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Review : The internationalization of R&D and the internationalization of innovation

Helena Barnard, John Cantwell
*Gordon Institute of Business Science,
University of Pretoria, P O Box 787602,
Sandton 2146, South Africa*
Email: barnardh@gibs.co.za
Tel.: +27 11 771 4213

UNCTAD's 2005 World Investment Report (WIR) once again provides researchers with a wealth of data on foreign direct investment, and also with a lucidly written explanation of a phenomenon that has become increasingly important in recent years: the internationalization of R&D. The annual WIR provides academics and policymakers with a virtual "primer" on current issues in the field on International Business, and this year is no exception. An extensive body of research over the past decades has found that FDI acts as a conduit for new managerial and technological capabilities. The WIR 2005 very clearly lays out why the expansion of capabilities, rather than the inflow of capital or the creation of jobs, is the main benefit that countries can derive from FDI. Although firms can develop new capabilities in many different ways, including through learning-by-doing and inputs from customers and suppliers, R&D has been long recognized to be one of the most important types of capability creation (Mansfield, 1965). This year the WIR focuses on this important type of capability creation in its report on "Transnational Corporations and the Internationalization of R&D".

The report reviews numerous trends in global R&D, including the growing internationalization and outsourcing of R&D, the considerations of firms when determining where to locate R&D, and the particular benefits (and costs) of TNC-led R&D activities. As a report on R&D, the WIR 2005 provides an important contribution to understanding the internationalization of a very important modality of innovation. The report does sometimes create the impression that R&D is the single most important means (and indicator) of innovation. This is to some extent a function of the scope of the report: it does not set out to investigate innovation through the acquisition of embedded technologies, e.g. in capital goods, or social innovations, e.g. the recent attempts in South Africa to expand banking to the "unbanked". But although the report acknowledges the existence of these other means of innovation, some of the claims in the report may create the impression that they are unlikely to have much impact unless accompanied by significant R&D investments.

Focusing on R&D as an indicator of innovativeness is not unproblematic, firstly because of data issues, a fact that is acknowledged in the WIR. Even within a single country, complications in the use of R&D data have been documented. For example, the apparently lower research productivity of large firms has been shown to be a function of their relatively higher spending on formal R&D (Acs and Audretsch, 1991), which may reflect the fact that more of the innovative work within small firms is done informally, or the greater ability of large firms to structure their operations so as to gain the tax benefits often associated with R&D. Either way, it suggests that R&D is an imperfect measure of innovation. This problem is even worse when attempting cross-national comparisons, as R&D in different countries is measured and regulated differently. The WIR 2005 makes some use of patenting as a complementary measure of innovativeness, but regards patents primarily as a measure of innovative output. The value of patents as an input measure has been long demonstrated (Comanor and Scherer, 1969) and indeed, if one accepts - as the WIR 2005 argues - that capability creation is an ongoing, incremental process, then the outputs from one stage become the inputs for another. Both the USPTO and the more recent European-based EPO provide a record of the most valuable patents from across the world, judged under a single regulatory framework. Moreover, because the locations of inventors are stated on patents, patents offer the potential of tracking the fine-grained details of intra-firm cooperation. It is a pity that the WIR does not exploit this measure of innovativeness more extensively.

But perhaps a more important concern has to do with the fact that both R&D spending and patents are better oriented to capturing innovation in large firms particularly in science-based industries, and only less well reflects

innovation in small and medium sized enterprises in engineering-based or service industries. Thus, these measures do not pick up well (say) the innovation of smaller firms in the textiles industry, in which the leading edge of innovation is to be found in design departments rather than in R&D departments. Nor do they pick up very well (if at all) basic capability formation in the earlier stages of development. Innovation in large firms especially in the science-based industries is an important source of competitiveness, but by no means the only one. Only three firms appear on the WIR 2005's Top 20 list for largest firms both in terms of foreign assets and R&D spending—the largest firm in terms of foreign assets, General Electric, does not. According to the report, more than half of the large R&D spenders are concentrated in three industries—automotive, IT hardware, and pharmaceutical/biotechnology (WIR 2005, p. 119). This is not to say that other industries are not innovative. The innovations that underpin the success of firms can be social (as documented by Lundvall, 2002), managerial (as documented by Chandler, 1977), or market-related (for example, in the work on lead users by Von Hippel, 1986). None of these are captured in R&D spending, and neither are they in the WIR's new innovativeness index, which combines the existing Human Capital Index with a Technological Activity index, consisting equally of R&D spending, USPTO patents, and scientific publications. The narrative of the WIR 2005 does acknowledge that there are numerous forms of innovation, but this easily gets lost in the emphasis on R&D. For example, a statement that R&D deepens technology transfer because it moves from "simply transferring the *results* of innovation to transferring the *innovation process* itself" (WIR 2005, p. 179) not only loses important distinctions over how innovation functions in different industries, but also oversimplifies the distinction between the process and outputs of innovation, which tend to be continuously interwoven in any successful technology transfer experience.

The stages of technology development are represented as a pyramid, progressing from a basic production capability to significant adaptation, to technological improvement and monitoring, and finally to the most advanced "frontier" technology stage (WIR 2005, p. 102). Different stages are characterized by different modalities of learning, and R&D spending becomes more important the more advanced the stage of development. As such, R&D tends to capture the "tip of the iceberg" of capability creation. This is particularly consequential for understanding capability creation in developing countries. The WIR 2005 offers an excellent discussion of the developmental implications of R&D by foreign-owned firms in developing countries (and of the costs and benefits for their home countries). It also argues that countries outside of that network may be at risk of falling further behind in terms of technological and innovative capabilities. In so doing, it falls into the common trap of (implicitly) assuming that innovation research that focuses on patents or R&D spending enables the gaining of *general* insights about capability creation, rather than about a relatively advanced phase of capability creation. Data on, e.g. licensing revenues may provide a better measurement tool for assessing the extent of engagement of countries in a relatively earlier phase of basic capability creation, which may be more grounded on small and medium sized enterprises and entrepreneurial initiatives, and better reflected in local software and design capacities than in R&D.

Where developing countries are catching up economically and technologically, they can be expected to pass through two stages of development. In the first such stage their knowledge and absorption of foreign technology is often acquired through trade and subcontracting agreements with foreign-owned TNCs, and especially in an era of increased arms length intellectual property transactions (including software sales) their success in building the most basic local technology generation capabilities can be measured by a rise in their own licensing revenues (Athreye and Cantwell, in press). In the second more advanced stage the knowledge and foreign technology required is more sophisticated, and since the local level of development has now become more attractive to incoming foreign direct investment, subsidiary R&D often begins to play a role. So by examining subsidiary R&D in the developing countries, the WIR implicitly focuses on this later stage of technological capability building, as opposed to the earlier kinds of local capability formation that precedes this.

Furthermore, within the more advanced stage of technological development we can distinguish between what the WIR terms adaptive R&D (to adapt existing areas of TNC technological expertise to local conditions or requirements), as opposed to what it variously terms technology sourcing or innovative R&D (to augment the technological expertise of the TNC parent company, through tapping into and becoming part of the technological search efforts of the local innovation system). This corresponds to the distinction between competence-exploiting and competence-creating R&D (Cantwell and Mudambi, 2005), which terminology better recognizes that all R&D is intended to be locally innovative, but that innovative learning can be decomposed into activities that focus on more

effective exploitation and those that focus on explorative search (March, 1991). In fact, one of the most noteworthy features of this WIR report is the abundance of examples and boxed illustrations that are given of competence-creating (or so-called innovative) R&D in many developing countries, and especially in East Asia. There tends to be somewhat of a discordance in this report between the acknowledgement that adaptive R&D remains the dominant form of international R&D, and the relatively few illustrations of the former compared to the latter.

As the WIR (Chapter V) points out, the dramatic ascent of China and India (respectively 74th and 83rd out of 117 countries on the Innovativeness Index) as R&D centers is due to the existence of a skills base that is large in absolute terms, yet small (or at least quite geographically concentrated) in terms of the overall skills base of the population as a whole. The nature of the economic upgrading and technological development process for countries with such a "narrow" pyramid cannot be assumed to be the same as for countries like Brazil and Chile, with a much lower level of incoming R&D, but with a broader basic skills base. Moreover, whether such countries are at risk of falling further behind is not a given, but an empirical question. For example, the highly developed Scandinavian economies are dominated by low research-intensive and resource-based industries, and the innovations driving their competitiveness have tended to be social rather than science-based (Lundvall and Borrás, 2005). It does not fall within the scope of this (already encyclopedic) WIR to examine other types of innovation, but it would have been helpful if the possibility of other developmental trajectories had also been acknowledged.

The section on creating an enabling policy environment covers some general policies, like the importance of ensuring a comprehensive, quality education system, facilitating the migration of skills into the country, and the need for competition. It also covers policies directed specifically at attracting R&D-related FDI, specifically the development of science parks, the role of performance requirements and/or investment incentives, and the importance of intellectual property rights protection. It represents mainly the consensus positions of the field—an adequate skills base always matters, whether developed locally or imported from elsewhere; the skills base must be connected to and responsive to the needs of industry; science parks and investment incentives can work, provided the basic infrastructure and skills base is in place; and so on. It is therefore perhaps not surprising that the weakest section of the policy chapter is that on intellectual property protection, where consensus has not yet emerged. Although the current climate is in favor of strengthening intellectual protection and expanding TRIPS provisions to more countries, there is increasing academic evidence that strong IPR regimes do not encourage innovation or development (Granstrand, 2004; Mazzoleni and Nelson, 1998; Murmann, 2003). Since patenting is so important in R&D-based innovation, a more comprehensive discussion of the arguments for and against stronger patent protection would have been helpful.

The great strength of this WIR report is that it offers a powerful antidote to the beliefs of dependency theorists and the like that TNCs would never locate any substantive R&D facilities in the developing countries, and that their innovative capacity would remain forever confined within the existing industrialized world. In that respect there is a great sense of excitement in discovery about this report, in that it shows not merely that TNCs are conducting R&D in the developing world, but that beyond this in various developing countries such subsidiary R&D facilities have successfully evolved into the most advanced competence-creating types of activity. In this respect the WIR provides food for thought not merely for the dependency theorists, but perhaps also even for the current conventional wisdom that what TNC R&D there is in developing countries will be more or less exclusively of the competence-exploiting (adaptive) kind, and unlikely to move much beyond this.

However, while this aspect of the report is in many ways welcome as a means of providing a counterweight to some other contemporary discussions of a more pessimistic orientation (for the prospects of economic and technological catch up in the developing countries), the variety of illustrations of competence-creating R&D of TNCs located in the developing countries sits a little unhappily with the acknowledgement in the main text of the report that the emergence of such competence-creating forms of subsidiary R&D is merely part of a much wider picture. While the policy-related and other discussion in the report quite rightly recognizes the broader context for capability creation at different stages of development, the evidence and the boxed illustrations that support the text present something of a mismatch that tends to emphasize the later phases of more sophisticated technological development.

It is important to note that most of these concerns focus on what has been omitted, not on what has been stated. The content of WIR 2005 once again provides an even-handed assessment of an important phenomenon, and although it can be faulted for not always adequately delineating the scope and especially the implications of its investigation, no

single publication can comprehensively describe a phenomenon as complex as economic development. That the WIR-series even tries to capture the state of the art research on the topic is remarkable. That the WIR has become such an important reference point is evidence that it also succeeds in producing a text that is representative of opinion in the field.

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