Innovation and Productivity in Formal and Informal Firms in Ghana

Xiaolan Fu, Pierre Mohnen, and Giacomo Zanello*

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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 find that innovation positively impacts the labour productivity of firms, and non-technological instead of technological based innovations are the significant factor. The effect is significantly greater for informal establishments. We suggest that surviving of some informal firms may be linked to their ability to innovate.

* Contacts: School of Agriculture Policy and Development, University of Reading, Early Gate, Whiteknights Road, RG6 6AR, Reading, UK. E-mail: g.zanello@reading.ac.uk.

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"I survive because I innovate"

Food processing entrepreneur of an informal firm, Accra (Ghana)

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 barrier to overcome (Cohen and Levinthal, 1989). The steam engine is a demonstrative example: it was invented in the United Kingdom at the end of the 18th century, but its diffusion to other countries took decades. Even if the Chinese empire came across this technology during the First Opium War (1839-1842), its potential impact was not fully realized at first, and then it 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 the United Kingdom. At that time, the second industrial revolution was in its infancy in Europe and the streets of European capitals were soon starting to have electric 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 on 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 an 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, the impact of which could go further than an improvement in productivity.

In analysing the contribution of innovation to 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 to specific constraints given by the context in which operate (Robson et al., 2009).

According to received wisdom, whereas the role of innovation in firms' growth in developed countries is largely documented, its impact in developing countries is still only partially understood. Difficulties related to data availability and how to measure innovation have limited the 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 the 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 use 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 level of formality, 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, what kind of innovation?
2. How does innovation affect firm's growth? Are there differences between formal and informal firms?

Our results show that innovation positively impacts the labour productivity of firms, and non-technological-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 may push informal firms to become formal.

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 in Section 4 by the description of the data at hand with a focus on the nature of innovation and the formal/informal status of firms. Section 5 reports and discusses the results. Finally, Section 6 concludes.

2. Literature review

Until a decade ago, innovation in the private sector in LICs was the focus of only a handful of studies every year (Zanello et al., 2015). Until then, innovation was often associated with patents or ground-breaking disc

overies. Those are the results of costly, risky and lengthy processes that 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, since 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 result from an original idea but can also emerge from diffusion, absorption, or imitation of new methods developed elsewhere. Because of that, an innovation could simply be new to the firm and not necessarily new to the market and yet have an impact on productivity and employment.

The recognized growing role of innovation in developing countries has opened a new sub-field 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 from formal markets. At the same time, the constrained ingenuity and resilience of the people living below 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, jugaad innovations (Gulati, 2010), in case the innovation involves arrangement or work-around and is born out of lack of resources by improvisation, or user innovations, when consumers are involved in the design of a product or service (Von Hippel, 1998).

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, linking their strategies to the changing 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 the potential to be leading the market.

In the recent years, an increasing number of studies have explored in great detail the role of innovation in LIC 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 strong evidence that innovators grow faster than non-innovators in terms of employment. Using a rich dataset of SMEs operating in Sri Lanka, De Mel et al. (2009) find an association between innovation and profits.

Overall, the evidence emerging from the literature suggests a positive impact of innovation on firms' performance measured as either profit or employment growth. However, recent

studies on the role of innovation on firms' productivity found a much weaker impact. Goedhuys et al. (2008, 2014) focused on the importance of various sources of technological knowledge on firm's productivity in developing countries. In Tanzania, they found that firm productivity is not enhanced by R&D, either product or process innovation, but business environment seems to play a more relevant role. Those conclusions suggest that the relationship between R&D, innovation, and productivity is weaker in developing than in developed countries. In a subsequent work in which three sectors (food processing, textiles and garment and leather products) and five countries (Brazil, Ecuador, South Africa, Tanzania, and Bangladesh) are considered, they conclude that the link between knowledge and productivity is sector - rather than country specific. In the food processing sector firms that import or license machinery and equipment are more productive, whereas no such evidence emerges in other sectors.

Especially in the context of developing countries, it is useful to differentiate 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 techniques need to be supported by changes in the 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 size of the informal sector in developing countries. 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 of 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, a 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 formal character 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 even 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, a few studies explore the determinants of innovation adoption, including firms' characteristics, such as size and the entrepreneur's level of education. Firm size, which captures the scale of operations and has been recognized as one of the defining 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 for 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 makes the non-formal training the main source for learning, together with 'learning by doing' (Oyelaran-Oyeyinka and Lal, 2006).

Despite ingenuity has been considered an engine of innovation activities for informal businesses (Prahalad, 2012), most of the literature has tended to look at observable indicators (e.g. firm size, age, education of workers and entrepreneur) in estimating determinants of innovation. In most cases data constraints have prevented the inclusion of soft skills – such as entrepreneurship and management skills – which may be equally important in the process of adoption and impact of innovation. An exception is the work of De Mel and colleagues (2009) which use a range of various indicators to provide evidence that the success of informal businesses in Sri Lanka is determined by not only the skills but also the acumen of entrepreneurs. Such findings reinforce the evidence that the role of the entrepreneur is more evident in small enterprises in every strategic 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., 2015). 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 existing technologies (Fransman, 1985; Lall, 1992). Therefore, in developing countries innovation 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 evidence on this is limited but notably De Mel et al. (2009) control for both entrepreneurs and firm 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 productivity.

The model, therefore, includes two equations. Let $\boldsymbol{i = 1, \dots, N}$ 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

$$\boldsymbol{I_i = \begin{cases} 1 \; if \; I_i^* > 0 \\ otherwise \end{cases}} \tag{2}$$

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

$$\boldsymbol{y_i = w_i'\alpha_1 + I_i^*\alpha_2 + v_i} \tag{3}$$

where $\boldsymbol{y_i}$ is labour productivity (log of output per worker), $\boldsymbol{w_i}$ 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) using a two-stage least squares (2SLS) regression approach and correct the standard errors accordingly.

In order to test our hypotheses, we expanded the basic model in two directions to capture the different nature of innovations and formal character of firms. First we decompose the innovation activity ($\boldsymbol{I_i}$) into technological ($\boldsymbol{T_i}$) and non-technological ($\boldsymbol{L_i}$) based innovation. Technological innovation includes product and process innovation, while non-technological

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

innovation includes marketing and management innovations. The first step of the estimation is expanded to include two knowledge productions

$$\boldsymbol{T_i^* = z_{i1}'\beta_1 + \varepsilon_i} \tag{4a}$$

$$\boldsymbol{L_i^* = z_{i2}'\beta_2 + \varepsilon_i} \tag{4b}$$

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

$$\boldsymbol{T_i = \begin{cases} 1 \; if \; T_i^* > 0 \\ otherwise \end{cases}} \tag{5a}$$

$$\boldsymbol{L_i = \begin{cases} 1 \; if \; L_i^* > 0 \\ otherwise \end{cases}} \tag{5b}$$

where $\boldsymbol{T_i}$ and $\boldsymbol{L_i}$ are respective observed binary variable equal to 1 if a firm undertook any technological and non-technological innovation activity in the past three years. The predicted values from (5a) and (5b) are then separately instrumented and included in the productivity equation

$$\boldsymbol{y_i = w_i'\gamma_0 + T_i^*\gamma_1 + L_i^*\gamma_2 + v_i} \tag{6}$$

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

$$\boldsymbol{y_i = w_i'\alpha_1 + I_i^*\alpha_2 + N_i\alpha_3 + I_i^* \times N_i\alpha_4 + v_i} \tag{7}$$

$$\boldsymbol{y_i = w_i'\gamma_0 + T_i^*\gamma_1 + L_i^*\gamma_2 + N_i\gamma_3 + T_i^* \times N_i\gamma_4 + L_i^* \times N_i\gamma_5 + v_i} \tag{8}$$

where $\boldsymbol{N}$ represents the degree of formality of a firm and $\boldsymbol{I_i^*}$, $\boldsymbol{T_i^*}$, and $\boldsymbol{L_i^*}$ are respectively the predicted value from models (2), (5a), and (5b).

In the estimation of our models we addressed two potential issues, exclusion restrictions and endogeneity. The reliability of the results relies on having exclusion restrictions, i.e. at least one explanatory variable in the knowledge production that does not appear in the productivity model. This variable should affect innovation, but affects productivity only through innovation. From an extensive qualitative research based on 32 in-depth interviews in 10 formal and informal firms that preceded the survey emerged that access to credit was one of the main constraint to innovation. In fact, at the time of the survey the current loan interest rate (~20%) was unaffordable for most of firms. We therefore used access to subsidised loan as exclusion restriction in our analysis being confident the impact of credit would affect productivity through investment in innovation. In addition to the exclusion restrictions we also needed to consider that 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 result in greater innovation activities. At the same time,

innovation is a driver of productivity. In the original model CDM model in the 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 on the personal characteristics of the entrepreneur.

4. Descriptive statistics

4.1 The nature of innovation

For this study we conducted with the support of the Science and Technology Policy Research Institute (STEPRI) 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-year period 2010-2013. We recognise that the development and adoption of innovations are 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 different levels of the formal character of the 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 cannot 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 sector and geographical representation of the Ghanaian informal economy. The population of firms from which we draw 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 size, and regional location.

The data collected cover 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 in wood and the manufacturing of wooden products. The remaining ten per cent are active in a multitude

[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).

of sectors, from manufactured paper products and rubber and plastics products to the 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 technological 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 improvements are relatively easy or affordable to implement. Non-technological 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 from a technology that was originally developed by others and licensed to the firm (with or without adaptation or modification) or developed in a formal R&D department within the company by scientists and engineers, amounted to respectively six and two per cent.

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 workers (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 of not more than 6 thousand 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 are located in the capital, Accra, or Tema, a nearby industrial area, and only five per cent of firms predominantly trade outside Ghana.

We capture entrepreneurship using a principal component analysis (PCA) on a series of questions that aim to capture the 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. The variables included in the PCA are listed in Table 2 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 captures the level of entrepreneurship with individuals that

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

are ingenuous, pro-active, methodical, and optimistic. The second component instead captures individuals that are more impulsive, less tenacious and unwilling to take risks.

4.2 The formal character of firms in the sample

We do recognize that there is not a standard definition of formal and informal firms (Benjamin and Mbaye, 2012). We, therefore, collected a self-reported formal character 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 follows 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).

Formal and informal firms differ in most dimensions. Informal firms are significantly less innovative than formal firms, both in technological and non-technological innovation activities. Informal firms also tend to have lower productivity, significantly smaller endowments, and poorer entrepreneurial skills than formal firms confirming the characterization of informal firms reported in La Porta and Shleifer (2014). 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 size, 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 for the informal firms. 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. Despite they are as innovative as the formal firms, their intensity of non-technological innovation activities is similar to the behaviour of informal firms. Their productivity is significantly lower than the one we find in formal firms. Semi-formal firms are significantly younger than formal firms and at the same time older than informal ones. Yet, regarding size, absorptive capacity, and location they resemble the latter. Such findings

provide an insightful picture of semi-formal firms in Ghana, highlighting how these are to a large extent in transition – and possibly trapped – between an informality and formality.

5. Discussion

5.1 Innovation activities in low-income countries

Table 3 reports the results from the first stage of the innovation model. Formal firms are more likely to innovate than informal firms, yet when we separate the innovation activities in technological and non-technological, we find the effect to be significant only for the former innovation. This highlights how even informal firms are equally able to adopt management and marketing innovations which by nature are more likely to be more affordable and determined by the capacity of the entrepreneur. In fact, entrepreneurship is a critical factor fostering innovation activities across all the specifications in our model. This reinforces the view that innovation adoption and creation in developing countries is still greatly influenced by the acumen and skills of entrepreneurs, to an extent that we do not find in developed countries where much of innovation is driven by R&D activities. In less structured establishment, innovation is driven by people with characteristics that make them overcome the constraints distinctive of LICs. Entrepreneurial skills and attitude, including marked curiosity and inclination to personal relationships, are important factors in the diffusion and adoption of innovations (Bruhn et al., 2010; De Mel et al., 2009).

Firm's size and the number of years a firm operated are positively correlated with higher non-technological innovation activities. Such findings are in line with previous studies of firms in Ethiopia and Ghana (Gebreeyesus, 2009; Robson et al., 2009). Firms located in the conurbation area which comprises the capital, Accra, and Tema, industrial harbour not far from the capital, are also associate with innovation activities, particularly no technological innovations. Large towns provide entrepreneurs the opportunities for personal interactions and exchange of information increased the likelihood that the entrepreneurs would be exposed to new ideas (Robson et al., 2009).

Other results are in line with the previous literature. A Larger proportion of skilled employees in the firms is associated with innovation activities, and the correlation is significant for both technological and non-technological innovations. This supports Bradley et al. (2012) study of Kenyan firms in which education and human capital were the main constraints to innovation. Competition seems to be a driver of innovation as well in the Ghanaian firms, pushing firms that work in competitive markets to innovate in order to remain in business. Market competition can nurture innovation capabilities and self-selecting firm that are able to thrive (Kumar and Saqib, 1996). Finally, access to subsidised rate loan is correlated as well with innovation activities. This reinforces our a priori expectation that credit is one of the main constraints to innovate for firms. The variable also proved to be a suitable exclusion restriction in the structural model.

5.2 Informality, innovation, and growth

Labour productivity greatly varies across the different level of formality of firms (Figure 1). Informal and semi-formal firms have a similar distribution, with higher concentration of informal firms at the extremes. At the far end of the spectrum, we only find formal firms that have the highest labour productivity in the sample. Such representation is in line with previous studies of large firms datasets that have highlighted the difference productivity level of firms (Porta and Shleifer, 2008), however it provides a new insights on the relatively low labour productivity of semi-formal firms which is not significantly different to the informal firm.

The econometric models support both the conventional wisdom that more innovative firms experience greater growth and that non-technological innovations have a greater impact on growth than technology-based innovations (Table 4). 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 a positive relationship between innovation and firms' growth. However, the impact and the significance level vary 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 find a positive and significance effect of non-technological innovation on growth. These 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. Wald test and Durbin-Wu-Hausman test confirm that the instruments used to control for the endogeneity of innovation activities in the model are strong throughout the specifications.

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 models show that the growth of informal firms is mostly driven by non-technological innovation. This is consistent with the fact that informal firms are characterized by modest absorptive capacity and limited resources, and technological based innovations are precluded in most of them. Informal firms can come across new technologies and products not only through other informal networks (e.g. members of a 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.

The finding that innovation plays a more crucial role for the growth of informal establishments may suggest informal firms use innovation to survive. Market conditions, lack

of financial resources and skills, and limited support from the government may provide a Darwinian environment in which only informal firms that are able to innovate, from delivering new product or services to targeting market niches, survive. The nature of the data does that allow us to infer that innovation may also be a driver that pushes informal firms to move to the formal sector. However, La Porta and Shleifer (2014) collect large evidence that shows how informal and formal sectors are segregated and rarely informal firms move to a formal status.

Across the various specifications, we find that firms that mainly operate in the local market tend to have lower productivity. Similarly, members of clusters which possibly rely more on economies of scale and collaborations to mitigate structural, financial, and managerial constraints. Firms located in the conurbation area are correlated with higher productivity, likely taking advantage of better infrastructure, larger pool of skilled labour market, and market opportunity.

Our results show a more relevant role of innovation on firms' growth than the recent findings from the work of Goedhuys et al. (2008, 2014), who found that supportive business environments have a greater influence on firms' performance than innovation activities. We also estimated different specifications in which we consider only technological innovations (products and process innovations) and the results are consistent with our main model (Appendix I). Two differences between the studies can explain the dissimilar results. Our setting focuses only on firms located in one country and, therefore, potential cross-country differences in business environments are not captured, besides the cross-industry differences in business environments. Given the rather homogenous sample of firms, we exclude the potential of significant differences at the industry level. Possibly more relevant, the two studies use difference sets of dependent variables, which provides different interpretations to the results.

6. Conclusion

Low-income countries rely on the 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, favoured 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 an LIC

recipient may also be more effective in receiving a similar level of technologies. We are assisting an initial process in which manufacturing industries will be eventually relocated to places where labour is cheaper – such as African countries – than current manufacturing countries where worldwide low-tech goods have been assembled and produced for four 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. The vast majority of the firms in LICs are informal; 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 informal firms use innovation to strive and survive.

A stronger emphasis among policy-makers should be placed in the fact that innovation is not the outcome of development but a means for development. Policies can play a critical role in accelerating the diffusion and creation of innovation and mitigating the obstacles LICs face. Too often in LICs, in the informal economy in particular, innovations are not recognized and innovation efforts in the firms are not properly supported. Therefore, new thinking and policies to recognize and support innovation, for example by mitigating financial and labour skills constraints, are necessary in the context of LICs for long-term growth and development.

Table 1: Sample description

	Description and unit	Mean full sample	Formal character of the firms			Statistical difference between groups		
			1. Informal (277)	2. Semi-Formal (116)	3. Formal (108)	1-2	1-3	2-3
Dependent variables								
Innovator	Whether the firm implemented any innovation (dummy)	0.78	0.69	0.85	0.94	***	***	
Technological innovation	Whether the firm implemented technological innovation (dummy)	0.70	0.59	0.81	0.87	***	***	
Non-technological innovation	Whether the firm implemented non-technological innovation (dummy)	0.40	0.34	0.43	0.55		***	
Labour productivity	Log (Turnover [in 1,000 GHc] / Number of employees)	0.37	0.23	0.06	1.08		***	***
Independent variables								
Capital / labour	Log (Fix assets [in 1,000 GHc] / Number of employees)	0.26	0.05	-0.12	1.19		***	***
Entrepreneurship 1	First component of entrepreneurship (PCA)	0.00	-0.36	0.53	0.36	***	***	
Entrepreneurship 2	Second component of entrepreneurship (PCA)	0.00	0.00	-0.17	0.18			**
Size	Number of employees (log)	1.78	1.14	2.04	3.13	***	***	***
Age	Age of the firm	15.82	13.01	17.58	21.16	***	***	**
Conurbation	Whether the firm is located in Accra or Tema (dummy)	0.50	0.50	0.51	0.48			
Skilled employees	Employees with specialization degree (%)	0.06	0.04	0.04	0.16		***	***
Competition	Degree of competition in the main market, from low (1) to high (5)	2.40	2.20	2.71	2.59	***	***	
Local	Whether the firm predominantly marketed locally (dummy)	0.68	0.78	0.63	0.50	**	***	*
Member of cluster	Whether the firm is member of a cluster (dummy)	0.13	0.10	0.09	0.25		***	***
Subsidized rate loan	Whether the firm obtained a subsidized rate loan (dummy)	0.05	0.02	0.05	0.10		***	

Notes: Statistical difference between the different degrees of formality of firms was performed with 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 risks	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 of innovation model: Determinants of innovation (Model I) and technological and non-technological innovation (Model IIa and IIb)

	I	IIa	IIb
Semi-formal firm	0.260	0.453***	-0.064
	(0.189)	(0.176)	(0.162)
Formal firm	0.576**	0.485**	-0.147
	(0.291)	(0.241)	(0.214)
Entrepreneurship 1	0.134***	0.132***	0.111***
	(0.036)	(0.033)	(0.036)
Entrepreneurship 2	-0.194**	-0.169**	0.009
	(0.075)	(0.067)	(0.064)
Capital/labour	0.031	0.043	0.093*
	(0.056)	(0.051)	(0.050)
Firm size	0.068	0.084	0.162**
	(0.079)	(0.074)	(0.072)
Age	-0.001	-0.005	0.015**
	(0.009)	(0.008)	(0.007)
Conurbation	0.451***	0.205	0.503***
	(0.156)	(0.139)	(0.131)
Local	0.209	0.123	0.274*
	(0.186)	(0.163)	(0.159)
Skilled employees	1.983***	1.235**	0.902*
	(0.712)	(0.587)	(0.502)
Competition	0.209***	0.186***	0.141***
	(0.061)	(0.057)	(0.054)
Subsidized rate loan	0.935**	0.814**	0.898***
	(0.427)	(0.352)	(0.312)
Constant	-0.360	-0.423*	-1.666***
	(0.277)	(0.251)	(0.254)
Correlation rho (ρ)		0.089	
		(0.086)	
Wald χ^2	80.71***	166.48***	
Correctly classified	81.24%	74.45%	68.86%
Observations	501	501	

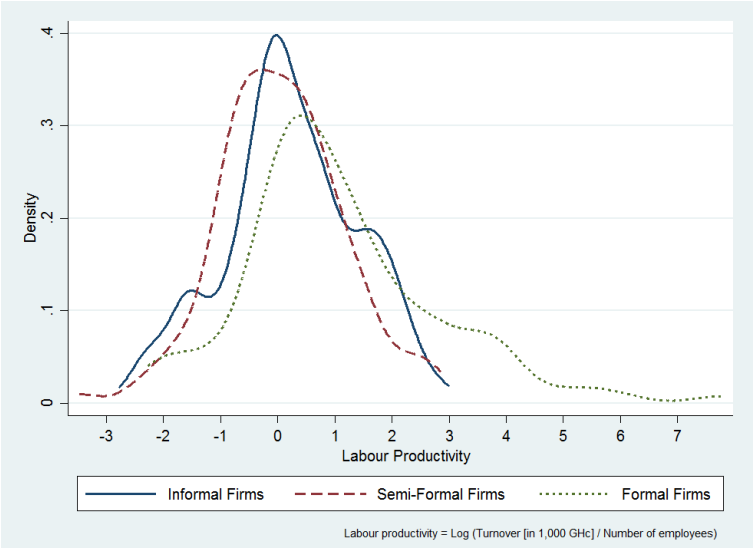
Notes: Coefficients are reported. Model I was estimated with a probit, while a bivariate probit was used to estimate Model IIa and IIb. Significance at the 10 per cent, 5 per cent and 1 per cent levels are indicated by one, two and three asterisks respectively. Robust standard errors are calculated throughout the estimations.

Table 4: Second stage of the innovation model: Determinants of firm's productivity by innovation (Model I and II) and technological and non-technological innovation (Model III and IV)

	I	II	III	IV
Innovation	1.826***	3.056***		
	(0.442)	(0.513)		
Technological innovation			-0.015	0.735
			(0.835)	(0.871)
Non-technological innovation			3.155**	4.543***
			(1.333)	(1.629)
Innovation x Semi-formal firm		-3.696***		
		(1.075)		
Innovation x Formal firm		-10.743***		
		(3.485)		
Technological innovation x Semi-formal firm				-2.588
				(1.704)
Non-technological innovation x Semi-formal firm				-2.949
				(2.203)
Technological innovation x Formal firm				-5.518**
				(2.716)
Non-technological innovation x Formal firm				-4.290**
				(1.975)
Semi-formal firm	-0.445***	2.424***	-0.293	2.621***
	(0.128)	(0.894)	(0.195)	(0.901)
Formal firm	-0.295*	9.286***	-0.039	6.183***
	(0.168)	(3.196)	(0.226)	(1.993)
Capital/labour	0.499***	0.477***	0.423***	0.450***
	(0.040)	(0.045)	(0.055)	(0.058)
Firm size	0.084	0.136**	-0.068	0.078
	(0.057)	(0.068)	(0.091)	(0.098)
Age	-0.002	-0.000	-0.017*	-0.013
	(0.006)	(0.006)	(0.009)	(0.009)
Conurbation	0.346***	0.453***	-0.030	0.084
	(0.095)	(0.107)	(0.229)	(0.233)
Local	-0.134	-0.212*	-0.251*	-0.325**
	(0.110)	(0.126)	(0.135)	(0.146)
Member of cluster	-0.244*	-0.341**	-0.275*	-0.335*
	(0.133)	(0.147)	(0.147)	(0.178)
Constant	-1.180***	-2.095***	-0.290	-1.407***
	(0.307)	(0.363)	(0.403)	(0.401)
R-Squared	0.43	0.40	0.35	0.31
Wald χ^2	267.86***	267.71***	234.49***	244.69***
Wald test (F)	249.72***	108.12***	358.80***	142.19***
Durbin–Wu–Hausman test	5.63**	30.68***	27.63***	50.23***
Observations	501	501	501	501

Notes: Models estimated with a two-stage least squares (2SLS) regression. Variables capturing innovation, technological innovation, and non-technological innovation were instrumented (including interaction terms). 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 are calculated throughout the estimations.

Figure 1: Distribution of labour productivity by level of formality of the firms.



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APPENDIX A

Table A: First stage of innovation model: Determinants of technological innovation (Model I) and non-technological innovation (Model II)

	I	II
Semi-formal firm	0.450**	-0.065
	(0.176)	(0.161)
Formal firm	0.484**	-0.152
	(0.240)	(0.215)
Entrepreneurship 1	0.131***	0.111***
	(0.033)	(0.036)
Entrepreneurship 2	-0.168**	0.011
	(0.067)	(0.064)
Capital/labour	0.043	0.093*
	(0.051)	(0.051)
Firm size	0.083	0.163**
	(0.074)	(0.072)
Age	-0.005	0.015**
	(0.008)	(0.007)
Conurbation	0.202	0.501***
	(0.139)	(0.131)
Local	0.126	0.274*
	(0.163)	(0.159)
Skilled employees	1.267**	0.903*
	(0.590)	(0.504)
Competition	0.188***	0.143***
	(0.057)	(0.054)
Subsidized rate loan	0.818**	0.897***
	(0.350)	(0.312)
Constant	-0.426*	-1.671***
	(0.251)	(0.255)
Wald χ^2	92.20***	75.34***
Correctly classified	74.45%	68.86%
Observations	501	501

Notes: Model I was estimated with a probit, while a bivariate probit was used to estimate Model IIa and IIb. 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 are calculated throughout the estimations.

Table B: Second stage of the innovation model: Determinants of firm's productivity by technological innovation (Model I and II) and non-technological innovation (Model III and IV)

	I	II	III	IV
Technological innovation	1.750***	2.891***		
	(0.419)	(0.484)		
Non-technological innovation			3.138***	5.220***
			(0.696)	(0.942)
Technological innovation x Semi-formal firm		-3.320***		
		(0.959)		
Technological innovation x Formal firm		-7.126***		
		(2.173)		
Non-technological innovation x Semi-formal firm				-5.750***
				(1.345)
Non-technological innovation x Formal firm				-6.679***
				(1.507)
Semi-formal firm	-0.561***	1.826**	-0.294**	1.793***
	(0.143)	(0.751)	(0.120)	(0.535)
Formal firm	-0.320*	5.422***	-0.038	2.667***
	(0.172)	(1.833)	(0.167)	(0.658)
Capital/labour	0.493***	0.484***	0.423***	0.482***
	(0.041)	(0.043)	(0.049)	(0.050)
Firm size	0.071	0.119*	-0.069	0.106
	(0.058)	(0.066)	(0.076)	(0.087)
Age	-0.000	-0.000	-0.017**	-0.009
	(0.006)	(0.006)	(0.007)	(0.007)
Conurbation	0.455***	0.524***	-0.026	0.124
	(0.092)	(0.100)	(0.143)	(0.148)
Local	-0.088	-0.151	-0.250*	-0.251*
	(0.106)	(0.117)	(0.128)	(0.135)
Member of cluster	-0.257*	-0.325**	-0.275*	-0.321*
	(0.134)	(0.145)	(0.147)	(0.182)
Constant	-1.030***	-1.728***	-0.297*	-1.375***
	(0.275)	(0.314)	(0.167)	(0.270)
R-Squared	0.43	0.41	0.36	0.29
Wald χ^2	267.11***	276.62***	232.92***	233.17***
Wald test (F)	350.76***	138.97***	157.90***	64.28***
Durbin–Wu–Hausman test	8.98***	30.92***	30.31***	41.84***
Observations	501	501	501	501

Notes: Models estimated with a two-stage least squares (2SLS) regression. Variables capturing innovation, technical innovation, and non-technological innovation were instrumented (including interaction terms). 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 are calculated throughout the estimations.