EMERGING INNOVATION TRENDS IN CENTRAL EUROPE BASED ON EUROPEAN PATENT APPLICATIONS

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Abstract

The sustainable growth and success of a society depends upon innovations. The EU and EU member states are well aware about that and have established and endorsed mechanisms inducing inventions, providing them with a legal title, patent, and facilitating their transposition into daily life as innovations. The European patent should be the key universal instrument to do so and innovation trends in Central Europe (Germany, Austria, Czech Republic, Hungary, Poland) should be based on applications for European patents. What message can be derived from Eurostat and the EPO about the quantitative, qualitative and typology features of the most recently filed applications for European patents by subjects from Central Europe? Do they imply trends, patterns and predictions regarding innovations in Central Europe? A contextual, evolutionary and comparative exploration of key indicators and data related to European patenting in 2020-2023, in particular of applications from Central Europe in 2023, reveals five highly important and pioneering propositions. The same patenting framework and similar legal regime are confronted with dramatically different macro-economic indicators, patenting effectiveness and efficiency as well as with national particularisms. The innovation gap appears to be widening rather than narrowing.

Key words: Central Europe, European patent (EP), invention, innovation.

JEL Code: E61, O31, O32

Introduction

Western civilization has millennial continental law roots, was shaped by Christianity and evolved into Medieval Western Christendom, the Renaissance and the Age of Discovery to reach the Industrial Revolution. The reoccurring issue was the "right and just" generation, distribution and use of resources (MacGregor Pelikánová *et al.,* 2021) and the eternal development command (Prędkiewicz & Prędkiewicz, 2014). The systematic transformation

required both creativity and responsibility (Fitzpatrick, 2023). Already in the Middle Ages, the states and their leaders recognized the importance of innovations (Terzić, 2017) and their protection, see, e.g., the mining of silver in Bohemia and transport of marble and artisan production in North Italy (MacGregor Pelikánová & Beneš, 2023). Progressively, various royal privileges and Guild permits turned into a title (patent) providing a temporary, territorial, absolute monopoly to a solution of a technical problem (invention) and its practical transposition (innovation) (MacGregor Pelikánová *et al.,* 2025). The Industrial Revolution magnified the importance of inventions and innovations. Theories justifying the patent protection started to mushroom (labour theory of property by Locke, social contract by Hobbes, consequentialism by Bentham, deontological imperative by Kant, extension of personality by Hegel, etc.) and led to the concept of "creative destruction" by Schumpeter cementing the need for the patent protection and the effective and efficient innovations (Schumpeter, 1934). Towards the end of the 19th century, it was clear that R&D are pivotal and that their results can be channeled via different assets protected by different legal regimes, see patents and trademarks covered by the Paris Union Convention in 1883 and copyrights by the Bern Union Convention in 1886 (MacGregor Pelikánová, 2019), both administrated along with other international treaties, by the World Intellectual Property Organization (WIPO). The motivation was to protect intangible assets in more jurisdictions by approximating national laws, to avoid national discrimination and to preserve the priority date. Two patenting systems emerged – one global, attached to WIPO and based on the Patent Cooperation Treaty (PCT) and another European, attached to the Council of Europe (not EU!) and based on the European Patent Convention (EPC) with European patents (EP).

Recently, the dichotomy between the PCT international route and EPC European route was enriched by a sub-option of the European route – Unitary Patent System (UPS). Pursuant to EU policies, the EPC/UPS should be the best patenting option for European inventions. To verify it in Central Europe, it is relevant to understand the current innovation framework, both its legal regimes and the economic pre-dispositions for European patenting (1.). The data about EP applications and granted patents in 2020-2023 offers a quantitative dynamic perspective (2.), while a more specific data regarding EP applications in 2023 offers a qualitative static perspective. This leads to five important pioneering propositions.

1 The Current European Innovation Framework

The EU has been placing innovations among its priorities, both in its policies and law (Billon *et al*., 2017). The EU is aware that sustainable development (Balcerzak *et al*., 2023) and competitiveness are feasible only if incentives, financing and protection are offered (Dima *et al.,* 2018) and this in particular regarding patented inventions (MacGregor Pelikánová, 2019). The EU strategy for smart, sustainable and inclusive growth in 2010-2020 (Europe 2020) put, as one its 5 targets, to achieving the investing of 3% of GDP in R&D. In 2020, as well as in 2025, the majority of EU jurisdictions has not reached the target regarding the investing of 3% of GDP in R&D. However, all EU members states are members of the EPC and of the PCT and their subjects can get simultaneous national patent protection.

1.1 Patenting Systems – legal regimes

The patent protection is basically territorial and linked to one jurisdiction. However, since the Paris Union Convention, there is a possibility for the development of a mechanism leading to a simultaneous patent protection in several jurisdictions. For Europeans, this is either via the international route (PCT) or the European route (EPC) with a new unitary option (UPS).

The PCT was signed in Washington in 1970 and created the PCT Union which has currently over 150 member states. The PCT allows a national or a resident from any of the PCT Union members to file a national patent application with the request to get an "international" patent protection or to file directly such a patent application with WIPO. Such an "international" patent application is subjected to an international search by one of the International Searching Authorities (ISAs) regarding the patentability of such an invention appears to meet patentability criteria in light of the search results. Then the applicant might withdraw or amend its patent application. Thereafter, the patent application is published in Patentscope and the applicant can ask an ISA to conduct an additional search. Typically, around 30 months after the priority date (the date of the national filing of the patent application) the applicant initiates the national procedures before offices in all PCT states where he wants to obtain a national patent. Ultimately, the successful applicant gets a number of national patents in PCT jurisdictions and needs, in each of them, to renew, every year, the patent and pay the national renewal fee. However, thanks to the PCT, the applicant benefits not only by the same priority date, but as well by unified procedures during the first years (search and assessing during the first 2 or 3 years).

The EPC is a multilateral treaty which was signed in Munich in 1973 and created the European Patent Organization and the European Patent Office (EPO). Currently, the EPO has 39 member states, i.e., all EU member states as well as Albania, North Macedonia, Iceland, Liechtenstein, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland and Turkey. The EPC sets an autonomous legal system operating either in English, French or German and which leads to granting of the EP. However, such a EP is not a single legal title providing patent protection in more jurisdictions, instead this is rather a permit to get a bundle of independent nationally enforceable, nationally revocable patents. The mechanism, cost, procedural aspects and language regimes of the PCT and EPC are rather similar. It is true that the EPC/EPO is more unified and deals with less jurisdictions than the PCT, but after all they both ultimately lead to a bundle of independent national patents.

Nevertheless, since 1st June 2023, successful applicants can ask to turn their EP into the Unitary Patent, instead of a bundle of national patents, i.e. the EP is a title offering a choice to get either a set of national patents or the Unitary patent providing an block protection in 18 member states. So far, one third of EPs granted to Europeans were turned into Unitary Patents, i.e., basically one third of successful applicants from the EU decided to opt out and instead of a conventional bundle of national patents to move from the EPC to UPS and to get a Unitary patent covering 18 EU jurisdictions.

The EU member states from Central Europe are members of the PCT and EPC, they share not only the same type of continental law tradition and history, but as well the same legal regime leading to patent protection in other jurisdictions. At the same time, they exhibit national particularism and different macro-economic parameters with patenting impact.

1.2 Central European States and their European patenting pre-disposistions

Several macro-economic parameters are considered to have impact on patenting and, pursuant to the prevailing tenor, they include: the population size, GDP, GDP per capita, the entire spending on R&D (Gross Domestic Expenditures on R&D aka GERD) and the share of R&D spending on the entire GDP (GERD/GDP aka GERD Index). Six central European states differed in these parameters significantly in 2020, i.e. when the Europe 2020 with 3% GERD Index target ended (being met only by Austria and Germany), see Table 1.

Tab. 1: Inhabitants, GDP, GERD in the Central European States in 2020

	Inhabitants in millions	GDP (nominal) in millions of EUR	GDP per capita in EUR	GERD (nominal) in millions of EUR	GERD in % of GDP	GERD per capita in EUR
AUT	8,92	380 318	42 651	12 199	3,21%	1368
CZE	10,70	220 311	20 590	4 285	1,94%	400
GER	83,16	3 449 620	41 482	106 583	3,09%	1282
HUN	9,75	138 955	14 252	2 196	1,58%	225
POL	37,91	531 827	14 029	7 293	1,37%	192
SVK	5,46	94 321	17 278	839	0,89%	154

Source: Prepared by the Authors based on Eurostat

Since the whole process of inventing-innovating (from the start of R&D to the Innovation realization) takes up to ten years and its patenting subpart (from filing to obtaining a patent) takes at least three years, it is proper to compare the above indicated pre-dispositions in 2020 with the predisposition in 2023, see Table 2.

Tab. 2: Inhabitants, GDP, GERD in the Central European States in 2023

	Inhabitants in millions	GDP (nominal) in millions of EUR	GDP per capita in EUR	GERD (nominal) in millions of EUR	GERD in % of GDP	GERD per capita in EUR
AUT	9,132	478 190	52 364	15 580	3,26%	1706
CZE	10,86	317 387	29 225	5 820	1,83%	536
GER	83,28	4 122 210	49 498	129 972	3,15%	1561
HUN	9,592	196 391	20 474	2 726	1,39%	284
POL	36,69	750 801	20 463	11 694	1,56%	319
SVK	5,427	122 813	22 630	1 280	1,04%	236

Source: Prepared by the Authors based on Eurostat

No dramatic changes occurred in 2020-2025. The apparent growth of the GPD and GERD was rather due to inflation and other external factors, while the GERD Index reached the magic 3% threshold again only for Germany and Austria. Does this mean that Germany and Austria, with the highest GPD per capita ration, GERD per capita ratio and percentage of GERD on GDP (GERD Index) are leaders in applying and getting EPs?

2 Central European patenting in 2020-2023 – Quantitative dynamic perspective

In 2020, the EPO received 180 417 EP applications, the number kept growing by 2-3% annually and in 2023 reached 199 275. In 2023, the EPO granted 104 609 EPs while 44.6% of them were granted to subjects from EPO member states, including from Central Europe.

Interestingly, in contrast to the general growing trend regarding EP applications in 2020-2023, the number of EP applications filed by subjects from Central Europe stayed, see Table 3.

Tab. 3: Central EP applications in 2020-2023

EP applications from/in	2020	2021	2022	2023
AUT	2 306	2 309	2 381	2 355
CZE	206	201	222	241
GER	25 882	25 891	24 612	24 966
HUN	109	119	104	108
POL	478	522	607	671
SVK	54	43	48	56

Source: Prepared by the Authors based on EPO Dashboard https://www.epo.org/en/about-us/statistics/patent-index-2023/statistics-and-indicators/european-patent-applications/origin

It needs to be kept in mind that applying is one thing, but getting the patent is another. Considering the three years long patenting process, the number of EP applications in 2020, along with pre-dispositions in 2020, see Table 1, should be linked to the number of EPs granted in 2023, while still longitudinal data series might be trend indictive. Interestingly, the number of EPs granted to subjects from Central Europe has not changed dramatically in 2020-2023 and, prima facia, again German and Austrian results look impressive, see Table 4.

Tab. 4: Central EP granted in 2020-2023

	2020	2021	2022	2023
AUT	1 756	1 327	1 151	1 504
CZE	154	133	85	134
GER	20 038	16 506	12 561	15 031
HUN	79	53	54	63
POL	278	240	188	258
SVK	15	33	17	23

Source: Prepared by the Authors based on EPO Dashboard https://www.epo.org/en/about-us/statistics/patent-index-2023/statistics-and-indicators/granted-patents/origin

The quantitative dynamic shows that there is a clear synergy, higher GDP, higher GERD, higher GERD/GDP are connected and in synergy lead to more EP applications and to more granted EPs. This fully matches the general statistic regarding all EPO member states. However, unlike for all these states, no changes regarding the number of EP applications and grants have occurred in Central Europe, i.e. there is no obvious growth in 2020-23. Even more surprising are propositions brought by a qualitative static perspective.

3 Central EP applications in 2023 – Qualitative static perspective

Considering the dramatic difference in the country size, it is misleading to deal with a nominal comparison, i.e. the consideration of the ratio between EP applications and the population and/or the amount of investment in R&D is more suitable for comparison purposes. The pre-disposition data regarding central European states in 2023 and EPO dashboard numbers about filed EP applications suggest clustering, see Table 5.

Tab. 5: Central EP applications per million inhabitants and share of GERD in 2023

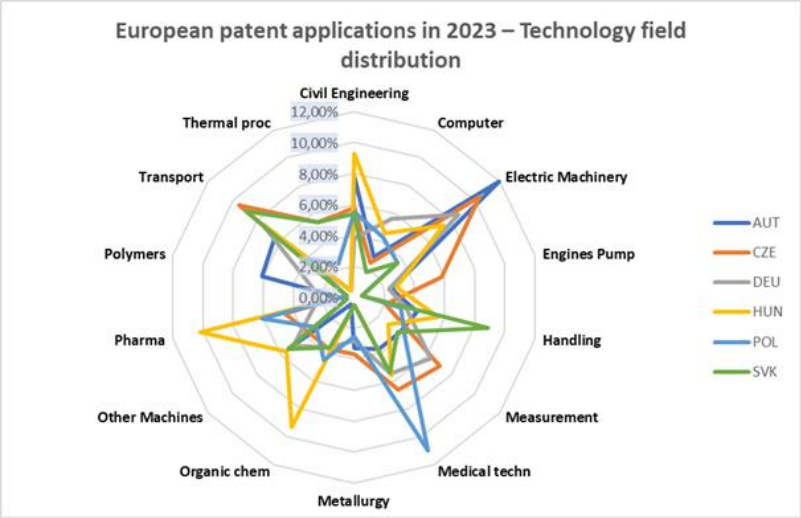
	EP applications (nominal)	EP applications per million inhabitants	GERD per EP application (in millions EUR)	Ranking in EP applications per million inhabitants
AUT	2 355	264	5,18	7.
CZE	241	23	24,15	29.
GER	24 966	300	5,21	6.
HUN	108	11	25,24	37.
POL	671	18	17,43	30.
SVK	56	10	22,86	38.

Source: Prepared by the Authors based on EPO Dashboard https://www.epo.org/en/about-us/statistics/statistics-centre#/applicationspercapita

The most EP applications per million of inhabitants were filed by subjects from Switzerland (1085), Sweden (495), Denmark (446), Finland (422), the Netherlands (403), followed by Germany (300) and Austria (264). From the Central Europe cohort, the closest to them were the Czech Republic (23) and Poland (18). There are many European states which generate less EP applications per million of inhabitants than Austria and Germany but more than the Czech Republic. This type of low effectiveness is magnified by a low efficiency, i.e. EP applications from the Czech Republic and Hungary are regarding investment in R&D over 4x more expensive than EP applications from Austria and Germany, see GERD per EP.

Moving from the effectiveness and efficiency to industries focus, it is enlightening to examine the type of inventions for which industries these EP applications were filed. In general, in 2023, the most popular technology fields covered by EP applications were digital communications, medical technology, computer technology and electric machinery and measurement and each of these five fields showed a growth compared to 2022. This general EPO statistic about all EP applications does not fit with the specific results in Central Europe with a massive fragmentation and differences between states, i.e. not all Central European states go for these five and each of them has a different top, see Figure 1.

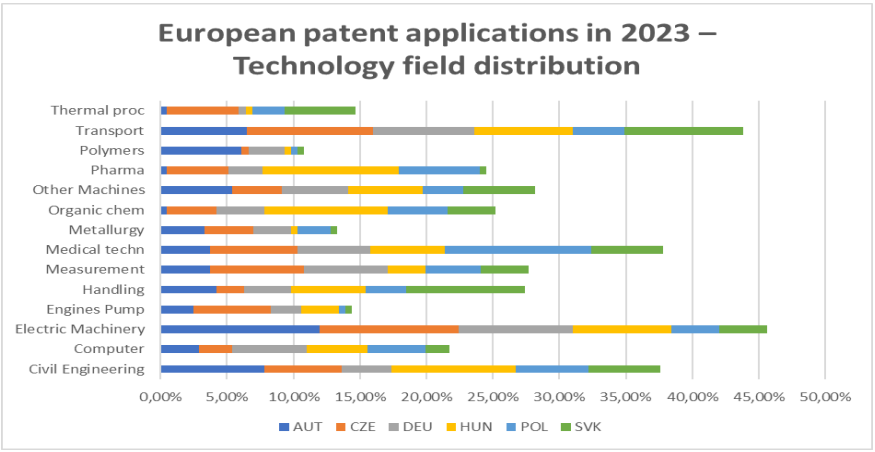
Fig. 1: Central EP applications in 2023 – technology fields – star view



Source: Prepared by the Authors based on EPO Dashboard Country profiles https://www.epo.org/en/about-us/statistics/statistics-centre#/countrydashboards

Technology fields preferences in the Central Europe overlap only partially with the general EPO statistics and only in some of Central European jurisdictions, see Figure 2.

Fig. 2: Central EP applications in 2023 – technology fields – column view



Source: Prepared by the Authors based on EPO Dashboard Country profiles
https://www.epo.org/en/about-us/statistics/statistics-centre#/countrydashboards

Moving from the effectiveness, efficiency, industries focus to the typology applicants brings further interesting propositions. In 2023, the most EP applications were filed by Huawei (5071), Samsung (4760), LG (3498), Qualcom m (3275) and Ericsson (1969). In total 69% of EP applications were filed by large enterprises, 23% by individual inventors or SMEs and 8% by European universities and public research organizations. The situation in Central Europe was different and considering the low nominal numbers of EP applications, the list of top 10 EP applicants is available only for Austria, Germany and Poland, see Table 6.

Tab. 6: Top 10 Applicants for EPs in 2023 from Central Europe

	Uni/Research Center	Group	AG	GMBH/KG
AUT	0	1	3	6
GER	1	0	7	2
POL	7	0	1	2

Source: Prepared by the Authors based on EPO Dashboard

Manifestly, the absolute top innovation drivers as witnessed by EP applications are Austrian enterprises having predominantly the legal form of the limited liability company, German enterprises with the legal form of the shareholder company and Polish universities and scientific institutions, see Table 7.

Tab. 7: Top 3 Applicants for EP in 2023 from Central Europe – identification, numbers

AUT	Borealis AG (183 EP applications)	Tridonic GmbH (60 applications)	Julius Blum GmbH (59 applications)
GER	Siemens AG (1889 EP applications)	BASF SE (1445 EP applications)	Robert Bosh GmbH (EP applications 1187)
POL	Uni Zielonogorski (31 EP applications)	Akademia Gornicko-Hutnizca (30 EP applications)	Uni Jagiellonski (14 EP applications)

Source: Prepared by the Authors based on EPO Dashboard

Conclusion

The EP is a viable and increasingly popular patenting protection instrument for subjects from the EU. The newest data about its use, in particular by subjects from Central Europe, leads to five highly relevant, and to a certain extent worrisome, propositions.

First, there is a clear synergy, higher GDP, higher GERD, higher GERD/GDP are connected and in synergy lead to more EP applications and to more granted EPs. Plainly, Germany and Austria have not only a much higher GPD and GPD per capita but, as well, a much higher GERD and GERD Index than other central European countries and they have as well much more EP applicants and granted EPs.

Secondly, no revolutionary changes have occurred and in contrast to EPO member states in general, the Central European states keep the same number of EP applications and granted EPs, i.e., there is no obvious growth.

Thirdly, it appears that the mentioned synergy of pre-disposition and steady trend leads to a massive magnification of differences in Central Europe, i.e., not only do Germany and Austria have a bigger pie (high GDP and high GPD per capita) and they give a bigger share of it on R&D (high GERD and GERD Index over 3%), but they get of it more EP applications than other Central European states. Namely their effectiveness is matched with efficiency, i.e., they spent less money on R&D to get one EP application. Boldly, one EP application from Germany or Austria requires 4-5x less investment than from Hungary or the Czech Republic! Certainly, this is a mere semi-proposition and other outcomes than EP can result from R&D, but still this point definitely calls for longitudinal deeper studies!

Fourthly, Central Europe is much more fragmented and diversified regarding EP preferred technology fields and the five EPO technology field leaders have dramatically variable popularity in Central Europe, e.g., transport is more popular than digital communications and computer technology.

Fifthly, Central European jurisdictions do not match the general EPO formula regarding EP applicants – 69% large enterprises, 23% small enterprises and individuals and 8% universities and scientific institutions. Based on top EP applicants, it can be suggested that Germany is inclined to go for the first category, Austria for the second category, Poland for the third category. Sadly, considering the extremely low numbers of EP applications from the Czech Republic, Slovakia and Hungry, it is basically impossible to speak about a typical EP applicant. This is bad, but perhaps worse is the third proposition, that once finally one EP application is filed from these three jurisdictions, then generally more R&D investment is required than in the case of Germany or Austria. This looks like a vicious spiral and definitely more studies need to be done to better understand it and, even more importantly, to break it.

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