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Ideas production and international knowledge spillovers: Digging deeper into emerging countries

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ABSTRACT

Research and Development (R & D) activities of emerging countries (EMEs) have increased considerably in recent years. Recent micro studies and anecdotal evidence points to industrialized countries as the sources of knowledge in EMEs. In this context, we examine ideas production and international knowledge spillovers in a panel of 31 EMEs by accounting for six diffusion channels and two types (national versus USPTO) of patent filings. Knowledge spillovers to EMEs accruing from (i) the industrialized world, (ii) the emerging world, (iii) different country and regional groups, (iv) selected bilateral cases, and (v) those within the regional clusters of EMEs, are modeled. Spillovers from the industrialized world appear robust via geographical proximity and disembodied channels only. Other conduits, including trade flows, are either insignificant or not robust. Spillovers from the emerging world are virtually non-existent. Analyses of regional clusters of EMEs do not support any role of language, culture or geographical characteristics in knowledge diffusion. Overall, the breadth and depth of knowledge spillovers to EMEs appear extremely moderate; however, we find pockets (specific countries and certain groups) generating positive spillovers. A carefully choreographed policy focusing on such pockets might be fruitful. We hope that this study (i) complements the micro literature, (ii) furthers the existing macro literature and (iii) provides some new policy insights. Our results are robust to a range of robustness checks, including the estimators – a cointegration approach versus a simple fixed effects OLS estimator.

1. Introduction

In recent years, emerging countries (EMEs) have made a significant headway in their research and development (R & D) activities. Their R & D expenditure has grown by 8.6% per annum (p.a.) in real terms during 1992–2010, rising from $69.3bn in 1992 to $305.6bn in 2010, compared to the growth rate of the Organisation for Economic Co-operation and Development (OECD) countries of 2.8%. Likewise, patent applications filed by the residents of EMEs at their national office grew by 10.4% p.a. during 1992–2011, compared to 2.3% growth for the OECD countries. Consequently, EMEs' world share of R & D expenditure has increased from 12% in 1992 to 26% in 2010 and their share of world resident patent applications has moved up from 11% to 36%. Patent filings by the residents of EMEs at the United States Patent and Trademark Office (USPTO) also increased by 21% (as opposed to 5.5% of OECD countries) p.a. during 1992–2011.[1]

The novelty of EMEs' patents is often called into question. However, recent studies have shed some new light on this issue. Branstetter et al. (2013) report that Chinese generated USPTO patents are as good as those generated by the Multinational Companies (MNCs) in their home countries, evaluated by their forward citations. However, Indian generated USPTO patents do not pass the same quality threshold. These findings highlight a potentially high level of divergence in the quality of EMEs patents – which is not surprising – yet they also underline that

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[1] These world shares and growth rates are the authors' own calculations. OECD consists of 34 member countries some of which are EMEs that joined as recently as 2010 (Chile, Estonia, Israel and Slovenia). For the calculation of world share and growth rates, we define an OECD pool comprised of the following 23 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Republic of Korea, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. Luxembourg and Israel lack complete data series. A further nine countries, namely, Chile, Czech Republic, Estonia, Hungary, Mexico, Poland, Slovak Republic, Slovenia and Turkey are also current members of the OECD but we categorize them as emerging economies for this analysis. Exclusion of the latter nine countries from the OECD pool only alters the calculated world share of OECD R & D expenditure by just 1%. For data reasons, while generating spillover pools from the industrialized world (Section 3), we base our computations on 20 OECD countries (henceforth OECD-20) excluding Belgium, Greece and Portugal from the above list. For the world share calculations, the pool of EMEs (emerging world) consists of over 70 countries (i.e., 70–80) – including the above nine EMEs which are members of OECD – for which UNESCO maintains R & D data. However, for econometric analysis we analyze a sample of 31 EMEs (see Section 2).

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some EMEs are making significant strides in the novelty of their innovations. Branstetter et al. (2013) also discover a strong degree of collaboration between indigenous (Chinese and Indian) firms and MNCs, leading to knowledge spillovers from co-invention teams to purely indigenous teams within the MNCs. However, spillovers from MNCs to indigenous enterprises outside of MNCs appear limited. This implies that knowledge diffusion outside of a bounded conglomerate may be hard to obtain.

China and India, no doubt, are the two major EMEs of the world, yet the recent upsurge in R & D spending and patenting is not limited to them.[2] Moreover, the public (government and higher education) sector still plays a major role in the R & D of most EMEs.[3] For example, the share of the business (private) sector in India's total R & D expenditure was just 35.5% in 2011. The average share of business sector R & D expenditure in our sample of 31 EMEs was 41.9% in 2011. China is a major exception, however. China's business sector R & D is reported as 75.7% of its total R & D in 2011 – a ratio which is higher than that of France (64%), Germany (67.6%), the UK (63.6%) and the US (68.6%). Whether the Chinese business sector R & D is indeed akin to the private enterprise led business sector R & D of the West could be a moot point; nonetheless, these data are from a credible source – UNESCO.[4]

Since most EMEs' business sector R & D is small and evolving, it is not hard to deduce that MNCs' R & D in these countries, important though they are, is likely to be rather small. To scrutinize this, a consolidated dataset on the total R & D activities of MNCs in each emerging country is needed which unfortunately is yet to be available. However, the US Bureau of Economic Analysis reports R & D performed abroad by majority-owned foreign affiliates of US parent companies. These data are useful because in some countries US MNCs are the major foreign R & D players – e.g., in India eight of the top ten MNCs filing for USPTO are US companies, whereas in China this number is only four (Branstetter et al., 2013). We calculate the R & D stake of majority-holding US MNCs in a range of EMEs using this dataset.[5] The US MNCs' R & D expenditure in BRICS countries (Brazil, the Russian Federation, India, China and South Africa) is just 2.5% and 3.7% of their total and business sector R & D, respectively.[6] Although, US MNCs do not represent the whole universe, nonetheless the collective MNCs' R & D is unlikely to be a high proportion of the total R & D of most EMEs. Based on the mean value of US MNCs' involvement of 2.5% in BRICS countries' total R & D, we hazard a guess that the share of MNCs will be well below 10% of EMEs' total R & D expenditure.[7] Thus, the magnitude of R & D performed by MNCs is still minor relative to the total R & D of most EMEs.

Further, recent micro literature (Blonigen et al., 2012; Branstetter and Drev, 2016; Guadalupe et al., 2012) reports that foreign investors carefully target the largest and most productive local firms – "cherry-pick" – to invest in and exploit their export networks. It is therefore hardly surprising that the joint venture MNC investments in these cherry-picked domestic firms in EMEs stand out. This raises the concern that what is evident in the labs of these large joint venture private companies in EMEs might not mirror the overall reality of R & D and knowledge spillovers in these countries. Likewise, the firm level evidence of weak knowledge spillover from MNCs to indigenous, outside enterprises, pointed out earlier, also casts doubt on the generality of spillover benefits accruing from MNCs. These micro findings, while important and interesting, do prompt the question: What is the role of knowledge spillover vis-à-vis inventions (production of new ideas) in EMEs at the aggregate level?

This is an important issue from policy perspectives and perhaps best addressed through a macro study.[8] In this context, a rigorous multi-country macro study of ideas production and international knowledge spillovers (IKS), especially focusing on a large panel of EMEs, is both timely and appropriate.[9] The aim here is to do just that. A well-known caveat of macro studies is the issue of aggregation bias, which hides technological heterogeneity, a potentially important issue in assessing knowledge spillover. However, micro studies are also susceptible to sample selection bias as they often select large and R & D active firms. Despite their respective caveats, the importance of both macro and micro assessments of evidence could hardly be over-stressed – if micro and macro studies corroborate the same evidence then their policy imperatives become overriding.

We estimate an ideas production function (IPF) and investigate IKS in a comprehensive manner by analyzing a panel of 31 EMEs. We compute both embodied and disembodied measures of potential 'foreign knowledge spillover pools' (FKSPs) – the sources of international knowledge spillage – by accounting for six different channels of international knowledge transmissions. Five of them are conduits of embodied knowledge transmissions – viz., ratios of total imports, machinery imports, foreign direct investment (FDI), geographical proximity and inventors' mobility – and the sixth is a disembodied measure. We construct separate FKSPs originating from OECD and EME countries. The idea that geographical origin and country heterogeneity might generate diverse FKSPs motivates separate enumerations (details in Section 3).

Countries enjoy special bilateral and/or multilateral relationships (e.g., Griffith et al., 2006). It is also reasonable to assume that certain countries or groups of countries are technologically more sophisticated and/or economically more open than the rest. This raises the possibility that IKS may be specific to country groups and/or country pairs. Hence, we also examine group-specific spillovers by pairing our sample countries with G7 and G3 (Japan, Germany and US), each as a separate group. G7 is the group of most advanced industrialized countries; arguably, Japan, Germany and the US are the most sophisticated technologically within G7, hence our choice as a separate group. For bilateral IKS from industrialized countries, we pair our sample countries with each of the G7 members. However, the choice of country groups and bilateral pairs is not as clear-cut in relation to EMEs. Reflecting their diverse economic strengths, we construct two emerging country groups – viz., the Group of Emerging Seven (E7) comprising China, India, Malaysia, Mexico, the Russian Federation, Thailand and Turkey,

[2] Countries such as China (21.1%), India (11.4%), Malaysia (12.4%), Sri Lanka (10.7%), Thailand (13.2%), Turkey (14.0%) have all recorded average annual patent growth rate in double digits (.) during the sample period. The average annual growth rate of the domestic patent of EMEs, as stated above, is 10.4%.

[3] Mazzucato (2013) provides a catalog of evidence on how the US government basically led major invention breakthroughs in the US. Celebrated high tech firms such as Apple simply integrated the pool of technology either invented by or invented with the key financial support of the US government. The thrust of her arguments is that the role of public sector R & D is vital in big knowledge breakthroughs that require high risk taking and huge resource commitments – something that private sector and venture capital firms tend to shy away from. We would argue that, given their nascent and evolving R & D sector, this is more so in EMEs.

[4] Data are from UNESCO at http://data.uis.unesco.org/; accessed on 04/09/2016 (dd/mm/yy).

[5] As of 2011, the proportion of majority-holding US MNCs' R & D in total (business sector) R & D is 4.7% (17.1%) in Argentina, 5.0% (9.3%) in Brazil, 1.5% (2.1%) in China, 4.0% (6.7%) in Hungary, 12.8% (36.9%) in India, 14.7% (23.0%) in Malaysia, 4.6% (16.1%) in Poland, 0.5% (0.9%) in the Russian Federation, 11.2% (25.3%) in Thailand and 0.8% (2.0%) in Turkey. Source: US Bureau of Economic Analysis. Data are available at www.bea.gov/iTable/index_mnc.cfm; accessed on 04/09/2016.

[6] We acknowledge that South Africa is the smallest among the BRICS members which joined the group in 2010. Until South Africa joined, the acronym was BRICs or BRIC rather than BRICS. The exclusion of South Africa hardly changes the proportions of MNC's R & D expenditure. The US MNC's R & D involvement into the four members of BRICs (i.e., excluding South Africa) is 2.6% and 3.8% of their total and business sector R & D, respectively.

[7] Of course, we acknowledge some individual country exceptions, as calculations in footnote 5 show but our conjecture is for the whole of the emerging world.

[8] Commenting on firm-level studies of knowledge spillovers Branstetter (1998, footnote 23) writes, "It is not clear that the results obtained from such studies apply to the relevant industry or the economy as a whole."

[9] There is a voluminous amount of literature examining the role of IKS on domestic total factor productivity (TFP) mostly utilizing OECD data. However, studies investigating ideas production and IKS in a large panel of EMEs are relatively lacking.