Vladimir Dženopoljac
United Arab Emirates University
College of Business and Economics
Al Ain, UAE

Bojan Georgievski
Wittenborg University of Applied Sciences
School of Business
Apeldoorn, Netherlands

Stefano Cavagnetto
Prague City University
School of Business
Prague, Czech Republic

Oualid Abidi
Australian University
School of Business
Kuwait

NATIONAL INTELLECTUAL CAPITAL: A COMPARATIVE LONGITUDINAL STUDY

Nacionalni intelektualni kapital – komparativna longitudinalna studija

Abstract

Since its inception, the intellectual capital (IC) framework, which developed from accounting and financial perspectives, focused primarily on firm-level analysis. There have been several important attempts in the literature to take IC to the macroeconomic level. The purpose of this paper is to assess the relationship between national intellectual capital, proxied with modified National Intellectual Capital Index (NICI) introduced by Bontis [7], and the Human Development Index (HDI), which became an important alternative to the traditional single dimensional measure of a country's development, like the gross domestic product [42]. The paper proposes a modified NICI suggested by Užienė [52]. The analysis includes panel data regression analysis for 12 countries. The dataset incorporated longitudinal data for weighted components of the NICI index for the period of 21 years (2000-2021). The results revealed that each of the elements of NICI, namely National Human Capital (NHC), National Market Capital (NMC), National Process Capital (NPC), and National Renewal Capital (NRC), exhibits significant impact on the levels of HDI in the said period. However, all elements, apart from NRC, show significant positive impact on HDI, pointing to the conclusion that these factors represent an important foundation for achieving and maintaining national competitiveness. Contrariwise, NRC was revealed to have the significant negative impact on HDI, opening the door to the question whether NRC is a real driver of national development, or just the effect of already reached development level.

Keywords: *national intellectual capital, panel data regression, fixed effects, panel data analysis*

Sažetak

Od svog uvođenja koncept intelektualnog kapitala (IK), koji je inicijalno nastao u oblasti računovodstva i finansija, uglavnom se fokusirao na mikro aspekte poslovanja. U literaturi se pojavio određeni broj pokušaja da se koncept IK prenese na makroekonomski nivo. Svrha ovog rada je da utvrdi odnos između nacionalnog IK, iskazanog kroz modifikovani indeks nacionalnog intelektualnog kapitala (engl. *National Intellectual Capital Index, NICI*), koji je formulisao i koristio Bontis [7], i indeksa ljudskog razvoja (engl. *Human Development Index, HDI*), koji je postao bitna alternativa tradicionalnom jednodimenzionalnom merilu razvoja jedne ekonomije, poput bruto društvenog proizvoda [42]. Ovaj rad predlaže primenu modifikovanog NICI indeksa, prema Užienė [52]. Empirijska analiza je obuhvatila panel data regresiju primenjenu na 12 zemalja. Podaci su po prirodi longitudinalni jer obuhvataju vremenski period od 21 godine (2000-2020). Rezultati istraživanja ukazuju na to da svaka od komponenti NICI indeksa, nacionalni ljudski kapital, nacionalni tržišni kapital, nacionalni procesni kapital i nacionalni kapital obnove, pokazuje značajan uticaj na HDI u obuhvaćenom periodu. Međutim, svi elementi, osim kapitala obnove, ukazuju na pozitivan efekat na HDI i na to da predstavljaju značajnu pokretačku snagu nacionalne konkurentnosti. Suprotno ovome, nacionalni kapital obnove ima značajan inverzan efekat na HDI, otvarajući vrata za pitanje u kojoj meri ovaj kapital predstavlja pokretač razvoja nacionalne ekonomije ili samo rezultat već postignutog nivoa razvoja.

Ključne reči: *nacionalni intelektualni kapital, panel data regresija, fiksni efekti, panel data analiza*

Introduction

The management of a company is significantly affected by the development stage of an economy, especially its technological and sociocultural characteristics. One of the main distinguishing features of the current era of last 60 or so years is that it is an outcome of two industrial revolutions: industrial revolution 3.0 and industrial revolution 4.0. The first one brought the beginnings of information era and the industrial revolution 4.0 accelerated its acceptance through the integration of physical and various cyber systems [10, p. 51]. With this continuing transformation, intellectual capital and intangible assets became one of the key components of economic growth, both on a company and on a country level. This continuous transformation recognizes intellectual capital (IC) as a competitiveness driver. As an important consequence, "knowledge society, knowledge economy, knowledge assets, knowledge management, and knowledge-based development – all these concepts have gained ground in the academic field as well as in public discussions" [30, pp. 343-344].

Intellectual capital, which is most frequently defined as knowledge-based value creation, shows the importance of acquiring, organizing, and disseminating knowledge in a company [5]. This additional knowledge, which is not shown in the financial statements of a company, is a vital resource for companies for three reasons [1]: a) it is essential for enterprises to create and store knowledge; b) firms' accumulated knowledge can increase in value through the replication of knowledge that is usable and valuable to the enterprise, which is done through sharing, categorizing, and codifying the available knowledge; c) an enterprise setting can influence the production and leveraging of knowledge through organizational norms, values, and culture. IC has been noted to create a comparative advantage to companies that invest in it significantly [18], [22]. While companies' financial statements fail to disclose investments in IC and only focus on the book value of intangible assets, the tangible effects of investments in IC are visible and crucial for company growth. As pointed out by Sumedrea [49] and Xu and Li [58], IC can be seen as a crisis buffer at a company level and at the national

level. It can serve as a tool for stabilizing profitability and creating competitive advantage in the periods when the economy is unpredictable [2].

Up until the 1990s, the reigning paradigm in the strategic management analysis was oriented towards external opportunities and threats in the quest for competitive advantage and favorable position in the market [11]. However, thanks to the works of Wernerfelt [54], Barney [4], Peteraf [39] and other renowned authors in the field of strategy, the focus shifted drastically towards the internal environment as a main source of competitive advantage. In line with this resource-based view (RBV) of the firm perspective, IC is viewed and assessed as the hidden capital of an organization, consisting of various immaterial resources, roughly categorized into human, structural and relational capital [12]. It can represent shared and public knowledge when it is legally acknowledged and disclosed as an intangible asset, such as copyrights or patents. IC arises from the culture of the company, from interacting with stakeholders. Overall, IC represents total knowledge and immaterial resources that the company has created and accumulated over time.

From the micro perspective of IC, a national-level IC analysis emerged. Although the logic behind the two concepts is interconnected and indisputably related, certain distinctions must be understood and considered. For example, it is important to understand how to identify and grasp the real effects of national IC. Additionally, it is unclear to what extent a certain category of IC, or a certain IC driver can be considered as a value driver for an entire country. Moreover, it remains to be seen and investigated to what extent certain IC elements are the drivers of macroeconomic growth and to what extent they represent the results of a growing economy. For example, the investments in research and development (R&D), which will be discussed in this paper in more detail, are seen as the part of a country's renewal capital but its origin remains to be investigated in more detail.

The current paper is structured as follows. The first segment after the introduction deals with a literature review in the field of IC and, more specifically, it will shed some light on the existing concepts of national IC and its related measurement attempts. Within the literature review,

the authors will discuss the human development index (HDI), as one of the widely used comprehensive measures of economic development. The second part provides the methodology description that entails explaining the used methodology framework, definitions of used variables, description of the sample for the empirical research and data collection approach. The methodology part of the manuscript ends with hypotheses development stemming from the existing body of literature. The next part of the paper shows the empirical analysis results, with adjoining statistical methods used for this analysis. At the end of the paper, the authors present the most important conclusions and provide future avenues for research regarding the national IC.

Literature review

Microeconomic perspective of IC

There are several important literature streams that emerged within the last three decades of IC research. The first stream of IC literature development began in mid-1990s and mainly relied on the microeconomic perspective. The critical topics during this phase were appropriate definitions, modeling, measurement, and IC disclosure within the financial reports of companies. The researchers, such as Lev and Sougiannis [32], Edvinsson [14], Sveiby [50], Stewart [48], Bontis [6], Mouritsen et al. [38], among others, set the important definitions of IC as a driver of corporate performance and a prerequisite for attaining competitive advantage. Additionally, these authors managed to establish a relatively unanimous categorization of IC, with minor etymological variations. These categorizations mainly rely on a trichotomous division of IC into human, structural, and relational capital. Soon after establishing the IC models, definitions, and taxonomies, the macroeconomic perspective was brought to a macro level, by introducing the concept of national IC, initially by Bontis [7] who set the grounds for development of National Intellectual Capital Index (NICI). Soon afterwards, some scholars took the strategic perspective into account, by relying on RBV, knowledge-based theory [20], and dynamic capabilities framework

of a firm [51]. In line with this, IC is defined as a sum of company's intangible assets, which reveals the true potential of an organization to create tangible outcomes. One of the main elements of IC is human capital, whose ability to create, store, and share knowledge is crucial for a firm's competitiveness. Thus, increased investment in education and knowledge leads to companies' improved performance [43]. This knowledge creation leads to the increase in competitive advantage through improved efficiency of workforce. Additionally, investments in IC lead to increased innovation [3].

The microeconomic literature stream on IC led to numerous attempts towards measurement, which was especially challenging in terms of measuring IC in monetary value [40], [48]. Furthermore, the literature picked up and numerous empirical studies emerged trying to tie the IC with corporate performance [16], [21], [28], [29], [35], [53].

National intellectual capital

Logically easy to grasp and build was the idea of IC being viewed as the driver not only of corporate performance, but also the economic performance of a country. However, it is questionable to what extent microeconomic IC can be extended to a national level, which is why it is important to assess and interpret any national IC related research with caution as it still represents an area that needs more research [44], [45].

A starting point and foundation of the national intellectual capital framework was undertaken by Bontis, who asserted that national IC represents the "invisible wealth of a country" [7, p.13] and therefore requires a system of variables that would uncover and manage these assets. He proposed a measurement system of national IC, which was the National Intellectual Capital Index (NICI), specifically proposed for the countries in the Arab region. The index consists of four distinguished, but overlapping and interconnected, types of national capital. The first one is the National Human Capital (NHC), which is the sum of the intellectual wealth of its citizens. This type of capital has multiple dimensions, like knowledge about facts, laws, and principles, but also certain types of knowledge that are more difficult to assess, such as

specialized knowledge, teamwork, communication [24]. Some of the critical components of NHC are the quality of educational system, literacy levels, and long-life learning frameworks [7].

The next element of NICI is the National Market Capital (NMC), which is reflected in a country's existing framework within which businesses operate. Also, this type of capital includes the international business relations that are formed between domestic and foreign companies. NMC is formalized through laws, policies, procedures through which a country is assessed as a friendly environment for doing business. Finally, important segments of NMC are international relations and the volume and quality of a country's export activities [7].

The National Process Capital (NPC) is the third element of NICI, and it is embodied in a country's information and communications infrastructure, as well as in databases, laboratories and various other organizational structures that are meant to store and disseminate knowledge created by the human capital component. The ability of a country to develop, manage, maintain, and adapt to new technology trends is the building block of NPC. One of the important measures in this regard is the usage and quality of internet network and the internet literacy of citizens [7].

Human capital mainly carries the knowledge, process capital stores the knowledge for future use, while a country's renewal capital is the one that creates new knowledge, updates the old one and tries to make it useful for future economic growth of a country. The main components of NRC are research and development

(R&D) expenditures, patents, scientific publications, number of researchers in the country and the like [7]. The NICI framework serves as the conceptual basis for this manuscript's empirical part.

There are other notable attempts in the literature that were aimed at framing the national IC and proposing a measurement model. One of these attempts is that of Lin and Edvinsson [34], who used various approaches to disclose information about national IC on 40 different countries in the world. They assessed these countries based on human capital, market capital, process capital, renewal capital, and financial capital. Another important attempt at comprehending the national IC was undertaken by Corrado et al. [8], who included computerized information (mainly computer software and digital data), innovative property (mainly scientific and non-scientific R&D, including search for minerals and natural resources), and economic competencies (mainly brand equity and firm-specific resources (human capital) [46, p. 168]. Finally, there are modified attempts at framing and quantifying national IC, one of which is that of Užienė [52], which serves as the measurement framework for the current research. Figure 1 depicts the difference in values between non-EU (including the United Arab Emirates) and EU countries in terms of NICI values in 2020. On average, these values do not show a consistent pattern. For example, in 2020 Serbia has a higher NICI index than Greece. This is largely due to Serbia's presence in international research and due to the quality of education.

Figure 1: NICI values for non-EU and EU countries, 2020
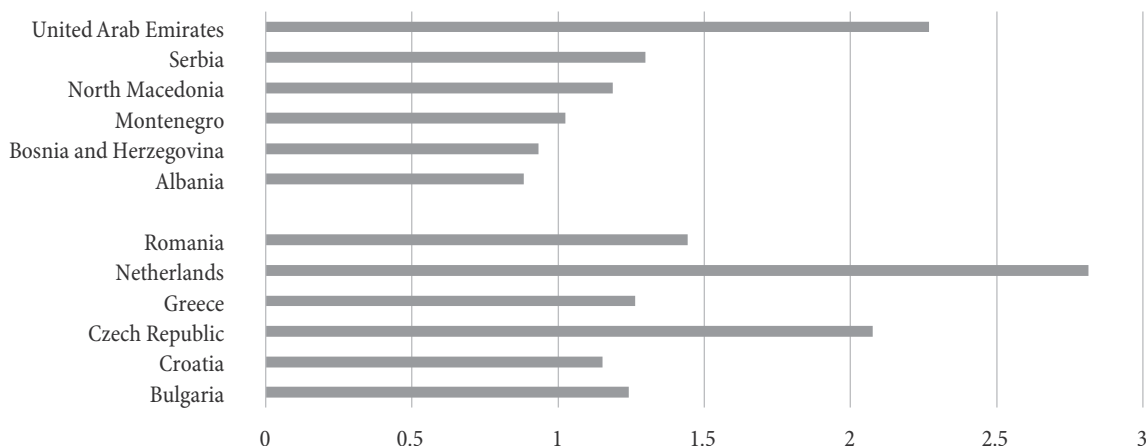
Human Development Index

The Human Development Index (HDI) was created by the United Nations Development Programme (UNDP) to broaden the spectrum of measuring the growth of a nation. The index has the purpose of including not only the measure of economic growth like GDP, but also the overall quality of life and knowledge within a country. Besides the GDP measure, HDI incorporates dimensions like the longevity of life and health, and the state of knowledge in a country. The first Human Development Report (HDR) was published in 1990, and it expanded the measurement of national growth, which predominantly used GDP or GDP per capita, to more inclusive measurement of human development [42]. However, HDI is often seen as an incomplete measure of human development because it leaves out many important elements. In order to encompass all elements that affect the quality of human development, HDI, besides the factors already incorporated, needs to include: mental well-being, empowerment, political freedom, social relations, community well-being, inequalities, work conditions, leisure conditions, political security, economic security, and environmental conditions [41, pp. 328-329]. The issue here is the measurement of all these missing components.

Despite its obvious shortcomings, HDI has been extensively used in the literature as a measure of national level development. For example, Khan et al. [31] assessed the possible gap between ICT, economic growth and human development in Pakistan, in the period between 1990 and 2014. The empirical results revealed that ICT affected HDI positively. Besides this, economic growth had a positive and significant impact on HDI. On the other hand, urbanization, trade, and foreign direct investments (FDI) had inverse effect on human development in Pakistan. In an empirical study conducted in Nigeria, the impact of FDI was assessed against HDI. The study pointed to the fact that FDI had a significant positive effect on HDI in the period 1972-2013. Furthermore, the authors stressed that this relationship is far from simple and that policymakers must take its complexity into account [19]. A study implemented in Indonesia between 1997 and 2016, assessed the relationship between Indonesian bank rate, foreign exchange rates, money supply, oil price, and gold prices on inflation. As the second order construct, the impact of inflation was addressed against HDI and poverty, which was determined to be positive and significant [59].

In terms of research studies that included Serbia, the literature is sparse and does not provide enough empirical evidence of the relationship between any component of intangible assets on a national level and HDI. However, Serbia is seen as a country that showed a moderate increase in HDI over the course of last three decades. This growth is slow and in recent years shows stagnating characteristics. Furthermore, Serbia still has a considerably lower position in the overall ranking compared to its neighbors and Central and Eastern European countries, such as Slovenia, the Czech Republic, Slovakia, Hungary, Croatia, Montenegro, Romania and Bulgaria [36, p. 13]. In the current sample, it can be observed that on average,

Figure 2: HDI between non-EU and EU countries, 2020
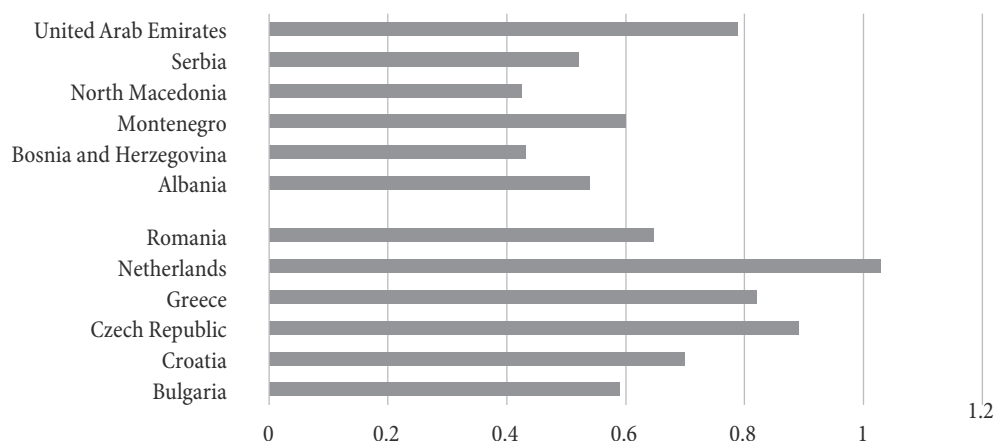
non-EU economies have lower values of HDI, except for the United Arab Emirates, which are a non-EU economy but belong to the group of world economies with higher economic growth (see Figure 2).

Methodology

Measurement framework

When comparing against other national economies, it is crucial to assess fundamental national level features, such as educational system, international trade, infrastructure, together with a country's renewal capabilities. All these features determine the national level of competitiveness and represent the elements of national intellectual capital [34]. The conceptual framework of the current research (see Figure 3) is built upon the categorization of national intellectual capital of Edvinsson and Malone [15], who asserted that national wealth consists of financial wealth and intellectual capital. Furthermore, the authors argued that intellectual capital has two subsegments, namely human capital and structural capital. In this approach, national human capital represents "knowledge, wisdom, expertise, intuition, and the ability of individuals to realize national tasks and goals" [34, p. 4]. Proxies for national human capital, as suggested by Užienė [52], include pupil-teacher ratio, employment rate, expenditure on healthcare,

higher education enrolment, level of lifelong learning, knowledge of foreign languages, and level of emigration.

A nation's structural capital is based on a country's market capital and organizational capital, formed by renewal and process capital.

The component labeled as market capital of a nation is reflected in a country's internal relationships. These relationships include a country's ability to create a quality environment for international clients. Additionally, this form of national capital entails a country's investments in international relations and exports of quality goods and services. Finally, the market capital of a nation is drawn from existing laws, market institutions, and various social networks [7]. The current research draws the measures of market capital from Užienė [52], which include exports of goods and services, high-technology exports, level of higher education internationalization, income from tourism, and foreign direct investments.

Another important segment of structural capital is a country's organizational capital that contains renewal and process capital. The renewal capital is seen as national "future intellectual wealth" [7, p. 24]. This refers to a country's investments in further developing and sustaining national competitiveness. The major component revolves around a country's investment in research and development (R&D) activities in many areas. The investments in R&D not only support a country's financial wealth but also increase a

Figure 3: National intellectual capital
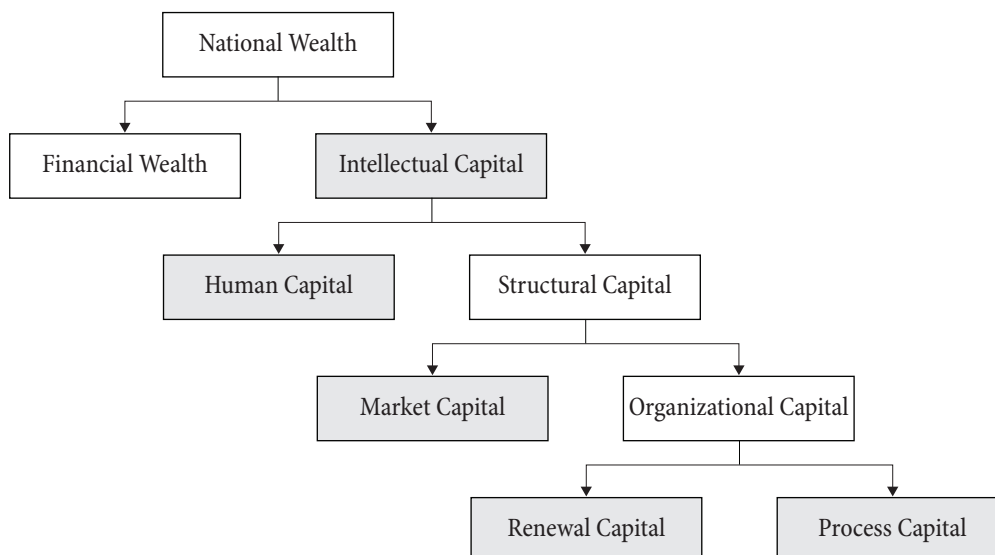
Source: [7, p. 13], [15]

country's efficiency as a whole [7]. However, usually in transitional or developing economies that constitute the majority of the sample in this study, this factor is largely underinvested and represents an important obstacle to future growth [27]. As proposed by Užienė [52], the possible measures of national renewal capital are the number of patent applications, number of R&D personnel and researchers, volume of R&D expenditure, number of trademark applications, new businesses started annually, and number of scientific publications.

Finally, an important driver of a country's wealth and growth is the process capital. This element of national intellectual capital represents "the non-human storehouses of knowledge" [7, p. 21], which supports a nation's human capital. The specific elements include information and communications technologies, hardware, software, different existing databases (statistical, registries, and the like), research laboratories, and other organizational structures that support development and storage of national human capital. Specific measurable components include level of internet usage, mobile cellular subscriptions, convenience of exporting, convenience of starting new business, government effectiveness, and income from intellectual property [52].

Variables definition

Selecting the adequate measures of each of the presented components of national intellectual capital was based on Užienė [52], the availability of data for selected countries over the analyzed period of 21 years and the authors' conception of the importance of each variable. The conceptual framework is mainly adapted from Edvinsson and Malone [15] and Bontis [7], while the approach to variables selection and calculation is adapted from Užienė [52]. To calculate the aggregate value of national intellectual capital, the authors applied the mentioned concept of National Intellectual Capital Index (NICI) and used the weighted values of selected measures.

As explained in earlier section of the paper, NICI represents the sum of National Human Capital (NHC), National Market Capital (NMC), National Process Capital (NPC), and National Renewal Capital (NRC).

Each component of NICI was calculated as a weighted sum of individual available and logical measures. The weights of each NICI component are derived from an expert survey, which assigned appropriate weights to each measure to reflect its relative importance. The calculation also included the steps of variable standardization and calculation of cumulative indices. The standardization of variables was mandatory because the retrieved variables were heterogeneous and need to be standardized for the purposes of comparison. Standardization was performed in MS Excel by using the function STANDARDIZE that returns a normalized value (z-score) based on the mean and standard deviation. The used syntax for standardizing the variables was =*STANDARDIZE (x, mean, standard_dev)*. The next step in the process was transforming all the standardized values into a score that ranges from 0 to 1. This stage was conducted by minimizing and maximizing of standardized variables. As suggested by Užienė [52], minimizing and maximizing variables are converted in the following way:

$$r_{ij} = \frac{r_{ij}}{max\ r_{ij}} \#(1)$$

$$r_{ij} = \frac{min\ r_{ij}}{r_{ij}} \#(2)$$

Where r_{ij} is the value of variable i, alternative j, max r_{ij} is the maximum value of variable i, alternative j, and min r_{ij} is the minimum value of variable i, alternative j. The values are now standardized and transformed into 0-1 range. After this, a simple additive weighting method was used to calculate the cumulative values of all elements of NICI. Finally, the NICI value is calculated as the total score of its four elements. The same procedure was used for standardizing and transforming the values of Human Development Index (HDI) for the mentioned period.

Sample and data collection

The dataset consists of 21 years of data for 12 countries: Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Greece, North Macedonia, Montenegro, Romania, Serbia, the United Arab Emirates, Czech Republic, and the Netherlands. The sample contains diverse countries,

among which European Union (EU) member countries are included (Bulgaria, Croatia, Czech Republic, Greece, the Netherlands, and Romania) as well as the countries in the Western Balkan region (Albania, Bulgaria, Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia). Additionally, the United Arab Emirates were included to diversify the sample and include an economy with very different principles, natural resources, and culture.

The data was collected from the World Bank Open Data website [57]. The used variables are listed in Table 1.

There are certain limitations to the selected measures. The first general issue stems from the conceptual link between micro measures of IC and transformed measures at macroeconomic level. There is no straightforward connection between the models used on a firm level [14], [40] and the ones developed for the measurement of national IC because the complexity of interrelations significantly increases for a country level analysis [34]. Additionally, different authors in the field of national IC are choosing different measurement models in an attempt to grasp as many contributing factors as they can to explain the relationship between various country capitals and long-term performance in terms of GDP, HDI, or some other measure. To overcome this obvious drawback, the current research employs a two-way fixed-effects model in which both individual and time effects were considered to control for the individual economy's differences and the time varying effect, similarly to that of Dženopoljac et al. [13].

Hypotheses development

There were several significant attempts to determine and quantify national intellectual capital in the literature [7], [25], [26], [30], [33], [37], [44], [47], [55]. However, this is not an easy task, which might be the reason why no significant study or approach has been discussed in almost a decade. Furthermore, the literature offers very few empirical studies in the field of national intellectual capital and even fewer when it comes to assessing the relationship between defined NICI and certain macroeconomic factors. In his initial work when developing the index, Bontis [7] attempted to assess the interrelationships between four elements of NICI and financial wealth of nations. More specifically, the research was done in the Arab region and included ten countries: Kuwait, Jordan, Tunisia, Egypt, Oman, Morocco, Saudi Arabia, Algeria, Yemen, and Sudan. In the mentioned research, the dependent variable that served as a proxy for nations' financial wealth was GDP per capital. Due to various sample limitations, the conclusion was more theoretical saying that national human capital represents the antecedent of overall national intellectual capital. Additionally, through complex internal relationships among analyzed NICI components, the author concludes that mainly thanks to national human capital and its development and support by other components of NICI, financial well-being of a country increases. In addition, the empirical study performed by Užienė [52] focused on determining the impact of NICI and its elements on GDP per capita, HDI, and World Competitiveness Scoreboard rank. The comprehensive empirical results obtained by Lin and Edvinsson [33] provide further proof towards the importance of national intellectual capital and predominantly, national human capital, for national wealth of nations. Research by Hervas-Oliver and Dalmau-Porta [25] revealed that a country's technological capability and governmental policy towards businesses are the key

Table 1: List of variables for measuring internal NICI constructs and their weights

National Human Capital (NHC)	National Process Capital (NPC)
Pupil-teacher ratio (0.15)	Individuals using the Internet (0.30)
Employment to population ratio (0.30)	Charges for the use of intellectual property (0.25)
Current health expenditure (0.20)	Mobile cellular subscriptions (0.10)
School enrollment, tertiary (0.35)	Ease of doing business score (0.35)
National Market Capital (NMC)	**National Renewal Capital (NRC)**
Foreign direct investment (0.20)	Patent applications (0.10)
High-technology exports (0.35)	Research and development expenditure (0.35)
International tourism, receipts (0.15)	Trademark applications (0.30)
Exports of goods and services (0.30)	New businesses registered (0.25)

factors of national IC and have impact on the levels of countries' IC and financial wealth of a nation. Ferreira and Hamilton [17, p. 16] assessed national intangible capital "as a residual, by subtracting the values of assets that the system of national accounts measures (produced capital and net financial assets) and estimates of the value of the stock of natural capital, from the value of comprehensive wealth". Presented in this way, the national intangible capital proved to be a crucial source of growth, especially within the high-income countries. Finally, the overall notion is that national intellectual capital represents a major factor for economic growth, whether all of its components affect this grow positively or not [44]. In line with the previous research, the current study proposes the following research hypotheses:

H1. *National intellectual capital is positively related to human development index*
   H1a. *National human capital is positively related to its human development index*
   H1b. *National market capital is positively related to its human development index*
   H1c. *National process capital is positively related to its human development index*
   H1d. *National renewal capital is positively related to its human development index*

Results

Descriptive statistics and correlation

In Table 2, the results of descriptive analysis for all considered variables in the study are presented. The data for the analyzed 21 years had the issue of missing data mainly due to the quality of national reporting systems in developing countries in the sample. For the missing data, a linear extrapolation formula was used: $Y(x) = b+(x-a)*(d-b)/(c-a)$. To ensure that the relationship between national intellectual capital and HDI was not changed due to the missing data, additional tests of the panel regression models were performed. Most of the missing data were caused by unavailability of data for the earlier years, but in most cases the data continued to be available once reported. Due to the later availability of data and since this did not cause any methodological weaknesses in resulting panel, the authors did not consider this as major issue for further analysis.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
HDI	252	.4839436	.2295874	.0026688	1.02807
NICI	252	1.16848	.5109132	.4444672	2.838758
NHC	252	.3950905	.0895133	.1744084	.6245142
NMC	252	.2573088	.139269	.0942305	.8523503
NPC	252	.3415961	.1970451	.0016076	.8948751
NRC	252	.1744846	.1568831	.008172	.5385972

Figure 4: Two-way scatter plot NICI-HDI
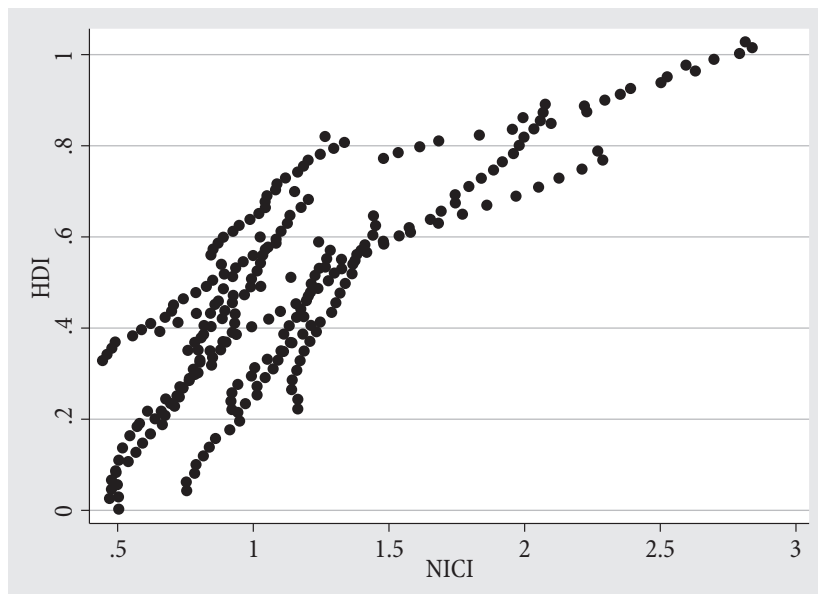
To further describe the data and possible relations between national intellectual capital and HDI for the mentioned 21-year period, we devised the two-way scatter plot that is presented in Figure 4.

The scatter plot reveals a strong and positive association between the analyzed variables. To further analyze the relationship between national intellectual capital and HDI, the correlation analysis is performed. The results of the correlation analysis are presented in Table 3. As it can be observed, there is a significant and strong positive correlation between all variables included.

Table 3: Correlation analysis

	NDI	NHC	NMC	NPC	NRC
HDI	1.0000				
NHC	0.8004	1.0000			
NMC	0.7857	0.7154	1.0000		
NPC	0.7616	0.6548	0.8439	1.0000	
NRC	0.6027	0.6112	0.6539	0.6016	1.0000

The strongest correlation was found between HDI and national human capital, as expected, while the national renewal capital exhibited the weakest correlation. The reason behind this is considered to be the fact that the sample mainly consists of transitional and developing economies, with the lower investments in R&D as compared to more developed economies, like the Netherlands.

In the final stage, the authors tested for the effects of multicollinearity among the used variables. Table 4 represents the results of testing the variance inflation factor (VIF).

Table 4: Variance inflation factor

Variable	VIF	1/VIF
NMC	4.37	0.228715
NPC	3.57	0.280263
NHC	2.24	0.447050
NRC	1.90	0.526036
Mean VIF	3.02	

The general rule of thumb for VIF values states that the regression model suffers from multicollinearity issue if VIF is higher than 5, but actually there is no perfect model to estimate the right cutoff values, they are merely suggested values [9]. In either case, the presented model has all values lower than 5, which suggests that some of the variables (e.g. NMC and NPC) are moderately autocorrelated

but the others are not. This is useful for further analysis since conceptually, the elements of HDI (i.e. knowledge) are indirectly linked with the elements of NHC.

Panel data regression

Analysis of the collected data was performed with statistical software Stata 16. The analysis of time varying factors in longitudinal dataset, the regression analysis can be implemented through panel data regression with fixed effects or panel data regression with random effects. In general, the fixed effects panel regression is usually more suitable because it is a more convincing tool for estimating the *ceteris paribus* effect [56]. Additionally, the fixed effects approach controls for all time-related variations between the countries so that the resulting coefficients are not biased by these country-specific characteristics.

Table 5: Hausman test

	Coefficients (b) fe	Coefficients (B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
NHC	.1910327	.2466385	-.0556058	.
NMC	.2772807	.2568005	.0204802	.
NPC	.7107242	.6988719	.0118524	.
NRC	-.6505414	-.5899558	-.0605856	.0040915

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
Test: Ho: difference in coefficients not systematic

$$\text{chi2(4)} = (b-B)'[(V\_b-V\_B)^{(-1)}](b-B)$$
$$= 84.59$$
$$\text{Prob>chi2} = 0.0000$$

However, a safer way in assessing which type of panel data regression to apply, the Hausman test was performed [23]. The results of the Hausman test are presented in Table 5. Given that, according to the Hausman test, the null hypothesis is that the preferred model of analysis is the random effects regression, while the alternate hypothesis is that the suitable model for analysis is fixed effects regression. According to this test if the *p*-value is small (less than 0.05), we reject the null hypothesis. This is the case with current data, so we accept the alternate hypothesis and apply the fixed effects panel data regression. The results of fixed effects panel regression analysis are presented in Table 6.

The two-way fixed effects panel data regression indicated in Table 5 has an R^2 of 0.8685, which means

that the variations in elements of national intellectual capital explain almost 87% of changes in HDI, which is high. This also confirms the goodness of fit for the selected regression model. Another confirmation of model fit can be seen in the indicator Prob>F=0.0000. If this number is lower than 0.05, the model is valid.

When observing the individual elements of national intellectual capital, we can see that all variables significantly impact the value of dependent variable, HDI because all of the p values are below 0.005. Moving to the nature of the relationship, we can determine that the strongest positive impact on HDI is exhibited by NPC or national process capital. This is followed by NMC and NHC, which has the lowest positive impact on HDI. Lastly, national renewal capital has inverse effect on HDI, which might seem like a contradictory conclusion. However, this conclusion is in line with the discussion by Lin and Edvinsson [33] in several aspects. The authors assert that national human capital is generally the trigger for national IC development, process capital is crucial for developing nations (which applies to most countries in the current sample), renewal capital is mainly important for highly developed economies, while national market capital is important factor for both developed and developing economies. In other words, the national renewal capital represents one of the crucial factors for a country's development, while for the transitional economies this factor might exhibit a contradictory effect due to its underdevelopment, or due to a country's heavy investments in this area that are expected to capitalize in the long run.

Conclusion and avenues for future research

The present study on the effects of components of national intellectual capital pointed to the conclusion that there is an evident positive long-term effect on the human development index. This suggests the need for macroeconomic decision makers to shift and maintain their focus on intangible elements of development. However, the effect varies depending on whether a country is labeled as developed or developing, in terms of the analyzed human development index. The developed countries' growth is primarily driven by the human and renewal capital, entailing education levels of a nation and country's investments in further deepening their knowledge base. In the case of developing economies, the renewal capital is not the key development trigger. This might be caused by the current low development levels of this sort of capital or by the fact that these investments possess significant lagging characteristic and thus have not yet been seen to reach the fruition phase. In other words, the investments might be impeding the current growth, but significant growth is expected when the investments in research and development are capitalized.

Table 6: Panel data regression with fixed effects

Fixed-effects (within) regression				Number of obs	=	252
Group variable: Countrycode				Number of groups	=	12

R-sq:						Obs per group:	
within = 0.8685					min =	21
between = 0.2363					avg =	21.0
overall = 0.3873					max =	21
				F(4,236)	=	389.51
corr(u_i, Xb) = -0.0024				Prob > F	=	0.0000

HDI	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
NHC	.1910327	.0946267	2.02	0.045	.0046117	.3774537
NMC	.2772807	.0689162	4.02	0.000	.1415112	.4130502
NPC	.7107242	.0348267	20.41	0.000	.6421133	.7793351
NRC	-.6505414	.0683644	-9.52	0.000	-.7852238	-.515859
_cons	.2078504	.0292703	7.10	0.000	.150186	.2655149
sigma_u	.18245806					
sigma_e	.04197093					
rho	.94974513	(fraction of variance due to u_i)				

F test that all u_i=0: F(11, 236) = 147.17	Prob > F = 0.0000

Serbia is seen as developing country in terms of human capital index value and rank in 2022, which ranks it at 64th position worldwide. In terms of NICI, Serbia ranks relatively good, compared to its counterparts in European Union (like Greece for example). This does not provide a solid basis for future growth, nor does it guarantee. This is caused by a complex relationship between NICI components and overall country-level growth and development. The important notion is that IC represents an important factor of economic growth. Even if not all NICI components affect HDI positively, they are all important ingredients, especially for developed economies. Developing economies still need to invest in all forms of IC to reach a higher development stage. "Some IC components function as pillars, some as drivers for economic growth in developed economies, and these pillars and drivers are different in economies on dissimilar economic levels" [44, p. 174], which makes the entire IC analysis a complex matter for policymakers. Finally, policymakers need to be aware of national IC in order to invest in it and develop it further, which is why the authors here try to bring the topic of national IC to their attention.

References

1. Abeysekera, I. (2021). Intellectual Capital and Knowledge Management Research towards Value Creation. From the Past to the Future. *Journal of Risk and Financial Management*, *14*(6), 238. Retrieved from https://www.mdpi.com/1911-8074/14/6/238

2. Al-Musali, M. A. K. M., & Ku Ismail, K. N. I. (2015). Board diversity and intellectual capital performance. *Accounting Research Journal*, *28*(3), 268-283. doi:10.1108/ARJ-01-2014-0006

3. Altindag, O., Fidanbas, O., & Irdan, G. (2019). The impact of intellectual capital on innovation: A literature study. *Business Management Dynamics*, *8*(12), 1-12.

4. Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

5. Bhatt, G. D. (2000). Organizing knowledge in the knowledge development cycle. *Journal of knowledge management*, *4*(1), 15-26. doi:10.1108/13673270010315371

6. Bontis, N. (1998). Intellectual capital: an exploratory study that develops measures and models. *Management Decision*, *36*(2), 63-76.

7. Bontis, N. (2004). National Intellectual Capital Index. *Journal of Intellectual Capital*, *5*(1), 13-39. doi:10.1108/14691930410512905

8. Corrado, C., Hulten, C., & Sichel, D. (2005). Measuring capital and technology: an expanded framework. In *Measuring capital in the new economy* (pp. 11-46): University of Chicago Press.

9. Craney, T. A., & Surles, J. G. (2002). Model-dependent variance inflation factor cutoff values. *Quality engineering*, *14*(3), 391-403.

10. Đuričin, D., Kaličanin, Đ., Lončar, D., & Vuksanović Herceg, I. (2021). *Menadžment i strategija* (12 ed.). Beograd: Centar za izdavačku delatnost.

11. Dženopoljac, V. (2014). Intellectual capital: importance, measurement, and impact on corporate performance. *Ekonomika preduzeca*, *62*(3-4), 173-186.

12. Dženopoljac, V., Kwiatek, P., Dženopoljac, A., & Bontis, N. (2022). Intellectual capital as a longitudinal predictor of company performance in a developing economy. *Knowledge and Process Management*, n/a(n/a), 1-17. doi:https://doi.org/10.1002/kpm.1696

13. Dženopoljac, V., Muhammed, S., & Janošević, S. (2019). Intangibles and performance in oil and gas industry. *Management Decision*, *57*(5), 1267-1285. doi:10.1108/MD-11-2017-1139

14. Edvinsson, L. (1997). Developing intellectual capital at Skandia. *Long range planning*, *30*(3), 366-373.

15. Edvinsson, L., & Malone, M., S. (1997). *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Roots.* New York: Harper Business.

16. F-Jardón, C. M., & Martos, M. S. (2009). Intellectual capital and performance in wood industries of Argentina. *Journal of Intellectual Capital*, *10*, 600-616.

17. Ferreira, S., & Hamilton, K. (2010). *Comprehensive wealth, intangible capital, and development* (World Bank Policy Research Working Paper No. WPS 5452). Retrieved from https://openknowledge.worldbank.org/handle/10986/3935 License: CC BY 3.0 IGO.

18. Gogan, L. M., Artene, A., Sarca, I., & Draghici, A. (2016). The Impact of Intellectual Capital on Organizational Performance. *Procedia - Social and Behavioral Sciences*, *221*, 194-202. doi:https://doi.org/10.1016/j.sbspro.2016.05.106

19. Gökmenoğlu, K. K., Apinran, M. O., & Taşpınar, N. (2018). Impact of foreign direct investment on human development index in Nigeria. *Business and Economics Research Journal*, *9*(1), 1-14.

20. Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *17*(S2), 109-122. doi:https://doi:10.1002/smj.4250171110

21. Gunay, S. D., Dženopoljac, V., Bontis, N. (2022). Social media as a proxy for intellectual capital: Twitter posts in the cryptocurrency market. *International Journal of Web Based Communities*, *18*(1), 1-20.

22. Hashim, M. J., Osman, I., & Alhabshi, S. M. (2015). Effect of Intellectual Capital on Organizational Performance. *Procedia - Social and Behavioral Sciences*, *2*11, 207-214. doi: https://doi.org/10.1016/j.sbspro.2015.11.085

23. Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the econometric society*, *46*(6), 1251-1271.

24. Healy, T., & Côté, S. (2001). *The Well-Being of Nations: The Role of Human and Social Capital.* Education and Skills: ERIC.

25. Hervas-Oliver, J. L., & Dalmau-Porta, J. I. (2007). Which IC components explain national IC stocks? *Journal of Intellectual Capital*, *8*(3), 444-469. doi:10.1108/14691930710774867

26. Hervas-Oliver, J. L., Rojas, R., Martins, B. M., & Cervelló-Royo, R. (2011). The overlapping of national IC and innovation systems. *Journal of Intellectual Capital*, *12*(1), 111-131. doi:10.1108/14691931111097935

27. Janošević, S., & Dženopoljac, V. (2013). Innovation-based competitiveness: the case of Serbia. *Ekonomika preduzeća, 61*(7-8), 439-456.

28. Janošević, S., Dženopoljac, V., & Tepavac, R. (2012). Corporate performance driven by intellectual capital: an empirical analysis. In *Management, Governance, and Entrepreneurship – New Perspectives and Challenges* (pp. 136-153). Darwenm, UK: Access Press.

29. Kamukama, N., Ahiauzu, A., & Ntayi, J. M. (2010). Intellectual capital and performance: testing interaction effects. *Journal of Intellectual Capital, 11*(4), 554-574. doi:10.1108/14691931011085687

30. Käpylä, J., Kujansivu, P., & Lönnqvist, A. (2012). National intellectual capital performance: a strategic approach. *Journal of Intellectual Capital, 13*(3), 343-362. doi:10.1108/14691931211248909

31. Khan, N. H., Ju, Y., & Hassan, S. T. (2019). Investigating the determinants of human development index in Pakistan: an empirical analysis. *Environmental Science and Pollution Research, 26*(19), 19294-19304. doi:10.1007/s11356-019-05271-2

32. Lev, B., & Sougiannis, T. (1996). The capitalization, amortization, and value-relevance of R&D. Journal of accounting and economics, 21(1), 107-138.

33. Lin, C. Y.-Y., & Edvinsson, L. (2012). National intellectual capital model and measurement. *International Journal of Knowledge-Based Development, 3*(1), 58-82.

34. Lin, C. Y. Y., & Edvinsson, L. (2008). National intellectual capital: comparison of the Nordic countries. *Journal of Intellectual Capital, 9*(4), 525-545. doi:10.1108/14691930810913140

35. Lu, W.-M., Wang, W.-K., & Kweh, Q. L. (2014). Intellectual capital and performance in the Chinese life insurance industry. *Omega, 42*(1), 65-74.

36. Madzar, L. (2022). Macroeconomic analysis of the financing of education system in the Republic Of Serbia. *Oradea Journal of Business and Economics*, 7(1), 8-18.

37. Malhotra, Y. (2003). *Measuring knowledge assets of a nation: knowledge systems for development.* Paper presented at the Invited Research Paper Sponsored by the United Nations Department of Economic and Social Affairs. Keynote Presentation at the Ad Hoc Group of Experts Meeting at the United Nations Headquarters, New York City, NY.

38. Mouritsen, J., Bukh, P. N., Larsen, H. T., & Johansen, M. R. (2002). Developing and managing knowledge through intellectual capital statements. *Journal of Intellectual Capital, 3*(1), 10-29. doi:10.1108/14691930210412818

39. Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal, 14*(3), 179-191.

40. Pulic, A. (1998). *Measuring the performance of intellectual potential in knowledge economy.* Paper presented at the 2nd McMaster Word Congress on Measuring and Managing Intellectual Capital by the Austrian Team for Intellectual Potential.

41. Ranis, G., Stewart, F., & Samman, E. (2006). Human development: beyond the human development index. *Journal of Human Development, 7*(3), 323-358.

42. Sagar, A. D., & Najam, A. (1998). The human development index: a critical review. *Ecological Economics, 25*(3), 249-264. doi:https://doi.org/10.1016/S0921-8009(97)00168-7

43. Salehi, M., & Zimon, G. (2021). The effect of intellectual capital and board characteristics on value creation and growth. *Sustainability*, *13*(13), 7436.

44. Ståhle, P., & Bounfour, A. (2008). Understanding dynamics of intellectual capital of nations. *Journal of Intellectual Capital, 9*(2), 164-177. doi:10.1108/14691930810870283

45. Ståhle, P., Ståhle, S., & Lin, C. Y. Y. (2015). Intangibles and national economic wealth – a new perspective on how they are linked. *Journal of Intellectual Capital, 16*(1), 20-57. doi:10.1108/jic-02-2014-0017

46. Ståhle, S., & Ståhle, P. (2012). Towards measures of national intellectual capital: an analysis of the CHS model. *Journal of Intellectual Capital, 13*(2), 164-177. doi:10.1108/14691931211225012

47. Stam, C., & Andriessen, D. (2009). Intellectual capital of the European Union 2008: measuring the Lisbon strategy for growth and jobs. *Electronic Journal of Knowledge Management, 7*(4), 489-500.

48. Stewart, T. (1997). *Intellectual capital: The new wealth of organizations.* New York: Doubleday.

49. Sumedrea, S. (2013). Intellectual Capital and Firm Performance: A Dynamic Relationship in Crisis Time. *Procedia Economics and Finance, 6*, 137-144. doi:https://doi.org/10.1016/S2212-5671(13)00125-1

50. Sveiby, K. E. (1997). The Intangible Assets Monitor. Journal of Human Resource Costing & Accounting, *2*(1), 73-97. doi:10.1108/eb029036

51. Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: an introduction. *Industrial and corporate change, 3*(3), 537-556.

52. Užienė, L. (2014). National Intellectual Capital as an Indicator of the Wealth of Nations: The Case of the Baltic States. *Procedia - Social and Behavioral Sciences, 156,* 376-381. doi:https://doi.org/10.1016/j.sbspro.2014.11.206

53. Vishnu, S., & Gupta, V. K. (2014). Intellectual capital and performance of pharmaceutical firms in India. *Journal of Intellectual Capital, 15*, 83-99.

54. Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

55. Weziak, D. (2007). *Measurement of national intellectual capital: application to EU countries*. Retrieved from Differdange, Luxembourg: https://liser.elsevierpure.com/ws/files/11787182/Working%20Paper%20n%C2%B02007-13

56. Wooldridge, J. M. (2015). *Introductory Econometrics: A Modern Approach.* Mason, OH: SOUTH-WESTERN Cengage Learning.

57. World Bank. (2022). *World Bank Open Data.* Retrieved from https://data.worldbank.org/

58. Xu, J., & Li, J. (2022). The interrelationship between intellectual capital and firm performance: evidence from China's manufacturing sector. *Journal of Intellectual Capital, 23*(2), 313-341. doi:10.1108/JIC-08-2019-0189

59. Yolanda, Y. (2017). Analysis of factors affecting inflation and its impact on human development index and poverty in Indonesia. *European Research Studies Journal, 20*(4B), 38-56.

Vladimir Dženopoljac

is an Associate Professor of Strategic Management at the College of Business and Economics, the United Arab Emirates University, UAE. He is also an Associate Professor and Lead Researcher at the School of Business, Prague City University, the Czech Republic. Previously, he worked as an Associate Professor and Director of MBA program at the College of Business Administration, American University of the Middle East, Kuwait. His academic career began at the Faculty of Economics, University of Kragujevac in 2003. Vladimir Dženopoljac earned his PhD degree from the University of Kragujevac, Serbia, in the field of the impact of intellectual capital on value creation in contemporary enterprises. Alongside his academic career, he was providing consultancy services in the fields of strategy development and execution, business planning, and financial planning and analysis. He has published a significant number of research papers in the areas of intellectual capital, knowledge management, leadership, and entrepreneurship.

Bojan Georgievski

is an Associate Professor and Lecturer at two different universities in the Netherlands. He is currently working for both Wittenborg University of Applied Sciences and Tilburg University. He earned his doctoral degree in Economics from the University of St Ciril & Methodius in Macedonia, in 2011. His working experience includes several different universities in Macedonia, Kuwait and the Netherlands. He has a combined teaching experience of 10 years and a combined professional experience in 3 different industries of almost 20 years working in finance and banking, legal affairs and education. His professional interests include banking and finance, sports economy and finance, real estate economics, financial crisis and impact. He specializes in financial crisis and its impact on several different aspects of everyday living. He holds two master's degrees in Corporate Finance and Banking, and Sport Management.

Stefano Cavagnetto

is currently the Dean of the School of Business, Prague City University (PCU) and Director of the Centre for Research and Interdisciplinary Studies (CRIS) at PCU. After earning his doctoral degree in Philosophy at the Amedeo Avogadro University in Italy and being visiting scholar at the Columbia University in NYC, Dr. Stefano Cavagnetto moved to Prague and specialized in Mathematical Logic and Computational Complexity Theory at the Institute of Mathematics of the Academy of Sciences of the Czech Republic, and earned his PhD in Mathematical Logic at Charles University. He has been a visiting scholar and fellow at the Isaac Newton Institute for Mathematical Sciences in Cambridge (UK) and has published in the fields of logic, theoretical philosophy, ethics, and strategy. He has written two university textbooks for undergraduate and postgraduate students on natural deduction and the formalization of natural languages and mathematical logic, respectively.

Oualid Abidi

is currently appointed as an Associate Professor at the College of Business at the Australian University (Kuwait). He joined that institution in February 2021 after 8 years and a half of service at the American University of the Middle East (7 years) and the Arab Open University in Kuwait (1 year and a half). Oualid Abidi earned his PhD degree in Administrative Sciences from Université Laval in 2011 (Canada). Prior to that, he received his master's degree in Project Management in 2005 from Université du Québec à Trois-Rivières (Canada). He was awarded his bachelor's degree in Finance in 2002 from the Institut Supérieur de Gestion de Tunis, Tunisia. He has eclectic research interests in the fields of international business, diversity management and entrepreneurship.