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Patents, trade and foreign direct investment in the European Union

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List of abbreviations

Countries

AUT	Austria
BEL	Belgium
BGR	Bulgaria
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
ESP	Spain
EST	Estonia
FIN	Finland
FRA	France
GBR	United Kingdom
GRC	Greece
HRV	Croatia
HUN	Hungary
IRL	Ireland
ITA	Italy
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MLT	Malta
NLD	Netherlands
POL	Poland
PRT	Portugal
ROU	Romania
SVN	Slovenia
SVK	Slovakia
SWE	Sweden
USA	United States of America

AI	Analytical instruments
EEA	European Economic Area
EC	European Commission
EPC	European Patent Convention
EPO	European Patent Office
EU	European Union
EU28	All 28 Member States of the European Union
FDI	foreign direct investment
GVC	global value chain
IP	intellectual property
IPR	intellectual property right
MNE	multinational enterprise
NACE	statistical classification of economic activities in the European Community (from the French term "nomenclature statistique des activités économiques dans la Communauté européenne")
OECD	Organization for Economic Co-operation and Development
PT	production technology
R&D	research and development
SME	small and medium-sized enterprise
TFP	total factor productivity
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UPC	Unified Patent Court
UP26	The 26 EU Member States participating in enhanced cooperation in the area of the creation of unitary patent protection

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Summary of the key findings

About this study

The study, carried out by the European Patent Office (EPO) with experts led by Professor Keith Maskus (University of Colorado Boulder), assesses the impact of the European patent system on the circulation of technologies through trade and foreign direct investment (FDI) in the European Single Market.

Industries with above-average use of intellectual property (IP), especially patents, are already known to make a greater contribution to GDP and external trade*. This study shows that further improvement is however possible. Under the current patent system, which is fragmented post-grant, limitations are found to hinder cross-border trade and investment in IP- and technology-intensive industries. The Unitary Patent will remove many of these limitations, and it is thus expected to facilitate technology transfer through trade and FDI within the EU, thereby supporting productivity growth and economic development.

Main findings

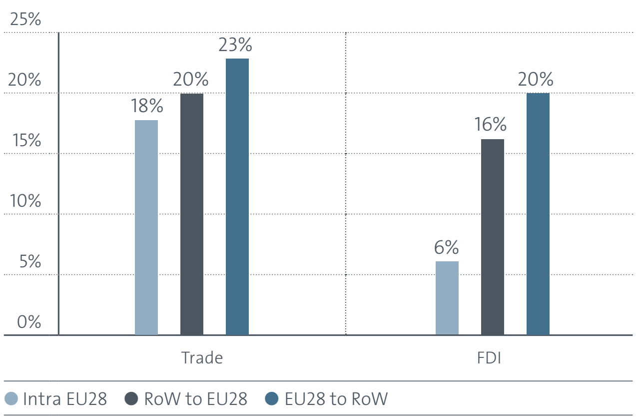
Contribution of high-IP industries to trade and FDI in the EU
Compared with other industries, IP-intensive industries such as analytical instruments, biopharmaceuticals, chemicals, ICT, medical devices and production technologies make a greater contribution to outgoing than to incoming or intra-EU trade and FDI flows. Trade and FDI flows in these high-IP industries are found to be particularly sensitive to the level of patent protection in EU countries.

Limitations in the EU market for technology
The current, fragmented European patent system creates limitations to the circulation of patentable inventions within the EU. Most European patents are only validated in a few EU member states, to save on the cost of validating and maintaining them in each country. In addition, they often end up providing uneven levels of national patent protection and are subject to the risk of parallel litigation with possibly divergent outcomes.

Economic benefits of harmonising patent protection
Further harmonisation of patent protection in the EU would boost European trade and FDI in high-IP industries. At EU level, high-IP trade and FDI flows to or between EU countries are expected to increase by 2% and 15% respectively, resulting in annual gains of EUR 14.6 billion in trade and EUR 1.8 billion in FDI. This corresponds to an increase of 5% and 29% respectively in high-IP trade and FDI flows into or between the 15 EU countries which will be most impacted by this development.

Figure 1

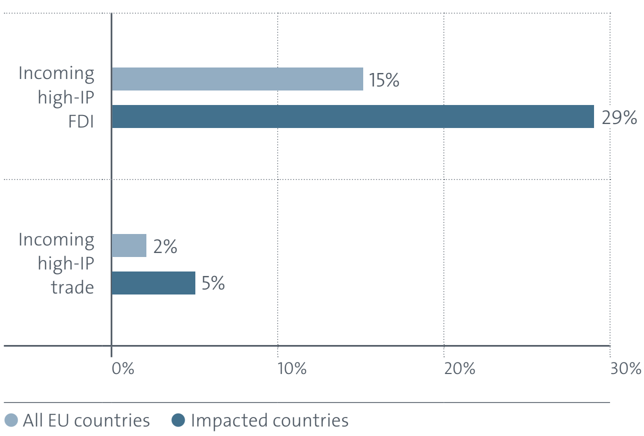
Proportion of high-IP industries in EU trade and FDI



Source: Comtrade, Zephyr of Bureau van Dijk, Delgado et al. (2013)

Figure 2

Gains from patent harmonisation



Source: Authors' calculations

* See "Intellectual property rights intensive industries and economic performance in the European Union. Industry-Level Analysis Report, October 2016", published by the European Patent Office and European Intellectual Property Office, epo.org/ipr-intensive-industries

Executive Summary

This study assesses the role of the European patent system in supporting the circulation of inventions through trade and foreign direct investment (FDI) in the European Single Market. It finds a positive impact of patent protection on trade and FDI in innovative industries. However, Europe's fragmented patent system is preventing the full benefits of the system from being enjoyed.

The economics of patents, trade and FDI

The first chapter of the study reviews the economic knowledge on the effects of patent protection on international trade and FDI. The latest economic literature provides consistent empirical evidence that stronger patent protection fosters international technology transfers through trade and FDI in medium-income and higher-income countries.

– Having greater and quicker access to foreign technologies has a strong impact on productivity growth in the recipient countries. It has been estimated that two-thirds of the productivity gains experienced by smaller OECD economies can be attributed to implementing technical information from the major technology-producing nations. These transfers primarily occur through international trade, FDI and licensing in high-tech industries.

– More specifically, the international trade of technology-intensive products and capital goods can generate significant productivity gains in the recipient countries. The likelihood of exporting such goods is higher where patents diminish the threat of local counterfeiting, thereby supporting sufficient returns to pay for the costs of entering markets. In particular, a number of recent studies have established causal impacts of the implementation of the 1995 TRIPS agreement on imports of high-technology goods (e.g. pharmaceuticals, chemicals and IT goods) in developing countries.

– FDI and licensing are also powerful levers for productivity gains, as they enable the local exploitation of foreign-sourced technology. For this purpose, they require patent protection to facilitate transactions with local partners, and to mitigate the risk of imitation by local competitors. Economic studies found that stronger patent rights have attracted production facilities in patent-sensitive industries in Eastern Europe, the former Soviet Union and Chinese provinces. The value added and the range of exports of both foreign affiliates and competing domestic firms have also been found to rise significantly after patent rights were strengthened in various countries. Available evidence suggests similar effects of patents on licensing.

The patent system in the European Single Market

The second chapter describes the current European patent system and its limitations in ensuring uniform patent protection in the European Union (EU).

– Today, an inventor can protect an invention in Europe via a national patent or a European patent. The European Patent Office (EPO) provides a single, uniform grant procedure for Europe, enabling owners of European patents to protect their rights in up to 43 states. It delivers high-quality patents. However, once granted, European patents must be validated and maintained in force in each individual country.

– Hence, most European patents are in fact only validated in a small fraction of the 28 EU Member States, usually the four or five largest ones, as a way of saving on validation costs. As a result, companies may dispense with entering some national markets due to the lack of patent protection, or have to operate in some countries without the benefit of such protection.

– The European patent, as a bundle patent "with the effects of a national patent", is subject to national legal regimes as regards a number of issues including enforcement. The owner of a European patent, just like the owner of a number of granted national patents protecting the same invention in different EU countries, cannot uniformly enforce his rights in one procedure under one single jurisdiction (see figure 4). Patent owners have to litigate in several jurisdictions in parallel, with resulting high costs and complexity. In addition, they face the risk of conflicting decisions in different jurisdictions, which creates legal uncertainty. Despite the existence of uniform patent law under the European Patent Convention, legal uncertainty is created by a lack of a harmonised interpretation of substantive law, which has led to different interpretations of patentability issues in different European countries. As a consequence, patent owners usually find it difficult to enforce their patents in all countries in which they have protection.

– The forthcoming Unitary Patent and Unified Patent Court will address these shortcomings. The Unitary Patent will give applicants the option to obtain a European patent with unitary effect for the entire territory of up to 26 EU Member States, thereby avoiding validation procedures before national patent offices. The Unified Patent Court will enable the Europe-wide enforcement and revocation of Unitary Patents and classical European patents. As such, it will be instrumental in establishing a harmonised approach to both patentability and patent infringement, providing a better framework for all parties involved in patent litigation in Europe.

Impact of patent protection on trade and FDI in the EU

The impact of patent protection on trade and FDI in the EU28 is assessed in the empirical part of the study. For this purpose, patent protection is measured by the legal scope and effectiveness of patent protection in EU countries under the current European patent system, setting aside cost considerations. The results indicate that uneven patent protection has a negative impact on the circulation of patented inventions through trade and foreign investment in innovative industries, thereby preventing the realisation of the full potential of the European Single Market for technology.

The analysis focuses on innovative manufacturing industries that intensively use intellectual property rights, namely: Analytical Instruments, Biopharmaceuticals, Chemicals, Information and Communication Technologies, Medical Devices and Production Technologies. Compared with other manufacturing industries, these "high-IP" industries make a stronger contribution to trade and FDI flows from the EU28 to the rest of the world than to intra-EU trade and FDI flows (Figure 1):

– In 2014, high-IP goods accounted for about 23% (EUR 371 billion) of EU28 exports to the rest of the world, 20% (EUR 341 billion) of its imports from the rest of the world, and 18% (EUR 461 billion) of its internal trade.

– In 2014-2016, high-IP industries accounted for about 20% (EUR 27 billion) of FDI from the EU28 to the rest of the world, 16% (EUR 14 billion) of FDI from the rest of the world to the EU28, and only 6% (EUR 4 billion) of FDI between different countries of the EU28.

Further analysis confirms the impact of patent protection on trade and FDI flows in these industries:

– Regression analysis shows that stronger patent protection has a positive and significant effect on high-IP imports and on the value of FDI deals in high-IP sectors. By contrast, trade and FDI in other sectors are not significantly affected by patent protection.

– The estimated sensitivity of high-IP FDI flows to patent protection in the recipient country is about ten times higher than the estimated sensitivity of high-IP imports.

– The model predicts increases of 2% in incoming trade in high-IP goods and 15% in inflows of high-IP FDI in the EU28, resulting in annual gains of EUR 14.6 billion in trade and EUR 1.8 billion in FDI. This corresponds to increases of 5% in high-IP trade and 29% in FDI inflows in the 15 EU countries which will be most impacted by this development (Figure 2).

1. Introduction

1.1 Patents and the European Single Market

The creation of a European single market based on the principle of the free circulation of goods, people and capital is a major achievement of the European Union (EU). Since the signature of the Rome Treaty in 1957, the gradual removal of physical, technical and fiscal barriers to trade, alongside the enlargement of the EU to new countries, have promoted intra-European trade, increased competition and job creation, and made the European economy more attractive for the rest of the world. It was for instance estimated in 2003 that the European Single Market had contributed to the creation of 2.5 million jobs and created more than EUR 800 billion in terms of wealth between 1993 and 2003 (European Commission, 2003).

However, the European Single Market remains incomplete in many respects. A number of recent studies point out the persistence of gaps in the implementation of the single market in some parts of the economy, which remain fragmented into national markets (Monti, 2010; Pelkmans and Correira de Brito, 2012; London Economics and PWC, 2013; EPRS, 2014).

The fragmentation of the European patent system is one of those gaps. Today, an inventor can protect an invention in Europe via a national patent or a European patent. For national patent protection, the applicant must apply for a patent in each European country where he wishes his invention to be protected. The burden and the costs of prosecuting parallel applications in several countries can be saved by filing a single application at the European Patent Office (EPO) for a European patent taking effect in up to 43 states[1]. However, applicants must still incur substantial costs for validation in each country in which the European patent is to take effect. As a result, most European patents are validated in only a small fraction of the 28 EU Member States, usually the four or five largest ones. Most inventions are therefore protected in only some EU countries.

In addition, the European patent, as a bundle patent "with the effects of a national patent", is subject to national legal regimes as regards a number of issues, including enforcement. Therefore the owner of a European patent does not enjoy uniform protection throughout the European Single Market. Patent holders cannot enforce their patent with one action before one court. They have to engage in parallel litigation in different national courts, resulting in high costs and complexity. In addition, they face the risk of legal uncertainty and conflicting decisions by different national courts. This is a further reason for limiting patent protection to a few countries only, which is an anomaly in a single market. For this reason attempts to create a single patent and a single court for patent litigation date back to the early years of the European Economic Area, the predecessor of the European Union.

Fragmented and uneven patent protection and the difficulties of enforcement in the EU Member States mean that products and processes derived from patented inventions circulate within a single EU-wide market for technology without an adequate level of protection. Such limitations may reduce intra-EU trade, foreign direct investment and ultimately return on R&D investment in patent-intensive industries. These industries are of strategic importance for the EU economy: according to a recent study, they contributed 10.3% of EU employment, 15.2% of EU GDP, and respectively 65.6% and 71.5% of EU imports and exports between 2011 and 2013 (EPO-EUIPO, 2016). Against this background, the harmonisation of intellectual property rights was identified by the European Commission (2012) as one of twelve priority levers to consolidate the European Single Market.

The forthcoming creation of a Unitary Patent and Unified Patent Court will be a major step forward in this direction. The Unitary Patent will complement the existing system by giving applicants a further option to obtain a European patent with unitary effect for the entire territory of the 26 participating EU Member States. By requesting unitary effect, applicants will be able to avoid the complex and costly national validation procedures before up to 26 national patent offices. In addition, they will benefit from uniform protection throughout the territories of up to 26 EU Member States. Finally, the Unified Patent Court will enable the Europe-wide enforcement and revocation of Unitary Patents and European patents. As such, it will be instrumental in establishing a harmonised approach to both patentability and the enforcement of patents in case of infringement and in providing a better framework for all parties involved in patent litigation in Europe.

1 38 European member states of the European Patent Convention, two extension states and three validation states, as of December 2017: http://www.epo.org/about-us/foundation/member-states.html

1.2 Objectives and scope of the study

The objective of the study is to assess the role played by the *current* European patent system in supporting trade and foreign direct investment in the European Single Market.

Trade and foreign direct investment are core components of the European Single Market, and major channels for international technology diffusion. Trade flows are large aggregates measuring international transfers of goods that take place in the EU on a regular basis. FDI flows in turn account for foreign investment projects that accumulate over time as a stock in the host country. This stock of foreign investments induces long-term economic effects, such as local production, and may in turn generate additional trade flows. The study focuses in particular on trade and FDI activities in high-tech manufacturing industries which intensively use intellectual property rights (hereafter high-IP industries).

Building on available economic studies and data, the study aims to:

- Analyse the current European patent system and identify the ways in which it may create limitations to the cross-border circulation of patented technology.

- Characterise the economic mechanisms whereby patent protection supports international trade and foreign direct investment (FDI) in innovative industries, as well as the economic benefits induced by such trade and FDI.

- Empirically estimate the actual impact of patent protection on IP-intensive trade and FDI in EU countries, and infer the potential benefits of better harmonisation of the European patent system.

The study provides new insights into the potential gains in trade and FDI from a further integration of the European patent system, including a quantitative assessment of the gains in trade and FDI from further harmonisation of patent law across EU countries. It thereby extends and complements prior economic research on the costs for applicants of securing or enforcing patent protection in the European patent system (Harhoff, 2008; Danguy & van Pottelsberghe, 2009; Kremers et al., 2013; Harhoff et al., 2016).

The focus on trade and FDI, however, implies that other economic activities supported by the patent system are not directly considered in the study. In particular, R&D investment and technology transfer taking place within each EU country are beyond the scope of this study, although they would also benefit from a more integrated European patent system. Similarly, the likely positive impact on R&D investment of enhanced patent valuation through trade and FDI is not addressed in this report. The potential development of IP services at the scale of the European Single Market is also not discussed in the study.

It should also be noted that the study focuses on the functioning and limitations of the European patent system as it currently stands. It thereby provides relevant insights into the expected benefits of the Unitary Patent and the Unified Patent Court, but does not constitute a full impact assessment of these reforms. Indeed, the empirical part of the study focuses on a scenario of harmonisation of national patent laws, setting aside limitations relating to the cost of patent application and litigation in Europe. It therefore accounts for only part of the expected benefits of the reforms, as the Unitary Patent is also designed to mitigate these costs.

1.3 Outline of the study

The rest of the report is organised in five chapters. Chapter 2 reviews the rich body of economic literature on the impact of patent protection on international technology transfers through trade and FDI. Chapter 3 in turn describes the current architecture of the European patent system and highlights its limitations in ensuring uniform patent protection at the scale of the European Single Market. Chapter 4 describes the data and methodology used as the basis for the empirical analysis of the impact of patent protection on trade and FDI in the EU. Chapter 5 presents and discusses the results of this analysis. Finally, Chapter 6 provides a conclusion and discusses some perspectives for further research.

2. Economic literature on patents, trade and FDI

There is an extensive body of economic literature on the impact of patent protection on trade and FDI. It has produced consistent evidence that the strengthening and international harmonisation of patent rights have had a positive impact on international technology transfers through these channels, thereby contributing to productivity growth in medium-income and higher-income economies.

This chapter provides a synthetic review of this literature. The first section gives a macroeconomic perspective on the impact of international technology transfers on productivity growth. The way in which patents can support these transfers is presented in the second section. The last two sections review available empirical evidence on the impact of patent protection on international trade and FDI respectively.

2.1 International technology transfers, productivity and growth

Countries around the world vary widely in various measures of productivity, in both the manufacturing and service sectors (Keller, 2010). Differences in technologies employed explain a major share of this variation (Easterly and Levine, 2001). Additional evidence shows that differences in the rate at which international technologies are adopted explain a significant amount of the variation across countries in per-capita incomes (Comin and Hobjin, 2010).

It follows that having greater and quicker access to the best global technologies is likely to increase productivity, a claim supported by considerable empirical evidence. It has been estimated, for example, that as much as two-thirds of the productivity gains experienced by smaller OECD economies can be attributed to importing and implementing technical information from the major technology-producing nations (Eaton and Kortum, 1996). More general evidence finds that in most countries outside the major technology producers, 90% or more of domestic productivity growth may be attributed to importing foreign technologies (Keller, 2010).

That such large cross-border growth effects exist has a strong implication: trade in ideas is a major factor in world economic growth. Inward technology diffusion into productive uses is the primary source of technical change and productivity growth in smaller and technologically lagging economies. This diffusion directly affects production capacities and increases consumer access to new goods. It also indirectly raises local productivity through various spillovers as domestic firms learn improved techniques and standards. Against this background, it is not surprising that economic studies find evidence of a positive correlation between foreign patent applications and total factor productivity in the recipient country (Lee, 2005; Xu & Chiang, 2005; Hafner, 2008).

Although there are many other factors determining the extent to which knowledge is transferred to particular countries, and within certain industries, patents and related intellectual property rights do indeed have important roles to play. The reason is that the primary channels through which technology is transferred – international trade in high-technology inputs, FDI, joint ventures and licensing – are responsive to patent protection. Moreover, there are newer and more complex organisational forms which rely on patents for sharing knowledge, such as vertical supply chains and research networks. Stronger patent rights in particular locations can encourage investment in such networks.

2.2 The role of patents in international technology transfers

Patents and other intellectual property rights are generally construed to be society's solution to the fundamental market failures inherent in creating and developing new inventions and creative works. At the most basic level, information and knowledge have characteristics of a non-rival good, meaning that the usage of a certain type of knowledge by one person does not preclude others from using it (Nelson, 1959; Arrow, 1962). It is thus difficult for innovators to appropriate adequate returns from new goods to cover investment costs, as those goods are easily copied. Patents and copyrights offer temporary exclusivity in use in order to deal with these problems. This enables innovators to retain the added value created by their creation, thereby incentivising investment in R&D (Schumpeter, 1942).

The protection conferred by patents is temporary[2] and implies the disclosure of the invention. Innovators thus face a trade-off between disclosing information and obtaining a temporary exclusive right for commercialising their inventions (Hall et al., 2014). Since disclosing information may help competitors to develop competing innovations based on a similar technological approach, firms may combine or replace patent protection with other appropriation mechanisms, such as trade secrets, a "lead time advantage" in the market, or the use of a purposely complex design of the product to prevent competitors from engaging in counterfeiting.

In addition to their role in incentivising innovation, patents are instrumental in facilitating the commercialisation of new technologies. There is in particular solid evidence from the economic literature that middle-income and higher-income countries with stronger patent rights tend to attract greater flows of inward technology through imports, inward FDI and licensing (e.g. Fink & Maskus, 2005). This evidence suggests that patents play a key role in facilitating the commercialisation of new technologies and the introduction of new goods to the marketplace. This is especially the case for international markets for technology, which face three interrelated difficulties that patents at least partially address.

– First, the fact that information can leak out into other uses implies that inventors of new goods and technical processes cannot appropriate their full economic value. This problem is likely to be greater when technologies are transferred to other countries due to investment costs, different legal systems or other factors. It reduces the willingness of inventors to transfer proprietary technology.

– A second problem is the difficulty of contractually organising international technology transfers. The owner of a technology may be reluctant to fully reveal it without an enforceable contract. The recipient partner would be unwilling to pay for it before being sure that the information is accurate, also requiring a contract at an acceptable price with performance guarantees. Because of such contractual problems, many otherwise mutually beneficial technology transactions may not happen, a problem that is made more severe across borders where business and legal environments vary.

– A third difficulty is that it is costly for foreign suppliers of new goods and technologies to monitor or manage how they are used by partner firms. Those local actors may opportunistically use the originator's technology or brand name, while selling lower-cost or lower-quality versions. The transaction costs involved in monitoring and disciplining such behaviour can be high, as are the costs of deterring local managers from leaving a partnership and opening a rival firm on the basis of technical information learned at the original firm (Keller and Yeaple, 2013).

These problems – a weak ability to earn returns on R&D investments due to the risk of imitation, information difficulties that diminish incentives to reach agreements, and transaction costs related to the absence of enforceable contracts – all reduce technology transfers (Maskus, 2004). Patent rights and other IPRs can help resolve these problems in global technology markets. By raising appropriability, IPRs increase the willingness of firms to ship technologies to foreign markets. The patent system moreover combines the grant of property rights on inventions with the early publication of those rights, which helps reduce the costs of achieving mutually agreeable contracts to transact in technologies. Patents also offer tools to deter opportunistic behaviour through enforcing the designated use of rights. These are the essential reasons why patents are, in theory, likely to expand international technology transfer flows.

2.3 Patents and international trade

The international trade of technologically-intensive products is one of the main channels of international technology transfers. In particular, the import and local use of technologically advanced capital goods (such as machines and equipment) can generate important productivity benefits and competitiveness gains in the recipient countries. As an illustration, China has acquired production technologies to develop a highly performing and *export-oriented* solar photovoltaic industry by purchasing machine tools or turnkey production lines from German, US and Japanese suppliers (de la Tour et al., 2011). In addition, international trade may induce knowledge spillovers in the recipient country (Rivera-Batiz and Romer, 1991) through business relationships (e.g. as customer or distributor) with the source company or through local counterfeiting of imported products.

2 The duration of a patent is limited to a maximum of 20 years.

Firms wish to profit from exporting, and the likelihood of doing so is higher where patents diminish the threat of local counterfeiting and support sufficient returns to pay for the costs of entering markets. Thus, there has long been evidence using macroeconomic data that exports and patent rates in destination countries are positively correlated (Maskus, 2000). Such correlations are found in recent studies with microdata linking firm-level exports and patenting as well. Hall et al. (2013) studied 8 500 UK-headquartered companies and showed that exporting firms are more likely to file patents, all other things being equal. Accetturo et al. (2014) also found, based on a sample of 3 085 Italian enterprises, that higher exports increase firms' tendency to register patents.

Observing such correlation between patents and trade among enterprises is not sufficient to establish a causal effect of patents on trade. However, a number of recent studies have also established such causal impacts, using appropriate techniques and data sets for this purpose.

Ivus (2010) for instance analysed the growth of high-technology exports from developed countries to developing countries associated with implementation of the 1995 TRIPS Agreement of the WTO. She found that patent-sensitive exports to countries with faster adoption of the TRIPS rules grew significantly faster than low-technology exports after TRIPS was negotiated.[3] Her estimates suggested that these policy changes added about USD 35 billion (in constant prices) to the value of OECD exports of patent-intensive products to the 18 developing countries covered. This represented an approximately 8.6% rise in those nations' annual value of such imports. Further analysis suggested that these impacts came primarily in higher trade quantities rather than in increased prices associated with market power.

A more recent study (Delgado et al., 2013) analysed the impact of patent reforms on the trade flows of a comprehensive set of countries, using the date at which countries became compliant with TRIPS requirements as a variable for policy change. Using a sample of 158 WTO members and trade data from 1993 to 2009, it found that developing countries significantly expanded their imports of particular high-technology sectors (e.g. pharmaceuticals, chemicals and IT goods) relative to other products.

Overall, there is thus a robust consensus that patent reforms have the ability to boost imports of higher-technology products. The logic for the import impact is straightforward: export firms wish to protect the intellectual assets inherent in those goods, or multinational firms wish to deploy high-tech inputs in local production.

2.4 Patents and FDI

Interestingly, some studies also find a positive effect of patent reforms on the country's performance in *exports*. For instance, the already-quoted study by Delgado et al. (2013) finds evidence of a rise in exports of middle-income economies in IT products after implementation of the TRIPS requirements. Similarly, Maskus and Yang (2016) find evidence of expanded exports of patent-sensitive goods among high-income and emerging economies as they changed their patent laws after TRIPS. The logic for this export impact is less intuitive:[4] stronger patent rights may, with a lag, help build domestic productivity and innovation capacity to support export growth (He and Maskus, 2012).

Besides facilitating imports of technology-intensive capital goods, the patent system is indeed a means to encourage international technology transfers through other channels, such as FDI or licensing (Vishwashrao, 1994; Maskus et al., 2005). Such forms of technology transfer are powerful levers for productivity gains, as they enable the local exploitation of foreign-sourced technology. For the same reasons, they are also sensitive to the effectiveness of local patent protection, as indicated by empirical evidence.

Patent laws are a significant factor that international firms consider when locating affiliates. Nunnenkamp and Spatz (2004) for instance analysed the cross-country location of FDI stocks owned abroad by U.S. multinationals over 1995-2000. They found a positive and significant impact of stronger IP rights[5] on the distribution of FDI among developing countries. Javorcik (2004) considered the impact of patents on the composition of FDI inflows

3 To establish a causal impact, she took advantage of the fact that developing countries with British and French origins had (on paper) the strongest patent laws before TRIPS. The agreement therefore obliged the other emerging countries (the "treatment group") to adopt relatively stronger reforms. Thus, Ivus estimated how the growth in bilateral high-technology (patent-intensive) exports from 24 OECD countries to 55 developing economies varied between the pre-TRIPS (1962-1994) and post-TRIPS (1995-2000) periods, depending on the extent of such reforms.

4 An intuitive explanation is that, as a country develops, its domestic innovation capacity increases, and there is political pressure for stronger patent protection. However, the studies of Delgado et al. (2013) and Maskus and Yang (2016) control for this effect in order to identify the reverse effect of patent law on exports.

5 IPR strength was measured using either the Ginarte-Park index or an index of the perceptions firm managers have of local IPR protection compiled by the World Economic Forum.

into several countries in Eastern Europe and the former Soviet Union.[6] She also found strong evidence of the impact of stronger patent rights on both location and distribution. In particular, stronger patent rights attract production facilities in patent-sensitive industries. Moreover, patents encourage a significant rise in inward investments in manufacturing production facilities compared to distribution facilities. Similar results were found in a study of the decisions of U.S. multinationals to locate affiliates in Chinese provinces (Du et al., 2008).

IPRs are also found to have an impact on the technology and value-added content of FDI. In an analysis of the reactions of U.S. multinational enterprises (MNEs) to the strengthening of patent laws in different countries, Branstetter et al. (2011) discovered positive increases in local affiliate sales, net plant and equipment expenditures and employee compensation. Each of these impacts was significantly higher for technologically progressive MNEs. Interestingly, the value added produced by local domestic firms competing with these affiliates also rose significantly, especially in technology-intensive sectors. Indeed, estimates indicated an average increase of 20% in value added generated by the local industries of reforming economies. Further, there was strong evidence that both affiliates and domestic firms in these countries expanded the range of their exports after patent rights were strengthened. This finding suggests that stronger patent laws, rather than shutting down domestic enterprises, may be a boost to their operations. Naghavi et al. (2015) found for instance that European enterprises are more likely to purchase highly complex products from firms outside their control when the partners engage in technology-sharing agreements. This tendency was more pronounced in countries with stronger intellectual property protection.[7]

In another study, Branstetter et al. (2006) analysed the reactions of affiliates of U.S.-based multinationals in 16 major developing economies that undertook changes to their patent laws. To begin with, they computed the impacts on licensing of U.S. parents to affiliates, finding that royalty payments rose by 34% on average in the post-reform periods. The bulk of this rise appeared to be an increased volume of technology sold rather than higher royalty fees. They also showed that there was a significant increase in R&D investment at local subsidiaries after the legal changes. Both of these impacts, which were significantly stronger for parent companies in high-technology industries, implied a substantial increase in technology shifted to these economies after legal reforms.

There are not many empirical studies of how patents affect licensing because data on this form of technology transfer are quite limited. Yang and Maskus (2001) found a U-shaped relationship between the strength of IPRs and the value of licensing payments by unaffiliated partners to U.S technology developers.[8] Nagaoka (2009) analysed individual technology licensing contracts between Japanese firms and unaffiliated foreign firms and found a significantly positive impact of patent rights. Wakasugi and Ito (2005) showed evidence that differences in patent laws across recipient countries were associated with a significant rise in price-adjusted royalties and licence fees paid by affiliates to Japanese parents. These tendencies were also demonstrated in a 2004 survey of senior executives of international firms.[9] Among the respondents, 84% claimed that the lack of IPR protection reduced their willingness to outsource their R&D, whether through location of research facilities or transfer of technology-intensive inputs and processes. A recent study on patents and trade secrets in Europe (EUIPO, 2017) similarly finds that companies which co-operate with distant partners (i.e. USA, China, India for EU companies) are much more likely to rely on patents than companies which do not co-operate or which co-operate with companies in their own country or in other EU countries.

6 She used data from a 1995 survey of around 1 400 global companies with operations in 24 of those nations. Javorcik estimated a binary (probit) model of both the decision to invest and the type of investment, broken down between production facilities and product distribution, with an extensive set of controls. Testing the composition of FDI is interesting in order to see whether firms would choose not to produce (and risk losing their proprietary technologies to managerial defection or reverse engineering) in countries with weaker patent rights.

7 They related multiple measures of affiliate activity to a post-reform dummy variable and its interaction with a measure identifying high-technology companies.

8 They interpreted this to mean that beyond a certain level of protection stronger patents would shift the transfer mode of MNEs away from FDI into licensing because of the reduced risk of imitation. However, they were unable to say whether this increase in dollar values of royalties reflected an increase in the quantity of licensing or a rise in fees.

9 This survey is described in Naghavi et al. (2015).

3. The patent system in the European Single Market

To protect an invention in Europe, an inventor can file either a national patent or a European patent. The EPO provides a single uniform grant procedure for Europe, enabling owners of European patents to protect their rights in over forty countries. It delivers high-quality patents. However, once granted, European patents must be validated and maintained in force in each individual country.

This fragmentation of the post-grant procedure remains a source of complexity and cost for users (Guellec and B. van Pottelsberghe de La Potterie, 2007), which may in turn create limitations to the circulation of patented inventions within a single EU-wide market for technology. These limitations are discussed in the first two sections of this chapter. The third section briefly discusses the expected benefits of the forthcoming Unitary Patent and Unified Patent Court in alleviating these limitations.

3.1 Geographical scope of patent protection

Patent owners face high costs when obtaining patent protection in several EU countries. This frequently results in selective patenting and therefore in incomplete protection in the European Single Market.

Filing at the EPO is a way to avoid the duplications of national procedural fees and related external expenses (for patent attorneys) when the applicant is willing to obtain protection in several European countries. However, validation requirements for EPO-granted patents can still cause high direct and indirect costs, including the cost of translations and validation fees (i.e. publication fees that are due in some member states for the translations), as well as related representation costs, such as the attorney fees related to the administration of the patent. Moreover, renewal fees have to be paid in each country where the validated European patent is kept in force. These costs significantly increase with the number of member states in which the patent holder validates his European patent.

As a consequence, patent owners generally do not seek to obtain patent protection in all EU countries (Danguy & van Pottelsberghe de La Potterie, 2009). Typically, they either file for national patents in one or a few countries, or apply for European patents which they validate in a larger yet limited number of large European countries. On average, a European patent is validated in 4.5 countries out of the 26 EU Member States (UP26) participating in enhanced cooperation in the area of the creation of unitary patent protection.[10] As a consequence, actual patent protection in Europe only partially overlaps with the geographical scope of the European Single Market.[11] Under the current system, the initial decision to validate in specific member states effectively means that companies have to make an ex-ante bet with respect to which national markets they will want to enter at a later stage. As a result, companies may dispense with entering new markets due to the lack of such protection, or have to operate in some countries without the benefit of patent protection.

Figure 3 illustrates how such incomplete patent protection translates at the level of EU countries. It represents the share of patents granted by the EPO between 2005 and 2014[12] that have since been validated in the different countries of the UP26. Importantly, this Figure excludes national validations of domestic inventions (for example an EPO-granted patent, initially developed in Germany, that is validated in that country), which makes it possible to focus on cross-border patent validations. Bearing this exclusion in mind, the data shows that there is tremendous heterogeneity within Europe as to the likelihood of a patent being validated in specific countries. The largest countries in terms of GDP, namely Germany, France and the UK, receive the most validations of international inventions, with validation rates of about 75% over the decade in each country. They are followed by Italy and the Netherlands, with significantly lower validation rates. The ranking clearly shows that EPO-granted patents are relatively rarely validated in central and eastern European countries, with validation rates way below 10%.[13]

10 Formal agreement on the two EU Regulations that made the Unitary Patent possible through enhanced cooperation at EU level was reached between the European Council and European Parliament on 17 December 2012. All EU member states except Spain and Croatia participate in the enhanced cooperation.

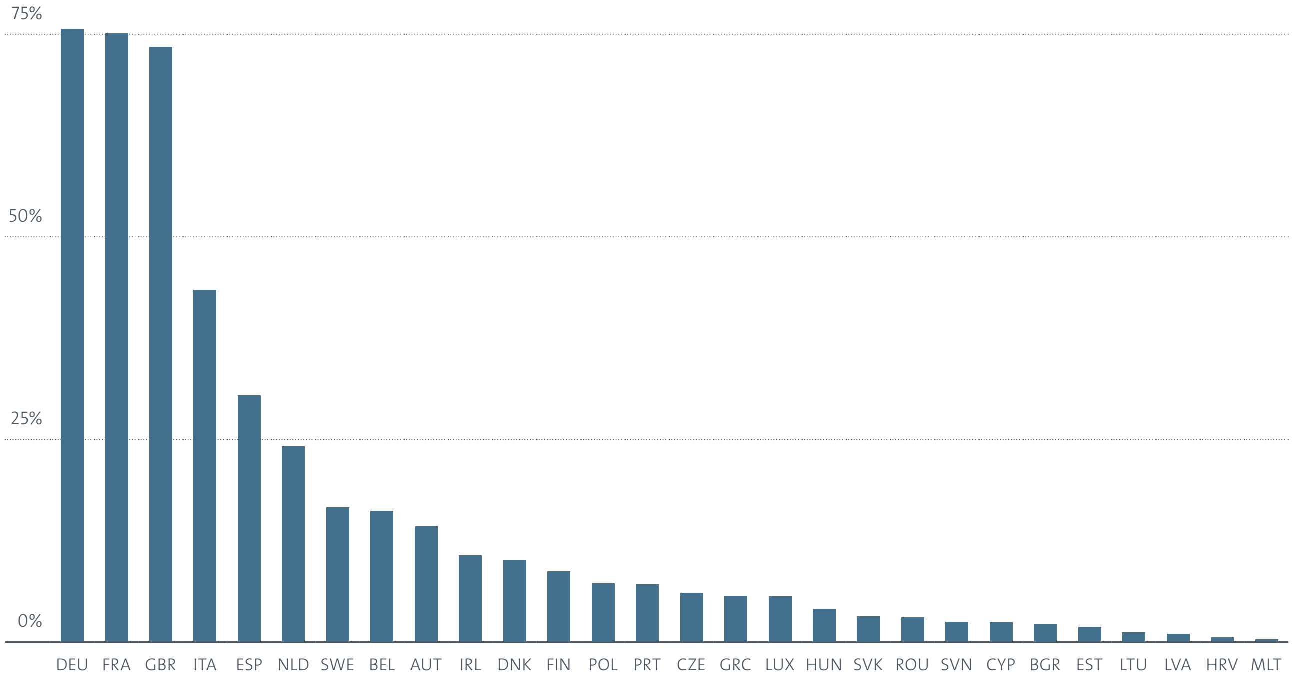
11 An analysis of the origins of patents, trade flows and FDI flows in different EU countries and sectors is reported in Annex 2. It shows a significant correlation of the origins of patents with the origins of trade flows and FDI flows.

12 Focusing on a ten-year period mitigates the impact of annual fluctuations, and the latest comprehensive year of data is 2014.

13 In a recent empirical study, Harhoff et al. (2016) analyse in more detail the various factors that prevent national validations. They confirm that the fees and translation costs that must be paid in each country constitute important barriers to validation. According to their estimates, a 1% decrease in the renewal fees or validation fees would lead to an increase in the probability of validation of, respectively, about 19.1% and 2.3%. The negative effect of translation requirements is found to increase with the size of patent documents. Against this backdrop, the validation of a European patent is more likely the higher the value of the patented invention, and the larger the size of the validation country. The estimated parameters suggest in particular that, all else being held equal, a 1% increase in the GDP per capita of the target country raises the probability of observing a validation by 37.3 percent. The probability of a validation is also lower for small applicants (such as SMEs or universities), and for applicants located outside Europe.

Figure 3

National validations of European patents granted 2005-2014, excluding domestic inventions



Source: Authors' calculations from the PATSTAT database

3.2 Different national jurisdictions

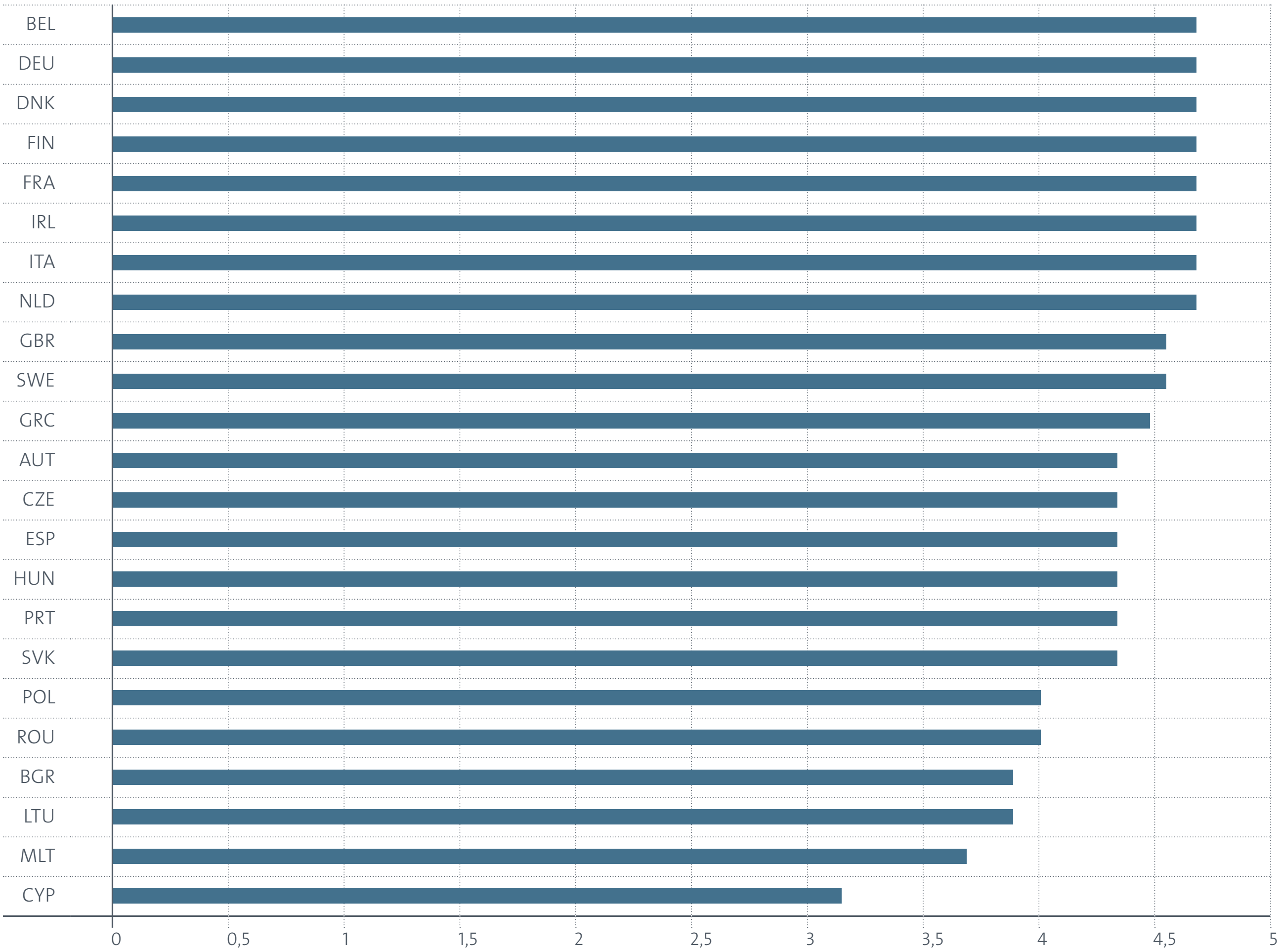
Patent holders who need to enforce their patents against infringers have to bring infringement actions before different national courts. This results in higher costs and complexity. In addition, there is significant legal uncertainty because of a risk of diverging and conflicting decisions of different national courts. The reason is not only the lack of harmonised laws on the scope of protection and on exceptions and limitations, but also that one and the same rules in the European Patent Convention which govern patentability are interpreted differently by different national courts. Moreover, the lack of specialised patent courts in the majority of EU Member States leads to long delays and unpredictability of decisions. This is a further reason for many patent holders to limit protection to a small number of countries.

This system may induce different degrees of patent protection in different EU countries. Despite the existence of uniform patent law under the European Patent Convention, there is indeed a lack of a harmonised interpretation of substantive law, which has led to different interpretations of infringement and patentability issues in different European countries. As an illustration, Figure 4 reports the different values of the Park index of patent protection between EU countries (Ginarte & Park, 1997; Park, 2008). This index considers five separate dimensions: the extent of coverage of patent protection, membership in international agreements, enforcement mechanisms, the duration of protection and restrictions on patent rights.[14] Since such criteria reflect only part of the relevant dimensions of the national patent systems, the Park index does not constitute a perfect measure of national protection. It does, however, provide an objective measure, based on standard criteria and allowing comparisons. According to these criteria, patent protection is strongest in Belgium, Germany, Denmark, Finland, France, Ireland, Italy and the Netherlands.

14 Each country received a score between 0 and 1 for each of the five components. The index is given by the unweighted sum of the respective scores and takes values between 0 and 5.

Figure 4

Park index of patent protection in EU Member States in 2010



Source: Park (2008) and update obtained directly from the author

Because of costs and complexity, patent holders and third parties alike try to avoid parallel litigation before different national courts. As a result patents are often neither enforced nor challenged in all countries in which they are validated.

Available studies estimate, for instance, that between 146 and 311 infringement cases were duplicated annually in the EU Member States as of 2009 (Harhoff, 2009), and that 8.4% of all litigated European patents (usually among the most valuable ones) in France, Germany, the Netherlands and the United Kingdom are subject to litigation in several countries (Kremers et al., 2013). In such cases, parties need to hire local attorneys and experts and pay court fees in all the states where litigation takes place. The resulting cumulative costs of parallel litigation can be very high and may constitute a major obstacle for both plaintiffs and defendants. This makes it difficult for SMEs in particular to effectively enforce their patents at the European scale, or to defend themselves if infringement actions are brought against them in several states.

All this is a cause of legal uncertainty for patent holders, competitors and the general public alike. Such uncertainty may induce a higher risk of litigation due to the difficulty of correctly anticipating the likely outcome of a dispute.[15] It may also make it especially difficult for patent holders and their competitors to make crucial business decisions relating to investment, production and marketing of patented products.

15 Economic research shows that legal disputes are mainly due to the parties' asymmetric information and diverging expectations about the likely outcome of litigation. By contrast, parties with common expectations about the litigation outcome have strong incentives to save litigation costs by reaching a settlement whereby they contractually replicate that expected outcome. See e.g. J. Lanjouw and J. Lerner (1998).

BOX 1

The Unitary Patent and Unified Patent Court

The creation of the Unitary Patent and Unified Patent Court will be an important step forward towards better integration and harmonisation of the European patent system. Although a full impact assessment of these reforms is beyond the scope of this study, their expected effects are briefly presented in this section.

Agreed on in 2012 by EU countries and the European Parliament, this "EU patent package"[16] will be applicable from the date of entry into force of the Agreement on a Unified Patent Court.

The creation of the Unitary Patent will give applicants a further option for obtaining pan-European patent protection, besides classic European patents granted by the EPO and national patents granted by national patent offices. A Unitary Patent is a European patent for which unitary effect will be registered by the EPO for the entire territory of the participating EU Member States at the patent proprietor's request. By requesting unitary effect for a European patent, applicants will thus have an opportunity to avoid the complex and costly national validation procedures before up to 26 national patent offices, while securing the same protection in all jurisdictions.

- The Unitary Patent will establish a one-stop-shop basis, substantially reducing the administrative burden for patent proprietors. The need to translate patent specifications, or parts of them, for validation purposes in countries with specific language requirements will disappear. No fees are due before the EPO for the filing and examination of the request for unitary effect or for the registration of unitary effect, which will remove the need to pay validation fees to national patent offices (i.e. the fees due in some Member States for publication of the translations) and the associated representation costs, such as the attorney fees relating to the national processing of the patent.

- The Unitary Patent will also replace the currently fragmented system of renewal fee payments by introducing a single payment for all the participating Member States at a level equivalent to the combined renewal fees payable in the top four participating EU Member States where a European patent was most frequently validated at the time the renewal fee scale was adopted (Germany, France, the Netherlands and the United Kingdom). These fees can be paid without a professional representative. Consequently, patent proprietors will be able to save the fees they currently pay to attorneys and service providers for the renewal fee payments in the different EU Member States.

As a result, overall costs for a Unitary Patent will be lower than for an average European patent validated in four EU Member States.[17] But more importantly, the protection provided by the Unitary Patent will cover a much broader territory of up to 26 countries. Besides lowering barriers to national market entry, this will put applicants in a better position to decide whether to enter new markets at any time, depending on the success of the product or on new business opportunities in other EU markets.

In addition, the Agreement on the Unified Patent Court (UPC) will be instrumental in establishing an effective forum for enforcing and challenging Unitary Patents and European patents and harmonising the scope and limitations of the rights conferred by a patent, and remedies available beyond EU Directive 2004/48/EC (Enforcement Directive). It will establish a unified specialist court to hear cases in relation to classic European patents and Unitary Patents for the EU Member States for which it enters into force. The UPC will enable patent proprietors to better enforce their valid patents, with Europe-wide effects of decisions, injunctions and damages, and enable third parties and the general public to seek revocation of European patents and Unitary Patents through a central revocation action, separate from the EPO's opposition procedure, at any time during the life of the patent.

The new court will take a harmonised approach to both patentability and patent infringement, with a uniform set of rules of procedure and experienced judges. It is thus expected to ensure a more affordable, harmonised and predictable patent system at the European scale:

- First of all, the UPC will limit the need for parallel litigation in different countries relating to the same patent and involving the same parties. As a result, the costs of litigation will be lower than for such parallel litigation and, in some cases, lower even than the cost of litigating in a single country. Potential yearly

16 The EU patent package is a legislative initiative consisting of two regulations and an international agreement that lay the ground for the creation of unitary patent protection in the EU.

17 See Annex 3 for an indicative comparison between the costs of a Unitary Patent and an average European patent.

savings from having access to a court system like the UPC have been estimated at between EUR 148 and 289 million in total (Harhoff, 2009).

– The UPC will also significantly reduce the uncertainty inherent in parallel litigation in cross-border cases by removing the risk that different national courts will issue conflicting and sometimes even contradictory decisions involving the same patents and the same parties. For the states where the UPC Agreement is in force, the UPC will harmonise the case law and so enhance legal certainty for all businesses. The overall increase in legal certainty has the potential to facilitate early settlements and thus enable parties to save litigation costs. The benefits of this harmonisation will also extend beyond the states where the UPC Agreement is in force if courts in other states are inspired to follow the UPC's case law.

Combining these elements, the Unitary Patent and the UPC will constitute a major improvement in comparison with the current fragmentation of the European patent system. By offering a cost-effective route to patent protection and dispute settlement across Europe, these reforms will foster the European Single Market for technology, and can be expected to boost trade and technology transfers towards EU countries where European patents are currently seldom validated.

4. Measuring trade and FDI in the EU: data and empirical approach

Because of the fragmentation and incomplete harmonisation of the European patent system, it is likely that the full potential of the European Single Market is not realised for trade and FDI in patent-intensive industries. This chapter presents the methodology that is used in the next chapter to empirically address this question.

The approach consists in assessing empirically the impact of the patent system on trade and FDI in the European Union, and the potential benefits of enhanced harmonisation of patent law. For this purpose, two econometric models are used to estimate, in turn, the effect of patent protection on incoming flows of imports and FDI to EU countries. In both cases, the strength of patent protection in EU countries is derived from a standard metric for the strength of patent protection in the economic literature (e.g. Hu and Png, 2013; Maskus and Yang, 2013). This measure is derived from the combination of two complementary indices, accounting respectively for the presence or absence of particular legal provisions in patent laws (Park index), and for the general efficacy of administrative and judicial enforcement mechanisms in the country of interest (Fraser index).

The chapter is organised in three sections. The first two sections introduce respectively the data on trade flows and FDI that is used for the empirical analysis, and the econometric model. The methodological limitations of this approach are discussed in the third section.

4.1 High-IP trade and FDI flows in the European Union

This section introduces the data on trade and FDI that will be used for the econometric analysis. It explains as a first step how these data are constructed in order to identify trade and FDI flows in industries that intensively use intellectual property rights (hereafter high-IP industries). It then presents some descriptive statistics on the contribution of these industries to trade and FDI in the European Union.

Measuring trade and FDI in high-IP industries

Data on manufacturing imports at bilateral level are compiled using the CEPII's BACI database, which contains detailed bilateral import and export statistics from the United Nations Commodity Trade Statistics database (UN COMTRADE). The very detailed classification system used in this database (a six-digit classification of commodities) makes it possible to specifically identify trade flows at the sector level.

Data on bilateral FDI flows in manufacturing are compiled using the Zephyr database of Bureau van Dijk. Zephyr provides the number and the value of completed deals of any kind including acquisition, capital increase, minority stake and share buyback deals. Acquiring companies and target companies are identified, as well as the country and industry in which they operate. Although Zephyr is one of the most comprehensive datasets of its kind, it does not cover every investment deal. In particular, deals of low value are potentially under-reported in the data because they are harder to measure. Consequently, FDI flows are generally underestimated. This underestimation could be even more significant within the single market because lower FDI costs allow more low-value investment deals to be made.

The identification of traded goods and FDI in high-IP, medium-IP and low-IP industries is based on the definition of high-IP products as constructed by Delgado et al. (2013) and shown in Table 1 below. The product categories based on SITC Rev. 3 (Standard International Trade Classification, Revision 3) are matched with the HS product classification used in the United Nations Commodity Trade Statistics Database (UN COMTRADE), making it possible to obtain aggregated trade flows in high-IP and low-IP industries. FDI flows are in turn classified by IP sensitivity, using the NACE Rev. 2 industry code of the target company.

BOX 2

Definition of high-IP and low-IP industries

High-IP clusters

Biopharmaceuticals	
Medicinal & pharmaceutical products	
Analytical Instruments (AI)	
Optical instruments	
Laboratory instruments	
Process instruments	
ICT	
Office machines	
Computers & peripherals	
Communications equipment	
Electrical & electronic components	
Medical Devices	
Diagnostic substances	
Medical equipment & supplies	
Chemicals	
Organic chemicals	
Chemically based ingredients	
Production Technology (PT)	
Materials & tools	
Process & metalworking machinery	
General industrial machinery	

Low-IP products

Food & live animals	
Crude materials, inedible, except fuels	
Mineral fuels, lubricants & related materials	
Animal & vegetable oils, fats and waxes	
Prefabricated buildings	
Apparel and accessories	
Prefabricated buildings	
Travel goods	
Manufactured goods by material	
	Leather
	Cork & wood
	Textiles
	Non-metallic minerals
	Non-ferrous metals
	Metals

Source: Delgado et al. (2013), Table A4b-c: Definition of high-IP clusters and low-IP products

Descriptive statistics

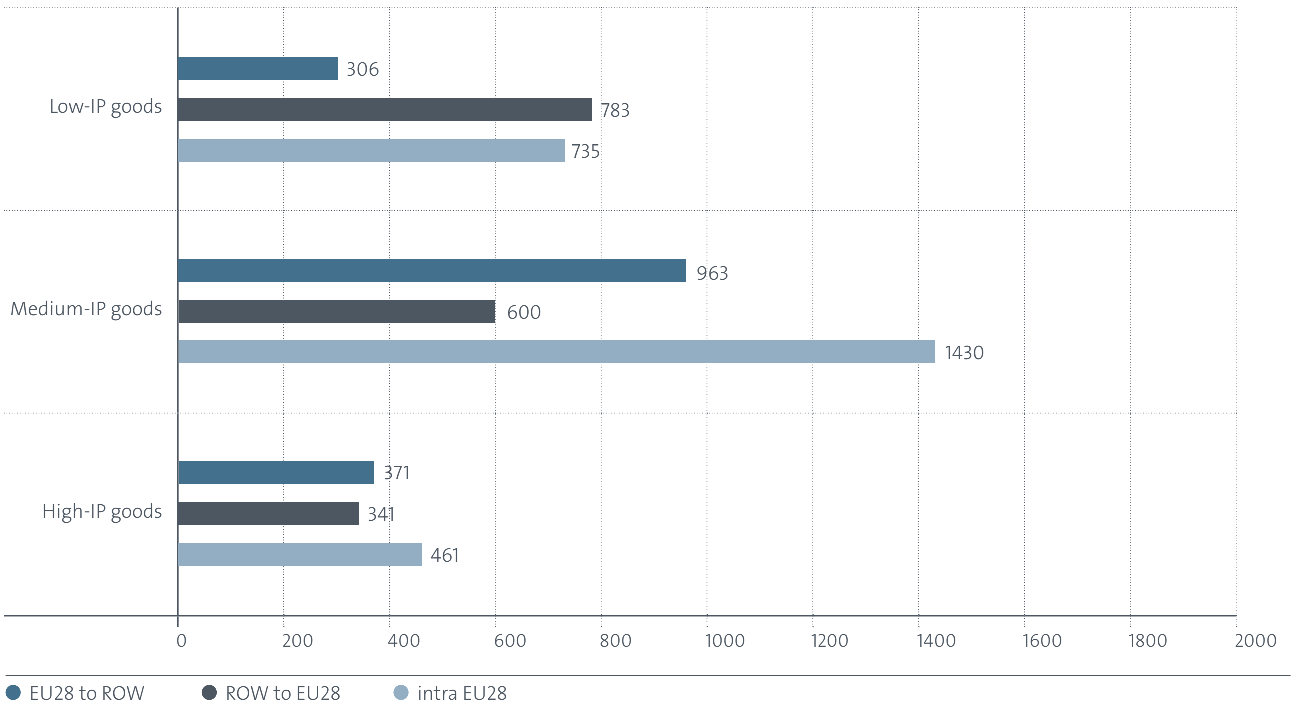
Figure 5 shows how the trade flows observed in 2014 are distributed between low-IP, medium-IP and high-IP goods. It firstly indicates that the weights of imports and intra-EU trade are relatively lower in high-IP goods. In 2014, high-IP goods accounted for about 23% (EUR 371 billion) of EU28 exports to the rest of the world, 20% (EUR 341 billion) of its imports from the rest of the world and only 18% (EUR 461 billion) of its internal trade. The opposite category of low-IP products accounts in turn for about 19% (EUR 306 billion) of EU28 exports to the rest of the world, 45% (EUR 783 billion) of its imports from the rest of the world and 28% (EUR 735 billion) of its internal trade.

Figure 5 also shows that the EU28 has better trade positions vis-à-vis the rest of the world for IP-related products. Comparing the flows of EU28 exports to and imports from the rest of the world reveals that the EU28 is a net exporter of high-IP and medium-IP products, with trade surpluses of respectively EUR 30 billion and EUR 393 billion in these categories. Conversely, it has a significant trade deficit of EUR 477 billion for low-IP products. These findings are similar to those of a recent EPO-EUIPO study (2016) which concludes that IPR-intensive industries and patent-intensive industries are major contributors to the EU's external trade and trade surplus.

Overall, EU-internal trade accounts for the largest share of total EU exports (61%) and imports (60%), although EU countries import fewer low-IP goods from other EU countries than from the rest of the world. In the case of high-IP goods, internal trade represents respectively 55% of EU28 exports and 57% of EU28 imports of high-IP goods.

Figure 5

Trade flows by low, medium and high-IP goods in the EU28 in 2014 (billion EUR)



Source: UN COMTRADE, Classification of goods into high/medium/low-IP is based on Delgado et al. (2013)

The EU's FDI flows in low-IP, medium-IP and high-IP sectors between 2012 and 2015 are reported in Figure 6. The annual value of these FDI flows is much lower than the value of annual trade flows reported in Figure 5. However, they are also of a different nature. Trade flows reflect the value of manufacturing goods transferred within a year from one country to another. By contrast, FDI flows reflect investment in productive capital. They are made in a longer-term perspective, and are likely to in turn generate economic activities and additional trade in the recipient country.

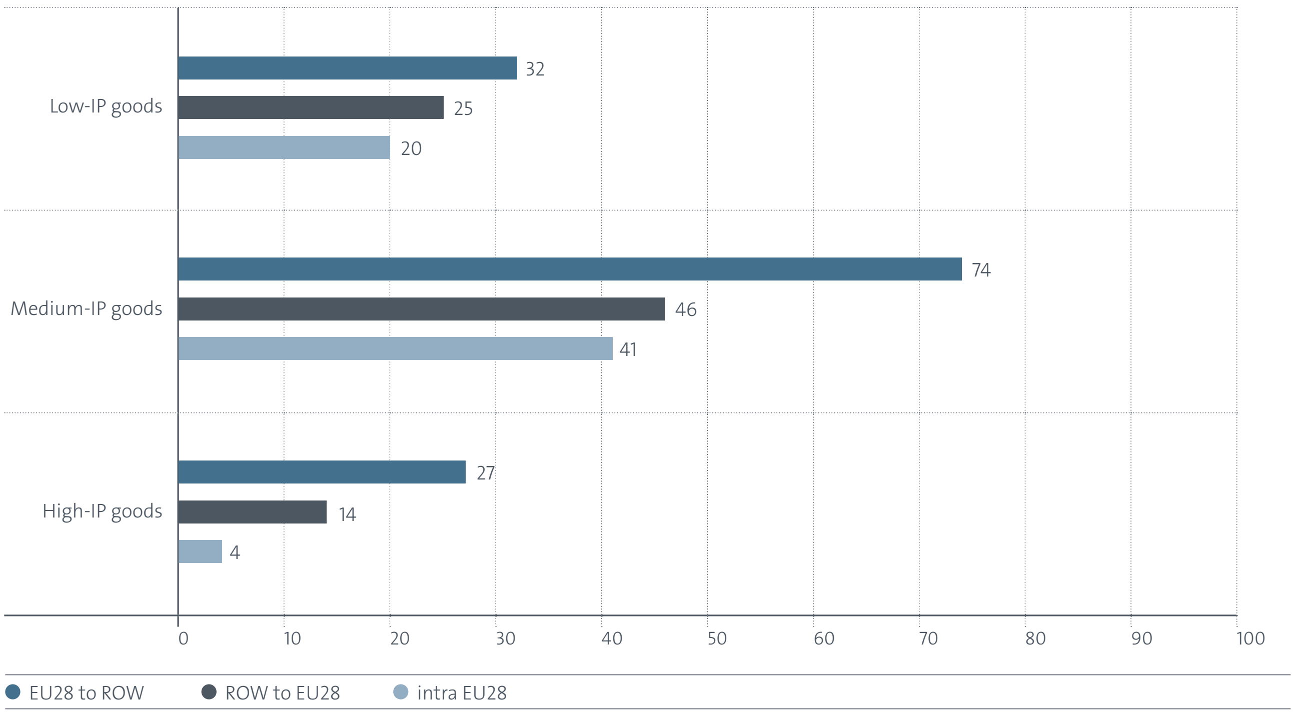
Figure 6 again suggests that the weight of intra-EU FDI is relatively lower in the high-IP category. In 2014-2016, high-IP FDI accounted for about 20% (EUR 27 billion) of EU28 FDI to the rest of the world, 16% (EUR 14 billion) of FDI from the rest of the world to the EU28 and only 6% (EUR 4 billion) of FDI flows between different countries of the EU28. The opposite category of low-IP FDI accounts in turn for about 24% (EUR 32 billion) of EU28 FDI to the rest of the world, 29% (EUR 25 billion) of its imports from the rest of the world and 31% (EUR 20 billion) of its internal trade.

These statistics show that the EU attracts less FDI from the rest of the world than it invests in the rest of the world. The EU is a net foreign investor in low-IP industries (+EUR 7 billion), and even more so in medium-IP industries (+EUR 28 billion), and in high-IP industries (+EUR 13 billion).

Overall, intra-EU FDI flows account for a minority of the FDI originating from the EU28 (32%) and of the inward-bound FDI to the EU28 (43%). Although the same pattern prevails in all categories of goods, it is particularly strong in high-IP goods, where intra-EU FDI represents only 13% of outward-bound FDI and 14% of inward-bound FDI.

Figure 6

FDI by low, medium and high-IP manufacturing industries in the EU28 (billion EUR, av. 2012-2015)



Source: Zephyr of Bureau van Dijk and Delgado et al. (2013)

Table 1 presents a country-level perspective on the trade and FDI inflows towards EU countries, with a focus on the share of flows that are related to high-IP goods.

Columns 1 and 3 present the total trade and FDI flows towards each Member State as a percentage of its GDP, such that the size of the economy is accounted for. In 2014, the Member States that imported the most relative to their GDP are Malta (106%), the Slovak Republic (78%) and Estonia (76%). At the opposite pole are France (23%), the United Kingdom (22%) and Italy (22%). Looking at the share of high-IP imports in total imports, a different picture is displayed, suggesting that top importers are not necessarily also importing the most high-IP-related goods. Column 2 indicates that the highest relative shares are found in the Czech Republic (26.4%) and Hungary (25.3%), where more than a quarter of total imports are the product of high-IP industries. In fact, among the countries where the share exceeds 20%, the majority are Eastern European. The average share of high-IP imports among the EU28 Member States is 17.7%, and most of the Western countries are situated below this average, suggesting there is an asymmetry in the importing patterns of the Western and Eastern countries. Malta and Cyprus import the fewest high-IP goods, in both absolute and relative terms.

As already explained, compared with trade, annual FDI flows are of a different nature and thus generally smaller in size, which explains the much smaller values of FDI relative to GDP. Over the period 2012-2015, the largest annual FDI flows relative to GDP were registered in Ireland (11.96%), Luxembourg (11.91%) and the Netherlands (6.89%), whereas the smallest ones were registered in Romania (0.18%), Lithuania (0.14%) and the Slovak Republic (0.02%). Eastern European countries are generally small recipients of FDI.

The distribution of the share of high-IP FDI flows is much more skewed than in the case of trade. Column 4 in Table 1 shows that the proportion of high-IP FDI exceeds 50% in Finland (54.4%) and Ireland (53.4%),[18] which is substantially larger than the EU28 average of 7.33%. Moreover, the divide between West and East appears to be much stronger in the case of high-IP FDI flows compared to trade flows. Only Western economies are situated above the EU28 average share. Eastern European countries are lagging in this respect and appear to attract technology transfers mainly through imports and not as much through FDI.

18 Ireland is frequently used as a hub by US companies to establish their European operations, especially in the Information and Communication Technology sector. The large share of high-IP FDI in Finland is largely explained by the acquisition of Nokia by Microsoft in 2013.

Table 1

Trade and FDI flows in high-IP industries by EU countries

	Trade flows (2014)		FDI flows (annual average 2012-2015)			
			FDI value		FDI deals	
	All goods (% of GDP)	High-IP (% of all imports)	All FDI (% of GDP)	High-IP (% of all FDI)	All FDI (nb of deals)	High-IP (% of all FDI)
AUT	38.8%	17.5%	**1.15%**	**2.0%**	**42**	**15.7%**
BEL*	75.3%	17.1%	1.89%	2.4%	77	13.6%
BGR	59.3%	14.6%	3.04%	0.1%	144	7.3%
CYP	37.0%	10.0%	1.21%	0.0%	8	9.4%
CZE	72.9%	26.4%	0.93%	1.2%	41	11.7%
DEU	29.1%	20.0%	2.43%	13.3%	526	24.2%
DNK	28.2%	18.2%	3.93%	25.2%	91	16.9%
ESP	24.9%	15.2%	1.47%	2.5%	446	8.4%
EST	76.0%	18.9%	2.09%	0.0%	35	5.7%
FIN	26.8%	16.9%	6.10%	54.4%	188	18.0%
FRA	23.1%	16.1%	1.51%	1.5%	415	14.9%
GBR	22.1%	17.5%	2.80%	8.1%	677	15.6%
GRC	25.6%	12.9%	0.83%	0.0%	11	2.2%
HRV	38.4%	14.5%	0.58%	0.2%	16	7.7%
HUN	71.4%	25.3%	0.40%	0.3%	28	11.7%
IRL	28.5%	24.1%	11.96%	53.4%	36	13.8%
ITA	21.6%	15.9%	1.59%	9.9%	251	23.0%
LTU	70.9%	14.5%	0.14%	1.0%	14	5.6%
LUX	–	–	11.91%	1.4%	28	12.4%
LVA	55.3%	16.5%	1.20%	0.1%	24	5.2%
MLT	106.2%	11.6%	0.47%	0.0%	< 1	0.0%
NLD	63.4%	21.3%	6.89%	5.6%	247	13.1%
POL	40.2%	19.4%	0.74%	3.9%	177	10.2%
PRT	34.6%	13.6%	0.90%	5.1%	26	8.7%
ROU	37.5%	21.0%	0.18%	0.7%	39	6.4%
SVK	78.1%	22.2%	0.02%	0.0%	8	6.1%
SVN	60.0%	16.5%	0.60%	0.8%	19	9.1%
SWE	26.8%	19.4%	5.21%	12.1%	205	24.1%

* UN COMTRADE data for Belgium includes the trade flows to Luxemburg

4.2 Econometric model

This section presents the econometric model and variables that are used to assess the impact of patent protection on incoming trade and FDI flows in EU countries.

The baseline model relates bilateral trade or FDI flows to or between EU28 countries to a set of variables that are expected to influence them, including an index of the strength of patent protection in each importing country. The model employs panel data and follows a standard gravity specification, whereby trade flows can be influenced by various measures of distance (e.g. geographic, linguistic, legal) between the source and recipient countries, in addition to the policy variables of interest.

In line with the recent empirical trade literature, the gravity equation is estimated in its multiplicative form (Santos Silva & Tenreyro, 2006). Since the value of trade and FDI between two countries in any period is a non-negative integer, it is natural to model the conditional mean as a log-link function of explanatory factors and to use a Poisson maximum likelihood estimator.[19] The baseline empirical model is:

$$F_{ijt} = exp\{\beta_1 \, Patent\_protection_{jt-1} + \beta_2 \, X_{ijt-1} + \gamma_{ij}\} + u_{ijt}$$

19 Non-linear models initially developed for count data analysis can be successfully applied to continuous variables such as trade data (Wooldridge, 2010). Studies have shown that log-linearised models estimated by OLS can be inefficient and biased where the data is heteroskedastic (Santos Silva & Tenreyro, 2006), as is often the case with bilateral trade data.

The dependent variable F_{ijt} is either the flow of trade or the flow of FDI from any source country *i* to EU28 country *j*, in year *t*. Following the definition of Delgado et al. (2013), bilateral flows are aggregated in three categories according to the product's IP intensity: low-IP, medium-IP and high-IP (see Box 1). Therefore, for both trade and FDI flows, the model is estimated several times, where the dependent variable F_{ijt} is in turn the sum of all bilateral flows, flows in low-IP, medium-IP and high-IP industries respectively.

The key explanatory variable of interest is $Patent\_protection_{jt}$ which measures the strength of patent protection in the *importing* country *j* in year *t*. This variable is defined as the product of two different indices:

– The first is the Park index, a composite indicator of various measures of patent protection available for 122 countries from 1960 to 2010 (Ginarte and Park, 1997; Park, 2008), and a standard metric for the strength of patent protection in the economic literature. The index focuses on the presence or absence of particular legal provisions in patent law and considers five separate dimensions: the extent of coverage, membership in international agreements, enforcement mechanisms, duration of protection and restrictions on patent rights. It therefore accounts *inter alia* for the countries' participation in the European patent system.

  Each country received a score between 0 and 1 for each of the five components of the Park index. The index is given by the unweighted sum of the respective scores and takes values between 0 and 5. Therefore, a country where patent protection is relatively stronger is associated with a higher value of the Park index. This index covers 122 countries from 1960 to 2010, in five-year intervals. For the years that are not available in the original source, the index was calculated by linear interpolation. Note that published versions of the Park index cover only the years 1960-2005. An update of the index to the year 2010 was obtained directly from the author.

– Since the Park index focuses only on the presence or absence of particular legal provisions, it does not account for the general efficacy of administrative and judicial enforcement mechanisms in the country of interest. Therefore, it is multiplied by the Legal index of legal systems and property rights in country *j* in year *t* (from the Fraser Institute's Economic Freedom of the World Annual Report).

  This combination provides a better indicator of the effectiveness of patent protection, and has been used in previous studies for this reason (Hu and Png, 2013; Maskus and Yang, 2013). The Legal index is reported on a scale of 0 to 10 and has been compiled from several measures relating to the efficacy of the judicial system, including protection of property rights. Therefore, the combined Patent protection index used in this study takes values between 0 and 50, with larger values indicating stronger patent protection.

X_{ijt} is a vector of control variables derived from the gravity literature. The following variables are common to the trade and FDI models:

– GDP_{it} and GDP_{jt} are the gross domestic products of countries *i* and *j* in year *t*, measured at market prices in current USD. Following the logic of gravity models, these indicators of the economic size of countries *i* and *j* are expected to positively influence the volume of bilateral trade or FDI flows between these countries. GDP data is from the World Bank's World Development Indicators.

– $GDPCAP_{jt}$ is the per capita gross domestic product of country *j* in year *t*, measured at market prices in current USD. It is an indicator of economic development in the importing/recipient country. It also makes it possible to control for possible correlations between the Park index and economic development in the recipient country.[20]

In addition, a number of control variables are specific to each of the two models considered:

– The trade model includes $Tariffs_{jt}$ and $NTbarriers_{jt}$ to control for tariffs and non-tariff trade barriers in the importing country. They are expected to have a negative impact on trade flows. Data on average tariffs at the country level and on non-tariff trade barriers comes from the Fraser Institute's Economic Freedom of the World Annual Report. The tariffs indicator is compiled based on three sub-components: revenues from trade taxes, the mean tariff rate and the standard deviation of tariff rates. In addition, the indicator of non-tariff trade barriers is derived from an annual survey conducted among businesses. Both variables are reported on a scale of 0 to 10, where a higher rating is given to a country with relatively lower trade barriers.

– $FreeMov_{jt}$, $LabReg_{jt}$ and $BusReg_{jt}$ are additional FDI gravity controls measuring respectively the freedom of FDI and movement of people, labour regulations and the weight of business regulations in the recipient country. These data come from the Fraser Institute's Economic Freedom of the World Annual Report.

20 See discussion of the Park index in Section 4.3

– In the trade model, the dummy variable $BOTHEEA_{ijt}$ indicates whether both countries *i* and *j* are part of the European Economic Area (EEA) in year *t*. It aims to control for the late entry into the European Union of some of the countries of interest during the focus period of the study. The dummy variables $BOTHEURO_{ijt}$ and $BOTHSCHENGEN_{ijt}$ indicate respectively whether countries *i* and *j* are part of the Eurozone and Schengen area.

– In the FDI model, these variables are adapted in order to account for the effect that a country's participation in a broader trade area may have on its ability to attract FDI. The dummy variable EEA_{jt} thus indicates whether country *j* is part of the European Economic Area (EEA) in year *t*. The dummy variables $EURO_{jt}$ and $SCHENGEN_{jt}$ in turn indicate whether country *j* is part of the Eurozone and Schengen area.

In line with the literature, all control variables are lagged by one year in order to mitigate potential endogeneity issues due to contemporaneous feedback effects.[21]

An important advantage of the chosen specification is that it includes country-pair fixed effects, denoted by γ_{ij}, for each combination of exporting and importing countries. These fixed effects capture any factor that is specific to a given country-pair and constant over time that is potentially correlated with patent protection. This includes the effects of other commonly used country-pair specific gravity model variables such as distance, contiguity, common language, common currency or colonial ties, which are time-invariant characteristics.

4.3 Limitations and caveats

This section reviews possible limitations of the empirical methodology implemented in this study. It explains first how empirical results can be interpreted in the light of the methodology, before discussing some specific limitations of this methodology.

Interpretation of the results

The empirical approach defined in this chapter and implemented in the next chapter aims to assess the sensitivity of trade and FDI to patent protection in different EU countries, and thereby to document evidence of a gap in the realisation of the single market for technology. However, it is important to bear in mind that it does not account for all the dimensions of the European patent system, and thus for all the barriers that may prevent the circulation of patented inventions between EU countries.

The strength of patent protection is measured by the Park index, which focuses primarily on the presence or absence of legal provisions relating to patent rights. As already stated, this index does not reflect the effectiveness of enforcement practices of such laws in the country of interest. Overall effectiveness of patent protection must consider both the presence of substantive patent law and the strength of its enforcement, which should be treated as complementary factors. For this reason, several scholars have suggested combining the Park index with the Fraser Institute's index of legal system and property rights, as the closest metric of enforcement of patent rights that is available (Hu and Png, 2013; Maskus and Yang, 2016). The multiplication of the two metrics is explained by their complementarity: for an inventor, the presence of complete patent laws with zero enforcement has the same implications as a complete absence of such laws.

However, the Fraser index of "Legal and Property Rights" is also subject to some limitations. It is based on a survey in which a limited number of business leaders or political experts from different countries are asked to provide a subjective assessment. It may therefore not constitute a fully objective measure of each country's legal system. In addition, not all the dimensions included in the index are equally relevant to patent protection and enforcement. Conversely, the Fraser index alone may capture some dimensions of the legal system that influence trade or FDI through channels other than the impact on patent enforcement.

21 For example, trade at time *t* directly influences GDP at time *t* but not GDP at time *t-1*.

Moreover, even the combination of the Park and Fraser indices does not capture all relevant aspects of the European patent system. In particular, neither of these two indices account for the cost of obtaining patent protection in EU countries through either applications at national patent offices or the validation of granted European patents in EPO member states. As a result, the econometric analysis does not make it possible to identify the impact on trade and FDI of this cost barrier to patent protection. Since the decision to obtain a national patent is largely driven by the size of the targeted market, this impact is indeed mainly controlled for by the country variables and country-pair fixed effects in the economic regressions. Further statistical analyses have been carried out to measure the correlation between patenting decisions and trade or FDI flows in EU countries. These analyses are reported in Annex 2. They suggest a significant correlation between the origin of patents and trade or FDI flows at the national level.

Against this backdrop, the main contribution of the study is to produce empirical evidence of the sensitivity to patent protection of trade and FDI flows in different industries, and of the relative magnitude of the resulting gap in incoming trade and FDI in different EU countries. By contrast, the results are not to be interpreted as a comprehensive impact assessment of the different limitations to trade and FDI created by the current European patent system. For the same reasons, the results of the study are not to be interpreted as an assessment of the expected effects of the Unitary Patent and Unified Patent Court. The effect of the cost savings allowed by the Unitary Patent is in particular outside the scope of the empirical methodology.

Methodological limitations

A first limitation of the chosen methodology is that FDI and trade are considered as independent economic phenomena in the chosen baseline econometric models, whereas in practice they are two interdependent channels for transferring technologies and selling products abroad. The interplay between trade and FDI is actually complex and may involve effects working in opposite directions. On the one hand, FDI can be a substitute for trade, allowing foreign companies to produce and sell goods directly in the targeted country instead of exporting them from abroad. On the other hand, local subsidiaries of foreign companies usually operate as part of broader international value chains.[22] As such, their activities are likely to generate additional imports of foreign-sourced intermediary goods, as well as exports towards other countries located downstream of the value chains. Solving these interdependences would require estimating a system of simultaneous equations, but in the absence of an established theoretical basis for the structural relationship between trade and FDI, separate reduced-form regressions were preferred as a more conservative approach for the present study.

In contrast with the UN COMTRADE database, which provides comprehensive and detailed global data on bilateral trade flows, the FDI data employed in this report also present two caveats. Firstly, the Bureau van Dijk Zephyr database does not cover every investment deal, and the countries where the investment deal takes place is likely to influence the probability of a deal being reported in Zephyr. This especially concerns countries with lax filing laws, where it is hard to track documents such as statements of capital.[23] Consequently, the least-developed countries are under-represented in the data. The size of the deal can also matter: deals of low value are potentially under-reported in the data because they are harder to track. Secondly, the Zephyr database does not allow financial investments to be distinguished from productive investments. While the latter are indicative of a transfer of production knowledge, the former are not. As a result, the empirical analysis may potentially underestimate the effect of patent protection on inward FDI in productive capital.

The use of the Park index as a measure for patent protection also implies a number of limitations. As already mentioned in section 4.2, this index covers a large number of countries (122) and a long time period (from 1960 to 2010). However, it is only available in five-year intervals, thus restricting the number of observations available in the period of interest for this study. This problem has been dealt with by using linear interpolation to infer interim values of the Park index for the years where the index was not available. This approach greatly enhances the number of available observations for the econometric estimation. It does however weaken the identification of the impact of patent reforms, by failing to identify the precise year during which they were implemented. The Park index is also likely to be correlated with the level of economic development (Maskus & Penubarti, 1995), implying a risk of picking up the impact of the latter in the regressions. This potential limitation is dealt with by using the level of per-capita GDP in the recipient country as a control variable in the gravity model.

22 The concept of global value chains (GVCs) refers to the full range of activities performed, across a potentially large number of countries, to bring a product from research and development to the final consumer (OECD, WTO & World Bank Group, 2014). According to the OECD (2015), about three-quarters of international trade in 2011 was generated by firms importing inputs and investment goods or services that contribute to the production process (Figure 3). Against this background, the countries' trade performance largely depends on their ability to effectively access foreign markets by profitably (re)exporting components or services that are themselves derived from imported inputs. This supposes, among other factors, an ability to develop capabilities in the high value-added segments of the GVCs, by allocating workers and attracting investments into the most productive activities.

23 In contrast, in countries like the UK, firms are required to file annual accounts through the government body "Companies House", which makes the information about a deal easier to collect.

5. Impact of patent protection on high-IP trade and FDI in the EU

In this Chapter, the methodology described in Chapter 4 is applied to empirically assess the impact of patent protection on trade and FDI flows in the European Union. The first two sections present the results of the estimation of the econometric models for trade and FDI. In the third section, the estimated econometric models are used to assess the economic impact on trade and FDI of a European harmonisation of patent law, as measured by the Park index.

As explained in the previous Chapter, the empirical analysis focuses on the legal scope and effectiveness of patent protection in the recipient countries, with a view to assessing the sensitivity of international trade and FDI flows to such protection. In that respect, it accounts for only parts of the effect of the fragmentation of the European patent system, as the barriers to patenting created by the cost of patent protection and enforcement in different EU countries are not assessed in this analysis.

5.1 Impact of patent protection on trade

This section reports the results of the econometric analysis of the impact of patent protection in the recipient country on trade flows in the European Union. The purpose of this analysis is to assess whether the degree of patent protection in European countries has an effect on the volume of imports of high-IP goods in the European single market.

The econometric model for trade is estimated as a conditional fixed-effects Poisson regression, based on the observation of 43 945 combinations of exporting country, importing country and year for each IP sensitivity category. As stated above, the equation is estimated separately for total trade and for trade in high-IP, medium-IP and low-IP goods respectively. The regression sample includes the bilateral trade flows between twenty four[24] importing EU28 countries and 183 exporting countries between 2001 and 2011. Descriptive statistics for the estimation sample are provided in Table 2.

Table 2

Descriptive statistics for the trade regressions

Variable	Obs	Mean	Std. Dev.	Min	Max
Total trade (in USD million)	43,945	1,023.58	5,038.22	0	127,877.90
Trade low-IP (in USD million)	43,945	333.16	1,608.14	0	51,563.28
Trade med-IP (in USD million)	43,945	490.70	2,773.30	0	85,747.08
Trade high-IP (in USD million)	43,945	199.71	1,130.52	0	40,237.19
Park x Legal index	43,945	31.03	7.25	16.85	44.91
Log GDP_i (source)	43,945	23.63	2.43	16.40	30.34
Log GDP_j (importer)	43,945	26.19	1.53	22.18	28.95
Log $GDPCAP_j$ (importer)	43,945	9.91	0.83	7.38	11.07
$TARIFFS_j$ (0-10 lower)	43,945	8.45	0.53	6.86	9.76
$NTBARRIERS_j$ (0-10 lower)	43,945	7.90	0.86	5.2	4.80
Both EEA members	43,945	0.09	0.28	0	1
Both in the Eurozone	43,945	0.03	0.18	0	1
Both in Schengen	43,945	0.05	0.23	0	1

24 The Park index is not reported for Croatia, Estonia, Latvia and Slovenia, and therefore these countries are excluded from the analysis.

The results of the estimations are presented in Table 3. The model is estimated for all goods pooled together (column 1), and then separately for high-IP goods (column 2). In addition, the last two estimations focus on imports of high-IP goods originating respectively in other EU countries (column 3) or from non-EU countries (column 4).

The results of the pooled estimation (1) suggest that stronger patent protection in the importing country, as measured by the combined Park and Fraser indices, has no statistically significant impact on the imports of all goods taken globally. However, estimation (2) indicates that patent protection has a positive impact on the import of high-IP goods. This is confirmed by estimations (3) and (4): the combined Park and Fraser indices have a significant effect on imports of high-IP goods originating in both EU and non-EU countries, although the magnitude of the effect appears stronger in the latter case. These results therefore show that trade in patent-intensive goods in the European Single Market is sensitive to the degree of patent protection in European countries. Unsurprisingly, trade in goods that are not considered patent-intensive is not affected by patent protection.

GDP in the source country is found to have significant positive effects on trade flows. In addition, per-capita GDP in the destination country is also positively impacting trade flows, suggesting that higher income per head reflects a larger demand for imports. Once the level of economic development in the destination country is controlled for per-capita GDP, the size of the economy (GDP) is found to negatively affect trade flows. A larger economy can produce more domestically in order to meet local demand and relies less on imports. The participation of the exporting and importing countries in the EEA also has a positive and significant impact on specifications (1) to (3), but a negative one when high-IP imports originate from non-EU countries. Tariffs and non-tariff trade barriers do not have any statistically significant effect.

Table 3

Result of conditional fixed-effects Poisson regression on the impact of patent protection on trade

	(1) Total Trade	(2) High-IP	(3) High-IP EU origin	(4) High-IP Other origin
$Park_j$ x Legal $index_j$	0.0058	0.0223***	0.0132*	0.0405***
	(0.0032)	(0.0063)	(0.0073)	(0.0108)
Log GDP_i	0.6178***	0.8269***	0.9056***	0.9072***
	(0.0299)	(0.0694)	(0.1394)	(0.0807)
Log GDP_j	-1.5302***	-2.7082***	-2.4781***	-2.6812**
	(0.3274)	(0.6799)	(0.7787)	(1.0915)
Log $GDPCAP_j$	1.9493***	3.3672***	3.0589***	3.5279***
	(0.3122)	(0.6326)	(0.7200)	(1.0643)
$TARIFFS_j$ (0-10 lower)	-0.0343	-0.0487	-0.0189	-0.1210
	(0.0221)	(0.0401)	(0.0421)	(0.0798)
$NTBARRIERS_j$ (0-10 lower)	0.0241	-0.0205	-0.0063	-0.0699
	(0.0144)	(0.0273)	(0.0298)	(0.0599)
Both EEA members	0.1066***	0.0918*	0.1350***	-0.2624*
	(0.0238)	(0.0407)	(0.0421)	(0.1355)
Both in the Eurozone	0.0340	0.0345	0.0339	
	(0.0238)	(0.0436)	(0.0410)	
Both in Schengen	-0.0036	-0.0438	-0.0543**	-0.0160
	(0.0148)	(0.0237)	(0.0273)	(0.0406)
Observations	**43,945**	**43,945**	**6448**	**33822**
Number of country-pairs	**4,091**	**4,091**	**598**	**3136**

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors are clustered at country-pair level

5.2 Impact of patent protection on FDI

This section reports the results of the econometric analysis of the impact of patent protection in the recipient country on the value of FDI flows in the European Union. A similar analysis of the impact of patent protection on the *number* of FDI deals is reported in Annex 4, and leads to similar results.

The econometric model for FDI is also estimated via a conditional fixed-effects Poisson estimator, based on the observation of 1 917 (and 2 920 respectively) combinations of source country, recipient country and year for each IP sensitivity category. The regression sample includes the bilateral FDI flows between the 24 recipient EU28 countries and 57 source countries between 2001 and 2011. Descriptive statistics for the estimation sample are provided in Table 4.

The results of the estimations are presented in Table 5. The model is estimated for all manufacturing sectors pooled together (column 5) and for the high-IP sensitivity category (columns 6 to 8).

The results of the pooled model (column 5) suggest that stronger patent protection in the recipient country, as measured by the combined Park and Fraser indices, does not have a significant impact on the value of total FDI inflows taken globally. However, the results of models 6, 7 and 8 indicate that patent protection has a positive effect on the value of FDI deals in high-IP sectors. These results are strongly (at 1%) significant in the model (column 6), and remain significant (at respectively 5% and 10%) when the estimation is restricted to FDI flows originating in EU or non-EU countries. The estimated coefficient is stronger for high-IP FDI originating in non-EU (column 8) than in EU (column 7) countries. In the main model (column 6), this coefficient is about 10 times higher than the estimated coefficient reported for high-IP trade in Table 3, suggesting a strong sensitivity of high-IP FDI to patent protection.

Table 4

Descriptive statistics for the FDI regression

Variable	Obs.	Mean	Std. dev.	Min.	Max.
5a: FDI value regressions					
FDI value (in USD million)	1,917	2,062.46	8,736.24	0	134,000
Park x Legal index	1,917	33.15	6.66	16.85	44.91
Log GDP_i (source)	1,917	27.16	1.70	22.03	30.34
Log GDP_j (recipient)	1,917	27.05	1.39	23.17	28.95
Log $GDPCAP_j$ (recipient)	1,917	10.15	0.74	7.38	11.63
Freedom of FDI and movement of people (0-10 flexible)	1,917	6.97	1.34	2.42	9.54
Labour regulations (0-10 flexible)	1,917	5.89	1.40	2.81	8.48
Business regulations (0-10 flexible)	1,917	6.51	0.84	3.88	8.71
EEA member	1,917	0.86	0.35	0	1
Eurozone	1,917	0.59	0.49	0	1
Schengen	1,917	0.68	0.47	0	1

In general, GDP in the source and destination country, as well as per-capita GDP in the destination country, are not found to have a significant positive effect on the value of FDI deals. However, GDP in the source country is found to a have a negative and significant effect on the value of FDI flows originating in the EU (column 7), suggesting that these FDI flows tend to originate in relatively small countries. The degree of freedom of FDI and movement of people positively impacts the value of all high-IP FDI deals and of high-IP FDI deals originating in the European Union. The impact of flexible labour regulations is ambiguous, since it has opposite and significant effects on the value of FDI deals originating in EU (negative effect, column 7) versus non-EU (positive effect, column 8) countries. Stronger business regulations appear to positively impact the value of high-IP FDI (columns 6 to 8), while they have no significant impact on the value of FDI flows in the pool of all industries. Membership of the destination countries in the Schengen area also has significant positive effects on all FDI in high-IP industries (column 6) and on high-IP FDI originating in other EU countries.

Table 5

Result of conditional fixed-effects Poisson regression on the impact of protection on FDI value

	(5)	(6)	(7)	(8)
	Pooled	**High-IP**	**High-IP EU origin**	**High-IP Other origin**
Park$_j$ x Legal index$_j$	-0.008	0.223***	0.141**	0.248*
	(0.057)	(0.078)	(0.061)	(0.13)
Log GDP$_i$	-0.469	-0.704	-6.345**	2.652
	(0.623)	(1.583)	(3.008)	(2.296)
Log GDP$_j$	-5.507	-12.033	-5.945	8.878
	(6.18)	(15.482)	(19.443)	(22.669)
Log GDPCAP$_j$	7.597	15.43	14,509	-11.163
	(6.478)	(16.52)	(20.818)	(22.431)
Freedom of FDI and movement of people (0 – 10 flexible)	-0.053	0.660**	0.757**	0.272
	(0.16)	(0.292)	(0.359)	(0.449)
Labour regulations (0 - 10 flexible)	-0.248	-0.312	-0.749*	0.961**
	(0.195)	(0.453)	(0.403)	(0.465)
Business regulations (0 - 10 flexible)	-0.315	-1.315**	-1.349**	-0.945**
	(0.21)	(0.655)	(0.653)	(0.453)
EEA member	-0.007	-0.03	-0.136	
	(0.57)	(0.977)	(1.127)	
Eurozone	0.137			
	(0.618)			
Schengen	0.35	2.026***	2.613***	-0.617
	(0.382)	(0.657)	(0.578)	(0.557)
Observations	**1917**	**922**	**381**	**171**
Number of country-pairs	**381**	**176**	**76**	**38**

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at country-pair level.

5.3 Impact of patent harmonisation

In this section, the results of econometric regressions are used to measure the potential benefit of a harmonisation of patent protection on trade and FDI flows in European countries or, put differently, the potential cost of the current lack of patent harmonisation in the EU. The econometric analysis indicates that patent protection influences both trade and FDI flows to EU countries in high-IP industries only. The simulation exercise thus focuses on these industries.

For this purpose, harmonisation is defined as an EU-wide alignment of the Park index of patent protection on the maximum value observed in EU Member States. Since the Park index reflects the presence or absence of particular legal provisions in national patent law, this simulated scenario can be interpreted as a harmonisation of substantive patent law, keeping unchanged the current framework for patent application and litigation in Europe. It must also be noted that the predicted impact of patent harmonisation is calculated at the country level and separately for trade and FDI, while the other factors influencing trade and FDI are kept constant in the simulation. Accordingly, the results of the simulation do not account for possible substitution effects whereby trade or FDI flows would be reoriented from one EU country to another as a result of patent harmonisation, or for possible substitution effects between trade and FDI as a channel for transferring technology.

Methodology
The most appropriate models for this impact assessment exercise are Model 2 for trade and Model 6 for FDI, as both of them have been specifically estimated for high-IP industries.

The impact assessment is based on the latest (2010) available observation of the Park index. It consists in predicting the increase in trade and FDI that would be induced by an alignment of the Park index on the maximum value observed for this index among EU countries in 2010.[25] Hence, by construction, the simulated design does not impact incoming trade and FDI flows in EU countries where the Park index was already at the maximum in 2010, namely Belgium, Denmark, Finland, France, Germany, Italy, Ireland and the Netherlands.

25 The 2010 values of the Park index for EU countries are reported in section 3.2, Figure 4.

The impact assessment is conducted in two steps:

- The first step consists in computing the variation of the synthetic $Patent\_protection_{j2010}$ index resulting from a harmonisation of the Park index. Since $Patent\_protection_{jt}$ is defined as the product of the Park and Legal indices, this variation is defined by:

  $$\Delta Patent\_protection_{j2010} = Legal_{j2010}.\Delta Park_{j2010}$$

  where $\Delta Patent\_protection_{j2010}$ and $Park_{j2010}$ denote respectively the (absolute) variations in $Patent\_protection_{j2010}$ and in the value of the Park index.

- As a second step, the variation in the level of high-IP trade and FDI flows is derived from the coefficient β_1 estimated for $Patent\_protection_{jt}$ reported in column 4 and 6 of our regression tables. This variation is given by the following equation:

  $$\Delta F_j = 100.(e^{(\beta_1)} - 1).\Delta Patent\_protection_{j2010}$$

  where ΔF_j is the relative variation (expressed as a percentage) of incoming flows of high-IP trade or FDI in country *j* as a consequence of the harmonisation of the Park index.

Results
Table 6 shows the results of the impact assessment for 15 EU countries that are impacted by a harmonisation of the Park index, thus excluding Belgium, Denmark, Finland, France, Germany, Italy, Ireland and the Netherlands, where the Park index was already at the maximum in 2010. These results are not reported for Estonia, Croatia, Latvia, Luxembourg and Slovenia, because the Park index is not available for these countries.

The first column of Table 6 indicates the variation of the Park index that would result from an alignment of this index on the best EU standard in each country. This variation is strongest for small and/or Eastern European countries such as Cyprus (+49%), Malta (+27%), Bulgaria and Lithuania (+20%), or Poland and Romania (+17%). In comparison, the harmonisation of patent law simulated by means of the Park index would affect Western countries such as Sweden or the United Kingdom only marginally (+3%).

The impact of patent harmonisation on high-IP trade flows is reported in the second column of Table 6. Incoming trade in high-IP goods is expected to grow by 5% on average across the 15 EU countries of interest. This represents an additional volume of EUR 14.6 billion in trade annually, which in turn implies a 2% increase in high-IP trade at the level of the EU28. Cyprus (+24%), Malta (+17%), Lithuania (+11%), Poland (+10%), Bulgaria and Romania (+9%) would experience the strongest increase, whereas the variation in high-IP imports would be smaller for Sweden or the United Kingdom (+2%).

The impact of patent harmonisation on high-IP trade is thus generally stronger for countries in which patent protection in substantive law (Park index) is currently weaker. However, the simulated strengthening of patent law is also compounded by the effectiveness of enforcement mechanisms at the national level, which explains for instance why the same variation of the Park index induces a stronger impact on trade in Austria (+6%), Portugal or Spain (+5%) than in the Slovak Republic (+4%).

The increase of high-IP FDI flows is reported in the third column of Table 6. On average, inflows of high-IP FDI are found to increase by 29%, or EUR 1.8 billion in the 15 EU countries of interest. This represents an annual gain of EUR 1.8 billion in FDI. At the EU level (also taking into account EU countries that are not impacted by patent harmonisation), this corresponds to a 15% increase in high-IP FDI.

At the country level, the effect of harmonisation on FDI follows the same pattern as the impact on trade, with a stronger impact on EU countries where patents are currently relatively less protected. The increase in high-IP FDI is highest in countries that currently attract the lowest volume of such FDI, namely Cyprus, Malta and Lithuania, followed by Poland, Bulgaria and Romania. By contrast, high-IP FDI flows would increase in smaller proportion in countries such as the United Kingdom and Sweden which already attract an important volume of such FDI.

As compared with trade, the greater increase in high-IP FDI reflects the higher estimated coefficient for patent protection in the model for FDI, compounded by the relatively stronger initial concentration of high-IP FDI in countries where the impact of patent harmonisation would be limited. The differentiated impact of patent protection on trade and FDI stems from the different economic natures of trade and FDI flows. On the one hand, trade flows are large aggregates measuring international transfers of goods that take place on a regular basis. On the other hand, annual FDI flows measure a limited number of foreign investment projects that accumulate over time as a stock in the host country. This stock of foreign investments induces long-term economic effects, such as local production, which are more directly comparable to trade flows. Since FDI flows measure only the annual variation of this stock, they are more volatile and of a smaller order of magnitude than trade flows.

Table 6

Simulated impact of a harmonisation of patent protection in the EU

	(1)	(2)	(3)
Country	**% increase in Park index**	**% increase in high-IP trade**	**% increase in high-IP FDI**
Austria	+ 8%	+ 6%	+ 69%
Bulgaria	+ 20%	+ 9%	+ 98%
Cyprus	+ 49%	+ 24%	+ 263%
Czech Republic	+ 8%	+ 5%	+ 52%
Greece	+ 4%	+ 2%	+ 28%
Hungary	+ 8%	+ 5%	+ 54%
Lithuania	+ 20%	+ 11%	+ 127%
Malta	+ 27%	+ 17%	+ 186%
Poland	+ 17%	+ 10%	+ 106%
Portugal	+ 8%	+ 5%	+ 57%
Romania	+ 17%	+ 9%	+ 96%
Slovak Republic	+ 8%	+ 4%	+ 49%
Spain	+ 8%	+ 5%	+ 57%
Sweden	+ 3%	+ 2%	+ 27%
United Kingdom	+ 3%	+ 2%	+ 26%
Average: impacted countries *		**+ 5%**	**+ 29%**
Average: all EU countries *		**+ 2%**	**+ 15%**

* The weighted average for FDI does not include Cyprus, Greece and Malta due to missing values.

6. Conclusion

This study has investigated the role played by patents in supporting trade and FDI in the European Union. Drawing on experience from past policy reforms, the first part presented how patent protection can be used to foster international technology transfers through trade and FDI in medium-income and higher-income countries. The second part was dedicated to the European patent system and its current limitations. It highlighted the limitations to the circulation of patented inventions between EU countries. The impact of patent protection on trade and FDI in the EU28 was empirically analysed in the last part of the study. The results confirm that incoming trade and FDI flows in high-tech manufacturing industries are sensitive to the different levels of patent protection in EU countries. They also suggest that this sensitivity is about ten times stronger in the case of FDI. Simulations suggest that an alignment of EU countries on the best existing standard of patent protection could generate a EUR 14.6 billion increase in annual high-IP trade inflows and a EUR 1.8 billion increase in annual FDI inflows in the EU.

These findings confirm that the fragmentation of the current European patent system is a persistent gap in the completion of the European Single Market for technology. They also reveal a significant associated loss for EU countries in terms of international technology transfers through trade and FDI. They are, however, only a first step towards a full assessment of the costs of the fragmentation of the European patent system. Indeed, the analysis focused on the strength of patent protection in national patent laws, without accounting for other important factors, such as the costs of obtaining multiple national patents or the cost and uncertainty of parallel litigation in Europe. It is likely that taking into account these additional factors would further amplify the potential gains of a better integration of the European patent system.

Addressing the fragmentation of the European patent system represents a major challenge for the European Union in the perspective of its transition towards a knowledge and innovation-driven economy. The forthcoming implementation of the Unitary Patent and Unitary Patent Court will be an important step forward in this direction. Besides reducing the current high cost and legal uncertainty of patent protection at the EU scale, these reforms will help to harmonise substantive patent law relating to the scope and limitations of the rights conferred as well as the remedies in case of infringement. They can thus be expected to boost trade and FDI in the European Single Market for technology.

Beyond this study, more research will be needed to further assess the potential gains from removing limitations to the circulation of patented technology within the EU. Future studies could aim at empirically assessing the impact of the cost of patenting on cross-border trade and investment. They could also focus on additional channels for technology transfers, such as licensing.

References

1. Accetturo, A., M. Bugamelli, A.R. Lamorgese, and A. Linarello. 2013. Innovation and Trade. Evidence from Italian manufacturing Firms. Banca d'Italia, Mimeo, (January).

2. Antras, P. and E. Rossi-Hansberg. 2009. Organizations and Trade. Annual Review of Economics 1: 43-64.

3. Arrow, K. (1962). "Economic Welfare and the Allocation of Resources for Invention", in The Rate and Direction of Inventive Activity, R. Nelson (ed.), Princeton University Press, Princeton, USA.

4. Baldwin, R. and D. Taglioni. 2012. Gravity Chains: Estimating Bilateral Trade Flows when Parts and Components Trade is Important", NBER Working Paper No. 16672.

5. Belderbos, R., Fukao, K. and H. U. Kwon. 2006. Intellectual Property Rights Protection and the Location of Research and Development Activities by Multinational Firms. Hitotsubashi University, Hi-Stat discussion paper no. 167.

6. Branstetter, L., Fisman, R. and C. F. Foley. 2006. Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-Level Panel Data. Quarterly Journal of Economics 121: 321-349.

7. Branstetter, L., Fisman, R., Foley, C. F. and K. Saggi. 2011. Does Intellectual Property Rights Reform Spur Industrial Development? Journal of International Economics 83: 27-36.

8. Bustos, P. 2011. Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. American Economic Review 101: 301-340.

9. Choi, N. (2013), "Measurement and Determinants of Trade in Value Added", KIEP Working Paper 13-01.

10. Cohen, W. M., Nelson, R. R. and J. P. Walsh. 2000. Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not). Cambridge MA: National Bureau of Economic Research working paper 7552.

11. Cecchini et al., 1988

12. Comin, D. and B. Hobijn. 2010. An Exploration of Technology Diffusion. American Economic Review 100: 2031-2059.

13. Danguy, J. and B. van Pottelsberghe de La Potterie. 2009. Cost-Benefit Analysis of the Community Patent. Bruegel Working Paper 20009/08.

14. Dechezleprêtre, A., Einiö, E., Martin, R., Nguyen K.-T., and J. Van Reenen, 2016. Do Tax Incentives for Research Increase Firm Innovation? An RD Design for R&D. NBER Working Paper No. 22405

15. De la Tour A., Glachant M., Ménière Y. (2011) "Innovation and International Technology Transfer: the Case of the Chinese Photovoltaic Industry". Energy Policy, 39(2), pp. 761–770.

16. Delgado, M., Kyle, M. and A. McGahan. 2013. Intellectual Property Protection and the Geography of Trade. Journal of Industrial Economics 61: 733–762.

17. Deloitte. 2012. Analysis of Prospective Economic Effects Related to the Implementation of the System of Unitary Patent Protection in Poland. Report for the Polish Ministry of Finance.

18. Du, J., Yi, L. and Z. Tao. 2008. Economic Institutions and FDI Location Choice: Evidence from US Multinationals in China. Journal of Comparative Economics 36: 412-429.

19. Easterly, W. and R. Levine. 2001. It's Not Factor Accumulation: Stylized Facts and Growth Models. World Bank Economic Review 15: 177-220.

20. Eaton, J. and S. Kortum. 1996. Trade in Ideas: Patenting and Productivity in the OECD. Journal of International Economics 40: 251-278.

21. European Commission. 2003. The Macroeconomic Effects of the Single Market Programme after 10 Years.

22. European Commission. 2011. Impact Assessment: Accompanying Document to the Proposal for a Regulation of the European Parliament and Council Implementing Enhanced Cooperation in the Area of the Creation of Unitary Patent Protection. SEC (2011), 482 Final.

23. European Commission. 2012. Communication on Single Market Act II. October 2012

24. European Patent Office and European Union Intellectual Property Office. 2016. Intellectual property rights intensive industries and economic performance in the European Union.

25. EPRS - European Parliamentary Research Service. 2014. The Cost of Non-Europe in the Single Market. September 2014 – PE 536.353

26. European Intellectual Property Office. 2017. Protecting Innovation through Trade Secrets and Patents: Determinants for European Union Firms.

27. Fan, H., Amber L., and S. R. Yeaple. 2015. Trade Liberalization, Quality, and Export Prices. Review of Economics and Statistics 97: 1033-1051.

28. Fink, C. and K. E. Maskus. 2005. Intellectual Property and Development. Lessons from Recent Economic Research. World Bank and Oxford University Press

29. Ginarte, J. C. and W. G. Park. 1997. Determinants of Patent Rights: A Cross-National Study. Research Policy 26: 283–301.

30. Guellec, D. and B. van Pottelsberghe de La Potterie. 2007. The Economics of the European Patent System , Oxford University Press.

31. Hafner, K. 2008. The pattern of international patenting and technology diffusion, Applied Economics, 40(21), pp. 2819-2837.

32. Hall B. H., Helmers C., Rogers M. & Sena V. (2014). "The Choice between Formal and Informal Intellectual Property: A Review". Journal of Economic Literature 2014, 52(2), 1–50.

33. Hall, B. H. and C. Helmers. 2012. The Impact of Joining the Regional European Patent Convention System. Manuscript, July.

34. Hall, B- H., Helmers, C., Rogers, M. and V. Sena. 2013. The Importance (or not) of Patents to UK Firms. Oxford Economic Papers, 65: 603–629.

35. Harhoff, D. 2009. Economic Cost-Benefit Analysis of a Unified and Integrated European Patent Litigation System, Final Report. Institute for Innovation Research, Ludwig-Maximilians-Universitat, Munich.

36. Harhoff, D. et al. 2016 Languages, Fees and the International Scope of Patenting, in: The Palgrave Handbook of Economics and Language.

37. He, Y. and K. E. Maskus. 2012. Southern Innovation and Reverse Knowledge Spillovers: A Dynamic FDI Model. International Economic Review, 53: 281-304.

38. Hu, A. and I. Png. 2013. Patent rights and economic growth: cross-country evidence. National Oxford Economic Papers, Volume 65, Issue 3, 1 July 2013, Pages 675–698,

39. Ivus, O. 2010. Do Stronger Patent Rights Raise High-Tech Exports to the Developing World? Journal of International Economics 81: 38-47.

40. Javorcik, B. S. 2004. The Composition of Foreign Direct Investment and Protection of Intellectual Property Rights: Evidence from Transition Economies. European Economic Review 48: 39-62.

41. Jensen, P., Palangkaraya, A., and E. Webster. 2016. The Effect of Patents on Trade. Swinburne University of Technology, mimeo.

42. Keller, W. 2010. International Trade, Foreign Direct Investment, and Technology Spillovers. In Bronwyn H. Hall and Nathan Rosenberg, eds., Handbook of Innovation: Vol. 2. Amsterdam: Elsevier-North Holland.

43. Keller, W. and S. R. Yeaple. 2013. The Gravity of Knowledge. American Economic Review 103: 1414-1444.

44. Kowalski, P., Lopez Gonzales, J., Ragoussis, A., Ugarte, C. 2015. Participation of Developing Countries in Global Value Chains. OECD Trade Policy Papers No. 179.

45. Kremers, K., Ernicke, M., Gaessler, F. Harhoff, D., Helmers, C., McDonagh, L., Schlieesler, P. and N. van Zeebroeck "Patent Litigation in Europe" ZEW Discussion Paper No. 13-072, September 2013.

46. Lanjouw, J. and J. Lerner. 1998. "The Enforcement of Intellectual Property Rights: A survey of the Empirical Literature" Annales d'Economie et de Statistique Nr. 49/50, 223-246

47. Lee, G. 2005. Direct versus indirect international R&D spillovers, Information Economics and Policy, 17(3), pp. 334–348.

48. London Economics and PWC. 2013. The cost of non-Europe: the untapped potential of the European Single Market. April 2013.

49. Maskus, K. E. 2000. Intellectual Property Rights in the Global Economy. Washington DC: Peterson Institute for International Economics

50. Maskus, K. E. 2004. Encouraging International Technology Transfer. Geneva: International Center for Trade and Sustainable Development, Project on IPRs and Sustainable Development, Issue Paper 7.

51. Maskus, K. E. 2012. Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century. Washington DC: Peterson Institute for International Economics.

52. Maskus, K. E. 2014. Benefit-Cost Analysis of Technology Initiatives Relevant to Sustainable Development Goals. Report for the Copenhagen Consensus Project.

53. Maskus, K. E., and M. Penubarti. 1995. How Trade Related Are Intellectual Property Rights?, Journal of International Economics 39:227–48.

54. Nogués, Julio J. 1993. "Social Costs and Benefits of Maskus, K. E., Saggi, K. and T. Puttitanun. 2005. Patent Rights and International Technology Transfer through Direct Investment and Licensing. In International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime, ed. Keith E. Maskus and Jerome H. Reichman. Cambridge: Cambridge University Press.

55. Maskus, K. E. and L. Yang. 2016. The Effects of Patent Reforms on the Structure and Growth of Exports. University of Colorado Boulder, mimeo.

56. Miroudot, S., D. Rouzet and F. Spinelli. 2013. Trade Policy Implications of Global Value Chains: Case Studies, OECD Trade Policy Papers, No. 161, OECD Publishing, Paris.

57. Monti, M. 2010. A new strategy for the single market. Report to the President of the European Commission José Manuel Barroso, May 2010.

58. Nagaoka, S. 2009. Does Stronger Patent Protection Facilitate Technology Transfer? Some Evidence from Licensing Contracts of Japanese Firms. Journal of Technology Transfer 24: 128-144.

59. Naghavi, A., Spies, J. and F. Toubal. 2015 Intellectual Property Rights, Product Complexity, and the Organization of Multinational Firms. Canadian Journal of Economics 48: 881-902.

60. Nelson, R. (1959). "The Simple Economics of Basic Scientific Research", Journal of Political Economy, V. 67, 297 306.

61. Noguera, G. 2012. Trade Costs and Gravity for Gross Trade and Value Added Trade. UC Berkeley and Columbia University, Job Market Paper.

62. Nunnenkamp, P. and J. Spatz. 2004. Intellectual Property Rights and Foreign Direct Investment: A Disaggregated Analysis. Review of World Economy 140: 393-414.

63. OECD. 2015. Trade Policy Implications of Global Value Chains. http://www.oecd.org/tad/trade-policy-implications-gvc.pdf

64. OECD, WTO and World Bank Group. 2014. Global Value Chains: Challenges, Opportunities and Implications for Policy. Report prepared for submission to the G20 Trade Ministers Meeting Sydney, Australia, 19 July 2014

65. Park, W. G., 2008. International patent protection: 1960-2005. Research Policy, vol. 37(4), pages 761-766, May.

66. Pelkmans, J. and A. Correira de Brito. 2012. Enforcement in the European Single Market. Centre for European Policy Studies, Brussels.

67. Rivera-Batiz L. and P. Romer. 1991. International trade with endogenous technological change, European Economic Review, Elsevier, vol. 35(4), pp. 971-1001.

68. Santos Silva, J. M. C. and S. Tenreyro. 2006. The Log of Gravity. The Review of Economics and Statistics, November 2006, 88(4): 641–658

69. Schumpeter J. (1942). "Capitalism, Socialism and Democracy", Harper and Row.

70. van Pottelsberghe de La Potterie, B. 2009. Lost Property: The European patent system and why it doesn't work. Bruegel Blueprint.

71. Vishwashrao, S. 1994. Intellectual Property Rights and the Mode of Technology Transfer. Journal of Development Economics 44: 381-402.

72. Wakasugi, R. and B. Ito. 2005. The Effects of Stronger Intellectual Property Rights on Technology Transfer: Evidence from Japanese Firm-Level Data. Journal of Technology Transfer 34: 145-158.

73. Xu, B. and E. P. Chiang. 2005. Patents and International Technology Diffusion, Journal of International Trade and Economic Development, 14(1), pp. 115–135.

74. Yang, G. and K. E. Maskus. 2001. Intellectual Property Rights and Licensing: An Econometric Investigation. Review of World Economy 137: 58-79.

75. Yang, L. and K. E. Maskus. 2009. Intellectual Property Rights, Technology Transfer and Exports in Developing Countries. Journal of Development Economics 90: 232-236.

Annexes

Annex 1: Mapping high-IP sectors to IPC classes

Definition of high-IP clusters

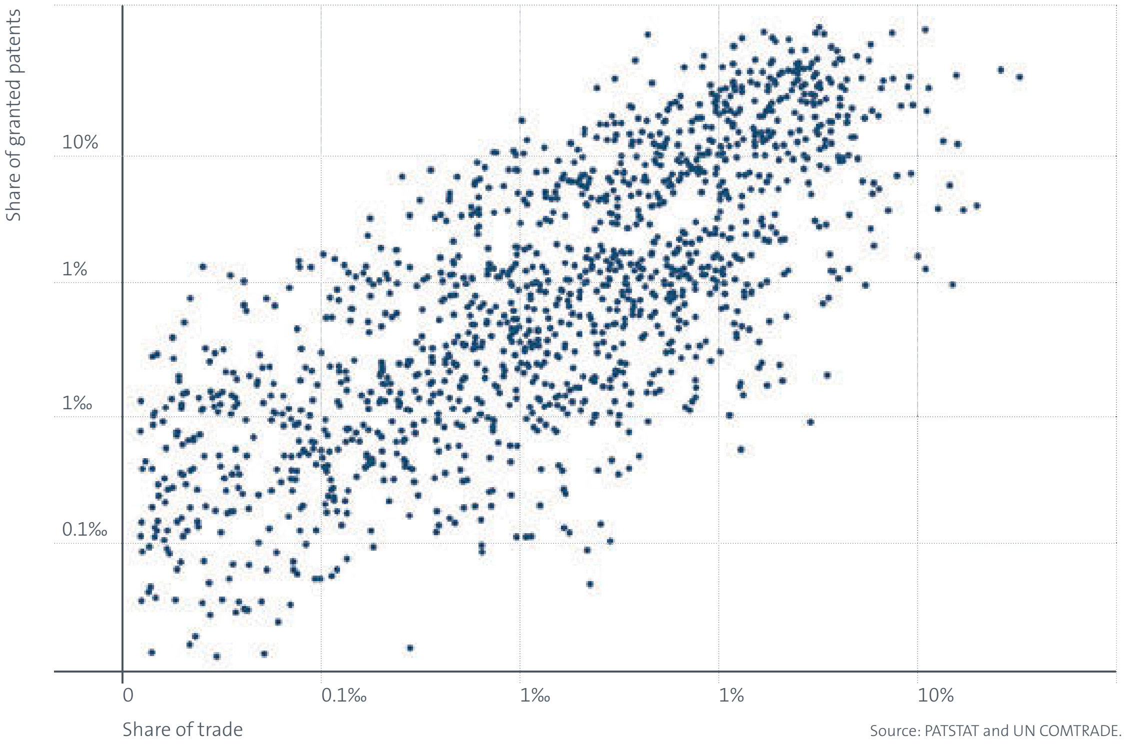
Cluster	SITC Rev. 3 labels and codes
Biopharmaceuticals	
Medicinal & pharmaceutical products	5411-6, 54199, 542
Analytical Instruments (AI)	
Optical instruments	8714, 8744
Laboratory instruments	87325, 8742-3
Process instruments	8745-6, 8749
ICT	
Office machines	7511-2, 7519, 75991-5
Computers & peripherals	752, 75997
Communications equipment	7641, 76425, 7643, 76481, 7649, 77882-4
Electrical & electronic components	5985, 7722-3, 7731, 7763-8, 77882-4
Medical Devices	
Diagnostic substances	54192-3, 59867-9
Medical equipment & supplies	59895, 6291, 774, 872, 8841
Chemicals	
Organic chemicals	5124, 5137,5139, 5145-6, 5148, 5156
Chemically based ingredients	5513, 5922, 5972, 59899
Dyeing & packaged chemicals	531-2, 55421, 5977
Production Technology (PT)	
Materials & tools	2772, 2782, 69561-2, 69564
Process & metalworking machinery	711, 7248, 726, 7284-5, 73
General industrial machinery	7413, 7417-9, 7427, 7431, 74359, 74361-2, 74367-9, 7438-9, 7441, 7444-7, 74481, 7449, 7452-3, 74562-3, 74565-8, 74591, 74595-7, 746-7, 7482-3, 7486, 7492-9

Definition of low-IP products

Product	SITC Rev. 3 labels and codes
Food & live animals	01, 03, 041-5, 05, 061, 071-2, 074-5, 08
Crude materials, inedible, except fuels	21, 22, 244, 261-5, 268-9, 273, 28, 292-7, 29292-3, 29297-9
Mineral fuels, lubricants & related materials	32-4
Animal & vegetable oils, fats and waxes	41-3
Manufactured goods by material	
Leather	61
Cork & wood	63
Textiles	6511-4, 652, 654-9
Non-metallic minerals	661-2, 6633, 6639, 6641-5, 6648-9
Non-ferrous metals	6821-6826, 68271, 683, 6841, 68421-6, 685-689
Metals	6911-2, 69243-4, 6932-5, 694, 6975, 699
Prefabricated buildings	811-2
Travel goods	83
Apparel and accessories	84

Figure 7

Origin of trade in patent-sensitive industries and patents across UP26 countries



Source: PATSTAT and UN COMTRADE.

Annex 2: Patenting and technology flows within Europe

The analysis reported in Figure 7 focuses on high-IP industries[26] as defined in Delgado et al. (2013). For each pair of importing country of the EU and exporting third country in the world,[27] it indicates (i) the weight of the third country in the EU country's imports of high-IP products and (ii) the weight of applicants of the same third country in the total number of patents granted in the EU country in the related technology fields.

The figure is built as follows:

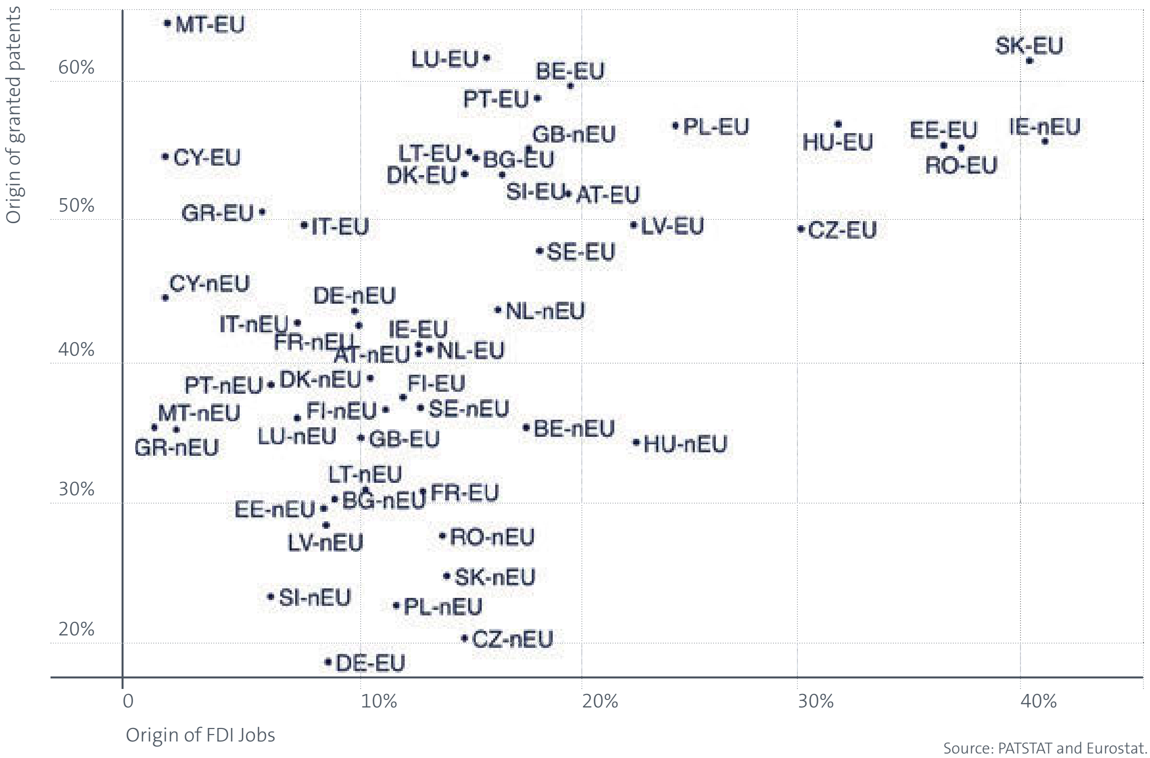
- Each dot corresponds to a pair of importing country of the EU and exporting third country.
- On the X axis, the "share of trade" indicator is defined as the share of imports of High IP goods to the selected EU country that originates from the selected third country.
- On the Y axis, the "share of granted patents" indicator is defined as the share of domestic patents granted in the selected EU country (as a result of a domestic application or validation of a European patent) to nationals of the selected third country.

26 A more detailed definition of high-IP sectors is provided in Annex 1.

27 96 exporting countries were considered for the analysis.

Figure 8

Value of imports and national EPO patent validations in patent-intensive industries



Source: PATSTAT and Eurostat.

For each EU country, Figure 7 thus relates the *proportion* of patents granted to foreign applicants to the *proportion* of imports originating from the same foreign country.[28] For example, 4.2% of high-IP products sold in Germany come from China, and 9.2% of patents in high-IP industries granted in Germany are filed by Chinese applicants.

One can observe a striking and positive correlation between the share of imports in high-IP industries coming from a particular country and the share of patents associated with these industries granted to nationals from the same country of origin. The correlation coefficient is 0.75, which is statistically highly significant. Thus, exporters of large volumes (relative to other exporters) of patent-sensitive goods into UP26 countries are also those who take out more patents in associated sectors in those markets.

Figure 8 in turn compares the *proportion* of patents granted to foreign applicants to the *proportion* of FDI jobs created by companies from the same foreign country. For this purpose, the analysis again focuses on patent-intensive industries as defined in a recent EPO-EUIPO study (2016).[29] In this case, the exact country of origin of incoming FDI cannot be observed with available data sources. However, it is possible to distinguish between FDI originating within EU28 countries and FDI originating from outside the EU28 for such patent-intensive industries.

28 The interest of such proportion measures is that they indicate the relative presence of patent owners in each EU country, while the differences in volumes would mainly reflect the country sizes and related barriers to validation.

29 The EPO-EUIPO study on IPR-intensive industries defines an industry that has an above-average number of patents per thousand employees as being patent-intensive. There are 140 patent-intensive industries identified at the EU level. For a detailed list, see European Patent Office and European Union Intellectual Property Office, "Intellectual Property Rights intensive industries and economic performance in the European Union", Industry-Level Analysis Report, October 2016.

There is again a positive correlation across Europe between the origin of FDI in patent-intensive industries and the origin of patents granted by the national office associated with these industries. The correlation coefficient is 0.43, again statistically highly significant. Thus, in those locations where patents are taken out by inventors there are correspondingly higher volumes of FDI coming from the same inventor countries. Interestingly, countries with both the highest share of patents coming from EU countries and the highest shares of FDI coming from EU countries (i.e. observations in the upper-right quadrant of Figure 8) are almost invariably in Eastern European countries.

Taken together, Figures 7 and 8 suggest that trade and FDI go hand in hand with patent protection in the most innovative industries. Although these data are correlations and cannot be interpreted as a causal relationship, they are consistent with the economic literature's usual findings that patents are used to secure and organise international technology transfers through market channels such as imports and FDI.

It must however be borne in mind that the proportion indicators reported in Figures 7 and 8 are not informative about the absolute number of national patents that are actually used to protect exports and FDI in European countries. In other words, the number of patents used to protect a given type of product or FDI is likely to be much lower in smaller EU countries, as suggested by Figure 3. Therefore, the currently fragmented European patent system may not fully perform its function of supporting intra-EU trade and investment in low-validation countries, which may in turn hinder technology transfers through trade and FDI in those countries.

Annex 3: Cost of a Unitary Patent

Renewal fees

To maintain a Unitary Patent, the patent proprietor will have to pay annual renewal fees. Whereas, for classic European patents, several renewal fees, which may vary in amount, have to be paid to different national patent offices operating under different legal requirements, in particular in terms of their deadlines, Unitary Patent proprietors will pay one single renewal fee to the EPO, in one currency and under a single legal regime as regards deadlines and admissible means of payment. This will greatly simplify matters for users.

Fees will be payable to the EPO – in euros – by payment or transfer to a bank account held by the EPO, or by debiting a deposit account held with the EPO. Holders of EPO deposit accounts will also be able to use the EPO's Online Fee Payment service. Any person will be able to pay fees; there will be no need to use a representative.

The renewal fees have been set at a very business-friendly level, corresponding to the combined renewal fees due in the four countries where European patents were most often validated in 2015, when the fee level was agreed by the Select Committee (Germany, France, United Kingdom and the Netherlands).

The fee level is particularly attractive in the early years, with annual fees for maintaining a Unitary Patent for ten years – the current average lifetime of a European patent – amounting to less than EUR 5 000.

Table 7

Annual renewal fees for a Unitary Patent and a European patent

Year	Unitary Patent (EUR)	26 member states (EUR)*
2	35	494
3	105	1 371
4	145	1 746
5	315	2 443
6	475	3 110
7	630	3 801
8	815	4 632
9	990	5 617
10	1 175	6 609

Year	Unitary Patent (EUR)	26 member states (EUR)*
11	1 460	7 789
12	1 175	9 005
13	2 105	10 309
14	2 455	11 586
15	2 830	12 877
16	3 240	14 462
17	3 640	15 972
18	4 055	17 490
19	4 455	19 302
20	4 855	21 043
Total	**35 555**	**169 667**

Note: *Based on national renewal fees as at 1 January 2017

Overall costs of a Unitary Patent

A comparison of the overall costs of a Unitary Patent with those of a classic European patent should consider not only the fees but also the costs associated with the validation and maintenance of a classic European patent. These costs can be considerable and typically include translation costs incurred for validations and the publication fees payable to the various national patent offices, as well as the fees charged by attorneys or other service providers for validation and the payment of national renewal fees.

Based on such a comparison of the overall costs, a Unitary Patent will be less expensive than a European patent validated and maintained in four of the 26 Member States participating in the Unitary Patent system, four being the average number of those countries in which European patents are validated at present. Consequently, the more countries a classic European patent would have been validated in, the more cost-effective a Unitary Patent will be.

For example, the overall costs incurred for a European patent validated in the four countries where patents are currently most often validated (Germany, France, the United Kingdom and Italy) and maintained for 12 years can amount to EUR 11 850 (estimate based on sample information collected from patent attorneys; with specialised service providers the transaction costs are likely to be somewhat lower).

Although the renewal fees for a Unitary Patent for the same period will be slightly higher, the transaction costs will be lower, bringing the overall cost down to EUR 11 260, which amounts to a 5% saving on the cost of a classic European Patent. That saving will increase to 8% for patents maintained for 15 years.

Table 8

Estimated overall cost (incl. external costs) of validation and maintenance in EUR

	Unitary Patent (UP)	Classic European patent (EP) validated and maintained in DE, FR, GB and IT
Total official fees for years 5-10	4 400	3 745
Total external costs* for years 5-10	3 000	3 855
Total cost up **to year 10**	**7 400**	7 600
	difference UP vs EP: **EUR -200 = -3%**	
Total official fees for years 5-12	7 635	6 585
Total external costs* for years 5-12	3 625	5 265
Total cost up **to year 12**	**11 260**	11 850
	difference UP vs EP: **EUR -590 = -5%**	
Total official fees for years 5-15	15 025	13 345
Total external costs* for years 5-15	5 105	8 645
Total cost up **to year 15**	**20 130**	21 990
	difference UP vs EP: **EUR -1 860 = -8%**	
Total official fees for years 5-20	35 270	30 750
Total external costs* for years 5-20	9 150	17 350
Total costs up **to year 20**	**44 420**	48 100
	difference UP vs EP: **EUR -3 680 = -8%**	

Note: *Attorney costs: translation (24 pages), validation and maintenance of a European patent granted during the fourth year after filing of the application.

Annex 4: Impact of patent protection on the number of FDI deals

Table 9

Descriptive statistics for the FDI deals regressions

	FDI deals regressions				
FDI deals	2,920	12.61	73.59	1	2104
Park x Legal index	2,920	32.92	6.80	16.85	44.91
Log GDP_i (source)	2,920	27.06	1.70	21.70	30.34
Log GDP_j (recipient)	2,920	26.92	1.40	23.17	28.95
Log $GDPCAP_j$ (recipient)	2,920	10.12	0.77	7.38	11.63
Freedom of FDI and movement of people (0-10 flexible)	2,920	6.93	1.31	2.42	9.54
Labour regulations (0-10 flexible)	2,920	5.92	1.36	2.81	8.48
Business regulations (0-10 flexible)	2,920	6.49	0.85	3.88	8.71
Both EEA members	2,920	0.86	0.35	0	1

Table 10

Result of conditional fixed-effects Poisson regression on the impact of patent protection on the number of FDI deals

	(A1)	(A2)	(A3)	(A4)
	Pooled	**High-IP**	**High-IP EU origin**	**High-IP Other origin**
$Park_i$ x Legal $index_j$	0.01	0.058*	0.064*	0.039
	(0.025)	(0.032)	(0.037)	(0.046)
Log GDP_i	1.606**	0.753**	1,026	0.278
	(0.692)	(0.299)	(0.739)	(0.32)
Log GDP_j	0.677	-1.127	-1.393	-3.038
	(1.691)	(3.319)	(3.468)	(3.924)
Log $GDPCAP_j$	-1.281	0.269	0.247	2.926
	(1.688)	(3.024)	(3.401)	(3.826)
Freedom of FDI and movement of people (0-10 flexible)	0.036	0.057	0.029	0.215*
	(0.042)	(0.064)	(0.07)	(0.112)
Labour regulations (0-10 flexible)	0.222*	0.125	0.091	0.255***
	(0.124)	(0.086)	(0.105)	(0.075)
Business regulations (0-10 flexible)	0.095	0.056	0.078	-0.032
	(0.079)	(0.056)	(0.064)	(0.143)
EEA member	-0.132	-0.131	-0.136	-0.466
	(0.147)	(0.169)	(0.193)	(0.435)
Eurozone	-0.679***	-0.285	-0.394	
	(0.155)	(0.289)	(0.289)	
Schengen	0.362	0.559*	0.672*	-0.329***
	(0.227)	(0.333)	(0.346)	(0.113)
Observations	**2 920**	**922**	**645**	**277**
Number of country-pairs	**516**	**176**	**117**	**59**

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at country-pair level.

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