The creation and diffusion of innovation in developing countries: A systematic literature review

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Abstract

In this study we review the literature on the creation and diffusion of innovation in the private sectors (industry and services) in developing countries. In particular, we collect evidence on what are the barriers to innovation creation and diffusion and the channels of innovation diffusion to and within developing countries. We find that innovation in developing countries is about creation or adoption of new ideas and technologies; but the capacity for innovation is embedded in and constituted by dynamics between geographical, socio-economic, political and legal subsystems. We contextualize the findings from the review in the current theoretical framework of diffusion of innovations, and we emphasize how the institutional context typical of developing countries impacts the diffusion itself.

Keywords: innovation, diffusion, development, low- and middle-income countries

JEL codes: O14 Industrialization, Manufacturing and Service Industries, Choice of Technology
O31 Innovation and Invention: Processes and Incentives
O32 Management of Technological Innovation and R&D
O33 Technological Change: Choices and Consequences, Diffusion Processes
O55 Africa
O53 Asia including Middle East

1. Introduction

Innovation is regularly recognized as a critical component of industrialisation and catch-up in developing countries. Fundamental innovation is costly, risky and path-dependent, and to date ground-breaking innovation is highly concentrated in a few rich countries, linked with specific forms of university science and research capacity, and amongst a small number of firms. Therefore external sources of technology account for a large component of productivity growth in most developing countries. If foreign technologies are easy to diffuse and adopt, a country with meagre technological capacity can follow a catch up strategy to acquire and more rapidly deploy the most advanced technologies (Bell and Pavitt, 1993). In the current times, this is one emerging insight from the broad diffusion and impacts of mobile technologies and affiliated value-adding financial and health services (Aker and Mbiti, 2010). This view is also supported by evidence from the European industrialization process in the 19th century and the Japanese economic reconstruction after War World II. Soete (1985) showed how during the first industrial revolution the United States and other European countries successfully reduced the technological gap with the United Kingdom, the main innovator at that time, thanks to a successful imitation and catching up process. Again, after the World War II the reconstruction and growth of the Japanese economy was absorptive in nature and based on integrating foreign technologies (Blumenthal, 1976). Similar paths to imitate the Japanese growth and structural changes were attempted in the past decades by other Asian countries as well, with South Korea and Taiwan as success stories (Biggart and Guillen, 1999).

This history supports the claim that the development process in low-income countries (LICs)[1] can therefore be accelerated by tapping existing knowledge and know-how from foreign countries or by facilitating the exchange of both external and local knowledge within a country. Where the technological gap between developed and developing countries is significantly wide, better implementation of basic technologies can also have greater impact in recipient countries than the adoption of new technologies (Prahalad, 2012). The transfer, adoption and adaptation of knowledge to low-income countries hence constitute an important issue to understand and promote economic growth and global development.

However, 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). 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 (Fu and Gong, 2011).

[1] In the text we use the terms 'developing countries' and 'low-income countries' (LICs) interchangeably. Similarly, we use the categories 'developed countries' and 'industrialized countries' in the same way.

A recently published review on the origins and evolution of the field of science policy and innovation studies, points out that innovation studies are a consolidated research field in the developed world, while innovation studies in developing countries have not received much attention so far (Fagerberg and Verspagen, 2009; Martin, 2012). One of the main reasons is that 'innovation' carries a different connotation in low-income country context in comparison to industrialized economies. Through the 1990s, most developing countries were facing multiple challenges to improve basic needs, and innovation – as understood in industrialized countries and by most researchers and policy-makers – was not in the agenda of governments and international donor and development agencies. For policy purposes, innovation was perceived to be a privilege of advanced economies and seen just as an end of development and less as a means to it. In the past decades basic development indicators have improved in most LICs and the concept of innovation has had a more relevant place in the development agenda of policy-makers. This is manifested by the fact that many developing countries have by now conducted at least one innovation survey and that Science and Technology Observatories have been set up in many Asian, Latin American and African countries (African Observatory of Science Technology and Innovation, 2013). Moreover, a series of events and factors made visible the potential impact of innovation to become critical in the shift from agrarian to industrialized economies of LICs. The openness of trade has brought a broader diffusion of innovation and knowledge in countries that earlier were isolated, many LICs have developed policies for an industrial sector, and finally a prominent role of new players in the global economy (e.g. China) have emphasized the potential of South-South collaborations.

Literature on the diffusion of innovations in developing countries is growing and taking different directions (Altenburg, 2009). It is critical to identify what we have learnt so far, what evidence is inconclusive, and what we still do not know enough about. The main purpose of this study is to review the state of the art of the research in this area, shed some light on the dynamics that drive the diffusion and creation of innovation in developing countries based on existing literature, and identify the gaps for future research. Specifically, we focus on the diffusion of innovation among private sector of LICs, a sector in which developing countries have a greater space for improvement since often are working far from the technological frontiers, and where they can build a competitive advantage with other countries. From past studies, the literature review aims to collect study cases and empirical evidence that will contribute to answer three questions:

i. What are the barriers to innovation creation and diffusion *in* developing countries?
ii. What are the channels of innovation diffusion *within* developing countries?
iii. What are the channels of diffusion of external innovation *to* developing countries?

To capture the diversity of innovation in developing countries, we use a broad definition of the term "innovation". This includes not only the adoption of new products or processes, or new organisational and marketing practices (where "new" means new to the world, new to the country or new to the firm), but, in line with Schumpeter (1934), also new business models and new sources of supply. As methodology we adopt a systematic reviews protocol, a rigorous and transparent form of literature review. To the best of our knowledge, Lorentzen (2010) is the only study that makes use of a systematic review protocol to evaluate studies on the diffusion of innovation in developing countries. Three important differences allow our study to build on and extend the Lorentzen

research. Firstly, given the diversity of policy-relevant conceptions of innovation in developing countries, we used a more inclusive approach in sampling relevant studies and so set the systematic review with a broader range of keywords. Lorentzen used only a couple of keywords to identify the relevant articles ('innovation' or 'development'), while we adopted 28 different words. Secondly, while Lorentzen collected evidence on the diffusion of innovation in a broad range of sectors, from industry to agriculture and health, we focus on the industrial and services sectors, that are sectors in which developing countries could build productive capacity and a competitive advantage for economic growth in the coming decades. Finally, we expanded the timespan of our search, confining the research to the studies published between 1985 and 2013, while Lorentzen focussed on the period 1997-2008.

This study also differs from other literature reviews on the role of innovation and development, not just on the methodology used, but also on the focus and breadth of the study. Bogliacino et al. (2012) summarize evidence from studies that analyse Innovation Surveys from developing and emerging countries. In their study, only selected countries are included (Russia, Ukraine, Turkey, China, South Korea, Malaysia, Thailand, Singapore, Taiwan, South Africa, Argentina, Brazil, Chile, and Colombia), most of those not being classified as low-income countries in the past decade. Moreover other literature reviews of this field do not specifically focus on developing countries (Cohen, 2012), or may concentrate on the broad role of innovation on economic development, with limited evidence from low-income countries (Fagerberg et al., 2010).

The remainder of the paper is organized as follows. We first introduce and define the concept of innovation in the context of developing countries and then contextualize it in the more general theory framework for the diffusion of innovation, critically analysing how opportunities and constraints distinctive of developing countries influence the diffusion of innovation. We then present and summarize the characteristics of the papers selected on key dimensions before commenting on the findings. The review of the results is divided into three sections, each one addressing our three primary research questions. First we identify the barriers that prevent the creation and the diffusion of innovations in developing countries. This includes external (e.g. economic or political barriers) and internal (e.g. lack of labour skills and technological knowledge) constraints to the firms. Then we investigate the determinants of innovation diffusion *in* and *to* developing countries. In particular, how firms with low innovation capabilities can benefit from exchange of knowledge and technologies with other firms, for example members of associations or clusters, or public institutions, such as universities, within a country. The review would also highlight the critical role of intermediaries, such as technology transfer processes and institutions, and other capacity-building initiatives. And finally, how innovations from outside a country can be introduced and adopted by local firms. This includes the impact of trade, foreign direct investments (FDI), migration, bilateral or multilateral agreements, and education abroad. A final section summarizes what we have learnt from this exercise, provides directions for further research. An online Appendix describes the methodology and the protocol used in the systematic review.

2. The nature and the creation of innovation in developing countries

A fundamental question for our literature review is how to define innovation in developing countries and how to reliably measure sources, forms, and impact of innovation. The *Oslo Manual* has been a standard reference for surveys of innovation in advanced economies and, from its third edition, in developing countries. In compiling the Oslo manual, statisticians were more in favour of an approach where innovation is measured similarly in developed and developing countries, a hypothesis that could have facilitated comparison between the two sets of countries. Innovation is defined 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). From the definition, two important aspects are worth highlighting. First, innovation can take a multitude of forms (product innovations, process innovations, marketing innovations, and managerial and organisational innovations). It is relevant to account for the different innovation modes to isolate their diffusion patterns and their impact on firm performance. For example, recent evidence suggests that in OECD countries product innovations have a significant impact on revenue productivity, while the impact of process innovation is less clear (Hall, 2011). Second, innovation does not necessarily have to be new to the market or to the world as a whole, but could simply be new to the firm and have impact on productivity and employment because of that. And that impact could be competence-enhancing or competence-destroying for the individual firm or even for an industry (Tushman and Anderson, 1986). This suggests how innovation can be either ground-breaking novel innovation or imitative innovation; both forms of innovation can add considerable value, albeit through different implementation processes and on different time scales.

Firms can be innovating not just by showing innovation output performances as those listed in the previous paragraph, but also by investing in knowledge-building activities, which especially in the case of developing countries includes more than just research and development (R&D), namely design and engineering activities, on-the-shop-floor attempts to improve productivity, investment in learning (Lundvall et al., 2010). Creation, adoption, adaptation, assimilation, diversification of technologies are all parts and pieces of the innovation process. Besides upgrading their technological capacities by imitating or importing existing technologies, firms in developing countries also adapt existing products and production methods developed in the North to the needs of customers and the availabilities of resources in the South. Because of the risk, cost, cumulative nature of innovation and the relatively low level of education in low- and middle-income countries , ground-breaking novel innovations are less likely to occur there, while imitative and incremental innovation are more frequently observed. Because of the high sunk costs of establishing R&D facilities and the appropriability problems firms in developing countries are less likely to engage in R&D activities and more likely to invest in knowledge acquisitions that are not systematically collected in statistical surveys. LIC economies are less diversified than developed economies and primarily in agriculture and extractive industries. Although innovation can also occur in those primary industries, we shall concentrate on firms active in the industrial and services industries. Finally, a large part of the economy in LICs operates in the informal sector, for which so far not much statistical data have been collected.

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 by markets. In the past decades, companies have developed goods or services affordable for the poorest segments of population. 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. Often this process is called "frugal innovation", in which non-essential features are removed from a product/service to contain costs and be marketed for lower income customers. 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. Frugal innovation can be thought to be a sub-set of inclusive innovation, although in the literature the two definitions and concept have sometimes been used interchangeably. Nevertheless, both processes recognized the role of innovation within the LICs socio-economic and political contexts and aim to create value for underserved markets.

3. The diffusion of innovations *in* and *to* developing countries within the general theoretical framework of innovation diffusion

In his seminal book *Diffusion of Innovations* Rogers (2003) conceptualized the factors that influence the diffusion of innovations and described the attributes that affect the decision of potential adopters of innovations.[2] According to him, "diffusion is the process by which an innovation is communicated through different channels in a certain period of time among the members of a social system" (Rogers, 2003: p. 5). Two factors are involved in the diffusion: the innovation must have a nature suitable for the context in which it is spreading and vectors of communication diffusion must be in place in order to transmit information. However Rogers' framework was heavily centred on developed countries with homogeneous environments and economic structures. The critique of Strang and colleagues (Strang and Meyer, 1993; Strang and Soule, 1998) on Roger's framework seems to address many shortcomings of its application in LICs. They argue that he neglects 1) the texture of the terrain in which diffusion occurs, 2) the ways that what diffuses itself is transformed

[2] Hall (2004) claims that most of the studies that have looked at the diffusion of innovations in developed countries used some variations of the theoretical framework provided by Rogers(2003).

over time, and 3) temporal variables that affect diffusion. What are the characteristics of developing countries that affect the diffusion of innovation?

First, the nature of the innovation strongly influences whether it will be spread and the speed of diffusion. Some low-tech innovations do not rely much on channels of transmission and do not require demanding pre-conditional capacity (in term of skills and capital), and therefore the diffusion amongst potential adopters in LICs may be faster. On the contrary, more advanced innovations, such as high-technology equipment, may not find the local absorptive capacity that would enable the diffusion in the host-country. For those reasons, innovations diffuse more easily within LICs than between developing and developed countries, as is the case for imported innovation. Those reasons also urge for the capability-building of indigenous and domestic innovations. The nature of innovation includes also the objective and use of the innovation itself.

A second constraint in the diffusion of imported innovations in developing countries is given by the fact that those may not be designed by people with similar needs, and therefore may not address local needs. Adaptability, i.e. the skills and tools needed to perform the modification, is an important component enabling innovation, which allows imported innovation to meet local specifications and needs.

Third, communication channels are essential vectors of innovations diffusion: potential adopters will embrace an innovation only if they come across it or hear of it. The channels may involve transmission of information (e.g. ICTs), but also transport infrastructures (e.g. roads, harbours, and airports) for moving goods from outside and within a country. The latter was tacit in Roger's work, although it is a relevant factor in LICs. The efficiency of communications depends on the level of development of infrastructures and on the geographical and cultural distances between the actors involved in the communication. Developed countries have efficient transport systems that facilitate the diffusion of knowledge and goods. In many LICs, the quality and efficiency of infrastructures limit the transport of goods both from other countries and internally thereby hampering the spread of innovation. Moreover, in many cases developing countries set high import duties on imported products which limit the choice of technology or compromise on the quality of imported technologies. Geographical distance affects not only the transport of goods, but also the communication. In case of imported innovation, communications from the owner of the innovation and the potential adopters in developing country is likely to be heterophilous, i.e. the actors may not share common meanings, languages, or personal and social characteristics. Misunderstanding and cultural differences on the way to carry out the negotiations can affect the diffusion. This is less common amongst developed countries, where the differences in local absorptive capacity and social capabilities across countries are less extreme compared to such differences between some developed and developing countries.

Fourth, a large part of diffusion of innovation within countries takes place with communication between firms and through intermediaries (trade association, government policies, movement of personnel). In high-income countries we observe a larger concentration of firms, which allows more interactions am and exchange of skilled personnel. This is particularly important for innovations that involve the communication of tacit knowledge. Instead, LICs have usually less diversified sectors,

fewer larger firms, and limited intra-firm workers mobility thereby reducing the capacity of collaborations and spillovers. In this respect, the formation of clusters facilitates the diffusion of innovation. Moreover, the typical composition of the economic sectors in developing countries may affect the internal spread of innovations. While the private sector of high-income countries is based on formal firms, a large part if not the majority of firms in LICs are informal firms. This may create two levels of innovation diffusion: diffusion amongst firms with similar characteristics (formal and informal), but also between the two groups. For example, the spread of innovation between formal and informal firms could move the latter to become formal.

Fifth, incomplete, outdated, or under-developed institutional arrangements are, as we shall see, crucial obstacles to innovation diffusion in LICs (see also Biggart and Guillen, 1999; Hamilton and Biggart, 1988). Developed countries can rely on reasonable conventional and stable economic and political environments, while this is often not the case in developing countries. For example, political instability and weak law enforcements discourage foreign investments and the opportunity of diffusion of innovation from outside countries. Outdated or resource-constrained national innovation systems do not meet the original objectives for which they were designed. Diffusion and creation of innovation in LICs is also restricted by weak interactions and cooperation between private and public sectors. Those obstacles are typical of developing countries, and occur less obviously or less routinely among more developed economies.

Sixth, internal factors of the firms, such as limited financial resources and lack of advanced and specific skills, are factors that hamper both diffusion and adoption of innovation in developed as well as developing countries.[3] However, those constraints have a stronger impact in LICs, where the financial and knowledge gap is greater. Limited financial resources of people living in developing countries narrow down the affordability of innovation, and the lack of technical knowledge may prevent some adoption of innovations that are too complicated or require technical adaptation. At the same time a constraint for innovation adoption, such as the lack of financial means, can be a leverage for innovation itself, pushing producers to manufacture cheaper products and services affordable to the poorest categories.

Figure 1 summarizes the factors affecting the diffusion of innovation and the interaction with the adoption. Most of the obstacles to innovation diffusion in LICs seem to be connected to structural issues that are related to the current conditions and are a consequence of aspects related to history and geography. This arguably provides an additional argument for the reinforcing role of innovation diffusion and adoption and economic growth of a country. A similar conclusion is supported by Fagerberg and Srholec (2008), when they analyse the causes behind the weakness of innovation system in developing countries. However, some of the lack of diffusion of innovation may also not derive from weak or missing transmission channels. Sometimes, innovations in developing countries do not spread simply because they do not fit the local needs: something that solves a problem in

[3] Diffusion and adoption of innovation are closely related Metcalfe (1988), in the sense that the diffusion process covers the adoption process of a population of individuals over time.

developed countries may not be resourceful in a different context. For each innovation that is not spread, it is essential to assess whether this is due to a design fault, missing channels, or lack of local capacities.

Despite the technological conquests witnessed in the past century and the technologies that made possible and ease the transmission of information and movement of goods worldwide, 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. In less structured establishments, 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.

Regardless of the multiple obstacles that developing countries face, the benefits from the spread of innovations are likely to be greater than in more advanced economies. Most of the firms in developing countries work far from the potential technological production frontiers; therefore small changes in their activities may have greater impact in the production and wealth distribution. Given the current state of local capacity, incremental and low-tech innovations are more likely to be adopted and have greater chances of success. Moreover in the past decades we witnessed a massive and rapid spread of ICTs (internet and mobile phones) in most LICs that has reduced the state of "informational isolation" of many countries. Entrepreneurs can rely on information found on internet, and the use of mobile phones allows a more reliable and quicker communication within a country. This could also support a greater integration of national institutions, for example better connections between firms and universities or research institutes.

4. Descriptive Results

4.1 Sample selection

Innovation in LICs could take multiple shapes. The methodology used in the literature search was therefore designed to be flexible enough to capture this diversity, but at the same time be rigorous enough to only allow the selection of most relevant studies. A systematic review was then adopted with a protocol adapted from Arup et al. (2011)[4]. An online Appendix includes detailed information on the methodology used. Table A in the Appendix reports on the summary items sampled at each stage of the systematic literature review protocol. We initiated the sampling process in April 2013 using the ISI Web of Knowledge and the first threshold retrieved 7,385 items. Around 60 per cent of the items (4,441) are from the combination of the word "innovation (or synonyms)" and the country name, while the remaining (2,944) are given by combing the word "innovation (or synonyms)" and the country definition. After screening the titles and abstracts, 512 (7% of the original sample)

[4] Arup et al. (2011) report the protocol used in a systematic literature review of the impact of innovation on employment in LICs. The findings have not been published yet.

studies were considered relevant for the study case (Stage II). Most of the rejected studies in this stage were short conference papers/abstracts or studies not focusing on innovation.

In the third stage, most of the studies were excluded because they did not meet the data and dimension criteria. In particular, a large number of studies were focusing on the adoption of agricultural technologies (seeds, fertilizers, etc.) or related to health innovation (drugs, contraception, etc.) which are not the focus of our research[5]. After this stage of the review, we considered eligible 131 studies. In the final stage, a comprehensive screening of full text to assess the validity, reliability and applicability of each study, further reduced the number of studies for the analysis to 64. The breakdown of each steps of the systematic review is reported in **Error! Reference source not found.** in Appendix. A manual search aimed to identify any study that was missed in the electronic search or that are not included in the ISI Web of Science database, such as grey literature and reports published by international organizations, retrieved an additional 24 papers, bringing the total articles surveyed to 88.

4.2 The nature of the studies selected

For this rigorously defined sample set of relevant studies, the earliest were published at the beginning of 1990s, with most of the studies published after 2005, with a peak in 2012 (Graph 1). This confirms our prior knowledge that research on innovation in the private sectors in LICs is a recent focus of systematic research, and a still novel but quickly growing research field. Most of the studies (n=73) are carried out by researchers based in universities or institutions outside LICs[6]. The remaining studies are mainly by researchers based in LICs (n=13) and only four have mixed author teams, with only one case where the first author was based in a low-income country.

The shortlisted papers appear in a wide range of academic journals (Table 1). More than half of the studies are found in economics and development journals, with *World Development* the predominant journal followed by the *Journal of Development Economics* (8). Innovation journals publish almost a fourth of the studies, with *Research Policy* having most of the papers, followed by *Technovation* and *Journal of Product Innovation Management*, both with 3 articles. Journals covering management studies are the third group, with less than 15 per cent of the papers. Eight relevant studies were published by international organizations. Most of those were published in the Working Paper Series (e.g. World Bank Policy Research Working Paper and UNU-WIDER Working Paper), while two studies published by OECD and UNCTAD were included because of their policy relevance. On average, the selected studies have been cited by other academic papers 25 times, with 14

[5] It could be argued that such studies can be informative in understanding the institutional context and be more explicit about political and cultural factors that promote or impede the diffusion of innovations compared to studies that focus on innovations in the private sector. For example, in Lorentzen (2010) the innovation studies in the agricultural and health sector accounted for 61 per cent of the total papers sampled. However, such studies refer to households or individual decisions in which the channels for innovation diffusion and motivations for innovation adoption differ from dynamics in the private enterprise sector.

[6] We were not able to control for researchers born in developing countries but working in universities or institutes outside developing countries. To the extent that the authors do not come from, and have not sufficiently experienced living in, LICs there is a possibility that they have a biased view of how innovation occurs in LICs.

articles having more than 30 citations.[7] However, most of the studies reported have been published after 2005, which may affect the number of citations[8]. The average impact factor, a measure more appropriate to assess the quality of the studies, is 1.75 in 2011 with a standard deviation of 1.07.

Only a marginal number of the shortlisted studies describe in detail the nature of innovations investigated. The reasons are twofold. In some cases, the papers analyse the diffusion of innovation at the macro-level; in other cases the studies do not rely on a clear definition of innovation in LICs. Among the studies that do report the innovations, we find that most of the innovations have an adaptive or incremental nature and none of the studies selected describe technologies or that are "new to the world". Therefore, most of the findings refer to incremental innovation, rather than innovations that leapfrog or redefine value creation processes. Although the majority of studies do not explicitly acknowledge which innovation is adopted, most of the innovations in case studies can be classified as process or organization innovations, and only a few of them refer to product innovations.

Finally, we looked at the geographical (Table 2) and sectoral (Table 3) coverages. Most of the studies focus on innovation in Asian countries (n=32), primarily China and India (9 each), followed by Indonesia (5). Taiwan and Vietnam are the setting of a couple of studies each, while Bangladesh, Nepal, Thailand, Pakistan, and Sri Lanka have one study each. African countries are covered in 19 studies; West Africa (Nigeria and Ghana, respectively with six and four studies) being more represented than East Africa (Tanzania, Zambia, and Kenya with respectively five, two, and one study). Brazil and Colombia are the only Latin America cases. Forty per cent of the studies focus on multiple countries; in general those employ macro analysis with cross-sectional data. As for the sectors studied, most of the studies (46) have an economy-wide approach and include different sectors. This is more common for macro analyses, theoretical papers, or works investigating the role of the Base of the Pyramid (BoP). Among sector-specific studies, the manufacturing sector is the predominant one (33). Those studies range from textile, food processing, woodcraft, metal craft, and paper and rubber transformation. Only four studies look at the services: these include the research institutes and universities (2), finance (1), and tourism (1).

4.3 The research questions and methodology used in the studies surveyed

In order to get a better understanding of the heterogeneity of the papers surveyed we analysed the research questions and labelled the studies accordingly. From this exercise it emerged how the studies can be divided in three distinguished categories based on the objectives. Most of the studies (56) investigate the determinants and mechanisms of innovation transmission external to the firms. Those focus on a range of vectors, from movement of goods (trade, esp. imports) to movement of capital (FDI, OFDI), and how different institutional settings that can support innovation transmission

[7] For this specific metric, we excluded the papers published by international organizations from which we do not have such data.

[8] Out of the 27 studies that have never been cited, 14 have been published in 2012. Studies published before the 2005 were cited on average 67 times, while the ones that were published in 2005 or after were cited on average 8 times.

and creation, such as an open economy, the degree of competition, the role of clusters, regulations and policies (e.g. national system of innovation), and cultural factors (ethnicity, language, and geographical location). Twenty-six studies look at the determinants and impact of innovations investigating the factors internal to the firms (e.g. education level of the entrepreneurs, financial means, size, location). Finally six studies focus on the BoP, both as entrepreneurs and as consumers.

Most of the studies reviewed (63) are quantitative in nature. The vast majority of those (54) adopt an econometric approach, while the remaining ones use statistical methods (mainly correlations and group comparisons). The sample includes 12 case studies. These studies investigate the BoP context as a new market but also as new sites for the production of innovation or the role and functions of clusters. Qualitative analyses are likely to better capture the nature of these two units of analysis and the intrinsic dynamics related to innovation creation and diffusion, while more quantitative approaches may not fully capture the heterogeneity of such actors. Finally, the sample includes two studies that have predominantly a policy orientation and one research that adopted a mix-methods approach.

Given the relevance of quantitative studies in our sample, it is worth to spell out the heterogeneity of the data and the methodology used. Among this group of studies, most of them use cross-sectional data, i.e. surveys of subjects at the same point of time. A minority of those studies pooled comparable cross-sectional surveys administrated in various years. Twenty-five studies instead use panel data, i.e. surveys of same subjects at different points of time. The different natures of data also drive the model specifications. The vast majority of studies adopting panel data have a structural form (i.e. models have endogenous explanatory variables), while cross-sectional studies tend to limit the specification to reduced form. In only one case the study undertook an impact evaluation. Studies adopting statistical methods tend to capture correlations or comparing different groups. In a couple of cases, principal component analysis was used. Roughly two fifths of the studies deploy primary data. The secondary data are often governmental databases or data collected by international organizations. The latter are mainly used in cross-country analyses, yet the World Bank Enterprise Surveys have been popular datasets for cross-country firm level analyses. In the last rounds those surveys collected data on firm's innovation activities and the breadth of the countries covered make them a valuable resource for researchers.

Finally, we can review the unit of analysis in the study reviewed. Most of the studies (55) consider firms as units of analysis. In twenty-one cases the studies focus on firms with specific characteristics, i.e. SMEs (13), large firms (4), multinational enterprises (3), and university-run enterprises (1). Only a minority of studies (9) use countries as the unit of analysis. In those cases, aggregate data on FDI, R&D expenditure or patents at country level are used. Only three studies use data on the diffusion of a specific technology.

5. Findings

The findings from the systematic review are presented in three sections. The first investigates the nature of innovation in LICs and includes two subsections, respectively covering internal and

external barriers to innovation. The second section presents evidence of the innovation diffusion within LICs, while the last section reports on the drivers of innovation diffusion to LICs.

5.1 Barriers to innovation creation and diffusion in developing countries

5.1.1. External factors: Political, economic, and institutional constraints

Factors outside the firms may prevent or promote mechanisms of innovation creation and diffusion which, in turn, determine the speed and pattern of diffusion among firms within a country (Cohen and Levinthal, 1989; Keller, 2004). The existing literature suggests that these barriers include political factors, such as a weak political system and widespread corruption across society; economic characteristics, such as openness of an economy and level of economic development, inadequate infrastructure; institutional factors, such as intellectual property rights and the interaction between private (firms) and public sectors (research institutes and universities); and cultural and linguistic distances. Each of them is a critical barrier to the diffusion of innovation in LICs.

A large number of studies reviewed capture the impact of political and economic barriers to innovation suggesting that poor institutional environments lower firms' return to innovation. Nguyen and Jaramillo (2014) analysed data for more than 6,000 firms in middle and low-income countries and found that lower institutional quality (specifically, rule of law, regulatory quality, property and patent right protection) lower the return to innovation. In a cross sectional study of 107 countries, Allard et al. (2012) found evidence that national systems of innovation were most likely to flourish in developed, politically stable countries and less likely to prosper in historically unstable countries. Innovation capabilities require education and technical skills which can only be developed with long-term investments and unlikely to exist in unstable countries. A further consequence of unstable political powers is the lack of trust between private sector and policy makers which inhibits innovation activities (Meagher, 2007). Srholec (2011) argued that the way a political system is organized has powerful indirect effects on development through innovativeness of firms. From an analysis of more than 14,000 firms in 32 developing countries surveyed in the Productivity and Investment Climate Survey (PICS) by the World Bank, he found that democratic governments are likely to provide better incentives to the innovation systems. The level of corruption in a country is also an important barrier to innovation. De Waldemar (2012) analysing 1,600 Indian firms from the World Bank Enterprise Survey, found that corruption, in the form of bribes, levied a de facto tax that diminished the probability of new products being introduced. To mitigate the possible endogeneity effect of corruption and innovation, he used an instrumental variables approach and estimated that a standard deviation increase of bribery 'tax' decreased the probability of innovation by five per cent. Analysing data from 19 countries in Sub-Saharan Africa, Amendolagine et al. (2013) found that efficient institutions and a reliable legal system are pre-conditions for boosting the linkages between foreign firms and local firms. Property rights also affect the diffusion of innovation. A study of small-scale furniture makers in the city of Mwanza (Tanzania) revealed the lack of property rights manifested in the lack of control that business owners have over assets and that this created disincentives to invest in site improvements or fixed capital (Murphy, 2007).

ThelLiterature further suggests that the level of economic development of a country is not as decisive as the openness of the economy and trade policies for the creation and diffusion of innovation (Tybout, 2000). Trade is the main access to foreign goods and technology for countries (Coe et al., 1997; Eaton and Kortum, 2002). Lucke (1993) tested the hypothesis that industrial process innovations in the textile and steel industries had diffused more slowly in developing countries than in industrialized countries. He concluded that overall the level of economic development had only a modest impact on the adoption of innovations. Instead, multiple studies stress the importance of economic openness as a determinant for diffusion of innovation. Using firm-level data across 43 developing countries, Almeida and Fernandes (2008) found a strong positive correlation between openness and technology adoption. After controlling for firm characteristics and country and industry fixed effects, minority foreign-owned firms, importing firms, and exporting firms were, respectively, 4.5, 6.4, and 3.1 per cent significantly more likely to engage in technological innovations than firms without these characteristics. More recently, Fu and Gong (2011) explored the different impacts of foreign and domestic investment on R&D. From a panel dataset of more than 50,000 Chinese firms, they found that the major driver of technology upgrading of indigenous firms were internal R&D activities, whereas foreign investment appeared to contribute to static industry capabilities. This suggests that indigenous capacity is likely to result in innovation, whereas FDI tends to reinforce existing industrial capacity. Openness of an economy can be supported by specific policies but infrastructure to physically move people and goods are often necessary to realize the full benefits/ impact of openness. This more precise specification reinforces our observations about absorptive capacity and local infrastructure that converts abstract potential (e.g., R&D expenditures) into realized benefits. Kinda (2010) used firm-level data from 77 developing countries and showed how the lack of physical infrastructure discourages FDIs.

A large literature among developed economies points to the role of national innovation ‘systems’ that link key institutions in a value-creating cycle (Lundvall et al., 2002; Nelson, 1992). In the context of LICs, obsolete national innovation systems in relation to the economic development of a country, and a lack of market competition are both barriers to innovation. In developing countries which are less successful in technological catching-up, to be effective national innovation systems must be linked to the economic structural development level. Using Thailand as a case study, Intarakumnerd et al. (2002) found that while the country moved from agricultural to an increasingly industrial economy, its national innovation system remained weak and fragmented. That undermined the innovation capabilities. A functional national innovation system seems to be critical for the acquisition, adaptation and development of more advanced technologies. Fu and Zhang (2011) analysed the solar photovoltaic industry in China and India and found that in both countries the national innovation systems successfully developed and supported the capacity for the industry to mix and sequence different technology transfer and indigenous innovation mechanisms. Similarly, innovation capabilities can also be nurtured by market competition. From a sample of 291 Indian manufacturing firms, Kumar and Saqib (1996) showed that in case the entry of new firms in a market is restricted by government policy the absence of competitive pressure reduces the likelihood of firms undertaking R&D. However, they found that the competitive pressure did not influence the intensity of R&D expenditures of firms once they had decided to invest in R&D.

Diffusion and creation of innovation is also restricted by weak interaction between private and public sectors. A number of the issues associated with the lack of innovation activity in North West Frontier Province Pakistani industries could be linked to the fact that Pakistan has not had an established tradition of interaction between the public and the private sectors in technology policy-making (Bashir et al., 2010). Meagher (2007) remarks that industrial development is better facilitated if the mechanisms driving it are embedded in the social institutions, capabilities, and competences found in a region. In this way, spillovers between different sectors are facilitated. Katrak (1997) looked at the poor performances of the partnership between the Indian national chemical laboratories and the local firms. It was found that the lack of complementary capabilities in the private firms and the inadequate technology developed in the labs were the main factors that weakened the relationship.

A further barrier to innovation creation and diffusion is the lack of connections between universities and the private sector (Kruss et al., 2012). From a study of 50 firms in Nigeria, Oyelaran-Oyeyinka et al. (1996) found that research and development institutions (RDIs) interacted more with firms that did not undertake any R&D but relied on RDIs for solutions to bottlenecks rather than developing new products and processes. More recently, Srholec (2011) used a multilevel model of innovation to find lack of evidence on the extent of public research infrastructure and the propensity of firms in developing countries to innovate.

Entrepreneurship policies are also determinant factors that can promote or prevent innovation in LICs. Hall et al. (2012) examined the participation of people at the BoP as entrepreneurs and not as consumers. They argue that weak institutions encourage undesirable outcomes, especially if entrepreneurship policies are based solely on economic indicators. They added that policies addressing both economic and social perspectives may foster more productive entrepreneurial outcomes, albeit at a more constrained economic pace. Allard et al. (2012) found that pro-business market reforms consistently showed a strong effect that counterbalanced the negative impact of political instability, especially in those developing country environments where science and technology were lagging behind.

Cultural and linguistic distances have also an impact on the diffusion of innovation, particularly regarding FDI spillovers. Analysing patent data to measure international diffusion of technological knowledge, MacGarvie (2005) found that diffusion is enhanced by sharing a common language, together with physical and technological proximity. Instead, Rodriguez-Clare (1996) built a theoretical model in which differences in languages between host- and source countries can actually foster the diffusion of innovation. The rationale is that when the costs of communication between headquarter and production site are higher, there is a stronger incentive to buy specialized inputs in loco. Similarly, different cultural background between host- and source-countries can increase domestic firms' opportunity to learn through exposure to different systems of technologies, management practices, and cultural values. These are the findings from a panel study of Chinese firms (Zhang et al., 2010). Ethnicity is an important bounding factor in economic transactions, and Huang et al. (2013) explored the impact of FDI on ethnic Chinese firms. Their results seem not to support the vision of ethnicities as factors that can close the information gap and contribute to contract enforcement in environments where legal institutions are underdeveloped, but rather

factors that privilege insiders at the expense of outsiders with as a consequence a reduction in economic efficiency.

Finally, Weinhold and Nair-Reichert (2009) highlighted two additional barriers to innovation: inequality (measured as share of middle class) and intellectual property rights (IPRs). They used data on patents granted to residents and non-residents from 1994 to 2000 across a sample of 53 countries, including several LICs, to capture the innovation level. Taking into account the likely endogenous nature of innovation, their findings indicate that the size of the middle class, and to some extent IPRs, explain resident, but not non-resident, patterns of patenting. They argue that the middle class impact on creation of innovation is likely to operate through increased market participation, which directly increases domestic, but not necessarily non-resident, innovation. Kumar and Saqib (1996), Javorcik (2004), Shi and Pray (2012), Yang and Maskus (2009), and Yongmin and Puttitanun (2005) found similar evidence of the negative impact of weak IPRs on innovation. Zhao (2006) showed how MNEs undertaking R&D in LICs take advantage of the arbitrage opportunities presented by the institutional gap across countries. Using data for over thousand US firms, she found that technologies developed in countries with weak IPR protection are used more internally, and as a consequence they show stronger internal linkages. The results suggest that firms may use internal organizations to substitute for inadequate external institutions. However, it is important to contextualize those results to the nature of innovation in LICs. For many of these, innovation is often imitation and adaptation of imported technologies and this is not reflected in the patents data.

5.1.2. Internal factors: Capabilities and resources constraints

Recurrently we also find in the literature references to factors internal to the firm that can stand in the way of innovation and affect the competitive strategy of a firm. The predominant factors are the lack of human capital (education and managerial skills), resources (financial capital and information), and networking capabilities.

Bell and Albu (1999) argued that the diffusion of innovation in LICs should be assisted with systems of knowledge accumulation, rather than just production systems. They developed a conceptual framework of clusters' active capabilities for generating and diffusing knowledge, and highlight the critical role of external sources of knowledge. Numerous studies have empirically tested the role of knowledge. Using data from 100 manufacturing firms in Nigeria, Abereijo et al. (2007) found a strong positive correlation among the few firms that showed some level of innovation abilities and the level of education of the managers, which included higher academic degree and education in science or engineering. Similar findings are reported in studies of firms in a multi-country setting (Wang and Wong, 2012), in Ghana (McDade and Malecki, 1997; Robson et al., 2009), Tanzania (Hall et al., 2012), Uganda (Oyelaran-Oyeyinka and Lal, 2006), and again Nigeria (Egbetokun et al., 2012; Ilori et al., 2000). Fu (2008) provided evidence showing that in regions of China with more highly educated and skilled workers FDI spillovers are greater. As Huang et al. (2003) point out, intellectual capabilities are also critical in the process of learning from failure. In many of the previous references, education is regarded as a necessary, although not a sufficient, condition for innovation. From a survey of 201 small business owners involved in a microcredit programme in Kenya, Bradley et al. (2012) advocate that capital is not a “silver bullet”, and education and human capital are the major constraints of

innovation. Robson et al. (2009) stress how the lack of access to educational opportunities in many developing countries further disadvantages female entrepreneurs in the pursuit of an entrepreneurial career. The lack of resources in the education system in many LICs, mainly in rural areas, make the non-formal training the main source for learning, together with "learning by doing" (Oyelaran-Oyeyinka and Lal, 2006). In addition to education, managerial skills have received increased attention as a factor explaining differences in firms' performance in LICs (Bruhn et al., 2010). Mano et al. (2012) ran a randomized experiment in Ghana where 167 metalworkers received a three weeks training program. Compared to the control group, the treatment group showed improved business practices (keeping business records and visiting customers) and better performance.

Technical innovation can be expensive, and firms cannot afford to implement them. For example, in the specific case of paper-manufacturing in Northern Vietnam, the financial constraint was a more critical obstacle to overcome than the lack of skill to adopt and use a new technology (Kimura, 2011). Financial and credit constraints seem to be a factor affecting firms in different settings and Kugler (2006) and Gebreeyesus (2009a) draw similar conclusions from respectively a sample of Colombian manufacturing firms and SMEs in Ethiopia. Subsidies and grants offer a concrete support for innovation in LICs. Vishwasrao and Bosshardt (2001) analysing data from Indian firms, concluded that not only machinery and assets should be subsidised, but skills, capabilities, and linkages as well. Egbetokun et al. (2012) argue that tax reduction for firms could achieve the same result.

Back in 1992, Bagachwa studied the performance of small- and large-scale grain milling techniques in Tanzania to explain why some firms select inappropriate techniques and products. Beside the lack of financial capital, he found that an important factor was the lack of information of the appropriate technology. In fact, about 80% of the mill owners did not have sufficient prior knowledge about costs of alternative milling equipment and their operating characteristics. The lack of information and knowledge was also responsible for an initial failure of the electronic banking of a commercial bank in Nigeria (Huang et al., 2003). A first implementation of Internet banking did not work and given the lack of technological capability within the bank it was not possible to simply generate a solution based on the organization's existing knowledge. They then argue that technology is not necessarily a panacea for innovation, and learning from experience can be equally relevant. McDade and Malecki (1997) showed how the lack of comprehensive information and experience in larger-scale manufacturing seemed to be the largest impediment to improving Ghana's industrial capacity. Kumar and Saqib (1996) pointed out how the lack of the right technology was also a barrier for the manufacturing sector in India. A different approach is taken by Van Dijk and Szirmai (2006). Based on a comprehensive sample of Indonesian paper manufactures from 1923 to 2000 they built an index of machinery efficiency that captured the technological distance of each firm to the world technological frontier. They found evidence of quick catch-up by the industry, although some firms (which had the finance and capabilities to adopt large-scale modern machinery) installed state-of-the-art machinery, while others installed older vintages. Some studies also considered the firm size as a barrier to innovation (Chen et al., 2011; Robson et al., 2009). However, arguably, the size of a firm and its resources are likely to be correlated.

Additional internal factors that facilitate the diffusion of knowledge and innovation are the openness and networking capabilities of the firm. Murphy (2002) collected data of 41 manufacturing firms in Tanzania and found that a firm's capacity for innovation was related not only to the quality of the social structures available to it (i.e. the institutions), but that innovation was also driven by the social capabilities or competences of the managers within the firm. He also emphasised how trust between actors, which often is not captured in empirical estimations, may be associated with different forms of innovation. In fact trust has an important function of binding and bridging mechanism in social relations that ultimately may facilitate information exchange and collective knowledge creation. Similar conclusions come from Meagher (2007), who found trust a determinant factor in the success of clusters in Nigeria. Finally, the lack of communication technologies could also be a barrier for knowledge diffusion. In a study at the dawn of the diffusion of mobile phones in developing countries, Overå (2006) found that a prompt communication between economic agents in Ghanaian firms had a significant effect in the diffusion of market knowledge.

5.2 Innovation creation and diffusion *in* developing countries

The literature review highlights three main vectors of innovation diffusion in LICs. Simple forms of clusters allow firms and entrepreneurs to share capabilities in the existing value chain. Case studies on the link between public (universities) and private sector underline how public funding can support the knowledge diffusion and innovation. Finally, a new and growing branch of research looks at the innovation diffusion within the value chain itself. The focus is twofold: to rethink the value chain of products and to provide affordable services and products.

The evidence found suggests that clusters in LICs do not seem to directly involve the creation of new products or processes, however they go farther than merely exploiting economies of scale. McDade and Malecki (1997) investigated the type of inter-firm interactions that take place among entrepreneurs of small-scale enterprises in the industrial district of Odawna (Ghana). Most of the interactions are associated with sharing tools or pieces of equipment, in addition to playing the role of word of mouth advertising. Although many examples are reported of ingenious innovations in the adaptation of material resources, much of the energy seems to be consumed in finding ways to accommodate the scarcity of basic economic and material resources. Murphy (2007) instead found that in the industrial clusters in Mwanza (Tanzania) there was no high-end innovation or high-quality production but rather situations exploited for market access and the collective efficiencies associated with tool sharing, labour pooling, and ready access to inputs. Both examples seem to fall within the category of "survival clusters", where micro- and small-scale enterprises produce low quality consumer goods for local markets, mainly in activities where barriers to entry are low (Altenburg and Meyer-Stamer, 1999). That example emphasises the importance of geographical location for the diffusion of innovation. Robson et al. (2009) found that more innovative Ghanaian firms were located in large towns, where the opportunities for personal interactions and exchange of information increased the likelihood that the entrepreneurs would be exposed to new ideas. A more recent study instead found stronger evidence for the role of clusters in enhancing innovation diffusion among its members. Gebreeyesus and Mohnen (2013) studied the learning process of informal shoemaking firms in a cluster in Ethiopia. In an environment where innovation is mainly

imitative in nature, they found that firms with more ties in local business networks tend to perform better in terms of innovation. Their findings suggest connectedness as the main factor of knowledge transfer, while co-location is not a sufficient determinant for the diffusion of innovation.

Several studies highlight the importance of connections between the public (universities and public research institutes) and the private sector in various technological fields, such as vaccine production in Vietnam (Ca, 2007), chemical and mineral extraction in Pakistan (Bashir et al., 2010), and cable and wire manufacturing industry in Nigeria (Egbetokun et al., 2012). Each study emphasises how the web of connection is crucially a win-win solution for both actors: the involvement of the private sector is essential for industrial competitiveness, which in turn is crucial to formulate and implement innovation policies. Nonetheless, Kruss et al. (2012) remark how there is a high degree of heterogeneity among LICs. For example, the nature of university–firm interaction in South Africa is more direct, formal and knowledge intensive than in Uganda and Nigeria. In turn, policy advances and university level interventions in Uganda have stimulated the emergence, albeit on a small scale, of more knowledge-intensive firms than in Nigeria. Eun et al. (2006) provided a good example on how the interactions between universities and the private sector couldtake different shapes. Since the market-oriented reform, Chinese universities have a strong propensity to pursue economic gains and strong internal resources to launch start-ups, and thus establish their own firms (the so-called University-run Enterprises). The main reasons provided to explain this evolution – low absorptive capacity of industrial firms and underdeveloped intermediary institutions – could be informative for LICs.

In the past decade the recognition of the people living at the BoPs as innovators and new potential consumers, has opened up a new sub-field of innovation studies. Prahalad and Mashelkar (2010) created the definition of "Gandhian innovation" to describe the process in India of designing inexpensive products and manufacturing them with limited capital, and on a scale so vast that their prices are affordable for customers who cannot afford products marketed by western companies. Affordability and sustainability, not premium pricing and abundance, become the new goals of effective innovation. To address the needs of this new market segment, firms must learn how to enhance new product adoption despite the barriers of poverty. An efficient approach is working backward from the constraints and circumstances, to ensure that the innovation is well received (Nakata and Weidner, 2012). At the same time, Prahalad (2012) claims that in such environments innovation can come from focusing on awareness, access, affordability, and availability (4As). He retraces the commercialization of a biomass stove for the rural poor in India to show how from a product-centric approach the focus is on business model innovation, of which the product is just a subset. The BoP is clearly a huge market, but in some countries it can be too little for multinationals, and this opens opportunities for local companies. Analysing the e-commerce sector in Nepal, Kshetri (2007) advocates that one of the reasons why the local web portal Thamel.com succeeded is because the Nepalese e-commerce market was too small to be attractive for multinationals like Google or Yahoo.

Hall et al. (2012) focused on the participation of the poor as entrepreneurs and not as consumers. Drawing on data collected from Brazilian tourism destinations, they found that tourism entrepreneurship provided the BoP with opportunities to improve social welfare, but at the same

time it was the cause of wider social problems. This finding suggests that policies should address both economic and social perspectives, although at the expense of a more constrained pace of economic development. Again, a different perspective is given by Ramachandran et al. (2012) who investigated the BoP producer, a member of the BoP population who creates value by producing goods and services for sale in nonlocal markets. Using as a case study Fabindia, an Indian handloom retailer, they coined the concept of "bridging enterprise", a business enterprise that originated at the intersection of specific BoP communities and the corresponding nonlocal markets. In return, BoP producers would obtain access to market, access to organization, and access to ecosystem with potential impact on poverty alleviation. Ramani et al. (2012) instead used an ethnographic analysis to identify and analyse the actual field practices of sanitation entrepreneurs in India, specifically in the delivery of pro-poor innovations. They found that sanitation entrepreneurs followed their target beneficiaries through three phases (pre-construction, construction and post-construction activities) the last one being the most crucial for the success of sanitation diffusion, and therein lies the most valuable lessons. This example shows how the innovation process goes behind a standard linear model of assessing need and appropriateness of technology. Innovation for and within BoP is often demand driven. In the rural areas of Bangladesh, in most cases the innovations are based on the farmers' perception of their needs and the available indigenous capability of the artisans (Uddin, 2006). The innovation process is kindled by the knowledge of producers gained through "learning by doing", and the experience of farmers through "learning by using".

5.3. Innovation diffusion *to* developing countries

The applied literature on innovation and developing economies has mostly focused on four channels of technology transfer across country borders: trade, FDI, migration, and licensing (Fagerberg et al., 2010). However, most of the empirical studies have mainly given attention to the first two, since data for migration and licensing are scarce in LICs[9]. Due to the challenges related to assessing innovation in LICs, the studies reviewed have predominantly looked at the direct impact of knowledge diffusion on productivity. Literature suggests that openness is a pre-requisite for diffusion of external knowledge; however the magnitude of FDI and trade depends on host-country policies. This highlights again the importance of local governance to nurture innovation in local firms attracting foreign knowledge and technologies (Dollar et al., 2005; Franco et al., 2011).

The trade and the degree of openness of an economy is a critical factor for knowledge diffusion. Coe et al. (1997) are the first to have shown that productivity capacity in developing countries is significantly related to the R&D activities in the country trade partners, providing evidence of spillover effects between developed and developing countries. A one per cent increase in the R&D capital stock in the industrial countries on average raises output in the developing countries by 0.06 per cent. Analysing a mix of 93 developed and developing countries, Edwards (1998) investigated the robustness of the relationship between openness and total factor productivity growth. He used nine

[9] A notable exception is the work of Seker (2011) which found that removal of license requirements from the Indian government led to a five percentage points faster innovation rates.

alternative openness indicators and in the vast majority of cases he found a positive and significant correlation with total factor productivity. Similar findings are related to the positive correlation between imports and local R&D (Kumar and Saqib, 1996), the attraction of foreign R&D activities in LICs (Bashir et al., 2010; Ca, 2007; Robson et al., 2009), increased international trade (Shi and Pray, 2012), globalization and local knowledge (Lederman, 2009), and firms' decisions to export (Abor et al., 2008). Both imports and exports can give access to foreign goods and technologies, furthermore favouring foreign investment can potentially bring positive spillovers to local firms. Almeida and Fernandes (2008) use data from 43 developing countries to investigate whether exporting and importing activities are important channels for technology transfer to LICs. They adopted a broad definition of innovation that included the creation of new production processes but also the adoption and adaptation of existing technologies to local conditions. They found a strong positive correlation between openness and technology adoption, importing firms being up to 6.4 per cent more likely to engage in technological innovations than autarky firms. Although they run several robustness checks, they did not fully address the potential endogeneity nature of innovation in their model. More recently, Seker (2012) draws similar conclusions. Again, the cross-sectional nature of the data used makes it difficult to interpret the relationship between trade and innovation as causal. Two studies overcome this limit using panel data. Thanks to a detailed panel of Indonesian manufacturers firms, Blalock and Veloso (2007) showed that firms in industries supplying import-intensive sectors had higher productivity growth than other firms. Moreover, they found that early exposure to downstream imports gave the greatest opportunities for learning. A rather large literature provides evidence of a link between a firm's efficiency and its becoming an exporter (Aw and Hwang, 1995; Chen and Tang, 1987). However, only recently scholars have focused on determining the direction of causality. Analysing firm level data from Colombia, Mexico, and Morocco, Clerides et al. (1998) could not identify the causal relationship and concluded that the relationship between exporting and efficiency is mainly explained by self-selection of the more efficient firms into the export market. (Hallward-Driemeier et al., 2002) argued that it is not self-selection, but the fact that firms that aim for export markets make different decisions regarding investment, training, technology and inputs, which all together raise firms' productivity. Their conclusions are based on analysing the years before entering a foreign market of 2700 manufacturing establishments in five Southeast Asian countries (Indonesia, Korea, Malaysia, the Philippines, and Thailand).

The openness of an economy can also positively attract FDI. Wang and Wong (2012) used a panel data of 77 countries and a stochastic frontier analysis to study the effect of foreign R&D transferred through imports and FDI on domestic technical efficiency. They found that foreign R&D transferred through both inward FDI and imports on average accounted for almost ten per cent of the world technical efficiency over 1986–2007, with the largest contribution in OECD countries at 12 per cent and the smallest contribution in sub-Saharan Africa at seven per cent. They then argue that the lack of human capital in local firms is a critical factor in the missing link between FDI and innovation. This confirms the theoretical work of Keller (1996) that underlines the distinction between technological information and human capital. Both are needed for a sustainable growth, although the latter is costly to accumulate, even in an outward-oriented regime, and needs largely to be home-provided.

In economic theory, we find three channels through which FDI can generate productivity growth for host-country producers: spillovers, linkage externalities, and competition[10]. Kugler (2006) analysed data from Colombian firms to assess the impact of each of these factors. He found limited *intra*-industry externalities but widespread *inter*-industry spillovers from FDIs. The findings also revealed outsourcing relationships of MNCs with local upstream suppliers. Young and Lan (1997) pointed out that policies of host countries are critical factors in exploiting the potential of FDI as an instrument of technological development. Using a mix of quantitative and qualitative methodology, they concluded that in China the impact of FDI is greater than theory would suggest, and given the size and growth of the market, substantial opportunities exist for increased technology transfer with appropriate policy changes. In particular, they advocated that Chinese policies have encouraged the quantity rather than the quality of FDI. In this respect, Glass and Saggi (1998) built a theoretical model in which they linked the quality of technology transferred through FDI to the technology gap between the developed and developing countries, as determined by the rate of imitation relative to innovation. The capacity of imitation of LICs allows FDI to transfer more advanced technologies, while the innovation rate of developed countries limits the transfer of more advanced technologies. However, the transfer of technology associated with FDI may have a different effect in local firms. Analysing data from Indonesian chemical and pharmaceutical firms, Suyanto et al. (2009) found that FDI spillovers have a significant impact in enhancing the local technological level, although it does not seem to significantly change technical and scale efficiency. Remarkably, a study of Indonesian manufacturing firms founds that knowledge spillovers seem to be significant only in FDI of foreign firms that perform R&D (Todo and Miyamoto, 2006).

The positive effects of FDI in technology transfer strongly depend on the host country's characteristics and policies (Blomstrom and Kokko, 2001). Besides fiscal incentives and performance and technology transfer requirements, they argued that the efficacy of FDI can be increased by policies in support of local technological capability and policies that ensure that the foreign affiliates operate in a competitive environment. Spillovers to local agents need fertile environments but also time to allow local absorption. Amendolagine et al. (2013) recently investigated the type of FDI that maximizes the likelihood of creating local linkages between MNEs and domestic suppliers in Sub-Saharan Africa. Using data from 19 different countries, they find that time since entry of foreign firms is associated with higher local linkages. The FDI's impact can also depend on the host's economic structure. Thompson (2002) analysed data of Hong Kong garment firms with manufacturing investments in Mainland China to empirically test whether FDI within geographical industry clusters transfers technology more that FDI that is geographically dispersed. He found that clustered FDI is significantly better than dispersed FDI at transferring technology, implying that industry cluster and FDI policies should be designed in tandem rather than separately.

Several studies looked at the different channels – vertical and horizontal – through which knowledge is transmitted along the production chain. Using a panel dataset of Indonesian manufacturing firms,

[10] Spillovers in emerging economies from multinational firms have received a large attention in literature. For a review of evidence see Blomström and Kokko (1998) and Görg and Strobl (2001).

Blalock and Gertler (2008) tested the hypothesis that not just the foreign-owned firm, but all firms downstream of that supply market were able to obtain lower prices. They found strong evidence of productivity gains, greater competition, and lower prices among local firms in markets that supplied foreign entrants. This finding suggests that linkages through vertical supply relationships are the channel through which import-driven technology transfer occurs. Similar conclusions that foreign-owned firms are more likely to benefit from trade than domestic firms are found in Vishwasrao and Bosshardt (2001) and Blalock and Veloso (2007). Bwalya (2006) investigates the nature of productivity spillovers from foreign to local firms using firm-level data on manufacturing firms in Zambia. The main findings bring weak evidence in support of productivity spillovers from foreign firms to local firms through horizontal channels, whereas there are significant knowledge spillovers occurring through backward linkages, from foreign firms in upstream sectors to local firms in downstream sectors. Goedhuys (2007) instead found horizontal linkage among local manufacturing firms in Tanzania. Foreign firms were more likely to innovate through connections with foreign firms, hiring better skilled personnel, and investing heavily in machinery and equipment. Instead, she found that local firms mainly innovated in collaboration with other local firms.

Finally, we find limited evidence on two additional channels of potential knowledge transmission to LICs, international cooperation and remittances. Sawada et al. (2012) built a panel dataset with 85 countries to investigate the role of international technical cooperation from developed to developing countries. They found that technical cooperation mainly complements the lack of human capital in hosting countries and its impact on technology transfer is only second to openness of the economy. Ca (2007) investigated the production of vaccines on the basis of research and technology transfer in Vietnam. He found that international cooperation on R&D was a critical factor in the success of turning Vietnamese research institutes into business operations. In this case the lack of capabilities of the local firms was supported by international cooperation efforts. Thanh and Bodman (2011) instead, investigated whether skilled workers from LICs, living and working overseas, can effectively channel technological knowledge back to their home country. They found that remittances have a positive and significant impact on the growth rate of donor countries, which suggests that openness to international migration can contribute to the economic development. This is the only study in our sample that looks at the impact of migration on innovation, however the endogeneity issues in the models are not fully considered.

7. Conclusions

We reviewed the state of art of research on the diffusion of innovation in the private sectors in LICs to gather the current evidence and identify the gaps for future research. A robust protocol of the systematic review and a rigorous procedure selected 88 studies which contributed to identify the barriers to innovation creation and diffusion in developing countries, and the factors of knowledge diffusion *in* and *to* developing countries. Most of the studies reviewed have been published in the past five years. This is both evidence of the early and partial nature of the findings, and also of the potential, importance, and energy for this research subfield. This research attention coincide with the fact that in the last decade several developing countries moved out of the poverty trap, spurring

an agenda among governments and international donors for knowledge about how to strengthen a private sector in agrarian transitional economies.

The literature shows that value-creating innovation in developing countries is about creation or adoption of new ideas and technologies; but various studies point to the on-going importance of diverse capacity for innovation embedded in and constituted by dynamics between geographical, socio-economic, political and legal subsystems. Several factors appear as predominant barriers to innovation across different settings and geographical areas. Weak education systems (from basic education to training and universities), unstable political powers, fragile legal systems (unsecure property right, weak intellectual property rights, and lack of law enforcement), limited financial resources, poor infrastructure (from transportation to market facilities), and cultural and linguistic distances are all factors that hamper the diffusion of innovations. The diffusion of knowledge within LICs is facilitated by the institution of clusters, the link between public (universities) and private sector, and the empowerment of the poor. Instead, knowledge diffusion to developing countries is conditioned by the degree of openness of an economy and host-country policies and characteristics that can favour FDI and international trade. It also emerged that innovation in developing countries is a phenomenon that involves institutional and environmental factors as well as personal and entrepreneurial characteristics. Firm owners' entrepreneurial acumen is as critical as firms' characteristics for innovation adoption. The review highlighted scattered evidence on this, De Mel et al. (2009) being the only study we found that controls for both entrepreneurs and firms characteristics in the adoption of innovations.

The evidence collected seems to show a heterogeneous picture of obstacles and channels of innovation diffusion, in which countries face different challenges that are related to socio-political and geographical factors. At the same time, it becomes evident that those factors are all connected to structural issues related to the current economic conditions. It is beyond the scope of this study to find a "one size fit all" recipe for innovation diffusion in developing countries. However, some patterns have emerged. Successful cases seem to arise from strengthening innovation diffusion within countries supporting local innovation. This would also support the facilitation of diffusion of innovation developed in similar context, with a potential role of South-South collaborations. To this end, an efficient and strongly supported agency able to serve the technical, financial, and commercial needs of innovators is instrumental to nurturing innovation ecosystems.

The findings also suggest that data on innovation should give priority to capture incremental innovation, much of which will document the diffusions of competence-extending innovation, rather than more disruptive innovation. In particular, it is critical to collect data that go beyond aggregate measures of innovation capacity such as R&D expenditures and patents. A rethinking of how to quantitatively measure innovation in LICs is needed. The current measures are important indicators, but they tend to over-attend to aggregate potential and to under-specify the critical need for more fine-grained, pervasive absorptive capacity, such that individual firms can benefit from the general diffusion of innovations. This emphasis on imitative and incremental innovation is consistent with the evidence what matters for innovation impact for developing countries. Given the current capacity of LICs, policies should therefore focus more on incremental innovations of existing technologies that are nevertheless new to firms and therefore have an impact because of that.

The review also showed a relative narrow range of countries and sectors covered (Table 2 and Table 3). This may reflect priorities of innovation studies in developing countries, but possibly also introduce some biases. Geographically, there seems to be a bias relative to former Commonwealth / English-speaking countries. On the one hand that could have emphasized some tacit institutional arrangements and legacy of British colonialism, and on the other hand the overall claims are based on a small, specific subset of developing countries cases. Future research should broad the geographical and sectorial focus.

The review also highlighted four relevant research areas that have not received much attention so far: the determinants of innovation diffusion in the informal sector, the potential role of open innovation networks in developing countries, the knowledge transmission through South-South trade, and case studies focusing on learning from policy failures.

Innovation diffusion in developing countries can take different shapes and the picture seems to be more heterogeneous compared to studies of innovation in developed countries. Innovation is a driver for economic growth, although only a few studies have been able to quantify the impact of innovation in firms' growth indicators (Bala Subrahmanya et al., 2010; Gebreeyesus, 2009b; Goedhuys et al., 2008, 2014). However, innovation can also be a tool for poverty reduction and inclusion (Paunov, 2013). Most of the studies reviewed take into account the first perspective and recognize the BoP as an unexplored vast market segment that has pushed international but also local firms to build affordable and sustainable products. Possibly more interesting — but also more unexplored — is the consideration of BoP as a user group of innovators. The ingenuity and constraints on which the BoP population lives are rich soil for innovation. The lack of research in this area originates from the fact that most of the studies focus on the formal sector. However given the typical economic environment of LICs, this is a limitation that provides only a partial evidence of the diffusion of innovation in LICs. Possibly the transmission of knowledge and the dynamics in which the informal sectors adopt and create innovation are different. Again, the success of informal businesses may be determined by not only the skills but also the acumen of entrepreneurs. Pro-active attitude, curiosity, perseverance are all factors that may influence the diffusion and creation of innovation among those groups. Moreover, the diffusion of mobile phones and Internet in developing country allows users to access to relevant contacts and content previously unavailable. Informal entrepreneurs may use this tool to overcome local constraints. The magnitude of the informal sectors in many LICs urges to explore and better understand these phenomena. This would also investigate how informal firms work or cooperate with formal firms. In particular, are formal and informal firms competitors or partners? How does innovation spread from one to the others? Again, what role intermediaries can have to support the innovation activities of informal firms?

In the last decade there has been an increasing interest around open innovation networks in advanced economies.[11] However, in the review process we could not find studies or evidence that report examples of open innovation networks in LICs. Investigating whether and where those occur, and with what impact, would be relevant since they may be a tool for contrasting under-developed innovation institutions, in the formal as well as the informal sector. For example firms with low innovation capabilities could benefit from inter-firms networks or university-industry linkages. Again, in survival clusters, such as Suame in Ghana or Mwanza in Tanzania, there may be situations where entrepreneurs and workers share capabilities to add value to their activities along the value chain of the products.

Recently the potential benefit of South-South trade and FDI for diffusion of innovation in developing countries has gained attention, both amongst policy makers (UNCTAD, 2012) and academia (Fu and Gong, 2011). The rationale is that the knowledge transferred to LICs is likely to be more appropriate since it comes from countries with a similar factor endowment and at a similar development stage. Absorptive capacity of a LIC recipient may also be more effective in receiving similar level of technologies (Glass and Saggi, 1998). Nevertheless, in our review we could not find empirical studies that focus on South-South flows or separate the impact of North-South with South-South FDI. Arguably, in this regard the lack of data is a major obstacle that needs to be addressed.

Lastly, implementation of policies to favour innovation in developing countries may have not worked as policy makers expected. The case studies reviewed tend to focus on successful examples and seldom analyse learning from failures. The cases of incomplete or failed initiatives, along with documentation of unintended consequences, would provide an empirical base for understanding the interplay of context, institutional capacity, and form/intensity of innovation. This would be a useful addition to the current body of literature, together with comparative analysis.

Acknowledgements

We would like to thank Anne Miroux, Calestous Juma, David Kaplan, George Essegbey, Jorge Katz, and Mammo Muchie for helpful comments and suggestions. We are also grateful for comments from participants at the UNU-WIDER Development Conference 2013 “Learning to Compete: Industrial Development and Policy in Africa” in Helsinki (Finland), the Academy of Innovation and Entrepreneurship 2013 Annual conference “Innovation and Entrepreneurship for Inclusive and Sustainable Development” in Oxford (UK), and the Development Studies Association (DSA) 2013 Annual conference in Birmingham (UK).

[11] Open innovation is defined as the process that occurs when an organization engages customers, suppliers, employees and other key stakeholders in the collaborative development of a product, service, experience, process, or idea that creates real value for them.

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Table 1: Articles by journal categories. Number of studies in parenthesis.

Economics and Development Studies	*Innovation Journals*	*Management Studies*	*International Organizations*
World Development (20)	Research Policy (6)	African Journal of Business Management (1)	World Bank Policy Research Working Paper (4)
Journal of Development Economics (8)	Journal of Product Innovation Management (3)	Harvard Business Review (1)	UNU-WIDER Working Paper (2)
Journal of Development Studies (3)	Technovation (3)	International Journal of Learning and Information (1)	OECD Science, Technology and Industry Working Papers (1)
Economic Development and Cultural Change (2)	Industrial and Corporate Change (2)	Journal of Chinese Economic and Business (1)	UNCTAD Technology and Innovation Report (1)
Economic Journal (2)	International Journal of Technology Management (2)	Journal of Information Technology (1)	
African Development Review (1)	Journal of Technology Transfer (1)	Journal of Management Studies (1)	
Agricultural Economics (1)	Technological Forecasting and Social Change (1)	Journal of Management Studies (1)	
American Economic Review: Papers & Proceedings (1)		Management Science (1)	
Developing Economies (1)		Science and Public Policy (1)	
Development and Change (1)		Small Business Economics (1)	
Economics Letters (1)		Strategic Management Journal (1)	
Journal of Economic Literature (1)			
Journal of International Development (1)			
Journal of International Economics (1)			
NBER Working Paper Series (1)			
Oxford Development Studies (1)			
Quarterly Journal of Economics (1)			
Regional Studies (1)			
Review of Economics and Statistics (1)			
Review of International Economics (1)			
Tijdschrift Voor Economische En Sociale Geografie (1)			
Tot.: 51 (58%)	Tot.: 18 (20%)	Tot.: 11 (14%)	Tot.: 8 (9%)

Table 2: Geographical coverage. Number of studies in parenthesis.

Geographical coverage			
China (9)	Nigeria (6)	Brazil (1)	Multi-Countries (29)
India (9)	Tanzania (5)	Colombia (1)	Multi-Countries in Africa (4)
Indonesia (5)	Ghana (4)		Multi-Countries in Latin America (1)
Taiwan (2)	Ethiopia (2)		Multi-Countries in Asia (1)
Vietnam (2)	Kenya (1)		
Bangladesh (1)	Zambia (1)		
Nepal (1)			
Pakistan (1)			
Thailand (1)			
Sri Lanka (1)			
Asia: 32 (36%)	Africa: 19 (22%)	Latin America: 2 (2%)	Multi-Country: 35 (40%)

Table 3: Sectoral coverage. Number of studies in parenthesis.

Sectoral coverage		
Manufacturing (33)	Universities (2)	Multi-sector (46)
Agribusiness (1)	Finance (1)	
Biotechnologies (1)	Tourism (1)	
Sanitation (1)		
Industry: 36 (41%)	Services: 4 (5%)	Multi-sector: 46 (52%)

Graph 1: Number of studies per year. (For 2013, it refers to studies published until April)

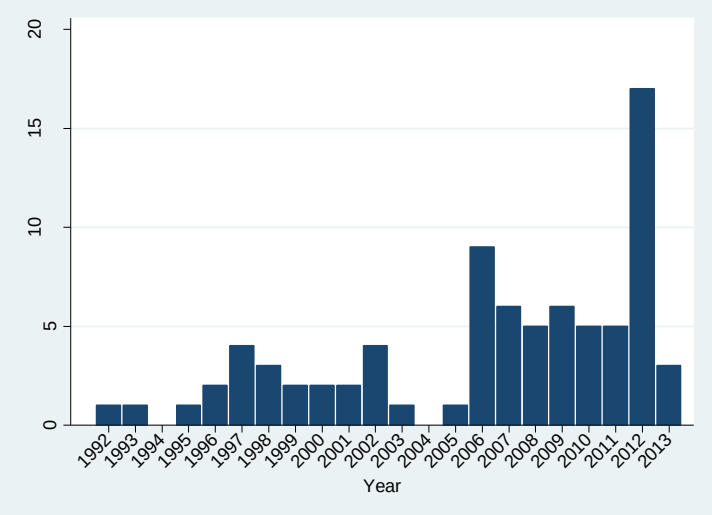
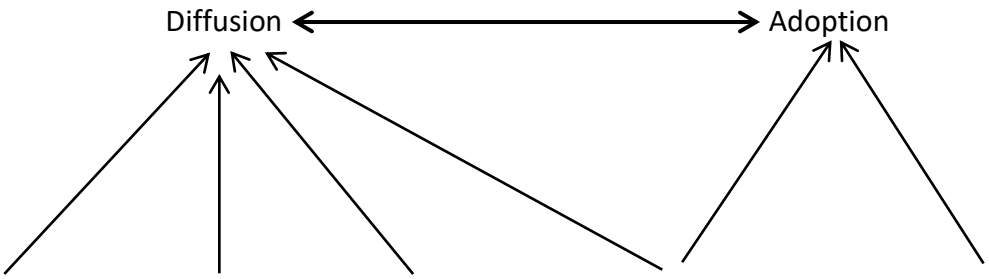


Figure 1: Framework of diffusion of innovation in LICs



Socio-political-economic systems	Information channels	Transport channels	Nature and characteristics of innovation	Individual/firms characteristics
- Political stability	- ICTs	- Road network	- Adaptability	- Education
- Economic openness		- Airports	- Compatibility	- Financial means
- Law enforcement		- Harbours	- Trialability	
- Financial support			- Utility	
			- Complexity	