

*Review*

# Why should governments of developing countries invest in R&D and innovation?

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The rationales for public investment in R&D and innovation have evolved over time from an initial emphasis on market failures amongst neoclassical economists towards a broader view based on a systemic characterization of innovation amongst evolutionary economists. More recently, a renewed emphasis has been placed on the critical role of innovation to address social challenges and overcome development traps. The purpose of this article is to summarize the different rationales for public investments in R&D and innovation in developing countries, with the aim of providing clear arguments to better advocate for the continuation and expansion of such investments in front of an audience that has to prioritize among multiple competing development agendas in the context of financing constraints, including budget allocators, high-level policymakers and the civil society at large.

**Key words:** Absorptive capacity, innovation, knowledge, market failures, R&D, spillovers, systemic failures, technology.

## INTRODUCTION

In the presence of acute social problems and limited budgets, why should governments of developing countries invest in R&D and innovation? We aim to contribute to addressing this critical question by reviewing the literature on the rationales for public investment in R&D and innovation, with particular attention to the specific context of developing countries. To set the stage for the discussion, it is first necessary to clearly define R&D and innovation, following the most widely accepted definitions set forth by the OECD (2002, 2005). Innovation is a broad concept that comprises the introduction of new products or services (product innovation), the use of new production processes (process innovation) or the implementation of new organizational and commercial practices (organizational and marketing innovations). R&D is one of the main routes to innovation, consisting in a creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of this

stock of knowledge to devise new applications. It comprises basic research, applied research and experimental development, generally performed in dedicated laboratories or R&D departments. Beyond R&D, there are also other less formal modes of innovation that occur outside research labs through on-the-job learning, using and interacting, which are just as relevant as R&D and can be expected to be of special importance in developing countries (Jensen et al., 2007).

Innovation, understood in a broad sense, is by definition a central aspect of all economic activity, and it is just as important in low-income countries as in the most advanced nations. Indeed, recent research has revealed that innovation is the main force driving increases in productivity and long-term economic growth (Aghion and Howitt, 2009). In an increasingly interdependent and competitive world economy, innovation becomes a necessary condition for catching-up and

upgrading in global value chains, since it translates into making better products (product upgrading), making them more efficiently (process upgrading) or moving into more skilled activities (functional or sectoral upgrading) (Humphrey and Schmitz, 2002). Contrary to the view that new technologies destroy jobs, innovation may be a critical driver of job creation by diversifying the economy towards new activities, often leading to higher quality jobs with higher wages and better work conditions. In addition, if properly mobilized, public investments in R&D and innovation can contribute to addressing specific development constraints such as food scarcity, lack of adequate health care or lack of infrastructure.

It should be stressed that innovation is a contextual phenomenon, in the sense that it may refer not only to an application that breaks the knowledge frontier ("new to the world"), but also to learning, acquiring and applying existing technologies that were developed elsewhere ("new to the country" or "new to the firm"). However, a frequent challenge in developing countries is that policy makers tend to have a narrow view of innovation, taking it as a sophisticated scientific activity aimed at breaking the technological frontier and mainly of interest to high-tech firms operating in the most advanced nations. Thus, in order to better integrate innovation policy in developing country contexts, a first line of action is to inculcate a broader view of innovation in the minds of policy makers, high level political leaders, the business community and the society at large. Public investment in innovation should not be associated only to formal R&D done in labs but extend further to programs aimed at stimulating technology diffusion and entrepreneurship.

Another challenge lies in the view that most of the knowledge that nurtures innovation, especially in developing countries, originates from foreign sources of knowledge entering the country through foreign direct investment, trade, technology licensing, international knowledge networks, human capital mobility, etc. In light of this evidence it would be tempting to conclude that national investment in R&D and innovation is not suited to laggard countries, assuming that they should focus instead on *imitation*. But the problem is that imitation is not an automatic process, since technological knowledge is much more than just information. Technology is not fully codified and its *tacit* component is critical but hard to grasp (Polanyi, 1966). Innovating through knowledge developed abroad requires the development of *technological capabilities* to be able to select and apply the most appropriate technologies to local contexts (Lall, 1992). In other words, imitation is not feasible without sufficient *absorptive capacity*, a concept which has been defined as the firm's (or country's) ability to acquire and exploit knowledge developed elsewhere (Cohen and Levinthal, 1990). Therefore, besides generating new knowledge, another possible outcome of investments in R&D and innovation consists in building the absorptive

capacity needed for identifying, selecting, assimilating, using, adapting and exploiting already existing knowledge. Indeed, several empirical studies have showcased the critical role that absorptive capacity plays as a driver of economic growth in developing countries (Keller, 1996; Onyeiwu, 2011; World Bank, 2008).

Once R&D and innovation are understood as key drivers of economic growth and development, the critical question to be addressed is why the government should intervene rather than relying on market forces alone for the allocation of resources to innovative activities. In this article, we discuss briefly the rationales for innovation policy through a critical review of the existing literature. These rationales have evolved over time from the emphasis on market failures prevalent in the neoclassical literature, towards a broader view based on a systemic characterization of innovation and, more recently, towards a higher recognition of the role of innovation in addressing social and developmental goals.

## OVERCOMING MARKET FAILURES

The classical rationale for public investment in R&D and innovation is based on the existence of *market failures*, meaning that if left to the market the amount invested by the private sector is likely to fall below the socially optimal level (Arrow, 1962; Nelson, 1959). The most evident source of market failures derives from the nature of knowledge as a *quasi-public good*, which implies that firms cannot fully appropriate the returns of innovation because of the diffusion of knowledge beyond control of the inventor. *Imperfect appropriability* means that new knowledge resulting from a firm's R&D can be imitated and adopted by other firms that did not incur in the development costs (a process known as *knowledge spillovers*). Given these *externalities*, the private return to R&D, which determines decision-making in firms, is lower than the total return to the economy, suggesting the need for public investment in R&D.

In addition to imperfect appropriability, other sources of market failure are related to the *risk and uncertainty* inherent in R&D activities and to the long term nature of the expected returns. The risk inherent in R&D is often reflected in the cost of capital to the firm intent on undertaking R&D, and the higher the risk, the more difficult it may be to acquire capital to undertake it. Access to finance is further constrained by the presence of *information asymmetries* between the innovative entrepreneur, who has a deep knowledge of the technology, and financial intermediaries like credit risk analysts and equity investors, who find it hard to understand the potential of the new technology, the expected results and the capabilities of the research team (Trajtenberg, 2005). Therefore, even in the absence of appropriability imperfections, there would be a *funding*

*gap* whereby innovative projects based on intangibles will tend to receive suboptimal funding compared to more tangible projects, resulting in an inefficient allocation of limited financial resources which would curtail economic growth.

Market failures will be higher for more risky projects that are further away from having a clear market application, suggesting that the government has a particularly important role in financing basic research. Market failures are also likely to be more acute in developing countries for different reasons. First, because of weaknesses in the intellectual property rights regimes and judicial systems; secondly, because of weaker financial systems and lack of specialized investors and credit risk analysts with the skills and experience to evaluate and manage the risks inherent in R&D projects. In any case, it is important to stress that the logic for innovation policy in developing countries may differ substantially from the market failure rationale which dominates the policy discourse in developed countries, given the presence of other bottlenecks and barriers to innovation specific to developing countries.

## OVERCOMING SYSTEMIC FAILURES

In contrast with the linear model of innovation prevalent in the mainstream neoclassical literature, which viewed technological progress as following a discrete path from basic and applied research to technological development and eventually to innovation, evolutionary economics and the innovation systems framework have characterized innovation as an interactive process where both formal and informal interactions and feedback between the different agents in the system play a critical role in the diffusion process (Nelson and Winter, 1982). The literature on innovation systems has shaped a new policy approach, bringing along the notion of *systemic failures*, beyond market failures, as a rationale for innovation policy (Chaminade and Edquist, 2008; Smith, 2000). Under this framework policy makers are expected to intervene when the system of knowledge generation and diffusion does not achieve its objectives of contributing to innovation and technological progress in an efficient manner because of the lack of well developed networks between the different actors of the system or because of institutional or infrastructural weaknesses. For example, systemic failures may include the inefficient flow of information, the lack of collaboration among firms, the lack of university-industry collaboration, the inadequacy between basic research done in universities and firms' needs, etc.

In developing contexts, systemic failures are exacerbated by institutional environments uncondusive to the formulation and implementation of innovation policies, including the following:

- i) Low priority given to innovation by public leaders, businesses and civil society, which is often reflected in lack of broad-based societal commitment to innovation, weak consumer demand for innovative products and services, weak private sector participation in priority setting for innovation policy and demanding accountability for results from public investment in innovation.
- ii) Inefficient policy instruments and regulations which could be reflected in lack of clarity regarding the roles and responsibilities of various contributors of innovation policy (for example, ministries of science and technology, education, economy, industry, trade, agriculture and various agencies); lack of consistency of policy instruments for various development goals (for example, private sector development and social protection, industrial policy and trade regulations); high administration costs of innovation policy instruments which exceed competencies and available resources of public agencies.
- iii) Ineffective government agencies, with unclear mandates with respect to innovation policy, who fail to achieve the outcomes, set by the innovation agenda and adjust their functions to changes in the environment, and whose communications with stakeholders and international community is insufficient.

In the presence of systemic and institutional constraints, the role of governments is not limited to providing funding for R&D projects, but extends further to facilitating linkages and enhancing the dynamism of the national innovation system, placing a higher attention on the importance of collaboration, on user-producer interactions and on how innovation and learning are framed by the institutional setting. Rather than searching for equilibrium in the level of spending by compensating for private underinvestment in R&D, the objective of policies extends further to making sure that the system “works right” and has the “right fit” for the particular stage of the country's development, adequate alignment and contribution to other development goals, and responds to the needs of key actors of innovation processes. Then, innovation policy becomes a problem of developing the appropriate local institutional capacity to realize the potential for development (Abramovitz, 1989).

## MAINSTREAMING INNOVATION POLICY INTO SOCIAL DEVELOPMENT AGENDAS

Innovation policy is most often associated with growth and competitiveness agenda, but it can also meaningfully contribute to other social challenges which the private sector alone fails to address. This leads some authors to speak of “public value failures” –in addition to market and systemic failures– as a rationale for public investment in R&D and innovation (Bozeman and Sarewitz, 2011). In particular, in low income countries, innovation can be

critical to address specific development constraints such as food scarcity, lack of adequate health care, lack of water and sanitation, lack of energy sources or lack of infrastructure, but these might not be perceived as profitable areas to mobilize innovative efforts of the private sector. Innovation policy can significantly contribute to meeting the Millennium Development Goals, and a growing body of research claims that more efforts are needed to ensure that investments in R&D and innovation in developing countries become more socially-relevant, inclusive, sustainability-oriented, pro-poor, etc. (Juma and Yee-Cheong, 2005; Lorentzen, 2011; OECD, 2010; STEPS, 2010; World Bank, 2010). Thus, governments should not only aim at influencing the total amount of resources invested in R&D, but primarily at mainstreaming innovation policy into key development agendas. Innovation is not an economic or social good in itself, and innovation policy should only be seen as a means to achieve specific development objectives. This requires efficient and transparent processes for setting up innovation policy priorities, open to diverse interests and new voices, including those of poorer and marginalized communities (STEPS, 2010). Governments should also embrace innovation policy to a larger extent to improve public services and institutions, for example, through e-government platforms to better deliver citizen services and reduce costs of doing business.

It is worth underscoring two specific innovation pathways which might be of special relevance for developing countries. Firstly, it is critical to consider how innovation works in the informal sector, given that it represents the main source of income for a large proportion of the population in low and middle income countries. Clearly, innovation in this context is not normally based on R&D but rather on incremental and non-technological innovation. However, the informal sector does not appear in official statistics and we still lack knowledge of how to assess and promote innovation in informal contexts. Konte and Ndong (2012) provide an interesting attempt to assess innovation in the informal sector in Senegal, but this still remains an under-researched area. A critical issue is to strengthen links and learning between the informal and formal sectors so as to transform marginal innovative activities into more sustainable ones, with wider impact (OECD, 2010). Secondly, growth in demand among relatively low income groups (the so-called "bottom of the pyramid") represents a vast business opportunity for developing countries and at the same time could foster a more equally-distributed economic growth (Kaplinski, 2011).

#### **CHANGING RATIONALES AT DIFFERENT STAGES OF ECONOMIC DEVELOPMENT**

While most of the reasons justifying public support to

innovation are irrespective of country, innovation policy should be seen as a gradual process where investments and policy actions are adapted to the stage of development, based on the country's specific needs, capabilities and comparative advantages. Rather than deciding *whether* to invest or not in public R&D and innovation, the critical challenge for governments is related to determining *how* to do it more efficiently considering the country's context.

Lower income countries need to focus on building the foundations for innovation activities through supporting capacity of economic and social actors to use new or existing knowledge produced elsewhere. Given their limited resources, this often means prioritizing skills- and institution- building over investments in R&D; nevertheless, some public R&D effort might still be necessary to develop a minimum level of absorptive capacity. It should also be clarified that at the earlier stages of development investment in R&D does not mean R&D of high-tech or cutting edge technologies. Investment in R&D in poor countries mostly pays off if it helps to find or adapt existing technologies to solve local development challenges such as food scarcity or lack of adequate health care. As countries move along the path of economic growth and development, other priorities will emerge to be able to upgrade and compete in international markets. For illustrative purposes, Table 1 shows how the priorities of innovation policy, and the corresponding policy instruments, generally evolve at different stages of development.

According to Chaminade et al. (2010), at an early stage of economic development, the lack of advanced research capabilities is not the most critical weakness of national innovation systems; the focus should be on the development of engineering and design capabilities and more general managerial capabilities such as knowledge management practices and the adoption of flexible structures in organization. However, at a further stage of development research capabilities become crucial for innovation and upgrading, and since the development of research capabilities is evolutionary and incremental, it can be argued that it is also important to start investing in R&D earlier on in order to enable a faster transition.

While it is useful to think of innovation policy as a staged process and to adjust countries' expectations to their level of development, it is also worth noting that there is a large heterogeneity among developing countries, some of which hold pockets of excellence in certain sectors and technologies. During the last decade, several emerging countries have challenged the supremacy of the Western World, producing breakthrough innovations in sectors ranging from banking, to ICT, to car-making, to healthcare. These developments are not only based on cheap labor but also on process improvement and business model innovations (Eyring et al., 2011). Conversely, within developed countries, firms

**Table 1.** Key priorities and instruments for innovation policy at different stages of economic development.

	Priorities for innovation policy	Innovation policy instruments
<b>Low-income</b>	Mainstream elements of innovation policy into basic economic and social challenges (agriculture productivity, health, nutrition).	Strengthen capacity to scan, acquire, and adapt global knowledge to local needs. Blend global and local knowledge for relevant application. Focus on dissemination of knowledge to upgrade traditional sectors. Develop basic infrastructure for metrology and quality control. Use knowledge to enhance value of natural resources.
	Build foundations for use and creation of knowledge (labor skills, basic knowledge infrastructure).	Establish demonstration projects of innovative technology for local settings. Increase availability of “general purpose technologies” to population.
<b>Lower-middle-income</b>	Improve productivity of traditional industries.	Intensify global scanning to find, acquire, and import relevant technologies. Agricultural extension services.
	Increase value added and sustain inclusive employment.	Strengthen market relevance and quality of existing public R&D institutions. Encourage technological and managerial competence of local firms and entrepreneurs.
	Diversify the economy. Establish niches for global competitiveness.	Encourage domestic innovative capacity. Encourage private sector investment in R&D.
<b>Upper-middle-income</b>	Increase availability of high quality jobs.	Promote collaboration and linkages among private firms, public R&D, education and public administration of innovation policy. Promote spillovers from FDI. Facilitate international knowledge flows and global integration of local industries and public R&D. Encourage productive entrepreneurship.
	Sustain economic competitiveness.	Strengthen strategic international alliances for R&D, production, marketing and distribution.
<b>High-income</b>	Use innovation policy to address global challenges.	Target support toward specific industries, sectors or clusters (“smart specialization”). Catalyze breakthroughs for national and global priorities. Encourage creative entrepreneurship.

Sources: World Bank (2007, 2010).

with very different levels of technological capabilities coexist, and the kind of innovation policies needed by less advanced SMEs is completely different from the demands of the most technologically competent and R&D-intensive firms. Therefore, beyond the general issues raised above, it would be risky to aim at

establishing predetermined policy prescriptions which would apply across the board to countries at each level of development.

Ultimately, regardless of the country’s level of development, comprehensive innovation policy strategies need to combine supply- and demand-side measures, cutting

across functional and administrative boundaries, and building upon open consultative processes and international cooperation. But fiscal constraints and an increasing cost of financing in many developing countries means that it is necessary to search for cost-effective solutions, involving delicate choices to focus on the specific policy instruments and technological areas best suited for tackling country-specific developmental goals.

### Concluding remarks

To be effective, public programs to invest in R&D and innovation need to be grounded in a clear discourse underlining the specific market, systemic and public value failures that are to be addressed. The kind of investments should be attuned to the country's technological capabilities and level of economic development. This article has provided a review of the rationales for public investment in R&D and innovation with particular attention to developing country contexts. Our review suggests that more research is needed to better understand the specific bottlenecks and barriers that hamper innovation in developing countries, and the policy options to overcome them.

In addition, in order to build sustained political and budget commitment to innovation policy, public investments would need to be accompanied by appropriate mechanisms to monitor and evaluate the results. Indeed, without clear evidence about the short, medium and long term returns of innovation policy, broad-based support is hard to mobilize and sustain. The problem is that measuring the results of public investment in R&D and innovation is very complex. There are direct returns but also indirect effects. Most of the returns are intangible. Some of the results can be measured in the short-term but most will only become visible in the long-term. A further difficulty is to attribute changes in a country's innovative performance to government policies, since there are many other factors that influence the results. A specific challenge for developing countries is related to the concern that a "critical mass" is necessary before countries are capable of generating substantial scientific outputs and yielding economic returns. This makes it harder for policy makers in developing countries to advocate for the continuation and expansion of public investment in R&D and innovation. Thus, it is necessary to develop clear arguments and new measures to better capture intermediate returns and the process of absorptive capacity building.

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