Abstract: The aim of the study is to indicate the factors shaping the export of R&D services in the global economy and to determine the directions and patterns in global trade in R&D services. The research is based on panel data extracted from the UNCTAD database regarding export and import of R&D services in 2010–2016. Two panel models with country-pair effects are estimated using different estimating procedures: generalized least squares and Hausman-Taylor model.

Trade in R&D services was found to be strongly concentrated in a relatively small number of countries with high technological potential. In the case of exports of those services, there was a clear dominance of two economies, i.e. the US and Germany, accounting for approximately 40% of global exports of the services concerned. On the side of importers of R&D services, statistically significant factors were as follows: developed production of high-skill and technology manufactures, significant direct investment resource coming from the exporter’s country, but also the existence of technological capabilities and R&D potential. It should be noted that the activity of transnational corporations within the framework of the network of own R&D subsidiaries located in the global economy is of key importance for the directions and intensity of trade in R&D services. Those connections generate the largest streams of trade in R&D services. However, the location of parent corporations in the country, especially from knowledge-intensive industries, is an extremely important factor.

Keywords: international trade in R&D services, expenditure on R&D, transnational corporations, high-skill and technology manufactures, technological capabilities

JEL Codes: F14, C23, O31, L84.

Introduction

The research area of this article is global trade in R&D services, having emerged relatively recently and comprising still insignificant trade flows; however, for about a decade, the volume of the trade concerned has shown robust growth. It is worth emphasising that the issue of trade in R&D services focusses on two areas of processes and phenomena observed in the present world economy, namely research and development activities and international trade in services.
Both areas are regarded as signs of the current stage of globalisation, whereas their buoyant development is indicated as a symptom of building innovative and competitive economies. On the one hand, R&D activity is an indispensable component of accelerating technological progress as a result of the creation of new products, processes, solutions, considered a pre-requisite of building a competitive advantage at the country as well as enterprise levels. Especially undertakings, in particular transnational corporations (TNCs), aware of the importance of conducting and speeding up R&D activities, have become the engine of global R&D for more than two decades, initiating processes of internationalisation, decentralisation, fragmentation (the creation of global value chains), the diffusion of knowledge and technology or, finally, of international exchange of R&D effects. On the other hand, international trade has markedly shown rising importance of services; one must also stress here the role played in the acceleration of trade in services by the largest corporations, seeking in the process not only a way of generating increased revenue but also of cutting costs by introducing profound changes in the organisation of manufacturing processes through building global value chains and trade in intermediate goods.

Therefore, the two areas combined to create a space for international exchange of R&D services whose nature results, on the one hand, from the effects of the global research and development activity itself and, on the other hand, the conditions arising from the specific characteristics of trade in services will influence trade in R&D services. It seems, however, when one looks at the role of both areas in the modern world economy, that in the nearest future trade in R&D services will gain in importance, becoming a vital element in stimulating technological progress as well as trade in services.

This study aims to identify the trends and patterns in trade in R&D services and to seek the determinants of the trade concerned. The investigation was conducted with the use of the UNCTAD database concerning global flows of trade in services for R&D services, at present the source of the most disaggregated and comprehensive statistics on various types of services in international trade. The data served to analyse the problem of the trends and patterns existing in world trade in R&D services, over a time span of 2010–2018. At the same time, for the purpose of identifying the determinants of the trade concerned, two methods (generalized least squares and Hausman-Taylor model) were applied to estimate two econometric models using panel data on trade in R&D services for pairs of countries; in that case, the available data covered the period 2010–2016.
The paper is composed of three main parts, an introduction and a summary. The first section reviews the world literature on trade in R&D services as well as on the underlying processes and phenomena; on the basis of the analysis of available investigations, the research hypotheses for this study were formulated. The second part focusses on the examination of the available statistics on trade in R&D services and, based on that, attempts to identify the trends and patterns existing in trade in R&D services. Finally, part three describes the econometric models used to indicate the determinants of global exports of R&D services.

1. A review of the literature and motivation

The increasing role of services in the world economy inspired studies, also by international institutions such as the World Bank, the UNCTAD (2013; 2018), and the OECD (Rouzet, Benz, Spinelli 2017), analysing the importance of services to economic growth and development (McNeil 2006; Lööf, Anderson 2008), as well as links between trade in services and enhanced efficiency of economies (Amiti, Wei 2009; Kirijama 2012). Services form an extremely differentiated category, comprising a wide range of various economic activities; some of those may be directly related to production activities (e.g. transport services) or completely independent (such as educational services, health care).

Business services are a special category, a certain channel for the transmission of innovative business processes among undertakings operating within an industry or between industries (Hoekman, Matoo 2008). It must be added that the nature of business services may be horizontal, i.e. they can be provided across industries (e.g. IT, accounting, human resource management services), or vertical, i.e. industry-specific (e.g. risk management in banking). The capacity to supply business services also depends on the available resources of adequately educated human capital (Gereffi, Fernandez-Stark 2010; Van der Marel 2015). The market in business services concentrates in advanced economies, with a large number of undertakings and their headquarters. Nevertheless, those services have also shown offshoring trends (Amiti, Wei 2009) and the creation of global chains, located in developing countries as well (Hernandez, Martinez-Piva, Mulder 2014, p. 68; Chilimoniuk-Przeździecka, Kuźnar 2016; Miroudot, Cadestin 2017).

For the past two decades, business services have formed an integral part of global value chains (GVCs), with a distinct upward trend (UNCTAD 2013; WTO 2019). It results from changes in the organisation of corporations, seeking to redefine their networks of branches and to focus on their core competencies (Miroudot, Cadestin 2017), thus increasing the range of
business services subject to outsourcing and offshoring (Hernandez Martinez-Piva, Mulder 2014, p. 67), which generates international trade in business services (Andrenelli et al. 2019).

Research and development activities as well as R&D services (Miles 2007), part of business services, certainly undergo the same processes and changes while maintaining their specific characteristics. It is worth emphasising that with regard to research and development value chain activities are coordinated and controlled by the main producers operating in the chain concerned (Andrenelli et al. 2019), whereas the authority flows vertically downwards, from the parent company to its branches or from the leading enterprise to suppliers (Hernandez, Martinez-Piva, Mulder 2014, p. 22). It is the so-called producer-driven chain.

It must be stressed that before global value chains emerged in the world economy research and development activities, mostly through TNCs, had been increasingly internationalised, despite a prior model of carrying out R&D activities in the TNC’s home country (UNCTAD 2005; OECD 2008; Odrobina 2014). Buoyant growth in the internationalisation of innovative activities led to the creation of global innovation networks (GINs). It means that TNCs locate various fragments of R&D activities in their foreign research and development subsidiaries, forming a corporate innovation network together with the central R&D laboratory in the home country (Barnard, Chaminade 2011; Chaminade, Plechero 2013; Moris 2018). GINs comprise affiliates of varying statuses, depending on the motivations for their creation, from resource-exploiting adaptation branches, only oriented towards tailoring the product and process concerned to the needs of the local demand, to resource-expanding subsidiaries, seeking to capture foreign knowledge, technology and human capital in order to transfer such knowledge, technology and information to the central laboratory in the home country (Kuemmerle 1997, pp. 62–63). A GIN constitutes a network comprising its own R&D units dispersed globally but also a variety of cooperation links with external partners and suppliers for the purpose of executing the innovation process; however, depending on the degree of meeting the characteristics of the global range, networking and innovation, it is possible to distinguish 27 types of GIN (Barnard, Chaminade 2011; Odrobina 2016). Therefore, in the case of research and development activities, we have two overlapping types of network, GVCs and GINs, with the former concerning tangible international flows, whereas the latter includes flows of intangible assets (OECD 2017).

Thus, international trade in R&D services is a phenomenon arising from a number of overlapping processes and developments mentioned above, observed in the very essence of global trade in services, especially including business services, and changes in global R&D activities. The roots of all those transformations are transnational corporations whose modes of
functioning and organisation of their own activities determine the emergence of flows of trade in R&D services (Keller 2009; Moris 2018).

It is worth pointing out that, as regards trade in R&D services, the existing research still seems to be modest, whereas the trade-related literature usually concerns analyses of services in general (Li, Greenaway, Hine 2003; Kelle, Kleinert 2010; Rouzet, Benz, Spinelli 2017; Miroudot, Cadestin 2017; UNCTAD 2018), or business services (Abramovsky, Griffith, Sako 2004; Amiti, Wei 2009; Kelle 2012; Vogel, Wagner 2012), primarily with regard to selected economies (Van Welsum 2004; Parthasarathy, Aoyama 2006; Hanson, Xiang 2009; Vogel, Wagner 2012). Therefore, the Authors intend to bridge the gap and to focus on an analysis of world trade in R&D services, for the purpose of identifying its trends and patterns and of attempting to indicate the determinants of the trade in question.

The above considerations based on examining the literature and analysing world publications allow to put forward the following research hypotheses for the study: (H1) trade in R&D services is characterised by a high degree of concentration in a limited number of countries since exporters of R&D services can be economies with significant R&D potential; (H2) trade in R&D services depends on the pursuit by transnational corporations of their internationalisation strategies, especially as part of foreign direct investment, used by TNCs to optimise their global operations.

2. Trends in international trade in R&D services

Trade in R&D services accounts for a marginal part of present-day trade in services in general; in the period in question, it merely represented from 2.5% to 3.1% (Figure 1). Despite an observed upward trend of the share of trade in R&D services in total international trade in services, the largest flows of trade in services basically concern services other than R&D services. At the same time, in both cases trade showed similar patterns in the period covered. Between 2010 and 2018, there was a rise in international trade in services; although a regular trend is hardly identifiable (particular years witnessed growth rates ranging from ca. 1% to as much as 12% against the previous year, with a marked drop in exports in 2015, by approx. 5%), in 2018 exports of services went up by 49% in comparison with 2010, to USD 5,845 billion. As regards exports of R&D services, in the period under analysis exports rose at a slightly higher pace, by 82% up to USD 179.4 billion (2018) against USD 98.7 billion USD (2010); however, as in the case of total trade in services, the growth rate varied widely – from 5.3% (2018) to 14.4% (2011) compared to the previous year, with a distinct decline in the value of trade in 2015, by ca. 4%. Therefore, it is possible to say that both categories of trade in services
show similar trends, although trade in R&D services continues to account for an insignificant proportion of global trade in services (at approx. 3%); but the volume of that trade grows at a slightly higher rate than that for world trade in services in general.

Simultaneously, the involvement of individual groups of countries in the categories of trade under comparison is very different, as illustrated in Figure 2. Developing countries appeared to account for a dominant share of total exports of services; in the period in question, they exported 68–69% of the value of global exports of services and the trend virtually remained unchanged. As regards the involvement of advanced economies in exports of services, it was around 28–30%, depending on the year. At the same time, countries in transition had a share of 2.1% to 2.8% in total exports of services. In the case of exports of R&D services, it is very strongly dominated by developed countries, invariably accounting for 87–89% of the volume of exports of R&D services, which results from the specific characteristics of the services concerned: mostly their high knowledge intensity, capital intensity as well as the necessary highly skilled human capital. The proportion of developing countries in exports of R&D services ranged from 10% to 12% throughout the period covered, basically thanks to activities pursued by Asian developing countries, representing ca. 90% of exports of R&D services realised by the whole group of developing economies. Countries in transition were marginal exporters of R&D services, with a steady downward trend of the share in the volume of trade, from 1% (2010) to 0.7% (2018).

Figure 1. Exports of R&D services and exports of total services in the world (USD billion)
Source: UNCTAD 2019 database.

Figure 2. Share of economies in exports of R&D services and total services in the world
Source: own calculations based on UNCTAD 2019 database.
When analysing the top-performing exporters of R&D services worldwide, one must observe that throughout the period under examination it was a narrow group of advanced economies, unquestionably led by the United States (Figure 3). It deserves emphasising that – depending on the year – the USA exported ca. 22% to nearly 25% of R&D services and the country’s position seems unchallenged; in nominal terms, in the period covered the value of exports increased by factor of 1.9 (from USD 22.5 billion in 2010 to USD 42.1 billion in 2018). The world’s second largest exporter is Germany, representing from ca. 14% to 16% (a record-high in 2014) of exports of R&D services. Although in 2010–2018 the nominal value of exports of R&D services in Germany rose more than 1.8-fold, individual years showed marked and irregular decreases and increases in the volume of exports; nevertheless, in 2018 Germany exported R&D services worth USD 24.9 billion. Therefore, it is worth noting that the two leading economies continuously exported more than 37% of global exports of R&D services, whereas in certain years (2015–2017) their combined share was nearly as high as 40%. The third best performer in the world in terms of R&D exports was France, whose volume of exports augmented 1.9 times in the period covered (USD 8.2 billion in 2010 versus USD 15.3 billion in 2018), with the share of France in global exports of R&D services was around 8–9%. The top three were followed by: the United Kingdom (USD 9.6 billion in 2018), Israel (USD 7.2 billion in 2018), Japan (USD 6.9 billion), Canada (USD 5.2 billion), Belgium (USD 5.0 billion), Sweden (USD 4.7 billion), Italy (USD 4.6 billion) and Switzerland (USD 4.3 billion). It is worth adding that the majority of the economies in question showed distinctly lower growth rates of exports of R&D services in 2010–2018 than the top three. The exceptions included Switzerland (up 2.4 times), Italy (2.1 times) and Sweden, the last country having increased the volume of exports to a degree similar to that of Germany.

Therefore, it is possible to indicate that the eleven leading economies export a total of approx. three-fourths of the R&D services in the world, which reflects very strong concentration of global trade in that regard. The rest of the world only accounted for around one-fourth of exports of R&D services. Therefore, considering the above-mentioned share of developing countries at ca. 10–12%, it appears that also in the group of developed economies, other than the eleven leaders, the involvement in exports of R&D services is not very significant since they merely represent approx. 12–14% of the volume of exports.

Therefore, we have an interesting picture of the leaders in exports of R&D services, not exactly corresponding to the map of the top performers in global research and development activities. Whereas for the USA, the world’s leader in both categories, it is possible to indicate similar patterns for the two phenomena, Germany shows certain differences as it only ranks
fourth globally in terms of R&D expenditure. In addition, France and the United Kingdom, both highly performing in exports of R&D services, rank in the top ten in terms of R&D expenditure in the world. At the same time, Japan shows the third largest (behind China) R&D expenditure, whereas in terms of exports of R&D services it ranks sixth. Interestingly, Israel does not rank at all among the countries characterised by the highest spending on R&D (although it is the world’s leader with regard to R&D intensity) but it is the fifth exporter of R&D services. High R&D intensity is also characteristic of Sweden. Simultaneously, Switzerland – the lowest-ranking country from the eleven leaders in exports of R&D services – is the top performer in terms of relative number of triadic patents obtained (*per capita*). Although the leading exporters of R&D services represent countries related to the world’s best in spending on R&D, there is no direct relationship between the two categories. Therefore, it seems more justified to ask about the actual determinants of trade in R&D services, the answer to that question being neither intuitive nor obvious.

* Switzerland and Liechtenstein  
** data estimated for 2018

*Figure 3. Exporters of R&D services (USD billion)*  
Source: UNCTAD 2019 database.

Since it was possible to observe certain patterns for exporters of R&D services, it is worth investigating the situation on the importers’ side, as presented in Figure 4. It can be seen that it is unfounded to intuitively expect importers of R&D services to be developing countries, i.e.
economies thus seeking opportunities to narrow the gap in knowledge and technology in their home countries. In contrast, the main importers of R&D services are advanced economies, the top importers being basically the same as the leading exporters of those services.

* data estimated for 2010–2011
** Switzerland and Liechtenstein

**Figure 4. Importers of R&D services (USD billion)**
Source: own calculations based on UNCTAD 2019 database.

Imports of R&D services were led by the United States, accounting for ca. one-fourth of global imports at the beginning of the period in question and slightly below 20% in the second half (18.2% in 2018). In nominal terms, the value of imports to the USA showed a steady increase (from USD 22.2 billion in 2010 to USD 35.2 billion in 2018). The world’s second largest importer of R&D services is Ireland, even jumping ahead of the US in 2016 with imports of USD 64.2 billion (i.e. 30% of global imports in that year). For Ireland, the breakthrough year was 2015 when it dramatically increased imports of R&D services (2.7 times in comparison with the previous year), whereas in 2017–2018 Ireland imported ca. 15% of the global volume of R&D services; in 2010–2014, the country ranked fifth or sixth in terms of global imports. The world’s third importer is Germany, whose share in the period covered was ca. 11–12% of overall imports of R&D services and the value of imports showed uninterrupted growth from USD 9.8 billion in 2010 to USD 23.3 billion in 2018 (i.e. up 2.4 times). It is followed by Japan, whose imports of R&D services more than doubled, to be USD 20.2 billion in 2018. The fifth
place is occupied by the only developing economy in the group of the leading importers, i.e. Singapore, with imports soaring 5.5 times over the period in question (USD 15.8 billion in 2018). It is followed by Switzerland (USD 13.7 billion in 2018), France (USD 12.9 billion in 2018), Belgium (USD 9.6 billion in 2018), Sweden (USD 5.8 billion in 2018) and the United Kingdom (USD 3.8 billion in 2018), thus also major importers of R&D services. Other importers include Denmark (USD 2.2 billion), Finland (USD 2.1 billion), Italy (USD 1.8 billion) and Canada (USD 1.2 billion), the first two not being major exporters of R&D services, whereas the other two countries also rank among the top exporters of those services. It is worth noting that Finland reduced its imports of R&D services throughout the period in question, cutting them by half. At the same time, Belgium increased its imports 2.7 times, as a result of significant growth in 2018. Surprisingly, other than the above-mentioned fourteen countries, the rest of the world accounted for less than 10% of imports of R&D services (from 7.1% in 2010 to 9.2% in 2018), which points to lesser involvement of the rest of the world in imports of R&D services than in the case of exports.

To recapitulate, the analysis of the leading importers indicates a high degree of concentration also in imports of R&D services, with the top fourteen importers representing more than 90% of global imports of R&D services. There is a marked trend consisting in the existence of a certain close system in trade in R&D services, i.e. the main exporters are mostly major importers of R&D services as well. Among exporters, Israel stands out (not a leading importer), whereas the group of major importers not being top performers in exports includes Ireland, Singapore, Denmark and Finland.

In addition, the established high degree of concentration in trade in R&D services is also a marked trend and pattern; therefore, it seems justified to verify and compare the level of concentration in exports and imports. To that end, concentration ratios\(^2\) \(CR_1, CR_3, CR_5\) and \(CR_{10}\) were calculated; their values for exports of R&D services are presented in Figure 5, whereas those for imports of the services concerned – in Figure 6.

It can be observed that there is higher concentration in imports of R&D services, particularly with regard to \(CR_5\) and \(CR_{10}\), as those respective ratios were 60–72% and 83–97% in particular years. At the same time, for exports \(CR_5\) ranged from 55% to 58%, whereas \(CR_{10}\) never

\(^2\) The concentration ratio is the measure most frequently used to assess the concentration of a market, having a merit of not being very sensitive to changes in the number of market players (especially small ones). The ratio is calculated by adding up the shares of the \(N\) largest firms, in accordance with the following formula: \(CR_N = \sum_{i=1}^{N} u_i\), where \(u_i\) is the share of market player \(i\). In the concentration analysis, the number \(N\) is appropriately selected depending on the objective of the research and the specific characteristic of the market concerned (Curry and George 1983, p. 207; Davies 1980; Kwiatkowska 2014, pp. 190–191).
exceeded 73.5%. As regards CR₁, the ratio showing the share of the market leader in global trade, it points to slightly greater concentration on the export side. Finally, CR₃ shows similar values in exports and imports, ranging between 45% and 50%, which indicates the proportion of the top three performers in overall trade in R&D services. Simultaneously, it can be stated that the concentration ratios in exports of R&D services are characterised by greater stability in comparison with clearly more fluctuating ratios describing imports.

The analysis of the concentration ratios in trade in R&D services allows to assume that it is largely determined by specific characteristics of global research and development activities (a high degree of concentration in a limited group of countries, with the strongest relationships within that group of economies) and trade driven by transnational corporations in intra-group cooperation (within their own foreign direct investment networks or chains) and inter-corporation transactions (but between firms with significant R&D potential).

3. Econometric models explaining determinants of exports of R&D services

Due to the scarcity of data concerning bilateral trade in services, we construct models explaining exports of R&D services only from Germany and the United States. However as these two countries play the fundamental roles in exports of R&D services, the models still explain relatively big part of the world exports of R&D services.

The dependent variable in estimated models is exports of R&D services from Germany and the United States during 2010-2016 (statistics extracted from the UNCTAD’s database - https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=135718 (accessed on 22.04.2019)). The list of independent variables used in models contains Table 1.
Table 1. Independent variables in estimated models

<table>
<thead>
<tr>
<th>Description of variable</th>
<th>Abbreviation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and development expenditure in pharmaceutical and biotechnology industries of top 1000 TNCs operating in importing country (current EUR)</td>
<td>R&amp;D_industry1</td>
<td>own calculations based on European Commission, <a href="http://iri.jrc.ec.europa.eu/scoreboard.html">http://iri.jrc.ec.europa.eu/scoreboard.html</a> (23.03.2018)</td>
</tr>
<tr>
<td>Research and development expenditure in electric and electronic industries of top 1000 TNCs operating in importing country (current EUR)</td>
<td>R&amp;D_industry5</td>
<td>own calculations based on European Commission, <a href="http://iri.jrc.ec.europa.eu/scoreboard.html">http://iri.jrc.ec.europa.eu/scoreboard.html</a> (23.03.2018)</td>
</tr>
<tr>
<td>Production of knowledge intensive goods in importing country (current USD)</td>
<td>production</td>
<td>own calculations based on <a href="https://unctadstat.unctad.org/wds/TableViewer/dimView.aspx">https://unctadstat.unctad.org/wds/TableViewer/dimView.aspx</a> (22.04.2019)</td>
</tr>
<tr>
<td>Dummy variable for regional trading arrangements including trade in services (1 for pair of countries belonging to the same RTA)</td>
<td>rta</td>
<td>own deliberation based on WTO, <a href="https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx">https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx</a> (22.04.2019).</td>
</tr>
<tr>
<td>Dummy variable – 1 if importer is a tax haven</td>
<td>taxhaven</td>
<td>own deliberation</td>
</tr>
<tr>
<td>Dummy variable – 1 if importer is a “very open economy” (“very open economies” if shares of intermediate goods and services in gross exports and imports are higher than the world average shares)</td>
<td>open</td>
<td>own calculations based on OECD, <a href="https://stats.oecd.org/index.aspx?queryid">https://stats.oecd.org/index.aspx?queryid</a> =75537 and <a href="https://stats.oecd.org/Index.aspx?datasetcode=TIVA_2018_C1">https://stats.oecd.org/Index.aspx?datasetcode=TIVA_2018_C1</a> (15.05.2017).</td>
</tr>
</tbody>
</table>

Source: Own deliberation.

We estimate linear models using general least squares (GLS) method with random effects (we do not estimate model with fixed effects because some independent variables are time invariant) and Hausman-Taylor method (some of the regressors are correlated with
country-pair effects). We use dependent and independent (apart from dummy variable) after logarithmic transformation (in the case of zero observations we employ ln(1+value) formula).

Table 2. Estimations results

<table>
<thead>
<tr>
<th>Variable</th>
<th>GLS, random effects</th>
<th>Hausman-Taylor (rta and lnFDI are endogeneous variables)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of observations: 739</td>
<td>No. of observations: 739</td>
</tr>
<tr>
<td>In R&amp;D</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>ln R&amp;D industry1</td>
<td>0.11***</td>
<td>0.08</td>
</tr>
<tr>
<td>ln R&amp;D industry2</td>
<td>0.16***</td>
<td>0.14**</td>
</tr>
<tr>
<td>ln R&amp;D industry3</td>
<td>– 0.09</td>
<td>–0.07</td>
</tr>
<tr>
<td>ln R&amp;D industry4</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>ln R&amp;D industry5</td>
<td>– 0.05</td>
<td>–0.04</td>
</tr>
<tr>
<td>ln researchers</td>
<td>0.08***</td>
<td>0.06***</td>
</tr>
<tr>
<td>ln patents</td>
<td>0.14***</td>
<td>0.11***</td>
</tr>
<tr>
<td>ln production</td>
<td>0.19***</td>
<td>0.16***</td>
</tr>
<tr>
<td>ln FDI</td>
<td>0.33***</td>
<td>0.19***</td>
</tr>
<tr>
<td>rta</td>
<td>0.22</td>
<td>0.17</td>
</tr>
<tr>
<td>taxhaven</td>
<td>0.40</td>
<td>0.07</td>
</tr>
<tr>
<td>open</td>
<td>1.42***</td>
<td>1.71***</td>
</tr>
<tr>
<td>constant</td>
<td>–4.42***</td>
<td>–2.36***</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, *p<0.1

Source: Own deliberation based on calculations in STATA.

According to the estimated models, R&D expenditure in importing country seems not to be the determinant of trade in R&D services (variables concerning R&D expenditure are not statistically significant or only weakly significant in the case of some industries\(^3\)). However, the more intensive trade in R&D services is accompanied by the higher number of R&D researchers and patent applications by resident in importing country. Additionally, the higher production of knowledge intensive goods in importing country goes together with more intensive trade in R&D services what suggests that imported R&D services play important role in the production process of knowledge intensive goods. As the variable illustrating FDI stock is strongly statistically significant with positive coefficient, the international trade in R&D services seems to be complementary to FDI activities. It is quite surprising that participation in regional trade arrangements does not affect the international trade in R&D services. Also the fact of being the importing country a tax haven does not matter. Finally, if importer is a “very open economy” what means that it exports and imports a lot of intermediaries (countries such

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\(^3\) R&D expenditure in 5 industries (which we included) accounts for about ¾ of total R&D expenditure conducted by TNCs. In the case of pharmaceutical, biotechnology and IT hardware industries, there are weakly statistically significant interdependences. It may suggest the important role of intra-firm trade in R&D services in the case of these industries.
as: Ireland, Belgium, Netherlands, Luxembourg, Finland, Sweden, Singapore, Malaysia, Korea, Japan, Taiwan), it also imports relatively more R&D services than other countries.

Summary

The above considerations and analyses allow to identify clear trends and patterns in international trade in R&D services, namely:

1. Trade in R&D services represents an insignificant part of total international trade in services as it only accounts for ca. 3% of the trade, even though the growth rate of trade in R&D services is slightly higher, which may lead, in the future, to increased importance of trade in R&D services in the volume of international trade in R&D services; however, the process is likely to be rather gradual.

2. In addition, trade in R&D services is observed to be the domain of developed economies. The domination of that group of countries at nearly 90% leaves no doubt that major exporters of R&D services are advanced economies. The share of developing countries as exporters of R&D services is around 10–12%, mostly due to activities pursued by Asian economies. The trends are very different from those seen in international trade in services in general, with the dominant position of developing countries exporting nearly 70% of the volume of services, whereas the proportion of developed economies does not exceed 30%. In both cases, transition countries play a marginal role.

3. Exports of R&D services, which nearly doubled in 2010–2018, are strongly dominated by eleven developed economies accounting for ca. three-fourths of exports, the indisputable leader being the USA, exporting approx. one-fourth of R&D services in the world. The second largest exporter is Germany with a share of 14–16%, thus the two leading exporters represented almost 40% of global exports of R&D services. Advanced economies distinguished by significant R&D expenditure rank high in exports of R&D services; nevertheless, there is no direct relationship between the level of R&D expenditure and exports of R&D services.

4. As regards importers of R&D services, those are characterised by even stronger concentration in a narrow group of countries, as reflected by the concentration ratios. Fourteen economies account for more than 90% of imports of R&D services, the leader remaining the USA. The degree of concentration in imports is markedly higher than in exports of R&D services.

5. It is worth emphasising that basically the world’s leading importers are simultaneously major exporters of those services, which constitutes a certain pattern in global trade in R&D
services. On the import side, the exceptions are as follows: Ireland, Singapore, Denmark and Finland. As regards exports, Israel ranks among the top performers, at the same time remaining outside the leading importers.

According to the estimated models, on the side of importers of R&D services from Germany and the United States, statistically significant factors are as follows: developed production of knowledge-intensive goods, significant direct investment resource coming from the exporter’s country, but also the existence of technological capabilities and R&D potential. It is possible that the important part of international trade in R&D services holds inside the transnational corporations and it is complementary to FDI.

References


Data sources: