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## Article

# The Nexus Between Research and Development, Protection of Intellectual Property Rights and Financial Development. A European Perspectiv

Amfiteatru Economic Journal

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*Suggested Citation:* Hurduzeu, Gheorghe; Lupu, Radu; Lupu, Iulia; Calin, Adrian Cantemir (2022) : The Nexus Between Research and Development, Protection of Intellectual Property Rights and Financial Development. A European Perspectiv, Amfiteatru Economic Journal, ISSN 2247-9104, The Bucharest University of Economic Studies, Bucharest, Vol. 24, Iss. Special Issue No. 16, pp. 970-988, <https://doi.org/10.24818/EA/2022/S16/970>

This Version is available at:

<https://hdl.handle.net/10419/281683>

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# THE NEXUS BETWEEN RESEARCH AND DEVELOPMENT, PROTECTION OF INTELLECTUAL PROPERTY RIGHTS AND FINANCIAL DEVELOPMENT. A EUROPEAN PERSPECTIVE

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## Please cite this article as:

Hurduzeu, Gh., Lupu, R., Lupu, I. and Călin, A.C., 2022. The Nexus Between Research and Development, Protection of Intellectual Property Rights and Financial Development. A European Perspective. *Amfiteatru Economic*, 24(Special Issue No. 16), pp.970-988.

DOI: 10.24818/EA/2022/S16/970

## Article History

Received: 15 August 2022

Revised: 30 August 2022

Accepted: 17 September 2022

## Abstract

Considering the role of research and development in increasing knowledge with creative work, in this study, we analyse the link between research and development expenditures in several performance sectors (business, government, higher education) and indicators regarding the protection of intellectual property rights and financial development. The analysis refers to the member states of the European Union, divided into two categories (Central and Eastern Europe and Western Europe), for the period 2007-2020. The results obtained after using a panel data methodology suggest that the settings are different for the two groups of countries. This new perspective (i.e., the disparity between regions and the type of sector) can be considered as evidence in favour of decisions to support research and development expenditures in sensitive situations.

**Keywords:** research and development, intellectual property rights protection, financial development index, panel approach, European Union.

**JEL Classification:** O30, O34, G10, G20

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## **Introduction**

Research and development (R&D) are considered an important means to configure the economic and social future (European Commission, 2018). Many studies suggest that R&D is an enhancer for economic growth and innovation, although a lag between expenditure and results can be expected (Romer, 1990; Guellec and Van Pottelsberghe De La Potterie, 2004; Baumann and Kritikos, 2016). Furthermore, R&D plays an essential role in the recent pandemic crisis or in combating the negative effects of climate change. For example, it has been documented that R&D expenditure has an impact on CO<sub>2</sub> emission reduction (Shahbaz et al., 2020). On the other hand, the intangible nature of R&D assets raises the issue of financial constraints.

Both governmental and private entities perform investments in R&D. The most recent statistical data reveal that in 2020, in the European Union (EU), the business sector allocated almost 65% of the total expenditure, while the second investor is the higher education sector with 24.57%. The third one is the government sector with 9.89% (Eurostat, 2021). However, the situation is different in the two large groups of countries – Central and Eastern European countries and Western European countries. While in Western countries, which are more economically developed, the percentage held by investments from the business enterprise sector is 65%, in Central and Eastern European countries it drops to 60%. In the last group, government investments in R&D are 14.37%, while in Western countries they are only 9.12%. In the case of the higher education sector, the percentage is similar (24.57% of the total). One of the aspects worth mentioning is the fact that the countries of Western Europe hold 85.43% of the total European investments in R&D. This fact, combined with the specific characteristics of the Central and Eastern European countries mentioned in the economic literature (Dinu, 2016), motivates the orientation of our research on two levels, more precisely on the two groups of countries in the European Union.

Intellectual property rights are decisive for countries' development on the economic and social levels. They represent an important way of valorising science, providing holders with economic exploitation, and thus encouraging creative activity. In the last century, innovation evolved substantially, the patent filings increasing constantly, and in each period other industries stand out: engine and transport in 1895-1925, biopharma in 1930-1960, information and communication technologies in 1965-2000, and digital technologies in 2000-2020 (World Intellectual Property Organization, 2022). Over time, many discoveries have not been protected by intellectual property rights, usually because of improper norms or lack of them in certain periods. In the last decades, many changes have occurred regarding the protection of intellectual rights and were documented that countries active in these aspects have had positive R&D experiences (Maskus, 2012). For this reason, protecting intellectual property rights is important for encouraging R&D investment. An overall score (IPR index) and sub-indicators for the perception of protection of intellectual property rights, patent protection, and copyright protection are calculated and made public on yearly bases (Property Rights Alliance et al., 2021). The IPR index, as calculated by Property Right Alliance, is considered for research related to innovation by Cumming et al. (2020) among others.

Financing innovative companies is a complex issue. Different financing sources are used, and they may vary depending on the innovation stage (Lupu and Criste, 2020). This is one of the reasons based on which we can conjecture that aspects of a country's financial development can be important for R&D investment. A reliable source for providing this kind of indicator is the International Monetary Fund, which provides an overall score for financial

development, developed on two pillars: institutions and markets. These indicators are calculated based on the methodology published by Sviryzdenka (2016).

In this study, we perform empirical analysis to assess the link between R&D expenditure, by sectors of performance and relevant indicators for the protection of intellectual property rights and financial development for European countries, taking into account the period 2007-2020 by applying procedures recognized in the specialized literature for the analysis of panel data. Overall, our analysis makes two major contributions to the specialized literature. First, we propose new empirical results for the Central and Eastern European countries and for Western European countries. Second, we examine both, intellectual protection rights and financial development contribution to the R&D expenses. Our conclusions are also based on the level of development of countries and the degree of protection of intellectual property rights, using the latest statistical data. In this way, the policies regarding R&D expenditure can be oriented towards the most sensitive situations, at the same time by enforcing the relevant aspects of intellectual property rights protection and financial development.

The remainder of the paper is structured as follows. The main economic literature on our theme is revised in Section 2. Section 3 presents the data and the employed methodology. The results obtained and the subsequent discussion are provided in Section 4. The last section summarises the main conclusions.

## **1. Review of the scientific literature**

The protection of intellectual property rights has increased significantly in the last decades, and this aspect, along with the number of patent applications and financial development, are considered for countries' ranking (World Economic Forum, 2018).

To some extent, the weak protection of intellectual property rights can be counterbalanced by society's confidence in promoting R&D; in general, the trust of the society is seen as a support for R&D investments (Meng et al., 2021). Moreover, the strong protection of intellectual property rights in countries with high individualism from a cultural point of view allows for the adoption of technology (Jayasekara and Fredriksson, 2021).

As emerged from the literature, R&D reactions to patent protection depend on economic and development features (Maskus et al., 2019). This argument motivates our approach to two different groups of countries in the European Union.

Even though R&D investments are considered a driver for development and economic growth, problems regarding their financing limit their potential. The fact that R&D expenses are consistent leads to the necessity of their financing, while the fact that the results of research or the acceptance of the final product by the market are often unpredictable, raises difficulties in finding adequate financing. As mentioned in the literature, the companies most active in R&D activity do not incur debts and rely more on internal financing resources and equity (Tirelli and Spinesi, 2021). In the same order of ideas, there was evidence that there is a positive link between equity and R&D intensity and a negative one between debt and R&D intensity (Banerjee, 2022). Financial frictions are sometimes barriers to R&D funding. A study conducted for European companies reveals this issue, especially for externally funded companies; the authors highlight the role played by external equity and mention the importance of stock market development and liberalization (Brown et al., 2012). This is confirmed in another way by Ang and Madsen (2012), who demonstrated that financial

development has a crucial role in promoting ideas and knowledge. This result reinforces the conclusions obtained by Mavrotas and Son (2008), which suggest that financial development indirectly stimulates the development of ideas and knowledge through domestic savings. Moreover, the underdevelopment of the financial market is responsible for capital misallocation, disadvantaging talented entrepreneurs (Buera et al., 2011).

The development of financial markets and institutions was considered for studying the R&D aspect for diverse sectors. In the new context of climate change's negative effects on the economy and society, renewable energy has an important role. It was documented that for this sector, financial development together with demographic changes has a relevant impact on R&D (Ma et al., 2022). While the development of stock markets and the banking sector have both a stimulating in developing and developed countries, the bond market is important in developed countries and foreign direct investments in developing markets. For the same domain, Chang et al. (2022) showed that in the case of China, an increase of 1% in the quality of financial development causes a growth of 24% in renewable use.

In an indirect way, protecting intellectual property rights (by patent protection) leads to an increase in patenting that further contributes to liquidity improvement for companies in the patent industry (Dass et al., 2021). The approach to the "tangible and intangible" character of the property-creation relationship is found in Jora (2016, pp.129-138).

Good financial development is considered to have a positive impact on the effectiveness of R&D at the total level, both for developed and developing countries (Chowdhury and Maung, 2012). Looking at the national vs. international perspective, it was argued that national financial market development has a powerful linkage with R&D intensity, with a special emphasis on the bond market; from the international point of view, only foreign direct investments play an important role (Maskus et al., 2012).

When analysing data for OECD countries, Maskus et al. (2019) have demonstrated that financial development aspects together with the existence of laws for patents increase the R&D, emphasizing the fact that this effect is greater when the banking sector and stock market are less developed. The literature related to the various aspects of financing and innovation debated by Kerr and Nanda (2015) motivates our choice to conduct our analysis both according to the general index of financial development and its components. Considering the same OECD countries, Brown et al. (2017) found that, for innovative industries, some aspects regarding the development of financial markets development (improved accounting standards and good contract execution) and the stronger protection of intellectual property rights positively influence the investment in R&D.

The special case of Central and Eastern European countries was analysed by Kiselakova et al. (2018). The authors investigated the link between R&D expenditures and their competitiveness and found out that the growth of these expenditures (with emphasis on the higher education sector) contributes significantly to their competitiveness.

## **2. Research methodology**

### **2.1 Data description**

In this paper, we investigate the relation between R&D expenditure, intellectual property rights protection, and financial development for European Union countries, in the period

2007-2020. Considering different economic features and distribution of R&D, we performed the analysis for two groups of countries: Western European countries (Austria, Belgium, Cyprus, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden, United Kingdom) and Central and Eastern European countries (Bulgaria, Czech Republic, Croatia, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia).

For the R&D expenditure, the used indicator is gross domestic expenditure on R&D by sector of performance (all sectors, business enterprise sector, government sector, and higher education sector), expressed in Euro per inhabitant. The source of data is Eurostat (Eurostat, 2021).

The indicators related to the protection of intellectual property rights are part of a more comprehensive international property rights index published by Property Rights Alliance et al. (2021), first created in 2007. The index has three main components: legal and political environment, physical property rights, and intellectual property rights. The assessment of intellectual property rights encapsulates both *de jure* and *de facto* perspectives. The overall index has three subcomponents for our sample period: perception of protection of intellectual property rights, patent protection, and copyright piracy. The first one is constructed based on a survey, the patent protection index evaluates the patent laws existing in a country taking into account six criteria, and the copyright protection is focused more on enforcement, estimating the volume of unlicensed software and the attitude of users. The indexes are evaluated through scores, the final assessment ranging from 0 to 10, where 10 is the highest score.

The indicators used to assess financial development are designed following Svirydzienka (2016) and Čihák et al. (2012). To better assess the state of financial development, the main indicator relies on two pillars: financial institutions and financial markets, each of them taking into account three components, as shown in Table no. 1.

**Table no. 1. Financial development index design**

Financial institutions			Financial markets		
Depth	Access	Efficiency	Depth	Access	Efficiency
Private-sector credit to gross domestic product (GDP)	Bank branches per 100,000 adults	Net interest margin	Stock market capitalization to GDP	Percent of market capitalization outside of the top 10 largest companies	Stock market turnover ratio (stocks traded to capitalization)
Pension fund assets to GDP	ATMs per 100,000 adults	Lending-deposits spread	Stocks traded to GDP	Total number of issuers of debt (domestic and external, nonfinancial and financial corporations)	
Mutual fund assets to GDP		Non-interest income to total income	International debt securities of government to GDP		
Insurance premiums, life and non-life to GDP		Overhead costs to total assets	Total debt securities of financial corporations to GDP		
		Return on assets	Total debt securities of nonfinancial corporations to GDP		
		Return on equity			

Source: Authors' processing based on Svirydzienka (2016) and Čihák et al. (2012)

All statistical data has an annual frequency, and all used variables are summarized and presented in Table no. 2.

**Table no. 2. Description of the used variables**

Variable	Description	Source
Gross domestic expenditure on R&D by sector of performance (all sectors, business enterprise sector, government sector, and higher education sector), expressed in Euro per inhabitant	R&D refers to creative work done in a systematic way with the aim of increasing knowledge. For R&D expenditures, all current expenditures and added gross fixed expenditure for R&D are considered; these are collected for all statistical units in an economy. R&D data are prepared according to the Frascati Manual 2015 (OECD, 2015). The sectors are established according to the System of National Account; the exemption is the sector of higher education, considered to be of important relevance.	Eurostat (Eurostat, 2021)
Intellectual property rights protection (overall) and its components: perception of protection of intellectual property rights, patent protection, copyright piracy	The perception of the protection of intellectual property rights index is constructed based on a survey. The patent protection index assesses the patent laws existing in a country taking into account six criteria. The copyright protection index relies on a survey and expresses the enforcement of intellectual protection rights. The indexes are represented by scores that range from 0 to 10, where 10 is the highest.	International Property Rights Index 2021 (Property Rights Alliance, Levy-Carciente and Montanari, 2021)
Financial Development Index; Financial Institutions Access Index; Financial Institutions Depth Index; Financial Institutions Efficiency Index; Financial Institutions Index; Financial Markets Access Index; Financial Markets Depth Index; Financial Markets Efficiency Index; Financial Markets Index	Table no. 1 depicts the design and content of these indicators.	International Monetary Fund (International Monetary Fund, 2022)

*Source: Authors' processing using the mentioned data sources*

## 2.2 Methodology approach

Our analysis relies on the panel regression methodology as in Wooldridge (2009), in which we first investigate the exogeneity, homoscedasticity, and non-autocorrelation assumptions of linear regression to decide whether our estimation approach is either a Pooled OLS analysis or one of the Fixed Effects or Random Effects framework. This first-hand analysis is based on values obtained for the White heteroscedasticity test, Breush-Pagan test and the values of Durbin-Watson.

We decided to use the Pooled OLS estimation if we cannot reject the null hypothesis of the White test or we cannot reject the null hypothesis of the Breush-Pagan test and Durbin-Watson produces values between 1 and 3.

In the other cases, we compute the Hausman test and use the Fixed Effects model when we reject its null hypothesis and the Random Effects otherwise.

The results of these steps for our analysis are presented in tables situated in appendix no. 1 for all combinations of explanatory and dependent variables present in the specifications mentioned in the following section.

### **3. Results and discussion**

Our analysis covers four specifications that depend on the choice of the set of explanatory variables, each performed for a set of four dependent variables. We run a panel regression analysis for each of the following R&D dependent variables: all sectors, business enterprise sector, government sector, and higher education sector. We use the following set of explanatory variables:

- Specification 1: Intellectual property rights protection (overall) and its components: perception of protection of intellectual property rights, patent protection, copyright piracy, and the Financial Development Index.
- Specification 2: Intellectual property rights protection (overall) and its components: perception of protection of intellectual property rights, patent protection, copyright piracy, and the Financial Institutions Index.
- Specification 3: Intellectual property rights protection (overall) and its components: perception of protection of intellectual property rights, patent protection, copyright piracy, and the Financial Markets Index.
- Specification 4: Intellectual property rights protection (overall) and its components, i.e. perception of protection of intellectual property rights, patent protection, copyright piracy; the components of the Financial Development Index, i.e. Financial Institutions Access Index, Financial Institutions Depth Index Financial Institutions Efficiency Index; and the components of the Financial Markets Index, i.e. Financial Markets Access Index, Financial Markets Depth Index, and Financial Markets Efficiency Index.

In table no. 3 is presented a synthesis of the results for Central and Eastern European countries for all four specifications, while the detailed ones are shown in Appendix no. 1, Tables no. 5, 7, 9, and 11. For the first specification, copyright protection has the most significant relationships in the case of all sectors, business enterprise sector, and higher education sector; it maintains this feature in specifications 2 and 3. Perception of intellectual property protection relates well to the same sectors, but with a lower significance. The business enterprise sector's R&D expenses strongly connect with the financial development index. For the higher education sector, the overall index of intellectual property protection is quite relevant; for all sectors, the financial development index is relevant. In the case of the second specification, the financial institution index is important for all sectors and the business enterprise sector. Perception of intellectual property protection is relevant for all sectors and the higher education sector and continues to be important in the case of specification 3. The financial market index is germane for all sectors and the business enterprise sector, similar to the financial institution index. In specification 4, the copyright protection and perception of intellectual property protection continue to be relevant for all sectors, business enterprise sector, and the higher education sector. When taken separately, all financial



development sub-indicators are important for the governmental sector, while for the business sector, the financial institutions' efficiency index and financial markets depth index are relevant.

**Table no. 3. Results for Central and Eastern European countries (Synthesis)**

<i>Exogenous variables (p-values)</i>	<i>Dependent variables</i>			
	All sectors	Business enterprise sector	Government sector	Higher education sector
<b>Specification 1</b>				
<b>Overall</b>				*
<b>Perception of Intellectual Property Protection</b>	**	**		**
<b>Patent Protection</b>				
<b>Copyright Protection</b>	***	***		***
<b>Financial Development Index</b>	*	***		
<b>Specification 2</b>				
<b>Overall</b>				*
<b>Perception of Intellectual Property Protection</b>	*			**
<b>Patent Protection</b>				
<b>Copyright Protection</b>	***	***		***
<b>Financial Institution Index</b>	**	**		
<b>Specification 3</b>				
<b>Overall</b>				*
<b>Perception of Intellectual Property Protection</b>	*			**
<b>Patent Protection</b>				
<b>Copyright Protection</b>	***	***		***
<b>Financial market Index</b>	**	**		
<b>Specification 4</b>				
<b>Overall</b>				
<b>Perception of Intellectual Property Protection</b>	**	**		*
<b>Patent Protection</b>				
<b>Copyright Protection</b>	***	**		**
<b>Financial Institutions Access Index</b>			***	**
<b>Financial Institutions Depth Index</b>	**		***	**
<b>Financial Institutions Efficiency Index</b>	***	***	***	
<b>Financial Markets Access Index</b>			***	**
<b>Financial Markets Depth Index</b>	**	***		
<b>Financial Markets Efficiency Index</b>	***		***	
<b>Total</b>	<b>15</b>	<b>11</b>	<b>5</b>	<b>14</b>

*Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)*

In Table no. 4 is presented a synthesis of the results for Western European countries for all four specifications, while the detailed ones are shown in Appendix no. 1, Tables no. 6, 8, 10, and 12. For the first specification, almost all relations are significant, besides overall intellectual property protection, patent protection and financial development index for the

government sector, and the overall and patent protection for the higher education sector. The situation resembles specification 2 less the fact that the financial part is represented by the financial institution index. In specification 3, the patent protection is not at all significant, while the financial market index is most significant, except for the government sector. In specification 4, the perception of intellectual property protection is the most relevant from the point of view of intellectual property rights. When taken separately, from the financial development perspective, the financial institutions access index, financial institutions depth index, and financial markets efficiency index are the most significant.

Table no. 4. Results for Western European countries (synthesis)

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
<b>Specification 1</b>				
Overall	*	*		
Perception of Intellectual Property Protection	***	***	*	**
Patent Protection	*	**		
Copyright Protection	*		*	***
Financial Development Index	***	***		***
<b>Specification 2</b>				
Overall	*	*		
Perception of Intellectual Property Protection	**	**	*	*
Patent Protection	*	**		
Copyright Protection			*	***
Financial Institution Index	***	***		***
<b>Specification 3</b>				
Overall		*		
Perception of Intellectual Property Protection	***	**		*
Patent Protection				
Copyright Protection	**		**	***
Financial Market Index	***	***		***
<b>Specification 4</b>				
Overall	*	**		
Perception of Intellectual Property Protection	**	***	**	
Patent Protection	***	***		
Copyright Protection			***	***
Financial Institutions Access Index	***	***		***
Financial Institutions Depth Index	**	***		***
Financial Institutions Efficiency Index				
Financial Markets Access Index	**		*	*
Financial Markets Depth Index				***
Financial Markets Efficiency Index	***	***	*	
<b>Total</b>	<b>19</b>	<b>17</b>	<b>9</b>	<b>14</b>

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

When comparing the two groups of countries, we notice both differences and some small similarities. In the case of Western European countries, the general conclusion is that there are more significant connections between R&D expenses with all explanatory variables. For both groups of countries, the indicator for all sectors has the biggest number of significant relations, while the one for the government sector has the fewest ones. For the Western European group of countries, the business sector has the second position, while in the case of countries from Central and Eastern Europe, the higher education sector is in this place.

In the case of specifications 1, 2, and 3, the financial development indicators are relevant only for all sectors and business sector for Central and Eastern European countries, and not significant only for the government sector in the case of Western European economies. For the first group of countries, from the point of view of intellectual property protection, copyright protection is most significant. In contrast, for the second group, the perception of intellectual property protection plays a more important role.

In the case of specification 4, for the Central and Eastern European countries, the financial development sub-indicators are more relevant for the governmental sector. In contrast, for the Western European countries, they are more significant for the higher education sector.

### **Conclusions**

Our results highlight the importance of intellectual property rights protection and financial development indicators for R&D investments that foster creative work and valorise research activities. Overall, the results differ across groups of countries and sectors of performance. The Western European economies have the most significant relations for the different sectors that invest in R&D; also, the business sector is sensitive to the indicators taken into account. In the Central and East European countries, the Higher education sector seems to take the lead. From the perspective of intellectual property rights protection, copyright protection is the most relevant for Central and East European countries, but the perception of intellectual property protection is of great importance for Western Economies. Our results point out that enhanced protection of intellectual property rights is prone to positively impact R&D expenses in both groups of countries, but for different subcategories. The R&D expenses made by the government sector are not dependent on financial development indicators, a situation that we can interpret as evidence to support towards valorisation of research regardless of the level of financial development. However, the business sector is quite sensitive to financial development indicators in both groups of countries. This reinforces the results in the literature that underline the difficulties of financing to support innovation.

Highlighting these differences can be useful for building or improving investment policies and the R&D agenda, in governmental and business sectors alike. This can be achieved by channelling resources, including the development of various internal financial markets, as also suggested by Maskus et al. (2012), but also by stimulating collaboration between private companies, governments, and higher education institutions, between countries and regions, so that knowledge can flow more easily. In recent years, the emphasis has been on constructing a stronger innovation ecosystem that will set the R&D profile for the future.

Improving the understanding of the process and the elements that contribute to the development of R&D requires further research, especially when considering differences between the two groups of countries. The availability of much more detailed statistical data

could allow the continuation of the analysis by sectors of economic activity and even the connections between them. This approach can also bring new insights if we consider the scale of sectors, as older studies suggested that financial development is more important for industries with larger financial needs (Buera et al., 2011).

## References

- Ang, J.B. and Madsen, J.B., 2012. Risk capital, private credit, and innovative production. *Canadian Journal of Economics/Revue canadienne d'économique*, 45(4), pp.1608-1639. <https://doi.org/10.1111/J.1540-5982.2012.01740.X>.
- Banerjee, P., 2022. Nature of financial constraints and R&D intensity. *Finance Research Letters*, 50. <https://doi.org/10.1016/J.FRL.2022.103184>.
- Baumann, J. and Kritikos, A.S., 2016. The link between R&D, innovation and productivity: Are micro firms different? *Research Policy*, 45(6), pp.1263-1274. <https://doi.org/10.1016/J.RESPOL.2016.03.008>.
- Brown, J.R., Martinsson, G. and Petersen, B.C., 2012. Do financing constraints matter for R&D? *European Economic Review*, 56(8), pp.1512-1529. <https://doi.org/10.1016/J.EUROECOREV.2012.07.007>.
- Brown, J.R., Martinsson, G. and Petersen, B.C., 2017. What promotes R&D? Comparative evidence from around the world. *Research Policy*, 46(2), pp.447-462. <https://doi.org/10.1016/J.RESPOL.2016.11.010>.
- Buera, F.J., Kaboski, J.P. and Shin, Y., 2011. Finance and Development: A Tale of Two Sectors. *American Economic Review*, 101(5), pp.1964-2002. <https://doi.org/10.1257/AER.101.5.1964>.
- Chang, L., Qian, C. and Dilanchiev, A., 2022. Nexus between financial development and renewable energy: Empirical evidence from nonlinear autoregression distributed lag. *Renewable Energy*, 193, pp.475-483. <https://doi.org/10.1016/J.RENENE.2022.04.160>.
- Chowdhury, R.H. and Maung, M., 2012. Financial market development and the effectiveness of R&D investment: Evidence from developed and emerging countries. *Research in International Business and Finance*, 26(2), pp.258-272. <https://doi.org/10.1016/J.RIBAF.2011.12.003>.
- Čihák, M., Demirgüç-Kunt, A., Feyen, E. and Levine, R., 2012. Benchmarking Financial Development Around the World. *Policy Research Working Paper 6175*, World Bank. <https://microdata.worldbank.org/index.php/citations/9654> [Accessed 10 August 2022].
- Cumming, D., Ji, S., Peter, R. and Tarsalewska, M., 2020. Market manipulation and innovation. *Journal of Banking & Finance*, 120. <https://doi.org/10.1016/J.JBANKFIN.2020.105957>.
- Dass, N., Nanda, V., Dennis Park, H., Xiao, S.C., Bergstresser, D., Carlin, B., Huang, G.-Y., Klasa, S., Lin, D., Popadak, J. and Png, I., 2021. Intellectual Property Protection and Financial Markets: Patenting versus Secrecy. *Review of Finance*, 25(3), pp.669-711. <https://doi.org/10.1093/ROF/RFAA033>.
- Dinu, V., 2016. The constraints to the economic development in the former socialist EU countries from the Central and Eastern Europe. *Amfiteatru Economic*, 18(43), pp.499-501. [https://www.amfiteatruconomic.ro/RevistaDetalii\\_EN.aspx?CodArticol=2536](https://www.amfiteatruconomic.ro/RevistaDetalii_EN.aspx?CodArticol=2536) [Accessed 7 August 2022].

- European Commission, 2018. *A renewed European Agenda for Research and Innovation- Europe's chance to shape its future*, COM(2018) 306 final. Brussels. [https://ec.europa.eu/info/sites/default/files/com-2018-306-a-renewed-european-agenda\\_for-research-and-innovation\\_may\\_2018\\_en\\_0.pdf](https://ec.europa.eu/info/sites/default/files/com-2018-306-a-renewed-european-agenda_for-research-and-innovation_may_2018_en_0.pdf) [Accessed 7 August 2022].
- Eurostat, 2021. *Statistics / Eurostat*. Eurostat. <https://ec.europa.eu/eurostat/databrowser/view/tsc00001/default/table?lang=en> [Accessed 7 August 2022].
- Guellec, D. and Van Pottelsberghe De La Potterie, B., 2004. From R&D to Productivity Growth: Do the Institutional Settings and the Source of Funds of R&D Matter? *Oxford Bulletin of Economics and Statistics*, 66(3), pp.353-378. <https://doi.org/10.1111/J.1468-0084.2004.00083.X>.
- International Monetary Fund, 2022. *Financial Development. Query IMF Data*. <https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b&sId=1481126573525> [Accessed 10 August 2022].
- Jayasekara, D.N. and Fredriksson, P.G., 2021. Culture, intellectual property rights, and technology adoption. *The Quarterly Review of Economics and Finance*, 80, pp.317-330. <https://doi.org/10.1016/J.QREF.2021.03.007>.
- Jora, O.-D., 2016. *Spiritualitate, materialitate și proprietate. Cultura mea, cultura ta, cultura noastră, cultura lor [Spirituality, Materiality and Property. My Culture, Your Culture, Our Culture, Their Culture]*. Bucharest: ASE Publishing House.
- Kerr, W.R. and Nanda, R., 2015. Financing Innovation. <http://dx.doi.org/10.1146/annurev-financial-111914-041825>, 7, pp.445-462. <https://doi.org/10.1146/ANNUREV-FINANCIAL-111914-041825>.
- Kiselakova, D., Sofrankova, B., Cabinova, V., Onuferova, E. and Soltesova, J., 2018. The Impact of R&D Expenditure on the Development of Global Competitiveness within the CEE EU Countries. *Journal of Competitiveness*, 10(3), pp.34-50. <https://doi.org/10.7441/JOC.2018.03.03>.
- Lupu, I. and Criste, A., 2020. Issues Regarding Innovative Companies and Their Financing. *Ovidius University Annals, Economic Sciences Series*, XX(1). [www.globalinnovationindex.org](http://www.globalinnovationindex.org) [Accessed 8 August 2022].
- Ma, Y., Zhang, T., Qian, W. and Wei, D., 2022. Financial development, demographic changes, and the growth of the non-hydro renewable energy Industry – An empirical test based on R&D and financing costs. *Renewable Energy*, 185, pp.217-229. <https://doi.org/10.1016/J.RENENE.2021.12.059>.
- Maskus, K.E., 2012. *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century*. Washington, DC: Peterson Institute Press. <https://doi.org/10.1017/s1474745613000189>.
- Maskus, K.E., Milani, S. and Neumann, R., 2019. The impact of patent protection and financial development on industrial R&D. *Research Policy*, 48(1), pp.355-370. <https://doi.org/10.1016/J.RESPOL.2018.09.005>.
- Maskus, K.E., Neumann, R. and Seidel, T., 2012. How national and international financial development affect industrial R&D. *European Economic Review*, 56(1), pp.72-83. <https://doi.org/10.1016/J.EUROECOREV.2011.06.002>.
- Mavrotas, G. and Son, S.-I., 2008. Financial Development and Economic Growth: Further Evidence from Panel Data Models. In: *Domestic Resource Mobilization and Financial*

- Development. Palgrave Macmillan, London. pp.39-69. [https://doi.org/10.1057/9780230594012\\_3](https://doi.org/10.1057/9780230594012_3).
- Meng, Y., Wang, X., Zhang, G. and Zheng, S., 2021. Trust and corporate R&D investment: Cross-country evidence. *Finance Research Letters*, 40. <https://doi.org/10.1016/J.FRL.2020.101696>.
- OECD, 2015. *Frascati Manual 2015. Guidelines for Collecting and Reporting Data on Research and Experimental Development, t, The Measurement of Scientific, Technological and Innovation Activities*. The Measurement of Scientific, Technological and Innovation Activities. *Frascati Manual 2015*. OECD Publishing, Paris. <https://doi.org/10.1787/9789264239012-en>.
- Property Rights Alliance, Levy-Carciente, S. and Montanari, L. (Ed. ., 2021. *International property rights index 2021. Property Rights Alliance*. <https://www.internationalpropertyrightsindex.org/> [Accessed 8 August 2022].
- Romer, P.M., 1990. Endogenous technological change. *Journal of Political Economy*, 98(5), pp.S71–S102. <https://doi.org/10.3386/w3210>.
- Shahbaz, M., Nasir, M.A., Hille, E. and Mahalik, M.K., 2020. UK's net-zero carbon emissions target: Investigating the potential role of economic growth, financial development, and R&D expenditures based on historical data (1870-2017). *Technological Forecasting and Social Change*, 161. <https://doi.org/10.1016/J.TECHFORE.2020.120255>.
- Sviryzdenka, K., 2016. *Introducing a New Broad-Based Index of Financial Development*. ISBN/ISSN:9781513583709/1018-5941. *Working Paper*. <https://doi.org/10.2139/ssrn.2754950>.
- Tirelli, M. and Spinesi, L., 2021. R&D financing and growth. *Economics of Innovation and New Technology*, 30(1), pp.24-47. <https://doi.org/10.1080/10438599.2019.1666505>.
- Wooldridge, J.M., 2009. Econometrics: Panel Data Methods. *Encyclopedia of Complexity and Systems Science*, pp.2769-2792. [https://doi.org/10.1007/978-0-387-30440-3\\_167](https://doi.org/10.1007/978-0-387-30440-3_167).
- World Economic Forum, 2018. *The Global Competitiveness Report 2018. Appendix C: The Global Competitiveness Index 4.0 Methodology and Technical Notes*. The Global Competitiveness Report 2018. [https://reports.weforum.org/global-competitiveness-report-2018/appendix-c-the-global-competitiveness-index-4-0-methodology-and-technical-notes/?doing\\_wp\\_cron=1660045080.6283590793609619140625](https://reports.weforum.org/global-competitiveness-report-2018/appendix-c-the-global-competitiveness-index-4-0-methodology-and-technical-notes/?doing_wp_cron=1660045080.6283590793609619140625) [Accessed 9 August 2022].
- World Intellectual Property Organization, 2022. *World Intellectual Property Report 2022: The direction of innovation*. Geneva. <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-944-2022-en-world-intellectual-property-report-2022.pdf>

Appendix no. 1

Table no. 5. Results for Central and Eastern European countries, Financial Development Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.2227	0.1042	0.5962	0.0907*
Perception of Intellectual Property Protection	0.0423**	0.0219**	0.7995	0.0326**
Patent Protection	0.6281	0.5452	0.2998	0.5157
Copyright Protection	0.0007***	0.0022***	0.588	0.0032***
Financial Development Index	0.0933*	0***	0.243	0.3961
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	1.62E-12***	7.62E-11***	4.05E-08***	1.64E-08***
F (p-values)	3.22E-21***	5.48E-17***	2.66E-11***	4.80E-12***
Breusch-Pagan Test				
Lagrange Multiplier (p-values)	1.49E-10***	9.11E-10***	1.27E-09***	6.11E-11***
F (p-values)	8.36E-13	1.24E-11	2.02E-11	2.14E-13***
Durbin Watson	0.4649	0.4196	0.4604	0.54963
Hausman Test (p-values)	0.6734	0.0964	7.79E-31***	0.8740
Model type	Random Effects	Random Effects	Fixed Effects	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

Table no. 6. Results for Western European countries, Financial Development Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.084*	0.0605*	0.2849	0.2607
Perception of Intellectual Property Protection	0.0056***	0.0066***	0.0904*	0.0144**
Patent Protection	0.0694*	0.0436**	0.8083	0.8829
Copyright Protection	0.0806*	0.5166	0.0553*	0.0029***
Financial Development Index	0***	0***	0.1487	0.0028***
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	1.07E-14***	1.94E-13***	6.18E-12***	2.33E-05***
F (p-values)	4.55E-21***	1.12E-18***	5.25E-16***	3.86E-06***

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
<i>Breush-Pagan Test</i>				
<b>Lagrange Multiplier (p-values)</b>	0.0002***	6.15E-05***	2.42E-07***	0.0007***
<b>F (p-values)</b>	0.0001***	3.63E-05***	6.09E-08***	0.0005***
<i>Durbin Watson</i>	0.3109	0.3281	0.2057	0.2983
<i>Hausman Test (p-values)</i>	1.15E-08***	4.41E-08***	0.494592492	7.31E-05***
<b>Model type</b>	<b>Fixed Effects</b>	<b>Fixed Effects</b>	<b>Random Effects</b>	<b>Fixed Effects</b>

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

Table no. 7. Results for Central and Eastern European countries,  
Financial Institution Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
<b>Overall</b>	0.3098	0.493	0.6539	0.0907*
<b>Perception of Intellectual Property Protection</b>	0.0448*	0.1156	0.6218	0.0244**
<b>Patent Protection</b>	0.413	0.2499	0.3884	0.4773
<b>Copyright Protection</b>	0.0009***	0.0022***	0.7026	0.0043***
<b>Financial Institution Index</b>	0.0641**	0.0199**	0.6039	0.6531
<i>White Heteroskedasticity Test</i>				
<b>Lagrange Multiplier (p-values)</b>	4.58E-13***	1.36E-13***	6.40E-06***	4.85E-08***
<b>F (p-values)</b>	9.05E-23***	2.37E-24***	1.62E-07***	3.72E-11***
<i>Breush-Pagan Test</i>				
<b>Lagrange Multiplier (p-values)</b>	1.54E-10***	1.28E-10***	1.33E-08***	1.43E-10***
<b>F (p-values)</b>	8.84E-13***	6.68E-13***	5.64E-10***	7.90E-13***
<i>Durbin Watson</i>	0.4133	0.3403	0.4745	0.5485
<i>Hausman Test (p-values)</i>	0.9730	0.9987	4.74E-09***	0.9918
<b>Model type</b>	<b>Random Effects</b>	<b>Random Effects</b>	<b>Fixed Effects</b>	<b>Random Effects</b>

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)



Table no. 8. Results for Western European countries, Financial Institution Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.0755*	0.0566*	0.2816	0.1473
Perception of Intellectual Property Protection	0.0192**	0.0212**	0.0903*	0.0782*
Patent Protection	0.0725*	0.0495**	0.8578	0.9611
Copyright Protection	0.3827	0.8805	0.0609*	0.0026***
Financial Institution Index	0***	0***	0.4426	0***
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	9.86E-18***	8.55E-16***	2.69E-11***	3.27E-05***
F (p-values)	1.75E-27***	2.85E-23***	6.36E-15***	6.00E-06***
Breush-Pagan Test				
Lagrange Multiplier (p-values)	3.98E-08***	3.76E-08***	5.45E-08***	0.0004***
F (p-values)	6.89E-09***	6.44E-09***	1.01E-08***	0.0003***
Durbin Watson	0.3218	0.3420	0.2055	0.2933
Hausman Test (p-values)	1.69E-09***	8.60E-09***	0.9666	0.2347
Model type	Fixed Effects	Fixed Effects	Random Effects	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

Table no. 9. Results for Central and Eastern European countries, Financial Market Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.1501	0.1754	0.3433	0.1473
Perception of Intellectual Property Protection	0.0064***	0.0045***	0.1192	0.0782*
Patent Protection	0.9607	0.9063	0.961	0.9611
Copyright Protection	0.0043***	0.009***	0.0306**	0.0026***
Financial Market Index	0.0126**	0***	0.3531	0***
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	1.85E-12***	6.00E-11***	3.47E-09***	4.57E-09***
F (p-values)	4.60E-21***	3.13E-17***	2.22E-13***	3.88E-13***
Breush-Pagan Test				
Lagrange Multiplier (p-values)	1.81E-09***	3.34E-09***	1.27E-09***	4.53E-11***
F (p-values)	3.37E-11***	8.10E-11***	2.02E-11***	1.34E-13***

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Durbin Watson	0.4461	0.4015	0.4497	0.5520
Hausman Test (p-values)	0.0263**	4.53E-12***	1	0.7492
Model type	Fixed Effects	Fixed Effects	Random Effects	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

Table no. 10. Results for Weastern European countries, Financial Market Index

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.1182	0.0865*	0.2809	0.1473
Perception of Intellectual Property Protection	0.0042***	0.0046**	0.1108	0.0782*
Patent Protection	0.185	0.1219	0.8364	0.9611
Copyright Protection	0.0145**	0.1568	0.0353**	0.0026***
Financial Market Index	0.0072***	0.0048***	0.1835	0***
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	4.01E-14***	2.66E-12***	9.42E-12***	3.99E-06***
F (p-values)	5.84E-20***	1.22E-16***	1.08E-15***	3.72E-07***
Breush-Pagan Test				
Lagrange Multiplier (p-values)	0.0002***	2.58E-05***	2.78E-07***	0.0001***
F (p-values)	0.0001***	1.37E-05***	7.17E-08***	0.0001***
Durbin Watson	0.2944	0.3116	0.2060	0.2865
Hausman Test (p-values)	0.0046***	0.0001***	0.7289	0.2692
Model type	Fixed Effects	Fixed Effects	Random Effects	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

Table no. 11. Results for Central and Eastern European countries, Financial Development Index 6 sub-components

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.2544	0.3485	0.7705	0.17
Perception of Intellectual Property Protection	0.0452**	0.0183**	0.7023	0.0565*
Patent Protection	0.907	0.5984	0.9189	0.6343
Copyright Protection	0.0068***	0.0153**	0.2905	0.0363**

<i>Exogenous variables (p-values)</i>	<i>Dependent variables</i>			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Financial Institutions Access Index	0.491	0.3763	0.0049***	0.0161**
Financial Institutions Depth Index	0.0209**	0.4494	0.0001***	0.0149**
Financial Institutions Efficiency Index	0***	0.0059***	0***	0.1737
Financial Markets Access Index	0.9752	0.2866	0***	0.0445**
Financial Markets Depth Index	0.0168**	0.0097***	0.6278	0.2956
Financial Markets Efficiency Index	0.0001***	0.1497	0.0004***	0.2477
<i>White Heteroskedasticity Test</i>				
Lagrange Multiplier (p-values)	0.0009***	0.0002***	0.1381	0.0072***
F (p-values)	8.35E-07***	1.18E-08***	0.0840***	0.0002***
<i>Breusch-Pagan Test</i>				
Lagrange Multiplier (p-values)	2.84E-08***	1.30E-06***	0.0004***	3.20E-06
F (p-values)	3.65E-10***	9.55E-08***	0.0001***	3.28E-07
<i>Durbin Watson</i>	0.6751	0.7341	1.0815	0.6176
<i>Hausman Test (p-values)</i>	1	3.61E-47***		1
Model type	Random Effects	Fixed Effects	Pooled OLS	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)

**Table no. 12. Results for Western European countries,  
Financial Development Index 6 sub-components**

<i>Exogenous variables (p-values)</i>	<i>Dependent variables</i>			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Overall	0.0523*	0.0266**	0.3924	0.3562
Perception of Intellectual Property Protection	0.0115**	0.0063***	0.0373**	0.143
Patent Protection	0.0049***	0.0017***	0.8613	0.8625
Copyright Protection	0.4456	0.702	0.0081***	0.0044***
Financial Institutions Access Index	0***	0***	0.4611	0***
Financial Institutions Depth Index	0.0207**	0.0002***	0.9092	0.0021***
Financial Institutions Efficiency Index	0.1377	0.175	0.8766	0.4354

Exogenous variables (p-values)	Dependent variables			
	All sectors	Business enterprise sector	Government sector	Higher education sector
Financial Markets Access Index	0.0226**	0.1098	0.0523*	0.0846*
Financial Markets Depth Index	0.2026	0.9211	0.236	0.0067***
Financial Markets Efficiency Index	0***	0***	0.0572*	0.6654
White Heteroskedasticity Test				
Lagrange Multiplier (p-values)	4.51E-13***	3.04E-11***	1.35E-08***	1.60E-11***
F (p-values)	1.30E-33***	2.77E-25***	2.67E-16***	2.03E-26***
Breusch-Pagan Test				
Lagrange Multiplier (p-values)	9.61E-12***	1.72E-11***	7.42E-17***	8.18E-09***
F (p-values)	3.11E-14***	7.28E-14***	1.88E-22***	3.78E-10***
Durbin Watson	0.3687	0.3779	0.4023	0.3892
Hausman Test (p-values)	0.0237**	0.0016***	0.1042	0.9706
Model type	Fixed Effects	Fixed Effects	Random Effects	Random Effects

Source: Authors' processing (\* significance at 10%, \*\* significance at 5%, \*\*\* significance at 1%)