highlighted how most of the innovations in LICs have an adaptive or incremental nature, and therefore innovations in such settings are unlikely to leapfrog or redefine value creation processes (Zanello et al., 2013). In fact, given the limited financial and knowledge resources and absorptive capacity of firms in LICs R&D based innovations are uncommon. The vast majority of innovation activities derive from the adoption (and adaptation) of innovations through the so-called "technological capability", the firms' ability to employ existing technologies and knowledge in order to adopt, adapt, and change exiting technologies (Fransman, 1985; Lall, 1992). Therefore innovation in developing countries is a phenomenon that involves institutional and

environmental factors as much as personal and entrepreneurial characteristics. Firm owners' entrepreneurial acumen is as critical as firms' characteristics for innovation adoption. Empirical on this is limited but notably De Mel et al. (2009) controls for both entrepreneurs and firms characteristics in the adoption of innovations. We adapted the CDM model to suit these conditions; in particular we had to take into account the lack of formal R&D activities[1] and the role of firm owners' entrepreneurial acumen in adopting innovations. We therefore apply a structural model, which takes the following basic form: a firm innovates based on characteristic of the entrepreneur together with other inputs and then the fruit of the innovation activity is a determinant of a production function.

The model therefore includes two equations. Let $\boldsymbol{i = 1, \ldots, N}$ index the firm, the first equation captures the knowledge production $\boldsymbol{I^*}$:

$$\boldsymbol{I_i^* = z_i'\beta + \varepsilon_i,} \tag{1}$$

where we consider $\boldsymbol{I_i^*}$ as an unobserved latent variable, and where $\boldsymbol{z_i}$ is a vector of determinants of innovation effort, including firm owners' entrepreneurial acumen, $\boldsymbol{\beta}$ is a vector of parameters of interest, and $\boldsymbol{\varepsilon_i}$ an error term. We use a probit model to estimate (1) as such

$$\boldsymbol{I_i = \begin{cases} 1 \; if \; I_i^* = 1 \\ otherwise \end{cases}} \tag{2}$$

where $\boldsymbol{I_i}$ is the observed binary variable equal to 1 if a firm undertook any innovation activity in the past three years and $\boldsymbol{I_i^*}$ is the respective latent variable.

In the second step we estimate a production equation

$$\boldsymbol{y_i = z_i'\beta + I_i\beta + v_i} \tag{3}$$

where $\boldsymbol{y_i}$ is labour productivity (log of output per worker), $\boldsymbol{z_i}$ is a vector of determinants of productivity, $\boldsymbol{I_i}$ is the innovation activity and $\boldsymbol{v_i}$ an error term. In our estimation, we take care of the endogeneity of $\boldsymbol{I_i}$ by using in the estimation the predicted values from the knowledge production function equations and instrumented it in (3).

In order to test our hypotheses, we expanded the basic model in two directions to capture the different nature of innovations and firms. First we decompose the innovation activity ($\boldsymbol{I_i}$) into technical ($\boldsymbol{T_i}$) and learning ($\boldsymbol{L_i}$) based innovation. Technical innovation include product and process innovation, while learning based innovation include marketing and management innovations. The first step of the estimation is expanded to include two knowledge productions

$$\boldsymbol{T_i^* = z_i'\beta + \varepsilon_i} \tag{4a}$$

[1] In our sample less than 6 per cent of the firms developed innovation through a formal R&D department.

$$L_i^* = z_i'\beta + \varepsilon_i \quad (4b)$$

where the starred dependent variables are latent variable. We jointly estimated model (4a) and (4b) with a bivariate probit

$$T_i = \begin{cases} 1 \; if \; T_i^* = 1 \\ otherwise \end{cases} \quad (5a)$$

$$L_i = \begin{cases} 1 \; if \; L_i^* = 1 \\ otherwise \end{cases} \quad (5b)$$

where T_i and L_i are respective observed binary variable equal to 1 if a firm undertook any technical and learning based innovation activity in the past three years. The predicted values from (5a) and (5b) are then separately instrumented and included in the production function

$$y_i = z_i'\beta + T_i\beta + L_i\beta + v_i \quad (6)$$

Secondly, in order to capture the effect of innovation activities on the different nature of firms, we estimated (3) and (6) interacting the two variables

$$y_i = z_i'\beta + I_i\beta + N_i\beta + I_i \times N_i\beta + v_i \quad (7)$$

$$y_i = z_i'\beta + T_i\beta + L_i\beta + N_i\beta + T_i \times N_i\beta + L_i \times N_i\beta + \beta v_i \quad (8)$$

where N represents the degree of formality of a firm and I_i, L_i, and N_i are respectively the predicted value from models (2), (5a), and (5b).

Productivity and innovation are thought to be endogenous. More productive firms may have higher profits and more opportunities for knowledge exchange with other firms, which may results in greater innovation activities. At the same time, innovation is a driver of productivity. In the original model CDM model in productivity equation innovation is instrumented with the R&D expenses (Crepon et al., 1998). In our case we use a measure of ingenuity that largely depends by personal characteristics of the entrepreneur.

4. Descriptive statistics

4.1 The nature of innovation

For this study we used an innovation survey of 501 manufacturing firms in Ghana. The data were collected between November 2013 and January 2014 and include detailed information on innovation activities undertaken by the firms during the three years period 2010-2013. We recognise that the development and adoption of innovations is not a static process but it spans through a period of time. Although the dataset is cross-sectional in nature, we recorded some data (such as turnover) both for 2010 and 2013 allowing us to have a partial view of the

dynamics and behaviours of firms during the three years under reviewed. More details on the survey methodology can be found in Fu et al. (2014).

The data at hand include various natures of firms, expanding the literature on innovation in developing countries that has concentrated on innovation in formally registered firms (Ayyagari et al., 2011). Since informal firms may not be recorded on official firms' databases, we use a different sampling framework in order to avoid under-representing the whole informal sector. We therefore sampled half of the sample from sources that were likely to mainly capture informal firms, and the other half from sources containing mainly formal firms. For informal firms, we randomly sampled 25 firms in 10 clusters spread in five regions. The choice of clusters and regions was determined to have a sectorial and geographical representation of the Ghanaian informal economy. The population of firms from which we withdraw the sample of the formal firms was compiled merging difference sources[2]. The sample was then randomly selected with three levels of stratifications: industrial sector, firm's size, and regional location.

The data collection focused on capturing only manufacturing firms. Half of the firms in the sample are equally distributed in the food processing and wearing and textile sector. Fifteen per cent are active in the manufacture of furniture and metal products, and ten per cent work with wood and manufacturing of products of wood. The remaining ten per cent are active in a multitude of sectors, from manufacturing paper products and rubber and plastics products to manufacture of leather or chemicals products.

Descriptive statistics of the firms in the sample are reported in Table 1. From our sample we see how innovation is a widespread phenomenon in the private sector in Ghana, where between 2010 and 2013 most of the firms (78 per cent) were active in some innovation activity. When we break down the nature of innovations, we observe that most of the firms (68 per cent) are involved in some technical innovation, which may include process or product innovation. This may reflect the fact that often firms in LICs work far from the technological frontier, and improvement are relatively easy or affordable to implement. Learning innovations, including management and marketing innovations, were implemented by 40 per cent of the firms. The vast majority of innovations introduced by the firms have an imitative and incremental nature, rather than being innovations that leapfrog or redefine value creation processes. Innovations that were born by technology that was originally developed by others and licensed to a firm (with or without adaptation or modification) or developed in a formal R&D department within the company, where scientists and engineers created it, were respectively six and two per cent.

[2] Specifically we used the latest available National Industrial Census (2003) by Ghana Statistical Service, Micro, Small and Medium Enterprises database from Ministry of Trade and Industry, Dun & Bradstreet database of Ghanaian firms, and the list of members of the Association of Ghana Industries (AGI).

Firms have been active on average for almost 16 years and employed 23 employees between 2010 and 2013. However, the distribution of the number of employees is heavily right skewed with 73 per cent of the firms employing less than 9 worker (micro firms), 17 per cent with 10 to 29 employees (small firms), and the remaining 10 per cent is equally distributed between medium (30-99 employees) and large firms, with more than 100 employees. The value of fixed assets greatly varies across the sample. On average, firms own assets for almost 55 million GHc, although most of the firms have fixed assets for not more than 6 thousands GHc.[3] The percentage of employees with a technical specialization degree, used as a proxy for the absorptive capacity of the firm, is on average 6 per cent. Finally, half of the firms sampled were located in the capital, Accra, or Tema, a nearby industrial area, and only five per cent of firms predominantly trade outside Ghana.

We captured entrepreneurship using a principal component analysis (PCA) on a series of questions that aimed to capture skills and attitude of the entrepreneurs. Those are more common in the entrepreneurial psychology literature and go beyond the level of education of the entrepreneur. A similar set of questions were used by (De Mel et al., 2009) in a study of Sri Lanka firms. Those are listed in Table 3 and include the degree of optimism, pro-active attitude, curiosity, and tenacity. All these factors may influence the diffusion and creation of innovation. From the PCA we identified two components. The first component capture the level of entrepreneurship with individuals that ingenuous, pro-active, methodical, and optimistic. The second component instead captures individuals that are more impulsive, less tenacious and unwilling to take risk.

4.2 The nature of firms in the sample

We do recognize that there is not a standardized definition of formal and informal firms (Benjamin and Mbaye, 2012). We therefore collected a self-reported nature of the firm asking the respondents "How do you define the nature of the firm?" and providing a spectrum of options that included different degrees of formality (informal, semi-formal, formal), in line with the idea that formality follow a continuum (Trebilcock, 2005). Moreover during the survey administration, the local enumerators were trained to cross-check this specific information based on the visit of the firm's premises and observing its activity. In our sample most of the firms (55 per cent) are active predominantly in the informal sector, a figure in line with other estimations of the informal establishments in Ghana and Sub-Saharan Africa (Institute of Statistical Social and Economic Research, 2013; Schneider et al., 2011). The remaining firms were similarly divided between semi-formal (23 per cent) and formal (22 per cent).

[3] The average exchange rate in 2010 was GHc 2.24/£ and GHc 1.45/$ and in 2013 GHc 3.45/£ and GHc 2.13/$.

Formal and informal firms differ in most dimensions. Informal firms are significantly less innovative than formal firms, with a greater difference with in R&D innovations. Informal firms also tend to have lower productivity than formal firms and have significantly smaller endowments. Informal firms are on average younger than formal firms (13 years old as opposed to 21 years old) and smaller in size, with on average only five employees compared to an average work force of 84 workers in formal firms. Despite the difference in sizes, the Ghana Statistical Service estimated that 48 per cent of the population in working age (16-64 years old) is employed in informal establishments (GSS, 2008). Absorptive capacity is also greater in formal firms, with 15 per cent of employees with a specialization degree compared to only four per cent of employees of informal firms with a degree. Formal and informal firms also tend to be predominantly active in different markets, with half of the formal firms active in the national or international markets and three quarters of informal firms in the local market.

Semi-formal firms share characteristics with both formal and informal firms, yet their profile is unique. They are as innovative as formal firms, but similarly to informal firms focus more on technical that learning innovations. Their productivity is significantly lower than formal firms, yet greater than the one we find in informal firms. Semi-formal firms are significantly younger than formal firms and at the same time older than informal ones. Yet, they share average size, absorptive capacity, and location with the latter.

5. Discussion

5.1 Innovation and firm's growth in low-income countries

The econometric models supports both the theory that more innovative firms experience greater growth and that learning activities have greater impact on growth than technology based innovations (Table 3). Consistent with the mainstream literature on the role of innovation in emerging and developed countries (Fagerberg et al., 2010) and evidence from studies in LICs (Bloom et al., 2013; Gebreeyesus, 2009), the models predict positive relationships between innovation activities and firm's growth. However, the impact and significance level varies across innovation outcomes. In line with a growing literature on the relevance of management and managerial skills in firms in LICs (Bloom et al., 2013; Mano et al., 2012), we found a positive and significance effect of learning innovation on growth. This findings support the evidence that the low efficiency of firms in LICs is partially due to poor management practices, from establishing standard procedures for operations and implementing quality control, to efficiently manage the inventory and human resources.

Our results shows a more relevant role of innovation on firms' growth than the recent findings from the work of Goedhuys and colleagues (2008, 2014), in which they found that supportive business environments have a greater influence on firms' performance than

innovation activities. Two differences between the studies can explain the dissimilar results. Our setting focuses only on firms located in one countries and therefore potential difference in cross-countries business environments are uncaptured, beside potential differences in cross-industries business environments. Given the rather homogenous sample of firms, we exclude that the potential differences at industry level are significant. Possibly more relevant, the two studies use difference sets of dependent variables, which provides different interpretations to the results. While we focus on changes in the turnover as measure of firm performance, Goedhuys et al. (2008, 2014) investigated the changes in productivity.

From the findings we can also see the relationships between firms' size, competition, and labour productivity. As firms increase in size, the effect of a larger number of employees on productivity lessoned. Competition and productivity is by an inverted U-shape. More competitive markets drive firms to be more labour productive (although increasing at a decreasing rate). Such results are in line with the main evidence in literature (Gebreeyesus, 2009; Robson et al., 2009).

5.2 Informality, innovation, and firm's growth

Informality is a widespread phenomenon in LICs, and better understanding the role of innovation in informal firms is critical for the support of economic activities that employ the vast majority of people in the non-agricultural sector. Our model supports the hypothesis that informal firms mostly rely on learning based activities for the adoption of innovation. Moreover, the impact of innovation on the growth of informal firms is significant for most innovation outcomes, while formal firms' growth is mainly associated to process and management innovation.

Examining the contribution of innovation activities on individual innovation outcomes, informal firms tend to mostly rely on learning based innovations and those have a greater impact than in formal firms. This is consistent with the fact that informal firms are characterized by modest absorptive capacity and limited resources, and R&D based activities are precluded to most of them. Informal firms can come across to new technologies and products not only through other informal firms (e.g. members of cluster) but also thanks to spillovers from formal firms. Moreover, the diffusion of mobile phones and Internet in developing country allows users to access to relevant contacts and content previously unavailable. Informal firms can use Internet for learning about new product to introduce or technologies to adopt, and potentially contact sellers.

The model strongly supports the hypothesis that the growth of informal firms is supported by learning based innovations The estimates suggest that the impact of learning based activities on the growth of informal firms is almost double than any other innovation activity in formal firms. Evidence confirms the role of innovation as determinant of firms' growth. Critically,

the role of innovation is more evident in informal establishment, suggesting on one hand how innovation could be a driver to the formal economy for the informal firms and on the other hand how firms survive because of the innovation. The market conditions, the lack of resources, and the limited support from the government may push firms to change in order to survive.

6. Conclusion

Low-income countries rely on transfer of technologies and knowledge from more advanced countries to increase the local wealth and welfare, reduce internal inequalities, and ultimately accelerate the process of catching up. The current developmental state of most LICs suggests that the diffusion to and adoption of major technologies in LICs are likely to be a faster process than what we witnessed with the diffusion of major innovations, such as the steam engine that took hundred years to be adopted in China. Economies nowadays are intrinsically more interconnected and lower-tech innovations have the potential to be adopted by LICs, favored by emerging countries to LICs trade and collaborations. The rationale is that the knowledge transferred to LICs is likely to be more appropriate since it comes from countries with not too dissimilar factor endowment, and absorptive capacity of a LIC recipient may also be more effective in receiving similar level of technologies. We are assisting an initial process in which manufacturing industries will be eventually relocated to places where labor is cheaper – such as African countries – than current manufacturing countries where worldwide low-tech goods have been assembled and produced for three decades. Nowadays the diffusion of information communication technologies holds the potential to promote the diffusion of information in places that until recently were disconnected and remote, and the increased capability with which people can move and travel is a powerful vector to support absorptive capacity of LICs with the injection of knowledge and skills.

In such scenario our results aimed to provide a better understanding of the critical role of innovation on firms' growth in LICs. These firms have characteristics and work in an environment that is very different to many firms in emerging countries and most of the firms in advanced economies. Many of the firms in LICs are informal in nature; they employ a large proportion of the population but work extremely inefficiently and in a low productivity regime. Moreover, the historical, socio-economic, and political environment of LICs provides strong challenges to firms, which face acute obstacles, from knowledge to market and resources constraints. We found that in such environment innovation is a determinant factor for the growth of firms. This is particularly evident in informal firms, suggesting on one hand how innovation could be a driver to the formal economy for the informal firms and on the other hand how some firms innovate to survive.

Table 1: Sample description

	Description and unit	Mean Full Sample	Nature of firms			Statistical difference between groups		
			1. Informal (277)	2. Semi-Formal (116)	3. Formal (108)	1-2	1-3	2-3
Dependent variables								
Innovator (dummy)		0.780	0.693	0.845	0.935	***	***	
R&D innovation (dummy)		0.699	0.585	0.810	0.870	***	***	
Learning innovation (dummy)		0.403	0.336	0.431	0.546		***	
Labour productivity	Turnover (log) / Num. employees (log)	1.082	0.997	1.035	1.351		***	**
Independent variables								
Fixed Assets	Log (GHc)	2.037	1.194	1.919	4.325	***	***	***
Entrepreneurship 1	First component (PCA)	0.000	-0.359	0.525	0.356	***	***	
Entrepreneurship 2	Second component (PCA)	0.000	0.004	-0.172	0.175			**
Size	Number of employees	23.265	4.314	11.328	84.694		***	***
Age	Age of the firm	15.822	13.007	17.578	21.157	***	***	**
Conurbation (dummy)	Firm located in Accra or Tema	0.497	0.498	0.509	0.481			
Spec. degree (% of tot. empl.)	Employees with specialization degree (%)	0.063	0.037	0.044	0.148		***	***
Medium tech (dummy)		0.026	0.011	0.000	0.093		***	***
Competition	Degree of competition in the main market (1-5)	2.403	2.202	2.707	2.593	***	***	
Exporter (dummy)	Whether the firm exported	0.052	0.036	0.078	0.065			

Notes: Medium tech sectors have been defining according to OECD (1994). Statistical difference between different nature of firms was performed with a pairwise comparisons of means with equal variances (Tukey post hoc test). Significance at the 10 per cent, 5 per cent and 1 per cent levels are indicated by one, two and three asterisks respectively.

Table 2: Entrepreneurship: Principal component (eigenvectors) and variable used.

	Sample mean	Component 1	Component 2
A. I plan tasks carefully	4.20	0.398	-0.055
B. I make up my mind quickly	3.54	0.127	0.715
C. I will pursue my goal despite many failures and oppositions	4.27	0.436	-0.080
D. I am well organised and good at multi-tasking	4.02	0.390	0.088
E. I browse internet a lot and like to meet new people	2.16	0.168	0.630
F. I am fully prepared to take risk	3.94	0.383	-0.088
G. I am always optimistic about my future	4.24	0.396	-0.219
H. A person can get rich by taking risks	3.75	0.389	-0.139

Notes: Responses to all questions are coded on a scale of one to five, with one indicating “strongly disagree” and five “strongly agree”.

Table 3: First stage innovation model: Determinants of innovation (Model I) and technical and learning innovation (Model IIa and IIb)

	I	IIa	IIb
Assets	0.051	0.049	0.130***
	(0.052)	(0.051)	(0.049)
Nature of firm	0.323***	0.332***	-0.028
	(0.121)	(0.108)	(0.096)
Entrepreneurship 1	0.127***	0.132***	0.098***
	(0.035)	(0.033)	(0.036)
Entrepreneurship 2	-0.216***	-0.175***	-0.038
	(0.073)	(0.066)	(0.064)
Firm size	-0.001	-0.000	-0.002**
	(0.001)	(0.001)	(0.001)
Age	-0.003	-0.005	0.015**
	(0.008)	(0.008)	(0.007)
Conurbation	0.480***	0.235*	0.496***
	(0.150)	(0.134)	(0.127)
Skilled employees	2.001***	1.203*	1.386***
	(0.696)	(0.628)	(0.420)
Competition	0.195***	0.188***	1.304**
	(0.059)	(0.056)	(0.588)
Medium tech		-0.455	0.124**
		(0.484)	(0.054)
Constant	-0.456*	-0.596***	-1.337***
	(0.254)	(0.231)	(0.210)
Correlation rho (ρ)		0.120	
		(0.087)	
Wald χ^2	66.27***	141.43***	
Correctly classified	82.84%	75.45%	66.87%
Observations	501	501	

Notes: Coefficients are reported. Significance at the 10 per cent, 5 per cent and 1 per cent levels are indicated by one, two and three asterisks respectively. Robust standard errors throughout the estimations.

Table 4: Second stage innovation model: Determinants of firm's productivity by innovation (Model I and II) and technical and learning innovation (Model III and IV)

	I	II	III	IV
Innovation	0.903***	2.554***		
	(0.254)	(0.537)		
Innovation x Nature of firm		-1.315***		
		(0.446)		
Technical innovation			-0.198	0.793
			(0.442)	(0.674)
Learning innovation			2.127***	3.961***
			(0.678)	(1.151)
Technical innovation x Nature of firm				-0.945**
				(0.436)
Learning innovation x Nature of firm				-1.009**
				(0.393)
Age	-0.004*	-0.004*	-0.016***	-0.016***
	(0.002)	(0.002)	(0.005)	(0.005)
Nature of the firm	-0.158***	1.006**	-0.162***	1.059***
	(0.048)	(0.410)	(0.060)	(0.345)
Exporter	-0.098	-0.152**	-0.172**	-0.296***
	(0.069)	(0.073)	(0.082)	(0.099)
Medium tech	-0.054	0.054	-0.842***	-0.585*
	(0.094)	(0.094)	(0.309)	(0.305)
Conurbation	0.064	0.113**	-0.239*	-0.205*
	(0.052)	(0.055)	(0.122)	(0.117)
Firm size	-0.002***	-0.002***	-0.003***	-0.001*
	(0.001)	(0.000)	(0.001)	(0.001)
Firm size squared	0.000***	0.000***	0.000***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Competition	0.163***	0.154***	0.075	0.027
	(0.060)	(0.059)	(0.073)	(0.074)
Competition squared	-0.054***	-0.051***	-0.044***	-0.032*
	(0.014)	(0.014)	(0.016)	(0.017)
Constant	0.084	-1.352***	0.612***	-0.928**
	(0.108)	(0.469)	(0.164)	(0.362)
Wald χ^2	73.59***	111.23***	61.26***	92.41***
Durbin–Wu–Hausman test	256.28***		256.28***	
Wald test (F)	3.21*	11.24**	23.43***	29.78***
Observations	501	501	501	501

Notes: Variables capturing innovation, technical innovation, and learning innovation were instrumented. Significance at the 10 per cent, 5 per cent and 1 per cent levels are indicated by one, two and three asterisks respectively. Robust standard errors throughout the estimations.

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