



## BACKGROUND NOTE

# Frontier vs. Catch-up Innovation

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# FRONTIER VERSUS CATCH-UP INNOVATION

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**It is important to distinguish between frontier innovation and catch-up innovation.** A key concern is whether countries should focus on *frontier innovation* (the first application of a specific innovation in the world) or on *catch-up innovation* (the first application of an innovation that already exists elsewhere in the world). These choices are particularly relevant for resource constraint developing countries since they often lag the world innovation frontier. Both types of innovation also work through different mechanisms to impact economic growth and development and therefore require tailored policy interventions.

**Data on innovation reveals that the type of innovation is strongly correlated with a country's income-level.** Cirera and Maloney (2017) note several stylized facts on trends in innovation inputs and outputs. They highlight the empirical fact that while firm-level data suggests that innovation takes place across all income spectrums and, in all sectors, it often only consists of marginal improvements in process or products, rather than in significant technology adoption or in new product imitation and, therefore, very rarely involves frontier research. Imitation and adoption seem to be the predominant forms of innovation in low- and middle-income countries. Further, the intensity in accumulation of innovation inputs such as research and development (R&D), licensing, purchase of higher-quality equipment, and training to improve management quality seems to rise with the level of income.

**The decision to choose between frontier innovation versus catch-up innovation should not be considered a zero-sum game.** One way to unpack this decision is by comparing the benefits of innovation against its costs. Frontier technology established through innovation enjoys rents and monopoly profits, and generates positive externalities (or spillovers) to other firms which are also exposed to this knowledge. The literature also highlights the positive impact of firm-level innovation, including R&D activities, on firm performance and productivity (Hall et al. 2009, Harrison et al. 2008, Mairesse et al. 2005, and Raffo et al. 2008). At a broader macroeconomic level, the benefits to frontier innovation can be even more rewarding if they assist in capital deepening and increase labor productivity, which works to trigger inclusive and sustainable economic growth. Innovation may also be pursued as a potential growth strategy to gain competitive advantage (United Nations Conference on Trade and Development [UNCTAD] 2018). Ultimately, innovation has been identified as one of the key factors behind economic growth and development (Romer 1990 and Aghion and Howitt 1992).

Engaging in frontier innovation is costly since it requires large financial and physical investment, and entails a high-risk of failure (Fu, Pietrobelli, and Soete 2010). It is often path dependent and depends largely on the initial endowment of resources and capabilities. Competing against developed economies who enjoy economies of scale and scope may handicap developing countries. Simply put, since a lot of knowledge on frontier innovation already exists and is constantly being updated, it is generally easier, less risky, and less costly to obtain it from elsewhere than to develop it independently again. The data seems to support this fact since foreign sources of technology account for a large part of productivity growth in most countries. In fact, most frontier innovation activities are largely concentrated in a few countries: the Japan, the People's Republic of China, the Republic of Korea, Singapore, United States, and in a handful

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of European countries such as France and Germany (Fu, Pietrobelli, and Soete 2010 and Cirera and Maloney 2017). However, the rapid advancement, diffusion, and declining cost of new technologies may provide new possibilities to developing countries who desire to engage in frontier innovation (UNCTAD, 2018).

**The drivers of frontier innovation may be different from the drivers of catch-up innovation.** The drivers of frontier innovation are identified as investment in R&D, investment in human capital, financial development, quality institutions and governance, trade openness, and macroeconomic stability. The drivers of catch-up innovation are driven largely on activities that increase the diffusion of innovation of domestic and international technology. More generally, technology can be diffused between firms and across regions and countries through various transmission mechanisms that are identified in Pietrobelli (1996): (i) through international trade; (ii) foreign direct investment; (iii) movement of people through migration, travel, and foreign education of students and labor; (iv) international research partnerships; (v) diffusion of knowledge through the media and internet; and (vi) integration into regional and global value chains.

**The policy choices stem directly from an understanding and application of these drivers.** Engaging in frontier innovation requires not only an effective design and implementation of innovation policies and agencies, but also policies and incentives that enable firms to upgrade their managerial and technological capabilities. To encourage diffusion, both intra and inter-regional trade openness that are complemented by free-flowing human and physical capital may be desirable. Countries focusing on catch-up innovation are encouraged to invest in human capital and in upgrading worker skills to enable quicker absorption of foreign technology and to create an environment that encourages indigenous or local innovation (Hoffecker 2018). Participating in regional and global value chains also facilitates rapid catch-up to foreign technology.

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