# Technological Profiles and Technology Trade Flows for Some European and OECD Countries

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**Abstract**

In the current context of increasing globalisation, innovation and investment in R&D become crucial. Furthermore, European Lisbon strategy gave disappointing results in terms of R&D expenditures and patents. In this context, our paper deals with some OECD characteristics concerning their connection to global markets of knowledge and technology trade. Statistical results show that the USA are great performers in terms of R&D expenditures and patents, with large openness to foreign collaboration, Japan is successful in innovative activities while quite isolated from global research network. The European Union seems to be in the opposite situation. Nevertheless contrasted situations are observed, depending on the European countries. For instance Sweden, Finland and Denmark register quite good results in terms of R&D. Concerning technological trade, Technology Balance of Payments (TBP) statistics give some additional results. While the EU15 used to exhibiting a TBP deficit, the situation has changed since 2006 and the EU15 registers a surplus. This performance relies on Germany, Sweden and Austria, which are the main exporters of technology among European countries. Thanks to this first statistical analysis, it seems that technological profiles of OECD countries impact on technological trade flows. Except some specific countries' characteristics, leaders in R&D are quite active in terms of technological exports and also imports. For instance, the European leaders in R&D export their technologies but seem also active by importing technologies from abroad.

**Keywords:** Disembodied technology, Markets for knowledge, Technology, Innovation, International trade

## 1. Introduction

The nineties have witnessed the emergence of global markets for knowledge and the increasing exchange of technology across industries and across countries (Gambardella et al., 2007). International trade in technology increases with internationalisation of patent activity via multinational enterprises' strategies since 1990. Moreover with the emergence of new actors (like China), international trade in technology is a major tool for globalization of innovation and knowledge.

OECD countries display some characteristics in terms of their performances concerning R&D spending and innovation. The objective of this paper is to see if these performances are linked to Technological balance of payments (TBP). Indeed countries, which record greatest Research and Development spending, should export more technology. On the contrary, countries that does not invest much in R&D activities compared with OECD average, should import more technology from leaders countries in order to fill intheir technological gap. This issue is particularly interesting especially because disembodied technology flows have been rather neglected by economists. Trade in disembodied technologies refers to the purchase of technologies (protected by intellectual property rights) by a firm that can be included in its production process (Note 1). These include patented technologies, licensed technologies and royalties-inducing technologies. Technological balance of payments (TBP) appraises trade in disembodied technology as it corresponds to cross-border technological receipts minus technological payments. Our paper will be organised as follow: first we will give some definitions concerning trade in technology. Then we will present technological profiles of main OECD countries. In a third section, technology balance of payments data will be analysed.

## 2. Trade in Technology: Some Definitions

The aim of this section is to explain what we mean by international trade in technology. In particular we will first stress the difference between *international transfers* and *technology spillovers*, and then we will define what we mean by disembodied technology.

Following Maskus (2003, p. 14), it is possible to define a technology, as the information needed "to achieve a certain production outcome from a particular means of combining or processing selected inputs". Technology diffusion may rely on transfers or spillovers (Shih & Chang, 2008; Keller, 2004). *Technology transfers* refer to any process by which one party gains access to a second party's information, and successfully learns and absorbs it into his production function. Taschler and Chappelow (1999, p.30) define technology transfer as "the managed, interpersonal, and systematic process of passing control of a technology from one party to its adoption by another party as evidenced by a strong emotional and financial commitment to sustained, routine use". Consequently, "technology transfer occurs between willing partners in voluntary transactions" (Maskus, 2003, p. 14-15). On the contrary, *technology spillovers* are "defined as technological knowledge being learned and absorbed into competition in such a way that the benefits do not fully accrue to the original owner of the technology" (Shih and Chang, 2008, p. 2). Technology or knowledge spillovers come from the fact that "technological investments frequently create benefits to individuals other than the inventor" (Keller, 2004, p. 753.) that is to say it generates positive externalities. (Note 2)

More and more technology transfers occur at international level mainly because multinational enterprises (MNEs) are performing abroad a growing share of their R&D (UNCTAD, 2005, p. 121). It is then important to distinguish two types of international transfer of technology: Firstly the market-mediated international transfer of technology (through licensing, R&D contracting and company sell-offs and cooperation in R&D) and secondly the intra-group transfer of technology. On the one hand, a market-mediated mechanism means that some form of formal transaction underlies the technology movement (Maskus, 2003) (Note 3). On the other hand, intra-group transfer of technology consists in exchange of technology between parent company and affiliates.

A common classification of technology relies on the distinction between embodied and disembodied technology. *Embodied technology* refers to "new technology (…) embodied in an asset (…) such as new personnel or (parts of) other firms or equipment" (Cassiman & Veugelers, 2000, p. 1-3). In other words, "Technology can be embodied in intermediate inputs, capital goods, or people" (Mendi, 2007, p. 121). On the contrary *disembodiedtechnology* refers to codified technology (in the form of formulas, blueprints, drawings, patent applications, and so on) or as uncodified form (in the sense of requiring implicit know-how from personnel know-how) (Maskus E. Keith, 2003, p. 14; Shih & Chang, 2008, p. 2-3.).

On the basis of previous definitions, three ways of transferring disembodied technology internationally can be identified.

*Licensing:* It "involves the purchase of production or distribution rights (protected by some intellectual property right) and the technical information and know-how required to make effective the exercise of those rights". License contracts can "cover a variety of transactions, including technical assistance, codified knowledge, know-how, establishment of turnkey operations, and intellectual property rights. Licenses may be offered for a fixed fee, a franchise fee, a royalty schedule (e.g., sliding share of sales), or a share of profits. They may offer rights to produce for, or distribute to, a limited geographical territory for a given period of time. The terms of a license contract may involve performance requirements of the licensee, such as non-disclosure mandates, "no-compete" clauses for personnel, and grant-back provisions on adaptive innovations" (Maskus E. Keith, 2003, p. 15 and p. 26).

*Collaboration* "International collaboration is also a means of disembodied technology transfer. It consists in partnership among researchers that can "take place either within a multinational corporation (providing research facilities in several countries) or through a research joint venture (JV) among several firms or institutions (collaboration between universities or public research organisations)." (Note 4)

Another significant channel of international technology and knowledge transfer is *"cross-border movement of technical and managerial personnel"*. Indeed, many technologies cannot be effectively or affordably transferred without the complementary services and know-how of engineers and technicians that must be on-site for some period of time.

Thus a firm can obtain new disembodied technology through a licensing agreement or by outsourcing the technology development from an R&D contractor or consulting agency (Cassiman & Veugelers, 2000, p. 3). In other words technical services and assistance provided by skilled employees who hold know-how necessary for a successful transfer of technology can be considered as disembodied flows of technology and knowledge (Note 5).

## 3. Technological Profiles of Countries

International diffusion of technology has been very often studied through international trade in embodied technology and spillovers. Economists have neglected the technology exchangesthat involve a transfer (as seen previously). In the meantime, we are witnessing the emergence of global markets for knowledge. For instance in this following table, we can notice that international trade of technology keeps increasing during the last decade. In most countries, the growth rate of international flows of technology is greater than annual growth rate for each country. This shows clearly that countries are increasingly interdependent even in exchanges of knowledge.

Insert Figure 1 Here

Due to this context of increasing international trade of technology and knowledge, it seems interesting to consider the technological profiles of OECD and European countries.

To build this technological profile, we examineGross Domestic Expenditure on R&D (GERD), expenditure on R&D in the business enterprise sector (BERD), triadic patents and patents with foreign co-inventors (Table 1). Unfortunately most of the time, it is not possible to present figures for the European Union as a whole because some countries do not communicate detailed data on these subjects. Despite those difficulties, OECD data allow to depict some particularities.

We can notice in Table 1 several things. First, R&D expenditures as percentage of GDP of the European Union lag behind Japan, the United States and OECD countries with the exception of Sweden and Finland. Second, innovative performances, measured by the share of countries in patent triadic families, seem to be a little bit smaller for the EU. Nonetheless co-inventions are particularly superior. To sum up, the USA are great performers in terms of R&D expenditures and patents, with large openness to foreign collaboration. Japan is successful in innovative activities while quite isolated from global research network. The European Union seems to be in the opposite situation. Finland, Sweden and also Denmark register quite good results in terms of R&D and appear opened to collaboration with foreigners.

Table 1 sums up these main profiles.

Insert Table 1 Here

Table 1 shows different interesting characteristics of OECD countries'technological profile. Does this technological profile impact directly on trade in technology of a country? Next section will analyse the links between technological profiles and countries' ability to export their technology, or their ability to use imported technology to introduce new products. Indeed, more than two-thirds of product innovators in New Zealand and the United States are not engaged in R&D as well as more than 90% in Chile and Brazil (OECD, 2011) (Note 6). It could let us think that these countries import disembodied technologies.

## 4. The Technology Balance of Payments

We have seen previously that innovative activities of European countries are characterised by their great openness to foreign collaboration. In this section, we will examine the technology balance of payments data to show the features of European countries compared with main OECD countries relating to trade in technology.

### *4.1 Presentation of the Technology Balance of Payment Data*

According to Mendy (2007), Technology Balance of Payments (TBP) "constitutes the only internationally comparable database on trade in disembodied technology" and their aim is "to provide an accurate measure of trade in technology, removing items without technological content". The OECD includes the following items in the TBP statistics: patents (purchases and sales); licenses for patents; know-how (unpatented knowledge); models and designs; trademarks (including franchising); technical services; finance of industrial R&D outside national territory. The OECD explicitly excludes from TBP: commercial, financial, managerial and legal assistance; advertising, insurance, transport; films, recordings, and material covered by copyright; design; software.

Technology receipts minus technology payments give the TBP. "*Technology receipts* depend on a country's R&D effort and also correspond to foreign sales of the marketable results of that effort". "Over 60% of such technology transfers in the major countries are between parent companies and affiliates". "*Technology payments* correspond to knowledge that is immediately useable by country's productive system as a technology input" (OECD, 2005; OECD, 2006).

As an indicator, "the technology balance of payments reflects a country's ability to sell its disembodied technology abroad and the extent to which it makes use of foreign technologies". Nonetheless, "the deficits / surpluses need to be carefully interpreted since they can reflect a wide range of factors including a country's degree of technological autonomy: its ability / inability to assimilate foreign technologies or its high / low levels of technology imports / exports". Ultimately, a country's technological development can "reflect the choice between domestic production of technology / inventions (via a high national R&D effort) or foreign absorption (via the acquisition of foreign technologies and the payment of licensing fees and royalties)." (Denis C. et al., 2006). Consequently a growing deficit does not necessarily indicate low competitiveness in technology. Finally, since most transactions correspond to operations between parent companies and affiliates, the valuation of the technology transfer may be distorted (Note 7). "Therefore, additional qualitative and quantitative information are needed to analyze correctly a country's deficit or surplus position" (OECD, 2006) as usual when considering balance of payments statistics.

The examination of the technological balance of payments of the US, Japan from 1993 to 2009 (Note 8) reveals that they have been constantly technology net exporters to the rest of the world. On the contrary the EU15's overall technological balance of payments used to be in persistent deficit since 1993. Nevertheless the situation changed, as Figure 2 shows it, and in 2006 the EU exhibited a surplus. This relies certainly on the performance of Northern European countries. Indeed Finland and Sweden increased highly their R&D spending as percentage of GDP and overtook Japan during the nineties.

Insert Figure 2 Here

Insert Table 2 Here

Table 2 presents TBP data for selected countries. Because of data non-availability, we do not have figures for the European Union as a whole. Moreover for some countries data are quite old (France for instance). In decreasing order the countries that record greatest surpluses are: the US, Japan, the UK, Germany, Sweden and Austria. The European countries exhibit contrasted situations but the ranking of European countries is not surprising as it fits in with GERD and BERD levels with the exception of the United Kingdom.

MNEs account for the greater part of international technology flows. Koopmann et al. (1999, p. 273) underline for example that "German companies with foreign subsidiaries in 1997 covered about three quarters of total receipts in manufacturing industry while nearly half of the corresponding payments were met by foreign controlled firms in Germany. In electronics the dominance of multinational corporations was almost complete". Nonetheless OECD data do not allow distinguishing between arm's-length and intra-group transfers of technology.

### *4.2 Geographical Patterns of Technology Payments*

The geographical patterns of technology balance of payments are interesting (Table 3). Concerning the first group of European countries, we can notice that they always register positive balance of payments, which means they export technology. Among countries that display greatest surpluses, the United-States collect more technological receipts from all countries with the exception of France in 2008. It is not possible to exploit Japanese and UK data because the geographical break down is not available for these countries.

Among European countries, Germany, Sweden and Austria are the main exporters of technology. Germany has a deficit with European Union (EU27) as a whole and the US. Sweden on the contrary displays a surplus with the EU27 but a deficit with the US. Austria has surpluses both with the EU27 and the US. Sweden and Germany are the best European performers in Asia. While Sweden exports more technology to non-OECD countries, Germany exports to Japan and Korea.

The second group of countries register more contrasted results. Indeed, for instance France registers a positive balance while it is not the case for Belgium from the 2nd group. Belgium shows a surplus with Ireland. (Ireland exhibits its greatest shortages with the US and OECD countries whereas it presents surpluses with European Union countries).

Portugal has an interesting characteristic as it collects great amount of technology receipts from Africa and the world while it is in deficit with European and OECD countries. It seems that trade of technology is influenced by historical and cultural links just like trade flows.

To sum up, technological trade balance results by group of countries seem to indicate some interesting correlations between the TBP and R&D spending. As we have just noticed it, surpluses or deficits can vary from a partner country to the other one. So, a country that invests heavily in R&D does not export systematically to all its partners. Similarly a country, which does not invest much in R&D, does not systematically import technology from all countries. To better understand what explains these results, it could be interesting to deepen the analysis by studying more exactly the correlations between exports and imports on the one hand and spending in R&D on the other hand.

Insert Table 3 Here

*4.3 Links between OECD Countries Technological Profiles and Trade in Technology*

Insert Figure 3 Here

Figure 3 clearly shows a positive correlation between R&D spending and exports of technology. Thus, the more a country invests in R&D, the more it exports technology. Nonetheless it is also noteworthy that the more a country invests in R&D the more it imports technology, with the exception of Ireland.

Insert Figure 4 Here

Figure 4 displays GERD, exports and imports of technology in percentage of the GDP. The aim is to reduce the country size effect. The figure allows us to find the three main categories of countries previously identified. European leaders such as Sweden, Finland, Denmark, are on the one hand among the most dynamic in terms of R&D and on the other hand also among the most important exporters of technology. Germany, and smaller countries like Austria, Belgium and the Netherlands (naturally more opened in terms of trade contrary to bigger countries), which record less good results in terms of R&D export also technology. On the contrary Japan, Korea and Chinese Taipei (Taiwan), export and import few technology while they are leaders in R&D. The United States also exhibits weak export and import ratios as percentage of GDP. This is quite logical and due to the size effect. It would be very instructive if we could obtain more data disaggregated by sector and by countries to better identify the determinants of such exchanges. Unfortunately, this type of data is not available.

For countries that import more technology than they export, we can note that most of the time, those countries register less spending in R&D (Italy, Poland and Hungary) with the exception of Switzerland and Singapore (see Table 4). Maybe, those countries import more to make up the weakness of their R&D spending.

Concerning atypical cases as Singapore and Ireland, Table 4 highlights their specific features. Indeed, these countries display strong export and import of technology ratios as percentage of GDP. It could reflect their strong openness to FDI. Maybe, FDI and more precisely MNF can be the source of these possible numerous technology exchanges. These MNCs are operating in Ireland or Singapore and can generate large flows of technology.

Insert Table 4 Here

Thesefirst statistical resultsallow us to realizethat there is probablya linkbetweentechnological profileand exchange in technology. However, ascan be seenfor example for Finland, Sweden and Denmark, those countries which are heavily involvedin R&D, are certainly concerned by an international division of labour within the global market knowledge within Europe. These countries are indeed both exporters and importers. Also, several tracks seem to emerge. What about these results at the sector level? Differences will certainly be noted. What are the determinants for these exchanges?

## 5. Conclusion

Several facts confirm the growing international trade in technology. Indeed firms are not only developing innovations internationally, they are also exploiting their innovations on world markets by licensing their technologies or by selling their innovations to foreign purchasers (Gassler & Nones, 2008). The balance of payments statistics reflect this tendency as the volume of transactions is increasing.

From a statistical point of view, it is not easy to highlight some European specificity because data for European Union as a whole are missing. Nonetheless thanks to the OECD data, it is possible to depict some particularities.

Considering the traditional input / output analysis of innovative activities, we notice first that GERD and BERD of the European Union lag behind those of Japan, the United States and OECD countries with the exception of Sweden and Finland. Second innovative performances as measured by patent triadic families seem to be a little bit smaller for EU. However innovative activities in Europe are more internationalised as co-inventions are particularly superior.

Technology balance of payments data allows us to expose some additional results. We notice that countries for which GERD as percentage of GDP are particularly high, always register positive balance of payments, which means they export technology. But one interesting result of this paper is that leaders countries in terms of R&D spending both export and import more technology than the countries that do not invest much in R&D.

To conclude, it is important to notice, that data are missing despite the efforts made by the OECD to collect data on trade in disembodied technology. For instance disaggregated data into affiliated and unaffiliated disembodied transfers of technology are really difficult to obtain. Yet more empirical studies at the firm level would be necessary to better understand the specificities of respectively arm's-length and intra-group transfers of technology. For instance, we could maybe better analysis Singapore and Ireland cases.

Furthermore, some characteristics seem to emerge to explain technological trade. It would be very interesting to deepen the analysis by examining the determinants of international technology trade in order to highlight their specificities.

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**Notes**

Note 1. For a definition of disembodied technology see Chang & Lee, 2006.

Note 2. According to Shih and Chang (2008), technology spreads internationally through two distinct kinds of spillovers: passive and active technology spillovers. *Passive technology spillovers* consist in the "implicit usage of the technological knowledge embodied in foreign intermediate goods for final-output production". A*ctive technology spillovers* are based on the "direct international learning or purchasing foreign technological knowledge involves the explicit usage of disembodied knowledge". On the contrary in this paper we will speak of *spillovers* to designate international diffusion of technology, which relies on externalities, and *transfers* of technology and knowledge will refer to the purchase of disembodied technology.

Note 3. According to Maskus (2003) p. 15, international technology transfers can flow through market and non-market mechanisms or otherwise by "formal" and "informal" channels. The "market channels of international technology transfers include: trade in goods and services, foreign direct investment, licensing, joint ventures, cross-border movement of personnel" The Non-market channels or "informal" channels through which knowledge and technology may flow are: "a) Imitation b) Departure of employees c) Data in patent applications and test data d) Temporary migration."

Note 4. OECD (2008), Compendium of patent statistics, p. 30.

Note 5. On the contrary hiring directly a new skilled employee is considered as an embodied flow of knowledge.

Note 6. Science, Technology and Industry Scoreboard 2011, Highlights, p. 12.

Note 7. For a discussion about TBP' limitations see: Mucchielli J-L., N. Avallone and S. Chédor (2009), "Global trade in knowledge, a survey of the literature", OECD, DSTI/IND/WPGI/ (2009)6, Working party on globalisation of industry, October 2009.

Note 8. Denis C., K. Mc Morrow and W. Röger (2006) present data from 1993 to 2003.

Table 1. Science and innovation profile of the main OECD countries, 2008

| Groups of European Countries * | Countries | RD expenditure (GERD) (% of GDP) | Business expenditure of RD (BERD) (% of GDP) | Triadic patents per million population | Patents with foreign Co-inventors |
|---|---|---|---|---|---|
| | Japan | 3,42 | 2,69 | | |
| | USA | 2,77 | 2,01 | | |
| 1st | Sweden | 3,75 | 2,78 | | |
| 1st | Finland | 3.49 | 2.77 | | |
| 1st | Denmark | 2.72 | 1.91 | | |
| 1st | Austria | 2.67 | 1.89 | | |
| 1st | Germany | 2,64 | 1.85 | | |
| 2nd | France | 2 | 1.27 | | |
| 2nd | Belgium | 1.92 | 1.32 | | |
| 2nd | UK | 1.88 | 1.10 | | |
| 3rd | Netherlands | 1.75 | 0.89 | | |
| 3rd | Slovenia | 1.66 | 1.63 | | |
| 3rd | Luxembourg | 1.62 | 1.32 | | |
| 3rd | Portugal | 1.51 | 0.76 | | |
| 3rd | Czech Republic | 1.47 | 0,91 | | |
| 3rd | Ireland | 1.43 | 0.93 | | |
| 3rd | Spain | 1.35 | 0.74 | | |
| 3rd | Italy | 1.18 | 0.60 | | |
| 3rd | Hungary | 1 | 0.53 | | |
| 3rd | Poland | 0.61 | 0.19 | | |
| 3rd | Greece | 0.58 | 0.1 | | |
| 3rd | Slovak Republic | 0.47 | 0.2 | | |
| | EU 27 | 1,81 | 1,13 | | 10,82 |
| | OECD | 2.33 | 1.63 | | 7,70 |

Interpretation:White colour means that observed country's performances are inferior to OECD average but superior to the EU27 average.

Grey colour indicates that performance of the observed country is inferior to EU27 average. < Inferior to EU27 average.

Bright colour indicates that performance in the observed country is superior to the one observed in OECD. > Superior to OECD average.

*Source:* OECD SCIENCE, TECHNOLOGY AND INDUSTRY OUTLOOK 2008. NB: S&E: Science and engineering.

*Note:* * The ranking is based on GERD as % of GDP.


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Table 2. Technology balance of payments for selected countries, 2008, Million of Euros

| Country / Area | Surplus (+) / Deficit (-) |
|---|---|
| **United States**[1] | 44 182 |
| **Japan**[2] | 10 988 |
| **United Kingdom** | 9 993 |
| **Germany** | 6 160 |
| **Sweden** | 3 797 |
| **Austria** | 2181 |
| **France**[3] | 1732 |
| **Finland** | 852 |
| **Italia** | 374 |
| **Czech Republic** | 102 |
| **Portugal** | 66 |
| **Slovak Republic**[4] | -214 |
| **Greece** | -392 |
| **Ireland** | -470 |
| **Hungary** | -690 |
| **Poland** | -1 254 |
| **Belgium** | -1 801 |

*Source:* Main Science and Technology indicators, 2010, OECD.

*Note:*[1] Royalties and licence fees, [2] 2007, [3] 2003, [4] 2005.

Table 3. Technology balance of payments by main partner zone/country, 2008*, million of EUR

| **Groups of European countries** | | | **1st** | **1st** | **1st** | **2d** | **2d** | **3d** | **3d** | **3d** | **3d** | **3d** | **3d** | **3d** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Partner zone or country** | **Japan** | **USA** [b] | **Sweden** | **Austria** | **Germany** | **France** | **Belgium** | **Italy** [a] | **Czech Rep.** | **Portugal** | **Greece** | **Hungary** | **Slovak Republic** | **Ireland** |
| AFRICA | | | 662 | | 511 | | | | | 173 | | | | 496 |
| Austria | | | | | -794 | | | | | 4 | | | -29 | |
| Belgium-Luxembourg | | | 225 | | | | -140[c] | 264 | 15 | 5 | | 180 | 5 | 752 |
| Canada | | 3 557 | | | | 61 | | | | | | | | |
| China | | | 342 | 149 | 647 | | | 42 | | | | | | |
| Czech Republic | | | | | | | | | | | | | -108 | |
| Denmark | | | | | | | | -23 | | 8 | | | | |
| EUROPEAN UNION (27)[$] | 1 527 | 20 501 | 787 | 835 | -399 | 218 | -653 | -162 | -97 | -115 | -355 | -49 | -112 | 8194 |
| Finland | | | | | | | | | 11 | | | | | |
| France | | -345 | 1 018 | | -369 | | -143 | -320 | -103 | 4 | -23 | 37 | -7 | 2215 |
| Germany | | 3 413 | -292 | 721 | | | -146 | 163 | -49 | -59 | -46 | -369 | -52 | |
| Greece | | | | | | | | | | | | | | |
| Hungary | | | | | 429 | | | | 14 | -14 | | | -6 | |
| Ireland | | | | | -974 | 78 | 130 | -26 | | -38 | | | | |
| Israel | | | | | | | | | | | | | | 159 |
| Italy | | | | | | 97 | -183 | | | 15 | -37 | | | -32 |
| Japan | | | | | 1017 | 255 | -138 | | -84 | | | 85 | | |
| Korea | | 2 155 | | | 304 | | | | | | | -83 | | |
| Mexico | | | | | 487 | | | | | | | | | |
| Netherlands | | | | | | 54 | -222 | 48 | 39 | 21 | -78 | | -9 | 1390 |
| MIDDLE EAST | 198 | | 1 022 | 198 | 363 | | | | | 6 | | | | |
| NON-OECD ASIA | | 5 730 | 1 838 | 213 | 874 | 68 | | | 12 | -7 | | 58 | | |
| Norway | | | | | | | | | | 3 | | | | 415 |
| OECD (30) | | | 1 021 | 1 165 | 2617 | 646 | -2389 | | -123 | -115 | -348 | -340 | | -1194 |
| Poland | | | | 128 | | | | 40 | 10 | | | | 2 | 465 |
| Portugal | | | | | | | | | | | | 52 | | |
| Russia | | | | 147 | 377 | | | | 150 | | | | | |
| Singapore | | 2 111 | | | | | | | | | | | | |
| Slovak Rep. | | | | | | | | | 61 | | | | | |
| SOUTH AMERICA | 334 | 2 336 [e] | | | 1052 | | | | | | | | | |
| Spain | | | | | 676 | 130 | | 17 | | -47 | | 116 | | |
| Sweden | | | | | | -348 | | | | -18 | | 57 | | |
| Switzerland | | 3 762 | 709 | 304 | 2118 | -54 | -97 | -106 | 12 | -19 | | | | 850 |
| Turkey | | | | | | | | | | | 21 | | | 192 |
| United Kingdom | | 3 927 | | -478 | -734 | 127 | -218 | -303 | -50 | -5 | -106 | | -16 | |
| United States | 3 517 [d] | | -469 | 104 | -1029 | | -1049 | -24 | 47 | 15 | -51 | -277 | 6 | -11208 |
| WORLD | 10 988 | 44 182 | 3797 | 2 181 | 6160 | 1732 | -1801 | 374 | 102 | 66 | -392 | -690 | -214 | -470 |

*Note:* * Except for Japan, Sweden: 2007, Slovak Republic: 2005, and France: 2003. $Europe for Japan, EU 25 for Sweden and the US. Data are not available for the UK and Finland.15 For France, Poland and Slovak Republic. [a] Figures for OECD (30) non available. [b] US Royalties and licence fees. [c] Luxembourg. [d] North America. [e] South and Central America.

Table 4. Export, import and spending in R&D for Ireland and Singapore, 2009*, in percentage of GDP

| | **Export/gdp** | **Rd/gdp** | **Import/gdp** |
|---|---|---|---|
| **Ireland** | 16,6 | 1,7 | 18,9 |
| **Singapore** | 3,2 | 2,3 | 9,3 |

Table 5. Technology balance of payments for selected countries, 2009, Million of Dollars

| Countries | Surplus (+) / Deficit (-) |
|---|---|
| **United States** | 33249,0 |
| **United Kingdom** | 19005,5 |
| **Japan** | 15821,6 |
| **Germany** | 8729,7 |
| **Sweden** | 6946,0 |
| **Netherlands** | 3504,2 |
| **Norway** | 3355,7 |
| **Austria** | 2767,3 |
| **Denmark** | 1730,3 |
| **Belgium** | 1029,4 |
| **Finland** | 440,5 |
| **Portugal** | 135,8 |
| **Romania** | -57,1 |
| **Spain** | -92,6 |
| **Luxembourg** | -289,0 |
| **Slovenia** | -315,8 |
| **Slovak Republic** | -359,7 |
| **Greece** | -606,0 |
| **Russian Federation** | -965,6 |
| **Poland** | -1510,4 |
| **South Africa** | -1595,0 |
| **Mexico** | -1945,6 |
| **Chinese Taipei** | -2316,8 |
| **Switzerland** | -2484,1 |
| **Korea** | -4856,2 |
| **Ireland** | -5056,7 |
| **Italy** | -5405,8 |
| **Singapore** | -11151,0 |

*Source:* Main Science and Technology indicators, 2011, OECD.

*Note:* [1] Royalties and licence fees, [2] 2007, [3] 2003, [4] 2005.

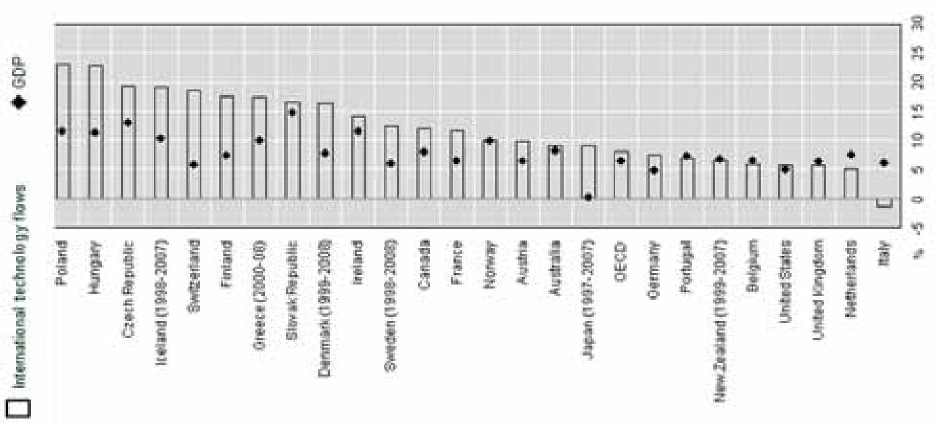


Figure 1. International technology flows* (royalties and license fees), 1997-2008, Average annual growth rate, based on USD, percentage

*Source:* OECD, Technology Balance of Payments Database, December 2009; and OECD, Trade in Services Database, December 2009.

*Note:* * Technology flows refer to the average of technological payments and receipts. Measuring innovation: a new perspective, OECD p. 106.

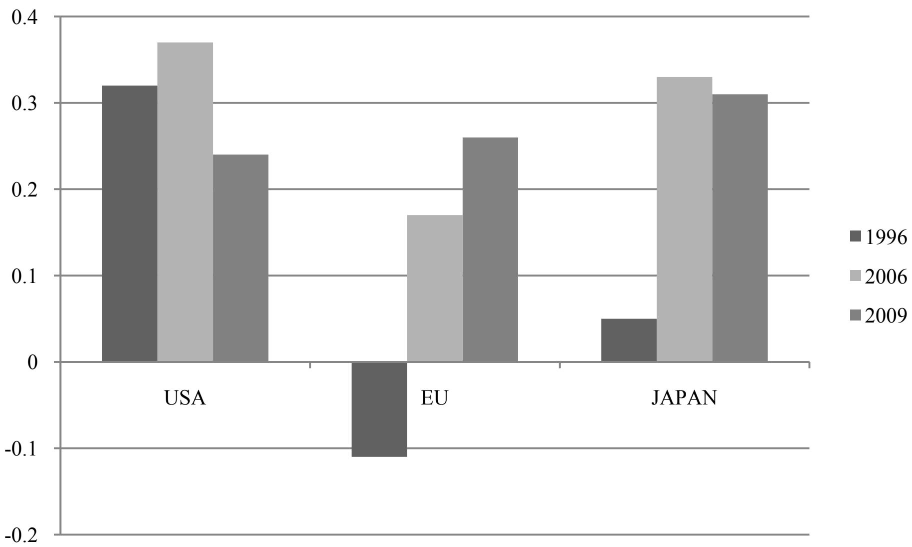


Figure 2. Technology Balance of Payments (1996, 2006, 2009), % of GDP*

*Source:* OECD Science, Technology and Industry Scoreboard 2009 for 1996 and 2006. For 2009, estimations calculated by the authors from MSTI OECD 2011.

*Note:* * For EU15, data include intra-area flows andare partially estimated (excluding France in 2009; Denmark and Greece in 1996, 2006).

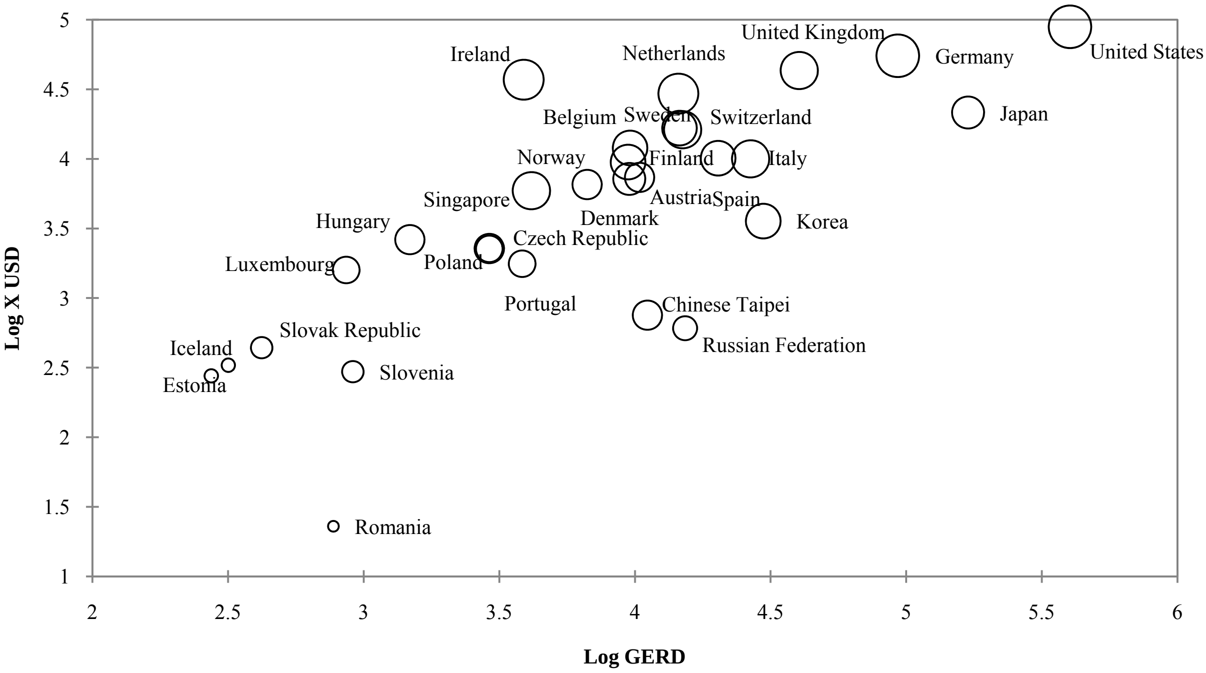


Figure 3. GERD (X axis), exports (Y axis) and imports (size of circle) of technology, million USD, 2009

*Note*: * Log-Log data.

*Source:* MSTI OCDE 2011.

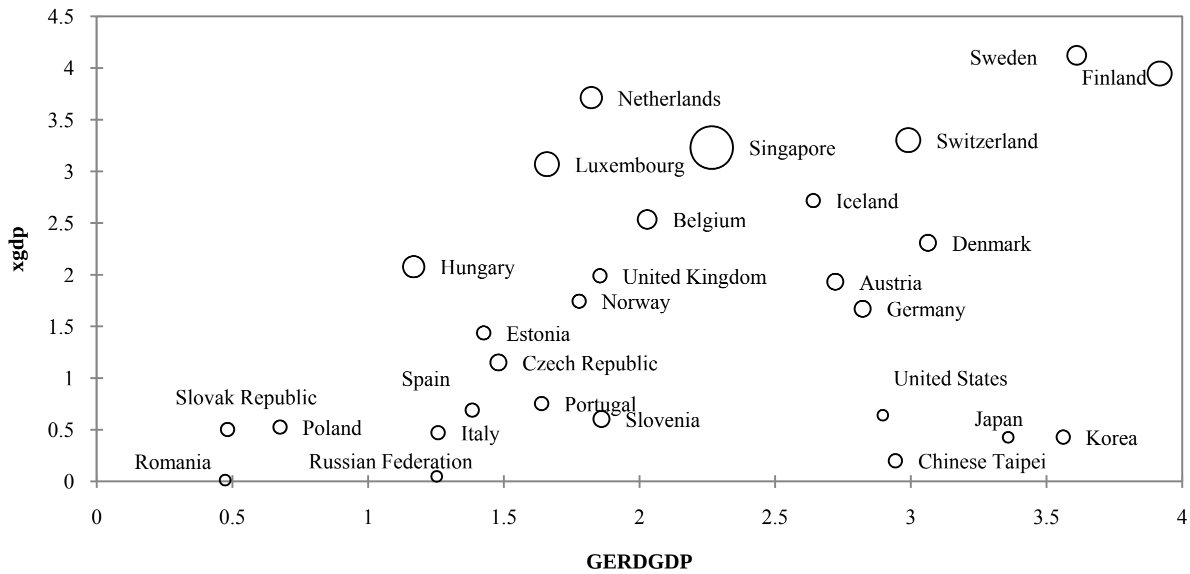


Figure 4. R&D (GERDGDP), export (xgdp) and import (mgdp, size of circle) of technology in % of GDP, 2009

*Source:* MSTI OCDE 2011.