

IMPACT OF CULTURE ON INNOVATIONS IN SELECTED COUNTRIES WITH AN EMPHASIS ON HUMAN CAPITAL AND RESEARCH

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Abstract

The new institutional economic theory distinguishes between formal and informal institutions and examines their quality and interaction. We analysed the impact of informal (culture measured by Hofstede's cultural dimensions) and formal institutions (Human Development Index) on innovation (Global Innovation Index). The main aim of this paper is to apply results of quantitative analysis to the Slovak and the Czech Republic. We used correlation analysis, pairwise regression analysis and graphical regression analysis using scatter plots. We found that in this case, informal institutions have a weak to moderate impact. We confirmed the negative impact of power distance and uncertainty avoidance on innovation. On the other hand, the Human Development Index has a medium to strong impact on innovation. For the Human Capital and Research subindex, according to the correlation analysis, there is an indirect moderate relationship between this subindex and the power distance and a direct moderate relationship with the Human Development Index, which was also confirmed by the paired regression analysis. Our recommendation for the decision-making sphere is to formulate a rational economic policy to stimulate innovation in accordance with the principle of subsidiarity.

Key words: Culture, Hofstede, Global Innovation Index, New Institutional Economic Theory, Human Capital and Research

JEL Code: O00, E14, J24

Introduction

Facing the current “Covid-19 economic crisis”, we are contemplating factors that would have the potential to reverse the negative development of the economy and at the same time to represent the prevention of future emerging crisis situations. Even before this current crisis, it was clear that some economies were not sufficiently focused on producing products with high domestic value added. In the Czech Republic, the Aspen Institute (2019) conference called for

maintaining and increasing the ability to create value added, otherwise there is a risk of lowering the living standards of the population by increasing inflation. Massive investment in education was recommended as a solution. The new institutional economic theory, which is well applied to the presented topic, recognizes formal and informal institutions. Formal institutions have primarily a legal form, informal institutions are represented by the culture of countries (for example Mlčoch, 2005).

Based on these considerations, we decided to apply a simple quantitative analysis evaluating the impact of the informal culture institution (Hofstede's cultural dimensions) on innovation (Global Innovation Index) and the impact of formal institutions on innovation, we consider the Human Development Index (UNDP, 2020) as proxy variable of formal institutions. The Hofstede Cultural Dimensions were obtained from The Hofstede Center (2019, original work Hofstede et al., 2010). The main aim of this paper is to apply results of quantitative analysis to the Slovak and the Czech Republic. Next, we focused more deeply on the impact of independent variables on the Human resources and research subindex. We think that this subindex is a crucial component of innovation with certain reservations. R. Cappelli et al. (2020) claim, that: *“technological resistance is more effective in regions with high levels of human capital. [...] human capital alone, after a crisis, is not enough to sustain the economic regional system if it's not coupled with a more general ability of the region to reorient innovative resources and technologies to shape a new growth path.”*

1 Literature review

When compiling the literature review, we focused mainly on papers also used the authors' own words, especially in abstracts and in hypothesis, in which they summarized the results of their studies. Collective of M. Rubino et al. (2020) examined the impact of Hofstede's cultural dimensions on the digitization of firms using regression analysis. In addition to the mentioned cultural dimensions, they also included gross domestic product, ICT adoption, the country's average level of firms' revenues, the country's average level of firms' size and the country's average level of firms' profitability. Based on the literature review, the authors established six hypotheses. They assumed a positive influence of individualism, short term orientation and indulgence on the digitization of companies. On the contrary, a negative effect was expected for power distance, masculinity and uncertainty avoidance. Culture is also an interest to the authors A. Chizema and G. Pogrebna (2019), but in this case they did not use Hofstede's cultural dimensions, but they decided to use linguistics to quantify individualism and collectivism.:

“For the fourth endogenous variable (individualism) we use a dummy variable of whether a country's primary language permits speakers to drop a personal pronoun (pronoun drop) when it is used as the subject of a sentence.” We also focused on the current literature on knowledge and innovation. D. Jiménez-Jiménez et al. (2019) dealt with reverse knowledge transfer (RKT), specifically examining the relationship between innovation and RKT in the parent unit, the relationship between knowledge transfer between subsidiaries, headquarters and parent units, then effect of absorptive capacity (AC) and coordination mechanisms in this relationships: *„Findings provide the evidence of a positive relationship between RKT and headquarters' innovation. This relationship is higher when the knowledge transferred from subsidiaries to parent units is of a more tacit nature, and also when the organizational distance between them is larger. The results also show that the parent unit's AC and the use of mechanisms for coordinating company units can facilitate RKT.“*

The last studies are dealing with human capital. R. Cappelli et al. (2020) examined the relationship between regional resilience, technological resilience and human capital. They dealt with EU Member States during the 2008 economic crisis: *“We analyze the impact of the 2008 crisis in European regions and we show that technological resistance is a good predictor of unemployment resistance. There is a strict link between the past ability of regions to sustain the production of knowledge and the ability of a regional economic system to resist in term of unemployment rates to the 2008 crisis.”* R. Baharin et al. (2020) examined the relationship between human capital and productivity: *“[...] the quality of human resources is cointegrated with labor productivity. In the short run, all variables including the variables of health, primary, secondary and tertiary education of the labor have a positive effect. This finding suggested that these variables need to be safeguarded by government policies.”* In contrast to these studies, our paper examines the Global Innovation Index and uses quantitative analysis to examine the relationship between this index and cultural dimensions. To illustrate those above-mentioned relationships, we have also decided to use the Human Development Index.

2 Methodology

In order to meet our aim, we compiled a database from various sources, which we processed in Microsoft EXCEL, PAST and GRETL. We interpreted the results of the quantitative analysis using the literature (Lukáčik - Lukáčiková - Szomolányi, 2011; Hanák, 2016). First, we created descriptive statistics in the PAST program, checked the normal distribution of variables, and compiled a correlation analysis. R. Hanák (2016) recommends, in case of non-normal

distribution of variables, to calculate Spearman's instead of Pearson's correlation coefficient. In our case, we chose Kendall's tau. Finally, we created a pairwise regression analysis in the software GRETl together with testing of single models. It should also be noted that in the case of Hofstede's dimensions, the value may be in the range 0 to 100, and a higher dimension value means a more intense dimension in the name. For example, in the case of IND, 0 means collectivist society, 100 individualistic. Table 1 contains a description of the variable. We limited the sample to the member states of the Organization for Economic Co-operation and Development (OECD) in order to preserve the homogeneity of dataset and the relative comparability of countries. Variables Inst_20, H_Cap_Res_20, Infr_20, M_soph_20, B_soph_20, K_tech_out_20, C_out_20. The variables represent the individual sub-indexes of GII_20 itself, in other words, these sub-indexes represent the GII_20 methodology.

Tab. 1: Description of variables

| Variable | Description |
|---------------|---|
| PDS | Power Distance |
| IND | Individualism |
| MAS | Masculinity |
| UA | Uncertainty Avoidance |
| LTO | Long Term Orientation |
| IDG | Indulgence |
| HDI_18 | Human Development Index from year 2018 |
| GI_20 | Global Innovation Index from report 2020 |
| Inst_20 | Institutions from report 2020 |
| H_Cap_Res_20 | Human capital and research from report 2020 |
| Infr_20 | Infrastructure from report 2020 |
| M_soph_20 | Market sophistication from report 2020 |
| B_soph_20 | Business sophistication from report 2020 |
| K_tech_out_20 | Knowledge and technology outputs from report 2020 |
| C_out_20 | Creative outputs from report 2020 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

Table 2 contains descriptive statistics of variables. Our analysis was influenced by the missing value of Indulgence for Israel. This fact is seen by the column N, which expresses the number of observations. Then we can observe minimum and maximum values, average values (mean), standard deviation, skewness and kurtosis.

For the purpose of our research, we have established the following hypotheses:

H1: The cultural dimensions will have a medium to strong impact on the innovation capacity of OECD countries.

H2: The Human Development Index will have a strong positive impact on the innovation capacity of OECD countries.

Tab. 2: Descriptive statistics

| | N | Min | Max | Mean | St. dev | Skew. | Kurt. |
|---------------|----|-------|--------|-------|---------|-------|-------|
| PDS | 36 | 11,00 | 100,00 | 46,36 | 19,55 | 0,47 | 0,26 |
| IND | 36 | 18,00 | 91,00 | 60,44 | 19,53 | -0,59 | -0,38 |
| MAS | 36 | 5,00 | 100,00 | 47,69 | 25,52 | 0,02 | -0,74 |
| UA | 36 | 23,00 | 100,00 | 67,17 | 20,80 | -0,28 | -0,86 |
| LTO | 36 | 21,00 | 100,00 | 52,97 | 21,59 | 0,32 | -0,98 |
| IDG | 35 | 13,00 | 97,00 | 51,23 | 20,23 | -0,14 | -0,59 |
| HDI 18 | 36 | 0,77 | 0,95 | 0,90 | 0,04 | -1,19 | 1,64 |
| GII 20 | 36 | 36,10 | 67,20 | 50,75 | 8,15 | -0,06 | -0,74 |
| Inst 20 | 36 | 57,40 | 93,90 | 81,86 | 8,82 | -0,81 | 0,46 |
| H Cap Res 20 | 36 | 32,40 | 66,50 | 49,57 | 9,73 | -0,12 | -0,95 |
| Infr 20 | 36 | 48,30 | 69,90 | 59,08 | 5,56 | -0,01 | -0,69 |
| M soph 20 | 36 | 43,60 | 87,00 | 58,02 | 9,89 | 1,08 | 1,11 |
| B soph 20 | 36 | 29,40 | 68,80 | 48,77 | 11,42 | 0,04 | -1,10 |
| K tech out 20 | 36 | 22,90 | 70,30 | 41,40 | 12,78 | 0,40 | -0,79 |
| C out 20 | 36 | 27,20 | 56,60 | 42,71 | 7,38 | -0,09 | -0,38 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

3 Results and discussion

In the first step, we proceeded to compile a correlation analysis in tab. 3. We showed only those correlation coefficients whose p-values in the PAST software were less than 0.05. To our surprise, we found out that the variables MAS and LTO did not have a single statistically relevant record. We focused on those correlation coefficients whose values were greater than or equal to 0.4. In this case, we can speak of a weak to medium dependence between the variables. Also, in this case, we measured relevant values for PDS and UA. Although IND and IDG had statistically relevant measurements, all their correlation coefficients were weak. Already in this step we can reject hypothesis 1 (H1), which assumed a medium to strong correlation between the cultural dimensions and innovation. We confirmed a really medium to strong dependence with Kendall's tau for the pair Human Development Index (HDI_18) and GII_20 (Global Innovation Index). However, we will evaluate the evaluation of hypothesis 2 (H2) only after the pairwise regression analysis.

Although PDS and UA achieved only a weak dependence in relation to GII_20, we can specify at least the direction of relationship. PDS has a negative correlation in relation to all examined variables as well as UA. HDI_18 has a presumed positive relationship to all variables examined. Variable H_Cap_Res_20 negatively correlated with cultural dimension PDS and positively with HDI_18. Both linkages were middle-strong.

Tab. 3 Correlation analysis – Kendall’s tau

| p-val. < 0,05 | PDS | IND | MAS | UA | LTO | IDG | HDI_18 |
|-------------------------|--------------|------------|------------|--------------|------------|------------|---------------|
| HDI_18 | -0,52 | 0,33 | - | -0,40 | - | 0,37 | - |
| GII_20 | -0,43 | 0,34 | - | -0,41 | - | 0,27 | 0,60 |
| Inst_20 | -0,43 | 0,36 | - | -0,43 | - | 0,38 | 0,65 |
| H_Cap_Res_20 | -0,40 | - | - | - | - | 0,31 | 0,53 |
| Infr_20 | -0,40 | 0,25 | - | -0,33 | - | - | 0,61 |
| M_soph_20 | -0,36 | 0,39 | - | -0,38 | - | 0,32 | 0,46 |
| B_soph_20 | -0,44 | 0,25 | - | -0,31 | - | 0,24 | 0,58 |
| K_tech_out_20 | -0,32 | 0,30 | - | -0,28 | - | - | 0,48 |
| C_out_20 | -0,42 | 0,26 | - | -0,42 | - | - | 0,49 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

We’ve created a pairwise regression analysis for six cultural dimensions and HDI, which is illustrated in tab. 4. None of the cultural variables has a statistically significant estimation if we take into account the R-squared (coefficient of determination). Based on this result and in combination with the result of the regression analysis, we actually reject hypothesis 1 (H1). In the case of the variable HDI_18 and its effect on GII_20, we found a statistically significant dependence (R-squared = 0.69). We first estimated the model with the ordinary least squares method (OLS), but based on the White's test of heteroskedasticity, we revealed the presence of this statistical error. For this reason, we constructed a corrected heteroskedasticity model (het.-corr.) for HDI_18. This model had a normal distribution of residuals. With an increase in HDI_18 of 0.01, we expect an increase in GII_20 of approximately 1.7 points.

Tab. 4 Pairwise regression analysis – dependent variable Global Innovation Index

| Dependent variable = GII_20 | | | | | | p-val. | |
|------------------------------------|-------------|--------------|-------------------|---------------|------------------|---------------------|--------------------|
| Var. | Est. | const | reg. coeff | p-val. | R-squared | White’s test | norm. resid |
| PDS | OLS | 62,44 | -0,25 | *** | 0,37 | 0,80 | 0,38 |
| IND | OLS | 37,68 | 0,22 | *** | 0,27 | 0,44 | 0,50 |
| MAS | OLS | 51,96 | -0,03 | | 0,01 | 0,98 | 0,79 |
| UA | OLS | 65,58 | -0,22 | *** | 0,31 | 0,21 | 0,85 |
| LTO | OLS | 48,06 | 0,05 | | 0,02 | 0,55 | 0,56 |
| IDG | Het.-corr. | 41,18 | 0,19 | *** | 0,19 | 0,00 | 0,08 |
| HDI_18 | Het.-corr. | -105,77 | 173,95 | *** | 0,69 | 0,04 | 0,39 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

Very similar results to pairwise regression analysis (tab. 4) and correlation analysis show tab. 5 with Human Capital and Research as dependent variable. R-squared values are very low and the regression coefficient between H_Cap_Res_20 and PDS demonstrate weak negative linkage. Statistical significance is in this case low, so for this reason we do not interpret the regression coefficient.

Tab. 5 Pairwise regression analysis – dependent variable Human Capital and Research

| Dependent variable = H_Cap_Res_20 | | | | | | p-val. | |
|-----------------------------------|------------|---------|------------|-------------------|-----------|--------------|-------------|
| Var. | Est. | const | reg. coeff | p-val. reg. coeff | R-squared | White's test | norm. resid |
| PDS | OLS | 62,37 | -0,28 | *** | 0,31 | 0,24 | 0,78 |
| IND | OLS | 39,60 | 0,16 | ** | 0,11 | 0,07 | 0,70 |
| MAS | OLS | 51,00 | -0,03 | | 0,01 | 0,70 | 0,39 |
| UA | OLS | 59,93 | -0,15 | ** | 0,11 | 0,25 | 0,88 |
| LTO | OLS | 48,14 | 0,03 | | 0,00 | 0,23 | 0,33 |
| IDG | Het.-corr. | 39,09 | 0,22 | ** | 0,16 | 0,03 | 0,07 |
| HDI_18 | OLS | -108,28 | 173,84 | *** | 0,56 | 0,96 | 0,80 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

The coefficient of determination (R-squared) of variables H_Cap_Res_20 and HDI_18 reaches the value 0,56 and for this reason the interpretation of the regression coefficient must also be taken with statistical reservation. With an increase in HDI_18 by 0,01, we expect an increase in H_Cap_Res_20 of 1,7 points. In this case, together with the correlation analysis, we will accept a moderate direct dependence between H_Cap_Res_20 and HDI_18.

We discuss our results with the above-mentioned study by M. Rubino et al. (2020). This study based on a quantitative analysis showed a positive effect of indulgence on the digitization of firms. The negative impact was confirmed by masculinity, uncertainty avoidance and individualism. Finally, the authors found out that power distance has no statistical effect on the digitization of firms. Our results have shown a negative impact of power distance and uncertainty avoidance on Global Innovation Index. Finally, we can model the actual values for Slovakia and the Czech Republic and compare them with statistical estimates. For comparison, in tab. 6 we also portrayed Switzerland as a major innovator of our dataset.

Tab. 6 Comparison of countries

| Variable | The Czech Republic | The Slovak Republic | Switzerland |
|--------------|--------------------|---------------------|-------------|
| PDS | 57,00 | 100,00 | 34,00 |
| UA | 74,00 | 51,00 | 58,00 |
| HDI_18 | 0,89 | 0,86 | 0,95 |
| GII_20 | 49,40 | 42,00 | 67,20 |
| H_Cap_Res_20 | 43,40 | 32,40 | 61,90 |

Source: Own processing by The Hofstede Centre (2019), Cornell University & WIPO (2020), UNDP (2020).

Based on regression analysis, we estimated the following coefficients of the regression equation, but only for the pair HDI_18 and GII_20 (effect of formal institutions):

$$GII_{20} = -105,77 + 173,95 \times HDI_{18}$$

If we substitute into the equation the real values from tab. 6, we obtain for the Czech Republic a score value of GII_20 of 49.05, while the actual value of GII_20 is 49.40. For the Slovak Republic, the modelled value is 37.44 and the actual value is 42.00. In the case of Switzerland, the estimation is 53.94 and actual value is 67.20. It is clear from the model, that the Slovak Republic and the Czech Republic were estimated reliably, Switzerland is underestimated. In the case of the Slovak Republic, we noticed a cultural disadvantage of PDS = value 100, which in our opinion determines the worse GII results. We can recommend mitigating this deficiency by rational and appropriate interventions. The reason, in addition to the general principles of ethics, is respect for the principle of subsidiarity (for example Baroš, 2017). It is also important to pay attention to the transfer of scientific and technical knowledge and information into economic practice, ie the transfer of technology (Kittová, 2016).

Conclusion

The current economic crisis and the warnings of experts about the exhaustion of the ability to generate added value became the inspiration for the presented contribution. We also proceeded from the considerations of the new institutional economic theory, which distinguishes between formal (Human Development Index) and informal institutions (Hofstede's cultural dimension). We examined the impact of these formal and informal institutions on innovation quantified by the Global Innovation Index. The main aim of this paper was to apply results of quantitative analysis to Slovak and the Czech Republic. We have established the following hypotheses:

H1: The cultural dimensions will have a medium to strong impact on the innovation capacity of OECD countries.

H2: The Human Development Index will have a strong positive impact on the innovation capacity of OECD countries.

We rejected hypothesis 1, but we proved the negative impact of power distance and uncertainty avoidance on the Global Innovation Index. Hypothesis 2 was confirmed by correlation analysis and pairwise regression analysis. We compared our results with the actual values for Slovakia, the Czech Republic and Switzerland. We found out that the first two mentioned countries are credibly estimated, but Switzerland was underestimated, which we also consider as the innovator of the region.

In addition to these results, we demonstrated a weak negative relationship between Human Capital, Research and power distance and also a moderate direct relationship between Human Capital, Research and the Human Development Index. Human capital and research are not

significantly influenced by culture, but naturally rather by human development. However, these results show that countries with high power distances really need to be more careful in setting up their formal and influencing informal institutions.

The limitation of our research was the use of pairwise regression analysis itself. Perhaps we would suggest using nonlinear forms of equations in further research. The limitation is also considered in the case of indulgence, in which we've lost sightings of Israel.

With our recommendation for countries for which our analysis estimates deteriorating results of innovation potential, namely high values of power distance and uncertainty avoidance, we propose to compensate for this disadvantage by a reasonable and rational state policy in the field of innovation with respect for the principle of subsidiarity. However, our recommendation is general, countries should reduce ineffective policies and support innovation-oriented ones. This represents a way out of crisis situations, as well as future proactive preventive measures.

Acknowledgment

This paper is a part of a research project of the Ministry of Education, Family and Sports of the Slovak Republic VEGA (in the period 2020 - 2022) No. 1/0777/20: Belt and Road initiative - opportunity or threat for the EU and Slovak export competitiveness?

Author is thankful to Ing. Zuzana Borovská for language check.

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