NEW ECONOMY Section

HUMAN CAPITAL INNOVATION AND KNOWLEDGE ECONOMY. ROMANIAN CASE

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Abstract. *The knowledge economy, innovation and human capital are three topics frequently present in the literature in the last decades. Romania, as a member state of the European Union, has aligned itself with the objectives of 2020 Strategy of building a knowledge – based society in which human capital and innovation plays a determinant role. The construction of this society implies, in the opinion of many specialists the increasing attention to the development of human capital, especially the one integrated in the creative activities (research-development-innovation), often the analyzes are channeling itself on an aspect of this societies, called by some the new economy or the informational economy. The paper is looking to decipher the extent to which Romania has aligned itself with the global and European trends in the construction of the knowledge economy and the role that human capital and innovation has in developing this economy. Over more, given the importance of human capital and innovation, the work tries to highlight the link between the indicators of the knowledge economy and the human capital and innovation in Romania and the extent to which their evolution contributes to the increase of welfare through the increase of knowledge, using the appropriate techniques for this purpose.*

Keywords: *knowledge economy, human capital, tertiary education, research-innovation*

JEL Classification: J24, D80, C19, D69, I23

1. Introduction

There is a large literature dedicated to the knowledge society, human capital and its interaction with development, innovation and knowledge society. Many studies highlight that the core of knowledge society is human capital and the main forces of this society are education, science and innovation, because knowledge is the result of learning and internationalization of information, data and experience. According to the World Bank paper (2018), Romania had in 2017 a low Human capital Index (HCI) with a level of 0.60, compared to 0.81 in Finland and an

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average of 0.75 in European Union (EU 28 countries), which means that Romania has a great gap to cover in the future to reduce this discrepancy versus other European countries.

The *knowledge society*, used as concept for the first time in 1969 by Peter Drucker, cannot exist without human capital, because knowledge is the result of people learning, of internationalization of information, data and experience facilitated by the digital technology. The knowledge society has the ability to develop knowledge and produce "new meaning", that implies creativity and two type of knowledge difficult to obtain without highly developed people. Jerzy Szeremeta, Irene Tinagl discussed about *tacit knowledge* which is "information combined with experience, context, interpretation and judgment" and *explicit knowledge* (information), as "justified (true) belief" (Jerzy Szeremeta, Irene Tinagl, 2005, p.19).

The OECD specialists consider that *knowledge based economy* "is directly based on the production, distribution and use of knowledge information". (OECD, 1996, p.7). The pillars of the knowledge society are: education, technology of information and communications (TIC), science, new technology and innovation. The new EBRD knowledge economy includes four pillars: "institutions for innovation, skills for innovation, innovation system and TIC infrastructure" (European Bank for Reconstruction and Development, 2019, p. 3)'.

The construction of this society implies, in the opinion of many specialists the increasing attention to the development of human capital, especially the one integrated in the creative activities (research-development-innovation)

Human capital, introduced first by Adam Smith, was developed as concept by Gary Becker and Jacob Mincer and "may be defined as the knowledge, skills, competence and other attributes embodied in individuals that are relevant to economic activity" (Hartog, 1999, p.1).

In the knowledge society, new technological progress means to invest more in human capital, especial in three types of skills important for labor market: "advanced cognitive skills such as complex problem solving, socio-behavioral skills such as teamwork, and skill combinations that are predictive of adaptability, such as reasoning and self-efficacy" (World Bank, 2019, p. 3). On the other side, Bontis (1999, p.447) "argues that human capital is important because it is a source of innovation and strategic renewal".

The current wave of globalization presents historically unprecedented trends towards interconnectedness and interdependence that are reshaping global and local political, economic and cultural processes (Held et al., 1999). The European Union (EU) Lisbon Agenda stipulates that EU must be "the most dynamic and competitive knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment". The Horizon 2020 program for research and innovation and the new EU cohesion policy for 2014-2020 adopt a new perspective on regional policy for research and innovation, one that relies on smart specialization strategies to eliminate innovation disparities in Europe and promote cooperation and synergies that will lead to a new research and development landscape. The novel approach to innovation policy in European regions requires the direct involvement of regional authorities and innovation players in the policy design process and the adaptation of strategies to local contexts.

In this context, we must know how connected Romania is to these a-priori desirable social goals and what we must to do in this respect.

This article is looking to decipher the extent to which Romania has aligned itself with the global and European trends in the construction of the knowledge economy, to analyze the role that human capital and innovation have in developing this economy and to highlight the link between the indicators of the knowledge economy and the human capital and innovation in Romania.

2.Evolution of human capital and knowledge economy

Romania, compared to other European countries, registered a 5.01 score of EBRD Knowledge economy index (1 is worst and 10 is best value of the score), less than Estonia which registered 8.01, Slovenia 6.65, Poland with 5.63, Hungary with 5.33 or Greece with 5.25. The values of the four pillars for Romania's index are presented in figure 1.

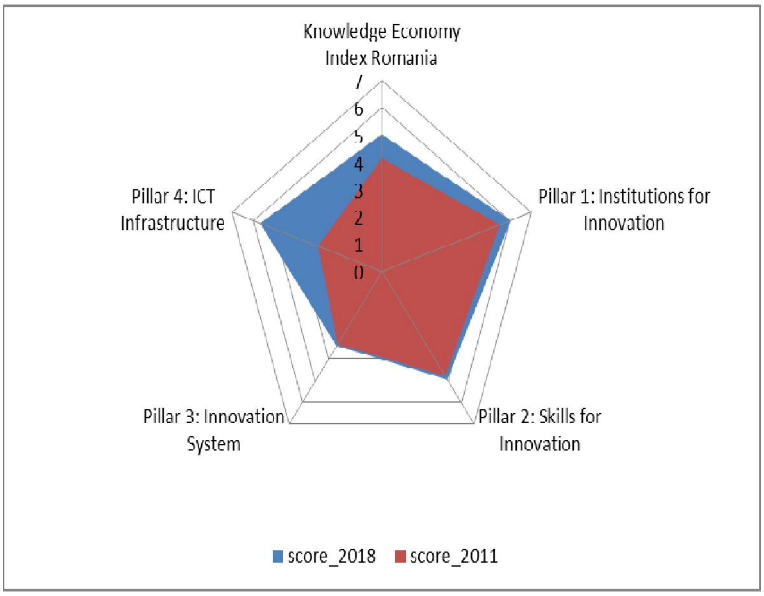


Figure 1. ERBD Knowledge Economy Index for Romania in 2011 and 2018.

Source: Author presentation based on data from table 2, Introducing the EBRD Knowledge Economy Index, p.6

Between 2001 and 2018, the ERBD Knowledge Economy Index for Romania increased from 4.1519 to 5.0136, based on increases for all four pillars. The great differences were registered on the pillars: institutions for innovation and skills for innovation, the last two pillars had registered very small differences. A small level was registered for innovation system with 3.414 in 2018 year with 0.0774 points more as compare to 2011, that means that Romania invested very little in innovation system (0.5% of GDP on research and development in 2017, compared to 2.06% of GDP in UE 28 (average) or 2.15% in Euro area, or 1.86 in Slovenia, 1.03% in Poland and 1.35% in Hungary, based on Eurostat data table [rd_e_gerdtot]).

Looking for the driver of knowledge development, we see that for Romania, which was included by specialists in the intermediate group of countries, the main driver was TIC infrastructure (score 5.677, compared to 5.31 for total intermediate group) with high progress in TIC availability. The second driver was institutions for innovation with a score 6.0179, compared to 5.58 average for intermediate group of countries, the dimension of governance and business being over the average score of the intermediate group. The drivers for the knowledge economy development and their contribution to the change of countries status from one stage to other are presented in table 1.

Table 1.
Drivers of the knowledge economy development

Pillar	Institutions for innovation			Skills for innovation		Innovation system			ICT infrastructure	
Dimension	Economic Openness	Business environment	Governance	General	Specialised	Inputs	Outputs	Linkages	Availability	Sophistication
From advanced to OECD comparators	16.1%			17.2%		43.1%			23.6%	
	0.4%	9.4%	6.2%	5.8%	11.4%	16.3%	12.8%	14.0%	11.9%	11.7%
From intermediate to advanced	34.8%			23.7%		18.1%			23.4%	
	5.3%	13.4%	16.0%	16.7%	7.0%	7.7%	6.9%	3.6%	16.1%	7.3%
From early to intermediate	29.1%			24.8%		9.2%			36.9%	
	7.6%	10.2%	11.4%	16.9%	7.9%	3.9%	1.0%	4.3%	21.3%	15.6%

High contribution   Low contribution

Note 1: The first row of the table shows how much each pillar of the KE Index accounts for the advances in knowledge economy observed at different stages. First, we calculate the average score in each pillar for each stage. We than calculate the difference between each stage and the next. Percentages are calculated as the total pillar change over the total change in the KE index from one stage to the next. For example, from the early to the intermediate stage, 36.9 per cent of the observed increase in the average KE index value is attributable to improvements in the ICT pillar.
Note 2: The second row of the table highlights the "dimensions" that contribute most (in darker green) and least (white) to knowledge-economy improvement in each stage.

Source: Introducing the EBRD Knowledge Economy Index, European Bank for Reconstruction and development, March 2019, p. 14.

Regarding the evolution of human capital index, some international organizations compute such index (World Economic Forum, World Bank) based on its own methodology. For example, according to World Bank specialists, the human capital index for Romania reached in 2017 the level 0.601 that means rank 68 from 158 countries. Compared to other EU countries, Romania registered a smaller level than Poland, Hungary, the best score being registered by Finland (see table 2).

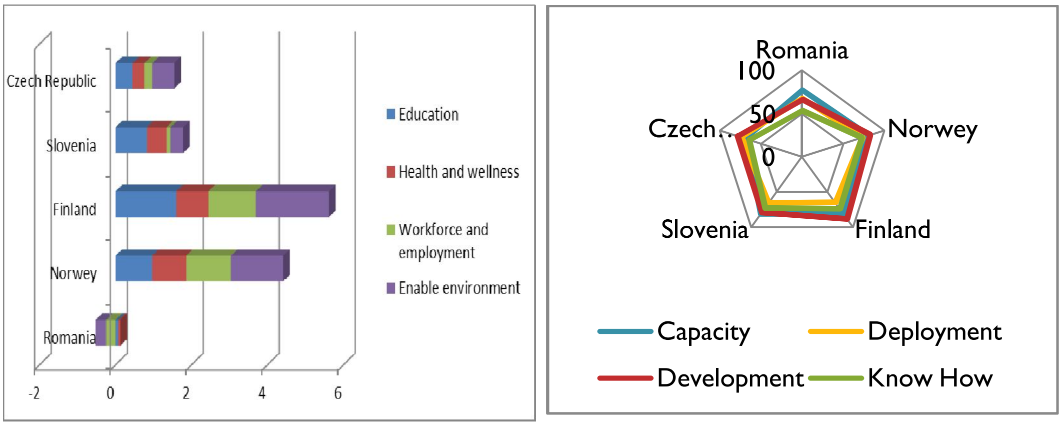
Table 2.
Human capital Index and his components in some EU countries in 2017

	Probability of survival to age 5	Expected Years of School	Harmonized Test Scores	Learning-Adjusted Years of School	Fraction of Kids Under 5 Not Stunted	Adult Survival Rate	HUMAN CAPITAL INDEX
Romania	0.992	12.172	452.241	8.807	..	0.869	0.601
Poland	0.995	13.205	536.781	11.341	..	0.887	0.747
Czech Republic	0.997	13.937	522.324	11.647	..	0.916	0.782
Bulgaria	0.993	12.920	497.611	10.287	..	0.867	0.676
Hungary	0.996	13.013	515.783	10.739	..	0.868	0.703
Slovak Republic	0.994	12.966	500.318	10.380	..	0.892	0.694
Slovenia	0.998	13.638	531.990	11.608	..	0.931	0.788
Finland	0.998	13.746	547.749	12.047	..	0.928	0.814
Germany	0.996	13.890	528.153	11.738	..	0.931	0.795
Denmark	0.996	13.445	530.728	11.417	..	0.931	0.774
Italy	0.997	13.580	513.693	11.162	..	0.950	0.769
Norway	0.997	13.703	512.474	11.236	..	0.944	0.771
Portugal	0.996	13.779	519.919	11.462	..	0.929	0.776
Spain	0.997	13.110	513.765	10.777	..	0.944	0.743

Source: Human development Index 2018, World Bank table API_HD.HCI.OVRL_DS63 en_excel_V2_426

The evolution of Human Capital WEF Report 2013 and 2017

World Economic Forum, the evolution of human capital index (HCI) highlights a different aspect depending on the method used. In 2013, the HCI was composed by four pillars: education, health and wellness, workforce and employment, enable environment (see figure 2a), different from the new methodology used in the Human capital Report in 2017, that included other components: capacity, development, deployment, and know how (fig. 2b).



a. Human capital Index in 2013 b. in 2017

Figure 2. Evolution of Human capital index in 2013 and 2017.

Source: Author computing data from "The human capital report,2013 and 2017'', World Economic Forum.

It can be seen that Romania registered a small level both in 2013 and 2017 compared to the countries considered the Nordic countries of EU, the smallest levels being registered in Romania's case by workforce and employment which had negative level in 2013 and by Know how components in 2017.

In 2018, Romania's rank was 42 from 126 economies in a Global Innovation Index composed by 7 pillars as: infrastructure, human capital and research, institutions, creative outputs, knowledge and technology outputs, business sophistication and market sophistication with a score of 39.16, as compare to 67.69 for Switzerland, the first rank and 63.82 for Sweden (the second rank). According to the Innovation Index of European Innovation Scoreboard, the results show a minimum level in 2015 with a slow tendency to increase after this date, as shown in figure 3. The Romanian's index relative to EU Index in 2010 was 52.9 and 31.1 relative to EU index in 2017, smaller relative to EU, compared to 53.6 for Poland or 51.2 for Hungary and 45.4 for Bulgaria.

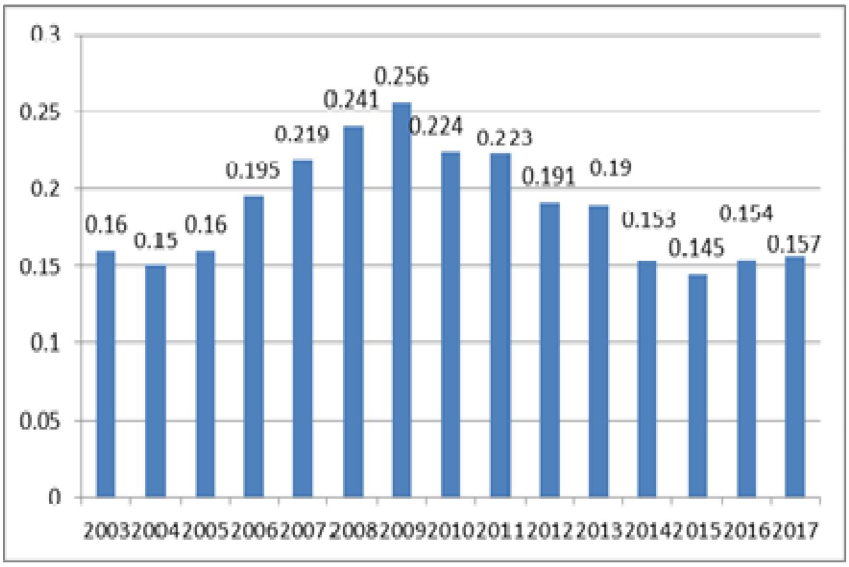


Figure 3. Evolution of innovative activity based on Innovation Index in Romania.

Source: Innovation Index of European Innovation Scoreboard for 2010 and 2017.

The Innovation capacity of a countries is influenced by the education index, so the correlation between these two indices in Romania was 0.6035, as we can see from figure 4.

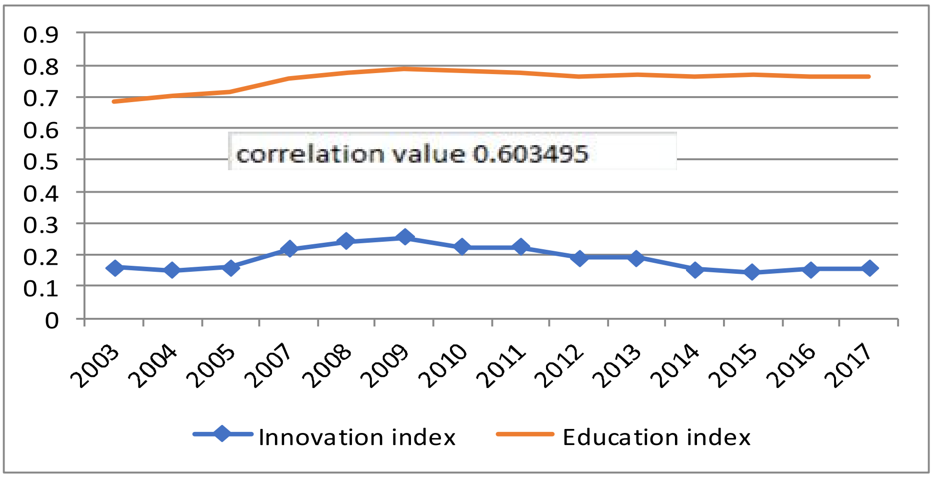


Figure 4. The correlation between the innovation index and education index in Romanian in 2003-2017.

Source: Author computation based on date form Innovation Index of European Innovation Scoreboard for 2010 and 2017 and Education Index http://hdr.undp.org/en/content/education-index

The results confirm Hippe's work (2013), who argued that level of education becomes a standard measure of human capital, or the innovative capability is linked with people abilities based on formal or informal education.

3. Short literature review

There are many studies regarding the human capital and innovation at countries level, the most of them highlighting a positive relation between them (Dakhli and de Clercq, 2004, Awad et all, 2013). Other authors consider growth of human capital as a source to increase the number of innovative entrepreneurs and innovative products that indirectly drive economic growth through the innovative channel (Diebolt and Hippe, 2019). Some papers highlight the positive effects of innovation, expressed via research-development intensity and education on development of the countries (Sterlacchini, 2008, Griliches et all, 1998).

Samad (2013) showed in his paper that human capital, especially competence and creativity capacity, influenced positive business performance based on correlation matrix and regression analysis.

Gregorio; López-Pueyo and Sanaú (2015) consider that "recently, interest has centered on analyzing the connection existing between human capital and the development of innovation", and their work shows that "innovation capacity appears to be compatible with the new theories of endogenous growth, which argue that human capital causes the growth of TFP".

Kacprzyk şi Doryń(2017), analyzing the impact of innovation (expressed by patents) and R&D expenditure on development in EU countries in 1993-2011, show that the stock of knowledge reduce the cost of R&D for the future innovations and that new knowledge helps the growth of human capital. Using a panel model, they showed a significant statistical relation between R&D expenditure and economic growth in UE 15 and UE 13 and a significant positive relation between patents and economic growth in UE 13.

Hakooma, Seshamani (2017, pp.72-74) considers that in the literature the human capital influences the development on countries in different ways. The "first category are the studies that show a positive a significant contribution on human capital to productivity growth;… the second category of studies found a negative and or insignificant relationship between education and economic growth;… the third category have shown that the influence of human capital is not uniform for all countries or groups or countries" included in the cross country studies; "the fourth category studies found insignificant relationship between human capital and economic growth". They found that government expenditure on education had a negative impact on economic growth in short run in Zambia.

4. Models used in the literature

Literature offers a diversity of econometric methods in order to highlight the relation between human capital, innovation and economic growth from Granger tests (Giménez et all, 2015; Cheng and Hsu, 1997; Asteriou and Agiomirgianakis, 2001; Ljungberg and Nilsson, 2009; Omojimite, 2010), to non-linear models (Hoetker, 2007; Van Uden et all, 2014), bivariate correlations (Lee, Florida and Gates, 2010), panel methods (Award, 2013, Petrakos et all, 2007), correlation matrix and regression analysis(Samad, 2013), vector error correction model (Hakooma and Seshamani, 2017).

In our paper we used the Least squares technic in order to highlight the influence of human capital and research development efforts on increasing the innovation output expressed by number of patents, using the following function:

$$Log(Pat)= \alpha \log H+ \beta \log X + \varepsilon,$$

where: log(PAT) is the logarithm of the number of patent as innovation output, which is a direct function of human capital H, expressed as proxi by average year of school (noted Med_schol) and innovation input (X) expressed by expenditure of research development (noted CH_CD), in logarithm forms.

The data used in the model are annual data for the period 1994-2017 from the Eurostat database. Data is stationaries in logarithm form and the results of ADF test are presented in table 3.

Table 3.
The Results of the ADF Test for the Variables Used in the Model

Method	Statistics	Prob.**	Cross-sectional data	No. Obs.
Levin, Lin & Chu	– 2.28821	0.0111	3	75
Im, Pesaran and Shin W-stat	– 1.13917	0.1273	3	75
ADF – Fisher Chi-square	10.1435	0.1187	3	75
PP – Fisher Chi-square	6.92125	0.3282	3	75

** The probabilities for Fisher test were computed using an asymptotic Chi-square distribution. All other test asume asymptotic normality

Source: Author's computations.

The results of the models computed with the EViews 8.0 programs are presented in table 4.

Table 4.

The results of the Least squares model

Dependent Variable: LOG(PAT)				
Method: Least Squares				
Sample (adjusted): 1994 2017				
Included observations: 24 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CH_CD)	0.699129	0.171905	4.066962	0.0006
LOG(MED_SCOL(-4))	10.8159	1.912258	5.656087	0.0000
C	-25.80417	3.627782	-7.112934	0.0000
R-squared	0.919765	Mean dependent var		3.121611
Adjusted R-squared	0.912123	S.D. dependent var		1.089315
S.E. of regression	0.322917	Akaike info criterion		0.693624
Sum squared resid	2.18978	Schwarz criterion		0.840881
Log likelihood	-5.323493	Hannan-Quinn criter.		0.732692
F-statistic	120.3651	Durbin-Watson stat		1.683225
Prob(F-statistic)	0.00000			

Source: Author's computations.

R2 is 0.919765 and adjusted R2 is 0.912123 and the DW is 1.683225. The model data indicate, as expected, a positive and statistically significant correlation between growth of Output result of innovation expressed by patents and the explanatory variables chosen as proxies for innovation and human capital. The model indicates a strong influence (10.8159 coefficient) of the human capital expressed as proxy by the average year of school and of innovation Input expressed as research development expenditure.

The model was tested and the results for coefficient confidence interval, residual diagnostic and stability diagnostic are presented in the Annex. The results confirm that the model is valid.

5. Conclusions

A wide literature is focused on the impact of human capital on economic growth or innovation at national and regional level and the results of studies show, in many cases, a positive relationship between these variables. More of that, the level of influence depends of the proxi selected for human capital and the model.

Human capital highlights a negative tendency during the period analyzed, with a slow increase after 2017, when the average years of school had an increasing tendency in Romania.

Education index as a proxy for human capital had a positive and significant influence on innovation activity in Romania, the correlation between these two indicators being around 0.6, that indicate a significant and positive relationship.

The results of the model show a positive and significant relationship between human capital, efforts in sustaining the research-development activity and the number of patents as output of innovation capacity of human capital. The results of the model confirm the theoretical expectations and are in line with other studies (Dakhli and de Clercq, 2004).

A positive and significant correlation was highlighted between research development (R&D) expenditure and output of innovation expressed as number patents in Romania, so more attention is necessary to sustain the R&D activity in Romania, taking into consideration the low level of expenditure for this activity (less than 0.5% of GDP and under the UE target).

ANNEX

The test for the coefficient diagnostic

Coefficient Confidence Intervals
Date: 05/27/19 Time: 10:50
Sample: 1990 2017
Included observations: 24

		90% CI		95% CI		99% CI	
Variable	Coefficient	Low	High	Low	High	Low	High
LOG(CH_CD)	0.699129	0.403326	0.994933	0.341634	1.056625	0.212406	1.185853
LOG(MED_SCOL(-4))	10.81590	7.525392	14.10640	6.839138	14.79265	5.401606	16.23018
C	-25.80417	-32.04665	-19.56169	-33.34856	-18.25979	-36.07572	-15.53262

The test for residual diagnostic

Correlogram

Date: 05/27/19 Time: 10:43
Sample: 1990 2017
Included observations: 24

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.15...	-0.15...	0.6796	0.410
		2	0.227	0.208	2.1467	0.342
		3	-0.15...	-0.09...	2.8267	0.419
		4	0.093	0.019	3.0970	0.542
		5	-0.03...	0.028	3.1435	0.678
		6	-0.09...	-0.14...	3.4641	0.749
		7	-0.03...	-0.04...	3.5030	0.835
		8	0.008	0.050	3.5052	0.899
		9	0.288	0.308	6.9633	0.641
		1...	-0.09...	-0.04...	7.3629	0.691
		1...	-0.04...	-0.21...	7.4545	0.761
		1...	-0.08...	-0.04...	7.8019	0.800

The Breusch – Godfrey test for serial correlation in residuals

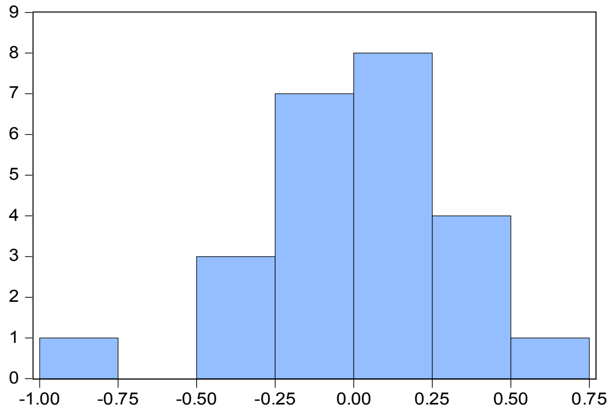
Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.461278	Prob. F(2,19)	0.6374
Obs*R-squared	1.111372	Prob. Chi-Square(2)	0.5737

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.465209	Prob. F(2,21)	0.2537
Obs*R-squared	2.938939	Prob. Chi-Square(2)	0.2300
Scaled explained SS	3.025035	Prob. Chi-Square(2)	0.2204

Histograms and statistics



Series: Residuals	
Sample 1994 2017	
Observations 24	
Mean	-5.93e-15
Median	0.016129
Maximum	0.537583
Minimum	-0.847979
Std. Dev.	0.308558
Skewness	-0.644770
Kurtosis	3.688770
Jarque-Bera	2.137321
Probability	0.343468

Ramsey RESET Test
Equation: EQ04
Specification: LOG(PAT) LOG(CH_CD) LOG(MED_SCOL(-4)) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.885927	20	0.3862
F-statistic	0.784867	(1, 20)	0.3862
Likelihood ratio	0.923830	1	0.3365

F-test summary:

	Sum of Sq...	df	Mean Squares
Test SSR	0.082689	1	0.082689
Restricted SSR	2.189780	21	0.104275
Unrestricted SSR	2.107091	20	0.105355

LR test summary:

	Value	df
Restricted LogL	-5.323493	21
Unrestricted LogL	-4.861578	20

Recursive residual