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Trends in technology services trade: a cross-country analysis

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Deliverable 1.1.1

Trends in technology services trade: a cross-country analysis

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This report is based on unpublished data on the Technology Balance of Payments made available to us by the OECD. I am very grateful to Isabelle Desnoyers-James (OECD - STI) for sending us this data. I would also like to thank Yong Yang for assisting in the data manipulation and analysis. Any errors of analysis are my own.

Abstract:

Although the growth in technology services trade has been widely noted, there is very little systematic analysis of its components or characteristics to guide European policy. In this report, we analyse unpublished data collated by the OECD to show that new member states and smaller EU countries have been the most active participants in the growth of trade in disembodied technology although the larger shares of this trade belong to old EU member states such as Germany, France and the UK. We also show that the sectors of origin associated with technology receipts and payments differ from country to country although some 'globalised industries' such as chemicals and non-electrical machinery are also dominant in the trade of many countries.

The dominant form of technology transfer associated with trade differs considerably between member states. Countries like the UK, France and the US which have long established IPR systems draw a greater proportion of technology receipts and payments from the receipt and payments of royalty and licensing revenues. Countries with weaker IPR regimes and with strong manufacturing sectors appear to depend more on the trade in technology related services. Countries with poor contract enforcement and weak IPR regimes (such as many new member states) also show a greater preference for trade in technology assets.

Direction of trade data reveals that Europe is the dominant trading destination for most European countries but countries with large volumes of patented technology like France and Germany trade somewhat less with the EU. Taken together, these findings suggest that the absence of a harmonised IPR may not be a large deterrent to technology trade in Europe perhaps due to shared norms about scientific research and its value to society and since nations have adapted to differences in IPR by choosing the form of technology transfer that mitigates the harmful consequences of poor environments for appropriability. However, for countries that are closer to the technological frontier (e.g. France Germany and the UK) and have a long history of IPR, lack of clarity on IPR may prove a barrier to increasing technology trade with other EU countries.

Trends in technology services trade: a cross-country analysis

Although the growth in technology services trade has been widely noted, there is very little systematic analysis of its components or characteristics to guide European policy. Thus we know very little about the various components of technology trade such as the importance of outsourcing of technical services, R&D abroad and the trade in licensing; if the trends in their growth differ much across nations and the industrial sectors most likely to originate this trade. There is also speculation about whether Europe is maximising its potential in technology trade. In particular there is anxiety that the lack of a unified IPR is holding back the growth of technology trade within the EU. This report aims to address in a preliminary way answers to these questions.

Data on international trade in technology services are recorded as part of the trade in services in the balance of payments of every country. Norms of reporting on these items have been harmonised since 1996 with the publication of the BOP Manual V.5 by the IMF. [1] Cross country data on trade in technology services have been collected in two publicly available databases viz. the World Development Indicators (WDI) and the OECD's Technology Balance of Payments. The WDI collates information on royalty and licensing fees across a broad grouping of developed and developing countries and since data on royalty and license fees have been collected for a long time the data are available for a long period of time. The OECD's technology balance of payments on the other hand has a smaller coverage (of OECD countries) but reports on a wider range of traded technology services. Thus the OECD defines trade in technology as comprising four main categories—the transfer of techniques (through sale of patents and licences, disclosure of know-how), through transfer (sale, licensing, franchising) of designs, trademarks and patterns, through trade in services with a technical content, including technical and engineering studies, as well as technical assistance and through industrial R&D services. The data sources used by the OECD are the same as that for the WDI, viz. the Balance of payments.[2] Since a large proportion of technology originates and is traded between OECD countries and because our interest is in analysing Europe's position in technology services trade, in this report we will explore published and unpublished data from the OECD's independently constructed Technology Balance of Payments.

Using unpublished OECD data on countries technology trade, we detail the extent of growth in technology trade amongst OECD countries and the position of EU countries in this trade. We detail the most important industries of origin associated with technology services trade

[1] This manual is publicly available and downloadable from http://www.imf.org/external/pubs/ft/bopman/bopman.pdf (last accessed 12 Nov. 09)
[2] See Appendix 1 for a full listing of the BOP data sources by country.

in the OECD countries and establish the heterogeneity in the use of different types of technology transfers by EU member states compared with the US and Japan Lastly, we analyse the available direction of trade data broadly to discuss the extent of technology trade within the EU and its most important technology partners.

1. Technology services trade and the European Union

In a globalised world countries need not depend only upon their own resources to acquire the technologies they need for production. The resources that can be acquired through trade relate to technology blueprints, patents, the right to use patents and various kinds of technical services. The tacit nature of technology has historically favoured the success of technology transfer that is embedded in particular people and the migration of key personnel in the successful technology transfer from Europe to the US has been noted by economic historians such as Rosenberg. Barriers to the movement of scientific people have made this type of technology transfer less common in the post-WW2 period. However a very well known corollary of free trade is that goods and services will move to compensate for the relative immobility of labour services. Thus, since the 1990s, large MNEs have also started to locate their R&D centres in countries with an abundance of technical labour and import R&D services from these regions. At the same time entrepreneurial activities have uncovered the provision of technical services as an important niche area of export for nations with scientifically trained personnel.

OECD data on the technology balance of payments collates information on internationally traded transfers of disembodied technology in the form of intangible asset purchase, sales and use, and also trade in technical and R&D services. We would expect countries who are technology leaders to be the big exporters and also smaller countries to depend on exports to commercialise their technologies on a larger scale. TBP data show that in 2006, the US was the largest recipient of technology earnings ($75094 million) followed by Germany and the UK who earned $36669 million and 32,069 million respectively. Japanese receipts stood at $20449 million and were the fifth largest. The total technology payments reported in OECD (2009) give some idea of the size of the market for disembodied technology trade. While US has the largest single market (its payments were $43780 million in 2006), the EU-27 region as a whole appears to be a larger market for technology trade than either the US or Japan. Technology payments by the UK and Germany alone stood at $ 48467 million.[3]

Who is likely to be most dependent on technology imports through internationalisation? Certainly we expect countries that are well behind the technological frontier to be big importers. However, small countries at the technological frontier are also likely to

[3] These rankings are based on estimates for 2006 reported in OECD (2009), Table 70.

participate in technology imports because their relatively smaller populations mean that they are more likely to run out of technically trained people.

Table 1 below confirms these intuitions. It reports on the 10 largest countries in terms of the ratio of International Technology payments to Domestic expenditures on R&D. We find that all ten are EU member states and that Ireland imports almost 10 times its own expenditure on R&D and some new member states of the EU are also add to their R&D capacity by substantial imports of technology. However, countries like Belgium, Luxembourg and Finland are countries with small populations. The absolute value of technology payments is the largest for the US, followed by Germany Ireland and the United Kingdom. However, these countries also have larger R&D expenditures so that their international technology payments to domestic R&D ratio are much lower. For the USA this ratio is 13.3% while for Germany and the UK it 45.5% and 35.4% respectively. Thus, it is clear that the internationalisation of innovation through trade has benefitted Europe and in particular helped smaller countries and helping technologically laggard nations to catch-up by supplementing domestic R&D effort.

Table 1: Technology balance of payments: Payments as a % of Gross domestic expenditure on R&D, 2006

Country	Payments as % of GERD
Ireland	981.5
Hungary	237.9
Slovak Republic	214.6
Luxembourg	173.7
Poland	135.1
Czech Republic	82.1
Belgium	81.9
Finland	67.9
Portugal	62.3
Greece	58.4

Source: OECD (2009), Table 71

The rate of growth of international technology trade has been uneven across countries. Based on unpublished disaggregated data available with the OECD we compute the annual average rates of growth of technology receipts and payments and report these in Table 2 below. Some new member states such as Poland, Slovak Republic, Czech Republic and Hungary show very high rates of growth of technology receipts (exports). Small countries like Finland Switzerland, Norway and Sweden show the greatest growth of technology imports. However, it is well known that average rates of growth are inversely related to the base that one starts from. Countries like Germany, UK and the US –which have large market shares and volume of technology trade -- show only modest rates of growth.

Table 2: Annual average rate of growth of technology receipts and payments (%)

Country	Period	Total Receipts	Total Payments
Poland	2000-2007	24.4	11.1
Slovak republic	1998-2006	18.1	11.3
Czech Republic	1997-2008	17.5	12.9
Hungary	2004-2007	17.3	9.7
Portugal	1996-2007	15.9	5.3
Norway	1988-2007	15.1	11.8
Sweden	1998-2007	14.0	8.7
Finland	1999-2008	13.6	20.4
Austria	1995-2008	13.4	8.7
Spain	1996-2007	13.0	9.6
Ireland	2003-2007	11.7	5.9
Germany	1986-2008	11.1	9.7
Japan	1981-2008	10.3	3.8
USA	2001-2007	8.9	14.5
France	1981-2003	8.2	5.6
Australia	1999-2007	8.2	7.4
Switzerland	1985-2007	7.9	16.1
Belgium	1996-2007	6.8	9.1
UK	1996-2007	6.8	5.1
Italy	1992-2008	3.4	1.3
Greece	1998-2007	-0.2	7.0

Source: Author's computations from unpublished OECD data

2. Industrial concentration of technology trade

The unpublished OECD data also contain details about the breakdown of technology receipts and payments by industries of origin, although these data are available only for six countries and at a very high level of aggregation (two-digit industrial classification).

One question of interest is to what extent the growth in technology trade reflects 'new economy' activities and globalisation in the non-manufacturing sector. Non-manufacturing activities that could be important are the growth of data mining and trade in databases in the Finance and the Publishing industrial sectors, and the spread of new activities like business services, franchising, and the growth of the gaming industry. Table 3 below reports on the share of manufacturing in technology trade activities- first for payments and then receipts. Manufacturing accounted for large percentage of technology payments in all countries we have data from the OECD for except Belgium. In Belgium payments on account of Banking, Insurance and Real Estate and Transport, Communications and Services

Table 3: Concentration of technology trade in manufacturing, 2006 (%)

Country	% share of manufacturing in technology trade	CR5 ratio of manufacturing concentration in technology trade	Largest five manufacturing sectors in technology trade
Technology Payments			
Austria	58.7	95.5	Wood, paper, printing, publishing; chemical products; motor vehicles; non-electrical machinery n.e.c.; food beverages, tobacco
Belgium	17.9	74.9	Chemical products; Non-electrical machinery n.e.c.; Textiles, apparel, fur and leather ;Office and computing machinery; Basic metals
Czech Republic	62.1	74.1	Motor vehicles; Radio, TV and communication equipment; Non-electrical machinery n.e.c.; Rubber, plastics; Food, beverages, tobacco
Germany	57.0	77.6	Motor vehicles; Chemical products; Other transport equipment; Electrical machinery; Radio, TV and communication equipment
Italy	67.1	64.6	Office and computing machinery; Chemical products; Non-electrical machinery n.e.c.; Petroleum, nuclear fuel; Textiles, apparel, fur, leather
Japan	90.4	31.6	Chemical products; Non-electrical machinery n.e.c.; Non-metallic mineral products; Electrical machinery; Furniture and other manufacturing industries n.e.c.
Technology Receipts			
Austria	24.7	90.0	Chemical products; Wood, paper, printing, publishing; non-electrical machinery; non-metallic mineral products; furniture and other manufacturing industries
Belgium	15.9	97.3	Chemical products; Electrical machinery; Office and computing machinery; Motor vehicles; Fabricated metal products (excl. Machinery)
Czech Republic	26.5	84.6	Motor vehicles; Non-electrical machinery n.e.c.; Radio, TV and communication equipment; Chemical products; other transport equipment
Germany	56.9	76.7	Chemical products; Motor vehicles; Electrical machinery; Other transport equipment; Radio, TV and communication equipment
Italy	65.8	62.9	Petroleum, nuclear fuel; Non-electrical machinery n.e.c.; Office and computing machinery; Chemical products; Textiles, apparel, fur, leather
Japan	97.6	80.3	Motor vehicles; Chemical products; Non-electrical machinery n.e.c.; Electrical machinery; rubber and plastics

Source: Author's computations from unpublished OECD data

far exceeded the share of manufacturing. In the case of technology receipts, we find that the share of manufacturing activities in technology receipts was low for Austria, Belgium and Czech Republic. In all three countries technology receipts by the Banking, Insurance and Real Estate sectors comprised a large share of total receipts.

Next we look at the manufacturing sectors that technology trade is concentrated in. The third column of Table 3 reports the CR5 concentration ratio of technology exports (imports) in manufacturing.[4] The large values of the CR5 ratio in both technology payments and receipts in all countries suggested technology trade is concentrated only in a few sectors. The one exception is the case of Japan where payments appear to be quite spread out over many industrial sectors.

The fourth column specifies the five largest manufacturing sectors for each country that we have data for. Sectors are reported in decreasing order of importance. We see that the manufacturing sectors that dominate technology trade are different from country to country although Chemical products, computer and office machinery and non-electrical machinery appear to be fairly globalised in terms of technology trade.

3. Cross country heterogeneity in the type of technology transfer

Technology trade can take different forms and one advantage of the OECD data which we also noted earlier is that it provides a fine breakdown of different kinds of disembodied technology trade. Thus the OECD data allow us to distinguish between the outright sale and purchase of patents, receipts and payment of royalty and license fees for the use of intangible assets, trade in technology related services and receipts and payments on account of R&D services. The form of technology trade chosen may depend upon characteristics of the technology (the extent to which tacit knowledge and continuous monitoring or customisation are important) and also on the institutional environment surrounding appropriability viz. the tightness of IPR.

Figure 1 below shows the percentage share of each type of technology trade in the total technology receipts of countries for whom we have the unpublished data available.[5] The form of technology trade preferred is quite different across countries. In the case of France, UK and US, the largest proportion of technology receipts is on account of royalty and license fees due to the out-licensing of technology and other intangible assets. Hungary, Sweden and Finland also use this form of transfer quite extensively in their receipts. However, for most of the EU countries receipts on account of technology related services are the biggest

[4] The CR5 ratio measures the export (import) of the largest five manufacturing sectors as a share of all technology exports (imports) from the manufacturing sector.

[5] We ignore the purchase and sale of patents here because the data on them are not consistently available for all countries.

component of technology receipts. R&D carried out abroad is a relatively small proportion of technology receipts in all cases.

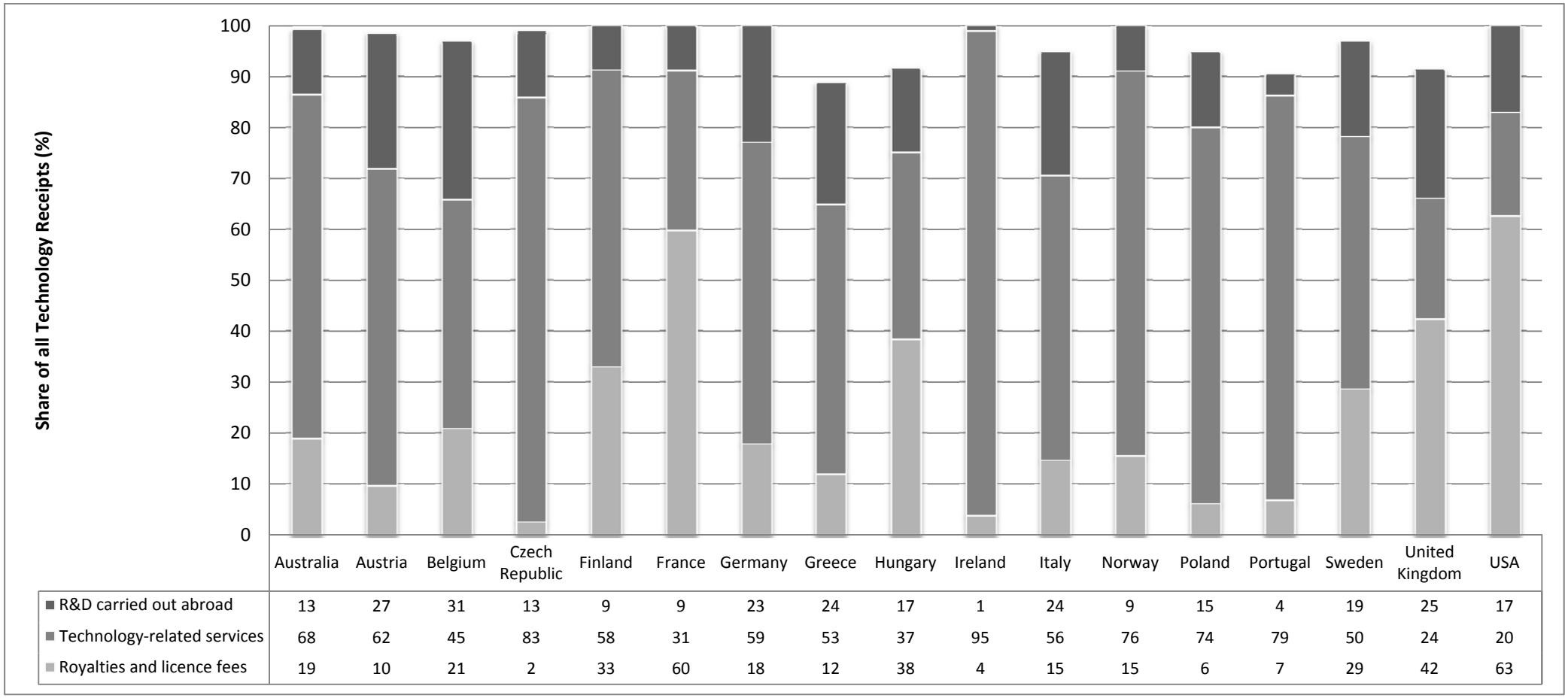
Figure 2 shows the importance of the different types of transfer in technology payments. Here too we find that UK, France and the US prefer to trade in royalty and licensing fees. We also find that for Ireland, Hungary, Greece and Australia technology transfer through royalty and licensing fee payments (in-licensing) is the largest item on their international technology payments. For the other EU countries technology related services dominate in payments. Outsourcing of R&D (captured by technology payments made on account of R&D services rendered abroad) is very high for Finland and Sweden followed by Belgium, UK, and the USA.

The reasons for this heterogeneity in the form of traded technology could be many. It may simply reflect the underlying characteristics of the technologies being traded. More tacit technologies are likely to be traded as technology related services or customised R&D services. The institutional environment may also play a role by influencing the appropriability conditions of technology. Licensing is profitable only in the face of tight IPRs which can be enforced reasonably quickly. Technology related services may depend less upon intellectual property changing hands as in the sale and purchase of technological services the intellectual property always belongs to the buyer of the service.

Table 4 reports on the annual average rates of growth of each type of technology transfer. As in the case of Table 2 new member states like Poland Hungary, the Czech Republic and the Slovak republic show very high rates of growth of some components. Particularly interesting is the finding that they appear to show a rapid growth in the purchase and sales of patents when compared to other categories. This may simply be a reflection of the small base from which they started out. But the dominance of purchase and sale of intangible technological assets in economies known to have weak property rights regimes also suggests that trading in technology related services is not the only response to the presence of weak IPRs. Inventors located in such countries may prefer to trade in the asset (patent) rather than the incomes from it (licensing).

More generally, the evidence we have presented suggests that the form of technology transfer that dominates bears relation to the environmental conditions in which the technology trade occurs and also the industry composition of technology trade (e.g. the large role of technology related services in the case of Germany is attributable to its industry characteristics). Nations have found the means to overcome constraints due to poor appropriability by evolving forms of technology transfer that mitigate the problem. Put differently, if there is technology to be exchanged then IPR alone doesn't seem to be a barrier. Shared (European) norms on scientific research and its rewards, the relative proximity of countries and peoples may also play a part. These conclusions however, need to be subject to more controlled and rigorous testing using the appropriate statistical tools. Work on this is currently underway.

Figure 1: Relative importance of the different components of the TBP: Receipts

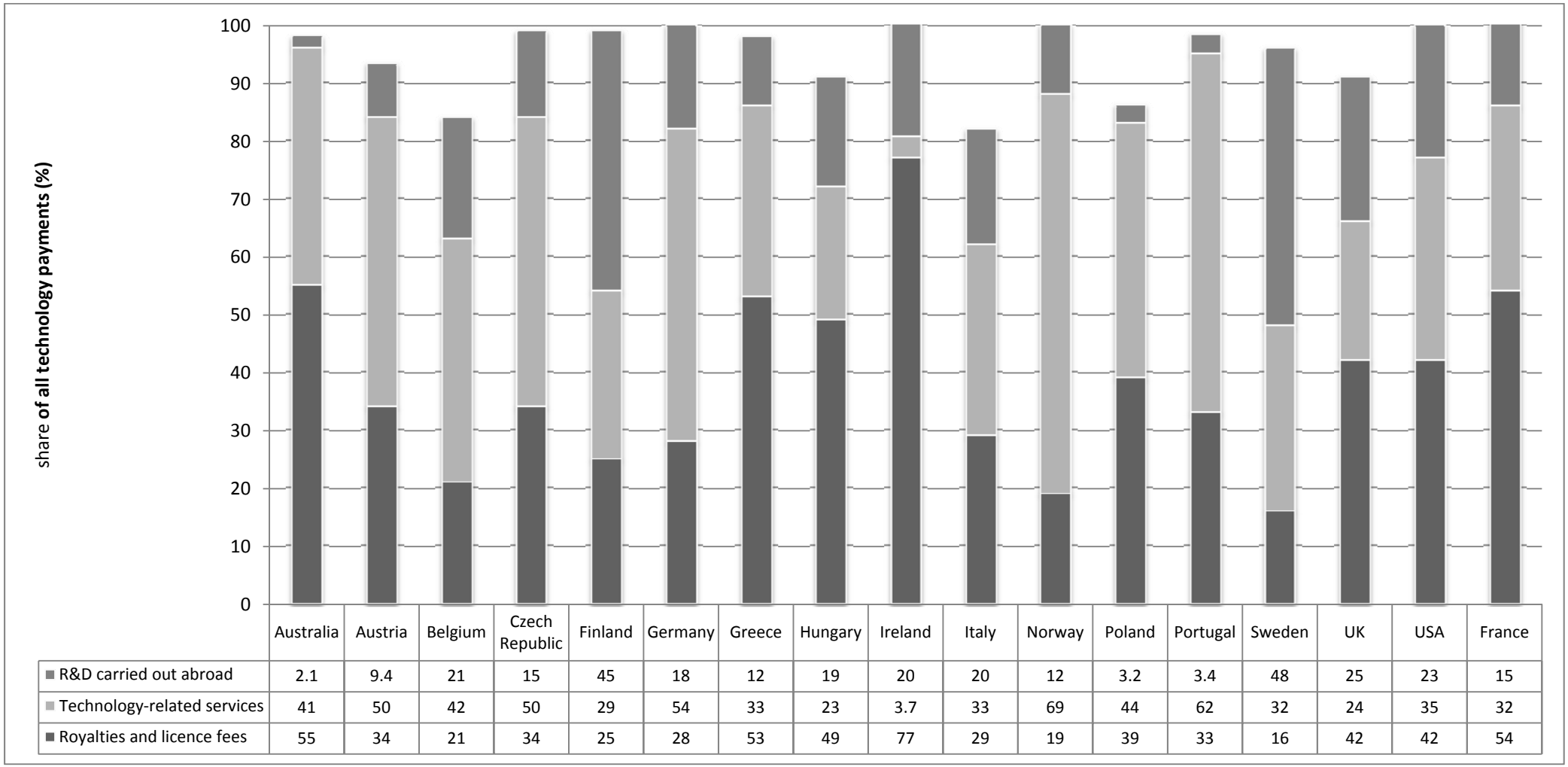


	Australia	Austria	Belgium	Czech Republic	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Norway	Poland	Portugal	Sweden	United Kingdom	USA
R&D carried out abroad	13	27	31	13	9	9	23	24	17	1	24	9	15	4	19	25	17
Technology-related services	68	62	45	83	58	31	59	53	37	95	56	76	74	79	50	24	20
Royalties and licence fees	19	10	21	2	33	60	18	12	38	4	15	15	6	7	29	42	63

Source: Author's computation from unpublished OECD data.

Notes: Purchase and sale of patents has been left out since data on this are not consistently available. Data for France pertain to 2003.

Figure 2: Relative importance of the different components of the TBP: Payments



	Australia	Austria	Belgium	Czech Republic	Finland	Germany	Greece	Hungary	Ireland	Italy	Norway	Poland	Portugal	Sweden	UK	USA	France
R&D carried out abroad	2.1	9.4	21	15	45	18	12	19	20	20	12	3.2	3.4	48	25	23	15
Technology-related services	41	50	42	50	29	54	33	23	3.7	33	69	44	62	32	24	35	32
Royalties and licence fees	55	34	21	34	25	28	53	49	77	29	19	39	33	16	42	42	54

Source: Author's computation from unpublished OECD data.

Notes: Purchase and sale of patents has been left out since data on this are not consistently available. Data for France pertain to 2003.

Table 4: Annual average rate of growth of technology receipts and payments (%)

		Technology Receipts				Technology Payments			
Country	Period	Sales of inventions	Royalty & License Fees	Technology Related Services	R&D Abroad	Purchases of inventions	Royalty & License Fees	Technology Related Services	R&D Abroad
Australia	1999-2007		4.3	9.5	9.8		6.2	10.3	0.6
Austria	1995-2008		13.5	12.2	17		7.5	7.7	13.8
Belgium	1996-2007	16.2	7.4	5.2	8.5	32.0	3.4	8.3	14.1
Czech Republic	1997-2008	24.6	-1.2	19.0	19.9	15.6	14.4	10.3	27.8
Finland	1999-2008		5.2	16.2	11.3		14.7	9.7	48.6
France	1981-2003		9.3	9.1	2.4		3.3	6.9	7.3
Germany	1986-2008		7.1	14.6	8.7		4.9	14.7	8.8
Greece	1998-2007	50.7	22.8	-5.7	16.4	31.7	13.0	-0.3	31.9
Hungary	2004-2007	81.7	12.6	19.3	13.5	21.7	11.8	11.7	0.5
Ireland	2003-2007		35.8	11.5	-4.5		4.0	14.0	14.2
Italy	1992-2008	5.2	5.1	1.4	10.9	-4.5	-4.8	-2.1	3.8
Norway	1988-2007		10.8	16.5	16.1		6.4	14.6	14.7
Poland	2000-2007	98.6	8.7	24.9	30.1	47.2	7.5	10.6	14.2
Portugal	1996-2007	29.9	14.4	15.6	10.3	11.0	4.5	5.8	4.2
Slovak republic	1998-2006	17.4	18.3	19.0	10.3	38.1	4.9	12.8	6.2
Spain	1996-2007	6.6	7.5	na	na	16.7	6.9	na	na
Sweden	1998-2007	1.4	13.2	13.7	23.0	6.8	4.7	2.5	23.5
Switzerland	1985-2007	na	na	na	na	na	na	na	na
UK	1996-2007	25.9	5.1	4.4	12.0	29.2	1.3	7.5	9.4
USA	2001-2007	na	4.1	na	11.8	na	3.2	na	24.8

Source: Author's computations from unpublished OECD data. Figures for France pertain to 2003.

4. The direction of trade

The OECD also collects data on the direction of disembodied technology trade, although these data are available for some countries and not for others. We would expect the EU area to provide a strong impetus to technology trading because the technological abilities of nations in the area are quite different but being in a single market there may be other (specialisation) advantages to such trade. Some confirmation of this tendency can be found in the Table 3 presented earlier where we saw that industrial concentration of trade was high but the industries involved were subtly different. Also of interest is the issue of whether North America and Japan are still important trading partners to individual member states.

Table 5: Direction of trade—Technology receipts

	Region of trade (shares in %)					
Country (year)	North America	EU(15)	EU(25)	Japan	Asia	Others
Australia(2007)	33.4	12.7		1.9	0.2	51.8
Austria(2006)	6.6	56.7		0.3	0.8	35.6
Belgium(2007)	17	68.8		1	0.4	12.9
Czech Republic(2007)	11.4	49.4		0.2	0	38.9
France(2002)	38.7	39.5		8.8	0.4	12.6
Germany(2007)	21.7	38		3.8	1	35.6
Greece(2007)	10.5	51.5		0.3	0	37.7
Hungary (2007)	11.7	56.8		16.1	1.3	14.1
Ireland (2006)		67.5				32.5
Italy (2007)		49.2		1.2		49.5
Japan(2006)	46				2.6	51.5
Poland(2007)	15.9	66.8		0.1	0.1	17.1
Slovak Republic(2005)	19.1	45.1		0.1	0	35.7
Sweden(2007)	18.6	37.6		1.5	0.8	41.4
USA(2006)	10		42.4	13.2	3.3	31.1

We report on the direction of trade for different countries considering technology receipts in Table 5 and technology payments in Table 6. We report the data by five large regions (North America, Europe, Japan, Asia and others) and use the latest available estimates for each country where data are available. Table 5 reveals that except for Japan and Australia, the EU is an important destination for technology exports of all EU Member Countries. America also exports the largest amount of technology to the Europe. For some of the EU member states such as Greece Italy, Poland, Austria and Belgium, the EU provides the largest export markets for their technology. For other EU countries such as France, Germany, Sweden and also UK (figures reported in deliverable 1.2), North America are also an important market for technology exports. Technology exports to Japan are on a much smaller scale although Japan and the US make substantial exports to each other.

Table 6: Direction of trade—technology payments

	Region of trade (shares in %)					
Region	North America	EU(15)	EU(25)	Japan	Asia	Others
Australia(2007)	46.5	19.4		7.6	0.5	26
Austria(2006)	4.6	74.4		0.6	0.1	20.3
Belgium(2007)	22.6	66.3		2.4	0	8.6
Czech Republic(2007)	7	70.3		6.2	0	16.5
France(2003)	45.6	43.8		2.8	0	7.8
Germany(2007)	26.1	49.7		1.8	0.2	22.3
Greece(2007)	9.9	73.4		0.1	0	16.5
Hungary(2007)	19.7	49.7		5.9	3.3	21.4
Ireland(2007)		28.2				71.8
Italy(2007)		65.3		1		33.6
Japan(2007)	71.8					28.2
Poland(2007)	13.3	70.6		1.5	0.3	14.4
Slovak Republic(2005)	7	49		0.7	0	43.2
Sweden(2007)	35.5	48		1.7	0.2	14.5
USA(2006)	3.8		44.4	29.5	0.2	22

For tables 5 and 6:

Source: Author's computations from unpublished OECD data.

Notes: The year in parentheses represents the latest year for which direction of trade data were available.

The patterns in the direction of trade described for technology receipts are repeated in the case of technology payments (Table 6 above).

As noted earlier a much debated issue is whether a unified IPR policy across the EU would increase the volume of technology trade within the EU region. We have not analysed the data systematically to answer this question but our descriptive analysis suggests that Europe is already an important trading partner for European member states and more important than North America for most EU countries. However, countries with strong IPR norms and large volumes of patented technology like the UK, France and Germany trade somewhat less with the EU when compared to the other EU countries.[6]

[6] UK data were not available in the unpublished OECD data but are reported and analysed separately in Deliverable 1.1.2.

5. Summary and policy implications

This report analysed available unpublished data from the OECD's technology balance of payments in order to shed light on:

(i) Europe's position in world technology trade
(ii) Industries of origin of technology trade
(iii) Importance of the different components of technology trade and lastly
(iv) Direction of technology trade for EU member states.

We find that Europe is a very big and important player in world technology trade and EU member countries such as the UK and Germany dominate technology receipts in absolute terms. Using the size of technology payments as a estimate of the size of the international market for technology in Europe we find that adding the payments made by Germany and UK alone would produce an international market larger than that in the US. Internationalisation of technology has also allowed many new member states to supplement their domestic R&D resources and some of these countries show very high levels of growth of technology trade both in receipts and payments.

Both manufacturing and non-manufacturing sectors are important originators of technology services trade. For the countries where data were available we found that in Belgium and UK (data reported in Deliverable 1.1.2), non-manufacturing sectors accounted for a large share of technology receipts and payments. Within manufacturing the sectors originating technology services trade were strongly concentrated and the five largest sectors accounted for a bulk of the trade. The composition of manufacturing sectors differed from country to country. Some sectors such as chemicals, office machinery and computing and non-electrical machinery were more 'globalised' in technology and could be found in the technology services trade of many countries.

We also found considerable heterogeneity in the form of technology trade. Countries like the UK, France and the US which have long established IPR systems draw a greater proportion of technology receipts and payments from the receipt and payments of royalty and licensing revenues. Countries with weaker IPR regimes but strong manufacturing sectors appear to depend more on the trade in technology related services. Countries with poor contract enforcement and weak IPR regimes (such as many new member states) show a greater preference for trade in technology assets.

Direction of trade data reveals that Europe is the dominant trading destination for most European countries but countries with large volumes of patented technology like France and Germany trade somewhat less with the EU. Taken together, these findings suggest that the absence of a harmonised IPR may not be a large deterrent to technology trade in Europe perhaps due to shared norms about scientific research and its value to society and since nations have adapted to differences in IPR by choosing the form of technology transfer that mitigates the harmful consequences of poor environments for the appropriability of value. However, for countries in the EU that are closer to the technological frontier (e.g. France, Germany and the UK) and have a long history of IPR, lack of clarity on IPR may prove a

barrier to increasing the volume of technology trade with other EU countries. This certainly points to an increasingly political situation where technologically more sophisticated countries are likely to push for stronger IPR, but more systematic analysis (currently underway) on the role of geographic proximity, IPR protection, shared norms and EU membership in influencing the direction of trade is needed before any firm conclusions can be drawn about the benefits of a unified IPR policy in Europe.

Appendix 1: Technology Balance of Payments data sources[7]

Australia

Source
Data come from the ABS's quarterly Survey of International Trade in Services (SITS). The methodology used to compile the Australian Balance of Payments conforms to the methodology set forth in the BPM5. The services classification used follows BPM5 and the more extensive OECD-Eurostat Classification. The reference period is the calendar year.

Coverage
Data include all TBP items except sale/purchase of patents and inventions. Other royalties and licence fees (for computer software and education) have been excluded.

Austria

Source
Data come from the balance of payments of the Austrian Central Bank.

Coverage
Data include all TBP items from 2006 onwards. Sale/purchase of patents and inventions is not available prior to 2006.

Belgium
Source
Data come from the balance of payments. Prior to 2002, it was compiled by the Belgian-Luxembourg Monetary Association and the National Bank of Belgium on a monthly basis and was not referring to Belgium only, but to the BLEU. Starting from January 2002, the introduction of the euro eliminated the reason for the existence of the Belgian-Luxembourg Monetary Association, and the National Bank of Belgium has taken on responsibility for collecting and processing the information relevant to the compilation of the balance of payments. The collection system set up by the National Bank of Belgium is no different from the system used by the Belgian-Luxembourg Exchange Institute, except for the introduction of an exemption from compulsory notification in the case of transactions not exceeding €12,500 (exclusion threshold).

Coverage

[7] This note on data sources was made available to us by the OECD and is reproduced for the countries whose data we included in this report.

Up to 1994, data cover royalties and licence fees (except copyrights and films royalties), and technical assistance (national codes 220 and 224). As from 1995, data also cover R&D services. The following BPM5 codes are thus included: 266, 280, 247, 263 and 279. From 2002, BPM5 code 247 has also been excluded only for data by type of transfer.

Canada

Source

Data come from the Business Enterprise R&D Survey conducted by the Science, Innovation and Electronic Information of Statistics Canada. From 1997 onwards, all firms with R&D expenditure of more than CAD 1 million are covered (administrative data are used for others). Data are published in *Industrial Research and Development - 2006 Intentions* (catalogue No. 88 202 XIB).

Coverage

Data cover the sales/purchases/licensing of patents; know-how; inventions; trademarks (including franchising), patterns and designs; R&D technical assistance.

Czech Republic

Source

Up to 2004, data come from the balance of payments of the Czech National Bank. From 2005, data are prepared by the Czech Statistical Office and come from the quarterly trade in services survey, except for the item "Sale/purchase of patents and inventions" which continues to be collected by the CNB.

Coverage

From 1997, all TBP components (Sale/purchase of patents and inventions, Patent licensing, Trademarks, patterns and designs, Technology-related services, R&D carried out abroad) are included. "Trademarks, patterns and designs" are included in "Patent licensing" up to 2002; they are separately available from 2003.

Finland

Source

Data come from the IMF Balance of Payments database. Until 1998, data were derived from settlements reported by domestic banks, which reported transactions effected on their own behalf and on behalf of their customers to compile the services account. Beginning in 1999, the data are based on the enterprise statistics and on surveys conducted by Statistics Finland.

Coverage

From 1999, data include the following BPM5 codes: 266, 280, 263 and 279.

France

Source

Data come from an annual survey conducted by the INPI (Institut National de la Propriété Industrielle). This data collection is suspended.

Coverage

As from 1983, data cover 5 categories: patents and patent licencing; trademarks, patterns and designs; know-how and software; technical assistance (staff training, secondment of technicians, technical consultancy, legal, financial, business and management consultancy); management fees (technical and economic research, engineering, sales/purchases of drawings).

Germany

Source

Data on cross-border payments for technological services come from the Deutsche Bundesbank, in the context of the balance of payments statistics.

Coverage

- Sale of patents and inventions: see Royalties and license fees.
- Royalties and license fees: this item includes transactions related to royalties, trademarks, registered designs, franchise fees, and the supply of technological know-how whereas royalties and the supply of technological know-how are allocated to sub-category "Patent licensing" and the other transactions to sub-category "Trademarks, patterns and designs" respectively. Generally, the data also cover transactions representing the acquisition or sale of patents, copyrights, etc. If such transactions can be identified, they are allocated to "Sale of patents and inventions". Film rights are not included in trademark rights.
- Technology-related services: these concern computer services and architectural, engineering and other technical services. Computer services predominantly refer to charges for data processing, analysis, planning and programming of plug-and-play systems (including the development and design of websites) and technical software consultancy, development, production, delivery and documentation of customer-specific software including customer-specific operating systems, maintenance and other support services, such as training as part of consultancy services, basic IT research and development including payments for licences as well as for standard software that is provided online. Charges for standard software in the form of data media (CD-ROMs, disks, DVDs etc) are not contained in computer services. Architectural, engineering and other technical services particularly include charges for planning and design services associated with the manufacture of technical products and units as well as charges for technical input and assistance. Charges for information, consultancy and training in the scientific and medical fields are also included in technical services.
- Research and development services: these predominantly concern charges for the development of new products and processes including scientific consultancy services. Research projects financed by the EU are also included.

Greece

Source

Data come from the Bank of Greece and are compiled from the Balance of Payments.

Coverage

Data cover sale/purchase of patents and inventions, royalties and licence fees; technology-related services; R&D carried out abroad (sum of BPM5 codes 480, 266, 263, 280, 279). Patent licensing and trademarks, patterns and designs cannot be separated and are presented summed up at the field of royalties and license fees.

Hungary

Source

Data are prepared by the Hungarian Central Bank. Up to 2003, the source of data was the balance of payment statistics compiled by the Hungarian Central Bank, based on the ITRS system (settlement information). Since 2004, data for trade in services have been compiled by the Hungarian Central Statistical Office from enterprise surveys. The survey-based system makes possible more detailed breakdown of services.

Coverage

Up to 2003, data cover royalties and licence fees and sale/purchase of patents and inventions (BPM5 codes 266 and 480). From 2004, "Computer services", "Architectural, engineering and other technical services" and "R&D carried out abroad" are also included.

Ireland

Source

The Central Statistics Office (CSO) is responsible for compiling and publishing official balance of payments for Ireland. Quarterly BOPS data compilation in Ireland is based on statutory CSO statistical surveys, combined with administrative data. More particularly, TBP data come from the survey of trade in services and royalties, which is quarterly for large enterprises and annual for smaller enterprises (same requirements as for quarterly respondents). 500 enterprises are surveyed.

Coverage

Data include the following items:

- Computer services: This item does not include exports and imports of computer software that is embedded in hardware or carried on other physical media; these are included under the goods component. Sales and purchases of software transmitted electronically, as well as exports of certain software licenses, are now recorded under computer services (formerly, the value of such licenses was included under the goods component). The item also includes payables and receivables relating to computer hardware and software and consultancy. In valuing these services reporters are asked to include the value of software licence fees received (exports) or paid (imports). This is a conscious CSO departure from the international standards which require that such licence fees be included under the service item royalties/licence fees.
- Royalties and license fees: The information covers payables and receivables for the use of patents, copyrights, and other intangibles. Royalty receivables and payables in connection with the entertainment industry (mainly concerning film distribution and musical recordings and performances) are currently excluded from royalties and licence fees and included under "Other services not elsewhere specified".
- Research and development services cover those services that are associated with basic research, applied research and experimental development of new products and processes. Activities in the physical sciences, social sciences and humanities are covered, including the development of operating systems that represent technological advances. Also included is commercial research related to electronics, pharmaceuticals and biotechnology.
- Architectural, engineering and other technical services covers services related to architectural design of development projects; planning, design and supervision of the

construction of civil and other engineering projects; surveying; cartography; product testing and certification; and other technical services.

Italy

Source

Since reference year 2007, data are compiled by the Bank of Italy (previously by the Ufficio Italiano dei Cambi, which was suppressed in January 2008). TBP data derive from the Communicazione Valutaria Statistica, which is an international transaction reporting system with a threshold of about 12 500 € from 2002 (10 000 € before). The data are available on the Bank's web site at the following URL: http://www.bancaditalia.it/statistiche/rapp_estero/altre_stat/bpt.

Coverage

Data are very detailed and are broken down into the following categories: sales of patents and inventions, patent licensing, trademarks, patterns and designs, technology-related services, R&D carried out abroad and other transactions in technology.

Japan

Source

Data come from the annual Survey on Research and Development conducted by the Statistics Bureau. Companies with a capital of 100 million yen or more (since the 1995 survey) are covered. "Software services" is included from 1996, "Wholesale and retail trade", "Finance and insurance", "Research" and "Business services" are included from 2001. Data are published annually in *Report on the Survey on Research and Development* by the end of March following the survey year.

Coverage

Data cover sale and licensing of patents and inventions and technology-related services.

Luxembourg

Source

Data come from the STATEC (statistical office) and the Central Bank, and are compiled from the balance of payments. The collection system used to report statistical data for the b.o.p. is an "international transactions reporting system (ITRS) of the open type", which is largely based on the collection of settlements.

Coverage

Data cover the sales/purchases of patents; patent licensing, trademarks, patterns and designs (no breakdown); R&D carried out abroad; technology-related services (architectural, engineering and other services; computer and information services).

Norway

Source

Data come from the International Transactions Reporting System at the Norges Bank. Data are reported by Statistics Norway, Division for National Accounts.

Coverage

Data cover royalties and licence fees; technology-related services; R&D carried out abroad (sum of BPM5 codes 266, 263, 280, 279). Copyrights and software royalties are included.

Poland

Source

Data come from the National Bank of Poland and the statistical office (GUS).

Coverage

Data cover the acquisition/disposal of non-produced, non-financial assets; royalties and licence fees; computer services; architectural, engineering and other technical services and R&D services.

Portugal

Source

The Portuguese central bank is responsible for the data collection and the compilation of balance of payments and international investment position statistics. Within the b.o.p framework, Portuguese technological balance of payments is compiled based on detailed information reported under the statistical system on external operations.

Coverage

TBP data include the following items:

- "Sales of patents and inventions" correspond to operations reported under the code 480, excluding operations related with sales and acquisitions of transfer rights of professional players;
- "Patent licensing and Trademarks, patterns and designs", that are not available separately, correspond to bop code 266;
- "Technology related services" correspond to bop code 263 plus 280; and
- "R&D carried out abroad" corresponds to bop code 279.

Slovak Republic

Source

Data come from the National Bank of Slovakia and are compiled from the Balance of Payments. The data are prepared by all commercial banks on the basis of the methodology prepared by the BOP Section. The data are collected on the basis of a system using specific transaction codes (payment titles), under which income and payments have to be assigned the relevant code from a list.

Coverage

Until 1997 inclusive, TBP data refer to royalties and licence fees and R&D performed abroad. As from 1998, data also include architectural, engineering and other technical services, computer services and sale/purchase of patents and inventions.

Spain

Source

For data up to 1995, data came from an annual survey conducted by the Ministry of Science and Technology (former Ministry of Industry and Energy). From 1996 onwards, data come from the Spanish Central Bank and are compiled from the Balance of Payments.

Coverage

For data up to 1995, the survey (survey into technological transfer in companies) is carried on a data basis of 1108 firms that made 5936 technological transfers since 1992. 159 of these firms despaired in 1997. Therefore, the questionnaire was sent to 949 firms, 108 of which were included in the survey for the first time. Results refer only to firms included in the poll. Nevertheless, as import/export of technology is concentrated on a relatively small number of firms, the results of the poll are considered to be a good approximation to technology transfers of the Spanish economy. Data cover sale and licensing of patents and inventions; trademarks, patterns and designs; technology-related services; R&D carried out abroad. These categories correspond to the following 5th IMF Manual headings: hardware services; engineering and other services; industrial, agricultural and mining services; rights for the exploitation of patents, brands, inventions and designs; sale/purchase of patents, brands, inventions and designs; research and development activities.

From 1997, all TBP components (Sale/purchase of patents and inventions, Patent licensing, Trademarks, patterns and designs, Technology-related services, R&D carried out abroad) are included. "Trademarks, patterns and designs" are included in "Patent licensing" up to 2002; they are separately available from 2003. Data for Technology-related services and R&D carried out abroad are confidential.

Sweden

Source

The data are prepared by Statistics Sweden and come from the quarterly trade in services survey. 4800 enterprises are surveyed of which 85 percent responds.

Coverage

All TBP components (Sale/purchase of patents and inventions, Patent licensing, Trademarks, patterns and designs, Technology-related services, R&D carried out abroad) are included. "Trademarks, patterns and designs" are included in "Patent licensing".

Switzerland

Source

Data come from the Swiss National Bank and are compiled from the Swiss Balance of Payments.

Coverage

Data cover sales/purchases of intangible assets, licence and patent fees and technological services (construction services, commercial and technical consulting, computer and information services).

United Kingdom

Source

Data come from the International Trade in Services (ITIS) survey of the ONS. In 1996, a new survey design was introduced to follow the recommendations of the 5th IMF Manual, in order to collect additional details of the type of services being traded, to move from an industry to a product-based presentation and also to meet the increased user demand for geographical disaggregation. A full product based dataset is available from 1996. The new ITIS survey has a sample size of 10 500 enterprises (4 000 from production industries and 6 000 non-production) and is sent quarterly to the top 650 companies (annually to the rest). Data are published in the annual Balance of Payments publication (Pink Book).

Coverage

From 1996 onwards, data cover sales of patents and inventions, patent licensing and trademarks (no breakdown), technology-related services and R&D carried out abroad. Technology-related services include: architectural, engineering, surveying, construction, agricultural, mining and other technical services.

United States

Source

Data come from the Bureau of Economic Analysis (BEA), US Department of Commerce. Services estimates are based on quarterly, annual, and benchmark surveys and partial information generated from monthly reports. Detailed data (by partner country and by affiliates/unaffiliates) are available in the October issue of the *Survey of Current Business*. All data are now available interactively at http://www.bea.gov/. Beginning 2006, for cross-border trade in services, more detailed data by type of service have become available. As a result, new statistics on total trade for several types of services are available for the first time; previously, only statistics for unaffiliated trade were available for these services. Most of these services are components of "other private services." New statistics on total trade in royalties and license fees by type of intangible asset are also now available; previously, detail by type of asset was only available for unaffiliated transactions.

Coverage

Up to 2000, data only refer to royalties and licence fees. From 1992, computer software royalties and license fees are included (they were previously classified under "Other private services"). Transactions involving intangible non-produced, non-financial assets and proprietary rights are included under this item (and not in the capital account).

From 2001, data also include "Research, development and testing services", which are defined as "Commercial and non-commercial research, product development services, and testing services."

From 2006, TBP data include:

- Royalties and license fees related to industrial processes, business format franchising fees, trademarks and other intangibles (the categories "Books, records and tapes", "Broadcasting and recording of live events" and "General use of computer software" have been excluded).

The selected categories represent 66% of total receipts and 81% of total payments for royalties in 2006.

- Research, development and testing services
- Computer and data processing services: data entry processing (both batch and remote), and tabulation; computer systems analysis, design, and engineering; custom software and programming services (including web design); integrated hardware/software systems; and other computer services (timesharing, maintenance, web site management, and repair).
- Architectural, engineering and other technical services: includes those engineering services performed in conjunction with construction and mining services projects. Includes services purchased in connection with proposed projects (e.g. feasibility studies) as well as projects that are actually being carried out.
- Industrial engineering: engineering services related to the design of movable products, including product design services.

These three latest items correspond to technology-related services.