A New Phase in the Globalization of R&D: the Rise of Co-invention in China and India

1.Abstract

The geography of innovation is shifting, and emerging economies such as China and India are poised to play an increasingly important role in the global innovation system. Conventional understanding views the acquisition of innovative capacity in frontier technologies as one of the final stages in a development process that usually stretches over decades (Vernon 1966; Puga and Trefler 2010). China and, especially, India are still in the early stages of this conventional development process, yet they are already hosting R&D centers sponsored by the world's technologically elite firms (Freeman 2006). Is the conventional understanding now obsolete? The growing role of emerging economies in global innovation has led American industry, academic, and government leaders to express serious concerns regarding the implications for public policy and corporate strategy. Is the recent growth in emerging economies' R&D activity undermining the traditional position of technological leadership enjoyed by the U.S. and other advanced industrial economies?

Using U.S. and European patent data, we examine the innovative explosion in China and India. We find that the surges in patenting from these two countries are driven, to a great extent, by companies from advanced countries. Co-invention, whereby teams of researchers based in different countries combine their skills and knowledge to generate patented inventions seem to be of particular relevance. This observation suggests that the surge in U.S. and European patents in emerging economies may less of a challenge to conventional views of development economics. It is possible that what we see in China and India is not a fundamental change of the development process, but rather a new move towards a much greater level of globalization of R&D. We hypothesize that R&D processes can now be disaggregated into multiple stages, which are then each located where they can be undertaken at lowest cost and best returns. This phenomenon is analogous to the "vertical specialization" or the "slicing up of the value chain," familiar in modern manufacturing (Hummels, Ishii, & Yi, 2001; Krugman, 1995; Yi, 2003). This is important because it would imply that, as long as the innovative activity is directed by and interconnected with Western firms, much of the increase in R&D activity in the emerging economies is likely to be a complement to R&D in the West, rater than a direct substitute for it.

2. Methodology & Preliminary Results

At the core of our research is a detailed analysis of patent data granted by the U.S. Patent and Trademark Office (USPTO), supplemented by analysis of patent data granted by the European Patent Office (EPO) as a robustness check.

Using the information appearing in the patent document such as application and grant date, assignee, technological classification, inventor location etc, we first trace out the general characteristics of the dramatic upsurges in USPTO and EPO patents in China and India across time, technological fields, organizational boundaries and geographic space. Our key findings include: 1) Parents resulting from co-invention and multinational sponsorship represent the majority of the patents generated by inventors in China and India; 2) Patents generated in China and India are technologically clustered in IT related fields; 3) Chinese and Indian inventors of these patents are geographically concentrated in a few developed areas.

We then set out to test the "vertical specialization" hypothesis. We take several steps. First, we want to find evidence of "slicing up of the value chain". If co-invention involves a division of labor in the Western research process and a transfer of research tasks to China and India, we should expect to find knowledge flows from the West to China and India. Using forward citations as a proxy for knowledge transfer and following the method developed by Singh and Agrawal (2011), we exploits the variation over time in Chinese and Indian inventors' citations to the Western co-inventors' pre-co-invention patents. Specifically, we compare pre-co-invention versus post-co-invention citation rates for the Western co-

inventors' prior patents and corresponding matched control patents. Early results for China suggest that co-invention indeed facilitates knowledge flows from Western co-inventors to Chinese indigenous inventors. The magnitude of such knowledge flows is comparable to those through personnel mobility found by Singh and Agrawal (2011) .

Second, we analyze how co-invention and multinational sponsorship affect the patent quality. The idea is that, if co-invention is part of a global distribution of knowledge, we should see no difference in the quality of multinational sponsored domestic patents and co-invented patents. In fact, if one considers that co-inventions that merit a global distribution of innovative work are more interesting than purely domestic or foreign ones, it is even possible that they have higher quality. To do so, we use patent forward citations as an indicator of "quality"(M. Trajtenberg 1990; Hall, Jaffe, and Trajtenberg 2001) and compare the "quality" of the following categories of patents: 1) co-invention and domestic patents; 2) multinational sponsored inventions and indigenous sponsored inventions; 3) patents created in emerging economies (both co-invention and domestic patents) with those which multinational companies (MNCs) produce in home countries. Our results suggest a quality superiority for MNC patents compared to those of indigenous firms, and better quality for co-invented patents over domestic ones. When considering cross-border MNC comparison, we find that the quality of co-invented patents with India is not different from that of patents in home countries and both are of higher quality than purely Indian patents granted to the MNCs. When looking at China, we find that co-inventions are of higher quality than those created in MNCs' home countries, with no difference found to the purely Chinese inventions.

Finally, we then consider the learning process of Chinese and Indian inventors. Chinese and Indian inventors may eventually accumulate knowledge to do much higher quality work through the collaborations with more sophisticated inventors from the West. This would indeed endow them with the ability to do independent invention that would substitute rather than complement Western work. We divide all patents that MNCs produce in China- and India-based from 1996-2010 into three 5-year subgroups and look at the time tread of quality changes. Preliminary results suggest evidence of quality improvement in China-based co-invention and purely Chinese invented patents; however, we do not find significant evidence of quality improvement for India-based patents.

3. State of the Research

As seen from section 2, we have made good progress in our research on innovation in China and India. Though the results from China and India differ to some extent, it is quite clear that the surge in patenting from both countries is driven by companies from advanced countries. We believe that, as long as the innovative activity is directed by and dependent on Western firms and the fruits of innovation are captured by these firms, the increase in R&D activity in the emerging economies is unlikely to undermining the traditional position of technological leadership enjoyed by the U.S. and other advanced industrial economies. Our research also suggests that R&D processes might now be disaggregated into multiple stages, which are then each located where they can be undertaken at lowest cost.

Despite our progress, more work needs to be done to evaluate much broader implications of this phenomenon. We still need to strengthen the results of both the knowledge transfer and quality analysis described above. We also need to bring to the analysis the role of inventor mobility. We observe that there are almost no personnel mobility and technological leakage from MNCs to Chinese or Indian indigenous firms and we need to explore why is this the case. We doubt that indigenous firms lack the capacity to effectively carry out knowledge transfer and knowledge absorption. We will further our investigation on knowledge flows by linking the analysis of co-invention with that of mobility to shed light on this question. By doing so, we would be able to further assess the degree to which R&D in emerging economies may become a substitute to R&D in advanced countries in the long term.

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