Researchers In R&D And Patent Applications By Residents: A Cross-Country Econometric Analysis

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Abstract: A patent application is a relevant indicator of the outcomes of research and development activities and also represents an incentive for firms and countries to invest in such activities for the economic and strategic value of the resulting goods or processes, protected for a certain period of time. In the current geopolitical and economic context, marked by fierce competition, inventions can make the difference between winners and losers on the world stage. This paper investigates the relationship between the number of researchers in R&D and patent applications by residents. It aims to determine the impact of research on innovation in Bulgaria, China, France, Germany, Hungary, Romania, Russia, Turkey, Ukraine, the United Kingdom and the US, using quantitative and econometric analyses (log-log, OLS, lag structures and non-linear specifications). The results indicate heterogeneities among the analysed countries, indicating that a high number of researchers in R&D is not enough to boost innovation. China exhibits a statistically significant, linear relationship with the highest positive elasticity between R&D and innovation, indicating an efficient conversion of researchers' activity into patent applications. France, Germany and the US showed non-linear relationships, whereas Romania, Bulgaria and Hungary registered weaker elasticities and lower research efficiency.

Keywords: R&D, researchers, patent application, innovation, econometrics
JEL Classification: O31, O32, O34, C23, O57

1 Introduction

Innovation is the main driver of progress since the beginning of recorded history. Civilisations rose and fell, led by new technologies or their absence. Particularly in the context of a knowledge-based economy, R&D and innovation are drivers of economic competitiveness and sustainable development. Against this background, the number of researchers working in R&D and the number of patent applications are relevant indicators for assessing the national innovation systems and generating and capitalising technological change.

According to the World Bank Group (2026a), researchers in Research & Development (RR&D) are "professionals who conduct research and improve or develop concepts, theories, models, techniques, instrumentation, software of operational methods, covering basic research, applied research, and experimental development."

Patent applications are "worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years" (World Bank Group, 2026b).

The EU aims to adopt the European Innovation Act in 2026, to create cross-sectoral legal framework conditions that remove barriers to bringing innovative ideas to market across all sectors, because it has an impressive amount of research and innovation that is not sufficiently capitalised as manufactured products or processes (European Commission, 2026).

This paper aims to compare the relationship between the number of researchers in R&D and patent applications by residents in a selection of countries across three continents, to identify whether the number of researchers alone matters, or whether other factors interfere in the innovation process.

2 Literature review

In general, the literature regards patents as an indicator of innovation in research and development activities. According to Carlino & Kerr (2014), a patent provides a legal right to exclusively make, use, or sell the invention or process for a specified period. It offers the economic motivation for inventors to pursue new opportunities by granting a temporary monopoly to successful efforts. Therefore, patent applications represent not only innovation but also an incentive to invest in R&D.

Several studies suggest there is a significant relationship between R&D personnel (human capital) and patent production. Hong & Jung (2012) identified a significant effect of the number and quality of R&D staff involved in corporate technology innovation on patent production. Their findings also emphasise that younger and larger companies tend to produce more patents, because they have more resources to support innovation, and pursue new technologies and innovative activities than older firms. Varas and de la Mata (2023) also found a strong correlation between patenting and R&D personnel, supporting the importance of specialised staff for innovation.

The role of skilled human capital in promoting innovation is also emphasised by Jin et al. (2020), who identified an extremely significant positive correlation between the number of patents and the human capital index at the company and significant positive correlations with the education level of personnel, and the proportion of engineering professionals. Thus, human capital plays an important role in innovation. Psachoulias (2021) makes the analogy to the production of physical goods when analysing how innovative output is determined by R&D activity and human capital.

There is research focused on the relationship between innovation and economic growth; for example, Beltrán-Morales et al. (2021) demonstrated that the Mexican states with the highest inventiveness activity and the greatest number of members of the National System of Researchers, on average, realised higher rates of economic growth. However, Shan (2018) argued that over 25 years, the Chinese labour force grew more slowly than R&D personnel (17% and 480%, respectively) and questioned whether such remarkable growth in R&D personnel and technological innovation capacity could continue to sustain China's economic development. The researcher believes that China’s economy and market share limit its ability to benefit from having more R&D personnel. Raghupathi & Raghupathi (2019) explored how innovation focus changes as economy develops, underline that as a nation develops, government expenditure on R&D decreases, and businesses increase local innovation. Related to that, when measuring innovation by the number of patents, Que & Zhang (2018) found that companies financed by foreign venture capital proved to be less innovative than those backed by domestic venture capital.

Castellacci & Natera (2013) found that the dynamics of national systems of innovation are driven by innovative input, scientific output and technological output, on the one hand, and infrastructures, international trade and human capital, on the other. This result varies and takes specific patterns in national systems characterised by different levels of development.

Overall, the literature suggests that R&D personnel is a central driver of innovation and patent applications, but heterogeneity exists due to institutional, economic and financial conditions.

However, despite the growing literature regarding the relationship between the researchers in R&D and patent applications by residents, there were no identified studies analysing specifically this relationship for the selected countries in this paper.

3 Methodology

This research is centred on World Bank data on researchers in R&D and patent applications by residents (PAR), covering the period 1996 to 2021. The analysis focuses on Romania and its neighbours, Bulgaria, Hungary and Ukraine, France and Germany, as the relevant countries for the EU, and the US and China as the leaders regarding the selected indicators worldwide.

In the quantitative analysis, we examined the dynamics of the selected indicators to better understand the econometric analysis results by observing their trends.

In the econometric analysis, to assess the relationship between researchers in RR&D and PAR, log-linear regression models (Ordinary least squares) are estimated, with PAR as the dependent variable and RR&D as the independent variable, to compare the relationships based on elasticities.

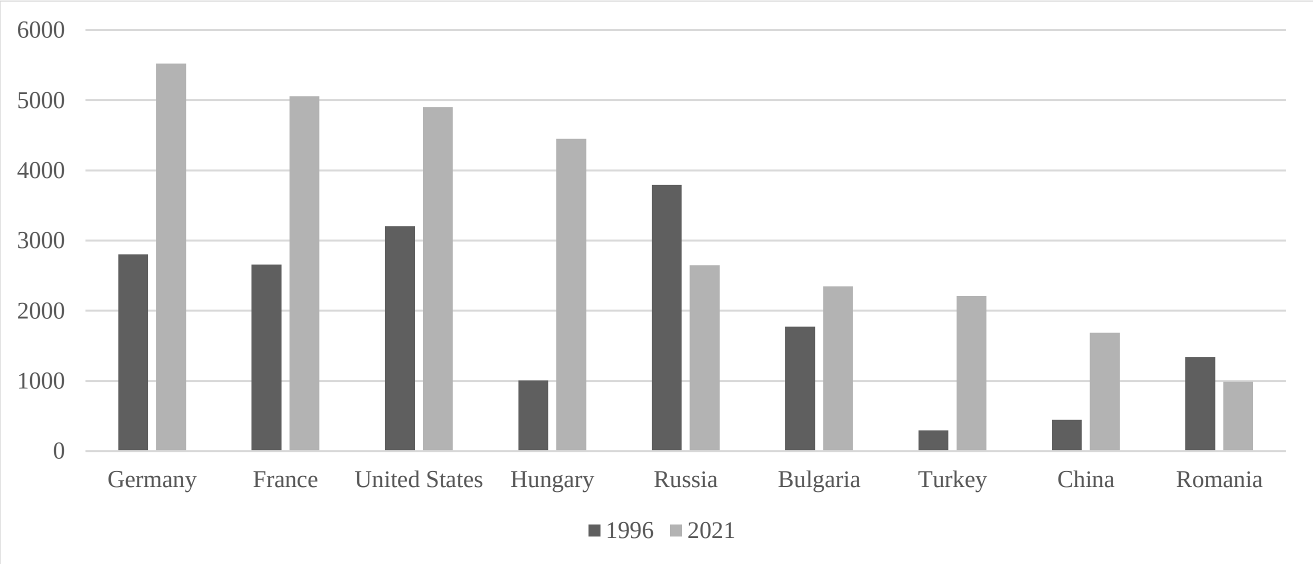
Because the effects of increasing research personnel in R&D may take time to generate relevant outcomes, several lag structures (1 to 11 years) were tested, and the models with the best explanatory power were selected.

Quadratic terms are introduced to capture potential non-linear relationships. Diagnostic tests (linearity, heteroskedasticity, autocorrelation, and normality of residuals) are conducted to assess the validity of models.

4 Quantitative analyses

In 2021, Germany registered the highest number of researchers in R&D per million inhabitants (Figure 1), at 5521, followed by France (5058) and the US (4901). Among the Eastern Bloc, Hungary leads with 4452, followed by Bulgaria (2347), with Romania ranking last in the selection (989). Among the non-Western countries, Russia ranks first with 2647 researchers in R&D activities, followed by Turkey (2210) and China (1686).

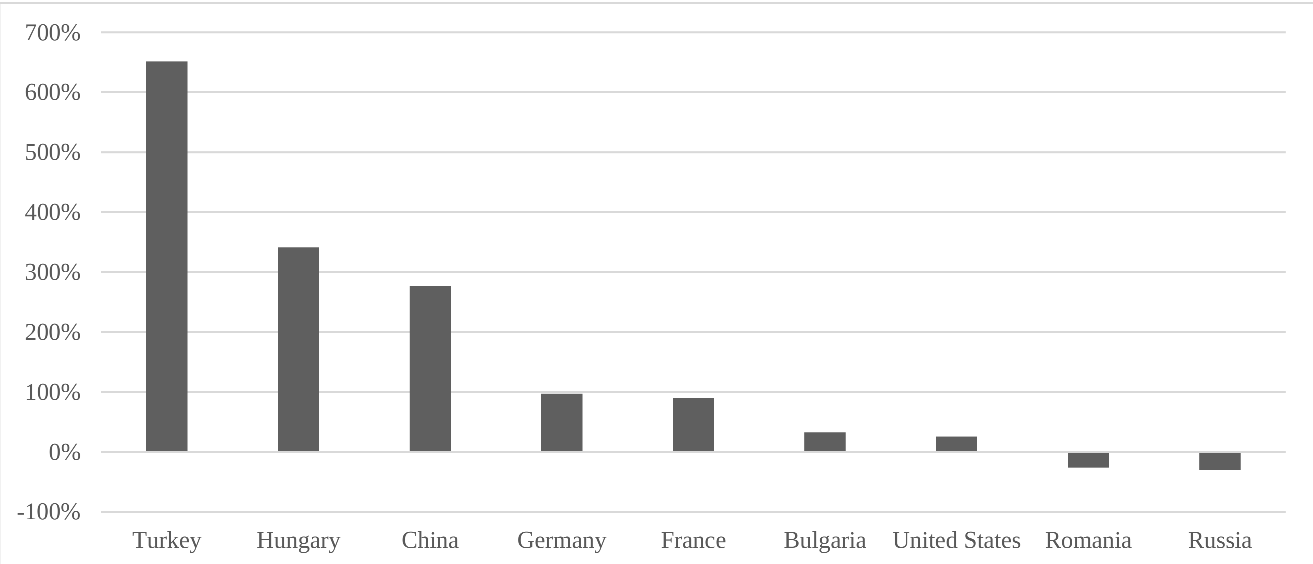
Figure 1. The number of researchers in Research & Development (R&D), expressed per million inhabitants



Source: Author's representation based on World Bank Group (2026a).

Between 1996 and 2021, Turkey recorded the highest increase in the number of researchers in R&D activities (651%), followed by Hungary (341%) and China (277%). Germany and France increased their numbers by 97% and 90%, respectively, while Bulgaria (32%) and the US (25%) rounded out the group of selected countries with increases. Romania and Russia recorded decreases in RR&D numbers (Figure 2)

Figure 2. The number of researchers in Research & Development, Percentage change between 1996 and 2021

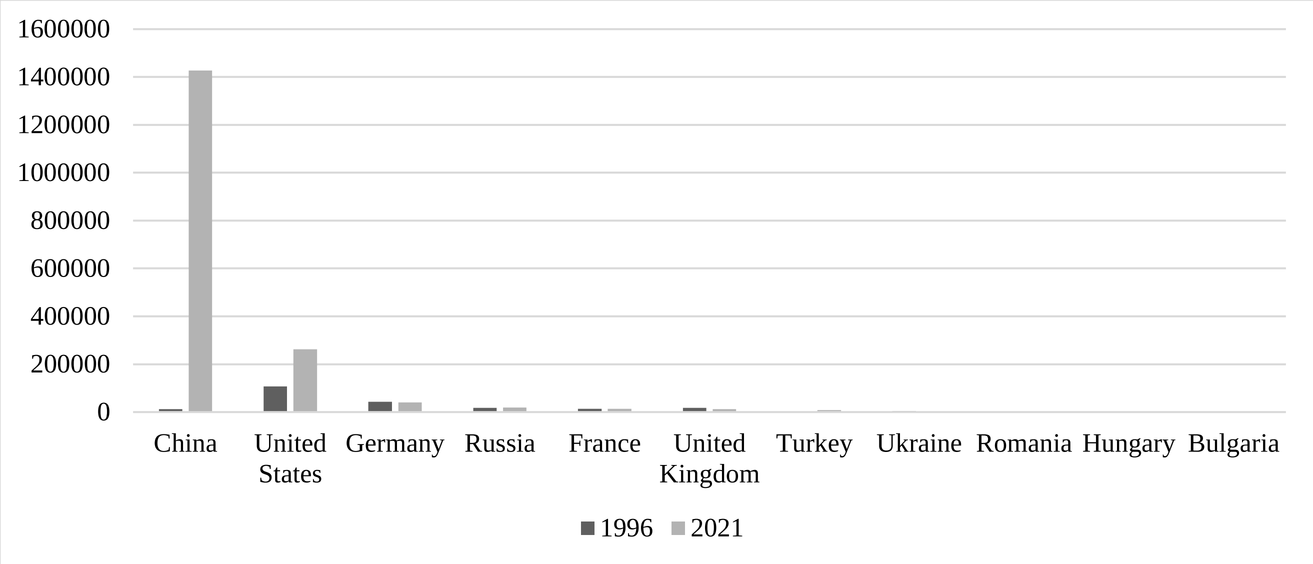


Source: Author's representation based on World Bank Group (2026a).

Regarding patent applications by residents, in 2021, China stands out at 1.4 million, followed by the US with 262 thousand, and Germany (40 thousand). There is a group of countries with a PAR between 10,000 and 20,000, including the United Kingdom, France and Russia. Ukraine and Turkey follow at 1,302 and 8,234, respectively.

Romania and its neighbours, Hungary and Bulgaria, are at the bottom of the ranking with 772, 433 and 165 PAR, respectively (Figure 3).

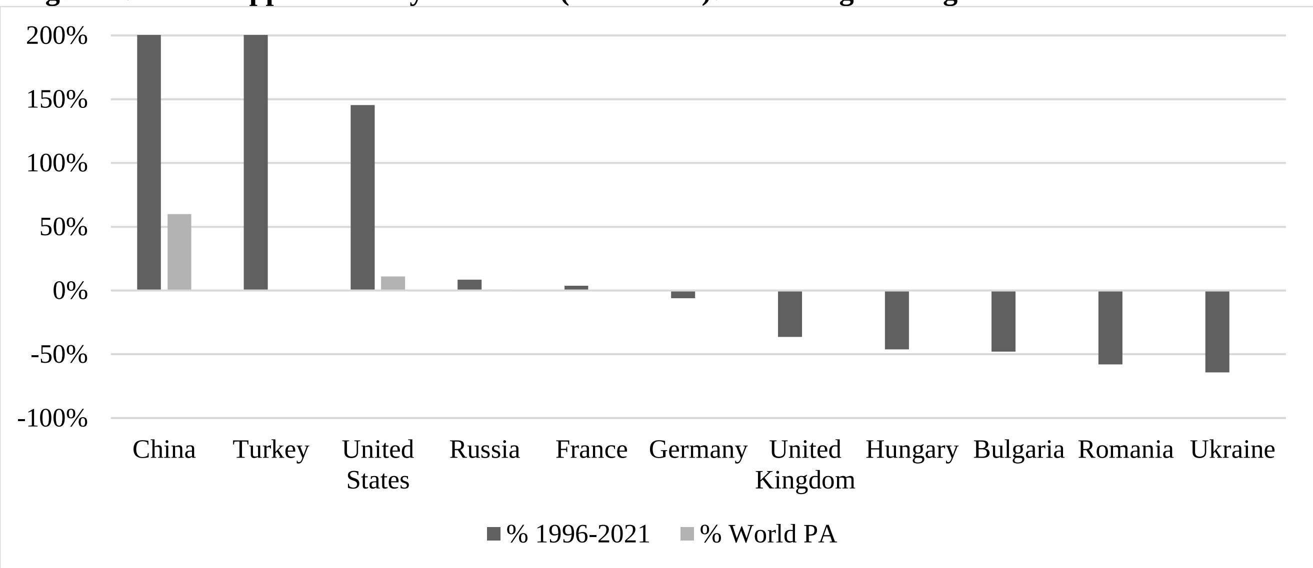
Figure 3. Patent applications, residents, 1996 vs. 2021



Source: Author's representation based on World Bank Group (2026b).

Between 1996 and 2021, China experienced a remarkable 12,169% increase in PAR (Figure 4), which accounted for almost 60% of the world's PAR in 2021. Turkey followed with a 4.256% increase, and the US ranked third with 145%. However, the US accounted for only 11% of the world's PAR, far behind China. In the positive range were Russia (9% increase in PAR) and France (4% increase in PAR).

Figure 4. Patent Applications by Residents (1996–2021): Percentage Change and Global Share in 2021



Source: Author's representation based on World Bank Group (2026b).

The rest of the selected countries recorded decreases in patent applications by residents: Germany (-6%), the UK (-36%), Hungary (46%), Bulgaria (-48%), Romania (-58%), and Ukraine (-64%).

5 Econometric analyses

To exemplify the methodology (log-log/lag), China, which had the highest elasticity among the analysed countries, was selected. The dependent variable was $lnPAR_{t,}$ and the regressor was lnRR&D, lagged by six years. The linear relationship was tested at the 95% confidence level to assess its statistical significance. The null hypothesis (H_0: $\rho = 0$) implied there was no statistically significant linear relationship between lnPARt and

$lnRR\&D_{t-6}$ in China. The alternative hypothesis (H_a: $\rho \neq 0$) supported a statistically significant linear relationship between the two variables. The regression statistics are displayed in Table 1. The models allowed us to estimate elasticity directly: a 1% change in $lnRR\&D_{t-6}$ leads to a ß% change in $lnPAR_t$.

Table 1. OLS, using observations 2002-2021 (T = 20). Dependent variable: l_PAR

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	−7.96888	1.87835	−4.243	0.0005
l_RR&D_6	3.13579	0.286987	10.93	<0.0001

Mean dependent var	12.81561	S.D. dependent var	1.208120
Sum squared resid	2.740023	S.E. of regression	0.390158
R-squared	0.901195	Adjusted R-squared	0.895706
F(1, 15)	119.3907	P-value(F)	2.25e-09
Log-likelihood	−8.501110	Akaike criterion	21.00222
Schwarz criterion	22.99369	Hannan-Quinn	21.39098
rho	0.445685	Durbin-Watson	0.987375

Since the P-value = 0.0001, smaller than the significance level: $\alpha = 0.05$, the null hypothesis (H_0) is rejected (Table 1).

Therefore, we are 95% confident that a statistically significant linear relationship exists between $lnPAR_t$ and $lnRR\&D_{t-6}$ in China.

Table 2. The results of tests to verify the assumptions

Lagrange Multiplier (LM) test for non-Linearity (squared terms), Null hypothesis: relationship is linear, α = 0.05	Test statistic: LM = 0.0915696 with p-value = P(Chi-square(1) > 0.0915696) = 0.762191 P-value> α, we fail to reject the null hypothesis Relationship is linear
White's test for heteroskedasticity, Null hypothesis: heteroskedasticity not present, α = 0.05	Test statistic: LM = 1.79654 with p-value = P(Chi-square(2) > 1.79654) = 0.407274 P-value> α, we fail to reject the null hypothesis Homoskedasticity
Test for normality of residuals, Null hypothesis: error is normally distributed, α = 0.05	Test statistic: Chi-square(2) = 0.309956 with p-value = 0.856434, P-value> α, we fail to reject the null hypothesis Error is normally distributed
Breusch-Godfrey test for autocorrelation up to order 3, Null hypothesis: no autocorrelation, α = 0.05	Test statistic: LMF = 2.13312 with p-value = P(F(3, 15) > 2.13312) = 0.1388, P-value> α, we fail to reject the null hypothesis No autocorrelation
Estimated Equation of the regression line	$ln(PAR_t) = -7.97 + 3.14ln(RR\&D_{t-6})$

According to the model, in China, a 1% increase in the number of researchers in R&D in year *t-6* is associated with a 3.14% increase in PAR in year *t*. The high elasticity ($\beta = 3.14$) indicates a very good efficiency of R&D researchers in producing patentable innovations. The six-year lag reflects the time it takes for the research to be converted into patents.

The model is statistically significant at the 95% confidence level ($\alpha = 0.0001<0.05$). R-squared = 0.9012, suggesting that over 90% of the variation in PAR is explained by the relationship between the two selected variables. The diagnostic tests confirm the validity of the economic model (Table 2).

The same methodology, with various procedures, was applied to the EU, as well as to Bulgaria, Hungary, Romania, Ukraine, the United Kingdom and the USA, as shown in Table 3.

Table 3. Summary table of linear regression statistical data and associated tests

Country	Model Equation	Lag	β	p-value	R^2	T	LM	WT	NR	BGA
Bulgaria	$\ln(PAR_t) = 8.87 - 0.461\ln(RR\&D_{t-2})$	t-2	-0.461	<0.0001	0.443	24	0.127	0.115	0.804	0.877
Hungary	$\ln(PAR_t) = 10.84 - 0.585\ln(RR\&D_{t-3})$	t-3	-0.585	<0.0001	0.782	23	0.190	0.581	0.318	0.133
Romania	$\ln(PAR_t) = 3.396 + 0.511\ln(RR\&D_{t-5})$	t-5	0.511	0.0282	0.139	21	0.763	0.810	0.423	0.354
Russia	$\ln(PAR_t) = 1.22 + 1.10\ln(R\ RR\&D_{t-10})$	t-10	1.103	0.0110	0.858	16	0.118	0.518	0.360	0.734
Ukraine	$\ln(PAR_t) = -6.79 + 2.02\ln(R\ RR\&D_{t-7})$	t-7	2.02	<0.0001	0.858	9	0.763	0.334	0.465	0.572
United Kingdom	$\ln(PAR_t) = 14.15 – 0.55\ln(R\ RR\&D_{t-7})$	t-7	-0.55	<0.0001	0.871	15	0.125	0.144	0.602	0.115
USA	$\ln(PAR_t) = 1.81 + 1.305\ln(RR\&D_{t-11})$	t-11	1.305	0.0007	0.51	15	0.899	0.694	0.566	0.228

The model for Turkey includes a quadratic term (sq_l_RR&D) that captures the non-linear effects of RR&D on PAR (Table 4).

Table 4. Model: OLS, using observations 1997-2021 (T = 25)
Dependent variable: l_PAR
HAC standard errors, bandwidth 2, Bartlett kernel

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	−13.8429	3.78367	−3.659	0.0015
sq_l_RR&D	−0.287976	0.0699808	−4.115	0.0005
l_RR&D	4.34211	1.15952	3.745	0.0012
l_PAR_1	0.722524	0.114509	6.310	<0.0001

Mean dependent var	7.482840	S.D. dependent var	1.323140
Sum squared resid	0.247722	S.E. of regression	0.108611
R-squared	0.994104	Adjusted R-squared	0.993262
F(3, 21)	6314.213	P-value(F)	3.49e-31
Log-likelihood	22.20558	Akaike criterion	−36.41117
Schwarz criterion	−31.53566	Hannan-Quinn	−35.05891
rho	−0.400934	Durbin's h	−2.445100

Table 5. Diagnostic tests

Lagrange Multiplier (LM) test for non-Linearity (squared terms), Null hypothesis: relationship is linear, α = 0.05	Test statistic: LM = 3.47467 with p-value = P(Chi-square(2) > 3.47467) = 0.175989, P-value> α, we fail to reject the null hypothesis Relationship is linear
White's test for heteroskedasticity, Null hypothesis: heteroskedasticity not present, α = 0.05	Test statistic: LM = 6.73591 with p-value = P(Chi-square(8) > 6.73591) = 0.565375, P-value> α, we fail to reject the null hypothesis Homoskedasticity
Test for normality of residuals, Null hypothesis: error is normally distributed, α = 0.05	Test statistic: Chi-square(2) = 0.578559 with p-value = 0.748803, P-value> α, we fail to reject the null hypothesis Error is normally distributed
Breusch-Godfrey test for autocorrelation up to order 3, Null hypothesis: no autocorrelation, α = 0.05	Test statistic: LMF = 2.00687 with p-value = P(F(3, 18) > 2.00687) = 0.149084, P-value> α, we fail to reject the null hypothesis No autocorrelation

Estimated Equation of the regression line	*$ln(PAR_t) = -13.84 + 4.34ln(RR\&D_t) - 0.288[ln(RR\&D_t)]^2 + 0.723ln(PAR_{t-1})$*

Although the null hypothesis of linearity cannot be rejected (p = 0.176), both the linear and quadratic coefficients are statistically significant at a 95% confidence level and display the expected signs for an inverted U-shaped relationship. (Table 6). For an inverted U relationship, the EKC-type relationship applied to innovation, the conditions are: $\beta1 > 0, \beta2 < 0$

Table 6. Results

Coefficient	Sign	p-value
β1 = 4.34211	positive	0.0005
β2 = −0.28796	negative	0.0012

Thus, even if the linear relationship cannot be rejected, the quadratic model is considered because it provides additional insights into the nature of the relationship by identifying the turning point and showing why the positive effect of increasing the number of researchers in R&D weakens beyond that level.

To find the turning point for $\ln(PAR_t) = -13.84 + 4.34\ln(RR\&D_t) - 0.288[\ln(RR\&D_t)]^2 + 0.723\ln(PAR_{t-1})$

The standard formula for a quadratic function is used:

$$\ln(RR\&D)^* = -\frac{\beta1}{2\beta2}$$

$$\ln(RR\&D)^* = -\frac{4.34211}{2x(-0.28796)} = \frac{4.34211}{0.57592} \approx 7.54$$

$\ln(RR\&D)^* \approx 7.54$

$RR\&D^* = e^{7.54} \approx 1880$, where e ≈ 2.71828 (the base of the natural logarithm).

The results indicate that in Turkey, below 1880 researchers in R&D, an increase in RR&D leads to an increase in PAR. Beyond that level, the marginal contribution to PAR begins to decrease.

For France, the same model was used, but the residuals deviate from normality. For Germany, the relationship is not statistically significant at the 95% confidence level. The results are presented in Table 6.

Table 7. Summary table of non-linear relationships

Country	Model Equation	Lag	β	p-value	R²	T	LM	WT	NR	BGA
France*	$\ln(PAR_t) = -34.46 + 10.03\ln(RR\&D_t) - 0.610[\ln(RR\&D_t)]^2 + 0.293\ln(PAR_{t-1})$	t, t-1	10.033 / - 0.610	0.0182 / 0.0185	0.669	25	0.058	0.087	**0.0002**	0.636
Germany**	$\ln(PAR_t) = -40.03 + 12.44\ln(RR\&D_t) - 0.761[\ln(RR\&D_t)]^2$	t	12.441 / −0.761	**0.0808 / 0.0755**	0.687	25				
Turkey*	$\ln(PAR_t) = -13.84 + 4.34\ln(RR\&D_t) - 0.288[\ln(RR\&D_t)]^2 + 0.723\ln(PAR_{t-1})$	t, t-1	4.342 / -0.288	0.0012 / 0.0005	0.994	25	0.176	0.565	0.749	0.149

* Model: OLS, using observations 1997-2021 (T = 25) Dependent variable: l_PAR, HAC standard errors, bandwidth 2, Bartlett kernel

** Cochrane-Orcutt, using observations 1997-2021 (T = 25), Dependent variable: l_PAR

6 Conclusions

Both quantitative and econometric analyses revealed heterogeneity among the selected countries.

China stands out with the strongest linear and statistically significant relationship at the 95% confidence level. The elasticity coefficient indicates that for a 1% increase in RR&D, patent applications by residents increase more than 3% after six years, reflecting a high productivity of research investment. The model's explanatory power is very high, with over 90% of the variation in patents being explained by the relationship between the two variables. The quantitative analysis supports these dynamics, showing an increase of more than 12,000% between 1996 and 2021. The results confirm why China alone accounts for almost 60% of the world's patent applications in 2021.

The United States and Russia have smaller elasticities (1.3 and 1.1, respectively) and lags of 11 and 10 years, indicating that a longer time is required to convert research into patentable innovation than in China.

Romania displays an elasticity below 1% and a lower model explanatory power (R^2=0.139). That indicates that other factors may influence the number of patentable innovations. Romania and Russia are the only countries in the selection where the number of researchers in R&D decreased between 1996 and 2021.

Despite the increase in the number of researchers in R&D during the analysed period, Bulgaria and Hungary recorded negative elasticities. That suggests inefficiencies in the innovation system. A 1% increase in RR&D leads to a decrease in PAR by 0.46% in Bulgaria and 0.59% in Hungary.

From the countries with a non-linear relationship between RR&D and PAR, Turkey provides the best model, with an inverted-U-shaped relationship between the variables and a turning point of 1,880 researchers, meaning that beyond that level, the marginal contribution of additional researchers to patent applications by residents diminishes.

France and Germany also displayed potential non-linear relationships. However, the model for France did not pass the diagnostic test regarding the residual normality, and the model for Germany was not statistically significant at the 95% confidence level.

Overall, the results suggest that the number of researchers in R&D alone is insufficient to increase patent applications. Therefore, further research should focus on other factors that might improve innovation output, such as R&D spending, the quality of education, patent quality metrics, and industrial structure. In this context, policymakers should adopt tailored strategies that not only aim to increase the number of researchers involved in R&D but also improve the quality of institutions, commercialisation capacity and cooperation between research and industry.

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Annexe 1. Researchers in R&D (1996-2021)

Year	China	France	Germany	Hungary	Bulgaria	Romania	Russia	Ukraine	UK	USA	Turkey
1996	447.10	2656.27	2801.62	1009.15	1771.85	1340.55	3792.64	N/A	2485.75	3206.68	294.09
1997	476.21	2646.35	2862.83	1083.88	1450.78	1264.79	3598.52	N/A	2495.08	3310.88	302.98
1998	389.63	2654.59	2884.31	1142.66	1464.18	1230.48	3333.55	N/A	2694.03	3472.49	298.98
1999	422.98	2723.93	3120.90	1228.77	1306.20	1056.12	3368.96	N/A	2853.24	3547.13	312.68
2000	549.57	2902.95	3154.48	1412.00	1179.70	926.24	3446.17	N/A	2893.38	3556.39	355.05
2001	582.79	2971.39	3230.27	1440.86	1157.05	897.21	3452.79	N/A	3078.41	3598.59	344.81
2002	631.73	3100.95	3240.75	1473.70	1168.80	928.25	3375.24	N/A	3335.63	3645.75	360.00
2003	667.93	3184.64	3275.19	1499.68	1224.20	966.75	3335.95	N/A	3631.26	3851.47	484.24
2004	713.43	3320.67	3290.96	1476.27	1263.77	988.66	3283.70	N/A	3818.24	3710.15	496.59
2005	856.66	3297.85	3315.76	1575.85	1301.71	1077.56	3206.19	N/A	4117.75	3635.29	567.50
2006	931.20	3405.18	3411.79	1745.00	1348.09	900.57	3218.09	1451.92	4176.44	3674.19	612.17
2007	1076.74	3563.57	3573.67	1731.43	1471.48	897.74	3259.50	1430.03	4122.71	3624.05	705.52
2008	1197.59	3636.48	3726.67	1846.00	1505.75	932.80	3137.58	1404.84	4077.29	3751.46	742.75
2009	861.25	3723.00	3916.78	2004.50	1593.43	933.39	3075.23	1324.32	4113.42	3877.89	801.95
2010	898.86	3849.59	4056.42	2135.63	1470.69	964.53	3071.56	1306.70	4089.21	3643.93	882.50
2011	972.02	3920.66	4191.52	2309.99	1606.21	789.88	3109.37	1237.48	3973.02	3754.88	977.26
2012	1028.98	4052.17	4355.57	2400.89	1537.41	891.60	3075.21	1210.05	4017.98	3734.66	1100.19
2013	1079.64	4133.56	4380.39	2527.85	1685.20	923.70	3050.28	1139.62	4171.81	3815.21	1175.90
2014	1101.80	4210.04	4336.02	2654.80	1822.03	904.76	3072.94	1002.51	4280.80	3915.03	1163.54
2015	1162.71	4310.71	4755.30	2569.67	1976.76	876.41	3096.03	1006.00	4389.56	3949.66	1136.18
2016	1208.86	4392.05	4839.85	2625.94	2236.86	910.45	2947.00	1037.24	4434.66	3897.11	1263.79
2017	1235.85	4546.76	5058.40	2902.24	2125.46	887.75	2811.97	994.08	4472.69	4020.59	1420.60
2018	1317.49	4670.53	5209.21	3846.49	2343.49	876.17	2772.64	988.08	N/A	4322.79	1585.08
2019	1483.86	4773.97	5398.63	4021.15	2420.09	887.47	2734.69	880.55	N/A	4367.21	1737.58
2020	1600.31	4883.22	5390.05	4309.62	2401.17	942.32	2710.16	846.25	N/A	4567.79	1964.66
2021	1685.98	5058.05	5520.58	4452.49	2346.70	988.68	2647.79	774.07	N/A	4900.77	2209.70

Source: World Bank (2026a).

Annexe 2. Patent applications, residents (1996-2021)

Year	China	France	Germany	Hungary	Bulgaria	Romania	Russia	Ukraine	UK	USA	Turkey
1996	11628	12916	42322	803	316	1831	18014	3636	18184	106892	189
1997	12672	13252	44438	737	394	1708	15106	4688	17938	119214	203
1998	13751	13251	46523	690	274	1299	16454	5319	19530	134733	207
1999	15626	13592	50029	729	282	1061	19900	5401	21333	149251	276
2000	25346	13870	51736	810	231	1003	23377	5620	22050	164795	277
2001	30038	13499	49989	919	283	1128	24777	7208	21423	177513	337
2002	39806	13519	47598	842	289	1478	23712	1601	20624	184245	414
2003	56769	13511	47818	756	278	881	24969	1635	20426	188941	489
2004	65786	14230	48448	748	263	937	22985	4090	19178	189536	682
2005	93485	14327	48367	705	261	916	23644	3538	17833	207867	928
2006	122318	14529	48012	718	243	814	27884	3474	17484	221784	1072
2007	153060	14722	47853	689	211	827	27505	3440	17375	241347	1810
2008	194579	14658	49240	683	249	995	27712	2825	16523	231588	2221
2009	229096	14100	47859	757	242	1054	25598	2434	15985	224912	2555
2010	293066	14748	47047	649	243	1382	28722	2556	15490	241977	3180
2011	415829	14655	46986	662	262	1424	26495	2649	15343	247750	3885
2012	535313	14540	46620	692	245	1022	28701	2491	15370	268782	4434
2013	704936	14690	47353	642	282	993	28765	2856	14972	287831	4392
2014	801135	14500	48154	546	218	952	24072	2457	15196	285096	4766
2015	968252	14306	47384	569	280	975	29269	2271	14867	288335	5352
2016	1204981	14206	48480	616	230	1005	26795	2233	13876	295327	6230
2017	1245709	14415	47785	496	202	1098	22777	2283	13301	293904	8175
2018	1393815	14303	46617	407	180	1100	24926	2107	12865	285095	7156
2019	1243568	14103	46632	427	186	881	23337	2097	12061	285113	7871
2020	1344817	12771	42260	428	239	817	23759	1361	11990	269586	7920
2021	1426644	13386	39822	433	165	772	19569	1302	11592	262244	8234

Source: World Bank (2026b).