

Review of Knowledge and Technology Adoption and Transference – Colombia

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Knowledge and technology adoption are key to long-term economic growth. There is evidence suggesting that innovation and technological adoption are key to foster productivity and development (Bauer, 1990). For instance, there is evidence suggesting that the exemplar economic development achieved by South Korea during the second half of the twentieth century is the result of systematically tackling barriers to technology and knowledge adoption, whereas the absence of outstanding economic outcomes are explained in part by the lack of similar efforts (Parente & Prescott, 1994).

Colombia displays a low capacity to adopt technology. Only 1.3% of country's exports are high-tech, while the percentage of exports of ICT services is only 0.7%. Also, only 0.2% of manufacturing in Colombia yields high or medium-high technology products. Moreover, Colombia ranks 86th on the percentage of knowledge-intensive jobs, with only 46.7% of the economically active population according to the Global Innovation Index (Cornell University, INSEAD, & WIPO, 2019). **Among the hurdles identified for the low capacity to adopt technology are: (1) the weak development of market institutions dedicated technology extension support & business advisory entities; (2) the relatively deficient levels of investment and managerial capabilities for technological catch-up; (3) and the limited synergies between the private sector and the academia.**

The country is characterized by a weak development of market institutions dedicated to technology extension support & business advisory entities focused on transference of knowledge and technology. One of the obstacles identified for innovation and improvements in productivity is the lack of information on available technology, as perceived by 45 % of innovative and potentially innovative companies and 53 % of non-innovative companies (Departamento Nacional de Planeación, 2016). Another obstacle found is the lack of skilled labor as shown in a survey to entrepreneurs in which nearly 80 % of respondents stated that there was a low supply of skilled workers and that SENA and other technical programs and technical schools failed to improve labor skills for experienced workers (Melendez & Perry, 2010). In addition, there is a lack of technological extension providers suited for the needs of Colombian firms and training programs for extension agents are required to meet demand (Centro Nacional de Productividad, 2018). All this reflects market and coordination failures that leads to the slow market development for technology extension support & business advisory entities (Departamento Nacional de Planeación, 2016).

Colombia faces relatively deficient levels of investment and managerial capabilities for technological catch-up. By 2018, only 4,2 % of the amount invested by companies is made to adopt or transfer technology or knowledge. Moreover, Colombian companies display low managerial capabilities¹ in regards to identifying improvements and generating innovations and managers perceive themselves as being much better than what objective evaluations suggest. According to the World Management Survey (WMS) management practices in Colombia are deficient (average score² of 2.57), compared to peer countries. The gap between this objective score and Colombian companies' self-evaluation score (3,76) is one of the largest in the world. This may lead to difficulty in accepting or identifying problems, compromising companies' response to changes in market conditions, identifying new technological opportunities, developing plans to exploit these opportunities and cultivate the human resources necessary to innovate (Cirera & Maloney, 2017; Rogers, 2013)

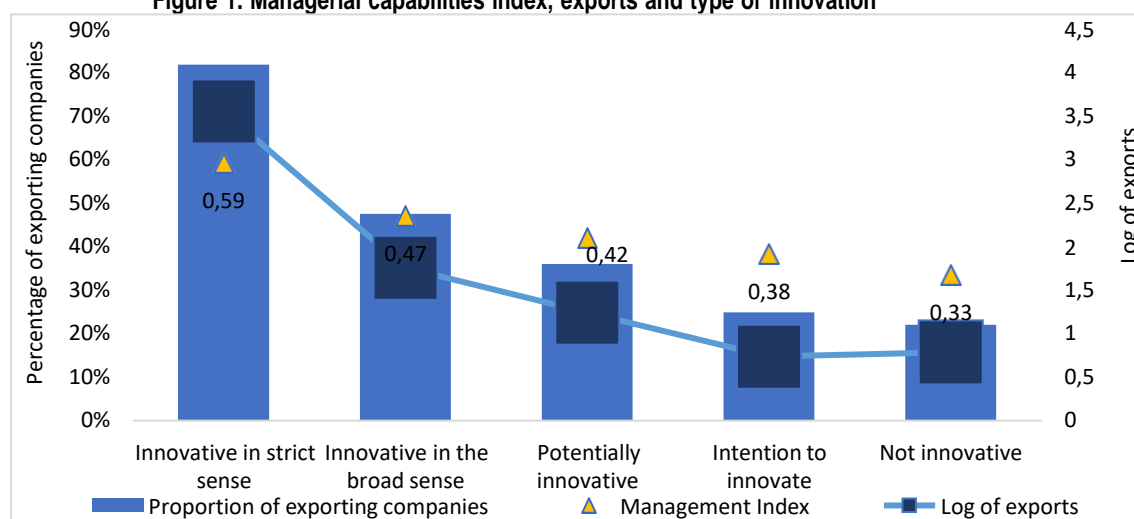
The deficient levels of managerial practices in most Colombian enterprises contrast with the higher levels of labor productivity found in local well managed and highly innovative. In Colombia, companies with superior management practices are up to 4 times more productive than those with worst practices. Likewise, these companies

¹ These are grouped into four dimensions, i) allocation of resources to identify process improvements and innovation, (for example, the use just in time processes), ii) internal feedback mechanisms, which are summed up by monitoring, evaluation and follow-up systems of company processes, results and conditions, iii) long-term planning, (definition of goals and objectives), and iv) the human capital necessary to support the above dimensions. (Cirera & Maloney, 2017).

² The Survey uses an interview-based evaluation tool that defines 18 basic management practices and scores them from **one** (worst practice") to **five** (best practice") on a scoring grid.

with proficient management practices receive export revenues up to 4.5 times higher than those with less developed practices (¡Error! No se encuentra el origen de la referencia.)

Figure 1. Managerial capabilities index, exports and type of innovation



Source: DNP calculations- EDIT IX

Also, the deficiencies displayed by Colombian enterprises contrast with successful pilots on technological extension implemented in the country that have showed positive effects on management practices. One of the pilots was implemented in the automobile parts sector in 2012. The pilot's impact evaluation showed that both individual and group-based lead to improvements in management practices of a similar magnitude (8 to 10 percentage points), in which the group-based approach dominates on a cost-benefit basis (Iacovone, Maloney, & McKenzie, 2018). Another pilot in technological extension provided technological extension for small and medium-sized enterprises (SMEs) willing to improve their products to bring them to the international market. The program implemented in 2018 served around 200 SMEs in five different areas. Currently, the program is under an impact evaluation led by the World Bank Group.

Finally, Colombia exhibits limited synergies for innovation and technological catch-up between the private sector and the academia both local and foreign. Less than 10% of the innovative and potential innovative country's companies have a strong relationship with universities (R&D institutes) to develop innovation activities (DANE, 2018) which contrast with a LAC collaboration average of 18% (Consejo Privado de Competitividad, 2021). Moreover, by 2017, only 2.62% of Colombian researchers had a link to the private sector, while the average in LAC was 16.60% (RYCIT, 2020) which limits the knowledge transfer to productive activities. These facts contribute to the current ranking of the country (61th) regarding University/Industry research collaboration as measured by the Global Innovation Index (Cornell, INSEAD, & WIPO, 2020). In addition, during the 21st century, the country has experienced a continuous decrease in the flow of international resources for financing STI activities (OCyT, 2019). A reflection of that is that only 699 of the recognized researchers (8.4%) have participated in a specialized knowledge network located abroad (MinCiencias, 2020). Furthermore, Colombia exhibits a low number of patents with co-inventors located abroad which ranked the country 72th among 141 countries in the Global Competitiveness Index (WEF, 2019).

The limited synergies for innovation and technological catch-up appear despite policy instruments such as Tax incentives and "STI royalties" designed to contribute to the promotion of knowledge and technology transfer through R&D&i projects, as well as private and public investment in STI. The country needs to design schemes that foster links between actors for the generation of new knowledge such as additional points for cooperating with a university or international centers for the development of these projects, will promote these. Likewise, matching grants are one of the most used direct support instruments to increase private R&D, technology adoption and innovation activities. A study carried out in Chile shows that matching grants that involve cooperation with universities or research

centers have a spillover effect on the TFP of companies in the same sector and region (Crespi, Figal, Maffioli, & Stein, 2019).

There are institutional and governance challenges regarding knowledge and technology transfer and international cooperation. Regarding international cooperation, Colombia requires to develop international cooperation mechanisms, formalize the scientific diaspora, develop a scientific diplomacy program for increase international STI investment in the country, design and implement a program for beneficiaries of MinCiencias scholarship programs to support them finding internships or fellowships at international knowledge centers or companies, and modify researcher's incentives to foster international scientific cooperation.

Tax incentives and "STI royalties" are instruments that contribute to the promotion of knowledge and technology transfer through R&D&i projects, as well as private and public investment in STI, therefore the generation of incentives such as additional scores for cooperating with a university or international centers for the development of these projects, will promote these links between actors for the generation of new knowledge. Likewise, matching grants are one of the most used direct support instruments to increase private R&D, technology adoption and innovation activities. A study carried out in Chile shows that matching grants that involve cooperation with universities or research centers have a spillover effect on the TFP of companies in the same sector and region **Fuente especificada no válida.**

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