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DOES RISING R&D INVESTMENTS INCREASE THE ACADEMIC PATENT REGISTRATION?

Анотація. *В статті за мету поставлено дослідження та аналіз академічної реєстрації патентів у чотирьох країнах Європейського Союзу. За результатами проведних досліджень визначено важливість академічних патентів і дії з передачі знань. Дослідження ґрунтується на аналізі академічної реєстрації патентів як відносного показника, який дозволяє отримувати найкращі розрахунки та порівнювати різні країни з урахуванням їх населення. Однією з головних цілей дослідницької роботи є дослідження того, чи можна знайти значний зв'язок між рівнем реєстрації академічних патентів і обсягом національних інвестицій у дослідження та розробки (НДДКР) у вибраних країнах. Витрати на НДДКР – це відсоток грошей, які країни інвестували в дослідження та розробки від свого річного валового внутрішнього продукту (ВВП). Для дослідження було обрано чотири європейські країни, а саме Швецію, Данію, Австрію та Угорщину, з двох різних регіонів ЄС – північної та центральної частин ЄС. Було також враховано історичне та культурне походження згаданих досліджуваних територій, оскільки ці фактори можуть сильно впливати на поточну поведінку навіть у згаданій досліджуваній території. Теоретично, щорічно інвестована сума грошей у дослідження та розробки в певній країні відіграє допоміжну роль у процесі передачі знань у країні, а також має збільшити кількість академічних зареєстрованих патентів. Проте, чи є зазначене твердження правдивим і правильним для аналізованих чотирьох країн? Проведене дослідження встановило, що зростання інвестицій у НДДКР не має позитивного впливу на рівень реєстрації академічних патентів. Ця гіпотеза була підтверджена в трьох країнах з чотирьох. Однак у Швеції, поки витрати на дослідження та розробки стагнували, рівень реєстрації академічних патентів продемонстрував позитивне зростання. Необхідно підкреслити, що отримані результати потребують подальшого продовження досліджень, оскільки не можна робити узагальнення, базуючись лише на чотирьох країнах.*
Ключові слова: *патент, академічний патент, НДДКР, інвестиції, рівень реєстрації патентів на душу населення*

JEL Classification: I21, I22, O31, O52.

Absztrakt. *A kutatás célja az akadémiai szabadalmak regisztrációjának tanulmányozása és elemzése az Európai Unió négy országában. A cikkben azonosítjuk az akadémiai szabadalmak fontosságát és helyüket a tudástranszferbe. Az akadémiai szabadalmi lajstromozási aránnyal való számítás célja, hogy a lehető legjobb minőségű számításokat és összehasonlításokat kapjuk a kutatásunk alpján. Tekintettel arra, hogy a vizsgált országok népességszáma eltérő, az akadémiai szabadalmi bejegyzési számot nem tudjuk összehasonlítani közöttük. Kutatásunk egyik fő célja annak vizsgálata, hogy van-e szignifikáns összefüggés az akadémiai szabadalmak regisztrációs aránya és a nemzeti kutatás-*

fejlesztési (K+F) beruházások mértéke között a kiválasztott országokban. A K+F ráfordítás az a százalékos értékarány, amelyet az országok éves bruttó hazai termékükből (GDP) a kutatásba és fejlesztésbe fektettek be. Az EU négy kiválasztott országát elemezzük, konkrétan Svédországot, Dániát, Ausztriát és Magyarországot. Ez azt jelenti, hogy az EU két különböző régióját, az északi országokat a középső EU-országokkal hasonlítjuk össze. Kiemelten fontos azonban, hogy ne feledkezzünk meg az említett vizsgált területek történelmi és kulturális hátteréről, mert ezek a tényezők nagymértékben befolyásolhatják a jelenlegi helyzetet még az említett kutatási területen is. Elméletileg az országosan évente K+F-be fektetett pénzösszegnek támogató szerepe van az ország tudástranszferében, és növelnie kell az akadémiai bejegyzett szabadalmak számát is. Igaz és helytálló azonban az említett állítás az elemzett négy országra? Kompressziós kutatásunkkal rájöttünk, hogy a növekvő K+F beruházásoknak nincs pozitív hatása az akadémiai szabadalmak regisztrációs arányára. Négy országból háromban helyes volt feltevésünk. Svédországban azonban, miközben a K+F kiadások stagnáltak, az akadémiai szabadalmak regisztrációs aránya pozitív emelkedést mutatott. Hangsúlyoznunk kell, hogy elemzéseink a kutatás további folytatását igénylik, mivel nem tudunk határozott általános kijelentéseket tenni, mindössze négy ország alapján.
Kulcsszavak: *szabadalom, akadámiai szabadalom, K+F, befektetés, egy főre jutó szabadalmi regisztrációs arány.*

Abstract. *The aim of the research paper is to study and analyze academic patent registration in four countries of the European Union. In the research paper we identify the importance of academic patents and the action of knowledge-transfer. Moreover, we work with the phrase of academic patent registration rate. The reason of calculating with academic patent registration rate, is to receive the best quality calculations and comparations possible. Due to the fact, that the analyzed countries´ population number is different, we cannot compare academic patent registration number among them. One of the main goals of our research paper is to study, if there can be found a significant connection between the academic patent registration rate and the amount of the national research and development (R&D) investment in the selected countries. R&D expenditure is the percentual rate of money which countries have invested into research and development from their annual gross domestic product (GDP). We study and work with four selected countries of the EU, concretely Sweden, Denmark, Austria and Hungary. It means, we compare two different regions of the EU, northern countries with central EU countries. However, it is extremely important not to forget about the historical and cultural background of the mentioned studied areas, because those factors can highly influence the current behavior even in the mentioned research area. Theoretically, the nationally annually invested amount of money into R&D has a supportive role on the knowledge-transfer process of the country, and also should increase the number of academic registered patents. However, is the mentioned statement true and correct for the analyzed four countries? With our compressional research we realized that rising R&D investments do not have a positive effect on the academic patent registration rate. In three countries out of four, it was correct. However, in Sweden while the R&D expenditure was stagnating, the academic patent registration rate has shown a positive rise. We need to emphasize, that our analyzes do need further continuation of the research. Since we cannot make strong general statements, based on only four countries.*
Keywords: *patent, academic patent, R&D, investment, per capita patent registration rate.*

Introduction. Research activities have always been important for the human being in the history. These activities were done by researchers in case of increasing their individual, group, institutional and global knowledge. Universities have been playing an important role of the mentioned activities. Fuller (2003) defined in his work that in an ideal situation university should play the main character of the knowledge transfer and they should be the epicenter of the knowledge spread. University is an institution where the knowledge is created by highly qualified researchers. Moreover, they can share the knowledge with other parties, in this case with the students of the university.

Furthermore, they can even build collaborations with the private sector. As a result of which the research activities can be fastened, since the university would provide the theoretical knowledge, companies would test them and suggest feedback to the university. The collaboration between the mentioned two actors can help in finding solution for complicated problems, since they are observing the problem from different point of view, with diverse professional background and experiences. As Zsigmond, Machová and Zsigmondová (2021) said "The businesses have to progress in transition", the same could be said about universities as well. Universities have to follow the trends and look for new opportunities in development, because the development in the 21st century is incredibly fast and the competition on the market is rapidly raising.

For research activities with significant results financial support and stability is needed as well. Since universities in many cases cannot afford the latest technologies the collaboration with the private sector could be a solution. However, in this case even the created knowledge has to be shared and the knowledge or the patent will be owned by at least two institutions. On the other hand, universities can ask for the help of the state. The state can invest from their GDP to research and development (R&D) by providing financial help to the universities. R&D expenditure is the percentual rate of money which countries have invested into research and development from their annual gross domestic product (GDP). The question is that, if this act is effective, and does it have a significant impact on the number of patents created by the academic institution. On the following pages we are going to be looking for an answer for this question by analyzing four countries of the EU. Concretely, we are going to study two Scandinavian countries - Denmark and Sweden - and two Central European countries – Hungary and Austria.

Literature Review. Ackoff´s (1989) Data-Information-Knowledge theory explains the connection between the mentioned three values. The availability of the raw data is not enough for knowledge creation, since that data still has to be transferred and interpreted into information. As it becomes information researchers are able to understand it. The next step is when the information becomes knowledge. In this phase the information becomes the property of an individual, by the fact that the person has learned the information. If we want to explain the data-information-knowledge theory on the case of the universities, we could say that the researcher group collects the raw data, which is not understood by the majority of the academic subjects. In the next phase the researchers analyze and interpret the data, thanks to which it becomes information. The newly created information is ready to be forwarded and shared by professors with the students.

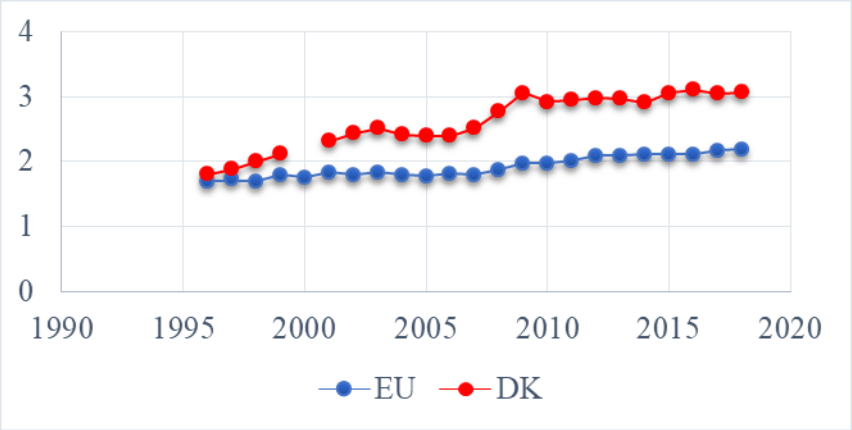
Barcziová, Machová (2021) in their study explained that the patent registration process starts with information collection process, which is followed by the analyses and the creation of a special knowledge. The patent registration process is a long-lasting process, approximately one year. The initiation of the registration has to be done the fastest, since there is always the risk, that the competition is faster. Academic patents are known as a sub-category of patents. (Lissoni, Montobbio, 2015) in their work stated that the condition that a patent could be registered an academic patent was the information, knowledge was created, founded and registered in the academic area. However, it does not matter if it was created in collaboration with the private sector. Universities next to the first mission of educating they have also other mission, as

creating and discovering new ideas, knowledge, theories, items for the future generation. The legal ownership of patents and knowledge is not enough, universities have to share, promote and sell their knowledge to the public on the market of patents, and work together for further exploration with knowledge transfer. This process is many times mentioned as the third mission of the universities. (Zomer, Benneworth, 2011)

The main goal of the article is to compare the academic patent registration procedures in two different areas of the EU - North European countries (Denmark, Sweden) and Central European countries (Austria, Hungary). The aim is to find an answer for the question, if the annually rising national R&D investment from GDP causes rise in academic patent registration as well. The study is incredibly interesting, since we are trying to find an answer for a national problem. It can be advised for academic workers, also for the employees of the government, since the study showing them the existing or non-existing connection between national R&D investments and academic patent registration rate. It is important to mention, that we have worked with per capita numbers, in case the correctness of the calculations was maximized.

Results of the Research.

Denmark. Denmark is located in Northern Europe, and its population is 5,806 million people (Eurostat, 2019). Denmark is member of the European Union (EU) since 1973 and the GDP per capita in Denmark in 2019 was on the level of 60,170.34 USD (Eurostat), which means Denmark´s was under the GDP per capita level of Germany, but higher than France, Norway or Sweden. In 2019, the unemployment rate in Denmark was 5% (Datacommons, 2019), which means only 5% of the population was registered as person without work. The unemployment rate in 2019 in Norway and Germany was lower than in Denmark, it was only around 4%, on the other hand in France was higher, almost 7 %.



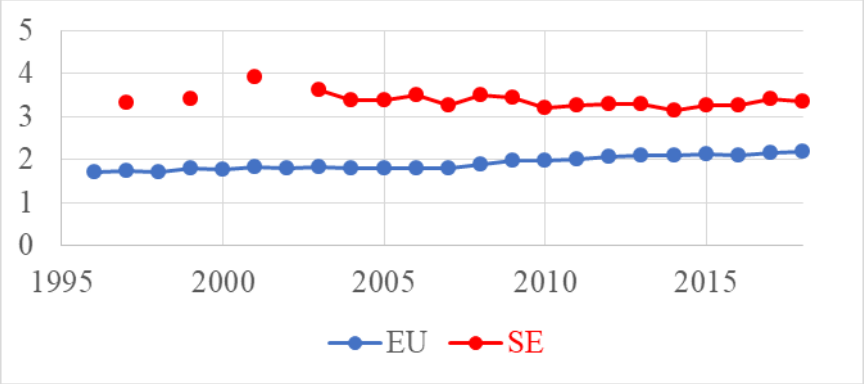
Graph 1. R&D expenditure in Denmark and the EU, % of GDP *

**Source*: The World Bank Database, own elaboration.

On the graph we can see the gross domestic expenditure rate on research and development of GDP in Denmark during the time period of 1996 and 2018. In the year 1996, the Danish government has invested only about 1,8 % of the GDP into R&D. This rate has raised till the year of 2008/2009 till the global economic crisis and the following financial recession. These happenings in 2008/2009 have negatively influenced the amount of money invested into the sector of R&D. Moreover, we can observe a reduction in this investment rate till the year 2014. Later, in 2017 the Danish

government has spent even 3,06% of the national GDP on the financial support of R&D activities in the country. If we want to compare it with the European Union, we can say that the Danish government has always invested higher percentage of its GDP to the R&D than the average European Union countries.

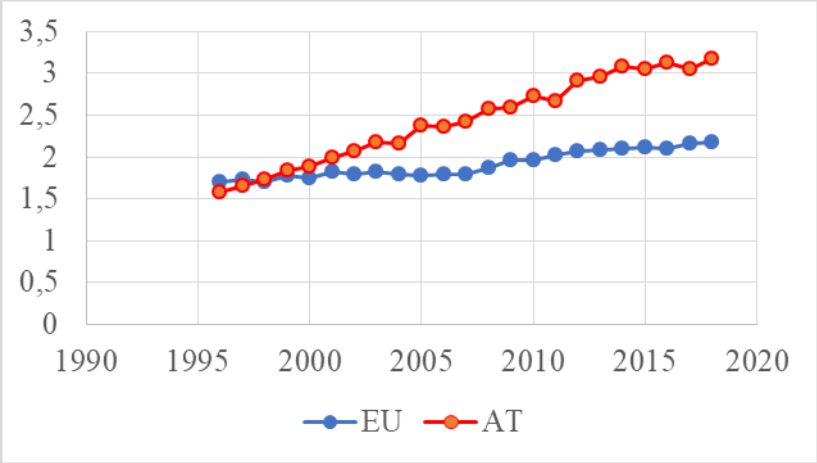
Sweden. Our second analyzed country is Sweden. Sweden in located in Northern Europe between Norway and Finland. Its population is around 10,23 million people (Eurostat, 2019) and is part of the European Union since 1995. The GDP per capita in Sweden in 2019 was 51 615.02 USD (World Bank, 2019), which means the Swedish GDP per capita in 2019 was higher than in Germany (46 445,25 USD) in the same year but lower than in Switzerland (81 993,73 USD). Furthermore, the unemployment rate in 2019 was more than 9% (Datacommons, 2019), other Scandinavian countries Norway, Finland and Denmark were deeply below this level. In Norway the unemployment rate in 2019 was lower than 5 %, so we can declare that the unemployment rate in Norway in only the half of the unemployment rate in Sweden.



Graph 2. R&D expenditure in Sweden and the EU (1996-2018), % of GDP*
**Source: The World Bank database, own elaboration.*

Graph 2 presents the R&D expenditure in Sweden and in the European Union in time period 1996-2016. From the graph we see that the Swedish government has always spent higher percentage of his GDP than the countries of the European Union in average. In the years 2008/2009 the global economic crisis has caused a reduction just as in the case of the Denmark. After this year we can see a slow rise in of R&D expenditure in Sweden. In the European Union this rising trend is more fix, without bigger decreases. In 2017, 3,3% of the Swedish GDP has been invested into R&D. In the European Union countries in average this expenditure was only at level of 2,1%.

Austria. Austria is a country located in Central-Eastern Europe and has the population of 8,859 million people (Eurostat, 2019). Republic of Austria is member of the European Union since 1995, and part of the Eurozone from the year 1999. In Austria in 2019 the rate of GDP per capita was 50 137,66 USD (World Bank, 2019). If we want to compare it with other European countries, we can constate that in 2019 the GDP per capita of Austria was higher than in Germany or France, but lower than in Sweden or Denmark. The unemployment rate in 2019 in Austria was 4,67% (Statista, 2019) which is very low, lower than in Denmark (around 5%), Sweden (around 5%) or France (above 6%), but higher than in Germany, where the unemployment rate was under 3% (Data Commons, 2019).

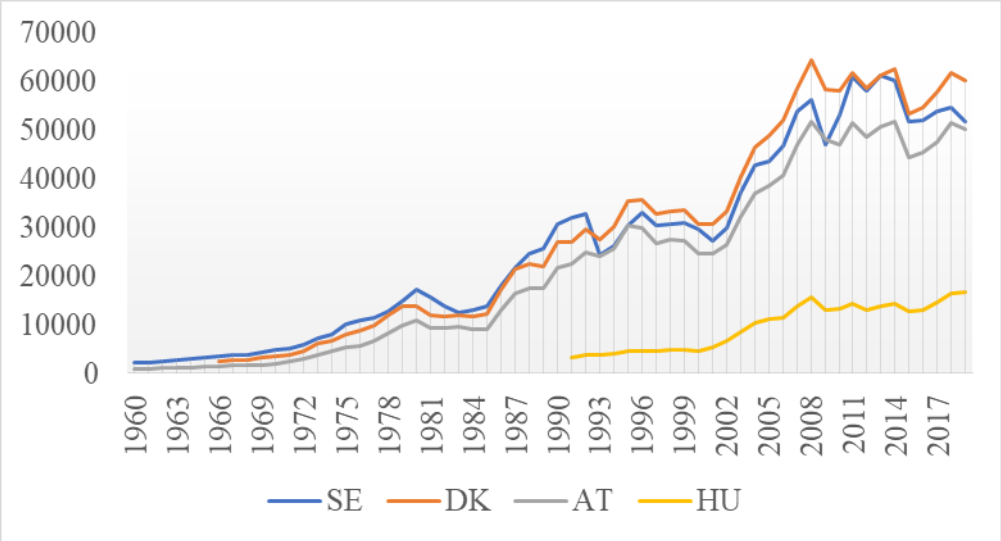


Graph 3. R&D expenditure (% of GDP) – Austria, European Union
Source: The World Bank database, own elaboration

The graph about R&D expenditure in Austria and the European Union is showing us a trend of its rate between 1996 and 2018. The year 2018 was important for the economy and for R&D sectors, in this year Austria started to overload the average government investments of the European Union members. It means before 2018 the Austrian government was investing into R&D from his GDP less than the EU average countries. Both curves show us a rising trend, so both countries, or group of countries are investing year by year more and more percentage of the national GDP into R&D. In the case of Austria, we can observe a faster rising trend.

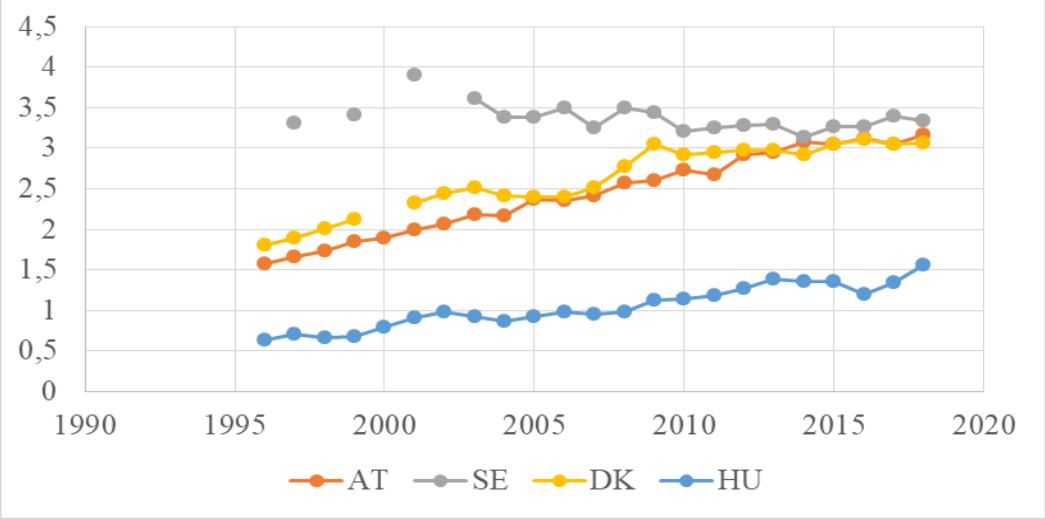
Hungary. As the fourth country, we analyze Hungary in our master thesis. Hungary is located in Central/Eastern Europe and has population of 9 769 526 people (Hungarian Central Statistical Office, 2020). The unemployment rate in 2019 was 3,4% (Statista, 2019). The history, economy, culture and mentality of the people in Hungary is highly influenced by historical events- being part of the Soviet Union. Nowadays, Hungary is called many times as a post-socialist country. Hungary is part of the European Union since 2004, but member of the Eurozone. In 2019, the GDP per capita of the country was 16 731,82 USD (World Bank, 2019).

Graph 4. shows us the level of GDP per capita in the studied four country, Sweden, Denmark, Austria and Hungary between the years 1960- 2019. Unfortunately, Hungary is lying much lower on the graph compared to the other analyzed countries. According to the data from the World Bank Database in 2019 Denmark had the highest level of GDP per capita, it was followed by Sweden, then Austria and Hungary. The level of GDP per capita can influence even the amount and the quality of public educational institutions and the number of registered academic patents. If a country has higher level of GDP per capita is able afford to spend bigger amount of money for R&D in the country, which can fasten the economic development and increase the quality of life.



Graph 4. GDP per capita in selected countries if EU (Denmark, Sweden, Austria and Hungary) between 1960- 2019

Source: World Bank database, own elaboration



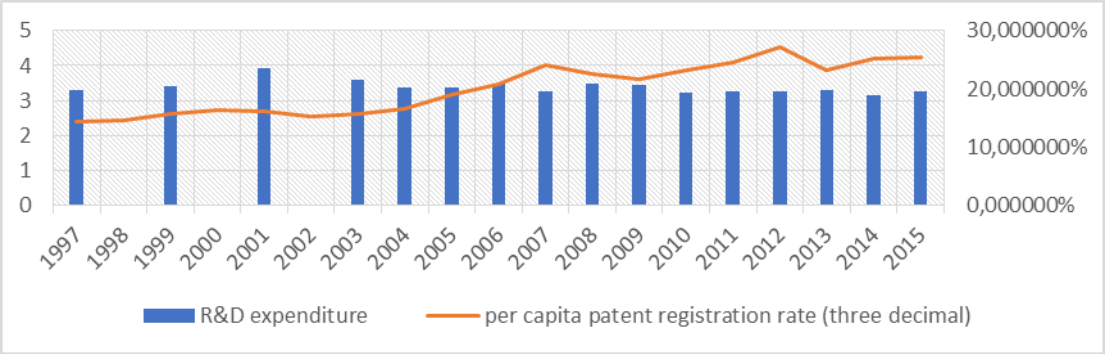
Graph 5. R&D expenditure (% of GDP) – Denmark, Sweden, Austria and Hungary (1996-2018)

Source: World Bank database, own elaboration

On graph 5, we compare the R&D expenditure (% of GDP) in the analyzed countries (Sweden, Denmark, Austria and Hungary) in the time period of 1996 and 2018. Also, we compare the mentioned countries with the average of the European Union countries. Most of the studied countries invest higher percentage of the national GDP into R&D than the EU average, like Sweden, Austria and Denmark. On the other hand, Hungary is lying below the curve of the EU. As the GDP per capita in Hungary was much lower than at other nations, even the R&D expenditure is on a lower level. While Sweden invests almost 3.5% of the national GDP for R&D, Hungary spends only 1,5% of its GDP. In 2018, Sweden has invested the highest rate of its GDP, it was followed by Austria and then Denmark.

R&D Expenditure and Academic Patent Registration. In our work we have analyzed R&D expenditure in countries: Sweden, Denmark, Austria and Hungary

(Graph 1, Graph 2, Graph 3, Graph 4). In the following part we are going to compare it with the number of patent registration in selected countries. In case this comparison has the highest quality, we compare R&D expenditure with per capita patent registration rate, so the population number will not change the results (countries with 5 million inhabitants, and countries with 10 million inhabitants).

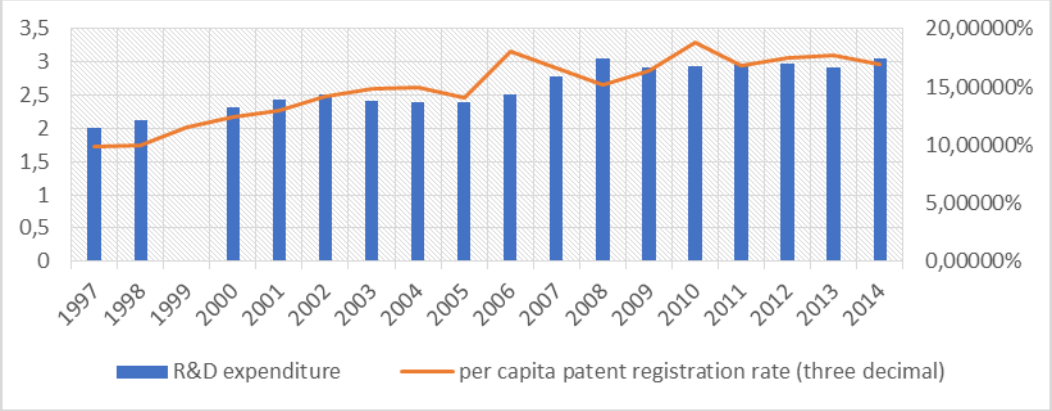


Graph 6: The connection between R&D expenditure and per capita patent registration rate in Sweden

Source: World Bank Database, OECD Patent Database, own elaboration

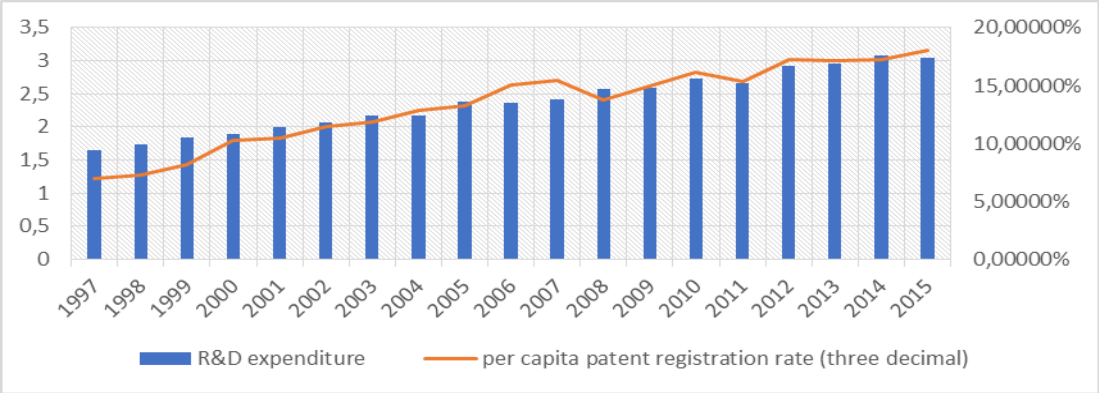
Graph 6. presents us R&D expenditure rate and per capita patent registration rate in Sweden. With blue color we see the percentual amount which the Swedish government as invested into R&D is various years. Red color presents us the percentual rate of per capita patent registrations. We can see in 2001 the Danish government has invested almost 4% of its GDP into national R&D. It was in important rise compared to the previous years (1997,1999), when less than 3,5% of the Swedish GDP was invested into R&D. After this significant rise in 2001 the number of patent registration started to rise too (since 2003). This rise has happened in 2 years delay, it can be explained by long lasting the patent administrational process. In 2008, we can observe another rise in the rate of R&D investments. As in the previous even 2 years after 2008, so in 2010 we can observe a rising trend in per capita academic patent registration rate.

Graph 7: The connection between R&D expenditure and per capita patent registration rate in Denmark.



Graph 7: The connection between R&D expenditure and per capita patent registration rate in Denmark

Source: World Bank Database, OECD Patent Database, own elaboration

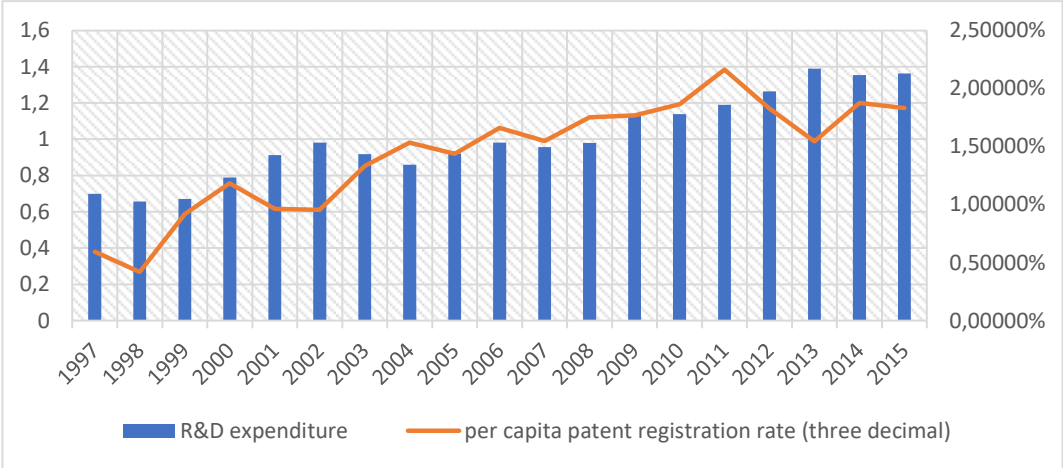


Graph 8: The connection between R&D expenditure and per capita patent registration rate in Austria

Source: World Bank Database, OECD Patent Database, own elaboration

In the case of Denmark, we analyze the connection between R&D expenditure and per capita academic patent registration rate between 1997 and 2015. The R&D expenditure, so the investment of the Danish government into R&D were increasing year by year, as well as the academic patent registration rate. In year 2009, in Denmark more than 3% of the GDP was invested in R&D, in the following years we can observe a rise in per capita patent registration rate as well.

Also, we analyzed central European country Austria, where the R&D expenditure rate from national GDP was increasing during these analyzed 18 years, and the per capita patent registration rate shows a stabile rising trend, too.



Graph 9: The connection between R&D expenditure and per capita patent registration rate in Hungary

Source: World Bank Database, OECD Patent Database, own elaboration

In the case of Hungary, the graph about the connection between R&D expenditure and per capita registration rate shows changing trend. With red color we can see the per capita patent registration rate during time period 1997-2015. This curve is rising since 1997 with smaller decreases. In 2011, per capita patent registration rate has reached its maximum level during 18 years, it has been 0,002%. R&D expenditure of the Hungarian government from its annual GDP has increasing trend during 18 years. In the case of Hungary, we can also observe that with the rise of R&D expenditure (for

examples, in 2000, 2001, 2002), the per capita academic patent registration rate rises, too.

Conclusion. To sum up, the role of the academic institution in the knowledge creation and the academic patent registration process in incredibly important, since they are in the position, from where the knowledge case be transported the fastest and the most effective way to the public. As we mentioned their work cannot be done alone, they do need help, especially financial help for improving their research methods and their punctuality. In the work we compared two regions, North Europe and Central Europe and four countries, Sweden, Denmark, Austria and Hungary. We wanted to study and analyze if there can be observed a connection between the rising R&D expenditure from national GDP and per capita patent registration rate. Moreover, our main goal was to find an answer for the question, if the rising R&D investments increase academic patent registration as well. With finding answer for the stated question, we could find a help for government institution and universities in their further works.

If we compare the four selected countries, we can have a look at Graph 6 and Graph 7 where we see the comparison of R&D expenditure and per capita patent registration rate in the studied and analyzed countries. In Hungary, per capita patent registration and lying below the curves of other countries, it means here is the less academic patent restarted from the 4 countries, and in Sweden the number of application per capita is the highest. If we think about R&D expenditure from national annual GDP the rank of investment is the same as the rank for per capita patent registrations. It means, in Sweden the R&D expenditure rate is the highest, which is followed by Austria and Denmark (these countries are on the same level), finally they are followed by Hungary. We can mention Sweden as an exception country, where the R&D expenditure rate is not rising as in the other three countries, it is presenting stagnation, a constant trend. Sweden invests the same or less percentual rate of their GDP into R&D every year. With the rise of R&D nation expenditure of GDP the per capita patent registration rate rises, too.

The previously mentioned facts mean that in three countries out of four with the rise of the R&D expenditure the academic patent registration rate was rising, too. Sweden was the only exception, where we could observe rise in academic patent registration rate even with stabile stagnation of the R&D expenditure.

We need to emphasize that the further study of additional countries is extremely necessary for being able to make general statements, since the analysis of four countries is not a strong and stable base enough for making statement in general. In the future, we definitely plan to continue our studies and make our country base wider. Furthermore, we are planning to study the collaboration between the universities and the private sector.

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