"Capturing International R&D Trade and Financing Flows: What Do Available Sources Reveal about the Structure of Knowledge-Based Global Production?"

by Fernando Galindo-Rueda, Daniel Ker, Francisco Moris, John Jankowski

Comment by Nune Hovhannisyan

Introduction

The fragmentation of production processes across international borders represents a new aspect of globalization. As part of this phenomenon, research and development (R&D) activities have also become fragmented. This shift has been driven by foreign direct investment (FDI) and global value chains mostly within multinational corporations (MNC), looking at both trade in R&D services and business R&D statistics. As a case in point consider US MNCs. Branstetter, Glennon and Jensen (2018) report that the foreign R&D landscape of US MNCs changed dramatically from 1989 to 2014, where the importance of the traditional R&D hubs (the UK, Germany, France and Canada) reduced from 74% of all foreign US MNC R&D to 43%. That decline mainly resulted from the emergence of new hubs such as Israel, India, and China. Research has shown that R&D is an important component that explains differences in productivity and innovation among MNCs and other firms through international trade and FDI linkages (Bilir and Morales 2019). It is widely known that R&D and innovation are crucial for economic growth and the convergence of countries. Thus, it is imperative to collect and construct various statistics to better understand R&D globalization.

In this chapter, Galindo-Rueda, Ker, Moris and Jankowski present an excellent collection of R&D statistics from existing and new sources by covering many countries pertinent to R&D globalization, following the revision of statistical guidelines. Their work highlights the importance of this new evidence for statistical and policy discussions in various economic areas, and promotes further work using R&D globalization data. Furthermore, their work compares various frameworks to measure their compatibility and provides excellent explanations of potential disparities.

Previous data limitations and challenges have been an impediment to the measurement of R&D globalization, but recent statistical advances offer improved methods of analysis. Specifically, the paper refers to the following statistical advances: (1) the System of National Accounts (SNA) revision of 2008 recognized R&D expenditures as a form of investment, (2) the Manual on Statistics in International Trade in Services (MSITS) provided new details for international transactions in R&D services, and (3) the 2015 Frascati Manual presented new guidelines for measuring R&D globalization in business and elsewhere (OECD 2015). The authors note that the globalization of R&D and international R&D-related flows plays a major role in observed differences between Frascati-based R&D statistics and the SNA view of R&D investment *(*see Figures 1 and 2). For example, Ireland presents an interesting case where, driven by large imports of R&D assets, R&D stock has grown more than nine-fold from 2000 to 2014.

Using economic ownership as a key organizing concept, the authors present evidence of R&D globalization through three different interrelated data channels:

1. R&D in services trade statistics (who buys and sells R&D)
2. Statistics on R&D performance and sources of funding (who funds R&D)
3. R&D performance by MNCs (who owns the company)

R&D in Services Trade Statistics

The presentation of R&D in services trade statistics in 2016 reveals that Ireland and Switzerland are net importers of R&D services (for Ireland, net imports of R&D services represent a striking 14% of its GDP). Israel and Luxembourg are net exporters, while the United States has a nearly zero balance (see Figure 3). In terms of volume, the main exporters of R&D services are the United States, Germany and France, while the main importers are Ireland, the United States and Germany.[1] With regard to bilateral trade statistics, the authors acknowledge the inconsistency of R&D services reported by different countries in relation to the United States (see Table 3). Specifically, the data show that R&D exports from the US reported by the US itself are much smaller than the R&D imports from the US reported by other countries, with differences ranging from 60% for Estonia to 600% for Austria. The authors mention several possible reasons for these discrepancies, including different data collection methods and standards, re-exporting and R&D services subcontracting. However, they defer to another OECD working party that is responsible for investigating these issues further. If we compare the trade in services to trade in goods, imports data generally represent a more reliable source than exports data because tariffs are assessed on the imports side, though the question remains as to which source is more reliable for trade in R&D services.

The data illustrate that multinationals play a leading role within R&D services trade with affiliated (parent-affiliate) trade being close to 90% for both R&D services exports from the US and R&D services imports to the US (see Figure 8). As the authors note, the absence of industry detail and data on trade with other affiliates of the same parent company (affiliate-affiliate) are major limitations. It would be interesting to look for additional evidence in relation to these issues in the Bureau of Economic Analysis (BEA) benchmark surveys, which typically provide more detailed data (including some data listed by both country and industry), as well as utilizing the royalties and licenses data collected by the BEA.

Statistics on R&D Performance and Sources of Funding

The data presented show that business enterprise expenditures on R&D (BERD) in OECD countries in 2015 totaled around $0.86 trillion USD, with US businesses representing approximately 42% of the total amount. Israel had the largest funding from abroad while having the lowest R&D net imports (greatest net exports). Ireland ranks fifth in R&D funding from abroad but, as noted above, leads in R&D net imports. The authors construct an interesting figure to compare R&D services exports with the BERD funded by the rest of the world (see Figure

[1] These data are based on the OECD Extended Balance of Payments Services (EBOPS) database which does not include countries like China or India.

11), highlighting the fact that R&D services exports are much larger than R&D funded from abroad. The authors list multiple reasons for this discrepancy and argue that funding of R&D from abroad is not a measure of international trade in R&D, but rather includes both payments for the acquisition of services as well as unrequited payments to support R&D performance. Good progress in this regard is illustrated by the Frascati Manual 2015, which recommends distinguishing R&D funding transactions between "exchange funds," which imply sales of R&D, and "transfer funds," which are paid towards R&D performance. Preliminary evidence from Switzerland and Finland presented by the authors suggests that less than 20% of R&D funding from the rest of the world for these countries are transfer funds. Meanwhile, the data behind who funds R&D from abroad indicate that multinationals play a leading role here as well (see Figure 12). Indeed, in most of the countries foreign affiliates are the main funders of R&D.

According to the authors, for many countries there is little data on R&D payments for R&D performed by others or outsourcing of R&D, mainly due to survey designs that make it difficult to distinguish R&D funders from performers. The authors mention that the United States Business Research and Innovation Survey (BRDIS) collects rich data on the outsourcing of R&D. Indeed, these data shed light on US-based companies engaging in R&D activities abroad and is very useful for studying technology transfer issues. For example, the data show that in 2015 most of the total R&D performed abroad was performed by foreign subsidiaries of US-based companies and was mostly paid for by the companies themselves. It would be beneficial if other OECD countries collected similar data to facilitate similar research on other countries.

R&D Performance by MNC

As mentioned above, the intricacy of multinational firms has a huge impact on globalization of R&D as foreign affiliates comprise a significant portion of business R&D performance. For example, "around 60% of all business R&D in Ireland, Belgium, the Czech Republic, and the Slovak Republic takes place within businesses majority owned by firms abroad" (see paragraph 78 and Figure 13). However, the same table shows that the share of business R&D that is funded from abroad is low. For Belgium, for example, those numbers are 62% and 10%, respectively. The authors offer a possible explanation involving the distinction between "internal" and "external" funds. Furthermore, the evidence presented shows that foreign-controlled ownership does not match closely with R&D services exports.

The authors present interesting data indicating that more European MNCs engage in R&D in the US compared to US MNCs doing R&D in Europe (see Table 6). This provides strong support for the technology sourcing hypothesis that countries can tap into US frontier knowledge by locating R&D in the US (Griffith, Harrison and van Reenen 2006) or by sending its business travelers to the US (Hovhannisyan and Keller 2019). Furthermore, the same table shows that US MNCs account for 25-35% of R&D in Europe but 62% in Canada. This suggests that even in the context of R&D globalization, geographic distance still matters as there is "gravity of knowledge" (Keller and Yeaple 2013) and that face-to-face communication is preferable for technology transfer and innovation (Hovhannisyan and Keller 2015).

The authors compare R&D performance statistics from an outward perspective to an inward perspective for the US. They show that there are large discrepancies in R&D reporting by majority-owned foreign controlled affiliates of US MNCs compared to partner countries reporting inward R&D. For example, the case for Switzerland is particularly striking, with figures being $4 billion vs. $4 million, respectively. More data and research are required to explain such discrepancies. In addition, "outward" R&D statistics by countries are only available for US multinationals, and other OECD countries should collect and report similar data. Using the European Union scoreboard for the R&D expenditures of 2500 companies and comparing it to national business expenditures on R&D, the authors provide some limited findings that show that total company reported R&D in Ireland is three times the business expenditures on R&D, while it was quite the reverse a decade earlier. The question remains to what extent tax savings and transfer pricing matter for R&D data discrepancies for MNCs. For example, Bilicka (2019) finds that foreign multinational subsidiaries in the UK considerably underreport their taxable profits compared to domestic firms.

Conclusions and Possible Future Directions

The paper by Galindo-Rueda, Ker, Moris and Jankowski analyzed available statistical data from OECD countries on R&D globalization, examining services trade, R&D performance and MNC activities. The paper did an excellent job of presenting evidence that these three ways of looking at R&D data are intertwined. The authors mention several important takeaways from their paper. First, various data sources exist but there are considerable differences in their conceptual frameworks. Second, affiliated companies play a major role in R&D globalization, and although parent-affiliate connection data are available there is a need for more affiliate-affiliate connection data. Third, more coordination between different statistical agencies and more international cooperation is crucial. Fourth, the analysis of micro data and comparison with macro data are important. An interesting preliminary insight from micro data shows that R&D performance is becoming less concentrated despite increasing concentration of economic activity between large players. Fifth, R&D and innovation are inextricably linked, and therefore R&D globalization should be viewed within the lens of global innovation frameworks. Finally, data on intangibles are not collected and/or integrated in R&D globalization data, however intangibles might also play a major role in R&D globalization.

Several opportunities to pursue future research in line with the conclusions enumerated by the authors should be noted. For US R&D data, for example, the three-way data linkage project between the BEA, the Census Bureau, and the National Science Foundation allowed further analysis of R&D data. Similar efforts to achieve data standardization and linkage for other OECD countries would be very valuable for the same purposes. Additionally, it is widely known that technological knowledge is hard to codify, and this might drive the underreporting of R&D trade in services, along with other factors such as tax shifting/transfer pricing. Future research in this area would be beneficial.

Additional avenues for future research include:

1. Data by industry, as R&D globalization might impact various industries disproportionally. For example, Branstetter et al. (2018) offer a new explanation for the shift in the location of foreign R&D, which involves an increasingly central role of information technology and a global shortage of engineers with basic skills.

2. Data by geographic detail, which would provide additional evidence on R&D globalization. For example, within the United States more disaggregated data at the state or county level could uncover the location of R&D. In our research, we linked several data sources to create US R&D data by state and found that there is a lack of R&D data at a more geographically disaggregated level. Similarly, examining data sources for regional R&D in Europe, we found that many missing observations inhibit research in this area (Hovhannisyan and Keller 2019).

3. Data on knowledge spillovers. While there are no data on knowledge spillovers per se, it is important to augment the current framework with proxies or indirect measures of knowledge spillovers as research has established the significance of those (Keller 2004).

4. Data on patents. Although the authors offer some initial statistics on patenting, more patenting and patent-citation data are needed. For example, using patenting databases from the United States Patent and Trademark Office (USPTO) it is possible to identify the percentage of US-owned patents invented by foreign inventors. In addition, the USPTO patent inventor database provides rich geographic and assignee details, so it is possible to gauge joint US/foreign innovation to augment data on R&D globalization.

5. Data on royalty and license payments are not linked, which would provide additional insights on the extent of R&D globalization.

To conclude, this is an excellent paper offering an important contribution to the understanding and measurement of R&D globalization, with helpful implications for further research and policy discussion.

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