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Relationship between intellectual property and economic competitiveness

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Abstract

Various economic theories indicate that many factors determine the competitive position of national economies. In addition to classical factors such as natural resources, technology, and capital (including human capital), other elements include openness and readiness to generate and implement innovation. An important role is played by institutional and legal systems, which provide economic liberty, free competition, and protection against monopolies, corruption, and crime. According to some research, an important role is also played by issues related to intellectual property (and more precisely, industrial property). The purpose of this article is to verify the importance of intellectual property on economic development. For this purpose, literary studies and patent research were primarily used, including an analysis of the relative specialization index (RSI). The analysis results indicated that the effect of IPP on GNP was not explicit and, depending on the starting position of an economy, and an increase in IPP outlays may have various effects. Another important finding is the extraordinarily dynamic growth of the Chinese economy, as measured by patent indices.

Introduction

The question of economic competitiveness has been of central interest to many economists for decades, and it is often analysed together with the concept of innovation, which is perceived as one of the main factors that determines competitiveness. One of the foundations of innovation are R&D outlays, which in turn are related to intellectual property protection (IPP). Although researchers and policymakers often explicitly present theses concerning the positive impact that intellectual property rights have on various economies, the empirical literature is much less explicit in this respect.

Theoretic Analysis of relations between IP and competitiveness

Intellectual property is defined within the Convention Establishing the World Intellectual Property Organization (WIPO), as the collection of rights that refer primarily to (Treaty, 1967):

- literary, artistic, and scientific works;
- interpretations of artist-interpreters and artistic performances;
- inventions in all areas of human activity;
- scientific discoveries;
- industrial models;
- trademarks and service marks, tradenames, and logos;
- protection against unfair competition;
- other types of rights concerning intellectual activity in industrial, scientific, literary, and artistic activity.

The analysis in this study will focus on industrial property. The incredibly diverse definitions of intellectual property rights in specific countries slightly hinders analysing the influence of IPP on the competitiveness of economies. Intellectual property is the object of numerous legal acts, and the sources of

such rights include both domestic and international acts. However, most intellectual property rights are established by domestic laws; hence, their scope is limited to the territory in which regulations apply. The principle of territoriality makes it necessary to apply for the IPP rights in several states simultaneously. The principle of territoriality refers to the right to industrial property – exclusive rights that primarily encompass a territory of a single country where protection is granted.

Issues concerning intellectual property rights can be analysed from either a micro- or macroeconomic point of view. When deciding to start a new innovative project, an entrepreneur must take into account uncertainty related to future income. Therefore, in order to decide which innovation to implement, the expected monopolistic rent from the introduction of an innovative product must compensate for an incurred risk. The less probable it is to obtain a monopolistic rent from an innovation, the greater the benefits may be from innovation for other market players. In this context, other economic entities may also benefit from the effects of technology or knowledge transfer. The launch of an innovative product in the market may lead to its imitation by a market competitor, which will also be a source of additional income. The most popular measure that secures an innovator's rent is the protection of intellectual property (NBP, 2016, p. 42).

From a microeconomic point of view (i.e., the point of view of an innovator), IPP plays a positive role because they give an innovator a chance to gain profit (innovator's rent) from the introduction of an innovation. An entrepreneur who has patented solutions may produce/offer a product they have created or gain benefits from issuing a license.

While trying to transfer microeconomic questions to a macro scale, one may begin with a traditional opinion that assumes a linear dependence between the strength of intellectual property protection and innovation. Stronger IP protection results in a longer period of maintaining a monopoly and the possibility of gaining benefits from the introduced innovation, which in turn stimulates further innovations and should lead to the growth in their number (NBP, 2016, p. 42). The above assumption, however, is not reflected in empirical data.

(Bochańczyk-Kupka, 2017) discusses issues relating to mutual dependencies between a state and its significance and IPP. The author claims that intellectual property is immensely important for contemporary enterprises and national economies, and also cites OECD reports that indicate changing trends in the structure of GNP generation. They highlight the fact that knowledge-, technology-, and innovation-based sectors currently produce more than 50% value-added. In addition, they are increasingly responsible for employment – in 2013, in EU member states, 1/3 of employees worked in enterprises that significantly used intellectual property (EUIPO, 2016).

Studies that concern the dependence between the pace of economic growth and the strength of intellectual property protection indicate the existence of two different approaches. According to one, the dependence between the pace of economic growth and the strength of an IPP system is directly proportional; therefore, enacting stricter IP protection accelerates economic growth. It is assumed that only the certainty of long-term and strong protection may encourage a potential creator to search for innovation.

In contrast, advocates of the second approach indicate that making the property protection stricter negatively impacts a growth rate because it facilitates the establishment and development of monopolies. Patent protection blocks the flow of knowledge, which may slow innovation processes in an economy (Boldrin & Levine, 2004).

One of the first detailed studies on the dependence between IPP and the level of economic growth was the work by (Falvey, Foster & Greenaway, 2006) which analysed data concerning 80 countries over 5 years. The findings of the study indicated the occurrence of a positive and significant dependence between the level of intellectual property protection and the economic growth rate. According to the authors, in the case of both high- and low-income countries, IPP reinforcement positively affects the growth rate. For rich countries, the provision of security and guarantee of profit for innovators plays an important role. In countries with low income, the strong IPP welcomes the inflow of direct foreign investments and positively affects imports. In the case of countries with an average development rate, the above-mentioned dependencies were not confirmed.

An attempt to combine the above-mentioned approaches is an eclectic model. According to proponents of this approach, the dependence between the level of intellectual property protection and innovation of economies has a U-shaped curve (Bessen & Maskin, 2009). Consequently, both insufficient and extreme IP protection is unfavourable from the point of view of economic competitiveness. Insufficient protection may adversely affect inventions because it does not provide innovator's rent. On the other hand, if protection is too strong, it increases the

share of monopolised sectors and negatively impacts production dynamics by, among other things, limiting the accumulation of experiences during the process of acquiring skills through practice (Furukawa, 2010).

In their research, Bessen and Maskin (Bessen & Maskin, 2009) adopted the assumption of the sequence and complementarity of innovation (a subsequent innovation is based on a previous one; every potential innovator adopts a different research path). In this view of innovation processes, patent protection will not stimulate innovation; therefore, the whole economy may perform better if there was no protection at all. Murray and Stern were also opposed to protection that is too strong. As a part of their analysis concerning relationships between patents and scientific publications, they concluded that the number of article citations significantly decreases after patent protection is granted to inventions described therein. This implies an active influence of obtaining a patent on knowledge diffusion and innovation (Murray & Stern, 2007).

Research into the relationship between intellectual property and economic growth was carried out by Gold et al. (Gold, Morin & Shadeed, 2019), who analysed data from 124 countries from 1995–2011 and used it to create an index that assessed the strength of IPP. The authors indicate the value of this index for economic research and presented initial evidence indicating that intellectual property leads to faster economic growth. Their results coincide with cause-effect relations shown in the literature, namely that IP leads to greater levels of technology transfer and increased domestic innovation. However, this simple picture is hard to match with other aspects that result from their research. An in-depth analysis of the obtained results leads to the conclusion that IP may have little direct influence on growth, and the causal relation stems more from beliefs and opinions rather than from the actual application of IP. This inexplicit situation may result from differences in the methodology, scope, and purposes of research (Lopez, 2009).

One should consider a complementary theory that explains the positive relationship between higher levels of IP protection and growth, i.e. that beliefs may play a greater role than has been previously recognised economic policy literature. More precisely, research suggests that a strong conviction that IP potential increases wealth may be sufficient in itself to obtain growth, despite the lack of a direct foundation in IP regulations in a target country. In this scenario, investors – mostly foreign – react to the increased level of IP not to obtain IP rights in such a place, but because the greater IPP reinforces their conviction that the economy will likely develop. According to this theory, such political convictions, as suggested by (Briggs, 2010) and detailed by (Morin & Gold, 2014), rather than the direct economic consequences of IP by themselves, lead to growth. This does not mean that IP has no direct impact. The presented evidence is in accordance with the argument that domestic IP systems directly affect the level of domestic innovation, which in turn contributes to economic growth; however, such an influence is at best limited.

While it is possible to 'prove' a negative statement - namely that IP has no direct economic influence, despite frequent assurances – a number of factors that have been analysed below suggest that an indirect placebo effect not only exists, but may provide a useful supplement (or substitute) for the direct IP impact on investments and imports (Park & Ginarte, 1997). Research carried out by Gold et al. (Gold, Morin & Shadeed, 2019) has shown that the placebo effect was approximately 5 times stronger than the direct IP impact.

As previously mentioned, the analysis of literature concerning IP, innovation, and growth suggests the existence of different opinions on the impact of IP on innovation. Hall and Harhoff explain that although patent rights stimulate research and development and their diffusion, they also hinder the combination of new ideas and inventions and raise transactional costs (Hall & Harhoff, 2012). Due to such mutually balancing tendencies, the authors concluded that theoretic literature does not contain an explicit result with respect to the stimuli provided by patents. Similar findings were given for other forms of IPP (Landes & Posner, 2003).

In the case of developing countries, this suggests that a direct impact of IP on the growth is affected by a number of factors, including the research and development potential of a country, wealth per capita, the character and efficiency of domestic institutions, and the phase of development (Chu, Cozzi & Galli, 2014). Therefore, there is no one optimum IPP level for all countries. Instead, the literature suggests that countries should modify their IPP depending on the comprehensive and liquid innovation ecosystem that encompasses the abovementioned factors. According to the conclusion of Hudson and Minea (Hudson & Minea, 2013), as a result of this situation, 'we do not observe any more an unchangeable single optimum IP level for every country, but rather an evolving level.

The recognition that an optimum domestic IPP level changes depending on circumstances does not explain which elements in the ecosystem are most important in determining domestic IP protection. Maskus suggested that developing countries can take greater advantage of increased IPP levels when they have 'adequate complementary advantages,' such as greater investments in human capital and more open economies and policies, such as strong antimonopoly regulations (Maskus, 2000). Hudson and Minea discovered that the initial IPP levels and GNP jointly affected the optimum IP levels of a country (Hudson & Minea, 2013). Sweet and Magio indicated that such optima depend both on the level of development and the complexity of an economy (Sweet & Magio, 2015). Ivus et al. indicated that the most important aspect is not the level of IPP but the form of such protection (Ivus, Park & Saggi, 2016).

Researchers have also suggested that IP likely contributes to growth through at least two separate processes: by encouraging foreign rights owners to export hi-tech goods to domestic economies, and by creating incentives for domestic innovation (Ivus, Park and Saggi, 2016).

Table 1 presents the latest leading research into the effectiveness of an IP system in stimulating economic growth, both directly and indirectly. The comparison of such research reveals deep contradictions between studies, which cannot be simply explained.

Table 1. Effects of intellectual property protection (IPP) (Gold, Morin & Shadeed, 2019)

Effect of IP on…	Results
Innovation	**Positive** – Kanwar, Everson (2003) – Chen, Puttitanun (2005) – Schneider (2005) **Negative** – Hudson, Minea (2013) – Lerner (2009) **U-shaped, according to level of development** – Kanwar, Everson (2003) – Hudson, Minea (2013) – Chu, Cozzi, Galli (2014)
GDP per capita (middle-income countries)	**Negative** – Kim et al. (2012) **No relationship** – Falvey, Foster & Greenaway (2006)
GDP per capita (low-income countries)	**Positve** – Falvey, Foster & Greenaway (2006) **Negative** – Kim et al. (2012)

It can be assumed that the discrepancies between the results of research presented in Table 1 may result from differences between models and applied methods. In addition, it can be concluded that economies constitute multi-dimensional systems and are subject to complex interactions and variables, which may be difficult to capture in a statistical model.

Nevertheless, even if one takes such differences into account, it is also necessary to explain extreme divergences between the obtained results, and one could propose several explanations of the abovementioned discrepancies. First, some research may be simply incorrect or incomplete. This may result from the applied models, used theories, selected indices, or collected data, which are incorrect or obsolete. Second, related to the first explanation, there may simply be an insufficient number of studies conducted, which would prevent the confirmation of an explicit pattern to explain the situation. Third, since the theory predicts that the impact of IPP on growth depends on other factors, we may observe the effects of an unknown and fundamental cause.

Despite the merit of such explanations, it seems that a fourth theory provides a more interesting clarification, which may be a starting point for future research. According to this theory, the current research has examined the wrong object, i.e., the direct impact of IP on growth, rather than the indirect influence of 'environmental (atmospheric) conditions,' especially the convictions that higher IPP levels lead to growth (Intarakumnerd & Charoenporn, 2015). The contradictory results in the abovementioned research stem, according to this theory, from including indices that are not related to convictions, and from not taking into account those that are related to them. If this theory proves right, the main obstacle to improving patent systems may lie not in obtaining new in-depth research findings, but in the economic policy of patent systems and particular interests owned by a number of stakeholders in the present system.

Analysis of Patents and their Relationship with the Competitiveness of Economies

Data from EPO and WIPO databases were used to determine which countries play a key role in the race of using knowledge and innovation to build a competitive advantage, and also to indicate which countries best use their potential in several selected sectors. Based on data from the European Patent Office databases (Table 2), it can be concluded that the number of patents is growing systematically. The only exception was the year 2011.

When analysing EPO data from 2009–2018 (Table 3), the European Union showed the most

Table 2. Number of patent applications to EPO (based on data from (EPO, 2019))

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of applications	134 511	151 015	142 822	148 562	148 027	152 703	160 004	159 087	166 594	174 317

Table 3. Total applications – split by main countries (based on data from (EPO, 2019))

Geographic origin	2009	2018	Share 2018	% change 2009–2018
EPO states	68 679	81 468	47%	18.6
United States	32 846	43 612	25%	32.8
Japan	19 863	22 615	13%	13.9
China, People's Republic of	1 629	9 401	5%	477.1
Korea, Republic of	4 189	7 296	4%	74.2
Others	7 305	9 925	6%	35.9
Total applications	134 511	174 317	100%	

applications, followed by the US, Japan, and China, the latter of which saw the highest growth rate.

To determine which technological areas featured the highest number of patent applications, data from 2018 were also analysed, and the list of the most frequently patented sectors is given in Table 4.

Table 4. European patent applications filed with the EPO (based on data from (EPO, 2019))

Technology field	Applications filed (2018)	% change 2009–2018
Medical technology	13 795	38.2
Digital communication	11 940	84.3
Computer technology	11 718	50.6
Electrical machinery, apparatus, Energy	10 722	40.0
Transportation	9 039	47.9
Measurement	8 744	45.2
Pharmaceuticals	7 441	33.5
Biotechnology	6 742	30.8

According to Table 4, objects of patent applications submitted to the European Patent Office are most often medical and digital technologies. An important role is also played by electronic and measuring devices, as well as transport solutions. This indicates which sectors are the greatest field of struggle among enterprises that use IPP in their businesses.

Table 5. Patents applications (WIPO) (based on data from (WIPO, 2019))

Country	Number of patent applications
China	1 381 594
USA	606 956
Japan	318 479
Republic of Korea	204 775
Germany	67 712
India	46 582
Russian Federation	36 883
Canada	35 022
Australia	28 906

The data concerning patent applications within the WIPO shows a different picture. The list of states with the highest number of patent applications (2017) is presented in Table 5.

Table 6. Universities with the highest number of patents granted in 2016–2018 (based on data from (WIPO, 2019))

University	Country	Number of patents (2016–2018)	% change (2016/2018)	Number of patents (2018)
University of California	USA	1417	15.40	501
MIT	USA	731	–8.47	216
Shenzen University	China	396	131.00	201
South China University of Technology	China	290	240.00	170
Harvard University	USA	511	3.68	169
University of Texas System	USA	474	1.94	158
Seoul National University	Korea	378	12.30	137
Tsinghua University	China	311	63.10	137
Stanford	USA	338	16.35	121
China University of Mining and Technology	China	297	35.71	114

The undisputed leader in this case is China, which far exceeds the US and Korea. The growing importance of China is further confirmed by the list of universities (Table 6) that are granted the highest number of patents, as well as enterprises that are patent application leaders (Table 7).

Table 7. Enterprises with the highest number of patent applications (2018) (based on data from (WIPO, 2019))

Company name (country)	Number of patents application
Huawei Technologies (China)	4 024
ZTE (China)	2 965
Intel (USA)	2 637
Mitsubishi Electric (Japan)	2 521
Qualcomm (USA)	2 163
LG Electronics (Republic of Korea)	1 945
BOE Technology (China)	1 818
Samsung Electronics (Republic of Korea)	1 757
Sony (Japan)	1 735

As a part of the analysis, the relative specialization index (RSI) was also used. When analysing patents, an additional value indicates that the country has a relatively high share of patents in the total number of applications concerning a technology area. The higher the value, the greater the country's advantage over other countries.

$$\mathrm{RSI} = \log\left(\frac{F_{C,T} / \sum_C F_{C,T}}{\sum_T F_{C,T} / \sum_{C,T} F_{C,T}}\right) \qquad (1)$$

F_{CT} – patent applications from country C and in the technology area T,
F_C – patent applications from country C,
F_T – patent applications within the technology T.

Data included in the following analysis came from the WIPO database from 2010–2014 and 2017–2018 for comparison. Considering another timeframe may result in significantly different results because the number of patent applications from a country within a technology area is not necessarily stable.

The diagrams in Figures 1–8 graphically present the results of the conducted analysis and indicate which countries have a relative international advantage in selected industry areas (technology). In addition, comparing data from 2010–2014 and 2017–2018 shows that in the case of this analysis, we also face the growing importance of the Chinese economy, which became a global IT leader in several sectors.

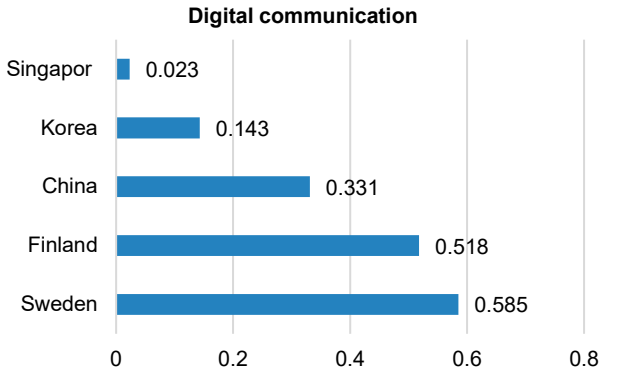

Figure 1. RSI index (2017–2018) for patents in digital communication (based on data from (WIPO, 2019))

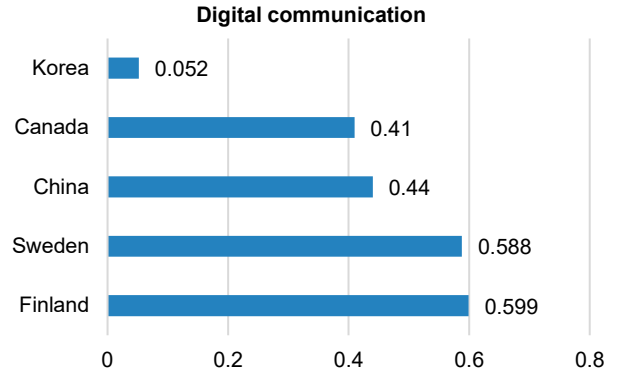

Figure 2. RSI index (2010–2014) for patents in digital communication (based on data from (WIPO, 2019))

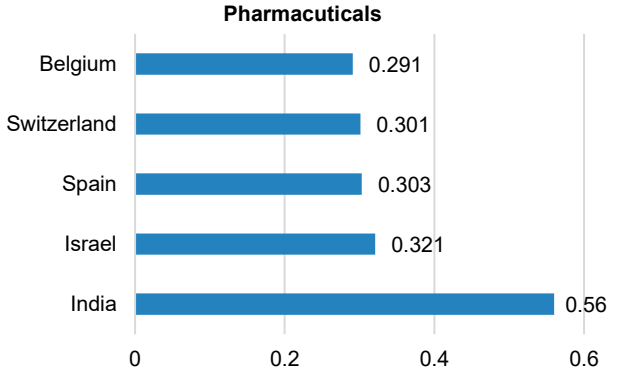

Figure 3. RSI index (2017–2018) for patents in pharmaceuticals (based on data from (WIPO, 2019))

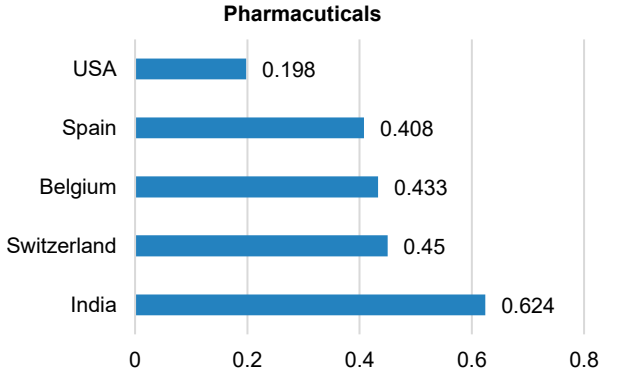

Figure 4. RSI index (2010–2014) for patents in pharmaceuticals (based on data from (WIPO, 2019))

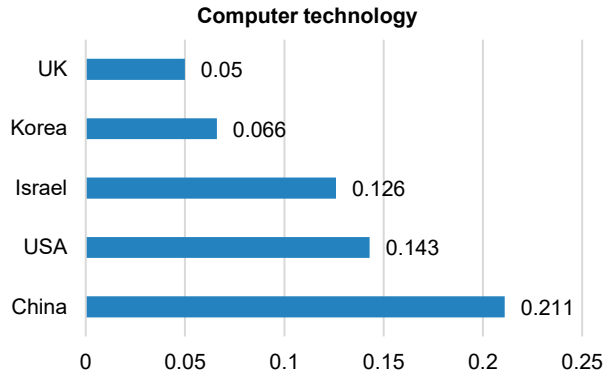

Figure 5. RSI index (2017–2018) for patents in computer technology (based on data from (WIPO, 2019))

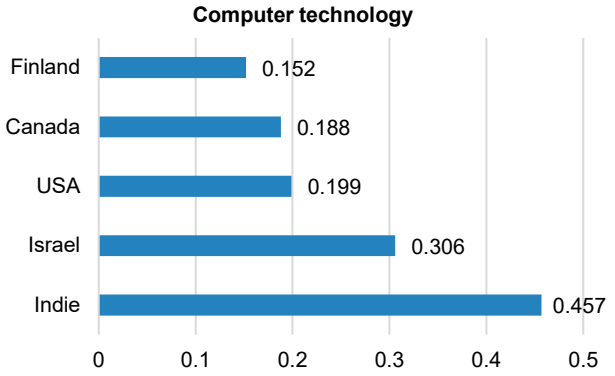

Figure 6. RSI index (2010–2014) for patents in computer technology (based on data from (WIPO, 2019))

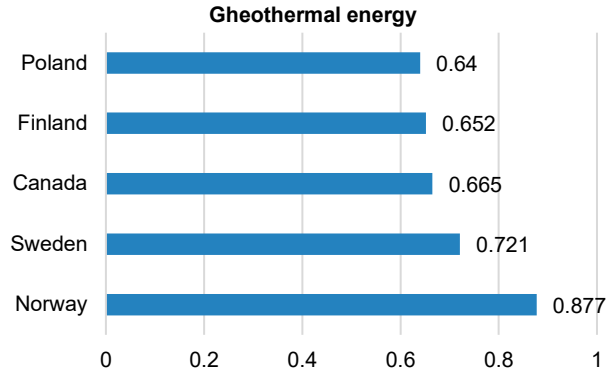

Figure 7. RSI index (2017–2018) for patents in geothermal energy (based on data from (WIPO, 2019))

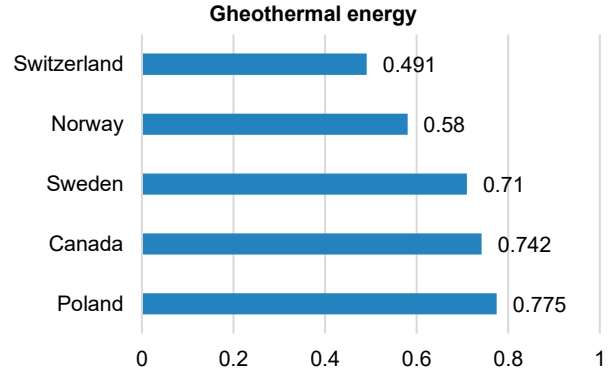

Figure 8. RSI index (2010–2014) for patents in geothermal energy (based on data from (WIPO, 2019))

The analysis shows that countries can play a major role in several technologies. It also reveals the growing importance of China. In addition, Switzerland plays a major role, which may be related to the fact that many international concerns (including pharmaceutical ones) have their registered offices in that country. Poland, on the other hand, is featured as a country with the largest number of patents in geothermal energy.

Conclusions

The conducted analysis leads to the conclusion that the dependence between competitiveness and IPP laws is stronger and noticeable on the micro-level. Enterprises with interesting solutions that are protected with patents, can be turned into a significant competitive advantage. However, with respect to macroeconomic analysis, this dependence is no longer so explicit, and one can quote a number of studies indicating that the strong IPP system negatively influences innovation and domestic GNP. Intellectual property rights can have both stimulating and hindering effects, and it is difficult to isolate the nature of such an influence, which depends on a variety of conditions.

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