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Editorial correspondence including manuscripts and submissions:

E-mail: submissions@jssidoi.org

http://0000-0002-9829-622X
Prof. **Fernando García**, Department of Economics and Social Sciences, Faculty of Busines Administration and Management, Polytechnic university of Valencia, Spain
Author ID: 57201603529
Dr. **Michal Fabus**, School of Economics and Management in Public Administration in Bratislava, Slovak Republic
http://orcid.org/0000-0002-3792-179X
Prof. **Sulphey, M.M**. Prince Sattam Bin Abdulaziz Universtiy, Al-Kharj, Saudi Arabia
http://orcid.org/0000-0001-6042-2123
***Prof*. Mirjana Radović-Marković,** Institute of Economic Sciences, Belgrade, Serbia
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Prof. **Ronaldo Lopes Rodrigues Mendes**, Federal University of Pará, Belém, Brazil
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INFRASTRUCTURE AND SECTORAL FDI INFLOWS IN CHINA: AN EMPIRICAL ANALYSIS

Faisal Mehmood [1], Muhammad Atique [2], Wang Bing [3], Hameed Khan [4*], Henna [5]

[1,2,3] College of Public Administration, Huazhong University of Science & Technology, Wuhan, China
[4] Department of Economics, Kohat University of Science & Technology, Kohat, Pakistan
[5]Institute of Business Studies, Kohat University of Science & Technology, Kohat, Pakistan

E-mails:[1] fmehmood_kmu@yahoo.com; [2]muhammad.atique1@yahoo.com; [3]wbyf@mail.hust.edu.cn;
[4] hameed.qec@gmail.com (Corresponding author); hennagulawat@gmail.com*

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Abstract. In this paper, for the first time, we investigate the relationship between infrastructure and sectoral distribution of FDI inflow in China. We use the Estimating Autoregressive Distributed Lag (ARDL) bound testing and Vector Error Correction Model (VECM) procedures of estimation. To unmask the shortcomings in the previous literature, we use a composite index of infrastructure with more than 30 indicators. The results show that there is a long-run relationship between sectoral FDI and infrastructure. A bidirectional causal relationship is confirmed by using VECM. However, we find unidirectional causality between the primary sector's FDI and infrastructure, and it is running from infrastructure to primary sector FDI. The inclusion of control variables, e.g., institutional quality, trade openness, and domestic investment, is robust in our analysis. The positive role of infrastructure in the sectoral distribution of FDI inflows is of utmost importance for policymakers and Chinese-government. Several policy implications are given in our study.

Keywords: Infrastructure; foreign direct investment; Estimating Autoregressive Distributed Lag (ARDL)

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JEL Classifications: F21; C22; O17

1. Introduction

The recent global financial crisis 2008 encourages the Chinese government to invest in infrastructure by 4 trillion Chinese Yuan (equivalent to 600 billion US dollars) as a fiscal stimulus package in its western provinces in 2008 (Ouyang & Peng, 2015). 1 trillion Chinese Yuan was further proposed to invest in infrastructure since the Chinese economy started to slow down in 2015 (*Financial Times*, August 5, 2015). Meanwhile, the miraculous surge in foreign direct investment in China is one of the key phenomena in the modern globalized world (Khan & Khan, 2019; Khan, Shaheen, et al., 2020). China became the second-largest destination all over the world. Therefore, a

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question of whether the infrastructure explains the FDI inflow naturally arises? Similarly, another question arises, 'whether the sectoral distribution of FDI is complementary in infrastructure development in China'?

During 2017, the tertiary sector (services) portion in total FDI is 66%, secondary sector (manufacturing) portion is 32% and the primary sector (agriculture, fishing & mining) counted for only 2%. China ranked the third largest FDI recipient country after the UK and USA in the year 2015. Similarly, by the year 2012, the largest share of foreign investment in China is from Hong Kong (70%), while in the shares of FDI in China by North America, Europe, and Latin America are 2%, 3% and 9% respectively.

On the outset of reforms; the first thing that happened is the Deng Xiaoping came to power and normalized relations with the USA. Deng took a trip to the USA and immediately announced the joint venture law designed to encourage foreign technologies to come to China. He mainly aims to bring technology to help to Chinese economy advance. When Deng visited the USA, very specifically went to Hi-tech cities like including Houston to see signal what China wants to collaborate with high technology firms. The joint venture law carried many specific provisions designed to entice foreign firms to invest in China. The first was that it provides very generous tax rate.

Previous literature focuses on the impact of infrastructure on aggregate FDI at the national level or cross-country analysis. The previous studies documented a single aspect of infrastructure like transport, ICT (internet & telecommunications) railways, etc. Keeping in view the expediency of FDI inflows and unmask the information for policy implications and in-depth knowledge, we, for the first time, contribute the literature by investigating the relationship between infrastructure and sectoral distribution of FDI. The earlier literature has never documented the role of institutional quality in FDI-infrastructure relationship in developing countries like China. We contribute the literature by using ARDL approach. Moreover, we contribute the earlier literature by adding an important variable, i.e., institutional quality.

Moreover, our contribution is the analysis of FDI and infrastructure relationship in a broader set of infrastructure indicators, which compose of transport, energy, communication, and finance. Therefore, foreign enterprises choose China as their destination for business by considering various dimensions of infrastructure. Similarly, the sectoral distribution of FDI affects the infrastructure.

The study is divided into sections as the following. Section 1 shows the introduction. The second section describes the stylized facts of infrastructure and FDI in China, followed by the theoretical framework of FDI and infrastructure relationship. Section IV shows the data and methodology. Section V reports empirical results. In section VI, we show the concluding remarks of the study.

2. Overview of China-infrastructure

China has emerged as the world's fastest-growing economy. This process started in 1978, the economic reform and opening up its doors to the rest of the world. Today, China is no longer an isolated country and attracted the attention of the international community as a global player on the World stage. We highlight three crucial sectors of infrastructure, i.e., transport, energy, and ICT (internet and telecommunications) in China.

China is endowed with vast land. Around 1.5 billion people are residing in China. To meet the growing demand for infrastructure, its government brought many reforms. In this study, we use physical infrastructure (e.g., transport, energy, ICT, and finance).

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2.1. Transport infrastructure

China is the most populous country in the world. Since China's reforms in its economy in 1982, China favored economic growth with an emphasis to have considerable investments in infrastructure. Mainland China has different constraints since it is much vast, and the population density is much lower at 389 people per square mile. Beijing itself is much denser on average. However, at 3200 people per square mile, it still is about one-fourth of Hong Kong population density. This means investing in a more expensive solution to reducing traffic is less utilized. They rely more heavily on road traffic which in China carries virtually half of all passengers' traffic. This causes the infrastructure to favor small roads, high buildings, and more expensive solutions like subways. Beijing is a major cultural and political center; therefore, its priorities are not centered on the same ones as other cities. Beijing has preserved many of the roads and streets from its long past. While small roads are kept, new roads are made to be spectacular in epic and scale.

China has focused heavily on infrastructure construction since starting his reform and opening-up process in 1978. It invested in developing modern highways and high-speed railways. Key cities are being connected, which helps the economy to expand rapidly. With a vast land, it was difficult for Beijing to connect with other parts of the country. The launch of HSR, in 2008, connected two major cities, i.e., Beijing and Tianjin, and it carries around 80,000 thousand passengers per day. Jiao et al. (2014) argue that China had the largest HSR (high-speed rail) network (9760 km), accounting for 46% of the world totals by 2013. China is increasingly spending on transport infrastructure to boost the economy. The high-speed intercity railways have been playing a pivotal role in boosting the local economy. HSR effectively merges cities providing favorable conditions for the exchange of commerce and trade. The high-speed railway is becoming more important to national economic and social development. Since its launch in 2008, the overall passenger transport volume of China's railways has increased by 10% annually reaching 2.8 billion passengers in 2016.

Despite the popularity of the high-speed railways, road users have not been forgotten. China has modernized and extended its road network adding new expressways to crucial routes. China now has the world's biggest road network. Most of China's expressways are built with government funding bank loans and other sources of financing, including toll roads. The expressway toll policy has boarded the financing channels of expressway construction. China has a diversified investment and financing model that includes national investment, local fundraising, social financing, and foreign capital. China's development of modern expressways and world-class high-speed railways has transformed the country. It has grown the economy in the process and changed the way people travel across China. Keeping in view the transportation infrastructure, we give the details of its aspects in Table 1. The length of highways and railway increased from 890,200 km and 51,700 km in 1978 to 4,773,500 km and 127,000 km in 2017, respectively. Rail is an essential mean of transportation in China. The substantial Chinese investment on BRI (Belt & Road Initiative) in railway sector would enable it to connect with Europe and Central Asian markets. Since 2011, the considerable investments in the railway sector and the launch of China Railway Express service also helped China to connect its cities with 15 European countries

Table 1. The total length of transport in China (10,000 km).

Year	Expressway	Highway	Railway	Inland waterway	Pipeline	Civilian flight routes
1978	0	89.02	5.17	13.6	0.83	14.89
1990	0.05	102.83	5.78	10.92	1.59	50.68
2000	1.63	140.27	6.87	11.93	2.47	150.29
2010	7.41	400.82	9.12	12.42	7.85	276.51
2017	13.64	477.35	12.70	12.70	11.93	748.30
2017/1978	*272.80*	*5.36*	*2.46*	*0.93*	*14.37*	*50.26*

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Source: China Statistical Yearbook, 2018

2.2. Energy infrastructure

Excessive energy demands accompany China's rapid economic growth. China has been given the blessing and the curse of being one of the largest energy consumers and was rapidly growing energy consumers over the last decade. That comes with significant benefits and some significant drawbacks. One of which is trying to procure enough energy to maintain rapid economic growth. China imports probably 60 percent of the oil that it consumes. It is the World largest oil importer. Similarly, coal is China's largest source of energy. 70% of the nation is coal-powered.

China has been doing a lot to make sure that its energy consumption across a range of fuels is more secure, affordable, and reliable. China is increasing its production domestically to the extent possible. It has some pretty impressive unconventional shale gas resources and moving into it's own offshore to produce more oil and gas. China has also been looking to diversify its imports, especially on the oil and natural gas side from the variety of different sources. Chinese national oil companies have spent around 9 billion dollars over a short period. The companies are trying to access and develop oil resources around the World, and contribute approximately 2 million barrels a day to their overall consumption. China has been able to grow its solar capacity and wind capacity. Now China is one of the largest markets for renewable energy technologies and services around the world. China is connecting all of that renewable energy power generation to the sources of consumption. Companies like State Grid Corporation of China and others are creating these lengthy sorts of transmission lines and plans to connect some of these resources from the big sort of renewable energy production centres to some of the consumption centres in the country. Table 2 shows that China has decreased coal consumption from 76.2% in 1990 to 60.4% in 2017, while its coal production decreased from 74.2% in 1990 to 69.6% in 2017. The clean energy consumption has been increased from 5.1% to 13.8% during 1990 to 2017, and its production increased from 4.8% to 17.4% from 1990 to 2017. The figures highlighted the importance of renewables for China.

Table 2. Consumption and production of energy and its composition (in percent)

Year	Consumption				Production			
	Coal	Crude Oil	Natural Gas	Hydro-, Nuclear-, and Wind Power	Coal	Crude Oil	Natural Gas	Hydro-, Nuclear-, and Wind Power
1990	76.2	16.6	2.1	5.1	74.2	19.0	2.0	4.8
1995	74.6	17.5	1.8	6.1	75.3	16.6	1.9	6.2
2000	69.2	22.2	2.2	6.4	73.2	17.2	2.7	6.9
2005	70.8	19.8	2.6	6.8	77.6	12.0	3.0	7.4
2010	68.0	19.0	4.4	8.6	76.6	9.8	4.2	9.4
2017	60.4	18.8	7	13.8	69.6	7.6	5.4	17.4
2017/1990	*0.79*	*1.13*	*3.33*	*2.71*	*0.94*	*0.40*	*2.70*	*3.63*

Source: China Statistical Yearbook (2018)

2.3. ICT infrastructure

Digitalization and ICT is a growing phenomenon in China and providing many business opportunities in various areas. It includes cloud technology, enterprise services, IC design, E-commerce and E-finance, mobile components and embedded software, big data, and app-based ICT platforms. At the core of the Chinese government's 12th Five-year plan, the ICT sector represents the largest single market in the world.

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Following the 19th Party Congress—on developing internet technologies for artificial intelligence (AI), internet of things (IoT), big data, cloud, and mobiles as new engines of growth—the Chinese leadership stressed that the information & communication technologies (ICT), as well as the digital economy, underpin the country's economic development. "Without information, there is no modernization" is the slogan that captured the high-level attention in China. Chinese internet, as well as other companies, has been growing enormously and became more influential because the private sector and state are financing them with needed capital both inside and outside of the country. Additionally, the digital economy became an integral part of daily life in China. The entrepreneurs create new business applications and technologies that support and bring innovation into the day to day activities and routine work.

Ministry of Industry and Information Technology (MIIT) is responsible for regulation about wire signals, the internet broadcasting & communication system, software, and electronic goods. Through the sustainability and introduction of proper regulations; now, more and more Chinese access the internet in their mobile phones. The usage of smartphones and other IT types of equipment resulted in less investment in fixed-line telephones and a more considerable amount of investment in more advanced technologies. Similarly, the introduction of these technologies enabled Chinese people to do many smart things like E-commerce, online shopping, etc.

During 2006, China announced the 2006-2020 National Informatization Development Strategy. The strategy focuses on the role of informatization as the engine for industrialization. It is characterized to achieve an increase in productivity, ensure sustainable development, low environmental pollution, high economic efficiency, and low consumption of materials. Moreover, the strategy is the plan to boost domestic companies and make them global champions by bringing indigenous innovative core technologies rather than imitating and introducing it from abroad. Additionally, the strategy is focusing on the establishment of a world-leading, safe, and reliable information system. The opportunities for domestic companies include information and innovative technologies. It will bring forth new ideas and know-how that may enhance the capabilities of the business entities to introduce a more sophisticated, diversified, and complex product. That may, in turn, lead to the overall sophistication of the economy. China also operates five-year plans. The latest five-year plan mainly focuses on e-logistic, e-commerce, traceability of agricultural products, epidemic surveillance, smart healthcare, and smart transportation system.

The sub-sectors of ICT in China include telecoms, hardware, and software. There are three big players in the *telecom industry*, i.e., China Unicom, China Telecom, and China Mobiles which share the Chinese market by 23%, 14%, and 63% respectively. During 2015, the total mobile subscribers concerning the telecom sector were 1292 million while there were 550 3G subscribers. Regarding the *hardware sector*, the leading domestic players include Lenovo, Huawei, Founder, Haier, Xiaomi, etc. while the foreign companies consist on IBM, HP, Dell, Apple, Cisco, and ARM. Chinese domestic companies make joint ventures and other kinds of partnerships with big foreign technology giants and make different kinds of hardware like integrated circuits (IC), broadband routers, health-tech devices, internet of thing (IoT), high-tech casings, etc. During the third quarter of 2018, the revenue of China's *software industry* revenue increased by 15 % to reach 647.4 billion. The software industry in China is composed of sub-sectors like a software product, system integration, operation service, embedded software, IT consulting, and IC design. Moreover, domestic firms in this sector consist of Kingdee, Huawei, and Neusoft, while foreign enterprises include Microsoft, Apple, SAP, Cisco, and Oracle.

In 2016 China's ICT exports account for 26.49% in total exports, the portion of ICT imports estimates 23.75% for total imports, and in 2017 the mobile cellular subscriptions accounted for 1.47 billion. Moreover, China's GDP growth is 6.9% in 2017, which is quite useful for such a huge economy. The Chinese annual growth of the big data market is 30%.

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3. Model and data

3.1. Model

The underlying concern of our study is to show the relationship between FDI and infrastructure as specified by earlier literature, i.e. (Asiedu, 2002; Cheng & Kwan, 2000; Flores & Aguilera, 2007; Loree & Guisinger, 1995; Wheeler & Mody, 1992). Therefore, we can construct our baseline models like the following:

$$FDI = f(INF, IQ, \text{TO}, \text{DI}), \qquad (1)$$

Here the terms FDI, INF, IQ, TO, DI represent the foreign direct investment, infrastructure, institutional quality, trade openness, and domestic investment respectively. The term X represents the control variables we include in different specifications.

The objective of our study is to show the link between FDI and infrastructure. Foreign firms make those countries as the destination where there is well-developed infrastructure, so that MNEs may smoothly run business activities and obtain better returns on their investments. Similarly, the spillover effects of foreign investment bring forth the development of necessary infrastructure.

According to Shatz and Venables (2000), the motive for MNCs to invest abroad include better serving the local market. This is called 'horizontal' or 'market seeking' (market access motivation) FDI to have access to lower-cost inputs. The first motive is mainly driven by market size. This is a substitute for international trade that implies a duplication of production plants, i.e., to economize on tariffs, transport costs and to tap a new market. Since there is fragmentation, therefore, the second motive for MNCs is to have access to lower-cost inputs. It is called 'production cost-minimizing FDI' or 'vertical FDI' (resource access motivation). Infrastructure is like an amenity that can help in reducing the cost of production. Hence it is believed that it has relatively more influence on vertical FDI though it also has an impact on horizontal FDI.

Khadaroo and Seetanah (2008) argue that the reduction of transport cost and an increase in accessibility are related to the development of infrastructure. The public infrastructure helps to maximize profit and reduce the cost of doing business for multinational corporations. Therefore, the infrastructure helps the businesses in the reduction of costs through the facilitation of the production process. In the absence of public infrastructure, the MNCs may incur additional costs and results in reluctance in investments (Erenburg, 1993). Therefore, it is generally considered that public infrastructure in the form of transportation, ICT, energy, and finance may lower the cost of production and facilitate business activities. For example, the improved infrastructure may results in the reduction in the cost through the efficient transportations of heavy types of equipment. It also helps in the construction of new factories. Similarly, efficient communication and energy setups help in the increase in overall productivity. Contrary to this, the abnormal shutdown of electricity and inefficient communication system may lead to a burden of extra costs and is deterrent for MNCs to invest overseas. Moreover, foreign enterprises invest in developing countries to reap the benefits of lower labour costs. However, if the infrastructure is not efficient, then the firms may incur additional costs associated with transportation, electricity generation, and installation of communication setups. Similarly, the presence of well-developed infrastructure enables firms to avoid any startup costs and ensure timely delivery of materials.

The public infrastructure enables the firms to deliver the products and receive the raw materials efficiently, thereby enhances their productivity and efficiency while reduces the cost of doing business (Erenburg, 1993; Khan, Khan, Jiang, & Khan, 2020). Additionally, the network of infrastructure and good quality of transportation

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make it convenient for the business entities to avoid maintenance costs. For example, highway maintenance and better road designs can help in the reduction of transportation as well as wear and tear costs. The argument is valid for private ships and barges, which require ports and navigable waterways, and for aircraft which require airports.

The public infrastructure increases the level of output per unit of input, e.g., the scarce resources are efficiently utilized. Therefore, countries attract FDI by improving the quality and quantity of infrastructure. Hence, the investments by foreign enterprises are subsidized, and returns on their capital increase through the provision of well-developed public infrastructure. Vertical FDI takes advantage of improved public infrastructure in the form of timely supply of their output and imports of the inputs. Horizontal FDI takes advantage in the form of increased output per unit of input. Similarly, the improved infrastructure enhances access to foreign firms to tap new markets in the neighbourhood as well as in the host countries.

Location advantages that foreign firms seek before investing and operating in the host country come under the purview of good infrastructure (including communications and transportation among others)(Cantwell, 2016; Dunning & McQueen, 1981). Therefore, the improved infrastructure can attract FDI through the provision of the environment that may ease their operations.

The empirical literature on the role of public infrastructure in firms' productivity is diverse. Previous literature suggests a positive relationship between infrastructure and productivity and a negative relationship between the cost of firms and public infrastructure (Aschauer, 1989; Nadiri & Mamuneas, 1994). However, there is no unanimous consensus on the role of public infrastructure in productivity. Therefore, the second strand of the literature shows no effect of public infrastructure and public investment in the firms' productivity (Holtz-Eakin, 1994; Holtz-Eakin & Schwartz, 1995). Regardless of any direct effects of public infrastructure on the productivity, there are empirical studies that show the indirect effect (spillover effect) of public investment and infrastructure (from clustering and agglomeration created by public infrastructure) on the cost and productivity of business enterprises. Moreover, the trade flow between countries is determined by the trade costs associated with public infrastructure, specifically the transport infrastructure (Limao, 2001).

Given the above theoretical overview, we are in a position to say that there are various reasons for the MNCs' presence abroad. Firstly, the output cost per unit of input applied reduces for the vertical FDI in the presence of improved public infrastructure. Secondly, horizontal FDI takes advantage in the form of increased output per unit of input.

3.2. Data

The basic concern of this study is to explore the relationship between infrastructure and sectoral FDI during 1988 to 2017. We apply the methodology on various indicators specified by Donaubauer et al. (2016) for the construction of our infrastructure index. We use 30 indicators and constructed a composite index. The indicators used in the construction of the Infrastructure Index based on transport (land, air, and sea transport), Internet & Communications Technology (ICT), energy (production and consumption of energy), and financial infrastructure. The sample selection dictates to the data availability. The index is constructed, keeping in view the shortcomings in the previous literature.

In this study, we use the sectoral FDI. The data about sectoral FDI comes from the China Statistical Yearbook. The data about sectoral FDI is composed of primary (mining & quarrying), secondary (manufacturing), and tertiary (services) sectors. We normalized FDI by GDP. So, the variables we have to show the FDI (% of GDP). This reduces the problem of aggregation bias. Following the previous literature, we include important control

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variables in our analysis to avoid the omitted variable bias. The baseline model with infrastructure and institutional quality indices greatly explain the variations in FDI.

Institutions are social, political, and economic elements that define the rules of the economies (Schout & North, 1991). Well-developed institutions reduce transaction costs and improve efficiency (Khanna & Rivkin, 2001; Schout & North, 1991). We rely on the International Country Risk Guide (ICRG) data. The data consists of government effectiveness, the rule of law, bureaucratic quality, investment profile, democratic accountability, and control of corruption. The individual aspects may not portray an accurate picture of institutional quality when put in a regression. Following Buchanan et al. (2012); Globerman and Shapiro (2003), we apply Principal Component Analysis (PCA) to derive a composite index of institutional quality.

Trade openness also influences the FDI inflow into the host economies (Iamsiraroj & Ulubaşoğlu, 2015), and domestic investment. Similarly, infrastructure is also affected by the above variables. For example, when the volume of trade and domestic investment increases, then there is a need for more public investment in infrastructure development. Trade share percent of GDP is used as a proxy for trade openness. Gross fixed capital formation (% of GDP) is used as a proxy for domestic investment. The data about trade openness and domestic investment is extracted from World Bank (2018).

The descriptive statistics are given in Table 3. It shows the measure of central tendency and variability of the data. In this regard, we report the mean, median, standard deviation, minimum, and maximum. The mean and median values of primary FDI are close to each other with standard deviation is 0.113, which shows that the data is less scattered. The primary FDI exhibits more stability and less variability. The stability implies that China attracted more FDI in the manufacturing and services sectors, while the FDI inflow in the primary sector increases at a very minimal rate. Therefore, we see here that FDI is services and manufacturing sectors shows more volatility and less stability. This implies that the macroeconomic environment affects the manufacturing and services FDI, which may occur due to the open door policies and infrastructure development. However, the infrastructure shows less variability based on median and mean values; however, the standard deviation is 0.382, which shows less stability. Moreover, all variables follow a normal distribution, according to Jarque-Bera (JB) test of normality.

Table 3. Descriptive statistics

Variables	Notation	Mean	Median	Max.	Min.	SD	JQ	Prob.
FDI (% share in GDP)	FDI	5.05	3.95	13.32	2.013	3.36	4.15	0.12
FDI in the primary sector	PRI	1.11	1.08	1.38	1.01	0.11	4.56	0.10
FDI in the manufacturing sector	SEC	3.68	3.17	9.47	1.34	2.41	4.32	0.11
FDI in services	TER	2.25	1.82	4.46	1.65	0.85	5.30	0.07
Infrastructure	INF	1.52	1.57	2.00	0.59	0.38	1.83	0.39
Institutional quality	IQ	1.18	1.50	2.43	-1.14	0.94	3.67	0.15
Trade share in GDP (%)	TO	43.74	40.43	65.47	25.27	11.1	1.56	0.45
Domestic investment share in GDP (%)	DI	38.92	40.07	46.51	25.56	5.89	1.39	0.49

Note. One is being added to actual values. SD and JQ represent standard deviation and Jarque-Bera statistic.

4. Method and results

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In this study, we apply the autoregressive distributive (ARDL) technique of cointegration, developed by Pesaran et al. (2001). There are several advantages to use the ARDL approach. First, the method is applicable irrespective of the order of integration of variables, i.e., I(0), 1(1), 1(1,0). If the variables are I(2) or above, then the F-statistics is not invalid (Ouattara, 2006). Second, ARDL is applicable in case some of the regressors are endogenous (Odhiambo, 2009). Third, the method is effective even in the case of small samples (Ghatak & Siddiki, 2001). In case of small samples, the method is better than Johansen and Juselius (Johansen, 1991), Engle & Granger (Engle & Granger, 2015), and Phillips and Hansen (Phillips & Hansen, 1990). Another advantage of using ARDL is that it overcomes the problems resulting from series with unit roots and the unrestricted error correction model (UECM) seems to take satisfactory lags that captures the data generating process in a general-to-specific framework of specification (Kinkyo, Matsubayashi, & Hamori, 2013). We aim to investigate the causal relationship between sectoral FDI and infrastructure across different specifications.

Before the estimation of the empirical results, it is imperative to determine the order of integration. In this regard, we use Augmented Dicky Fuller (ADF) test. We also apply the Phillips- Perron (PP) test in order to get robust results. Moreover, we also apply the Zivot-Andrews breakpoint unit root test in order to avoid misleading and biased results. We follow Ayala and Triguero (2017) and apply Baum's modified methodology for unit root testing against the alternative of trend stationarity with a shift in time trend, shift in mean, and a shift in both slope and intercept.

Table 4 reports the results of the unit root. All the tests show that none of our variables is integrated of I(2). Similarly, there is mix integration of variables, i.e., some variables are integrated of I(0) while others are I(1). Moreover, the response variable is integrated of order I(1), which satisfied the precondition specified by Pesaran et al., (2001).

Table 4. Unit root and stationary test results

Variable	ADF		Phillips- Perron		Zivot-Andrews					
	I(0)	I(1)	I(0)	I(1)	Zd	Break	Zt	Break	Zdt	Break
FDI	-3.003	-4.32**	-3.62**	-4.26**	-3.111	2014	-5.173***	1994	-4.106	2009
INF	-3.492*	-7.36***	-3.56*	-7.25***	-3.985	1995	-4.086	2000	-4.166	2008
IQ	-1.853	-5.22***	-3.35*	-5.49***	-3.723	1995	-3.832	1999	-4.8	2001
TO	-0.75	-3.58*	-0.974	-3.62**	-4.504	2013	-4.148	2011	-4.912*	2013
DI	-3.83**	-3.71**	-2.264	-3.52*	-4.497	2015	-4.717**	2014	-5.839***	2011

Note. * p<0.10, ** p<0.05, *** p<0.01. ADF and PP tests include intercept and trend. The ZA tests are the minimum Dicky–Fuller statistics with one structural break in intercept (Zd), trend (Zt), and both intercept and trend (Zdt). Break indicates the year when minimum DF statistic is obtained.

The next step is to apply the ARDL (autoregressive distributed lag) bounding testing procedure of cointegration. The bound test provides us with F-statistics whether cointegration exists or not. If the F-statistic value is higher than upper-bound, then there is cointegration. Similarly, the values of the F-statistic below the lower bound value indicate no cointegration. While the F-statistic value between the upper and lower bound indicate inconclusive region.

In order to investigate the relationship between infrastructure and foreign direct investment, we can formulate the unrestricted error correction model (ECM) as the following;

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$$\Delta FDI_t = \alpha_{0\,fdi} + \sum_{i=1}^{p} \psi_{ifdi} \Delta FDI_{t-i} + \sum_{i=1}^{p} \rho_{ifdi} \Delta INF_{t-i} + \sum_{i=1}^{p} \phi_{ifdi} \Delta IQ_{t-i} + \sum_{i=1}^{p} \delta_{ifdi} \Delta TO_{t-i} + \sum_{i=1}^{p} \rho_{ifdi} \Delta DI_{t-i} + \lambda_{1\,fdi} FDI_{t-1}$$
$$+\lambda_{2\,fdi} INF_{t-1} + \lambda_{3\,fdi} IQ_{t-1} + \lambda_{4\,fdi} TO_{t-1} + \lambda_{5\,fdi} DI_{t-1} + \mu_{1t} ------ Equation(2)$$

$$\Delta INF_t = \alpha_{0\inf} + \sum_{i=1}^{p} \psi_{i\inf} \Delta INF_{t-i} + \sum_{i=1}^{p} \phi_{i\inf} \Delta FDI_{t-i} + \sum_{i=1}^{p} \rho_{i\inf} \Delta IQ_{t-i} + \sum_{i=1}^{p} \delta_{i\inf} \Delta TO_{t-i} + \sum_{i=1}^{p} \rho_{i\inf} \Delta DI_{t-i}$$
$$+\lambda_{1\inf} INF_{t-1} + \lambda_{2\inf} FDI_{t-1} + \lambda_{3\inf} IQ_{t-1} + \lambda_{4\inf} TO_{t-1} + \lambda_{5\inf} DI_{t-1} + \mu_{2t} ------ Equation(3)$$

In Eq. (2) the term FDI is the foreign direct investment. Similarly, the dependent variable in the Eq. (3) is represented by INF. To have in-depth analysis, we repeat the same methodology by replacing the aggregate FDI with sectoral FDI, i.e., PRI (Primary), SEC (Manufacturing), TER (Services sector) in the above equations. We use institutional quality, trade openness, and domestic investment as controlled variables. The subscript *t* is the time dimension. ARDL technique is applied to the model for identification of the long- and short-run dynamics. Pesaran et al. (2001) provided upper and lower bound critical values. However, the values are applicable for large samples. In the case of small samples, the decision based on the Pesaran et al. (2001) critical values can mislead the estimation results (Herzer, 2010). If the computed F-statistic falls above the upper value bound, the null is rejected, indicating cointegration. If the computed F-statistic falls below the lower bound, the null hypothesis of no cointegration is accepted. In contrast, if the computed F-statistic falls within the bounds, the inference would be inconclusive.

The significant F-statistics of the estimated ARDL bound test in Table 5 both for foreign direct investment and infrastructure as dependent variables, reject the null of no cointegration. This implies that a stable long-run relationship between FDI and infrastructure exist at aggregate as well as sectoral level.

Table 5. ARDL bounds test results

FDI as dependent variable			INF as dependent variable		
Models	Max lag.	F-Statistics	Models	Max lag.	F-Statistics
F(FDI/INF, IQ, ,TO, DI)	(3,1,3,3,3)	13.49***	F(INF/FDI, IQ,TO, DI)	(1,2,3,2,2)	13.09***
F(PRI/ INF, IQ,TO, DI)	(3,0,3,3,1)	4.873**	F(INF/PRI, IQ,TO, DI)	(3,1,3,0,0)	5.496**
F(SEC/ INF, IQ,TO, DI)	(3,3,3,3,0)	5.73**	F(INF/SEC, IQ,TO, DI)	(1,2,3,3,3)	10.71***
F(TER/ INF, IQ,TO, DI)	(2,3,2,0,2)	4.63**	F(INF/TER, IQ,TO, DI)	(3,3,1,0,2)	12.39***

Note. * p<0.10, ** p<0.05, *** p<0.01. The first letter outside the brackets denotes dependent variables. The null hypothesis of no cointegration is tested with F-test, critical values are taken from Narayan (2005). Lag selection is based on the AIC. For upper and lower bound critical value; please see Appendix , Table A1

Hence, we generalize that there is a long-run relationship between FDI and infrastructure. We check the cointegration in Johansen Johansen multivariate cointegration framework in order to check for robustness. The results are given in Table 6. We see that there are three cointegrating vectors which validate the presence of a long-run relationship between the variables, which indicate the ARDL results are robust and reliable.

Table 6. The Johansen cointegration analysis.

Hypothesis	Trace statistic	Max.eigen value
R=0	170.4004***	83.64441***
R≤1	86.75601***	39.01881***
R≤2	47.7372***	26.90004***

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$R \leq 3$	20.83716***	16.08317**
$R \leq 4$	4.753994**	4.753994**

Note. * p<0.10, ** p<0.05, *** p<0.01

In the next step we reparametrize the equations that show cointegration. For this purpose, the following ARDL framework is presented;

$$(1-\Omega_1 L-...-\Omega_s L^s)\, FDI_t = \tau_0 + (1-\tau_1 L-...-\tau_u L^u)\, INF + (1-\gamma_1 L-...-\gamma_v L^v)\, IQ + (1-\pi_1 L-...-\pi_w L^w)\, \text{TO}$$
$$+ (1-\varnothing_1 L-...-\varnothing_x L^x)\, DI + \mu_{3t} ------ Equation(4)$$

$$(1-\Omega_1 L-...-\Omega_s L^s)\, INF_t = \tau_0 + (1-\tau_1 L-...-\tau_u L^u) FDI + (1-\gamma_1 L-...-\gamma_v L^v)\, IQ + (1-\pi_1 L-...-\pi_w L^w)\, \text{TO}$$
$$+ (1-\varnothing_1 L-...-\varnothing_x L^x)\, DI + \mu_{4t} ------ Equation(5)$$

In the next step, we reparametrize Eq.(4) to (5). The step is done to obtain long-run coefficient estimates by including those equations that show cointegration. The long-run relationship from infrastructure to FDI and vice versa is presented in Table 6. The results reveal that infrastructure coefficients in all the specifications are significant and positive, which implies that infrastructure positively influences FDI inflow. Similarly, the reverse impact also holds. Coefficients of FDI (aggregated as well as sectoral) are significant and positive, which shows that FDI inflow is one of the reasons that boosted up the infrastructure in China. The reports of control variables are according to the economic theory and prior expectations. The diagnostic results show that our models are correctly specified (see Table 7).

Table 7. Results on Long-Run Effect

Dependent variable	Cons.	INF/FDI	IQ	TO	DI	***F-stat.***	LM Test		Hetero (Arch test)	Ramsey Reset Test	JQ
							AR1	AR2			
Panel A. **INF to FDI**											
FDI	6.60*** (1.45)	0.18* (0.1)	0.10*** (0.02)	0.02 (0.02)	0.05** (0.02)	114.89 (0.00)	1.13 (0.28)	2.37 (0.31)	2.26 (0.13)	1.91 (0.27)	0.17 (0.92)
PRI	9.112*** (1.78)	0.07*** (0.02)	0.021 (0.12)	0.01 (0.02)	0.112* (0.05)	100.46 (0.00)	2.64 (0.10)	3.70 (0.15)	0.015 (0.91)	1.32 (0.37)	0.93 (0.63)
SEC	5.08** (1.99)	0.72** (0.37)	0.19 (0.17)	0.02 (0.02)	0.04* (0.02)	17.071 (0.00)	1.98 (0.15)	2.44 (0.12)	2.28 (0.13)	0.49 (0.7)	0.33 (0.85)
TER	0.79 (1.18)	0.1*** (0.03)	0.24*** (0.06)	0.02* (0.01)	0.06** (0.03)	11.402 (0.00)	1.51 (0.23)	1.05 (0.31)	1.58 (0.21)	1.44 (0.3)	0.33 (0.85)
Panel B. **FDI to INF**											
F(INF/FDI)	-12.25*** (3.09)	1.158* (0.65)	0.081 (0.09)	-0.04* (0.02)	0.02** (0.01)	78.245 (0.00)	0.39 (0.53)	2.27 (0.13)	2.06 (0.15)	3.13 (0.1)	0.16 (0.92)
F(INF/PRI)	-1.25 (2.3)	0.15** (0.05)	0.11 (0.07)	-0.05* (0.02)	0.03** (0.01)	64.122 (0.00)	2.41 (0.12)	1.42 (0.23)	0.007 (0.93)	0.69 (0.59)	1.52 (0.47)
F(INF/SEC)	-1.01 (3.37)	0.79* (0.43)	0.08 (0.06)	0.01 (0.01)	0.05*** (0.01)	57.545 (0.00)	2.7 (0.10)	2.26 (0.13)	2.15 (0.14)	1.36 (0.36)	0.86 (0.65)
F(INF/TER)	2.51 (1.57)	0.09* (0.05)	0.27*** (0.07)	0.01 (0.01)	0.02* (0.01)	67.612 (0.00)	1.84 (0.17)	2.57 (0.11)	0.06 (0.81)	2.17 (0.17)	2.34 (0.31)

Note. * p<0.10, ** p<0.05, *** p<0.01. Values in parenthesis of coefficients represent standard error. Values in parenthesis in diagnostic panel represent p-values and values outside parenthesis are F-statistics. All the estimated models are stable.

If the long-run relationship exists (the necessary condition for cointegration but not a sufficient condition) then under the VECM environment, granger causality test show long-run and short-run causality for the two variables.

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Under the VAR framework, traditional Granger causality test can produce ambiguous results; therefore, under the VECM framework the following is its improved version;

$$\Delta FDI_t = \alpha_{0\,fdi} + \sum_{i=1}^{p} \psi_{ifdi} \Delta FDI_{t-i} + \sum_{i=1}^{p} \rho_{ifdi} \Delta INF_{t-i} + \sum_{i=1}^{p} \phi_{ifdi} \Delta IQ_{t-i} + \sum_{i=1}^{p} \delta_{ifdi} \Delta TO_{t-i} + \sum_{i=1}^{p} \delta_{ifdi} \Delta DI_{t-i} + \Omega_1 ECT_{t-1} + \mu_{5t} \text{------} Equation(6)$$

$$\Delta INF_t = \alpha_{0\,fdi} + \sum_{i=1}^{p} \psi_{ifdi} \Delta INF_{t-i} + \sum_{i=1}^{p} \rho_{ifdi} \Delta FDI_{t-i} + \sum_{i=1}^{p} \phi_{ifdi} \Delta IQ_{t-i} + \sum_{i=1}^{p} \delta_{ifdi} \Delta TO_{t-i} + \sum_{i=1}^{p} \delta_{ifdi} \Delta DI_{t-i} + \Omega_2 ECT_{t-1} + \mu_{6t} \text{------} Equation(7)$$

To reach in long-run equilibrium for the variables INF and FDI; ECTs (error correction term) are the speed of adjustment. The significant value of F-statistics indicates that short-run causality exists between the two variables, whereas the significant value of t-statistics for ECT_{t-1} indicates the long-run causality.

The results of the VECM are given in Table 8. The long-run relationship is confirmed by the ECT terms that are significantly negative in FDI equations. The long-run ECT is the speed of adjustment to restore equilibrium. Similarly, ECT terms are significantly negative in all the INF equations; except in the equations where we use primary FDI as an independent variable. Here we note that there is a long-run bidirectional causal relationship between infrastructure and FDI at aggregate, manufacturing, and service sector FDI. The significant value of F-statistics determines the short-run causality. The causality is determined by the F-statistics to test the joint significance of all the lagged first differences of independent variables (Ali & Wang, 2018; Lee, 2010; Zhang, 2001). We see that short-run bidirectional causality exists between INF with FDI, SEC, and TER. However, we see unidirectional causality running from infrastructure to primary FDI.

Table 8. Granger causality results

INF to FDI			*FDI to INF*		
Dependent variable	*Short-run F-stat* Δ(INF, IQ, TO, DI)	$ECT_{(t-1)}$	Dependent variable	*Short-run F-stat* Δ(FDI, IQ, TO, DI)	$ECT_{(t-1)}$
ΔFDI	5.74**	-0.55**	ΔINF	6.4***	-0.286**
ΔPRI	4.22**	-0. 19*	ΔINF	3.09	-0.395**
ΔSEC	4.6**	-0.263**	ΔINF	4.71**	-0.497**
ΔTER	6.62***	0.33**	ΔINF	13.98***	-0.445**

Notes: The symbol***,** and * indicate significance at 1% , 5%, and 10% respectively

The open-door policies and transitional reforms enable China to attract massive FDI in various sectors. We sum the sectors into a three strata industrial level, i.e., primary, manufacturing, and services. The above result reveals that primary, services-oriented and manufacturing industries attract more efficiency- and market-seeking FDI. Through the forward and backward linkages, the foreign inventors make their entries into the host economies.

Moreover, the size of the Chinese middle class is booming. Therefore, the Chinese government is keen on developing and maintaining the supply-side structural reforms along with the infrastructure arrangements to attract foreign investor in the service sector. The development of the services sector was a strategic priority in the 12th Five-Year Plan (2011-2015) of the Chinese Government. The well-developed infrastructure framework increases productivity and efficiency. Therefore, the Chinese government should take a keen interest in developing the infrastructure. The massive FDI inflows carry spillover effects. These effects may not be reversed in the presence of poor institutional quality (Feldstein, 2000; Loungani & Razin, 2001). Therefore, well-

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developed institutions should also be one of the priorities of the Chinese government. On the primary sector level, the peasantry is still meaningful large since the economic reforms in 1978 and with the restoration of *private property rights*. Similarly, *intellectual property rights, joint-venture laws, contract enforcement,* and other institutional reforms are introduced to attract FDI in manufacturing sectors.

In a nutshell, we see here that infrastructure plays a vital role in the sectoral distribution of foreign direct investment. We find that the impact of infrastructure in stronger in the manufacturing sector than the agriculture and services sectors. Due to the massive FDI inflows, the Chinese government spends more on infrastructure. Therefore, we see that infrastructure in energy, transport, ICT, and the financial sector is enhanced due to the foreign enterprises' presence of in these sectors like Volkswagen AG, AT&T Corp., Citibank, Morgan Stanley & Co., France's Citreon, Microsoft, Philips Electronics, etc. The findings are consistent with the view that multinationals have significant complementarities with local industry and may stimulate development in host economies (Markusen & Venables, 1999). China's rate of return on capital, an essential measure of investment efficiency, far outstrips than that of the most developed countries. MNCs motivate to invest in China due to efficient infrastructure, which increases in the rate of return on their investment.

5. Conclusion

Globalization and open-door policies boosted Chinese economy by attracting a huge amount of foreign direct investment. Similarly, in the meantime, the infrastructure also developed at the same time. Therefore, a natural question arises as to whether the FDI inflow is complementary to the infrastructural development or other factors explain the scenario? Similarly, we also investigate the role of infrastructure in the sectoral distribution of FDI.

Previous literature focuses on the impact of infrastructure on aggregate FDI at a macro level or cross-country analysis. Keeping in view the FDI-infrastructure relationship, the previous literature focused on a single aspect on infrastructure like transport, internet, ICT (internet & telecommunications) railways, etc. We, for the first time, contribute the existing literature by investigating the role of infrastructure in the sectoral distribution of FDI in China. Similarly, for the first time, we contribute the literature by investigating the effect of FDI inflows on infrastructure development. The earlier literature ignores the institutional quality, which may affect the FDI-infrastructure relationship in emerging countries like China.

Applying the ARDL cointegration technique, we came to know that there is a long-run bidirectional relationship between infrastructure and FDI. We also found that infrastructure positively affects the sectoral distribution of FDI in China. However, the extent of the impact of infrastructure on secondary sector FDI is more than the services sector and primary sector FDI. We also find short-run bidirectional causality between FDI (aggregate, secondary, and services). However, our results reveal unidirectional causality between primary sector FDI and infrastructure. The causality is running from infrastructure to primary FDI.

China's rapid integration into the world economy and her open-door policy has potential implications. To enhance the FDI inflow; there should be good infrastructure so that the MNCs can reap the benefits of improved efficiency, productivity, and rate of return on their investments. Since multinationals spend a huge amount on R&D activities, therefore, *investment promotion policies* should be in place to harness FDI to increase productivity and efficiency of the domestic firms. Investment Promotion is quite effective in increasing inflows of FDI. Similarly, most of the spillovers occur through interactions between multinationals and their local suppliers. Therefore, the following policy should be the *supplier development programs*. Better financial institutions and financial infrastructure can attract more FDI through the allocative channel, transaction cost reduction, enforcement contract, and liquidity. So the financial reforms should be introduced to facilitate the smooth functioning of the economy in general and investment in specific.

Disclosure statement
The authors report no potential conflict of interest.

Aknowledgement
All the authors equally contributed in this research.

Appendix

Table A1. Narayan (2005) upper and lower bound critical values.

K	(1%)		(5%)		(10%)	
	I(0)	I(1)	**I(0)**	**I(1)**	**I(0)**	**I(1)**
1	6.02	6.76	4.09	4.66	3.30	3.79
2	5.2	6.3	3.5	4.4	2.9	3.7
3	5	6	3	4	2.7	3.6
4	4.3	5.8	3.1	4.2	2.5	3.6
5	4.134	5.76	2.91	4.193	2.40	3.517

Note: Critical values for the bounds test: Case II: restricted intercept and no trend. 'K' represents number of regressors

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Faisal MEHMOOD is the doctoral student of public administration and Assistant Director, Quality Enhanncment Cell, Kohat University of Science & Technoloy, Kohat. He is interested to hightlight the significance of Special Economic Zones and their associated benefits related to socioeconomic development.
ORCID ID: orcid.org/0000-0002-3948-7819

Muhammad ATIQUE is the doctoral student of public administration in E-government. He is interested to hightlight the significance of E-government and its associated benefits.
ORCID ID: orcid.org/ 0000-0002-7157-8702

Professor Wang BING has doctorate degree in enivornment economics. His areas of interest are environment economics, public administration, foreign investments, and special economic zones.
ORCID ID: orcid.org/0000-0003-2322-5387

Dr. Hameed KHAN is Doctoral in Economics from Jilin University, Changchun, China. Currently, he is working at Kohat University of Science & Technology, Kohat, Pakistan. His research interests consist of MNCs, Finance, and Institutions.
ORCID ID: 0000-0003-1775-0687

Ms. HENNA did MS from Preston University Kohat campus, Pakistan. Currently, she is working as a visiting lecturer at Government Postgraduate Girls College, Kohat. Pakistan. Her research interests consist of Finance and Accounting.
ORCID ID: 0000-0003-3012-3047

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TECHNO-ECONOMIC ASSESSMENT (TEA) AND LIFE CYCLE COSTING ANALYSIS (LCCA): DISCUSSING METHODOLOGICAL STEPS AND INTEGRABILITY*

Lorenzo Giacomella

Department of Economics and Management, University of Ferrara, Via Voltapaletto 11, 44121 Ferrara , Italy

E-mails: lorenzo.giacomella@student.unife.it; lorenzo.giacomella@gmail.com

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Abstract. Researchers have always been concerned about investigating new methods of economic evaluation, in order to endow reliable observations and support the sustainable development of new products. In this sense, clarity and homogeneity are necessary to exploit the effectiveness of such instruments that, only in this way, can provide consistent recommendations among sectors and industries of the economy. With respect to technological innovation, two diffused methods are the techno-economic assessment (TEA) and the life-cycle costing analysis (LCCA). However, despite their diffusion and approval, these instruments still lack clear guidelines and a complete documentation of their distinctive elements. Furthermore, no discussion exists about their complementarity and integrability, despite the fact that these methods are frequently concurrently used in the analyses. With the goal of reviewing what sets one method apart from the other, this research shed some lights on the distinctive elements of TEA and LCCA, as well as providing a preliminary discussion on their (possible) methodical integration. At a first glance, present literature provides numerous cues for an analysis which aim is to improve the comprehension of the norms of application of TEA and LCCA. Though, it is necessary a reorganisation of contents which, at present time, appears heterogenous and uncoordinated. Despite some limitations and its preliminary nature, this research contributes to improve the comprehension of the methods under investigation, also introducing a new vision which sees TEA and LCCA converge in a structured model.

Keywords: techno-economic assessment; life cycle costing analysis; economic evaluation; technology readiness level; economic evaluation

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1. Introduction

Minimizing the cost of projects has been a main concern of designers and constructors for many years now. Ever since technological innovation has gained a key role for a sustainable growth of the economy, more accurate and inclusive evaluation tools have been explored to guide research and development towards the market. More recently, the increasing environmental deterioration has evoked the importance for new metrics of evaluation within orthodox economic analyses. The intention is to support the advance of more comprehensive assessments, oriented to win-win outcomes – i.e. profit maximization and environmental impacts minimization. This is the case of techno-economic assessment (TEA) and life-cycle costing analysis (LCCA). However, these two evaluation methods are currently affected by the scarcity of theoretical discussion and a heterogenous practice.

In general terms, the TEA supports the identification of the most efficient pathways for technological development and assesses how a technology might be successfully deployed in a profitable and desirable way (Kuppens,2012). On the other hand, the LCCA is usually considered as a valuable method that considers the cost effectiveness of a project by embracing all phases of its life. Also, it gives a framework for estimating incremental costs of developing, producing, using and disposing of an object (Asiedu & Gu, 1998).

Both evaluation methods are experiencing a renewed interest by academics and professional communities since not only they represent an effective mean to guide decisions during the development of a project[†], but also, and above all, they are open to the inclusion of environmental and social considerations. In fact, it is not surprising that most of Research and Innovation programmes (e.g. Horizon 2020) foresee specific tasks to conduct these analyses. In an optic of sustainable development, TEA and LCCA represent valuable tools to drive a more efficient utilization of resources, as well as driving and speeding up technological progress in line with nowadays' societal challenges. However, since overall established frameworks are lacking, the application of TEA and LCCA is harmed by their dependency to the specificities of single cases. In this sense, a homogenisation and development of systematic approaches may support an effective deployment of the methods, which may guarantee to take full advantage of these techniques.

With regard to TEA, most advanced guidelines are proposed within CO2 Utilization technologies (Zimmerman et al., 2018), chemical industry (Buchner et al., 2018) and biofuels production (Van Dael et al., 2015). Contrarily, users of LCCA can rely on few sectorial standards, as for the building (ISO15686:2017) and petroleum and natural gas industry (ISO 15663:2000) but, differently to TEA, the LCCA can count on the support of the well-recognised and rather diffused life-cycle assessment (LCA), regulated by ISO 14040:2006. As a result, a broad spectrum of empirical approaches is applied, which ultimately not only undermines comparative analyses, but also runs the risk of generating partial and/or misleading information that may lead to the selection of sub-optimal alternatives (Ellis, 2007). Finally, even though TEA and LCCA are sometimes combined in the same analysis (Rajesh Banu et al., 2020; Zayed et al., 2020), no strict academic discussion on their integration has been revealed so far.

1.1. Objectives and contribution

The aim of this research is to shed some lights on the distinctive elements of TEA and LCCA, and hence exploring the potential of using the tools in an integrated fashion. So far, the lack of reliable common frameworks,

[†] Hereafter, with the term "project" we refer indistinctly to products, processes or services.

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the self-determination of studies and the ambiguity in methodological choices, significantly reduced comparability and transparency of studies. Furthermore, the specific aspect of TEA-LCCA integration has not been addressed from a theoretical point of view. By investigating the available literature and current practices, this study provides a novel contribution to the methodological discussion on the structure of the methods, identifying and analysing the distinctive elements of these economic appraisal tools, and providing practitioners and academia with a through discussion.

Specifically, the following research questions (RQ) were addressed:

- RQ1: What are the distinctive elements of TEA and LCCA? On which basis scholars may analyse and assess these elements?
- RQ2: Are the (apparently) mutual aspects of the TEA and LCCA treated at the same way? And, to what extent the two methods can be implemented together, and what constitutes a correct integration?

As for RQ1, main distinctive elements and theoretical foundations are identified and outlined for TEA and LCCA, respectively. The reference to technological readiness levels (TRL), as an example, appeared as the most distinctive component of TEA. The LCCA, on the other hand, presents peculiarities in identifying alternatives and treating preference of time (discounting). Both methods present components of costs, profitability and uncertainty analysis.

As an answer to RQ2, what emerge is that, still treating some elements similarly, there are peculiar differences concerning, among others, the focus of the methods, their consideration of inflation, time preferences and technological performances. Finally, elaborating the information gathered through the revision of the literature, a proposal for a possible methodical combination of the tools sees the LCCA as an integrative piece of analysis for TEA. In this sense, a complete evaluation of the life-cycle cost might be implemented once the project has reached a certain degree of technological development, when a more advanced and precise consideration of the economic feasibility is required.

2. Research methodology and background information

The entire study was subdivided in three main phases. In a first phase, a preliminary literature review was performed to detect principal background information and current patterns of diffusion for TEA and LCCA. In this phase the following strings of search were used on Scopus database – the enquiry was executed on March 2020:

TITLE ("*Techno-Economic Assessment*" OR "*Techno-Economic Evaluation*" OR "*Techno-Economic Analysis*")

and,

TITLE ("*Life Cycle Cost*" OR "*Life Cycle Costing*").

Overall, the research produced almost five thousand results between 1969 and 2020. Respectively, 2213 denoted techno-economic studies, while 2744 were related to LCCA, see *Table 1***.** As for TEA some synonymous have been included in the research in order to generate a more accurate set of results, for LCCA it seemed more appropriate to include terms with lower specificity since the strong heterogeneity and poor clearness affecting the language in the field.

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Table 1: Results of the preliminary research on literature

Keywords	Results	Variation
TEA		
Techno-Economic Assessment	524	-
Techno-Economic Assessment OR Techno-Economic Evaluation	928	404
Techno-Economic Assessment OR Techno-Economic Evaluation OR Techno-Economic Analysis	2213	761
LCCA		
Life Cycle Cost	2290	-
Life Cycle Cost OR Life Cycle Costing	2744	454

Source: Scopus database (March 2020)

Referring to abovementioned set of results, the analysis of the temporal diffusion of the studies (see *Figure 1* suggests a renewed interest for TEA, against a flattening adoption of LCCA. The fact may suggest a better compliance of the first method with the necessities claimed by the technological industry, in which the production of innovation more than ever needs to deal with a higher level of complexity driven by economic aspects, but also technical, social and environmental. However, overlapping terminologies may also contribute to the polarisation of results and a poor classification of languages may hide a natural embedment of the LCCA in techno-economic analyses. It is not uncommon that peculiar techniques to LCCA are adopted without straight references to the general evaluation method. As a consequence, the correct classification of cases is potentially biased.

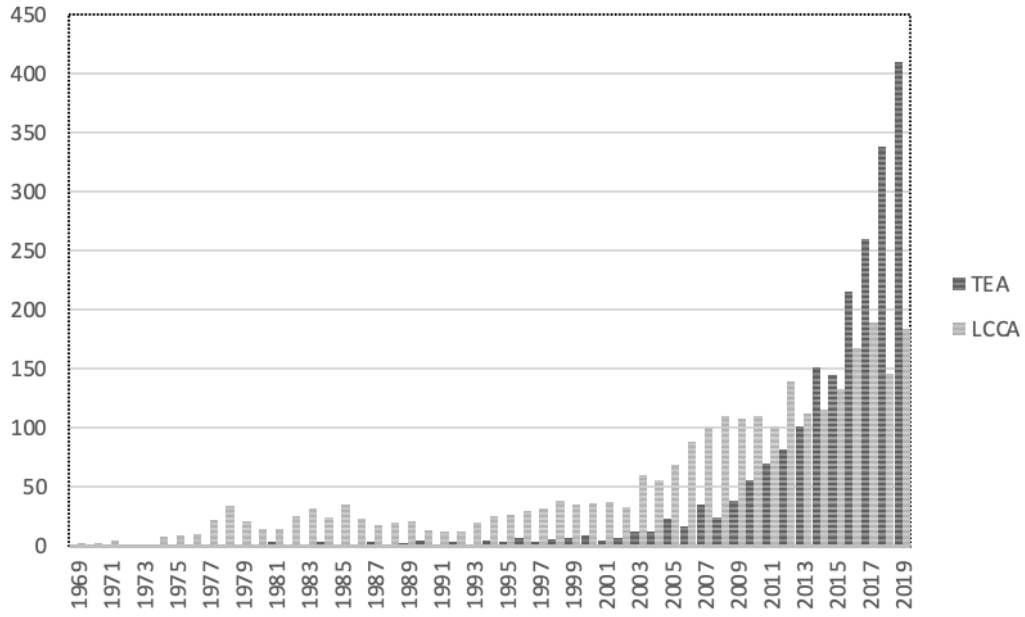

Figure 1: Publications per year on TEA and LCCA

Source: Scopus database (March 2020)

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In the second phase, the distinctive elements of TEA and LCCA were identified on the basis of the most recurrent theoretical concepts and methodological elements in the revised literature. It goes without saying that conducting an in-depth analysis for almost five thousand articles was not realistic. Therefore, reference has been made to limited set of articles. This further selection was conducted taking into consideration only those articles whose main focus was theoretical and / or methodological, and which presented particular interest for a methodological discussion. In addition, we also considered the inclusion of complementary sources (i.e. grey literature) to obtain a more accurate and complete reference base. Amongst the more relevant implementations: Fabrycky and Blanchard (1991), Van Dael et al. (2015), Zimmerman et al.(2018), Rajendran and Murthy (2019).

Finally, in the last phase of the research, the focus has turned to real case studies in order to verify the existence, completeness and appropriateness of those methodological elements outlined formerly. Base on a combination of our previous researches on Scopus, a new list of studies was retrieved. The research was performed accordingly to those publications which elements simultaneously belonged, entirely or partially, to both evaluation methods. The records were gathered using the following string:

> TITLE-ABS-KEY ((“*Techno-Economic Assessment*" OR "*Techno-Economic Evaluation*" OR "*Techno-Economic Analysis*") AND ("*Life Cycle Cost*" OR "*Life Cycle Costing*"))

From this, a preliminary list of 77 studies was obtained. Further, a primary analysis of the abstracts was carried out to exclude inappropriate studies and inaccessible sources. Since the research was strictly aimed at real case studies, articles concerning reviews, general discussion of the methods, analysis of specific elements – e.g. uncertainty – or delineation of supporting material – e.g. costs database – were, this time, excluded from the list. As a result, 25 papers out of 77 resulted coherent with the objective of the analysis. From this reference set, a categorisation and reorganisation of contents allowed to identify possible sources of misunderstanding, as well as similarities, differences and opportunities for integration.

3. TEA: methodological steps and distinctive elements

Literature lacks a pure theoretical discussion on the methodological setting for TEA, which appears weak and almost inexistent. Most of the information need to be gathered by specific industry reviews and exclusive studies on particular technological fields. This deficiency forces to derive the conceptual structure of the method mostly by sectorial specific guidelines which, however, results considerably oriented towards specific industrial specificities.

The inspection of selected references produced the categorisation of the six following methodological steps, from which the distinctive elements are derived:

i. Definition of technology readiness levels (TRL);
ii. identification of system elements and boundaries;
iii. study of economic feasibility, costs and market conditions;
iv. profitability analysis;
v. risk and uncertainty analysis through sensitivity and scenario forecasting;
vi. recommendations.

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Technology readiness assessment and TRL.

Generally, a project is completed because of subsequent successful technical improvements through its entire development. For this reason, the maturity and/or capability of a technology need to be constantly tested. According with Mankins (2009), the moments in which this verification happens take the name of technology readiness assessments (TRAs). Through TRAs, other than defining the technology readiness level (TRL) it is also possible to provide reliable evaluations on riskiness of project progress.

As for techno-economic assessment, the readiness level of a project influences not only assumptions, quality and availability of data, but also and foremost the decisions of metric and consequently results and interpretability (Zimmerman et al., 2018). It follows that determining TRL is a fundamental and distinctive element in the iterative process of TEA and its analysis needs to be performed in the very first step of the evaluation procedure. Further, its constant review and adjustment should accompany the entire project. Recently, technology readiness levels have been proposed as a backbone of TEA by Buchner et al. (2018). Based on TRLs, in fact, the authors were able to sort several cost estimation methods, profitability indicators and approaches to the market analysis for each level.
However, an appropriate analysis of TRLs is not straightforward since multiple elements and heterogeneous "sub-technologies" may define the overall project, requiring lot of effort to properly assess the components individually. Enhancing comparability among different studies may ease and expedite such an assessment.

Below, *Table 2* recollects the specific definitions for each development stage, accordingly with each technology readiness level.

Table 2: Technology readiness level scale

Level	*Development phase*	*Definition*
TRL 1	Research	Observation of basic principles.
TRL 2	Research	Conceptual formulation of the technology.
TRL 3	Research	Concepts are proved experimentally.
TRL 4	Development	Laboratory validation of the technology.
TRL 5	Development	Validation of the technology in relevant environment (industrially relevant environment in the case of key enabling technologies).
TRL 6	Development	Demonstration of the technology in relevant environment (industrially relevant environment in the case of key enabling technologies).
TRL 7	Deployment	Prototype demonstration in operational environment.
TRL 8	Deployment	System complete and qualified.
TRL 9	Deployment	Prove of the actual system in operational environment (competitive manufacturing in the case of key enabling technologies).

Source: Horizon 2020, General Annex-G

System elements and boundaries.

In life-cycle assessment (LCA) the product system identifies the 'collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product' (ISO 14040:2006). Each activity in the system, be it a unit process, operation or equipment, is a system element

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(Zimmerman et al., 2018) and it is coherently defined within the system boundaries. Identifying system elements and system boundaries is of primary importance for TEA. In fact, their description is a fundamental operation when input and output flows are determined, as well as in analysing interconnections among elements and phases of the project's development. Overall, this analysis takes the name of product system analysis.

System boundaries are essential to delineate the processes and operations to be taken into account when analysing the product system. Also, they are useful to revise what is included in the analysis and, at the same time, give consistent elements for a transparent comparison with benchmark systems and other TEA studies (Zimmerman et al., 2018). It is important to consider that, not only the definition of boundaries requires large amount of data, time and economic resources (Reap et al., 2008), but it is also sensible to subjective considerations that makes necessary a transparent communication of assumptions and defining criteria (Jensen et al., 1998). Amongst the most diffused settings are the gate-to-gate, cradle-to-gate and cradle-to-grave. These respectively indicate the inclusion or not of the several lifecycle stage of a project. From the narrower (Gate-to-Gate), which mainly focuses on specific modules of the project's development, to the broader Cradle-to-Grave where all stages of the lifecycle of a project are addressed, from the extraction of materials to the disposal/recycling time (Torabi & Ahmadi, 2020). It is worth noting that setting broad enough boundaries – e.g. cradle to grave – may provide a contact between TEA and LCCA, since it can associate them to a common lifespan of interest.

Similarly, also the process flow diagram (PFD) is common for TEA. Its implementation gives a graphical representation of the objects under analysis but, other than exploring elements and connections, it can also include mass and energy balance of a process (Van Dael et al., 2013, 2015). This additional characteristic allows a direct estimation of expenses, such as operational costs (Buchner et al., 2018) and, at the same time provide with a more inclusive representation of the true performances of the project. However, with respect to the more general product system analysis, the PFD requires more sophisticated computations, higher efforts and specific competences of analysts. To note that, in some cases (Michailos et al., 2018; Zimmermann et al., 2019), the product system analysis may acquire the nature of a preliminary step in the PFD definition, but also that the first iterations of PFD may present just a block scheme structure (Van Dael et al., 2015), similarly to a product system. On this basis, it is reasonable to think about the PFD as a sort of ultimate and most detailed characterisation of a product system analysis.

Cost analysis and market conditions

Together with technical viability, determining economic feasibility is the other main purpose of TEA. However, determining if the project is worth the investment (profitability analysis) requires a previous evaluation and examination of costs and conditions which may affect the accomplishment of the project's objective.

The evaluation of the economic conditions in a techno-economic study starts from costs and market conditions. These are strongly interconnected elements which have a mutual effect in perfectionating and determining each other (Buchner et al., 2018). On the one hand, evaluating market conditions supports the understanding and proper identification of expenditures; on the other hand, the cost breakdown may reveal new market sensibilities and drive future iterations of market analysis. However, for both analyses different approaches exist. As a matter of fact, the evaluation of expenses is approached with several different estimation tools and practices, while the market analysis can show up at different stages of the evaluation process and be motivated by different purposes. As exposed in Buchner et al. (2018), TRLs may provide a reasonable guide to clarify how and when these two essential analyses should be implemented.

Following, the theme of market analysis and cost estimation are treated separately.

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Market analysis

Market analysis is sometimes proposed as the very first step in the techno-economic assessment (Kantor et al., 2010; Van Dael et al., 2015). In these cases, the analysis looks for competitors, customer preferences, size, trends and needs of the market, as well as preliminary information about costs, revenues and critical success factors. However, the best approach to market analysis needs to consider the overall level of advancement of the project. If implemented too early or too late, with respect to its best placement, the analysis may be inconsistent with data. In other words, the market analysis may result in excessive, or insufficient information and cause an inefficient allocation of resources. As previously anticipated, relying on TRL may drive practitioners during the market analysis. The design, the level of detail and the point in time at which the market evaluation take place can all rely on the grade of technological development in order to respect the most efficient arrangement. However, until a clear TRL-based scale is developed, practitioners will mostly rely on personal knowledges and specific characteristics of the case. Table 3 summarises, in relation with cost estimation, the most appropriate phase to perform market analysis and the main constitutive elements.

Table 3: An introductory TRL-based framework for market analysis in TEA

TRL levels		Phase	Elements
TRL (*Research*)	1-3	Before cost estimation	Need of the market, comparison with alternatives and benchmarks
TRL (*Development*)	4-6	Parallel to cost estimation	Sales prices and volumes, market size, customer preferences
TRL (*Deployment*)	7-9	Individual analysis	Trends, entry strategies, SWOT analysis, Volume chain analysis

Source: excerpted from Buchner et al. (2018)

In early stages what should be investigated are the main opportunities and space for the technology, together with a first identification of alternatives and benchmarks. In this case the market analysis should precede the cost estimation and support a preliminary analysis of expenses. Following, as the TRL advances more specific examinations should consider aspects such as: prices, volumes, and customer preferences but, differently from before, the market and cost analysis would work synergistically and being performed in parallel. Finally, the market analysis may assume an individualistic profile and address more specifically the entrance in the market.

Cost estimation

On the other edge of the economic evaluation, cost estimation is central for TEA. In its broader meaning, it aims to quantify total costs on the basis of operational (OpEx) and capital (CapEx) expenditures. Usually, the first refer to recurring costs that necessarily emerge for the maintenance and operativity of a project, while in the latter all costs that protract their effects through time, such as designing, constructing or commissioning expenses converge and define the aggregate. As for capital and operational expenses, both can be broken down into their constitutive elements, providing additional information for further analysis on profitability. Moreover, their combination can provide informative aggregates such as: cost of good manufactured (COGM) and cost of goods sold (COGS). While COGM and COGS are essential figures in cost management and accounting procedures, they are limited in projects with a strong productive nature. On the other hand, the life-cycle cost (LCC) is a more common figure

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but, rather than a mere aggregate, it should be intended as the result of the LCCA. This distinction is particularly relevant since it is during the cost evaluation step that most of the misperceptions around LCCA and TEA emerge, producing misleading implementations of the first method and an ambiguous adoption of terminology. It is straightforward that, conformably with the development stage of the project and quality of information, several approaches can be adopted to evaluate costs, each with different levels of complexity and reliability. According with the Cost Estimate Classification System by the Association for the Advancement of Cost Engineering (AACE International), five types of costs estimates can be defined, each differing in aspects such as the maturity level of the project, the purpose of the estimate or the accuracy. The five classes of estimates are summarised in *Table 4* Also, we propose a hypothetical correspondence with technology readiness levels.

Table 4: Cost estimate classification and characteristic

Type of estimate	Maturity level of the project (% of complete definition)	TRL	Purpose of the estimate	Accuracy
Order of magnitude estimate (ratio estimate)	0% to 2%	1 to 3	Concept screening	L: -20% to -50% H: +30% to +100%
Study estimate (factored estimate)	1% to 15%	3 to 5	Study or feasibility	L: -15% to -30% H: +20% to +50%
Preliminary estimate	10% to 40%	4 to 7	Budget authorization, or control	L: -10% to -20% H: +10% to +30%
Definitive estimate (project control estimate)	30% to 70%	7 to 8	Control	L: -5% to -15% H: +5% to +20%
Detailed estimate (contractor's final cost estimate)	50% to 100%	8 to 9	Check estimate	L: -3% to -10% H: +3% to +15%

Source: excerpt from Christensen and Dysert (2005) and Coker (2007)

Obviously, "cost estimation" belongs to the overall discipline of economic evaluation and a multitude of tools and approaches have been developed to break and estimate expenses. Due to this variability, every case needs specific considerations in order to identify the solution which best fits with the purpose of the evaluation. Even if developed for the chemical industry, a good exposition of relevant cost estimation tools is provided by Coker (2007).

In conclusion, it is worth noting that, still recognizing the fundamental importance of the assessment of costs, it should not be performed at the expense of other elements of the entire analysis. In other words, who perform the techno-economic assessment needs to balance all the necessary elements and do not concentrate the majority of resources to evaluate the expenses, while leaving poor, or insufficient considerations to other parts of the analysis, such as market or profitability analysis.

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Profitability evaluation

Consequence of gathering and examining costs and market conditions, is the profitability analysis. Profitability analysis looks for monetary gains (or losses) and usually compares them with alternatives and/or thresholds. Overall, it guides decisions about the allocation of resources and the definition of investments (Buchner et al., 2018). Also, it offers a significant qualitative view about the economic performances of the project, adding insights on the project's development.

Generally, the profitability of a project is judged comparing earnings and costs, but this information rarely gives enough evidence for a conscious decision and additional metrics are needed. However, identifying and deciding about profitability indicators is challenging due to lack of standardization; further, the wide range of possibilities makes proper decisions harder. Practitioners mostly need to decide without clear instructions, leaving space to biases due to subjective comprehensions and personal preferences. Again, Buchner et al., (2018) gives interesting directives to decide the best profitability indicators according with the advancement of the project. These are summarised in *Table 5* below.

Table 5: Profitability indicators and TRL

TRL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Profitability indicator	Qualitative evaluation — e.g. comparison with benchmarks)	Relative gross profit	Relative profit	Static profit	Net Present Value (NPV)	Inclusion of interest rates for different cost items.	Economic simulations	Actual data for Cap Ex	Deeper economic simulations
			Specific profit	Static payback time	Dynamic return on investment (ROI)	Specifications on how CapEx is financed.			Past economic activities are summarized in accounting for cost checks and profit calculations
				Static return on investment (ROI)	Internal rate of return (IRR)				

Source: excerpt from Buchner et al., (2018)

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Uncertainty: sensitivity and scenario analysis

Every evaluation developed on assumptions and estimates inevitably produces uncertainty in results. For TEA, uncertainty is mainly caused by errors in input data, uncertainties in the model itself, and the characteristics of the context in which the analysis is performed (Zimmerman et al., 2018). The inspection of uncertainty represents the last methodological steps of a techno-economic analysis.

The necessity for uncertainty analysis is due to the fact that that decision makers need to be informed on the reliability of positive results, as well as on which technical and economic parameters have the potential to influence most the profitability of a project (Kuppens et al., 2015). Accordingly, there are two main tools usually embraced to deal with TEA's uncertainty: sensitivity analysis (SA) and scenario analysis. SA identifies the portion of uncertainty in the output caused by different model input factors (Helton et al., 2006; Saltelli et al., 2010). Further, the SA can take the form of a "local" or "global" analysis (Haaker & Verheijen, 2004). The first considers 'how much of the output is changed by a small variation of the random input around a reference point', while the latter 'measures the contribution of an individual random input to the output within the entire range space of the input' (Tang et al., 2015). In other words, while the local SA looks how outputs are influenced by singular variations of inputs, a global SA considers multiple and simultaneous variants. Scenario analysis, on the other hand, does not specifically address the uncertainty of parameters, but rather considers contextual variations and possible future events that may affect results. It is usual to set three possibilities for the uncertain variables: a pessimistic, a most excepted and an optimistic scenario. According to Van Dael et al. (2015), through scenario analysis it is possible to deduct information about maximal economic loss, but also about the expected value of benefits, in case probabilities of occurrence can be determined

In the following section the same approach of analysis is adopted to go more in deep into the distinctive elements of the LCCA. By adopting the same approach confrontation results easier. Furthermore, it consents to critically revise differences and similarities on the basis of a more unbiased standpoint.

4. LCCA: methodological steps and distinctive elements

As already noted, the LCCA is an older evaluation method than TEA. Practitioners can count on more reliable references, identifiable in specific guidelines and sectorial standards and also benefit from a harmonisation with the well-defined LCA framework (ISO 14040:2006). However, differently from the LCA, and at the same way of TEA, the LCCA have not achieved any complete standard and the proposed guidelines still fail to define a universal and flexible framework, able to clearly state the distinctive elements of the tool, their characteristics of application and a clear procedural approach.

Source of this misalignment between theoretical conception and practical approach is due to the fact that, instead of defining a complete hypothetical structure, the method has been diffused and implemented through years to address specific industrial issues (Sherif & Kolarik, 1981), leaving individualities of cases, subjective considerations and sectorial characteristics guiding the adoption of the LCCA. European practitioners, in the specific, can count on several industrial-specific national and international regulations, such as the Norwegian standard NS 3454, the UK procurement guide 07 or the ISO 15686-5: 2017 for the building industry, while the ISO 15663:2000 is a reliable reference for the petroleum and natural gas business. Langdon (2007) can be consulted for a deeper view on some relevant LCCA guidelines. However, out of these sectors LCCA mostly rely on subjective analyses and variations.

It is straightforward that systematising the method, independently from the sector, may ease adoption and diffusion, facilitating also a reliable comparison of studies. However, also standardization needs to deal with some issues and controversy. On the one hand, the absence of a universal recognition by the industry represents one of

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the main barriers for reliable and consistent data (El Haram et al., 2002). On the other hand, homogenising specific cost figures is unlikely to match with individual cost systems and may result to negatively affect the overall methodology (Hunkeler et al., 2008). For these reasons, the homogenisation process should focus on defining the methodological structure of the method, allowing for a sufficient level of adaptability in those aspects which cannot be standardised but that still can be regulated by some criteria – e.g. selecting cost breakdown structure.

All this considered, only if a transparent and coherent methodological framework is in place the method can progress and become adaptable. A balanced homogenisation should not prevent the effectiveness of LCCA applications, rather it would guide LCC-users in the correct combination and/or selection of critical features according to their needs. Ultimately, a clearer identification and estimation of methodological components of LCCA represents a way to improve interpretability and comparability of studies.

Following the elements of the LCCA are explored based on two main groups of references: theoretical studies and "standards & guides". Particular attention has been given to certain methodological frameworks (Fabrycky & Blanchard, 1991; Woodward, 1997), for which insights and practical steps are summarised in TABLE X, and the "Life-cycle costing Manual" for energy projects by Fuller and Petersen (1996).

Table 6: Summary of Fabrycky-Blanchard and Woodward methodological proposals

Fabrycky and Blanchard (1991)	**Woodward (1997)**
Insights	
~ Importance of alternatives	~ Optimization and minimum life cycle cost
~ Cost break down and categorization	~ Discounting and inflation
Practical steps	
1. Definition of the problem	1. Establishment of operation profiles
2. Identification of feasible alternatives	2. Establishment of utilization factors
3. Development of CBS structure	3. Identification of cost elements or area of costs
4. Selection of a Cost model for analysis	4. Definition of cost parameters
5. Development of cost estimates and cost profiles	5. Calculation of costs at current prices
6. Accomplishment of break-even-analysis	6. Escalation of current costs
7. Identification of high cost contributors	7. Discounting costs to the base period
8. Accomplishment of sensitivity analysis	8. Sum-up discounted costs
9. Accomplishment of risk analysis	
10. Recommendation of a preferred approach	

Source: excerpt from (Fabrycky & Blanchard, 1991; Woodward, 1997),

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Coherently with other studies in literature (Cole & Sterner, 2000; Fisher, 1970), the following methodological steps are identified for LCCA:

i. Definition of object, problems and alternatives;
ii. analysis of costs (cost breakdown, selection of cost modelling and estimation);
iii. economic evaluation and discounting future cash flows;
iv. considering risk and uncertainty
v. comparing alternatives.

Object, problems and alternatives

In its very first stages, LCCA needs to clearly identify the objects and problems which wants to address. While the detection of problems is directly attributable to purposes of the study and answers to the question "Why the study?", the objects definition refers to the physical entity of the analysis addressing the problem of "What is studied?". In this phase, all relevant information and assumptions have to be outlined, together with a well-defined identification of the boundaries-system and objectives. The identification of boundaries-system may follow the same considerations already moved for TEA that will not be repeated. We stress again the relevance that boundaries system may have as a connective force for the two methods under analysis. Following, the discussion about the objectives.

Fundamental in this early stage of the process evaluation is clearly state the aims of the LCCA. The LCC Manual by Fuller and Petersen (1996) provides a list of possible reasons that may motivate a study of life cycle costing:

- Acceptance or rejection of single projects or system option,
- selection of optimal solutions among alternatives, and
- ranking of different projects

It is straightforward the relevance of alternatives. Most of the times, LCCA is used to identify the most cost-efficient option among a series of alternatives and/or design solutions. According to the international standard for buildings and constructed assets, in fact, the LCCA 'allows consistent comparison to be performed between alternatives with different cash flows and different time frames' (ISO 15686-5:2017).

It follows that the identification of alternatives is a distinctive element of the LCCA, which become essential in the design stages, when the LCCA planning is performed (Hunkeler et al., 2008). Feasible alternatives need to be decided on the basis of technical features with potential economic consequences (Fuller & Petersen, 1996). Identifying technically sound and practical alternatives need to be consistent with both techno-economic constraints and the objects of the analysis. A detailed analysis of technical performances may take a cue from TEA, even if the same level of detail is no required.

Cost analysis

Once the LCCA is profiled, estimating and categorising costs follows. In its nature, the life-cycle cost analysis looks at expenses with a broader-than-usual perspective by considering all relevant life-cycle stages of a project. In this way a more realistic representation of the economic state is possible. However, practitioners still seem hesitant to accurately include very early/late phases of the lifecycle, such as R&D and disposal phases in their analyses.

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Evidently, as it is the case for TEA, a costs breakdown is necessary to detect the nature and consistency of the expenses involved in the project. Since the dependency on specific needs of practitioners, as well as characteristics of the operational environment, the structures proposed in literature vary in their perspective and spotlights. It follows that costs may be classified in accordance with the distinctive stages of a project, as in the case of some wind farm evaluations (Mytilinou et al., 2018; Shafiee et al., 2015), but also with the typology, manifestation in time and rate of recurrence (Fuller & Petersen, 1996). Similarly, the theoretical frameworks by Fabrycky & Blanchard, (1991) recommended a cost classification linked with the specific life-cycle stage, while in Woodward (1997), it is the nature of the expenses to drive their definition.

Finally, an interesting "five-levels" breakdown structure comes for the British Standard 5760: part 23:1997 on the reliability of systems, equipment and components. The framework has the peculiarity to propose a cost categorisation which evolves with the development of the project or product. In this framework each consecutive phase enhance the details and broaden the typologies of costs considered (El Haram et al., 2002). Starting by detecting a limited set of cost categories which can be allocated to the overall project, the costs are further grouped with regard to the life cycle phase, cost category, elements, tasks (or activities) and specific resources expenses, deepening the analysis and including increasing groups of costs.

Time discounting

Discounting is a pivotal distinctive element for LCCA, and its proper adoption is crucial for consistent results. As pointed out by Woodward (1997), poorly projecting costs may introduce inaccuracy in calculations. Furthermore, process of discounting back at a base period provides a common base for comparison of alternatives, while concurrently reflect the implications of time.

In practice, all influences of time are condensed into a specific parameter, the discount rate. However, its definition is challenging, and lot of theoretical discussion exist proposing multiple discount functions and approaches – e.g. hyperbolic discount function, null discount rate and decreasing discount function). While it is not the purpose of this research to investigate their theoretical backgrounds, for our purposes we deemed important to distinguish between real and nominal discount rates. Real discount rates are netted out of inflation and are used with constant-currency amounts; on the other hand, nominal discount rates include general inflation and are used with current-currency amounts (Fuller & Petersen, 1996). To note that, if nominal rates are used inflation should still be treated separately since lacking to consider variation in costs may importantly affect results.

Typically, discount rates range from 5 to 20 percent for private and corporate investments, whilst for the public sector rates may be lowered up to 2 per cent (Hunkeler et al., 2008; Zizlavsky, 2014). However, setting the correct rate is challenging and, even if some specific national legislations and sectorial recommendations exist, lot is left to personal judgments of those who operate the study.

Economic evaluation

As a result of the discounting process, the net present value (NPV), also referred to as net present cost or sometimes life-cycle cost (LCC), aggregates all future discounted cash flows into a unique figure and representatively indicates the economic performances of a project. It is computed as:

$$\text{Net Present Value (NPV)} = \frac{\sum_{t=0}^{T}(C_t - B_t)}{(1+d)^t} = \frac{\sum_{t=0}^{T}(NCF)}{(1+d)^t}$$

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where, T = total life cycle in years, t = time (year), C = future negative cash flows (future costs), B = future positive cash flows (future benefits), d = discount rate and NCF = net cash flow.

However, the NPV is not the only evaluation criteria used in the LCCA. In fact, while providing a preliminary view of the excepted economic performances of the project under analysis, it is also the base to determine other explicative measures, such as: the internal rate of return (IRR), net savings (NS), savings to investment ratio (SIR) and discounted payback period (DPP). Although, it is not aim of this research to enter the analysis of such measurements, explanations and adoption procedures can be found in the studies by Fuller and Peterson (1996) and Langdon (2007).

Uncertainty and risk analysis

As it is the case of TEA, LCCA need to address the uncertainty issue. As a reminder, uncertainty analysis explicates the overall alteration of results caused by statistical uncertainty of probabilistic events and the future state of the world. General observations previously moved for TEA are still valid. Uncertainty analysis is a major and necessary concern that allows for a correct interpretation of results, as well as highlighting the most influencing parameters and their relationships with results. As for LCCA, the most common sources of uncertainty are identifiable in: errors in estimations, technological advancement, fluctuations in price levels and inflation, differences between expected and actual performances and changes in operational assumptions (Woodward, 1997).

In LCCA literature deterministic and non-deterministic, or probabilistic, approaches for analysing uncertainty are common. The deterministic approach – e.g. local sensitivity– represents the easiest way to measure the effects of changes in one, or multiple key values. Input parameters are introduced as discrete values and no probability distributions are present. On the other hand, non-deterministic methods – e.g. global sensitivity – consider probabilistic distributions of events to determine weighted averages, expected values and other statistical indicators, as well as allowing all significant input parameters to change simultaneously (Diependaele, 2018). Still representing a more explicative and complete approach, probabilistic inferences require more sophisticated analyses, as well as broader quantity of data and resources, in terms of time, money and expertise (Fuller & Petersen, 1996). Due to this, the majority of cases adopts non-deterministic methods that, however, result more mutable to subjective considerations. Probabilistic approaches are not deeply investigated here, while some attention is given to the deterministic methods of sensitivity and breakeven analysis.

Sensitivity analysis (SA) and breakeven analysis (BEA) are amongst the most common methods used by practitioners to approach uncertainty in LCCA. The "LCC Manual" provides a good explanatory practical guide for both these tools. At the same way of TEA, the sensitivity analysis is used to investigate how changes in key assumptions or parameters – e.g. prices – alter the performances of the project. Input values are moved around a reference number making clear the changes in results. Major influencing parameters can be ranked and further analysed through scenario analysis (Diependaele, 2018), which would also help to define a possible range of values among sensible indicators, usually upper, medium and lower bound. However, differently from TEA, which seems to adopt a broader approach addressing contextual factors such as institutional frameworks, subsidies, etc., sensitivity analysis in LCCA generally focus on cost-related parameters.

Break-even analysis (BEA), on the other hand, emphasises the maximum or minimum value of a crucial factor for maintaining the break-even (Fuller & Petersen, 1996). In this case the assessment is determined by solving a simple equation: operational savings and additional investment related costs are equalized, and all but breakeven variables are specified.

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$$\text{Operational Savings} = \text{Additional investment related costs}$$

$$S = \Delta C$$

Deterministic methods are valid approaches for uncertainty analysis; however, as much as the maturity of the project is advanced, some limitations may affect their efficiency. In fact, at least three shortcomings can be identified with regard to deterministic analyses (Langdon, 2007): firstly, the impossibility to identify the best alternative when the ranking is affected by changes in model variables; secondly, local sensitivity approaches may reduce the interpretability of combined and simultaneous influences on final results; finally, probability distribution or likelihood of outcomes are not considered making the reliability of results impossible to evaluate. Non-deterministic methods may partially overcome these issues.

5. Towards an integrative approach

Whilst the techno-economic assessment and the lifecycle cost analysis share the same reason of existence: providing a more inclusive and reliable evaluation method for a better allocation of resources, their approach and objective is somewhat different. Recalling what previous, TEA aims to simultaneously consider economic and technical performances of a project so that sensible elements can be detected, and adjustments taken. On the other hand, the main intention of the LCCA is to appraise the best among different solutions based on costs considerations. However, several studies rely on a simultaneous adoption of such tools but without the possibility to rely on any sort of regulation. For this reason, it seems appropriate to investigate and discuss on which elements and aspects TEA and LCCA converge or diverge, in order to give a basis for objectively evaluate a potential integrative and methodical approach.

Following, *Table 7* offers, in a compact form, the main points of convergency/divergency between the two evaluation methods. Such a distinction is based on the main concepts analysed through the text; however, still recognising the potential validity of such theoretical assumptions, in practice clear distinctions is missed.

Table 7: *Convergencies and divergencies between TEA and LCCA*

Elements	*Convergency*	*Divergency*	*Description*
Uncertainty	●		Similar process. Distinctive of TEA is the scenario analysis, while breakeven analysis for LCCA.
Boundaries	●		Same definitional approach. LCCA may be adopted to expand the perspective into a more appropriate cradle-to-grave.
Cost analysis	●		In TEA may be sufficient to generally identified CapEx and OpEx. LCCA provide a more detailed analysis of these costs.
Market analysis	●		Should be explicit in TEA. Not specifically required for LCCA. But could be consider implicit.
Profitability analysis	●		Same approach to the determination of economic feasibility but different metrics.
Benchmarks and alternatives		●	While TEA mainly rely and identify particular technological benchmarks, LCCA main reference is given by alternatives.

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Focus	•	TEA strongly focus on the relationships between techno and economic performance. LCCA is mostly used in for evaluating and ranking alternatives.
Inflation	•	In the computation of costs for LCCA. Analysed through scenario analysis in TEA.
Technological aspect	•	Present in TEA only.
Time	•	Forecasting (TEA) and actualization process (LCCA).
TRL	•	Not present in LCCA, essential for TEA.

Source: own elaboration

Main theoretical divergencies concerning TEA and LCCA are identified in the adoption of technology readiness assessments for the analysis of TRL, the different attention to time and inflationary effects. Also, the adoption of benchmarks, for TEA, and alternatives, for LCCA, is a characteristic which distinguish the methods in the way they recognise the results. As for TRL, we already had the chance to note its significance for techno-economic analysis due to the opportunity it offers in guiding decisions about several characteristics of the assessment. Same importance is not acquired by TRL for the analysis of the life cycle costing. Next, regarding the approach to time it could be stated that, while TEA ought to be more concerned about forecasting of exogenous events – e.g. scenario –, LCCA is be more committed to an actualization process. In other words, while TEA usually projects the future, LCCA brings it back to a current meaning. Finally, inflation is apparently addressed in different ways by the two methods, in fact, while in LCCA it should be integrated during the computation of costs, in TEA the volatility of prices is mostly addressed through scenario analysis.

With respect to the points of convergency, most are identified in the economic analysis expected by the methodological frameworks and the setting of the boundaries system. The latter aspect is mostly treated at the same way, with referment to communal, standard, definition – e.g. cradle-to-gate –, while the economic analysis usually follows similar methods even though different metrics may be involved. Similar considerations hold for profitability analysis as well.

Such a synchronicity existence of converging and diverging points between TEA and LCCA leaves space, and gives reason, to the opportunity to enhance their simultaneous adoption by investigating a methodical integrative framework.

5.1 Thoughts for an integrative approach: reasons and possible pathways

Many times, the distinctive elements of the LCCA are adopted by analysts in their techno-economic assessments. However, in most cases, the LCCA is denatured, and its elements are reduced to a discounting process which originates net present value metrics. As a consequence, important features, such as the identification of alternatives or the inclusion of inflationary costs are usually left out of the study. This inadequacy originates from lack of clear standards for both sides, as well as the total absence of any systematic procedure to implement LCCA into TEA. For this reason, if the aim is to integrate TEA and LCCA for an all-inclusive analysis, then a methodical process needs to be developed. Only in this way, the peculiarities of both evaluation methods may be exploited and unified in a more detailed and reliable examination. In order to select the most cost-efficient solution, TEA is already arranged to incorporate investment and performance assessment (Kantor et al., 2010);

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however, this cannot be at the expenses of the completeness of the analyses. This conclusive section by no means wants to give an absolute procedure for integrating the two methods under analysis, but just some insights on a potential approach.

In general, while TEA can be mainly used to identify potential hotspots and technical weaknesses, LCCA may furnish a detailed examination of the economic conditions. In such a way, the relationships between economic and technical performances may result clearer than it is the case of individual adoption of these tools. Also, as already mentioned, LCCA can be implemented to extend the perspective of a TEA. Finally, LCCA may represent for TEA a way to include different viewpoints of some distinctive elements in the analysis, such as uncertainty and time dependency, or systematically address profitability with a specific tool.

First of all, until the technology is validated in a relevant environment (around TRL 5), it is not reasonable to supplement the techno-economic analysis with a LCCA. In the early phases of development, actually, the quality and quantity of data is subject to relevant variability and uncertainty. As proposed by Buchner et al. (2018), until the project is in its mid-phase, qualitative considerations should prevail. It follows that only from an advanced phase more accurate quantitative measures, such as the one adopted through the LCCA ought to enter the analysis. Moreover, as pointed out in the TEA Guidelines for CO2 Utilization (Zimmerman et al., 2018), LCCA may result helpful when extending the boundaries of the analysis. In light of this, however, the practice shows a difficulty to properly assess all costs occurring throughout the entire lifecycle of project, especially when these are far distant in time or do not have the characteristics for a direct economic evaluation.

Much more interesting are the considerations about inflation, time and uncertainty. A through consideration of these elements would provide significant improvements in term of both interpretability and completeness when integrating TEA with LCCA. Recalling what previously, inflation is usually treated through scenario analysis in TEA in order to identify possible influences of price volatility on the project's feasibility, especially on the edge of capital expenditure. However, when LCCA practices are implemented inflation enters the actualisation process and escalate the current expenses (Woodward, 1997). In this way, costs are weighted for inflation and more accurate considerations may arise. Finally, LCCA may introduce in the evaluation more details to understand how inputs and outputs interact to each other. Hence, one of the main features of TEA may be enhanced, as well as the overall uncertainty level reduced. Throughout a cost-oriented sensitivity analysis and break-even analysis, it is possible to highpoint which costs mostly influence the economic viability of the project, usually the NPV. Differently from TEA, which also include technical variables but may lack of some economic considerations, under LCCA uncertainty is deeply investigated in its economic dimension. It follows that, in an integrative approach, other than understanding which technical and economic factors generally affect the performances of the project, the financial feasibility is deeply investigated. This process may also open to the possibility of further examine which technological factors influence the driving costs of feasibility in order to guide even further improvements.

Summarising, techno-economic and life cycle-costing analyses should be kept separate until the project's development reach certain level of development. Then, once more quantitative data are available, LCCA may join TEA supporting the enlargement of boundaries and the inclusion of more explicative variables in the explanation of the economic feasibility of the project. In mid-development phases, LCCA may represent an adequate solution to investigate alternatives of design and NPV. Furthermore, as we mentioned earlier, new aspects of uncertainty may be recognised thanks to the wider range of variables considered. Finally, the LCCA may be enriched itself by TEA, since costs may be also associated to their technical drivers.

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6. Conclusions and recommendations

It is undoubted that the techno-economic assessment (TEA) and the life-cycle costing analysis (LCCA) offer valuable insights when evaluating the economic feasibility of technological projects, by also allowing the identification of sensible parameters and connections between inputs and outputs. However, present methodological approaches and standards lack of clear and harmonised frameworks for their implementation. Furthermore, often their structural elements overlap, causing partial examinations and potentially biasing the results and the recommendations.

The purpose of this study was to contribute to a critical and comprehensive explanation of the two appraisal methods with a first consistent attempt to reveal their possible integrability. Overall, we tried to give to practitioners and academia new elements to appraise present literature and structuring new studies. From this, two main contributions resulted from the research:

- The identification and analysis of distinctive elements in the techno-economic and life-cycle costing evaluation procedures; and
- The proactive position towards a potential integrative framework.

The first originated from a deep analysis of different schemes and methodological concepts proposed by literature. It occurred that under a methodological point of view, the methods involve similar procedural steps, such as: boundaries set, cost evaluation, uncertainty and profitability analysis. However, the way they approach these same components may vary in the procedures and details. On the other hand, distinguishing points have been detected in the way they approach time and inflationary effects, technological elements and references for comparisons. While TEA may deeply rely on the level of technological development to define its structure and usually project the future by usually relying on the use of scenario analysis, LCCA does not consider technology and generally brings future to a current meaning with the actualisation of cash flows. To note that also TEA may contemplate net present values to assess the economic feasibility, even though this should happen only in mid-phases of development. Furthermore, LCCA guides the decisions relying on a comparison with alternatives, while TEA identifies benchmarks and weights results on the basis of technical considerations.

However, due to the poor theoretical discussion and wide heterogeneity affecting guidelines and standards, while in theory the methods are differentiable, in practice the distinctive elements of the one and the other may be overlapped. Most of the times this happens with TEA that, trying to broaden its perspective and perfectionate its economic considerations, includes in the analysis features of the LCCA, but without a complete and coherent implementation. From this, the second contribution of this work. It resulted that a positive integration is desirable and may enhance the results of techno-economic analyses, allowing to include more explicative metrics and a larger set of boundaries. In general, a complete and coherent integration may strengthen the connection between the economic and technical aspects of technological advancement, keeping the consistency with the theoretical foundations of the methods. To stress out the fact that, by including only partial elements of one or the other method, may bring to a loss of informative data and define wrong, or less-efficient, pathways of development.

To conclude, the main limitations of this research mainly derive from the strong heterogeneity affecting both practice and theoretical discussion, which make it difficult to state comprehensively the nature of TEA and LCCA. Furthermore, the impossibility to test our propositional concepts of integrability leave the overall discussion on a theoretical approach, which still needs to be proven in actual fact. Still, the hope is that this study

will contribute to the development of clearer set of rules which would provide higher level of comparability among studies, as well as a more reliable utilization of TEA and LCCA. Through this research we wanted to highlight a problem which, at present time, is not properly discussed but that may significantly influence the reliability of the evaluations based on TEA and LCCA. While acknowledging the preliminary nature of this work, still it provides an innovative approach to investigate the TEA and LCCA, both as individual entities and integrable tools. Also, we are optimist that the initial proposition about an integrative method may act as a starting point for a future, and deeper investigations of the subject.

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Lorenzo GIACOMELLA is going to take its Master's Degree in Economics, Management and Policies for Global Challenges, curriculum Green Economy and Sustainability, from the University of Ferrara and holds a Bachelor' s Degree in International Economy and International Markets from the University of Trieste. His current interests range in the fields of Sustainability and theoretical economics.
ORCID ID: https://orcid.org/0000-0001-8537-7269

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METHODOLOGY OF ANALYSIS OF THE INFLUENCE OF THE ECONOMIC POLICY OF THE STATE ON THE ENVIRONMENT*

Natalya Andryeyeva [1], Oksana Nikishyna [2], Borys Burkynskyi [3], Nina Khumarova [4], Oleksandr Laiko [5], Hanna Tiutiunnyk [6]

[1,2,3,4,5,6] *Institute of Market Problems and Economic&Ecological Research NAS of Ukraine, 65044, French boulevard, 29, 65044 Odessa, Ukraine*

E-mails:[1] andreevann@ukr.net, [2]ksenkych@gmail.com, [3]Burkinskij@nas.gov.u, [4]oss_iprei@ukr.net, [5]alexlayko@gmail.com, [6]ecoregnaturres@ukr.net

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Abstract. The methodological vision of the formation of the state economic policy, based on the needs of society sustainable development was proposed; the methodology for analyzing the impact of economic and environmental indicators of the implementation of the state economic policy, as an alternative to decoupling analysis was developed. Methodology. Methodological basis is formed by the convergence of four methodological approaches: methods of evaluation of indicators of "green" growth of the OECD; National System of Sustainable Development; methodological support for determining the economic and environmental priorities of "green" economy in the context of sustainable development; normative approach to the evaluation of parameters of economic safety of the state. Results. The proposed methodological support was approbated on the example of Ukraine in the period from 2010 to 2018. Practical approbation of the methodology allowed us to determine the cause-and-effect relationships between the dynamics of changes in economic and environmental indicators, positive and negative trends in the process of environmental transformation of economic policy. Value/originality. The original feature of the author's methodology is a logical and structural analysis of the main factors influencing the components of resource and environmental productivity of GDP and an extended diagnostic procedure.

Keywords: analysis; economic policy; environment; indicators; diagnostics; sustainable development

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1. Introduction

The public view of the economic development of the world community is currently actively associated with the international paradigm of sustainable development. Sustainability should be viewed as humanity's target goal of human-ecosystem equilibrium, while 'sustainable development' refers to the holistic approach and temporal processes that lead us to the endpoint of sustainability (Richard Ross, 2015). The concept of sustainable development has developed beyond the initial intergenerational framework to focus more on the goal of "socially inclusive and environmentally sustainable economic growth" (Sachs, Jeffrey D. 2015). The global economic growth generates an increase in the extraction and consumption of natural resources, increasing the degree of negative impact on the environment. Currently, the task of studying the possibilities of economic growth without increasing the natural capacity of economic systems and reducing environmental damage from economic activities is of particular relevance. The world's strategic development guidelines are reflected in the 17 Sustainable Development Goals, which focuses on strengthening the means of implementation and revitalization of global partnership for sustainable development (Goal 17, 2020).

Sustainable development is a major global objective to overcome the economic, environmental and societal crises in many countries. In the last 30 years, the concept of sustainable development has taken shape thanks to a greater awareness of the need for sustainable development. Various public Institutions at international and national levels (e.g. International Organization, National Public Administration, Municipality, and University) played a key role. Sustainability is defined as the practice of maintaining world processes of productivity indefinitely – natural or human-made by replacing resources used with resources of equal or greater value without degrading or endangering natural biotic systems (Lynn R. Kahle, Eda Gurel-Atay, Eds., 2014). One of the main instruments to develop a smart, sustainable and integrated growth (European Commission, 2010) is through the circular economy (European Commission, 2014, Pardo, P. & Schweitzer, J.P., 2018; Stankevičius A, Novikovas A., Bakaveckas A., & Petryshyn O., 2020). Furthermore, it is important to promote a sustainable behavior (Goal of the Sustainable Development Goals) specifically on sensitive issues such as social and environmental responsibility, so that all citizens can acquire and develop skills needed to promote the goals of the Agenda 2030 (United Nations, 2015, Barbier, E., 1987).

The purpose of the article is to form the methodology and develop the methods for analyzing the impact of economic indicators on the environmental condition of the state and their approbation at the state level. There is a large discussion among the international scientific communities about the complexity of making management decisions considering social, environmental, and investment and innovation factors. In this issue, it is very important, firstly, to ensure the combination of society, science, business and government, and secondly, to consider the existing natural and resource potential of territories and existing natural capital, as well as to determine the level of environmental pollution.

Events, especially large-scale ones, produce several impacts on a territory, which are not exclusively economic in nature. The evaluation of the environmental and social effects of an event is very complex, not only because the effects are often indirect and intangible, and, therefore, difficult to perceive and measure in time, but also because the variables which affect the outcomes are manifold in reality. Moreover, because of the wide range of the goals pursued and of the heterogeneity of the subjects involved both directly and indirectly (stakeholders), it is extremely difficult to single out the parameters by which to measure the success of an event. In fact, several scholars have stated that these performance measures differ according to the subjects involved in the evaluation (promoters, organisers, communities and sponsors) and the goals pursued (Bowdin, G., Allen, J., O'Toole, W. G., Harris, R. & McDonnell, I., 2011, Carayannis, E. G. & Campbell, D. F. J., 2010; Mirzayeva, G., Turkay, O., Akbulaev, N., & Ahmadov, F. 2020).

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However, as for making managerial decisions at the state level, it is very important to form the balanced algorithm of actions, which is formed on the basis of an in-depth analysis of economic and environmental indicators (O'Sullivan, Arthur & Sheffrin, Steven M., 2003). In economic theory, the scientists have developed a number of concepts of the relationship between economic growth and environmental pressure, in particular, the concepts of dematerialization, environmental efficiency, environmental competitiveness, and so on. The concept of decoupling as a phenomenon of the gap between economic development and the degree of anthropogenic impact on the natural environment has become the most widespread in recent years. In the field of environmental-economic research, decoupling refers to the direction that could allow the economy to grow without a corresponding increase in pressure on the environment. Currently, in many countries, increased production is increasing the burden on the environment. An economy that supports economic growth while reducing the amount of resources used, such as water or fossil fuels, while not linking environmental degradation would be said to be decoupled (Decoupling Natural Resource Use and Environmental Impacts from Economic Growth, 2020). Relative decoupling refers to a decline in the ecological intensity per unit of economic output. Absolute decoupling refers to a situation in which resource impacts decline in absolute terms (Jackson, Tim, 2009). At the same time, the implementation of economic and environmental priorities of the state in the practical plane makes it necessary to develop new methodological approaches to the analysis of the transformational impact of economic indicators on the environment conditions in the state (Smith, Charles Emrys, 2009). Despite the existing methodological developments, there is a need for new approaches to the multidimensional study of the relationship between economic growth, destructive impact on the environment and the use of natural resources, with an emphasis on the diagnosis of economic and environmental indicators, as well as the assessment of many factors as an alternative to decoupling analysis (Sachs, Jeffrey D., 2015). These circumstances determined the purpose and objectives of this study.

2. Results

The methodology for calculating GDP productivity indicators provides for the use of three GDP indicators (see table. 1). For calculating specific indicators (per 1 person), the dynamics of the population of Ukraine is important. The values of these indicators and their basic indexes (compared to 2010) are shown in table 2. Attention is drawn to the significant difference between the basic GDP indexes in actual and comparable prices in 2010, which is a consequence of inflationary influence. Thus, in 2018, compared to 2010, the GDP index in actual prices was 329.7%, in comparable prices in 2010 – 96.7%. In other words, in comparable prices, there is a downward trend in GDP in the period from 2014 to 2018, which is due, in particular, to a decrease in the statistical sample of data from the temporarily occupied territories.

Table 1. Methodology and methodological support for the analysis of the impact of economic indicators of state economic development on the environment

1. Goal	Measuring the progress of "green" growth by determining the level and dynamics of the interaction of economic and environmental indicators, as a methodological basis for developing mechanisms for managing economic relations in the context of the international paradigm of sustainable development
2. Task	1. Systematization of information flows in terms of the main areas of evaluation 2. Assessment of the state and dynamics of the components of the basic indicator 3. Assessment of the state and dynamics of factors influencing the components of the basic indicator 4. Generalized evaluation of the results of the analysis as a basis for making managerial decisions on the mechanisms of sustainable development 5. Forecasting the dynamics of indicators of resource and environmental productivity of GDP
3. Principles	1. Systematic 3. Effectiveness 2. Objectivity and accuracy 4. Scientific and flexible
4. Methodical basis	1. OECD methodology - indicators of "green" growth of the OECD (a group of indicators of environmental and resource efficiency) 2. Methodology for assessing the Sustainable Development Goals, adapted for Ukraine 3. Methodological support for determining the economic and environmental priorities of the "green economy" in the context of sustainable development of Ukraine 4. Normative assessment of the parameters of economic security of the state

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Continuation of the table 1.

5. Indicators of resource and environmental productivity of GDP	1. Indicators for estimating the amount of consumed resource (resource factors): 1.1. Water productivity (capacity) of GDP 1.2. Energy productivity (capacity) of GDP 2. Indicators for environmental impact assessment (environmental factors): 2.1. Carbon productivity (capacity) of GDP 2.2. Productivity of GDP by waste
6. Components of GDP performance indicators	1. GDP in actual, constant prices, constant prices in 2011 for PKS 2. Volumes of water consumption; volumes of water abstracted from natural water bodies. 3. Final energy consumption; general supply of primary energy 4. Carbon dioxide emissions 5. Volumes of generated waste of I-IV classes;
7. Factors influencing the components of GDP productivity	1. Structural transformations of gross value added 2. Production volumes in sectors of the national economy 3. Average annual population 4. The amount of costs for environmental protection (capital investment and current costs) 5. Structural changes in environmental investment
8. Evaluation procedure	1. Analysis of indicators of economic development of the country in the context of economic security parameters 2. Assessment of the dynamics of factors influencing the components of GDP productivity indicators 4. Assessment of the level and dynamics of water productivity and water capacity of GDP 5. Assessment of the level and dynamics of energy productivity and energy intensity of GDP 6. Assessment of the state and dynamics of carbon productivity and GDP capacity 7. Assessment of the state and dynamics of productivity and GDP capacity by waste 8. Assessment of the impact of agriculture and raw material exports on the state of the environment 9. Generalized diagnosis of the impact of economic indicators on sustainable development of the state and the environment

Source: authorial development

This reason led to a sharp decline in the population index from 99.2 % in 2013 to 93.7 % in 2014, which should be considered when analyzing the interaction of economic and environmental indicators. The volume of output in national economic sectors is an important factor influencing the components of GDP productivity

Table 2. Values and basic indices of GDP and population in Ukraine

Indicators	Years							
	2010	2012	2013	2014	2015	2016	2017	2018
1. GDP at actual prices, UAH billion	1079,35	1404,67	1465,20	1586,92	1988,54	2385,37	2983,88	3558,71
% to 2010.	*100,0*	*130,1*	*135,7*	*147,0*	*184,2*	*221,0*	*276,5*	*329,7*
2. GDP at constant prices in 2010, UAH billion	1079,35	1141,06	1140,75	1066,00	961,82	985,30	1009,60	1043,27
% to 2010	*100,0*	*105,7*	*105,7*	*98,8*	*89,1*	*91,3*	*93,5*	*96,7*
	2010	2012	2013	2014	2015	2016	2017	2018
3. GDP at constant 2011 prices for PKS, billion int. dollars	358,92	379,44	379,33	354,48	319,49	327,22	335,4	346,9
% to 2010	*100,0*	*105,7*	*105,7*	*98,8*	*89,0*	*91,2*	*93,4*	*96,7*
4. Average annual population, million people	45,87	45,59	45,49	43,00	42,84	42,67	42,49	42,27
% to 2010	*100,0*	*99,4*	*99,2*	*93,7*	*93,4*	*93,0*	*92,6*	*92,1*

Source: calculated by the authors according to the State Statistics Service of Ukraine (Report on Green Transformation in Ukraine based on OECD Green Growth Indicators, 2016, Sustainable Development Goals: Ukraine: National Report, 2017, Statistical Yearbook of Ukraine for 2018).

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Some idea of their dynamics is provided by statistical data on the dynamics of product indexes, in particular in industry, construction and agriculture (Table 3).

Table 3. Dynamics of indices of industrial, construction and agricultural products in Ukraine,% to the previous year

Indicators	Years							
	2010	2012	2013	2014	2015	2016	2017	2018
1. Index of industrial production, total, incl.:	112,0	99,5	95,7	89,9	87,0	102,8	100,4	101,6
1.1. Mining and quarrying	104,5	101,9	100,6	86,3	85,8	99,8	94,3	102,4
1.2. Processing industry	116,2	98,0	92,9	90,7	87,4	104,3	104,8	101,1
2. Indices of construction products	n.d.	91,7	88,9	79,6	87,7	117,4	126,3	108,5
3. Agricultural production indices	98,6	96,1	113,6	102,2	95,2	106,3	97,8	108,1

Source: Calculated by the authors according to the State Statistics Service of Ukraine (Statistical Yearbook of Ukraine for 2018).

In 2014-2015, there was a decrease in the level of industrial production indexes, including in the mining and processing industries, as the main consumers of resources, which affects the level of the GDP productivity indicator for this period. For agriculture in the period from 2013 to 2014, there is a tendency to increase production (by 13.6 % and 2.2%), which in 2015 changes to the opposite. The dynamics of production indexes should be considered when evaluating indicators of resource and environmental productivity of GDP, because resources treated as important economic assets (Barbier, Edward B., 2006). Another important factor affecting the productivity components of GDP is the amount spent on environmental protection (see table. 1). According to statistics, in 2018, total expenditures on environmental protection in Ukraine amounted to UAH 34.39 billion. (in actual prices), an increase of 162% over the 2010 baseline. During the study period, the volume of environmental investment varied from 1.5 % of GDP in 2012 to 1.0 % of GDP in 2018. At the same time, the growth of the indicator in actual prices was accompanied by a decrease in its share in GDP from 1.2 to 1 % (Richards, G. & Palmer, R., 2010). In 2010-2018, there were structural changes in the composition of expenditures on environmental protection: the share of capital investments increased from 21 % to 29 %, while the share of current expenditures, on the contrary, decreased from 79% to 71%, respectively. The dynamics of capital expenditures and current expenditures on environmental protection in Ukraine is clearly shown in fig. 1.

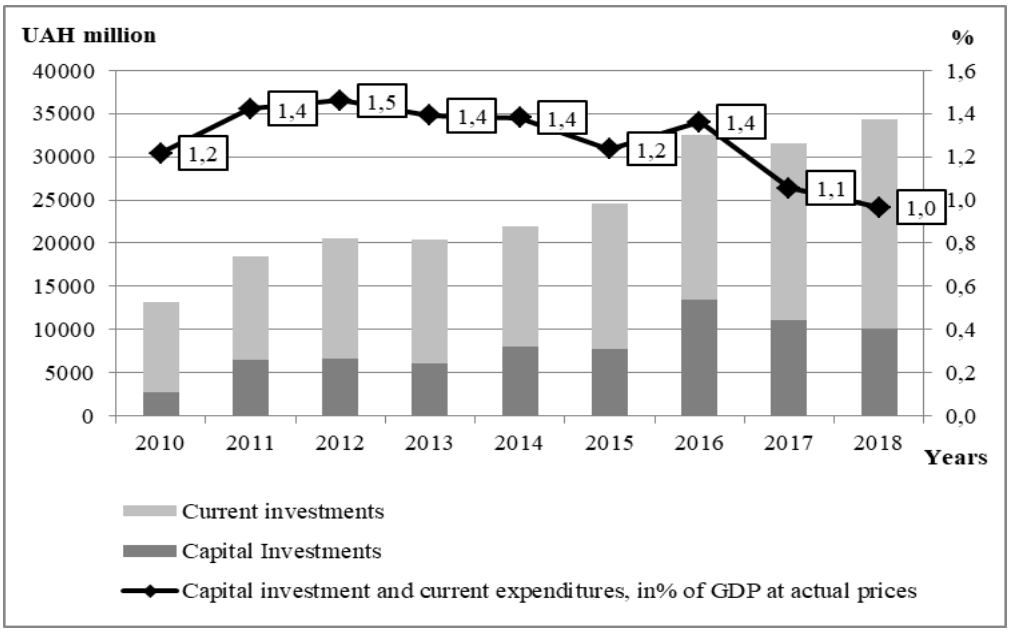

Fig. 1. Capital investments and current expenditures for environmental protection in Ukraine, UAH million and% of GDP
Source: built by the authors according to the State Statistics Service of Ukraine (Report on Green Transformation in Ukraine based on OECD Green Growth Indicators, 2016, Sustainable Development Goals: Ukraine: National Report, 2017).

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In 2018, 86.9% of expenditures on environmental protection were made up of own funds of enterprises and organizations, 6.7 % – the state and local budgets, and 6.4 % – other sources of financing. In 2018, by structure, the largest share of capital investments was directed mainly to atmospheric air protection (34.8 %), radiation safety (20.2%), and wastewater treatment (16.8%) (table 4). During the reporting period, the structure of current expenditures was dominated by the expenditures on wastewater treatment (39.6%) and waste management (36.3%).

Table 4. Structure of capital investments and current expenditures for environmental protection in Ukraine, % *

Environmental protection measures	**Capital Investments**			**Current investments**		
	Years		Changes (+,-)	Years		Changes (+,-)
	2010	**2018**		**2010**	**2018**	
1. Atmospheric air protection and climate change issues	41,2	34,8	-6,4	12,7	11,9	-0,8
2. Return water treatment	26,6	16,8	-9,8	48,6	39,6	-9,0
3. Waste management	17,2	11,7	-5,5	25,1	36,3	+11,2
4. Protection and rehabilitation of soil, groundwater and surface water	11,6	14,4	+2,8	4,6	5,3	+0,7
5. Reduction of noise and vibration	0,4	0,6	+0,2	0	0,9	+0,9
6. Conservation of biodiversity and habitat	0,7	0,7	-	2,3	3,3	+1,0
7. Radiation safety	0,1	20,2	+20,1	4,4	0,5	-3,9
8. Research work environmental orientation	0,3	0,1	-0,2	0,5	0,5	-
9. Other types of environmental activities	1,9	0,7	-1,2	1,8	1,7	-0,1
Total:	**100**	**100**	**X**	**100**	**100**	**X**

Source: calculated by the authors according to the State Statistics Service of Ukraine

Analyzing the structural changes in environmental investments, we can state that the priorities of the state's environmental policy have changed in the direction of implementing measures to ensure radiation safety, wastewater treatment, and waste management, which, of course, has affected the indicators of GDP productivity for water resources and waste. Environmental policy is used to influence human activities in order to prevent unwanted impacts on natural resources and the environment. It is also designed to ensure that changes in the environment do not have unacceptable consequences for humans (McCormick, John, 2001). The procedure for assessing the GDP resource productivity will be considered in detail on the example of water productivity of GDP in Ukraine, and environmental productivity – on the example of GDP productivity for waste. A group of indicators that characterize water productivity and water capacity of GDP in Ukraine is shown in table 5.

Table 5. Dynamics of indicators of water capacity and water productivity of GDP in Ukraine *

Indicators	Years							
	2010	2012	2013	2014	2015	2016	2017	2018
1. Water was taken from natural water bodies, million m^3	14846	14651	13625	11505	9699	9907	9224	11296
% until 2010	*100,0*	*98,7*	*91,8*	*77,5*	*65,3*	*66,7*	*62,1*	*76,1*
2. Water capacity of GDP, m^3 of used water per 1000 UAH. GDP (at actual prices)	13,75	10,43	9,30	7,25	4,88	4,15	3,09	3,17
3. Fresh water consumption, million m^3	9817	10507	10092	8710	7125	7169	6853	7363
% until 2010	*100,0*	*107,0*	*102,8*	*88,7*	*72,6*	*73,0*	*69,8*	*75,0*
4. Water productivity of GDP, UAH / m^3 (at constant prices in 2010)	109,9	108,6	113,0	122,4	135,0	137,4	147,4	141,7
% until 2010	*100,0*	*98,8*	*102,8*	*111,3*	*122,8*	*125,0*	*134,1*	*128,9*
5. Volume of water intake per person, $m.^3$.	323,6	321,3	299,5	267,6	226,4	232,2	217,6	267,2
% until 2010	*100,0*	*99,3*	*92,6*	*82,7*	*70,0*	*71,8*	*67,2*	*82,6*

Source: calculated by the authors according to the State Statistics Service of Ukraine

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Over the period from 2010 to 2018, the water capacity of GDP in Ukraine decreased by 4.3 times: from 13.75 m^3 per thousand UAH of GDP up to 3.17 m^3 per thousand UAH of GDP, reaching the target value of 2020 (3.2 m^3 per thousand UAH of GDP). The tendency to decrease the water capacity of GDP was caused by a decrease in the volume of water taken from natural water bodies (in 2018, the base index was 76.1 %), while the GDP indicator in actual prices increased. In 2018, a significant increase in the volume of water taken (by 22.5% compared to the previous year) caused the growth of the indicator of water capacity of GDP by 0.08 m^3 per thousand UAH of GDP.

Water productivity of GDP (in constant prices in 2010) increased from UAH 109.9/m^3 in 2010 to UAH 141.7/m^3 in 2018. *The dynamics of water productivity of GDP was influenced by the following factors:*

1) in 2011 and 2013, the GDP growth rate in constant prices of 2010 exceeded the growth rate of fresh water consumption, which provided the indicator value at the level of UAH 113/m^3; in 2012, the opposite ratio was observed; 2) in 2014, a 10.1% drop in industrial production as a result of military aggression in Eastern Ukraine and the partial loss of CIS markets led to a decrease in water consumption and an active increase in water productivity of GDP; 3) in the period from 2014 to 2018, the rate of reduction in water consumption (25% in 2018) was consistently higher than the rate of decline in the GDP indicator in constant prices of 2010 (3.3 % in the reporting year), which led to a growing trend in GDP productivity in Ukraine (see fig. 2).
2)

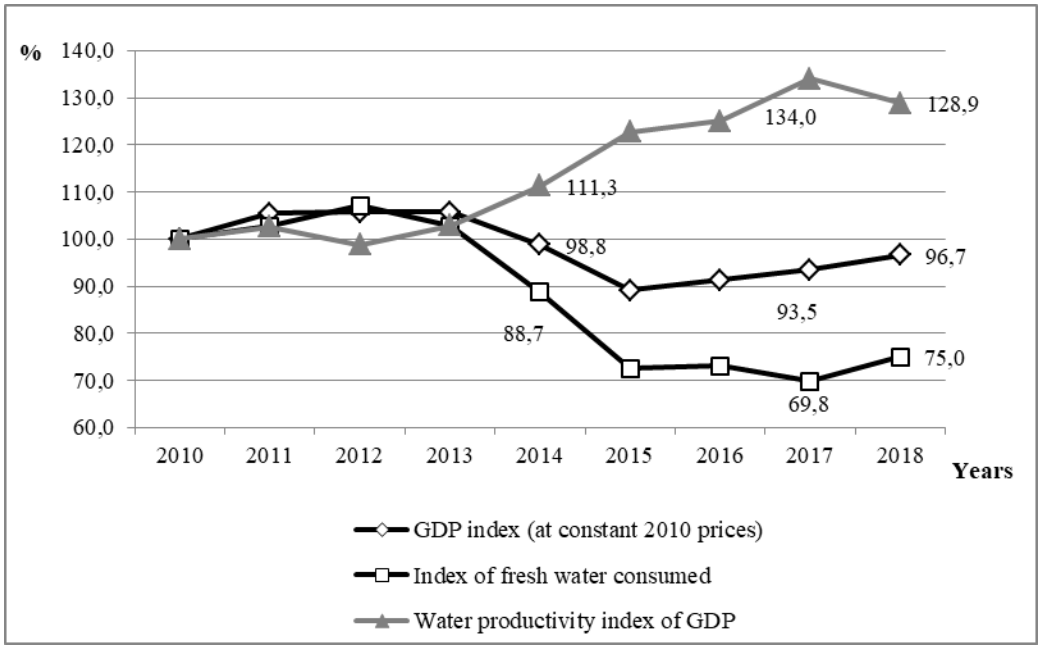

Fig. 2. Dynamics of basic indices of GDP, fresh water consumption and water productivity of GDP in Ukraine (in% until 2010)
Source: built by the authors

The current trend was reinforced by a drop in industrial production in the country - by 10.1% in 2014 and by 13% in 2015 compared to the previous year (see table 3). Since industry is the main consumer of water (43% in 2016), the decrease in industrial output in the country was the main factor in reducing water capacity and, consequently, increasing the water productivity of GDP during the study period. A less noticeable impact on the dynamics of these indicators was a decrease in the volume of agricultural products (by 4.8 % in 2015 and by 2.2 % in 2017 compared to the previous year). Agriculture is the second largest consumer of water (32% in 2016). The concept of sustainable agriculture extends intergenerationally, passing on a conserved or improved natural resource, biotic, and economic base rather than one which has been depleted or polluted.

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The decrease in water consumption and increase in water productivity in Ukraine was influenced by the decrease in the population (by 7.9 % compared to 2010), a drop in economic activity and industrial production, and more economical use of water due to the widespread use of water meters. In general, in the reporting year, the volume of water intake per 1 person in Ukraine reached 267.2 m^3, decreasing by 17.4% compared to 2010 (see table 5).
Over the period from 2010 to 2018, the rate of reduction in the volume of discharges of polluted wastewater into water bodies was higher than the rate of reduction in the capacity of treatment facilities in Ukraine. Thus, in 2018, compared to 2010, the amount of discharges of polluted wastewater decreased by 45.4% against the background of a reduction in the capacity of treatment facilities by 27.6%, which is a positive moment (Sustainable Development Goals: Ukraine: National Report, 2017). The positive trend of reducing the volume of discharges of polluted wastewater into water bodies in Ukraine is evidence of the gradual introduction of priorities for rational nature management. According to the indicator "wastewater treatment" in the rating of the Environmental Performance Index of 2018, Ukraine received a fairly high rating - 78.76 points (69th place out of 180 countries) (Report on Green Transformation in Ukraine based on OECD Green Growth Indicators, 2016). Therefore, we can speak about the positive impact of environmental investments on the state's water resources. A group of indicators that characterize the waste productivity and waste intensity of GDP in Ukraine is shown in table 6.

During the study period, the dynamics of the indicator of waste productivity of GDP in Ukraine is unstable, characterized by periods of decline (2012) and significant growth (by 31.4% in 2016). In 2018, the indicator value reached UAH 2961/ ton (in constant prices in 2010), increasing by 16.8% compared to 2010 (see fig. 3).

Table 6. Dynamics of indicators waste productivity and waste capacity of GDP in Ukraine*

Indicators	Years							
	2010	2012	2013	2014	2015	2016	2017	2018
1. Volumes of generated waste of I-IV classes, thousand tons	425914	450727	448118	355000	312268	295870	366054	352334
% until 2010	*100,0*	*105,8*	*105,2*	*83,4*	*73,3*	*69,5*	*85,9*	*82,7*
2. The volume of formed HSW**, thousand tons	7611,6	9713,3	10803,7	7021,3	6789,2	6946,2	6183,2	6211,2
% until 2010	100	*127,6*	*141,9*	*92,2*	*89,2*	*91,3*	*81,2*	*81,6*
3. Waste productivity of GDP, UAH / ton (at constant prices in 2010)	2534,2	2531,6	2545,6	3002,8	3080,1	3330,2	2758,1	2961,0
% until 2010	*100,0*	*99,9*	*100,5*	*118,5*	*121,5*	*131,4*	*108,8*	*116,8*
4. Productivity of GDP by HSW, thousand UAH / t (at constant prices in 2010)	141,8	117,5	105,6	151,8	141,7	141,8	163,3	168,0
% until 2010	*100,0*	*82,8*	*74,5*	*107,1*	*99,9*	*100,0*	*115,1*	*118,5*
5. Waste capacity of GDP at constant prices in 2011 for PPP, kg / thousand dollars	1186,7	1187,9	1181,3	1001,5	977,4	904,2	1091,4	1015,7
6. Volume of generated household and similar waste, kg / person	165,9	213,0	237,5	163,3	158,5	162,8	145,5	146,9
% until 2010	*100,0*	*128,4*	*143,1*	*98,4*	*95,5*	*98,1*	*87,7*	88,6

Source: Calculated by the authors according to the State Statistics Service of Ukraine (Report on Green Transformation in Ukraine based on OECD Green Growth Indicators, 2016, Sustainable Development Goals: Ukraine: National Report, 2017, Statistical Yearbook of Ukraine for 2018);
** HSW - household and similar waste.

The changes in the waste productivity of GDP over time can be divided into two periods:
1) the period from 2010 to 2013 is characterized by a slight increase in dynamics due to higher GDP growth rates in constant prices in 2010 compared to the growth rate of the volume of generated waste of the I-IV classes;
2) the period from 2014 to 2018 is characterized by the 10-20% growth rate of the indicator due to the excess rate of waste reduction compared to the same indicator for GDP in constant prices in 2010.

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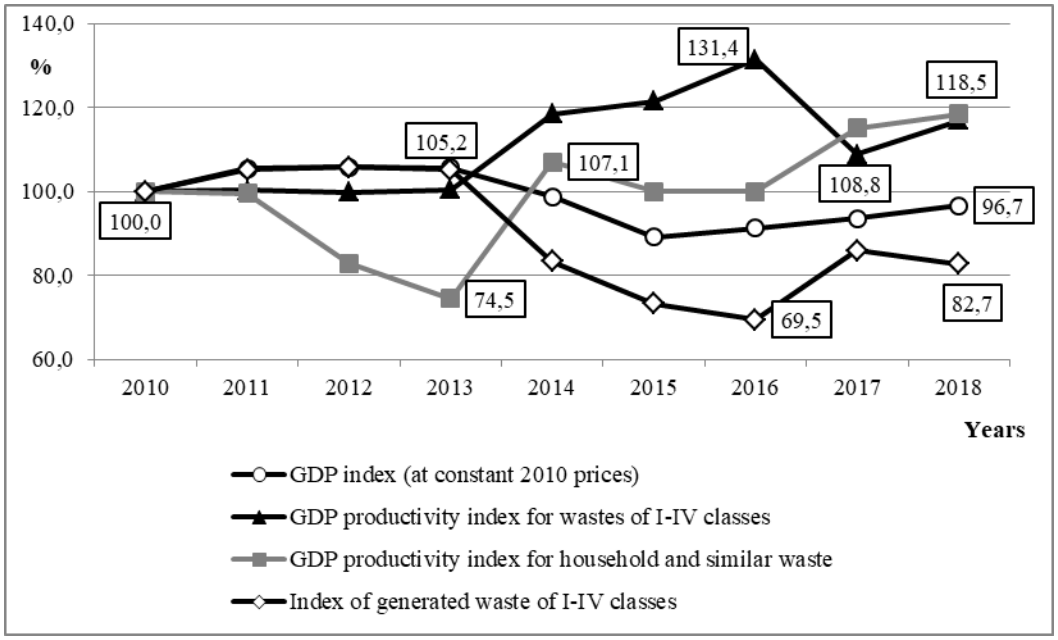

Fig. 3. Dynamics of GDP indices, generated wastes of I-IV classes and waste productivity of GDP in Ukraine, % (2010 - 100%)*
Source: built by the authors

The main factor that caused the reduction of generated waste of the I-IV classes in Ukraine in 2014-2016 is the decrease in production volumes of the extractive industry and quarry development (see table 3), which generates more than 80% of the total generated waste in the country. In 2017, compared to 2010, the volume of waste from mining and quarrying decreased by 9.7%, while compared to 2016, it increased by 32.1 %, which slightly slowed the growth in the level of waste productivity of GDP (from 31.4% to 8.9%). The decrease in production volumes of the processing industry in 2012-2015 (see table 3), which generated about 10% of waste of the I-IV classes during this period, is also a significant factor in reducing their volumes in the country.

In 2018, the GDP productivity for household and similar waste (HSW) was UAH 168 thousand/t (in constant prices of 2010). The dynamics of the basic indexes of this indicator is quite variable, characterized by a significant reduction in 2013 to 74.5% and increase in 2018 to 118.5 % (see fig. 3). In the reporting year, the excess of the rate of reduction in the volume of generated household and similar waste (18.4 %) over the rate of decline in GDP in constant prices in 2010 (3.3%) caused the 18% increase in GDP productivity for HSW in Ukraine (see table 4). A significant factor in the positive trend of reducing the amount of HSW in the state is the direction of a significant share of environmental investments to solve this problem. The share of investments in waste management in the structure of current expenditures increased from 25.1 % in 2010 to 36.3 % in 2018, taking the second place among environmental measures (see table 4).

In 2018, UAH 1 182.1 million capital investments were allocated for the implementation of waste management measures (2.1 times less than in 2016), including 96.1% of funds were allocated for cleaning and 3.7% – for integrated technologies. At the same time, in the reporting year, UAH 8830.2 million current expenditures were directed to waste management, which is three times higher than in 2010. Of these, 75% of funds are spent on waste collection and transportation, and 16.7 % – on waste treatment, disposal and destruction (Positions of Ukraine in the rating of environmental efficiency in 2018).

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The allocation of a significant part of current expenditures to improve waste management contributed to the elimination in 2014 of unauthorized landfills formed due to incomplete coverage of the population of Ukraine with services for the collection and removal of household waste (Daly, H.E. (Ed.), 1980). This factor, together with the reduction in the population, caused the 35% decrease in the volume of HSW in 2014 compared to 2013. At the same time, the volume of HSW per 1 person decreased by almost a half: from 237.5 kg/person in 2013 to 163.3 kg/person in 2014. In 2017, the indicator was 146.9 kg/person, decreasing by 11.4% compared to the 2010 baseline (see table 5).

In 2017, the level of waste intensity of GDP in constant prices in 2011 for the HSW amounted to 992.6 kg/thousand USD, an increase of 9.7% compared to 2016, exceeding the 2020 target value (950 kg/thousand USD) by 42.6 kg/thousand USD, due to a significant increase (24%) in the volume of waste generated in 2017. Given the double reduction in the amount of capital investment in waste management, we should expect a continuation of the negative growth trend in the waste intensity of GDP in 2020.

3. Discussion

To assess the progress of "green" growth, the OECD methodology uses a group of *environmental and resource productivity indicators* that describe the key aspects of the transition to a low-carbon and resource-efficient economy (Xingrong Zhao, Xi Zhang, Ning Li, Shuai Shao & Yong Geng, 2017, Yi Li, Jan Degener, Matthew Gaudreau, Yangfan Li & Martin Kappas, 2016). In our opinion, a group of indicators of environmental and resource productivity of GDP can be used as the basis for the author's methodological approach (see table 1).

At the same time, we propose to supplement the calculation of the dynamics of basic indicators that are the results of the values of their structure-forming components (in particular, GDP and resource or environmental components) with an analysis of the factors that influence these components.

Such an extended assessment procedure, as a component of the Methodological recommendations, will allow us to identify many factors that influence GDP productivity indicators over a certain time period, to identify the main factors and problem areas in the progress of "green" growth, and mechanisms for overcoming them.

3. Materials and Methods

The main *ideology of methodology and research methodology* is to measure the progress of "green" growth by determining the level and dynamics of mutual influence of economic and environmental indicators, as a methodological basis for developing mechanisms for managing economic relations in the context of sustainable development of the state. The assessment of the impact of economic indicators on the main indicators of "green" growth in the state is based on *a set of principles*, to which the authors include the following: consistency; objectivity and accuracy; effectiveness; (scientificity and flexibility). The selected principles orient the research vector to assess the interaction of economic and environmental indicators taking into account all internal and external links between their components, main factors, the objectivity and accuracy of the information base and analytical calculations, the practical significance of the Methodological recommendations and their flexibility and adaptability to new changes in the economic and natural environment, their scientificity and openness to advanced methodological developments in the context of sustainable development.

The methodological basis of the recommendations (see table 1) is formed by the convergence of four methodological approaches: methods of evaluation of the indicators of "green" growth of the OECD; National System of Sustainable Development (Sustainable Development Goals: Ukraine: National Report, 2017); (3) methodological support for determining the economic and environmental priorities of "green" economy in the

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context of sustainable development (Seneca, J.J., 1984); (4) normative approach to the estimation of parameters of economic safety of the state (Stavins, R., Wagner, A., Wagner, G., 2003).

The GDP performance indicators can be divided into 2 groups. The first group consists of the indicators for estimating the amount of resource consumed (*resource productivity of GDP*). The main ones are water and energy productivity of GDP. The second group is formed by the indicators for assessing the destructive impact on the environment (*environmental productivity of GDP*). The main ones are the carbon productivity of GDP and the waste productivity of GDP (see table 1). The ratio of GDP to the amount of the resources consumed (or pressure on the environment) determines the level of the indicator of resource (or environmental) productivity of GDP. The reverse is the GDP capacity indicator.

The main structural component of all productivity indicators is the volume of GDP, which is estimated in actual and constant prices, as well as constant prices in 2011 at purchasing power parity (PPP). In various combinations, these indicators are used to calculate the resource and environmental productivity of GDP, thus enabling their normative and cross-country comparison over a certain period of time. The second basic component of GDP productivity indicators is the amount of resource consumed (water, energy) and the level of environmental impact (carbon dioxide emissions, waste generated, etc.).

Among the main factors influencing the level of GDP, the authors highlight its structural transformations, in particular, changes in the sectoral structure of gross value added, and the dynamics of production volumes in the sectors of the national economy, which is manifested in the changes in product indexes (industrial, construction, agricultural, etc.). The main factors influencing the resource and environmental components of GDP productivity are the average annual population, the amount of environmental protection expenditures in terms of capital investment and current expenditures, and structural changes in environmental investment (see table 1). It should be noted that the group of factors in the Methodological recommendations can be expanded if there is a sufficient information base for their calculations.

The assessment procedure provides for the introduction of a step-by-step analysis of the impact of economic indicators of the state's economic development on the environmental condition (see table 1). It is proposed to start assessing the parameters of economic security of the state and the dynamics of indicators-factors of influence, since they directly or indirectly affect the components of all indicators of resource and environmental productivity of GDP, and then to detail the assessment in the context of these four basic indicators.

The analysis procedure involves comparing the actual values of GDP performance indicators, their components and impact indicators with the base period (2010), with the target values of indicators of 2020 for Ukraine, provided by the National Report (Sustainable Development Goals: Ukraine: National Report, 2017), with the values of indicators for the OECD member countries (interstate comparisons), the comparison of basic indexes of main and factor indicators, as well as the comparison of evaluation results with the components of the Environmental Efficiency Index of Ukraine of 2018 (Positions of Ukraine in the rating of environmental efficiency in 2018, 2019, Environmental Policies and Instruments, 2020).

The advantages of the proposed Methodological recommendations are the relative simplicity of indicators calculation (compared to the decoupling index), the analysis of not only the components of the basic indicator, but also a set of indicators that influence their level, which expands the analytical framework of the study, allowing both normative comparisons within the country and interstate comparison. The index of decoupling characterizes the relationship between its components, whereas the Methodological recommendations developed by the authors provide an in-depth logical and structural analysis of influence factors on the GDP resource and environmental productivity, allowing you to define original causes of changes, causal links and to substantiate the most effective tools for promoting "green" transformation of the economy (The History of Development, 2008).

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Conclusions

In the course of the research the authors developed Methodological recommendations for assessing the impact of economic indicators on the state of rational nature management, which are based on many principles (systematicity, objectivity and accuracy, efficiency, scientificity and flexibility), convergence of European and national methodological approaches to environmental indicators evaluation procedure, which, in addition to assessing the level and dynamics of factors and indicators of GDP productivity, provides an analysis of economic security and the impact of agriculture and raw materials on the environment, which allows to deepen the analysis of socio-economic factors on the environment and "green" economy.

The assessment of the state and dynamics of the indicators of resource and environmental productivity of GDP in Ukraine allowed us to establish some general trends in their changes due to the influence of a number of factors. Thus, in the period from 2010 to 2018 there is a tendency of growth of all indicators of GDP productivity due to the combined effect of the following main factors: (1) the rate of reduction of GDP in constant prices (since 2014) is lower compared to the rate of reduction in resource use and environmental impact; (2) reduction in 2014 and 2015 of industrial production by 10.1% and 13%; (3) structural transformation of gross value added; (4) reduction of volumes of discharges of polluted sewage into water objects, volumes of the generated wastes of the I-IV classes, including household and similar waste, due to the increased funding for environmental measures. A comparative analysis of the basic GDP productivity indexes shows the highest growth rates of water productivity (28.9%) and the lowest – GDP productivity for waste (16.8%).

The results of assessing the impact of economic indicators on the main indicators of "green" growth in Ukraine allowed us to identify positive and negative trends in the process of "green" transformation of the economy. *Positive trends* include the following: the growth of environmental protection expenditures (2.6 times); a significant increase in the indicators of water and carbon productivity of GDP (base indexes of 129 % and 126%, respectively); a decrease in the volume of discharges of polluted wastewater into water bodies; a stable increase in the area of organic land. *Negative trends* in the progress of "green" growth include the following: deviations of most parameters of economic security from the normative values; low level of energy productivity of GDP, according to which Ukraine is at the end of the rating of European countries; growth in the volume of waste of the I-V classes in 2017 compared to the previous year by 24 % and the growth of the waste intensity of GDP; growth of raw material exports.

In general, the growth trend of all indicators of resource and environmental productivity of GDP in Ukraine in the period from 2010 to 2018 is due to the complex interaction of positive and negative changes in indicators-factors. Positive changes include the growth of environmental investments and their structural transformations, while negative changes include a reduction in production volumes in the sectoral dimension and the population of Ukraine.

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Andryeyeva Natalya - Doctor of Economics, Professor of Economics, Academician of the Academy of Economic Sciences of Ukraine, Chief Researcher of Institute of Market Problems and Economic&Ecological Research of NAS of Ukraine, Professor of Marketing, Odessa National University of Economics, Professor of Environmental Economics, Odessa State Ecological University. Her work was awarded for educational and research work by diplomas of the Ministry of Education and Science of Ukraine, the Odessa Regional State Administration and the mayor of Odessa. She is an official international UN expert of UNDP projects in Ukraine (participated in the expert evaluation of the UNDP project "Integration of the provisions of RIE Conventions into the national policy of Ukraine"). Today he is a member of the editorial board: the international Czech journal "European Journal of Economics and Management", the Ukrainian scientific journal "Economics. Ecology. Socium", a collection of scientific papers "Economic Innovations". Research interests: sustainability, green economy and regional development, environmental innovation and investment, strategic and environmental marketing, environmental economics and security.
ORCID ID: orcid.org/0000-0002-9960-559X

Oksana Nikishyna – head of Department of market mechanisms and structures of Institute of Market Problems and Economic&Ecological Research of NAS of Ukraine, Odessa, Ukraine.
Her methodical developments have received awards as the best works in competitions for innovative projects in Ukraine. She currently directs research work «Formation of effective logistics of commodity markets» at the Institute of Market Problems and Economic&Ecological Research NAS of Ukraine, edits articles for the scientific journal «Food Industry Economics», Ukraine. Research interests: theory and practice of commodity markets, regulation and evaluation of the efficiency of commodity markets, market logistics, «green» economy, sustainable reproduction development of a market economy.
ORCID ID: orcid.org/0000-0002-7172-3551

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Borys Burkynskyi is the Doctor of Economics, Professor of Economics, Academician of the National Academy of Sciences of Ukraine, Chief Researcher of Market Mechanisms and Structures Department, Institute of Market Problems and Economic&Ecological Researches, NAS of Ukraine, Odessa, Ukraine. His scientific works were awarded with prestigious national prizes and awards of Ukraine. He is the editor-in-chief of the scientific collection "Economic Innovations" and the head of the scientific council of the international journal "Economics. Ecology. Society". Research interests: development of commodity markets; property relations for recreational and tourist resources; regional investment policy; "green" economy; environmental economics
ORCID ID: orcid.org/0000-0001-9303-0898

Nina Khumarova is Doctor of Economics, Professor of Economics, the Chief scientist of Nature Use Economic Regulation Department, Scientific Secretary, Institute of Market Problems and Economic&Ecological Researches, NAS of Ukraine, Odessa, Ukraine. She is the executive secretary of Ukrainian scientific editions` editorial boards "Economic Innovations" and "Food Industry Economics", and reviewer for studies on the sustainable development of the national economy and the nature management economics. Research interests**:** ecologization of entrepreneurial activity; sustainable use of natural resources; ecological audit and managment; inclusion approaches in nature use managment.
ORCID ID: orcid.org/0000-0001-5255-8004

Oleksandr Laiko is the Doctor of Economics, Senior Researcher, Vice-director for scientific work, Institute of Market Problems and Economic&Ecological Research NAS of Ukraine, Odessa, Ukraine. His scientific work, dedicated to mechanisms of capital outflow regulation, won awards of the President of Ukraine for young scientists. Results of his research on investment-innovative development of regions in emerging economies were positively appreciated and implemented by OECD (Paris, France). Now he is engaged in preparation of methodology of international and interregional investment flows estimation that is to be sent for evaluation by Global Financial Integrity, USA. Research interests: investments and capital flows, regional development, strategizing of territorial communities development, sustainable investments.
ORCID ID: orcid.org/0000-0001-7082-0862

Hanna Tiutiunnyk is the Candidate of economic sciences, Researcher of Institute of Market Problems and Economic&Ecological Research NAS of Ukraine, Odessa, Ukraine. Her scientific work was awarded by the Southern Research Center of the National Academy of Sciences of Ukraine and the Ministry of Education and Science of Ukraine, the Department of Education and Science of the Odessa Regional State Administration. Research interests: economic&organizational provision of formation ecologically safe lands, green economy, inclusive economy, experience economy, sustainable developmemt.
ORCID ID: orcid.org/0000-0003-4864-6129

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MEASURING AND EVALUATING EDUCATION QUALITY OF FUTURE PUBLIC ADMINISTRATION EMPLOYEES AT PRIVATE UNIVERSITY IN THE SLOVAK REPUBLIC*

Luboš Cibák [1], Vojtech Kollár [2], Stanislav Filip [3]

[1,2,3] *School of Economics and Management of Public Administration, Furdeková 16, 851 04 Bratislava, Slovak Republic*

E-mails: [1] *lubos.cibak@vsemvs.sk;* [2] *vojtech.kollar@vsemvs.sk;* [3] *stanislav.filip@vsemvs.sk*

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Abstract. The private School of Economics and Management of Public Administration in Bratislava educates experts for public administration in Slovakia through bachelor and master study programs. The high percentage of graduates employed in governing bodies and municipalities proves the high quality of theoretical and practical level of education. The scientific and pedagogical personnel and particulary the ingenious and comprehensive education quality control system has its share in achieving distinct results. The authors of this article present a well-established system of education quality. They analyze and evaluate the system of quality measuring and evaluating using internal tools and procedures. The article pays special attention to the external form of quality measurement and evaluation through independent international institution Trendence. Criteria and areas of evaluation are assessed throughout the university, Slovakia, and Europe, which is presented by more than 1,000 higher education institutions.

Keywords: Public administration; employer of public administration; quality measurement

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JEL Classifications: I 21, I 23, I 24, I 28

1. Introduction

The European Higher Education Area (EHEA) is the result of the political engagement of 48 countries that have gradually built up the education area using shared tools over the last twenty years. Ongoing higher education reforms in european countries are based on common key values - such as freedom of expression, the autonomy of institutions, independent student unions, academic freedom, free movement of students and staff. Through this process, countries, institutions, and stakeholders of the European area constantly adjust their higher education

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systems, which improves compatibility and strengthen their quality assurance mechanisms. The main goal common for all countries in question is to increase staff and students' mobility and to facilitate the entry of graduates into the labor market. This paper presents selected methods and tools for education monitoring at the university through the standards of the internal system of quality assurance.

2. Literature review

The literature review contains publications and legal norms that describe the methodology and standards for evaluating the quality of higher education at the international level, in the EU area, and also in the Slovak Republic.

Description of methods and quality of higher eductions standards at the international level is the topic of (M. Šiškovič, M. Játi, 2015). Publication entitled *"What do the international rankings of universities really measure"* provides the famous world universities rankings such as ARWU (Shanghai Ranking), QS World University Ranking (QS), and Times Higher Education World University Rankings (THE).

The results of a workshop on the use of benchmarking to improve higher education, which was organized by the European Network for Quality Assurance in Higher Education in Helsinki in 2002, are published by a team of authors (K. Hämäläinen et al., 2002) and entitled *"Benchmarking in the Improvement of Higher Education"*.

The European Center for Strategic Management of Universities has published *"A Practical Guide to Benchmarking in European Higher Education"* as result of an EU-funded project. The guide recommends benchmarking method as a comparative tool for self-assessment and comparison with key competitors and implementations of the best procedures. (ESMU, 2008).

Further international source literature: (Ross, W. 2018) *Comparing and Benchmarking Higher Eeducation System as a Com 14th Chapter of Research Handbook on Quality, Performance and Accountability in Higher Education* , (U. Swahn, 2004) *"International Benchmarking and National Quality Assessment Systems"* as a case of Sweden; (J. Urquhart, D. Ellis, A. Woods, 2002). *„Benchmarking guidelines for university technical Services“.(* Seberová, A., Malčík, M.2009). *“School self-evaluation - from theory to practice and research”. (*Sanders, J. R., Davidson, E.J. 2003). “*A Modelfo school evaluation”.* (Novák, M. 2012). *Overview of key phenomena, properties, assessed activities of self-evaluation*

International publications of this sort could also include publication, which is the result of the mutual research of the University of Transport Todor Kableshkov – Sofia, Bulgaria, and School of Economics and Management of Public Administration in Bratislava, Slovakia. A team of authors led by D. Todorova et all. (2019) *"International Business - Benchmarking of Nordic Business Studies in Higher Education"* (U. Swahn, 2004) published a monograph entitled *"Benchmarking model - Intelligent Portfolio for Quality Measurement and Management of Education at Bulgarian and Slovakia Higher schools"*.

An interesting problematics of racial equality in the context of improving the education quality at universities is presented by J. Rodrigues, N.G.L. Rodrigues and K. Feeman, (2018) in the article *"Students Evaluation of teaching: prenology in the 21st."*

The topic of the IT technologies contribution to the quality of higher education is discussed by M. Lytras, (2018) in the article *"Technology-Enhanced learning research in Higher Education"*.

The Standards and guidelines for quality assurance in the European Higher Education Area were adopted by the European Association for Quality Assurance in Higher Education (ENQA), the European Students' Union (ESU),

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the European University Association (EUA), the European Association of Institutions in Higher Education (EURASHE) in cooperation with Education International (EI), Business Europe and the European Quality Assurance Register for Higher Education (EQAR) and are published in the *"Standards and Guidelines for Quality Assurance in the European Higher Educational Area (ESG)".*

The general criteria for evaluating the quality of higher education in the Slovak Republic were established by Act of Federal Assembly of Czech and Slovak Federative Republic no. 172/1990 Coll. This legal act has been gradually changed after the independence of the Slovak Republic. The first modification was brought by the Act of the National Council of the Slovak Republic no. 41/1991 Coll. which established military universities. The substantial change was however brought by the Act of the National Council of the Slovak Republic no. 324/1994 Coll. , which amended the original Act no. 172/1990 Coll. Accreditation Commission in Slovakia was established in section 17 as an advisory body of the Government of the Slovak Republic to comment on the quality of higher education institutions by recommending to the Government of the Slovak Republic ability to grant or withdraw university rights. Further adjustments in the Higher Education Institutions law, which took place in 1997 or more precisely in 1999 did not fundamentally change the measurement and assessment of the quality of universities in the Slovak Republic.

Progress in the process of evaluating the quality of higher education was brought by Act of the National Council of the Slovak Republic No. 131/2002 Coll. on higher education institutions. The Accreditation Commission was granted the competence to assess and evaluate the quality of education, research, development, or artistic activities at universities.

The last and rather substantial change in the assessment and evaluation of education quality at universities in the Slovak Republic was brought by the Act of the National Council of the Slovak Republic No. 269/2018 on Quality Assurance in Higher Education. This act defined new rules on higher education quality assurance in accordance with European standards. Due to the given purpose Accreditation Commission, at that time performing as an advisory body to the Government of the Slovak Republic was dismissed and the Slovak Accreditation Agency was created. This agency has developed and approved Standards for the Internal System, Standards for the Study Program, Standards for the Rehabilitation Procedure, and the Inaugural Procedure.

3. Objectives and methods

The paper aims to provide comprehensive information on the importance, goals, procedures, and results of internal and external evaluation of the education quality at private university in the Slovak Republic and compare them with EU policy in the field of education quality. The partial goal of this paper is to create a framework for the profound research and comparison of problematics at other universities within the EU countries (Bulgaria) and third countries in Europe that have shown a lasting interest in joining the EU (Ukraine and Serbia). Regular monitoring and evaluation of study programs provide valuable information to school principalship for decision-making processes. Study courses, programs, and teacher evaluations are regularly evaluated with the involvement of students and other stakeholders at the university.

Based on a comparative analysis of these internal evaluation areas, external evaluation, and quality standards of education, partial goals are formulated and aimed at:
- content of study programs concerning the latest research results;
- changing needs of society;
- students' knowledge and competences within the national and European qualification framework;
- efficiency of student evaluation procedures;
- satisfying the needs and contentment of students in relation to the study program;

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-educational environment, support services for subjects of the educational process, and their suitability for the given study program.

The object of the research

The internal system of quality of higher education includes the policy and processes of internal quality assurance of higher education and creative activity, through which the university fulfills its mission. It creates preconditions for the permanent fulfillment of standards for the internal system and standards for the study program. The standards for the study program are defined as a set of requirements while their fulfillment serves as a condition for the accreditation grant of the study program by an authorized person. Internal system standards are a set of requirements for an internal system and means of its implementation. Quantitative and qualitative indicators are used to evaluate the degree of criteria fulfillment in the process of assessing the compliance of the internal system and accreditation of the study program. The Standards and guidelines for quality assurance in the European Higher Education Area (ESG) were adopted by the Ministers responsible for higher education in 2005 following a proposal drawn by the European Association for Quality Assurance in Higher Education (ENQA) in cooperation with the European Students' Union (ESU), the European Association of Institutions in Higher Education (EURASHE) and the European University Association (EUA). The main objective of the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) is to contribute to a common understanding of quality assurance in learning and teaching are across geographical boundaries by all stakeholders.

The Standards and guidelines have played and will continue to play an important role in the development of national and institutional quality assurance systems throughout the European Higher Education Area (EHEA) and the development of cross-border cooperation. Engagement, especially in external quality assurance processes will enable European higher education systems to demonstrate their quality and increase transparency; the institutions will thus contribute to strengthen trust and will improve mutual recognition of educational attainment, study programs, and other services provided.

Student-focused survey on learning and teaching quality plays an important role in stimulating students' motivation, self-assessment, and involvement in the learning process. Regular monitoring and evaluation of study courses, study programs, and teachers' performance are important for students' progress and future careers. The results of the survey are regularly reviewed and evaluated with the involvement of students and other subjects involved. The obtained information is analyzed and the study programs are adjusted to ensure up-to-dateness.
External quality assurance in various forms can verify the effectiveness of internal quality assurance at a university, act as a catalyst for improvement, and offer new perspectives to the university. At the same time, it provides information on the quality of the activities to the university and the public.

The subject of the research

School of Economics and Management of Public Administration in Bratislava was established in response to the change of political and social conditions in Slovakia after 1989. Changes in the structure of public administration in the Slovak Republic, especially the establishment of municipal bodies created an urgent need for educated and professionally trained employees at all levels of public administration, i.e. state administration and municipality. This requirement became topical as well at the time of the public administration reform, which was between the years 1998 and 2004 and was one of the key systemic changes carried out in the transformation process in Slovakia. The reform aimed to create the functioning state administration and municipality, which could provide high-quality services to citizens and actual participation in the administration of public affairs. Achievement of this goal required systematic training and an increase in the public administration employee qualifications directly affecting the quality of the work.

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School of Economics and Management of Public Administration in Bratislava was the first private school in Slovakia providing an offer to satisfy the demand on the education market through comprehensive higher education for public administration employees within the framework of retraining or increase of qualifications. Accredited university study programs have become an opportunity for secondary school graduates to obtain the qualification of a public administration employee and thus gradually replace retiring employees or cover the fluctuation. Current number of nearly 400,000 employees working in state administration and municipality bodies introduced necessity to constantly prepare university-educated and professionally qualified public administration employees for the natural turnover of employees. Only employees well-trained in the theoretical and practical area are able to fulfill the strategic goals of providing quality services to a citizen. The bachelor's and master's degree study program, quality pedagogical staff, education support, and service at VŠEMvs* in Bratislava create preconditions for fulfilling an ambitious goal. The quality of the educational process for the study program Public Administration and Regional Development included in the study field of Economics and Management alignes with the highest requirements.

The main topics of the core knowledge of the economics field of study include the basic principles of economic thinking, the rules of functioning of the economic system, and its components, on a national and international scale, with interaction with economic policy and regional economic relations.

In the field of management, it consist of principles of strategic, tactical, and operational management in the regional environment respecting the functions of management, the legal form of the economic entity, and the rules of the functioning of its individual functional components.

Education quality maintenance and assurance are conditioned by the content of the study program and the range of knowledge, skills, and competencies that the student acquires upon graduating.

Used Methods

Standard methods of scientific research were applied in the preparation phase of the article. In addition to methods of scientific abstraction and description, scientific methods of analysis and synthesis, comparative methods and specifically benchmarking methods are applied in the article. Statistical survey methods were used for purpose of internal measurement and assessment of the education quality.

3. Process and steps of the quality management system implementation

Quality management has been an integral part of the management processes of VŠEMvs in Bratislava since 2014. Within the scope of the Internal Quality System at VŠEMvs in Bratislava, quality monitoring is focused on monitoring the profile of the graduate in the respective cycle of study, focusing on the acquired knowledge, skills, and competencies. (Kollár, V., Polakovič, P., Gasperová, J. 2016).

At the university, internal quality system is built as a set of systems, resources, and information dedicated to maintaining and increasing the education process quality, science, and research, including the experience of students and external entities.

Development of the internal quality system was based on recommendations of the European Association for Quality Assurance, the European excellence model, and process-oriented quality system, which uses norms of ISO 9000 series for building the system and provision, improvement, and measuring the effectiveness. Our university implements the strategy of securing and increasing quality into all processes and activities to meet set goals.

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Identification of processes and activities at the university is the basis of a process approach to quality management. Its advantage is the continuous management of the links between the individual processes within the system, as well as the management of the combinations and interactions of the processes that this approach provides.

This approach emphasizes the importance of:
• understanding and fulfillment of requirements, demands, and wishes,
• understanding of processes in terms of added value,
• gaining knowledge about the efficiency and effectiveness of processes,
• continuous process improvement based on objective measurements.

We applied the method of planning and monitoring the performance of all processes. The basis is the implementation, measurement, and control of performed activities, which lead to the continuous improvement of transparency, accountability, cooperation, and informedness at the vertical and horizontal levels within the organizational structure of the university.

The main goal of the internal quality system is to develop the quality importance in a way that the system is helpful for:

- education and training of university professionals, who will have knowledge, skills, and competencies that will enable them to successfully enter the labor market in a competitive environment at home and abroad,
- developing knowledge and education based on creative scientific research in the field of public administration, small and medium-sized enterprises, and municipal security to create a basis for ensuring and improving the quality of the educational process and its components,
- strengthening the position of VŠEMvs in Bratislava in its integration into the network of higher education institutions in the Slovak Republic and the European educational and scientific research area.

The quality policy is based on the long-term development plan of VŠEMvs and its updating. The aim of the quality policy in common activities and in all areas of VŠEMvs is to achieve the satisfaction of current and future requirements, demands, and wishes of all members of the academic community.

The fundamental tools of the internal quality system are map of processes, internal guidelines, and regulations of university management. The organization of the internal quality system in the horizontal and vertical structure is implemented by connecting the primary, management, and auxiliary processes to the organizational structure of VŠEMvs.

In the process of managing, securing, and improving the education quality policy and in connection with other activities, VŠEMvs promotes:

- Open access at all cycles and forms of education, by applying the principle of equal opportunities for all those interested in studying.
- Ensuring student satisfaction by understanding their current and future needs, demands, and desires.
- Innovation of existing accredited study programs and development of new study programs needed for the education and labor market.
- Strengthening the pride of students and future graduates of VŠEMvs, by creating a motivating environment for the involvement of students and employees in the fulfillment of set goals in the long-term plan of the university.

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- Creating conditions for personal and professional growth of each member of the academic community of VŠEMvs in Bratislava.
- Internationalization of education, improvement of science and research, cooperation and partnerships with other institutions from the regions of Slovakia and foreign institutions as well as with universities at home and abroad.
- Motivating students and staff for further education, strengthening loyalty and good relations between members of the academic community of VŠEMvs in Bratislava,
- Planning, monitoring, evaluating, and improving the quality of all processes and activities in response to the dynamically evolving requirements, talent, and excellence of stakeholders.

In the process of building the internal system of quality assurance and improvement at VŠEMVS in Bratislava, we identified three groups of processes fig. 1.

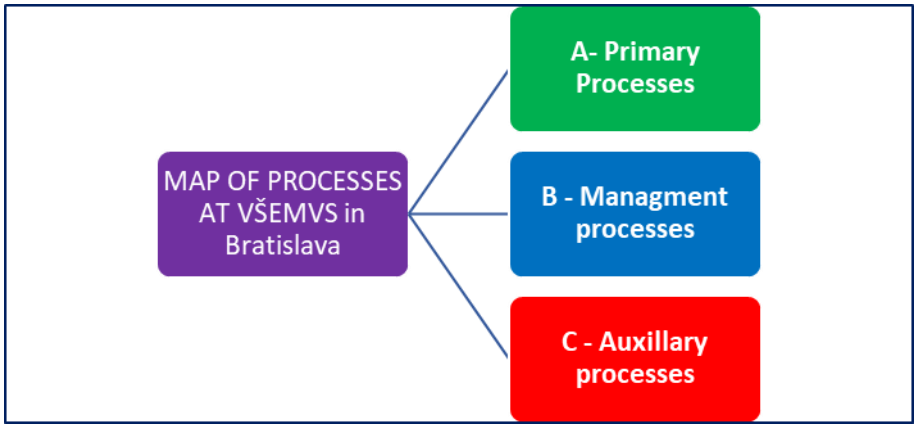

Fig. 1. *Map of processes at VŠEMVS in Bratislava*
Source: internal data

P1. Educational activity: focused on the subjects of the educational process:
PB1, PM1, PR, PLL -processes of bachelor's, master's study, rigorous procedure, and lifelong learning.

P2. Scientific research activity - processes of creative activity, which include comprehensive problematics of research and development, science and research projects, and transformation and development projects.

P3. Cooperation with practice - processes of cooperation with educational, scientific, and research departments at home and abroad. Economic entities and organizations of state administration and self-government.

M. Management processes - focused on the implementation of the vision, strategy, and the goals and tasks of the long-term plan of the university.
M1 Strategic management
M2 Operational management
M3 Internal audits

A. Auxiliary processes - support for the creation, updating, and collection of information, decision-making, and implementation of corrective measures.

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A1 Creation of study programs
A2 Update of study programs
A3 Information system management
A4 Admission of students
A5 Admission of foreign students
A6 Review of decisions
A7. Monitoring, analysis, and improvement

The advantage is the continuous control of the links between the individual processes within their system, as well as the control of the combinations and interactions of the processes that this approach provides. Such approach determines the importance of:

-understanding and meeting the requirements, demands, and desires,
-understanding the processes in terms of added value,
-acquiring knowledge about the efficiency and effectiveness of processes,
-continuous process improvement based on objective measurements.

The method of planning and monitoring the performance of processes can be applied to all processes. Essential is the implementation, measurement, and control of activities performed, which lead to the continuous improvement of transparency, accountability, cooperation, and information at the vertical and horizontal levels within the organizational structure of VŠEMvs.
Internal quality system procedures in the field of quality assurance and improvement are developed and applied in the following areas:

a) creation, approval, monitoring, and regular evaluation of study programs, which are developed in the primary process of bachelor's and master's studies, auxiliary and management processes focused on creating, updating and auditing study programs, monitoring student satisfaction with the educational process, which is carried out by questionnaire survey,
b) defining of descriptors, criteria and rules for student evaluation elaborated in the study regulations, the primary, management and auxiliary process focused on monitoring, analysis, and improvement,
c) ensuring the quality of university teachers through their selection according to the criteria for the positions of university employees at VŠEMvs and specifying the job responsibilities of employees in the positions of professor, associate professor, and professional assistant in publication, scientific research, and other creative activities,
d) providing material, technical, and information resources to support education and publishing of necessary information about students and graduates,
e) collection, analysis, use, and publication of current information necessary for effective management, implementation, and improvement of study programs through the academic information system and its software support in education and self-study, e-learning, distance learning, etc.

4. Internal measurement and evaluation of the education quality

Monitoring and evaluation of the education quality at VŠEMvs in Bratislava is carried out according to internal regulations and criteria, which are part of:

-Internal quality assessment regulation at VŠEMvs.
-Statute of the Council for the education quality at VŠEMvs.
-Criteria for filling the positions of university employees at VŠEMvs.
-Concretization of work duties of VŠEMvs employees in Bratislava in the positions of professor, associate professor, and professional assistant in publishing and scientific research activities.

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The content of the previously described documents corresponds with the requirements for knowledge, skills, and competencies of graduates of the Public Administration study program.

Procedures for creating study programs are regulated in the activities of auxiliary processes of the internal quality system manual. The evaluation is carried out in the internal environment of the university by monitoring students' satisfaction with the courses of the relevant study program in various cycles and forms of study, by measuring and controlling activities in the educational process, which lead to the continuous improvement of transparency, accountability, cooperation, and information at the vertical and horizontal level within the organizational structure of VŠEMvs.

To compare the increasing requirements in specific cycles of higher education within the main processes at VŠEMvs, we applied the Dublin descriptors to their content focus, while using them to describe the level of education and present the requirements for specific cycles of education with the determination of evaluation criteria and the method of allocating and accumulating credits. We paid attention to the optimization of the hourly workload of students within the specific cycles of study in accredited study programs, by defining the credit subsidy for compulsory, compulsory elective, and elective subjects in full-time and distance study form.
Preparation of the methods for the implementation of courses for the full-time and combined method of study according to their extent, the credit method for the realization of the subject, and the optimal student workload. At the same time, the optimization of proven parameters also determines the requirements for the content, organizational, and qualification level.

Monitoring of the pedagogical process in the form of inspections, evaluation of students' entrance tests, and evaluation of students after completing the courses is carried out at institutes and their departments according to the internal quality system. The inspection activity controls the pedagogical process at lectures, seminars, exercises, and consultations and is carried out by the pedagogical staff of the university.

The aim of course evaluation is to assess the content focus of the course, placement to the structure of the study plan, the form and scope of education, the topicality of the presented problematics, the availability of study literature. The evaluation of study programs is focused on the assessment of the content, the continuity of subjects and their credit evaluation, courses in foreign languages, the offer of compulsory elective and elective courses, the study program with the requirements of practice, and current knowledge.

Monitoring the quality of education by students in the relevant semester of the academic year is carried out through a questionnaire survey online via the Internet
http://bit.ly/1jmUNee.

PUBLIC ADMINISTRATION courses evaluation
https://docs.google.com/forms/d/e/1FAIpQLScQQSQdwXOxLPr_qUnCbASGAf2Y8iyu8wQ102ous1BvKwQ5VQ/viewform

Evaluation of the STUDY PROGRAM
- https://docs.google.com/forms/d/e/1FAIpQLSdo4rMN9qbDmu94UHup1NpaS-ZK9bHa0uWVpw_j_H-3Ka8XZw/viewform

Evaluation of the teacher's PEDAGOGICAL PERFORMANCE
https://docs.google.com/forms/d/e/1FAIpQLScKaxAcgqZB_x4nR7sVyyLR1uNmvfbpxzmXeJZRrqtQiiIu1A/viewform

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The highest number of students at VŠEMvs in the time period form 2012 to 2019 was in 2012 at 4549; until 2011, the number of students had an overall upward trend, but since 2012 the development has taken a downward trend concerning several factors (demographic changes, study opportunities at several universities and in all countries,...). In 2018, compared to the previous year, the total number of students decreased by 272, which is by 15.4%. When comparing the change in numbers in the full-time form of study, there was an increase from 1,279 in 2018 to 1,435 in 2019, which is 156 students more. In distance form, there was a decrease from 490 in 2018 to 62 in 2019, which represents 428 students. This was caused by the introduction of a full-time study form through the combined method, which many first- and second-year students used.

Regarding the evaluation of specific cycles of study, the development of the number of students at the 1. cycle of the study had a more balanced course until 2011 after which there is a relatively strong declining trend. In 2019, compared to 2018, there was an increase in the number of 26 students (approximately 3%).

In the 2nd cycle of study, since 2012 the development of the number has been slightly cyclical and slower declining and in 2019, compared to the previous year, a decrease of 298 students was recorded (approximately 32.5%) (Table 1 and Table 2).

Table 1. Development of the number of students since 2012 in the 1st and 2nd cycle of study (full-time and distance study together)

year	2012	2013	2014	2015	2016	2017	2018	2019
1st cycle	3066	2847	2181	1717	1321	985	854	880
2nd cycle	1483	1566	1456	1263	1302	1184	915	617
Total	4549	4413	3637	2980	2623	2169	1769	1497

Source: internal data

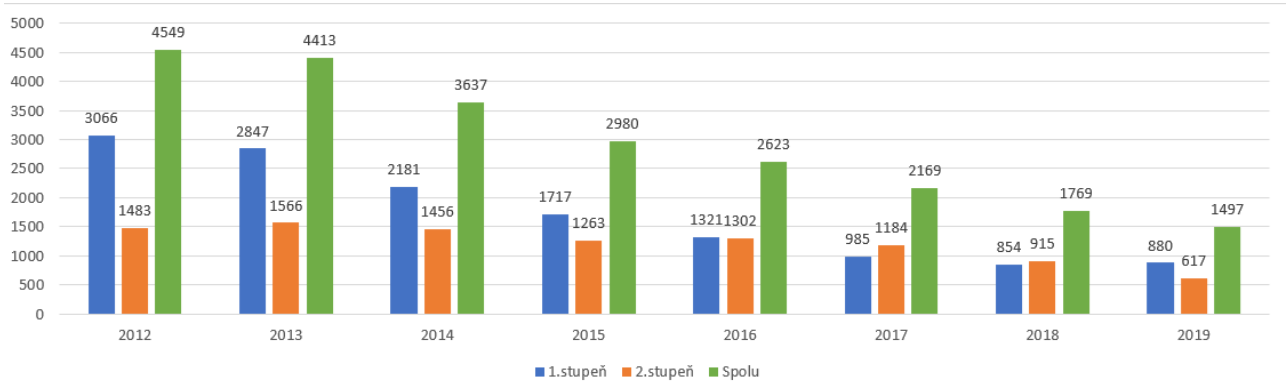

Fig. 2. Graphic representation of the development of the number of students since 2012 by study cycles (full-time and distance study together)
Source: internal data

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Table 2. Monitoring of student assessment 1st and 2nd cycle of study

Number of Year	COURSES	STUDENTS	STUDY PROGRAMS	STUDENTS	PEDAGOGUES	STUDENTS
2014	14	1018	2	1018	31	1081
2015	22	1212	2	1212	34	1212
2016	25	988	2	988	33	988
2017	27	1009	2	1009	32	1009
2018	22	897	2	897	33	897
2019	19	988	2	988	31	988
SPOLU	129	6112		6112	194	6112

Source: internal data

Between 2014 and 2019, 6,112 students participated in the survey and evaluated 129 subjects of the 1st and 2nd cycle of study. Most students involved were in the full-time form of study. Students directly involved in the evaluation of courses reached 4.5% of the total number of full-time students in the observed period.

On average, 2.2% to 5.9% of full-time or distance students participated in the evaluation of teachers and study programs of the 1st and 2nd cycle of study. On average, the number of respondents indicates that the results of the survey were significant. The management of VŠEMvs pays attention to surveys and regularly discusses comments and proposals at the level of diocesan and self-governing levels of the university.

5. External measurement and evaluation of education quality

We have been using the method of external evaluation of the education quality at VŠEMvs in Bratislava since 2010. VŠEMvs accepted the offer of the international company Trendence based in Berlin to participate in an independent international survey called Gradue Barometer.

In the period from 2010 to 2016, 2542 VŠEMvs students participated in the survey. The most, 660 of them were involved in the 2012 survey and the least, only 169 respondents in 2011.

On average, however, the participation was 9.4% per year, which indicates that the results of the survey were credible. This was also the reason why the management of VŠEMvs is acquainted with the results of the survey and takes measures to improve the assessed situation (see Table 3).

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Table 3. Overview of VŠEMvs' participation in the Gradue Barometer survey in the years 2010 to 2016

Indicator	2010	2011	2012	2013	2014	2015	2016
Number of participating countries	24	24	27	27	27	24	24
Total number of participating universities within Europe	850	1 077	950	1 057	1 000	952	930
Total number of students involved	220 000	310 945	343 796	317 617	302 261	281 479	300 000
Number of respondents from economic schools	71 545	96 431	123 479	105 442	94 991	98 837	106 475
Number of students of economic schools from the Slovak Republic	2 355	2 392	1 870	2 999	2 073	1 485	1 554
Number of VŠEMvs students	381	169	424	660	312	290	307
Total number of VŠEMvs students	4330	4620	4549	4413	3637	2980	2980
% of the total number of VŠEMvs students	8,7	3,7	9,3	14,9	8,6	9,7	10,6

Source: own processing according to the Trendence reports on the results of the 2010-2016 survey

The evaluation system consisted of filling in an anonymous electronic questionnaire, which was available to full-time and distance students on the VŠEMvs internet portal. Instructions on participating in the survey were developed by Trendence together with a link to the questionnaire. At least 3 months are usually available for data collection, from November to the end of January.

In 2010, areas such as the quality of university education, respondents' views on their future careers, students' views on the attractiveness of employment were evaluated.

Areas as well as specific quality evaluation criteria developed in consideration of the evaluation results. Therefore, it was not possible to evaluate development trends for several years in a row. It was not until 2015 that the number of key areas and individual criteria stabilized. Students - respondents participated in their selection. Currently, the subject of university quality assessment is 10 key areas with a total of 28 criteria. Table 4 shows the results of the VŠEMvs evaluation for 2016.

Table 4. Quality assessment of VŠEMvs according to Graude Barometer 2016

Field	Indicator	Europe [%]	Slovakia [%]	VŠEMvs [%]
Professors / Teachers	Professional competencies	84,9	83,1	89,1
	Pedagogical competencies	73,5	70,2	84,9
	Availability	70,6	67,7	72,3
	Motivation and willingness to help	73,2	68,3	77,1
Connection of study field with practice	Relevance of study content for practice	64,5	50,4	65,3
	Excursions, case studies, lectures by guest speakers	49,9	51,7	68,0
	Internship as a part of study (experiences, internship)	51,6	40,0	61,5
The international dimension of the study	Lectures in a foreign language (e.g. in English)	49,7	42,8	47,7
	Exchange programs, partnerships with other universities	66,1	65,9	74,0
Cooperation of the university with the private sector	Job offers (internships, part-time jobs)	53,7	42,1	59,4
	Job / career fairs	58,3	45,8	55,8
	Cooperation with companies in research projects	47,5	39,3	52,8
Quality availability of IT	Wifi	74,0	69,7	68,6

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infrastructure	Availability and equipment of computer rooms	68,2	68,3	60,4
Quality and availability of libraries	Diverse and current offer	79,3	64,7	72,4
	Availability of literature	77,4	59,5	66,1
	Plenty of space to work in the library	69,0	75,7	82,1
	Opening hours	78,7	74,8	85,7
Career center and counseling	Career counseling, job offers	52,1	32,8	50,5
	Events (e.g. job/career fairs)	57,7	47,1	50,9
Service and advisory	Transparent authority	58,9	48,0	68,7
	Competent staff	64,8	58,6	75,4
	Quick response to questions	64,0	56,9	73,9
Location	Transport infrastructure	71,2	76,1	83,8
	Possibilities to spend free time, availability of shops	67,3	77,6	73,5
	Price level / cost of living (e.g. rents)	58,4	59,3	56,0
Student activities	Events (e.g. film club, sports activities, parties, concerts)	69,0	72,5	71,9
	Higher education policy (student parliament)	58,8	60,5	71,2

Source: own processing according to the Trendence Gradue Barometer 2016 report

Evaluations mentioned above provide opportunity to highlight the best evaluation for the areas of professors/teachers, the connection of the study field with practice, and the service and advisory at VŠEMvs. These three key areas of education quality at VŠEMvs shows better evaluation in all criteria compared to the European and Slovak average.

Even development trends of quality assessment are interesting. The number of evaluated criteria, for which we found a match during the years 2013 to 2016, is presented in Table 5.

Table 5. Trends in the evaluation of selected indicators for the years 2013 to 2016

Indicator	**2013**	**2014**	**2015**	**2016**	**Index** 2013/2016
Professional competences	80,5	67,5	88,8	89,1	**1,11**
Pedagogical competencies	79,8	72,6	85,5	84,9	**1,06**
Availability	70,6	69,9	88,2	72,3	**1,02**
Relevance of study content for practice	55,7	53,4	79,9	65,3	**1,17**
Excursions, case studies, lectures by guest speakers			62,0	68,0	**1,09**
Internship as a part of the study (experiences, internship)			79,9	61,5	**-1,25***
Lectures in a foreign language (e.g. in English)			51,6	47,7	**-1,08***
Exchange programs, partnerships with other universities	64,3	56,0	75,6	74,0	**1,15**
Job offers (e.g. internships, part-time jobs)	29,1	35,7	57,6	59,4	**2,04**
Job/career fairs			59,8	55,8	**-1,07***
Cooperation with companies in research projects			56,4	52,8	**-1,06***
Wifi			65,7	68,6	**1,04***
Availability and equipment of computer rooms	65,1	61	64,3	60,4	**-1,07**
Diverse and current offer			70,9	72,4	**1,02**

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Availability of literature			66	66,1	**1,00**
Plenty of space to work in the library				82,1	**-**
Opening hours			75,5	85,7	**1,13***
Career counseling, job offers			54,4	50,5	**-1,7***
Events (e.g. career/job fairs)			53,7	50,9	**-1,05***
Transparent authorities			67,1	68,7	**1,02***
Competent staff			81,3	75,4	**-1,07***
Quick response to questions			78,5	73,9	**-1,06***
Transport infrastructure			89,9	83,8	**-1,07***
Possibilities to spend free time, availability of shops			80,2	73,5	**-1,09***
Price level / cost of living (eg rents)	46,8	56,7	63,2	56,0	**1,19**
Events (e.g. film club, sports activities, parties, concerts)	47,2	62,2	73,5	71,9	**1,52**
Higher education policy (student parliament)			81,4	71,2	**-1,14***

** Index for the years 2015/2016*

Source: own processing according to the Trendence reports on the results of the 2010-2010 survey

Data in the table hint a positive evaluation trends in the quality of teachers, in connection with the study program with practice, offers of part-time jobs for students. There is a slight decrease in the evaluation in the provision of student internships, the provision of lectures in a foreign language, career counseling, and in cooperation with companies. These trends are observable in the Gradue Barometer reports for the last two years as well as in the European and Slovak evaluation.

Conclusions

Higher education has developed rapidly in Europe and has responded to swiftly changing demands. In Europe, the level of education is constantly increasing, a comprehensive picture of the life we live in and in which we prepare generations for their future. Our goal is the success of our students. Quality education for students is an opportunity to develop the skills and knowledge at the high level that our societies require. Thanks to the Bologna Process and the Erasmus + program, students have more study and job opportunities abroad. Mutual cooperation and sharing of common topics in a changing environment is an opportunity for a new quality in education and for finding and answering questions. How do we recognize and reward good education? What does a good research mean and how it can be used in education? How do we ensure that young people have equal access to quality education and that they will complete higher education successfully? How do we remove obstacles of courses acceptation process and education at specific cycles? And how do we increase the relevance of higher education programs for the labor market? The Bologna Process gives European countries an opportunity to discuss these challenges. This paper asks such questions and creates a space for cooperation and critical dialogue.

The Bologna Process emphasizes Europe's potential to set high standards for modern and relevant education providing. The Bologna Process inspired us in the preparation and implementation of a cooperation project between higher education institutions in Bulgaria, Serbia, Ukraine, and Slovakia.

The main goal of the project is to define, identify, monitor, and evaluate key indicators of quality measuring and management of education through a benchmarking model and based on the comparison of the result to assess the competitiveness of education in the European education market with a focus on selected fields and programs. It is important to recognize the fact that today, more than ever, the European Union must focus on the countries

preparing for EU accession - which is also our mission. Our efforts are to bring European institutions of higher education, researchers, and students closer together and connect them.

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Ľuboš CIBÁK, Assoc. prof. Ing. PhD. MBA is Chairman of the Management Board of the School of Economics and Management in Public Administration in Bratislava, Slovak Republic and head of Department of the Managerial Informatics. His research and publication activities are focused on management, informatics systems, investment protection and business law.
ORCID ID: https://orcid.org/0000-0003-3881-7924

Vojtech KOLLÁR, Prof. Ing. Phd., is the First Vice-rector and Vice-rectorfor Science and Research an teacher of the School of Economics and management in Public Administration in Bratislava.As a professor, he works in the field of trade and marketing, where he has been inaugurated at the University of Economics in Bratislava. In the field of pedagogy and research, he is concerned with product policy, product quality and production, innovation management, product management, non-tariff barriers to trade, integrated management system, environmental quality management system and product and production competitiveness. He is the author and co-author of university textbooks, monographs and encyclopaedias published at home and abroad, several dozen university textbooks, scientific and professional articles and articles.
Researcher ID:9738858000
ORCID ID: https://orcid.org/0000-0003-4800-1021

Stanislav FILIP, Assoc prof. Ing. PhD. is the Vice-Rector for foreign affairs an teacher of the School of Economics and management in Public Administration in Bratislava. His text books, monographs and scientific papers deal with the Risk and crisis managemtn in public sector, international crisis management and public administration at the national and EU level. He is succesfull leader and manager of the several scientific projects with support from the EU structural funds. He also organise and control international colaboration and Erasmus plus program with the high educational and research institutions in abroad.
Researcher ID: F-7984-2017
ORCID ID: https://orcid.org/0000-0003-3000-9383

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POLITICAL STABILITY AND ECONOMIC GROWTH IN DEVELOPING ECONOMIES: LESSONS FROM MOROCCO, TUNISIA, AND EGYPT TEN YEARS AFTER THE ARAB SPRING

Nizar Becheikh

The American University in Cairo, School of Business, AUC Avenue, P.O. Box 74, New Cairo 11835, Egypt

E-mail: nbecheikh@aucegypt.edu

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Abstract. In 2011, the Arab region has seen an unprecedented popular uprising commonly referred to as the "Arab Spring". The objective of this paper is to analyze the economic performance and institutional changes that have taken place in Egypt, Tunisia, and Morocco following the Arab Spring, and understand the interconnect between the socio-political context on the one side, and economic performance and growth on the other side, in a period marked by severe turbulences, especially in Tunisia and Egypt. The analysis covers the economic, institutional, competitiveness, business environment, infrastructural, and human capital aspects in the three countries. It is based on the author's own research and knowledge of the region, the recent emerging literature on the topic, newspaper archives, and the publicly available economic and business data and reports provided by international organizations. Our analysis shows that Tunisia, the country that has ignited the Arab Spring, was the one most hit by its aftermath on the economic, social, and institutional levels. We argue that, although pure authoritarian regimes were historically a failure in the region, "Western" democracy has so far shown several limits when applied into the Arab region context as it led to neither socio-political stability nor economic growth.

Keywords: economic growth; institutions; political stability; Arab Spring; Egypt; Morocco; Tunisia; Political Economy

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JEL Classifications: E02, P48

Additional disciplines: political science

1. Introduction

Friday, December 17, 2010, 11:30 am (local time), a 26-year-old Tunisian street vendor named Mohamed Bouazizi doused himself with gasoline and set himself alight with a match. Bouazizi was in total despair after years of hopeless trials to make a decent living, which led him to get into debt to buy a small wheelbarrow and use it to sell fruits and vegetables in the streets of Sidi Bouzid, an inland impoverished city located some 260 kilometers away from Tunis, the capital city. With no vending permit, and no money to bribe the police officials to allow him continue his small business, he saw his cart confiscated by a municipal officer who was reported to have publicly spat at him and slapped him in the face. Outraged, Bouazizi put himself in fire to die a couple of

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weeks later by succumbing to his burns. His sister described his death as a "rebellion against insult" pushed by "oppression, injustice, and despotism" (Coşkun, 2019; Pearlman, 2013).

Bouazizi's self-immolation ignited a country-wide uprising, known as the "Jasmin revolution", that pushed then-President, Zine El Abidine Ben Ali, to step down and flee the country on January 14, 2011. Tunisians celebrated their "victory", and overnight started looking forward to the future with eyes full of confidence and optimism. They were confident that the upcoming years will bring them "jobs", "freedom", and "dignity", the slogans they had vigorously voiced during the two weeks of massive protests.

The popular upheaval moved soon to Egypt, where millions of people went into the street on January 25, in Tahrir square and all over the country, calling for the end of the Mubarak regime that had ruled the country for almost thirty years. Their claims were: "bread", "freedom", and "social justice" reflecting the economic and social hardships that Egypt was enduring (Mabon, 2013). Unable to contain the enormous popular uprising, Hosni Mubarak resigned on February 11 as President of Egypt.

Popular protests expanded in a domino effect to other countries in the region such as Libya, Yemen, Syria, Bahrain, and others, leading to what is commonly referred to as the "Arab Spring". The claims in all countries were the same: unseating the autocratic rulers that have been in power for decades, combatting rampant corruption, favoritism, and repression, and instituting democratic regimes reflecting a social contract based on economic inclusiveness, social justice, and the respect of the people and their rights (Acemoglu et al., 2018; Kienle, 2012).

Ten years later, different scenarios have taken place in the region. Syria, Libya, and Yemen witnessed a gloomy fate, as these countries entered into civil wars that were made difficult to end with the involvement of external parties supporting one side or the other of the conflict. Tunisia and Egypt have been spared this dramatic scenario. Despite the multiple episodes of instability, both countries ensured a relatively smoother transition, avoiding armed conflicts and ensuring the continuity of the State and its institutions.

Amidst these conflictual events, Morocco was one of the countries in the region that succeeded in maintaining order by absorbing the relatively modest social uprising led by the February 20 Movement (F20M) (Burger et al., 2013; Campante and Chor, 2012; Costello et al., 2015). King Mohamed VI, whose reign started in July 1999, had swiftly accommodated pressures of the furious crowd for more inclusive political, economic, and social reforms, which was deemed sufficient by the people as basis for activating the debate with the opposition for further renegotiations of the existing social contract (El-Haddad, 2020). The reforms implemented entailed continuity rather than radical changes though (Bergh and Rossi-Doria, 2015; Kienle, 2012; Looney, 2014). Morocco has thus been spared the political struggle that Egypt and Tunisia endured over the last decade.

The objective of this paper is to provide a holistic review of the three economies with a specific focus on the evolution of the macroeconomic and competitiveness parameters as well as the business and institutional environment over the last decade. Our aim is to understand the impact the Arab Spring had on the three economies, and analyze the interlocking ring between the socio-political context on the one side, and economic performance and growth on the other side, in a period marked by severe turbulences, especially in Tunisia and Egypt. The analysis is based on the author's own research and knowledge of the region, the recent emerging literature on the topic, newspaper archives, and the publicly available economic and business data and reports provided by international organizations.

The remainder of this paper is organized as follows. We first review the post-Arab Spring economic performance in the three countries (section 2). Section 3 follows with the analysis of competitiveness, innovation, and business environment developments. Section 4 reviews next the evolution of the infrastructure and human capital aspects.

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We then discuss the parallel between the socio-political context and economic performance in section 5, before ending with the main conclusions with regards to the decade-long impact the Arab Spring had on the three economies.

2. Economic Performance and Growth

Economic performance and growth followed different trajectories in the three countries. Post-revolution **Tunisia** has reported an overall negative economic performance translating into a Gross Domestic Product (GDP) (**Fig.1**) and GDP per capita (**Fig. 2**) decline throughout the decade. In the years preceding the revolution, and despite the serious flaws pertaining mainly to corruption, high unemployment, and unequal regional development, the World Economic Forum (WEF) repeatedly ranked Tunisia as the most competitive economy in Africa, and the World Bank (WB) as well as the International Monetary Fund (IMF) heralded Tunisia as a role model for other developing countries (Rijkers et al., 2017; World Bank, 2014). Ten years after the revolution, the Tunisian government is still struggling to boost economic growth and alleviate the negative effect the Arab Spring had on the aggregate economy (Matta et al., 2019).

The repeated terrorist attacks, political assassinations, and endless labor strikes have been a drag on the economy. Foreign Direct Investments (FDIs), despite a rebound in 2012, have consistently regressed over the years to amount $0.99bn in 2018, down from $1.33bn in 2010 (**Fig. 3**). International Tourism Receipts (ITR) have fallen from $3.5bn in 2010 to $1.7bn in 2016, before recovering to $2.3bn in 2018 (**Fig. 4**). Phosphates production, which was about 8 million tons in 2010, dropped to 2.5 million tons in 2011 (AfDB 2012), and has not recovered since then. Labor strikes, social protests, and the 21,000 new employees hired, many of them believed to be ghost jobs, have caused a loss of almost $1bn a year since 2011 to *Compagnie des Phosphates de Gafsa*, the state-owned phosphates producer, which had been providing Tunisia with 10% of its total exports, and are driving it to bankruptcy (Ghanmi, 2019; Serrano, 2019). Most other State-owned enterprises have suffered the same fate (Brockmeyer et al., 2015; Raballand et al., 2015).

Unemployment soared from 13.05% in 2010 to 18.33% in 2011, before falling gradually to 15.51% in 2019 (**Fig. 5**). The massive recourse to international debt has dramatically increased the external debt ratio which reached a critical 90% of the Gross National Income (GNI) in 2018 (**Fig. 6**). In 2018, the Tunisian dinar (TND) was traded at almost the double of its 2009 exchange rate to the USD (**Fig. 7**).

Most of the externally contracted debt was directed to finance the outrageously increasing government spending which reached 20.5% of the GDP in 2019, up from 16.6% in 2010 (Source: https://bit.ly/3tiKdz4).This increase is mainly attributable to the massive expansion of the wage bill in the wake of the revolution to reward supporters, honor the sharp rise in public sector hiring, and finance the multiple revisions of unionized public sector employees' wages (El-Haddad, 2020; Matta et al., 2019). In 2011 and 2012, around 95,000 new employees joined the public sector, versus 18,000 hired in 2010. The massive non-competitive recruitment, along with automatic promotions and salary raises, caused a degradation of competencies and a 44% increase in the wage bill between 2010 and 2014, compared to 28% increase between 2006 and 2009 (Brockmeyer et al., 2015). Moreover, the increased investment in the military to combat terrorism and maintain order put another strain on the public finances (Serrano, 2019).

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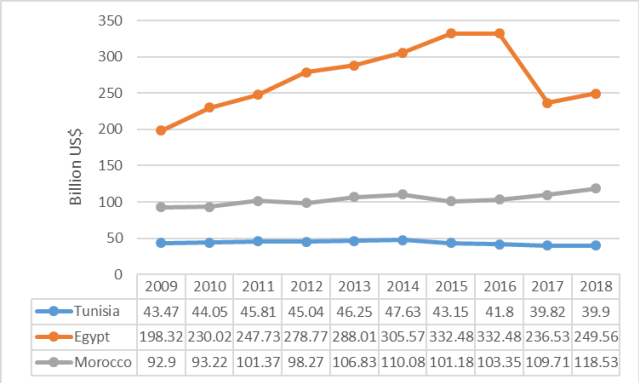
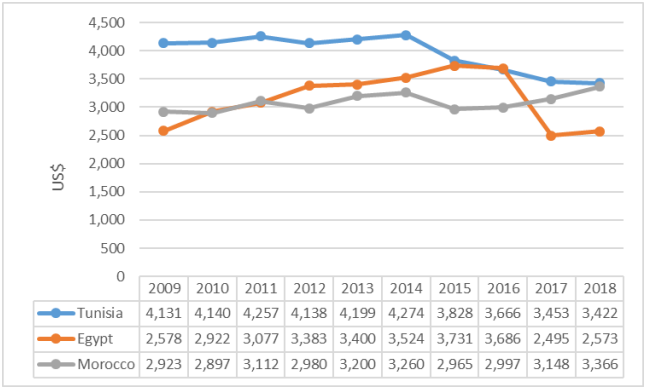


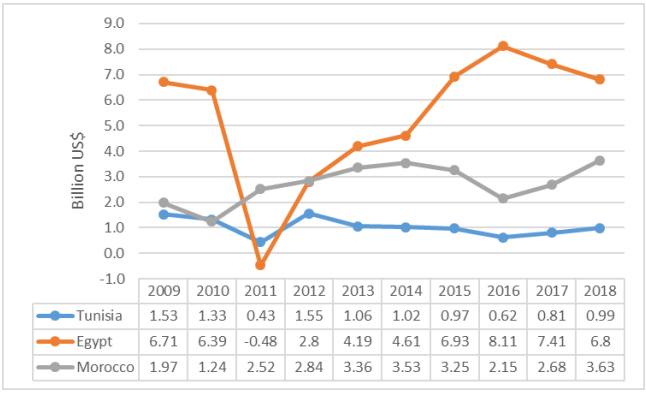
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	43.47	44.05	45.81	45.04	46.25	47.63	43.15	41.8	39.82	39.9
Egypt	198.32	230.02	247.73	278.77	288.01	305.57	332.48	332.48	236.53	249.56
Morocco	92.9	93.22	101.37	98.27	106.83	110.08	101.18	103.35	109.71	118.53

Fig 1. Gross Domestic Product (current prices)
Source: Own elaboration based on data retrieved from www.statistica.com



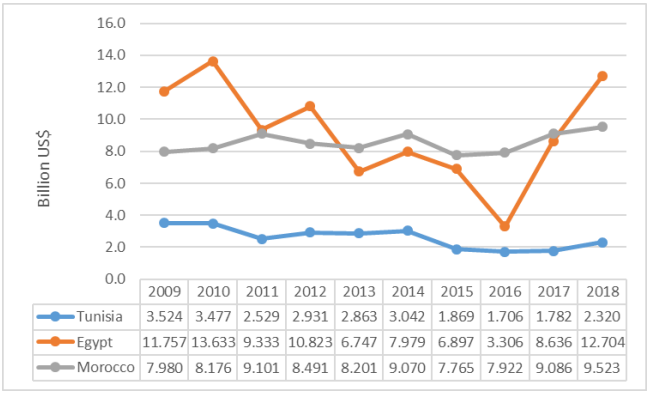
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	4,131	4,140	4,257	4,138	4,199	4,274	3,828	3,666	3,453	3,422
Egypt	2,578	2,922	3,077	3,383	3,400	3,524	3,731	3,686	2,495	2,573
Morocco	2,923	2,897	3,112	2,980	3,200	3,260	2,965	2,997	3,148	3,366

Fig 2. GDP per capita (current prices)
Source: Own elaboration based on data retrieved from www.statistica.com



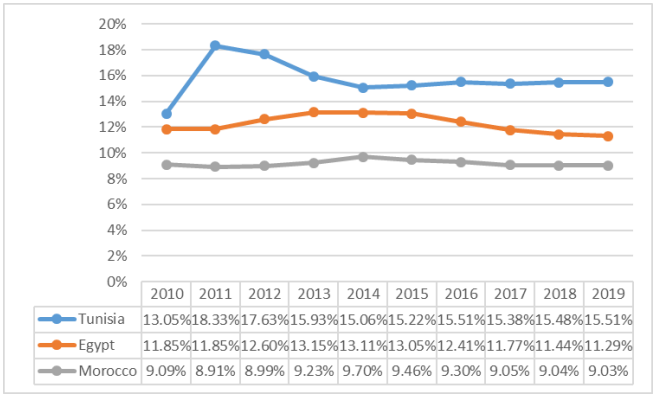
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	1.53	1.33	0.43	1.55	1.06	1.02	0.97	0.62	0.81	0.99
Egypt	6.71	6.39	-0.48	2.8	4.19	4.61	6.93	8.11	7.41	6.8
Morocco	1.97	1.24	2.52	2.84	3.36	3.53	3.25	2.15	2.68	3.63

Fig 3. Foreign Direct Investment
Source: Own elaboration based on data retrieved from www.theglobaleconomy.com



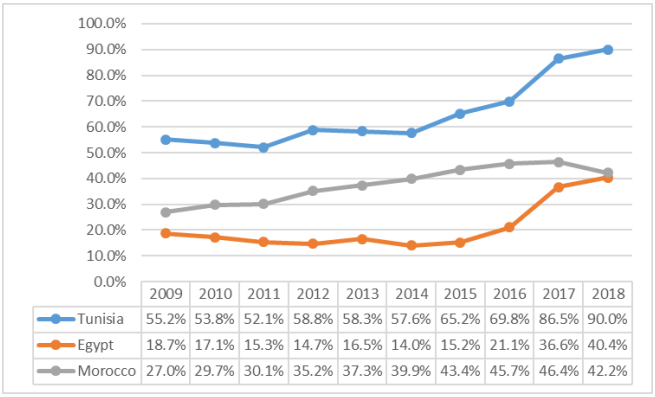
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	3.524	3.477	2.529	2.931	2.863	3.042	1.869	1.706	1.782	2.320
Egypt	11.757	13.633	9.333	10.823	6.747	7.979	6.897	3.306	8.636	12.704
Morocco	7.980	8.176	9.101	8.491	8.201	9.070	7.765	7.922	9.086	9.523

Fig 4. International tourism receipts
Source: Own elaboration based on data retrieved from https://data.worldbank.org



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Tunisia	13.05%	18.33%	17.63%	15.93%	15.06%	15.22%	15.51%	15.38%	15.48%	15.51%
Egypt	11.85%	11.85%	12.60%	13.15%	13.11%	13.05%	12.41%	11.77%	11.44%	11.29%
Morocco	9.09%	8.91%	8.99%	9.23%	9.70%	9.46%	9.30%	9.05%	9.04%	9.03%

Fig 5. Unemployment rate
Source: Own elaboration based on data retrieved from www.statistica.com



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	55.2%	53.8%	52.1%	58.8%	58.3%	57.6%	65.2%	69.8%	86.5%	90.0%
Egypt	18.7%	17.1%	15.3%	14.7%	16.5%	14.0%	15.2%	21.1%	36.6%	40.4%
Morocco	27.0%	29.7%	30.1%	35.2%	37.3%	39.9%	43.4%	45.7%	46.4%	42.2%

Fig 6. External debt as percent of GNI
Source: Own elaboration based on data retrieved from www.theglobaleconomy.com

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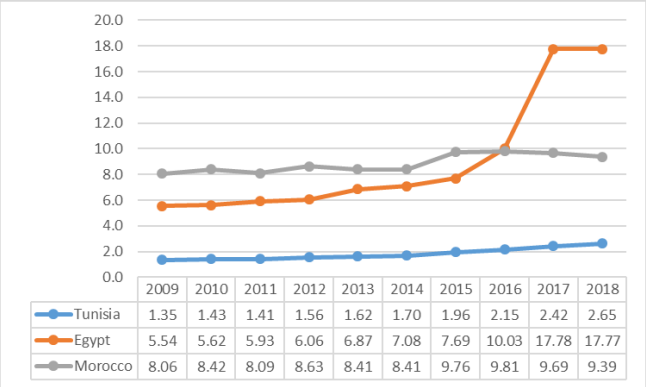
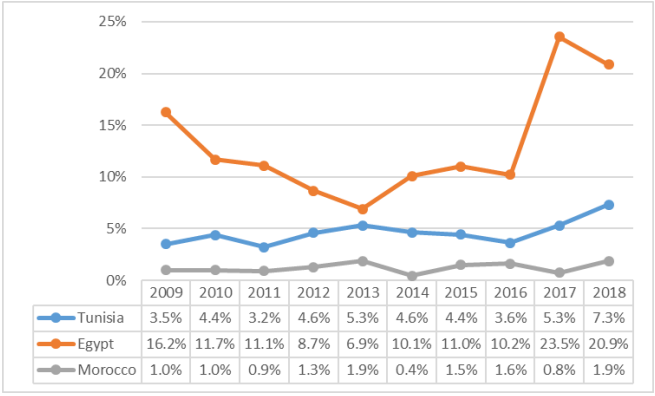


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	1.35	1.43	1.41	1.56	1.62	1.70	1.96	2.15	2.42	2.65
Egypt	5.54	5.62	5.93	6.06	6.87	7.08	7.69	10.03	17.78	17.77
Morocco	8.06	8.42	8.09	8.63	8.41	8.41	9.76	9.81	9.69	9.39

Fig 7. Exchange rate: local currency units per US$
Source: Own elaboration based on data retrieved from www.theglobaleconomy.com



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tunisia	3.5%	4.4%	3.2%	4.6%	5.3%	4.6%	4.4%	3.6%	5.3%	7.3%
Egypt	16.2%	11.7%	11.1%	8.7%	6.9%	10.1%	11.0%	10.2%	23.5%	20.9%
Morocco	1.0%	1.0%	0.9%	1.3%	1.9%	0.4%	1.5%	1.6%	0.8%	1.9%

Fig 8. Inflation rate
Source: Own elaboration based on data retrieved from www.statistica.com

In **Egypt**, January 25th (Jan25) revolution had an immediate drastic effect on the FDIs. Year 2011 saw the investors fleeing the country which resulted in a negative net FDI of $0.48bn (net outflow) down from $6.39bn inflows in 2010. The numbers have quickly recovered though, peaking at $8.11bn in 2016. ITRs have dropped dramatically from $13.6bn in 2010 to a low of $3.3bn in 2016, before rising again to $12.7bn in 2018. November 3rd, 2016 marked a turning point in the post-revolution Egyptian economy. In an attempt to stabilize the economy and increase the foreign currency inflows which were severely affected by, among others, a significantly continual increase in the trade balance deficit since 2010, and to meet one of the key demands of the IMF to secure a $12bn loan, the Central Bank of Egypt decided to float the Egyptian Pound (EGP). Overnight, the exchange rate of the EGP to the USD passed from 8.8 to 15.3, to further rise to more than EGP18/USD by January 2017.

While this decision considerably improved the trade balance deficit, it led to a severe inflation that was exacerbated by the government decision to introduce new taxes and cut energy subsidies. Inflation soared from 10.2% in 2016, which was below 2010 levels (11.7%), to a critical high of 23.5% in 2017; a level that had not been seen in a generation (**Fig. 8**). On the positive side, the floating of the EGP has revived the tourism sector, which with the mega infrastructure, energy, and technology projects initiated by the government, helped in bringing the rising unemployment back to the pre-revolution levels. The recent years have seen the Egyptian economy getting slowly back to positive economic growth and performance. The level of external debt remains a source of concern though, as the ratio of external debt to GNI jumped from 17.1% in 2010 to 40.4% in 2018; an increase of 136%.

Morocco sustained the most regular GDP growth following the Arab Spring. Morocco's GDP rose to $118.53bn in 2018 up from $93.22bn in 2010; a 27% increase. This reflected on the Moroccan Dirham which, despite a slight depreciation, has maintained a relatively stable exchange rate fluctuation to the USD compared to the TND and the EGP. Morocco has posted a modest increase of 16% in its ITR which grew from $8.2bn in 2010 to $9.5bn in 2018. In 2018, the FDIs rocketed to $3.63bn up from $1.24bn in 2010, an increase of 193%. Despite cutting subsidies for some energy products in late 2014, Morocco succeeded in maintaining inflation at less than 2%. This relatively positive economic performance did not help in improving employment though; even though the unemployment rate remains the lowest among the three countries (9.03% in 2019) and has been maintained stable during the post Arab Spring years. Similar to Egypt and Tunisia, Morocco relied heavily on foreign debt, which led to an increased ratio of external debt to GNI from 29.7% in 2010 to 42.2% in 2018.

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A crucial aspect in assessing economic prosperity is the distribution of wealth. The Gini index is commonly used as a gauge of economic inequalities among a population, with higher coefficients showing higher inequalities. The available data show a Gini index of 30.2% and 35.8% in Egypt and Tunisia, respectively, in 2010, and 39.5% in Morocco in 2013 (Source: data.worldbank.org/indicator/SI.POV.GINI). In 2020, Egypt, Tunisia, and Morocco posted Gini coefficients of 31.8%, 40%, and 40.9%, respectively (Source: Gini Coefficient by Country Population (2020-02-17). Retrieved from worldpopulationreview.com). These figures show that a decade later, the Arab Spring pushed the Gini coefficients upward in the three countries, reflecting higher inequalities.

Contrary to Egypt, Tunisia has failed to maintain a wealth distribution comparable to 2010, although the share dedicated to regional development in the public budget quadrupled after the revolution (Turki and Verdeil, 2015). The reasons for this unexpected outcome are multiple: the economic downturn, bureaucratic bottlenecks preventing the efficient spending of regional development budgets, but also rising corruption (I Watch, 2016; Matta et al., 2019), and the reckless increase of labor strikes which affected the competitiveness of the economy and further weakened the public finances that constitute the tool for wealth redistribution (Baccouche, 2016). Moreover, the convoluted semi-presidential political system that the 2014 constitution instituted bestows the power to three Presidents: President of the Republic, President of the Parliament, and President of the Government, which turned to be an obstacle to efficient governmental action and has repeatedly contributed to political stalemates (Mekki, 2018). In Morocco, inequalities have increased in both urban and rural areas (Loonley, 2014), and remain in 2020 at levels higher than Tunisia's and Egypt's ones. These high Gini coefficients translate the frustration of the disadvantaged in all three countries with no exception.

3. Competitiveness, Innovation, and the Business Environment

The macroeconomic data indicate that overall, among the three countries, Egypt has struggled the most in the immediate aftermath of the Arab Spring, before recovering gradually in the recent years, Morocco has benefited from a more stable environment to gradually improve economically, while Tunisia has seen its economic dashboard deteriorating over the years and the situation does not seem to recover. The following sections will focus on the business environment by examining the progress of competitiveness indicators and their prerequisites.

3.1 The Institutions

The WEF Executive Opinion Surveys provide the factors considered as the most problematic for doing business in the included economies. **Table 1** recapitulates the top three most problematic factors for the period 2009/10-2017/18 for the three economies under review. A surprising observation for Tunisia is that seven years after the revolution, corruption moved gradually from a low ranked barrier to business to the second most problematic factor for doing business in 2017/18. "Inefficient government bureaucracy" and "Policy instability" represent the two other obstacles to business in the top-three list. In Morocco, "corruption" and "inefficient government bureaucracy" were also the top two business barriers in 2017/18. Together with "access to financing", they have consistently been among the top-three list in the recent years. As for Egypt, the country has shown the most changing profile with multiple factors entering and exiting the top-three list throughout the years. "Policy instability" and "government instability" represent overall the two factors that most affected businesses in Egypt in the last decade though, while "corruption" and "inflation" became most problematic in 2017/18.

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Table 1. Top-Three Most Problematic Factors for Doing Business

	2009/10	2011/12	2013/14	2014/15	2015/16	2016/17	2017/18
				Tunisia			
Inefficient government bureaucracy	**1 (14.3%)**	**1 (12.2%)**	**2 (11.9%)**	**1 (12.7%)**	**1 (16.4%)**	**1 (18.1%)**	**1 (18.1%)**
Corruption	11 (3.7%)	7 (7.1%)	10 (4.4%)	6 (6.7%)	4 (8.0%)	**3 (11.7%)**	**2 (11.6%)**
Policy instability	12 (0.6%)	4 (10.8%)	**1 (16.5%)**	**3 (11.8%)**	**3 (10.7%)**	**2 (13.8%)**	**3 (10.0%)**
Restrictive labor regulations	**3 (11.5%)**	5 (10.4%)	6 (7.2%)	4 (8.3%)	10 (4.9%)	4 (7.4%)	4 (8.1%)
Government instability	13 (0.5%)	**3 (11.0%)**	5 (7.7%)	8 (5.4%)	13 (3.2%)	12 (4.3%)	5 (7.5%)
Access to financing	**2 (14.1%)**	**2 (11.9%)**	**3 (9.3%)**	**2 (12.3%)**	**2 (11.8%)**	5 (6.4%)	6 (6.6%)
				Egypt			
Inefficient government bureaucracy	**1 (12.3%)**	4 (9.1%)	14 (1.9%)	14 (2.7%)	**2 (10.5%)**	14 (2.7%)	4 (9.0%)
Corruption	5 (9.5%)	6 (7.3%)	5 (7.5%)	5 (7.7%)	12 (4.1%)	5 (7.7%)	**3 (9.8%)**
Policy instability	15 (0.7%)	**1 (13.6%)**	**1 (22.9%)**	**1 (21.0%)**	**1 (11.8%)**	**1 (21.0%)**	**1 (15.2%)**
Government instability	14 (1.0%)	8 (6.4%)	**2 (14.7%)**	**2 (12.5%)**	8 (6.1%)	**2 (12.5%)**	11 (3.5%)
Access to financing	7 (7.6%)	**3 (10.6%)**	4 (7.8%)	**3 (10.2%)**	5 (9.2%)	**3 (10.2%)**	6 (7.9%)
Tax regulations	**2 (12.0%)**	13 (3.0%)	12 (4.2%)	13 (3.1%)	13 (3.9%)	13 (3.1%)	13 (3.0%)
Poor work ethic in national labor force	6 (7.8%)	7 (7.1%)	8 (5.4%)	8 (5.4%)	**3 (10.4%)**	7 (5.4%)	9 (5.0%)
Inadequately educated workforce	**3 (10.4%)**	**2 (13.4%)**	6 (6.4%)	7 (5.4%)	4 (10.1%)	8 (5.4%)	5 (7.9%)
Inflation	4 (9.9%)	10 (4.6%)	11 (3.7%)	12 (3.2%)	9 (5.0%)	12 (3.2%)	**2 (14.2%)**
Crime and theft	11 (4.5%)	12 (3.6%)	**3 (9.3%)**	9 (4.3%)	10 (4.5%)	9 (4.3%)	16 (0.7%)
				Morocco			
Inefficient government bureaucracy	5 (8.8%)	4 (10.0%)	**1 (19.1%)**	**2 (13.9%)**	**2 (15.6%)**	**3 (12.7%)**	**2 (13.8%)**
Corruption	**2 (15.2%)**	**2 (17.7%)**	**2 (15.8%)**	6 (10.0%)	**3 (12.2%)**	6 (10.5%)	**1 (15.1%)**
Access to financing	**1 (15.9%)**	**1 (18.6%)**	**3 (13.5%)**	**1 (16.3%)**	**1 (17.9%)**	**1 (15.4%)**	**3 (11.4%)**
Inadequate supply of infrastructure	**3 (10.6%)**	**3 (11.6%)**	10 (4.1%)	4 (10.2%)	8 (4.8%)	8 (5.7%)	8 (5.4%)
Inadequately educated workforce	6 (8.3%)	7 (5.7%)	6 (7.9%)	**3 (11.3%)**	4 (11.2%)	**2 (13.0%)**	5 (10.3%)

Source: Data retrieved from the yearly Global Competitiveness Reports published by the World Economic Forum.
Percent of responses between brackets.

These country profiles suggest that the revolution, particularly in Tunisia, has amplified corruption, favoritism, and inefficiencies, the main reasons that set it off in the first place. The WEF institutions-related indicators confirm this observation (**Appendix A**). Although it is estimated that the total value of Ben Ali related clans confiscated assets in 2011 amounted to more than a quarter of **Tunisia**'s GDP (Rijkers et al., 2017), which suggests outrageously corrupted industrial policies mainly captured by cronies, the WEF data suggest that the situation is worse off after the revolution. Despite establishing a Commission for Good Governance and Anti-Corruption in the new 2014 constitution, corruption has eventually escalated (I Watch, 2015; Transparency International, 2016). Among the main reasons of these rising corruption levels is the decision made by the successive post-revolution governments to convert corrupted businessmen associated with the *ancien régime* into a political capital instead of prosecuting them or initiating a large scale reconciliation process. "*After the revolution, a constant idea regularly came back: how to finance the political parties? The parties need businessmen and their money*" declared AbdelFattah Mourou, one of the founders of *Al-Nahda* Islamic party and then Vice-President of the Tunisian Parliament, in an interview in 2014 (Kchouk, 2017). This granted entrepreneurs and the business elite, some of them were closely connected to Ben Ali's cronies, a safe and powerful come back as this gave them higher influence on the economic, but also the political decisions to further consolidate their resources and find new opportunities (Oubenal and Ben Hamouda, 2018).

The impact corruption had on the economy was augmented by the instable political scene and the highly volatile economic environment, especially in the aftermath of the assassination of Chokri Belaid in February 2013 and Mohamed Brahmi in July 2013, two important figures of the opposition to the Islamic-led government dominated by *Al-Nahda* (Matta et al., 2019). Moreover, "there were policy uncertainties associated with the political deadlock between secular and Islamic political leaders, some of whom wished to follow an Islamic economic

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model similar to the one attempted by the Muslim Brotherhood in Egypt", explain Matta et al. (2019:248). *Al-Nahda*, whose public discourse articulates moderate positions on the role of religion in society, has been in reality courting groups with more extreme views such as *Ansar-al-Sharia* which between 2011 and 2013, and under the eyes of *Al-Nahda* government, occupied the public space, taking over more than 400 mosques where it selected jihadist imams who played a central role in galvanizing the base, recruiting Tunisian fighters for Syria, and reinforcing the jihadist base in the country (Serrano, 2019).

This political turmoil led to souring relationships and reduced trust of Tunisians in the ruling class and systems (Taylor and Miller, 2018). The WEF data confirm this reality. As shown in **Appendix A**, "Public trust in politicians", "irregular payments and bribe", "judicial independence", "favoritism in decisions of government officials", "burden of government regulation", "transparency of government policymaking", and "business cost of terrorism" are all indicators where Tunisia has collapsed over the last decade. An improvement has been recorded recently though in the transparency of the governmental budgeting process and the incidence of corruption, following the strict oversight exerted by the parliament over the government decisions and activities as a result of the nascent democratic system instituted by the 2014 constitution and gradually implemented thereafter.

Egypt started the decade in a worse situation compared to Tunisia. Contrary to Ben Ali who relied more on technocrats and kept the private capital out of the government and the parliament (Kchouk, 2017; Oubenal and Ben Hamouda, 2018), Mubarak gave entrepreneurs access to leading positions in the cabinet, and all ministers related to industrial development were owners of large enterprises (Altenburg, 2011). Moreover, firms connected to Mubarak crony, despite their lower financial performance, were "given" easier access to financing and larger market shares than their non-connected competitors (Chekir and Diwan, 2013; Darwisheh, 2012). After the Jan25 revolution, Egypt had a quasi U-shaped progress. Immediately after the revolution, the political and economic uncertainties reached their apex (Darwisheh, 2020). Until 2014, in addition to street violence and social turmoil, none of the governments that followed Mubarak ousting had presented clear policy directions for more equitable and sustainable economic transformation (Pfeifer, 2015). The situation gradually improved thereafter allowing Egypt to make major leaps forward, especially in reinforcing the independence of its judicial system and budget transparency. Corruption and terrorism remain serious threats to Egypt's transitional economy though.

Morocco started the decade in the worst position among the three economies for many of these indicators. In Morocco, similar to Egypt, entrepreneurs and businessmen had a substantial influence on policy making as ministers and, since 1997, as parliamentarians (Bennani-Chraïbi, 2008; El-Haddad, 2020). The structural institutional reforms gradually introduced after 2011 by King Mohamed VI and the Moroccan government helped the country close the gap and even overtake Tunisia and Egypt in areas such as public trust in politicians, incidence of corruption, burden of government regulations, transparency of government policymaking, and, expectedly, terrorism incidence. The reforms introduced have succeeded in changing the perceptions about the authoritarianism of the monarchy and the *Makhzen*, power structure surrounding the King, even though the 2011 constitution and the subsequent institutional reforms did not really change the monopolistic role the King holds as arbiter between the various forces, and the iron fist the *Makhzen* has on the country's economy and the various branches of power (Bergh and Rossi-Daria, 2015; Desrues, 2013).

Looking forward, the WEF data (**Appendix A**) reveal that Moroccans and Egyptians are more confident than Tunisians in the ability of their governments to ensure policy stability through a clear long term vision and responsiveness to change. The frequent reshufflings of governments and cabinets since 2011, coupled with the struggling economy, and lagging economic and social structural reforms seem to have cast a shadow over the Tunisians' trust in their politicians and their ability to ensure a brighter future for the country and its citizens.

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3.2 Competitiveness and Innovation

Since the late 1980s, Tunisia, Egypt and Morocco have carved out important niches in the global apparel supply chain (Cammett, 2007). They have gradually become privileged suppliers of textile and clothing products to the European Union, counting on their proximity advantage and cheaper transport to win market shares over the strong Southeast Asian competition (World Bank, 2006). This global competitive advantage has been reinforced during the 1990s and 2000s by promoting industrial clusters as means to upgrade and boost industrial productivity and innovation.

The *Programme de Mise à Niveau de l'Industrie* (PMNI, Industrial Upgrading Programme) adopted in 1995 in **Tunisia** provided support for industrial companies to reinforce their competitive capacity and prepare their effective integration into global value chains (Ait Ali and Msadfa, 2016; ITCEQ, 2017). Although textile and clothing is still dominating with almost 70% of the manufacturing products (Ayadi and Mattoussi, 2014), the country has expanded its sectoral focus to other areas where Tunisia has been building a comparative advantage such as agrifood, mechanical and electric industries, as well as biotechnology, pharmaceuticals, healthcare and renewable energy (ECCP, 2017). Prior to the Jasmin revolution, nine industrial clusters have been established to encourage the development and internationalization of activities in these sectors. The PMNI continued after the revolution but its effectiveness has been remarkably limited for lack of strategic direction, making the preservation of the pre-revolution performance a challenging target (ITCEQ, 2017).

Cluster-based industrialization has also been a key pillar in **Egypt**'s industrial development, especially with the adoption of the *Industrial Development Strategy* in 2005 (Ait Ali and Msadfa, 2016). This enabled an effective diversification of the economy into labor intensive sectors such as textile, furniture, leather, food processing, handicrafts, and medicinal and aromatic plants, but also into technology oriented sectors such as information and communication technologies (ICTs) with, notably, the establishment in 2001 of Smart Village, a state-of-the-art technology cluster and business park located in Western Cairo (Abdelaziz et al., 2018). Sustaining industrial clusters continued to play a central role after the Jan25 revolution and appears among the key pillars of Egypt's industry and trade development strategy 2016-2020 (Entrust, 2018; MTI, 2017). In addition to sustaining the traditional sectors, the strategy highlights clustering in value added sectors such as renewable energy, waste recycling, car components, and manufacturing machines and equipment, as key development axes.

In **Morocco**, the *Emergency Plan 2005*, the *National Pact for Industrial Emergence 2009*, the *Industrial Acceleration Plan* (IAP) *2014-2020*, and the recently adopted *IAP 2021-2025* represent the main frameworks guiding the public policies for industrial development and technological transformation (See Hahn and Vidican-Auktor (2018) for a review of Morocco's economic models and industrial policies from 1950 to 2017). In addition to reinforcing Morocco's comparative advantage in textile, these successive plans have given birth to industrial clusters, mainly in agrifood, ICTs, microelectronics, renewable energies, aerospace, and the automotive sector. Most of these clusters are underperforming though, mainly due to a poorly structured research and innovation ecosystem, ill governance, and the lack of public-private partnerships (Amraoui et al., 2019). These shortcomings explain, at least partially, the modest progress Morocco had over the last decade with regards to its global competitiveness performance (**Appendix A**).

Morocco recorded a deterioration of the nature of its competitive advantage. Despite the heavy investments in its industrial development, Morocco's global competitive advantage is still based primarily on low-cost labor and low-value-added activities rather than on unique products and processes. This applies even to technology sectors such as automotive supplies (Hahn and Vidican-Auktor, 2017). Egypt and Tunisia have seen their performances completely collapsing here with Egypt's and Tunisia's global rankings plummeting from 35th and 44th in 2010/11 to 95th and 120th in 2017/18, respectively. The competitiveness of both countries was mainly affected by an overall significant deterioration in the intensity of local competition, the quantity and quality of local suppliers,

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the breadth of their value chain, and the capacity of companies to innovate. Egypt has shown significant improvements in 2019 though, especially in the innovation capabilities of firms and the extent of market dominance, suggesting corporate activities that are spread among larger number of firms. Morocco has made some small steps forward on most of these fronts; steps that were insufficient to help the country make significant overall progress though.

The Global Innovation Index (GII) data (**Appendix B**) provide additional insight on the way the business environment has evolved in the three countries in the aftermath of the Arab Spring. Overall, Morocco has shown improvements compared to Tunisia and Egypt; although Tunisia still maintains the best relative position among the three countries in terms of overall innovation performance.

Tunisia has been significantly affected by the deteriorating state of its innovation clusters falling from a 56th/125 global position in 2011 to 100th/129 in 2019; an area where Egypt and Morocco succeeded to improve over the decade. Morocco's performance is largely attributable to the sustained development of its automotive cluster which has experienced a fresh momentum with the deployment of the country's second Renault plant in Tangier in 2012, and a Peugeot factory in Kenitra in 2019. By 2014, Morocco became the second-largest vehicle producer in Africa (Hahn and Vidican-Auktor, 2017), and by 2018 it surpassed South Africa as the leading automotive producer in the continent (Hakam, 2020; Kasraoui, 2018).

Moreover, from 2012 to 2017, Morocco succeeded in adding eight clusters to its network in various areas such as textile, seafood products, eco-constructions, and solar energy (Amraoui et al., 2019). As for Egypt, despite a setback in the years following the revolution, the country has succeeded as well in maintaining a relatively well-entrenched innovation clusters network, which was reinforced in 2017 by the establishment of Borg Al Arab Innovation Cluster specialized in Artificial Intelligence and the Internet of Things (Source: https://bit.ly/2UTkzlt) This placed Egypt in the best relative ranking (38th/129) in the state of cluster development in 2019.

Tunisia still holds the best performance for the university/industry research collaboration, government effectiveness, and the ease of resolving insolvency, although the country was performing better in these areas in 2009/10 as compared to 2019. Morocco was more successful in maintaining easier procedures for entrepreneurs to start their businesses; an area where both Tunisia and Egypt have dramatically failed throughout the years. Overall, these data show that Tunisia, although struggling to sustain its overall innovation performance, is still ahead of Morocco and Egypt. However, this was only possible because of the deteriorating performance of Egypt and the modest improvements for Morocco over the last decade, rather than real advances for Tunisia.

3.3 The Financial Market

Financial support plays a critical role, especially in developing countries, to help businesses grow within a usually unfavorable institutional and business environment. **Appendix A** presents selected indicators reflecting the performance of financial markets in Tunisia, Egypt, and Morocco for the last decade. An alarming observation for Tunisia, which started the decade ahead of Egypt and Morocco along all parameters, is the dramatic gradual degradation of its performance, dragging the country down to the last relative position by the end of the decade. Egypt, which had a significant plunge along all indicators after the Jan25 revolution, has quickly recovered and succeeded in gradually consolidating its financial systems starting 2016. In 2017/18, Egypt held the best relative position for the availability of financial services, and the ease of access to loans, and in 2019, it became best performer, comparatively, for the soundness of its banks, the financing of SMEs, and the venture capital availability. This performance is the result of sustained public efforts to boost economic activity and raise financial inclusion. In 2019, and in an effort to further promote SMEs financing, the backbone of the domestic economy, the Central Bank of Egypt obliged Egyptian banks to dedicate 20% of their total loans portfolio to SMEs, which is expected to provide 350,000 SMEs with EGP 200bn (around $12bn) within four years at an

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interest rate of 5% (Akinfieva, 2019). Despite this remarkable comeback, Egypt has not yet regained its 2010/11 performance for most of its financial market parameters.

Unexpectedly, Morocco degraded along all indicators, except the soundness of its banks. Morocco does not seem to have seized the opportunity of a decade of relative stability to strengthen its financial markets and provide better financial assistance to its businesses. To the opposite, almost all indicators have fallen over the last decade, most notably for the availability of venture capital and other financial services. The GII data (**Appendix B**) confirm this negative performance as the reported results place Morocco in the 94th/129 position for the "ease of getting credit" in 2019, 7 ranks below Tunisia (87th) and 40 positions below Egypt (54th).

4. Infrastructure and Human Capital

A review of the performance of the three countries cannot be complete without an examination of three key pillars to any economy: infrastructure, education, and labor market efficiency. The following sections provide details on the evolution of these economic pillars in Tunisia, Egypt and Morocco in the aftermath of the Arab Spring.

4.1 Infrastructure Development

Building the critical industrial infrastructure is an essential part of providing new opportunities for economic rebalance in post-Arab Spring North Africa (McCarthy, 2012). The years following the Arab Spring have seen infrastructure development following three different paths in the three countries, with Tunisia being the most significantly hit by the Arab Spring aftermath. Even though under Ben Ali's regime investments in most sectors remained under state control, and private investments and FDIs in infrastructure, among others, depended on the express authorization of the public authorities (Altenburg, 2011; Rijkers et al., 2017), Tunisia started the decade with the best quality of overall infrastructure, ahead of both Egypt and Morocco (**Appendix C**). Over the years, Tunisia has gradually slipped to the last relative position, ending the decade in the 85th/141 rank, behind Egypt (52nd) and Morocco (53rd).

The relatively limited investments in the utility and transport related infrastructure since the revolution did not help Tunisia sustain its long standing comparative infrastructural advantage. To the opposite, Tunisia has seen its advantage reversed in all infrastructure related aspects with no exception. Egypt has made tremendous improvements, especially in enhancing the quality of its roads and the quality of electricity supply to end 2019 in the best relative position in those areas. The leadership shifted to Morocco for all remaining infrastructural aspects, although the efforts put forth in some areas such as the availability of latest technologies to firms, and firm-level technology absorption remain modest.

The significant improvements in Morocco are the result of the priority given to modern infrastructure development over the last decade, which placed the country as one of the best infrastructure hubs in the African continent (Ballard, 2020). Only for the period 2010-2015, the Moroccan government invested more than $15bn in upgrading and expanding its basic infrastructure (MCCG, 2019), which boosted Morocco's assets, especially for the quality of roads, port infrastructure and seaport services, and the quality of air transport infrastructure and services. Morocco's railroad infrastructure has also been bolstered with the inauguration in 2018 of the first high speed rail line in Africa connecting the northern port of Tangier with Rabat (the capital) and Casablanca (the main commercial hub); an investment of $2.5bn (Berrada, 2018).

Egypt has seen a quasi U-shaped progress for most of its infrastructural indicators. The country has seen a dramatic slump of its infrastructure at all levels in the years following the Jan25 revolution. In the period 2013-2016, Egypt's global positioning was beyond 100 for multiple years in the quality of roads, the quality of electricity supply, the availability of latest technologies, and the firm-level technology absorption. However,

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improvements started to show up afterwards, especially in the quality of roads, the quality of railroad infrastructure and services, the quality of air transport infrastructure and services, and the quality of electricity supply. This is the result of the large scale infrastructure projects initiated by the government in the recent years such as the $8.2bn expansion of the Suez Canal and its economic zone (BBC, 2015), and the 2018 construction boom leading Egypt to surpass Saudi Arabia as the second largest single projects market in the region with more than $33bn of contract awards and $300bn of projects in the pipeline (Egypt Today, 2019). In 2018, Egypt also secured 62 electricity and 40 drinking water projects, 100 high and medium technology and 186 traditional greenhouses for agriculture and farming, in addition to mega projects initiated to build or ensure maintenance for roads, highways, bridges, tunnels, railway lines, railcars, and railway systems (El Tawil, 2019).

In sum, from a pure infrastructure perspective, Morocco and Egypt have clearly overtaken Tunisia which has seen most of its infrastructure-related rankings dropping by more than 50 positions by the end of the decade.

4.2 The Educational System

Education is another fundamental pillar to any economy. It determines the quality of a country's human capital and its readiness to serve the country's needs. Historically, the Tunisian educational system has been one of the best in the Arab region following the strategic importance and the heavy investments made in this area since the independence of the country in 1956. Education, healthcare, and women emancipation are areas that Habib Bourguiba, founding President of the Republic, has given a central place in Tunisia's development strategy (Baccouche, 2016). These efforts continued under Ben Ali regime. From 1990 to 2010, the Tunisian government devoted an average of 6.3% of GDP to education (7.2% in 2010), and in 2010, 6.2% of the adult population held a university degree, compared to a world average of 3.9% (AfDB, 2012). Even though Ben Ali's policies have received criticisms with regards to education and healthcare particularly, he left power with Tunisia being in advanced global positions with regards to all education parameters and outcomes as shown in **Appendix C**.

In 2010/11, Tunisia was 8th/139 in the quality of math and science education, 20th/139 in the overall quality of the education system, and 22nd/139 in both the quality of primary education and the quality of management schools. Tunisia had also the best relative position for the enrollment rates in primary, secondary, and tertiary education. Tunisia had the best quality of scientific research institutions with a global ranking of 38th/139, compared to 93rd and 110th for Morocco and Egypt, respectively. A decade later, Tunisia rankings have all collapsed, although the country is still ahead of Morocco and Egypt along all indicators, except the tertiary education enrolment rate and the prominence of research institutions, where Egypt became best in class. The collapse of the Tunisian educational system is alarming. Between 2010 and 2017, the country lost more than 80 positions in its global ranking for the overall quality of the educational system to crash to the 103rd/137 rank. In 2019, Tunisia was positioned 108th/141 for the skillset of graduates and 99th for the implementation of critical thinking in teaching.

Egypt has always suffered a lamentable educational system. The situation worsened after the Arab Spring, especially from 2013 to 2016 where the country was placed at the latest ranks globally. Although the situation has slightly improved later, the country is still among the worst globally in this area with a global ranking of 130th/137 for its overall educational system in 2017/18, and 133rd/141 for the skillset of graduates in 2019.

The situation is only slightly better in Morocco compared to Egypt. Education is still an area where Morocco is deeply suffering as a result of decades of marginalization of the rural population, especially under the reign of King Hassan II (1961-1999). Contrary to Bourguiba, Hassan II made the forestalling of the emancipation of rural areas, which at the time represented 60% to 70% of the Moroccan population, one of the main arms of his strategy to control this large segment of the population and keep it depoliticized and disconnected from the urban centers (Bergh and Rossi-Doria, 2015). The illiteracy rates, which certainly have decreased over time from 65% in 1982 to 43% in 2004, remain higher among the rural population where the illiteracy rate was of 60.5% in 2004

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compared to 29.4% in the urban areas (Source: https://bit.ly/3ajTM8c). The Moroccan educational system further collapsed after the Arab Spring from 105th/139 in 2010/11 to 120th/137 in 2017/18. Despite some improvements in the enrolment rates, Morocco posted huge degradation when it comes to education quality.

4.3 Labor Market Efficiency

Labor market efficiency is another important aspect that underlies development in any economy. It reflects the level of suitability between jobs and workers' skills and the level of incentives for both employers and employees to behave in ways that promote human capital productivity (Schwab and Sala-i-Martín, 2015). Here again, Tunisia started the decade in leading positions compared to Egypt and Morocco, and has gradually lost its advantage throughout the years (**Appendix C**). In 2010/11, Tunisia was ranked 40th/139, and 52nd/139 globally for the "reliance on professional management", and the "hiring and firing practices", to see its rankings deteriorate to 104th/141 and 126th/141 in 2019, respectively. Tunisia lost its comparative advantage to Morocco (58th) for the former and to Egypt (63rd) for the latter.

The impact the Arab Spring had on Tunisia was also dramatic for the country's capacity to retain its "brains". The political and economic unrest and the lack of options and prospects resulted in a decade of massive waves of highly skilled professionals fleeing the country. It is estimated that the number of engineers who left the country amounted 10,000 in the period 2017-2019, while the number of medical doctors fleeing to France, Germany and the Gulf countries each year has doubled (Blaise et al., 2019). From 2011 to 2017, Tunisia's global position in the country's capacity to retain its talents plummeted from 42nd/139 to 111th/137, and in 2019, Tunisia was 88th/141 for the ease of finding skilled employees.

The comparison between the three economies shows that Egypt had the best overall accomplishments as it succeeded in improving considerably along most aspects related to its labor market. Despite starting the decade with a particularly unrewarding labor market for the relatively skilled (Campante and Chor, 2012), and a significant setback in the years following the revolution, Egypt was able to recover gradually starting 2014 for the country's capacity to retain talents, the availability of skilled employees, and the hiring and firing practices, areas in which Tunisia and Morocco had both declined. Egypt has also overtaken Tunisia for the "reliance on professional management" and finished 2019 thirteen positions ahead of Tunisia, but behind Morocco which from a mediocre performance in 2010/11 (105th/139), ended the decade in the best relative position (58th/141). Morocco lost its comparative advantage to Egypt in "pay and productivity" though, which, despite a significant drop in the wake of the revolution, realized a remarkable rebound in 2018/19 to finish the decade in a leading 58th/141 position, ahead of Morocco (85th) and Tunisia (127th).

5. Political and Social Stability: A Thorny Challenge

The above analysis shows that **Tunisia** started the decade as a role model in the Arab region in all aspects relating to its development pattern. This overall success was hiding growing deficiencies though; deficiencies that were at the basis of the Jasmin revolution. The favorable aggregate socio-economic indicators were actually hiding huge inequalities between the urban cities and the hinterland. Poverty rates, which certainly had improved overall during the 1990s and 2000s, were not reflecting the regional disparities within the country. In 2010, the announced official poverty rate in Tunisia was 2.55%, albeit in reality poverty was affecting up to 30% of the population in inland areas (AfDB, 2012). The overall unemployment rate was an inaccurate representation of the rising unemployment among youth and university degree holders (Rougier, 2016). The authoritarian Police State regime implemented and carefully taken care of by Ben Ali intensified repressions of civil and political rights, and ensured repetitive extensions of Ben Ali's presidency through rigged elections.

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The Jasmin revolution came as a peaceful revolt against this economic, social, and political injustice. It came to bring hope for a better future, hope for democracy, hope for respect of human rights, and hope for inclusive economic development. Today, Tunisia can boast of its democratic transition placing the country as most democratic Arab country (The EIU, 2020). Since the revolution, Tunisia has seen multiple peaceful democratic transitions of power between successive governments and Presidents. Unfortunately for Tunisians, this democratic rise-up did not translate into better living standards despite the huge potential the country had at the outset.

The reasons for this dilemma are multiple. First, the Tunisian democracy is still at its infancy stage. The EIU 2020 report classifies Tunisia as a "flawed" democracy. This group, includes countries where significant weaknesses persist despite the existence of free and fair elections. Although Tunisia scored among the best globally for its electoral process and pluralism, the country scores for civil liberties, political culture, and functioning of the government remain relatively low. These scores are due to a great extent to the rising interlock between politics and economics in the wake of the revolution, which in its turn led to rising levels of corruption, favoritism, and mediocre performance.

As explained earlier, contrary to Mubarak in Egypt and Mohamed VI in Morocco, Ben Ali had succeeded in keeping the private capital out of the government and the parliament. In pre-Arab Spring Egypt and Morocco, entrepreneurs and businessmen were granted easy access to leading political positions. Political decision making was therefore fundamentally influenced by the personal interests of the business elite in power. To the opposite, Ben Ali has always relied on qualified technocrats as ministers, and used his close allies to leverage his pressure on the business community to financially support his political and economic ambitions. An example is the placement of Hedi Jilani, a major player in Ben Ali's crony and closely connected to him through family ties, at the top of the UTICA, one of the largest and most important employers' organizations in the country. Jilani led the UTICA for 22 years during which he acted as Ben Ali's arm to keep an iron grip on economic activities and ensure their full support and generous contribution to the country's economic and social development strategies. Relying on qualified technocrat ministers was determinant in helping the country achieve greater overall economic success compared to neighboring countries, despite the economic and social disparities explained earlier, which, as it happened, were common to all countries in the region (Belhaj Hassine, 2015; Malik and Awadallah, 2013; Rougier, 2016).

The situation has fundamentally changed after the revolution. From a handful of active political parties under Ben Ali's regime, the Tunisian political scene has seen the number of parties exploding to reach 115 by the first elections held in 2011. By 2019 this number peaked to 219, although only a fraction had real political influence, including *Al-Nahda*, the dominant Islamic party, and a handful of other secular parties. These new players were in dire need of funding to gain popular recognition and attract supporters, and the only internal source of funding available was the business community. This has offered a number of Ben Ali's cronies a permissive transition, some of them have even seen their confiscated assets returned and political power augmented (Kchouk, 2017). The economic capital, which was barely involved in policy decision making under the *ancien régime,* became strongly influential politically through the formal and informal involvement in the parties, which skewed governmental decisions and prompted higher levels of corruption and nepotism.

The fragmented political arena resulted in fragmented parliaments requiring unnatural alliances between *Al-Nahda* and secular parties to govern. Unlike the pre-revolution governments where technocrat ministers were appointed based on their expertise, most post-revolution governments were molded based on political quotas. Many ministers were sworn into office with no qualifications for the post. This lack of vision and competencies in leading political positions dramatically affected the performance of the successive governments. For instance, since the independence of the country in 1956, Tunisia governmental action has always been guided by five-year plans of economic and social development, known as *plans de développement quinquennaux*, prepared by the

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finest economists and experts in the country. This planning process was suspended after the revolution and the planning aspect in the governmental action became limited to short term budgets preparation and execution. Longer term planning resumed later with the *plan de développement quinquennal 2016-2020*, but this plan sounded more like a wish list to attract FDIs rather than a realistic development plan taking into consideration the many challenges the country was facing.

Moreover, the intricate semi-presidential system instituted by the 2014 constitution has contributed to ongoing political stalemates. The endless worker strikes, road blockades, and calls for governments resignations added strains on the already tensed political and social context, and had all disruptive impacts on the economy. The multiple terrorist attacks and political assassinations came to add fuel to the general discontent, especially with mounting popular accusations against the Islamic party *Al-Nahda*, the only party that has been represented in all post-revolution governments, of complicity with terror by protecting terrorists and facilitating their movements.

Morocco has been spared this scenario as the reforms initiated following the F20M protests targeted incremental improvements within the continuity of the State and its pre-Arab Spring institutions. This ensured a relatively stable political and social context, which made it easier for the government to implement economic and social reforms that ensured incremental developments.

In **Egypt**, the Tunisian scenario has been observed to a greater extent in the few years following the Jan25 revolution. Muslim Brothers (MB) and Salafists attracted more than 70% of the votes in the 2011/12 parliamentary election (Elsayyad and Hanafy, 2014). Islamists' control over the political scene culminated in the election, in June 2012, of the MB candidate Mohamed Morsi as President of Egypt with 51.7% of the vote. Morsi's term as President was marked by extreme controversies. Popular discontent emerged against his policies blindly following the MB Guidance Office's directives and serving the movement's interests and agenda. Public outrage reached its peak in November 2012 with the sudden issuing of a presidential decree proclaiming all constitutional declarations, laws, and decrees issued by the President since he took office and until a new constitution is approved, final, binding, and cannot be appealed by any way or to any entity, nor shall they be suspended or canceled and all lawsuits related to them and brought before any judicial body against them are annulled (Al-Ahram, 2012). This move led to massive protests all over the country and violent clashes were reported between protesters and the police. "*Morsi today usurped all state powers & appointed himself Egypt's new pharaoh. A major blow to the revolution that cld have dire consequences*" Twitted Mohamed ElBaradei following the announcement (Birnbaum, 2012). Morsi's declaration was also condemned by Egypt's highest body of judges, and human rights groups such as Amnesty International, Human Rights Watch, and Freedom House.

Morsi's controversial decisions continued after this crisis, which ultimately pushed millions of people to rally in Tahrir square and across Egypt on June 30, 2013, calling for his resignation. The scene recalled Jan25 revolution days and obliged the Supreme Council of the Armed Forces to intervene by giving a 48-hour ultimatum to political parties to heed "the will of the people", and warned to intervene if the situation was not resolved. One day later, Morsi rejected publicly the Army statement, sparking further anger among protesters (Bowen, 2013). The conflict became a stalemate, which pushed the Army to intervene by ousting Morsi from office and appointing Adly Mansour, the head of the Constitutional Court, as Interim President. Mansour served as Interim President until June 8, 2014, the day AbdelFattah Al-Sissi was sworn into office as President of Egypt after winning the May 2014 Presidential elections.

Al-Sissi declared a fierce war against terrorism. The violent reactions of the MB believed to have carried out suicide bombings and political assassinations to revenge Morsi ousting have led to declaring them a terrorist organization. Contradicting reactions have been put forth to describe Morsi ousting. While MB's supporters call it an illegitimate coup, others consider it as an inevitable course correction of Jan25 revolution, which saved Egypt from the MB's grip. One thing is for sure though, what happened enabled a regain in socio-political stability,

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which in its turn contributed to a great extent into the economic recovery observed in the recent years as explained earlier in this paper.

Conclusions

The objective of this paper was to analyze the economic performance and institutional changes that have taken place in Egypt, Tunisia, and Morocco following the Arab Spring, and understand the interconnect between the socio-political context on the one side, and economic performance and growth on the other side, in a period marked by severe turbulences, especially in Tunisia and Egypt. Our analysis shows that the script for the three countries is fundamentally different. Economically, Morocco has benefitted from a relatively stable political context to sustain a positive economic growth. Egypt, has been severely hit economically in the wake of the Jan25 revolution but has gradually recovered in the recent years. As for Tunisia, the decade-long economic trend had an overall negative slope and the situation does not seem to be recovering. A similar trend is observed overall for most institutional, competitiveness, and business environment indicators with Morocco showing positive incremental improvements at different degrees, versus a U-shaped progress for Egypt, and a deteriorating performance for Tunisia.

The parallel between political and social stability and economic performance in pre and post-Arab Spring eras, clearly reveals that the economic woes Egypt and Tunisia witnessed post 2011 were principally due to the generalized instability in both countries resulting of the growing political contentions. The Arab Spring came as a popular rebellion against autocratic regimes which, for decades, restricted political liberties, controlled economic resources, and ignored social problems. Our analysis shows that from a pure economic perspective, the Tunisian scenario yielded the least returns, while from a political point of view, Tunisia has undergone the most remarkable democratic transition. The Egyptian scenario confirms this parallel. The democracy index surveys over the last decade, show that Egypt scored its best democracy performance in 2012; although the score achieved placed the country as barely hybrid regime, far below even the "flawed" democracy status. Year 2012, was also the year the socio-political turmoil in the country reached its peak and led to a serious economic downturn. This raises a fundamental question: is democracy and obstacle to socio-political stability in the region, which in its turn is a prerequisite to economic performance?

The decade long experience in Tunisia, and Egypt's struggling in the wake of Jan25 revolution seem to bring an affirmative answer to this question. However, this answer needs to be nuanced as Tunisia and Egypt democracies are far from being perfect ones. The Tunisian democracy is still "flawed". The weak political culture and the tensed political polarization between the religious party, *Al-Nahda*, and opposing secular parties are significantly affecting the polls. In most municipal, parliamentary, and presidential elections held after the Jasmin revolution, almost no party provided clear and coherent economic and social programmes, and the voting process was to a great extent influenced by the ideological orientations of voters and the financial subsidies provided prior to each ballot by the candidates to needy electors. The political competition became one based on ideologies and financial power of parties rather than concrete developmental visions, strategies and plans.

The political strife shifted after each election to the institutions of the State, the parliament in particular. Secular deputies continue to accuse *Al-Nahda* of complicity with terror mainly because of its historical connections with the MB movement in Egypt and the controversial decisions *Al-Nahda* made in support of Morsi regime in Egypt and terrorist members in Tunisia. On the other side, *Al-Nahda* is accusing secular deputies of obstructing the course of the revolution by disrupting parliament's work. Amidst these political tensions, the economic and social discourses have rarely risen up to higher levels in the priorities and discussions between the parties involved. In Egypt, the situation was made worse by the higher levels of poverty and illiteracy, which clearly undermined the democratic process in the country. The intense polarization between the Islamic and secular parties ultimately culminated into the 2012 political deadlock.

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In the light of these results, it is clear that the relationship between political regimes and economic development needs further investigation in the specific context of Arab countries. While pure authoritarian regimes were clearly a failure, which led to the Arab Spring massive protests, "Western" democracy has also shown its limits when applied within the Arab region context, as it led to neither political stability, nor economic growth. It is worth noting here that studies on the relation between democracy and economic development suggest that democratic transitions often occur randomly, but once there, only countries achieving economic growth remain democratic (Epstein et al., 2006; Przeworski et al., 2000). Future research are therefore needed within this perspective.

At the time these words are being written, Egypt and Morocco seem to benefit from a relatively more stable environment to continue their economic and social progress. In Tunisia, political contentions are still ongoing and reached new heights in the Tunisian Parliament with an extreme polarization between *Al-Nahda* and its allies from the one side, and the opposition led by the *Free Destourian Party* on the other side. The newly formed government is cautiously navigating through the tensions caused by the fragile governmental alliance between *Al-Nahda* and some of its historical opponents, the stiff relationship with the Parliament, and the standoff between the Parliament and the President of the Republic. The COVID-19 global pandemic came to put more strain on the already battered economy. Regaining political stability remains a condition *sine qua non* for economic recovery and inclusive development; the key claims of the Jasmin revolution. Unless this happens, the whole Tunisian experience remains at stake and its democratic transition threatened.

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Appendix

A. Selected Competitiveness Indicators

	Country	2010/11*	2013/14	2015/16	2017/18	2018**	2019
Number of economies included		139	148	140	137	140	141
Global Competitiveness Score (rank between brackets)	Tunisia	**4.65 (32)**	4.06 (83)	3.93 (92)	3.93 (95)	55.6 (87)	56.4 (87)
	Egypt	4.00 (81)	3.63 (118)	3.66 (116)	3.90 (100)	53.6 (94)	54.5 (93)
	Morocco	4.08 (75)	**4.11 (77)**	**4.17 (72)**	**4.24 (71)**	**58.5 (75)**	**60.0 (75)**
INSTITUTIONS							
Public trust in politicians ("future orientation of government" reported for 2018 & 2019) **	Tunisia	**- (15)**	**3.3 (53)**	3.0 (64)	2.9 (75)	37.5 (98)	55.2 (72)
	Egypt	- (40)	2.8 (82)	2.8 (83)	3.0 (67)	47.8 (57)	60.0 (43)
	Morocco	- (59)	3.1 (64)	**3.4 (50)**	**3.4 (53)**	**51.2 (46)**	**60.3 (42)**
Irregular payments and bribe ("incidence of corruption" reported for 2018 & 2019)**	Tunisia	**- (33)**	3.9 (69)	3.6 (92)	3.5 (88)	**42.0 (63)**	**43.0 (62)**
	Egypt	- (64)	3.4 (101)	4.1 (60)	**4.2 (57)**	32.0 (99)	35.0 (91)
	Morocco	- (82)	**4.3 (59)**	**4.1 (58)**	3.7 (78)	40.0 (69)	**43.0 (62)**
Judicial independence	Tunisia	**- (40)**	**3.6 (77)**	3.8 (71)	3.8 (70)	3.9 (66)	3.7 (77)
	Egypt	- (63)	3.5 (82)	**4.5 (45)**	**5.1 (31)**	**5.2 (29)**	**4.9 (34)**
	Morocco	- (79)	3.4 (87)	3.5 (83)	3.8 (75)	3.9 (65)	4.1 (55)
Favoritism in decisions of government officials	Tunisia	**- (12)**	**3.4 (44)**	3.3 (55)	3.3 (55)	-	-
	Egypt	- (95)	3.0 (80)	**4.1 (25)**	**3.5 (48)**	-	-
	Morocco	- (52)	3.4 (46)	3.5 (46)	3.4 (50)	-	-

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Burden of government regulation	Tunisia	- **(15)**	3.5 (71)	3.3 (84)	3.0 (103)	3.0 (103)	2.9 (112)
	Egypt	- (79)	3.2 (96)	3.5 (60)	3.2 (87)	3.2 (87)	3.4 (75)
	Morocco	- (61)	**3.5 (64)**	**3.5 (58)**	**3.8 (39)**	**4.1 (25)**	**4.1 (23)**
Transparency of government policymaking ("budget transparency" reported for 2018 & 2019) **	Tunisia	- **(20)**	4.0 (82)	3.7 (100)	3.9 (79)	46.2 (90)	39 (66)
	Egypt	- (68)	3.9 (90)	3.7 (99)	3.0 (129)	38.5 (110)	41.0 (63)
	Morocco	- (76)	**4.2 (66)**	**4.4 (43)**	**4.4 (49)**	**50.0 (77)**	**45.0 (56)**
Business costs of terrorism ("terrorism incidence" reported for 2018 & 2019) **	Tunisia	- **(28)**	3.8 (137)	3.4 (128)	3.2 (128)	97.7 (105)	97.9 (106)
	Egypt	- (132)	2.6 (148)	2.7 (138)	4.5 (104)	41.6 (135)	41.6 (136)
	Morocco	- (84)	**5.3 (81)**	**5.8 (39)**	**5.3 (56)**	**100 (28)**	**100 (29)**
BUSINESS COMPETITVENESS & INNOVATION							
Nature of competitive advantage	Tunisia	- (44)	**3.5 (64)**	2.8 (119)	2.6 (120)	-	-
	Egypt	- **(35)**	3.5 (66)	**3.2 (90)**	3.1 (95)	-	-
	Morocco	- (73)	3.2 (94)	2.9 (109)	**3.2 (87)**	-	-
Intensity of local competition ("extent of market dominance" reported for 2018 & 2019) **	Tunisia	- **(34)**	4.9 (80)	4.7 (90)	5.0 (79)	3.6 (79)	3.6 (87)
	Egypt	- (91)	4.1 (131)	4.2 (128)	4.8 (88)	**3.9 (47)**	**4.3 (36)**
	Morocco	- (69)	**5.1 (60)**	**5.0 (73)**	**5.2 (64)**	3.7 (67)	3.8 (69)
Local supplier quantity	Tunisia	- **(14)**	**4.9 (46)**	4.4 (82)	4.8 (38)	-	-
	Egypt	- (36)	4.6 (85)	4.5 (68)	4.3 (85)	-	-
	Morocco	- (52)	4.6 (84)	**4.6 (55)**	**4.8 (31)**	-	-
Local supplier quality	Tunisia	- **(45)**	4.2 (84)	3.9 (97)	4.1 (83)	-	-
	Egypt	- (89)	4.1 (100)	3.8 (109)	4.0 (95)	-	-
	Morocco	- (78)	**4.4 (71)**	**4.1 (83)**	**4.3 (68)**	-	-
Value chain breadth	Tunisia	- **(24)**	**3.8 (61)**	3.6 (88)	3.7 (78)	-	-
	Egypt	- (67)	3.6 (79)	3.7 (73)	**3.9 (56)**	-	-
	Morocco	- (70)	3.7 (76)	**3.8 (68)**	3.9 (58)	-	-
Willingness to delegate authority	Tunisia	- (60)	3.4 (104)	3.4 (103)	3.6 (122)	3.8 (116)	4.1 (98)
	Egypt	- **(57)**	**4.1 (40)**	**4.2 (34)**	3.7 (118)	3.9 (102)	**4.1 (88)**
	Morocco	- (96)	3.4 (107)	3.6 (82)	**3.9 (98)**	**4.1 (80)**	4.1 (90)
Capacity for innovation ("innovation capability" reported for 2018 & 2019)**	Tunisia	- **(36)**	**3.2 (99)**	3.5 (109)	3.8 (93)	32.7 (84)	32.6 (92)
	Egypt	- (109)	3.1 (111)	3.1 (133)	3.4 (123)	**37.7 (64)**	**39.6 (61)**
	Morocco	- (94)	2.8 (129)	**3.5 (108)**	**3.9 (83)**	34.0 (78)	35.1 (81)
FINANCIAL MARKET							
Availability of financial services	Tunisia	- **(42)**	3.9 (100)	3.7 (121)	3.7 (106)	-	-
	Egypt	- (60)	3.8 (112)	3.4 (129)	**4.2 (73)**	-	-
	Morocco	- (61)	**4.6 (64)**	**4.6 (57)**	4.0 (87)	-	-
Affordability of financial services	Tunisia	- **(31)**	3.9 (87)	3.9 (90)	3.3 (103)	-	-
	Egypt	- (69)	3.7 (106)	3.3 (126)	3.6 (85)	-	-
	Morocco	- (56)	4.2 (67)	4.2 (61)	3.7 (76)	-	-
Ease of access to loans ("financing of SMEs" reported for 2018 & 2019) **	Tunisia	- **(30)**	**2.9 (67)**	2.8 (71)	3.4 (104)	3.6 (90)	3.4 (109)
	Egypt	- (49)	2.4 (100)	1.9 (128)	**3.9 (66)**	3.6 (89)	**4.3 (41)**
	Morocco	- (44)	2.8 (69)	**3.1 (47)**	3.8 (77)	**3.9 (56)**	4.0 (61)
Venture capital availability	Tunisia	- **(21)**	**3.0 (44)**	2.3 (111)	2.5 (100)	2.7 (91)	2.7 (95)
	Egypt	- (41)	2.9 (51)	2.5 (91)	**2.8 (74)**	**2.8 (74)**	**3.1 (75)**
	Morocco	- (40)	2.8 (56)	**2.7 (68)**	2.6 (90)	2.8 (81)	3.0 (86)
Soundness of banks	Tunisia	- **(59)**	3.9 (131)	3.2 (131)	3.7 (117)	3.8 (112)	3.7 (123)
	Egypt	- (61)	4.0 (125)	4.8 (70)	5.4 (49)	5.6 (32)	**5.9 (23)**
	Morocco	- (69)	**5.7 (41)**	**5.2 (54)**	**5.4 (48)**	**5.7 (23)**	5.7 (30)

Rank between brackets. Top ranked country in bold.

* Only rank is provided for this year

** In 2018, the WEF introduced the new GCI 4.0. It uses a new methodology for calculating scores and indices, introduces new indicators, renames some, and cancels others.

Source. Own compilation based on data retrieved from the yearly Global Competitiveness Reports published by the World Economic Forum.

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B. Selected Innovation Indicators

	Country	2009/10*	2011	2013	2015	2017	2018	2019
Number of economies included		132	125	142	141	127	126	129
Global Innovation Index score/rank	Tunisia	**3.05 (62)**	**33.89 (66)**	**35.82 (70)**	**33.48 (76)**	32.30 (74)	**32.86 (66)**	**32.83 (70)**
	Egypt	2.91 (74)	29.21 (87)	28.48 (108)	28.91 (100)	26.00 (105)	27.16 (95)	24.47 (92)
	Morocco	2.74 (94)	28.73 (94)	30.89 (92)	33.19 (78)	**32.72 (72)**	31.09 (76)	31.63 (74)
Political and Operational Stability	Tunisia	**5.21 (60)**	**53.3 (52)**	**60.5 (81)**	41.6 (114)	42.8 (102)	41.8 (112)	64.9 (79)
	Egypt	3.82 (103)	24.5 (91)	34.6 (125)	24.1 (135)	31.3 (119)	31.8 (119)	56.1 (105)
	Morocco	4.11 (92)	30.2 (82)	54.7 (95)	**51.8 (96)**	**55.7 (79)**	**58.0 (80)**	**66.7 (74)**
Government Effectiveness	Tunisia	**3.79 (54)**	**65.2 (50)**	**38.9 (66)**	**41.4 (68)**	39.5 (78)	39.9 (85)	**44.9 (75)**
	Egypt	2.74 (91)	44.3 (83)	21.9 (108)	17.3 (123)	22.6 (113)	28.8 (107)	31.5 (104)
	Morocco	3.15 (76)	51.4 (70)	32.4 (82)	39.4 (74)	**40.6 (76)**	**42.7 (75)**	42.7 (81)
Ease of starting a business	Tunisia	6.60 (28)	90.4 (42)	81.3 (81)	83.6 (81)	85.0 (78)	85.0 (77)	90.2 (53)
	Egypt	**6.76 (15)**	**94.2 (21)**	**88.6 (42)**	88.1 (61)	**92.4 (33)**	84.5 (80)	84.1 (84)
	Morocco	6.56 (30)	89.4 (43)	86.9 (55)	**90.3 (45)**	92.3 (34)	**92.5 (31)**	**93.0 (31)**
Ease of resolving insolvency	Tunisia	-	-	**55.6 (36)**	**54.7 (52)**	**54.5 (55)**	**54.5 (59)**	**54.2 (62)**
	Egypt	-	-	19.5 (122)	36.2 (110)	39.5 (97)	38.9 (100)	42.3 (89)
	Morocco	-	-	37.8 (77)	38.5 (104)	33.9 (109)	34.0 (110)	52.8 (65)
Ease of getting credit	Tunisia	-	-	50.0 (93)	35.0 (102)	45.0 (84)	45.0 (88)	50.0 (87)
	Egypt	-	-	**56.3 (80)**	**50.0 (65)**	**50.0 (72)**	**50.0 (79)**	**65.0 (54)**
	Morocco	-	-	50.0 (93)	40.0 (93)	45.0 (84)	45.0 (88)	45.0 (94)
Microfinance gross loans (% GDP)**	Tunisia	1.12 (68)	1.4 (56)	0.3 (55)	0.2 (56)	0.3 (41)	0.4 (41)	**0.5 (30)**
	Egypt	1.13 (67)	1.5 (55)	0.1 (71)	0.1 (72)	0.0 (61)	0.0 (65)	0.1 (58)
	Morocco	**1.25 (62)**	**8.7 (36)**	**0.5 (49)**	**0.5 (44)**	**0.6 (33)**	**0.5 (37)**	0.4 (37)
University/Industry Research Collaboration	Tunisia	**3.66 (51)**	**51.3 (38)**	**45.8 (57)**	32.0 (114)	32.8 (98)	32.8 (97)	**38.2 (80)**
	Egypt	3.08 (95)	30.8 (109)	28.1 (122)	23.8 (127)	23.8 (121)	29.2 (106)	30.0 (106)
	Morocco	2.79 (112)	34.9 (95)	33.5 (113)	**37.2 (93)**	**35.4 (93)**	**33.4 (96)**	31.2 (103)
State of Cluster Development	Tunisia	3.29 (74)	**43.3 (56)**	38.7 (93)	41.8 (85)	36.3 (97)	33.8 (105)	37.0 (100)
	Egypt	**3.89 (40)**	42.8 (58)	41.3 (78)	**54.5 (35)**	**54.5 (31)**	**47.7 (53)**	**53.9 (38)**
	Morocco	3.24 (79)	42.0 (61)	**46.1 (61)**	46.3 (68)	43.6 (74)	46.9 (57)	45.9 (71)

Rank between brackets. Top ranked country in bold.

* The significant difference in scores between 2009/10 and the subsequent years is due to the change of the GII methodology introduced in 2011.

** Named "Microfinance Institutions (MFIs) -Average loan balance per borrower/GNI per capita" in 2009/10.

Source: Own compilation based on data retrieved from the yearly Global Innovation Index (GII) Reports.

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C. Selected Infrastructure, Education, and Labor Market Indicators

	Country	2010/11*	2013/14	2016/17	2017/18	2018**	2019
Number of economies included		139	148	138	137	140	141
INFRASTRUCTURE							
Quality of overall infrastructure	Tunisia	**- (30)**	4.1 (80)	3.7 (84)	3.7 (86)	62.5 (84)	62.7 (85)
	Egypt	- (68)	3.3 (118)	3.1 (108)	4.0 (73)	70.5 (56)	**73.1 (52)**
	Morocco	- (71)	**4.9 (48)**	**4.5 (50)**	**4.7 (42)**	**71.5 (53)**	72.6 (53)
Quality of roads	Tunisia	**- (37)**	3.8 (77)	3.5 (87)	3.7 (84)	3.8 (81)	3.6 (96)
	Egypt	- (75)	2.7 (122)	3.0 (107)	3.9 (75)	**4.5 (45)**	**5.1 (28)**
	Morocco	- (88)	**4.5 (53)**	**4.4 (55)**	**4.5 (43)**	4.5 (48)	4.7 (41)
Quality of railroad infrastructure ("efficiency of train services" reported for 2018 & 2019)**	Tunisia	**- (29)**	3.4 (49)	2.8 (63)	2.8 (67)	3.2 (70)	3.2 (59)
	Egypt	- (46)	2.7 (63)	2.6 (73)	3.3 (50)	3.6 (58)	3.8 (50)
	Morocco	- (37)	**3.9 (37)**	**3.9 (37)**	**3.9 (38)**	**3.7 (55)**	**3.9 (44)**
Quality of port infrastructure ("efficiency of seaport services" reported for 2018 & 2019)**	Tunisia	**- (41)**	4.0 (82)	3.3 (100)	3.3 (101)	3.5 (88)	3.4 (95)
	Egypt	- (69)	4.1 (80)	4.3 (58)	4.7 (41)	4.6 (39)	4.8 (41)
	Morocco	- (62)	**5.0 (41)**	**4.8 (38)**	**5.0 (32)**	**4.9 (28)**	**5.1 (24)**
Quality of air transport infrastructure ("efficiency of air transport services" reported for 2018 & 2019)**	Tunisia	**- (38)**	4.5 (67)	3.9 (97)	3.9 (98)	3.8 (102)	3.6 (118)
	Egypt	- (39)	4.8 (59)	**4.8 (52)**	**5.1 (42)**	**5.1 (43)**	5.1 (46)
	Morocco	- (67)	**5.0 (49)**	4.7 (55)	4.8 (54)	5.0 (46)	**5.3 (38)**
Quality of electricity supply	Tunisia	**- (35)**	5.3 (56)	5.1 (60)	5.1 (60)	87.3 (98)	88.0 (98)
	Egypt	- (53)	3.4 (107)	3.5 (102)	5.0 (63)	**92.4 (74)**	**91.8 (77)**
	Morocco	- (66)	**5.5 (47)**	**5.3 (53)**	**5.6 (46)**	88.3 (97)	88.4 (97)
Availability of latest technologies	Tunisia	**- (42)**	4.8 (77)	4.6 (76)	4.6 (76)	-	-
	Egypt	- (91)	4.1 (117)	3.9 (117)	4.3 (91)	-	-
	Morocco	- (68)	**5.0 (66)**	**5.0 (50)**	**5.1 (50)**	-	-
Firm-level technology absorption	Tunisia	**- (33)**	**4.7 (70)**	4.1 (106)	4.0 (111)	-	-
	Egypt	- (58)	4.2 (110)	3.8 (121)	4.1 (100)	-	-
	Morocco	- (74)	4.4 (95)	**4.6 (63)**	**4.5 (62)**	-	-
EDUCATION							
Quality of the education system ("skillset of graduates" reported for 2018 & 2019)**	Tunisia	**- (20)**	**3.7 (71)**	**3.1 (107)**	**3.1 (103)**	**3.6 (103)**	**3.6 (108)**
	Egypt	- (131)	2.2 (145)	2.1 (135)	2.5 (130)	2.9 (136)	3.1 (133)
	Morocco	- (105)	3.1 (110)	2.8 (119)	2.7 (120)	3.5 (117)	3.5 (117)
Quality of primary education ("pupil-to-teacher ratio in primary education" reported for 2018 & 2019)**	Tunisia	**- (22)**	**3.9 (72)**	**3.6 (85)**	**3.7 (83)**	**16.2 (51)**	**16.2 (55)**
	Egypt	- (126)	2.0 (148)	2.1 (134)	2.4 (133)	23.1 (86)	23.8 (89)
	Morocco	- (100)	2.9 (118)	2.9 (118)	2.8 (119)	26.6 (95)	28.0 (102)
Quality of math and science education ("critical thinking in teaching" reported for 2018 & 2019)**	Tunisia	**- (8)**	**4.7 (31)**	**4.4 (57)**	**4.6 (44)**	**3.1 (94)**	**3.1 (99)**
	Egypt	- (125)	2.2 (145)	2.6 (130)	2.8 (122)	2.6 (123)	2.7 (123)
	Morocco	- (67)	4.3 (52)	4.0 (72)	3.8 (80)	2.2 (138)	2.7 (121)
Quality of management schools	Tunisia	**- (22)**	4.3 (66)	4.1 (78)	**4.0 (83)**	-	-
	Egypt	- (122)	2.3 (145)	2.5 (138)	3.2 (124)	-	-
	Morocco	- (49)	**4.6 (45)**	**4.1 (76)**	4.0 (86)	-	-
Quality of scientific research institutions ("research institutions prominence" reported for 2018 & 2019)**	Tunisia	**- (38)**	**3.3 (94)**	**3.2 (111)**	**3.3 (96)**	5.2 (52)	4.4 (57)
	Egypt	- (110)	2.7 (127)	2.6 (128)	2.8 (121)	**15.3 (32)**	**14.8 (37)**
	Morocco	- (93)	3.2 (103)	3.1 (112)	3.0 (111)	5.8 (50)	5.9 (53)
Primary education enrollment rate, net %	Tunisia	**- (33)**	**99.4 (14)**	**98.6 (21)**	**98.6 (24)**	-	-
	Egypt	- (73)	95.6 (58)	98.0 (28)	98.0 (33)	-	-
	Morocco	- (99)	96.0 (54)	98.4 (22)	98.4 (26)	-	-
Secondary education enrollment rate, gross %	Tunisia	**- (53)**	**92.6 (59)**	**87.6 (82)**	**88.2 (81)**	-	-
	Egypt	- (90)	72.5 (102)	86.1 (85)	86.1 (84)	-	-
	Morocco	- (110)	69.8 (103)	69.1 (101)	69.1 (100)	-	-
Tertiary education enrollment rate, gross %	Tunisia	**- (69)**	**37.1 (71)**	**34.6 (79)**	34.6 (79)	-	-
	Egypt	- (78)	27.8 (82)	31.7 (81)	**36.2 (76)**	-	-
	Morocco	- (102)	14.1 (106)	24.6 (92)	28.1 (85)	-	-

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LABOR MARKET							
Hiring and firing practices	Tunisia	**- (52)**	3.5 (105)	2.8 (126)	2.7 (130)	2.9 (129)	3.0 (126)
	Egypt	- (76)	3.3 (120)	**3.9 (61)**	**3.7 (70)**	**4.0 (51)**	**3.9 (63)**
	Morocco	- (66)	**3.7 (93)**	3.3 (103)	3.3 (109)	3.4 (103)	3.8 (73)
Pay and productivity	Tunisia	- (52)	3.5 (108)	3.0 (132)	3.1 (126)	3.2 (124)	3.2 (127)
	Egypt	- (76)	3.1 (131)	3.2 (125)	3.4 (107)	**3.8 (75)**	**4.2 (58)**
	Morocco	**- (50)**	**4.0 (67)**	**3.4 (114)**	**3.6 (96)**	3.6 (87)	3.7 (85)
Reliance on professional management	Tunisia	**- (40)**	3.9 (98)	3.8 (94)	3.9 (88)	3.9 (88)	3.9 (104)
	Egypt	- (86)	3.1 (137)	3.1 (133)	3.9 (92)	4.0 (82)	4.1 (91)
	Morocco	- (105)	**4.0 (90)**	**4.0 (84)**	**4.0 (79)**	**4.2 (66)**	**4.5 (58)**
Country capacity to retain talent ("ease of finding skilled employees" reported for 2018 & 2019)**	Tunisia	**- (42)**	3.4 (74)	2.8 (110)	2.7 (111)	**4.2 (66)**	4.0 (88)
	Egypt	- (114)	2.3 (133)	2.9 (104)	2.9 (103)	3.6 (109)	**4.0 (87)**
	Morocco	- (76)	**3.6 (54)**	**3.2 (91)**	**3.2 (90)**	3.8 (99)	4.0 (94)

Rank between brackets. Top ranked country in bold.

* Only rank is provided for this year.

** In 2018, the WEF introduced the new GCI 4.0. It uses a new methodology for calculating scores and indices. New indicators were introduced, some were renamed, and others canceled.

Source: Own compilation based on data retrieved from the yearly Global Competitiveness Reports published by the World Economic Forum.

Nizar BECHEIKH is Associate Professor of Strategy and Innovation Management and former Dean at the School of Business of the American University in Cairo (AUC, Egypt). He earned a Ph.D. in Business Administration and a MBA in International Management from Laval University (Canada). His current research interests focus on political economy in the Arab region, innovation paths and best practices in developing countries, and managing growth and innovation in small and medium-sized enterprises in Arab countries.
ORCID ID: orcid.org/0000-0002-4572-1675

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SMALL AND MEDIUM ENTERPRISES IN REGIONS - EMPIRICAL AND QUANTITATIVE APPROACH*

Ladislav Mura [1], Zuzana Hajduová [2]

[1]Pan-European University, Faculty of Economics and Business, Tematínska 10, 851 05 Bratislava, Slovakia
[2] University of Economics in Bratislava, Faculty of Business Management, Dolnozemská cesta 1, 852 35 Bratislava, Slovakia

E-mails: [1] ladislav.mura@gmail.com; [2] zuzana.hajduova@euba.sk

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Abstract. The problem of identifying and quantifying the efficiency of accommodation units is currently a discussed issue. Recognition and identification of the most important aspects that increase the financial efficiency of a rapidly changing business environment, especially in a difficult period of economic and tourism bounce back is a key issue. Only the companies that adequately address the issue of their measurement and evaluation and are able to choose the right approach in this regard will win the competition. Our work focuses on the identification of key factors influencing the management of business entities. We carried out a detailed analysis of accommodation units in selected accommodation facilities at the regional level. We wanted to point out the differences within the individual regions of Slovakia. By applying the DEA method, we used individual models focused on inputs and outputs in order to determine the inefficient units in our research, and revealed its shortcomings and pointed out the way to improve the economic results of these research subjects.

Keywords: small and medium enterprises; regions; DEA; models; correlation

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JEL Classifications: C14, C44, L21

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1. Introduction

The focus of this research is to identify the relationship between the key economic factors and the efficiency of businesses (Belas et al., 2020; Baša et al., 2019), which we examine through interrelated financial indicators. The concept of performance is compared to the productive capacity of the company in terms of achieving performance in individual research areas (Duygulu et al., 2016). In today's global environment, it is the best to define business performance as market success (Teles, Schachtebeck, 2019; Wach, 2020), the ability to succeed in competition, and find opportunities for further growth in a changing unstable environment (Thames et al. 2016; Cepel et al., 2018; Stacho et al., 2021). Tumpach (2008) considers efficiency to be one of the main criteria for evaluating the company's results and defines it as a measure of achieving the set goals and creating conditions for their fulfillment in the future (Herman et al., 2018). Business performance has been examined from different perspectives, but flexible reaction to the changing environment is important (Aisyah et al., 2017; Aisyah et al., 2017). According to Sahid et al. (2018), efficiency is achieved if the company is able to increase the resulting volume of outputs while maintaining an identical amount of inputs. However, efficiency can also be increased while maintaining the required final output and limiting the resources expended to achieve it. The most important factor is the efficiency criterion, which expresses the ratio between the outputs of economic activity and the given inputs. A large number of modern efficiency measurement models have emerged due to the development of statistical methods, information technology, as well as growing interest from banks, rating agencies and businesses (Kozubikova, Kotaskova, 2019; Obeidat et al. 2016; Curado et al. 2018; Morrison.2011). The overall efficiency of a company can be assessed in the context of the company's strategy. Waal (2013), Borocki et al. (2019) define the strategic performance as the company's ability to achieve the determined strategic goals. Dad. et al. (2012) point out, however, the company is evaluated by different market players from different perspectives (Kokocinska, Puziak, 2018; Krizanova et al., 2018), the concept of efficiency acquires a relative and at the same time very complex character. One recent study by Shih (2018) states that the efficiency of a business entity is most affected by its ability to innovate radically and achieve a competitive advantage through an established brand and products offered. Another new study showed that a company's performance is directly positively affected only by its strategic orientation and indirectly by its organizational structure and different production capabilities (Chatzoglou et al., 2018). A large number of studies examine for example Udriyah, 2019; Tien et al., 2018, but also setting business goals in the SME segment (Virglerova et al., 2020; Csabay, Stehlikova, 2020; Chong et al. 2019; Lazikova et al., 2018; Binh, 2010; in a family business environment (Ballini et al., 2019; Dagnino et al., 2017; Zahra, 2017; Ślusarczyk, Ul Haque, 2019). The influence of institutional factors on ensuring the innovative performance of SMEs deserves attention. SMEs have become an important area of research in the last years of our century (European Commission, 2016; Cibik, 2018; Podhorska et al., 2019). The aim of this research is to reveal the influence of orientation on the interaction of individual inputs and the effective operation of companies in the field of services (European Commission, 2017). Factors with a direct impact on the level of business affect the results in the field of finance, quality of production, increase in revenues, reduction of costs, increase in profits, influence of liquidity of companies, stock levels (Muhammand Khan, 2020; Tamulevičienė, Androniceanu, 2020).

However, the number of studies evaluating effectiveness at regional level is relatively low compared to the number of studies evaluating individual countries. We focused on and a reviewed the efficiency of accommodation facilities in the regions of the Slovak Republic. Tourism, as an important sector of the Slovak economy was significantly affected by the pandemic. It is necessary to kick start the economic recovery, also by increasing the performance of business entities in the field of accommodation services. It is necessary to realize that in the time of the ongoing recession of the world economy, tourism, as a cross-cutting sector of the national economy, is one of the ways to increase state budget revenues and improve the economic situation and employment not only in regions with potential for its development (Smerek, Vetráková, 2020; Machyniak, 2018;

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Imrovic, Kovacik, 2019). Domestic tourism is an important source of value creation – GDP (Matijová et al, 2019), foreign exchange incomes, job creation and has the potential to play a significant role in revitalizing the economically weaker regions, respectively to become an accelerator of regional development with the assumption of balancing regional disparities (Maris, 2015; Štefko et al., 2017; Melichová et al., 2017; Vekic et al., 2020). Domestic tourism represents a significant source of revenue to the state budget in Slovakia. In addition to economic, it also fulfills social, health and cultural functions (Bačík et al., 2019), helps to become aware of cultural and natural heritage, social integration, national harmony of residents and motivates the optimal use of free time.

2. Current situation

In 2018, 4,007 accommodation facilities were registered in the regions of Slovakia. Most of these facilities were located in the Žilina region, up to 27% of the total number and in the Prešov region 18%. The overall growing trend in a positive sense was recorded by the Trnava region with a growth value of up to 39% (Fig. 1).

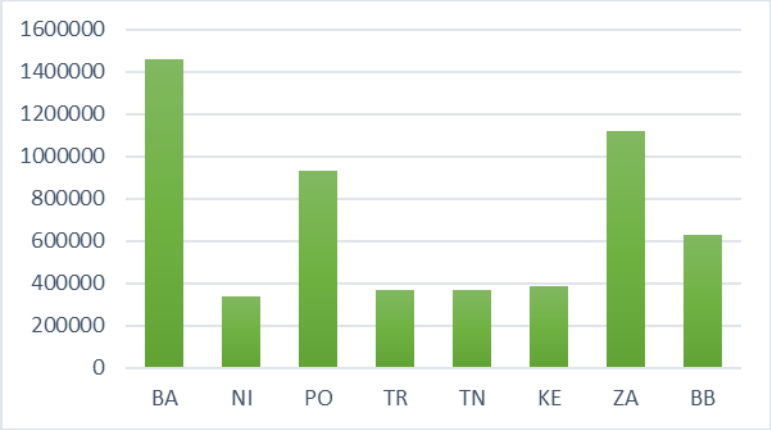

Figure 1. Visitors by regions in SR 2018

Source: own processing

Bratislava region is in leading position with the number of accommodated guests up to 1,460,000, which represents up to 25% of the total revenue from the segment with a volume of 429,000,000 euros (Fig. 2).

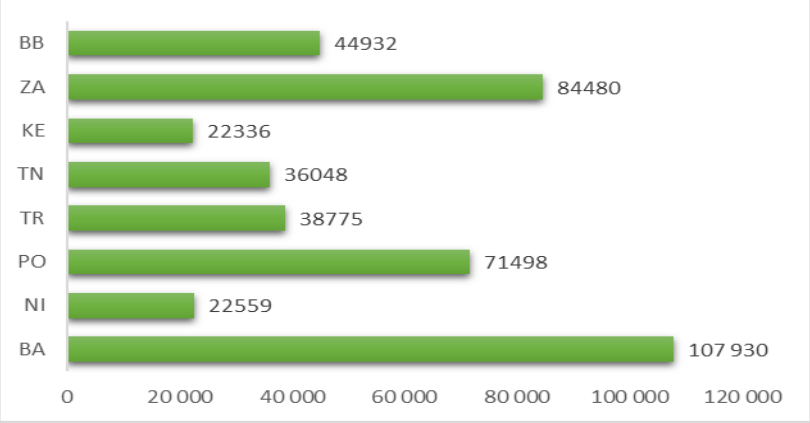

Figure 2. Revenues of accommodation facilitiesby in SR 2018

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Source: own processing

We would like to evaluate the development of efficiency of accommodation facilities in individual regions in connection with the development of tourism in Slovakia. In 2019 we recorded an increase in this segment by 22.1% compared to 2018. This means that up to 48,042 people used the services of these facilities. While comparing the ratio of foreign and domestic visitors, we can assume an increasing trend of domestic visitors to 27.6%. In the monitored period, about 158,790 foreigners visited the regions of Slovakia and used the services of accommodation units. The number of accommodation establishments in the observed period from 2018 to 2019 increased annually by an average of 11.7% (Table 1).

Table 1. Capacity of tourism accommodation establishments 2019

Regions of SR		Number of accommodattion establishments	Occupancy rates of bedrooms(%)	Number of bedrooms(total)
Bratislava region	BA	385	45,4	24238
Trnava region	TR	315	41,2	16493
Trenčin region	TN	323	39,2	15153
Nitria region	NI	399	26,5	15341
Žilina region	ZA	1171	29,1	42374
Banská Bystrica region	BB	642	38,2	22914
Prešov region	PO	853	32,6	33977
Košice region	KE	385	26,4	14905
Total	SR	4473	35,1	185395

Source: own processing

These statistics prove that tourism in Slovakia has recorded a rapid increase in recent years, but a new situation has occurred the accommodation units have to deal with. In the last decade, the Slovak Republic (SR) has gained popularity as an international and domestic destination. It ranked on the 43rd position based on the number of foreign tourists arrival. The perspectives for international and domestic tourism for the country as a whole are therefore clear. According to the data of the United Nations World Tourism Organization (UNWTO), the income from tourism in Slovakia increased from 6.2 million to 9.1 million EUR. These statistics prove that tourism in Slovakia has seen a rapid increase in recent years, but the impact of COVID-19 created new circumstances that the accommodation units have to deal with.

Nowadays, tourism is one of the sectors most affected by the measures taken against the spread of COVID-19. The development of tourist accommodation statistics was therefore very specific in April 2020. The almost

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complete closure of tourism services and radical restrictions on travel at national and international level has led to a drop in number of visitors. Tourism businesses are facing existential problems and need to increase their efficiency in order to survive this difficult period. Even if they manage to survive, their financial health and stability will be marked by high to chronic indebtedness. However, many regions are already losing sources of funding today because they have lost income from accommodation tax due to the widespread closure of facilities. Accommodation tax is paid by the visitor when staying in the facility, usually up to one euro per person / overnight stay. In 2018, the revenues of communities from this tax amounted to more than 15 mil. €. The estimated loss of income of communities from this tax for the last months as a result of tourism slowdown was is more than 4.5 mil. €. The figures since the beginning of 2020 are very unfavorable (Fig. 3). While in April 2020, only 417 foreigners were accommodated in these facilities, at the same time in 2019 it was 171,000 visitors. 1.1 million visitors have been accommodated in tourism facilities since January 2020, which represents an annual decrease of 35.8%. In detailed figures, 705,857 (64.8%) were domestic visitors and 383,435 foreigners (percentage data). The number of domestic visitors decreased annually by 34.3% and the number of foreigners by 38.3%. The number of overnight stays also decreased by about a third (3.1 million nights).

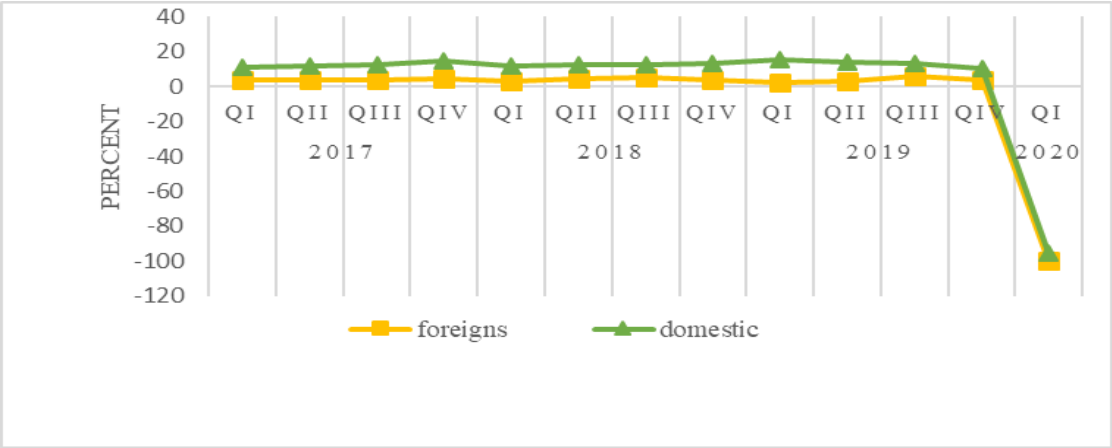

Figure 3. Development of number visitors (2017-2018)

Source: own processing

3. Methods, methodology and research data

Based on a review of the literature, we identified that the Data emoloyment analysis (DEA) is a widely used method for evaluating efficiency in health care but also in the environment. Its theoretical foundations were laid by (Farrell, 1957; **Charnes, A,1984**) and subsequently developed in many other studies. Cooper et al. (2007) made significant theoretical development. They proposed models that assume either constant returns to scale, the so-called CCR DEA models, and models that assume variable returns to scale, the so-called BCC DEA models. In this paper, we will use exclusively input-oriented DEA models, as in terms of the models used, the influence of inputs and not outputs can be assumed. Moreover, in terms of efficiency results, this is irrelevant, as output efficiency is only the inverse of input efficiency.

Relative efficiency DMUj, j = 1,. . . , n are defined as a function of the determined factors as follows:

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$$E_j(u,v) = \frac{y_j^T u}{x_j^T v} \quad (1)$$

Assuming that we have m input items and s output items, we have determined individual $DMUj$ from a set of n units we will record input data (x_{1j},…, x_{mj}) in the matrix X and output data (y_{1j},…, y_{sj}) in the matrix Y. Then it has matrix X size (m x n) and matrix Y size (s x n) ,(Mardani et al.,2017):

Purpose function: $\max_{v,u} \theta = \frac{u_1 y_{1o} + \cdots + u_s y_{so}}{v_1 x_{1o} + \cdots + v_m x_{mo}}$ (2)

Restrictive conditions: $\frac{u_1 y_{1o} + \cdots + u_s y_{so}}{v_1 x_{1o} + \cdots + v_m x_{mo}} \leq 1 \qquad j = 1,2,\ldots,n$ (3)

Non-negative condition $v_1, \ldots \ldots v_m \geq 0;\ u_1, \ldots \ldots u_s \geq 0$ (4)

CCR DEA model - input-oriented CCR model based on standardization of the value of $x_j^T v = 1$

assesses the efficiency of units. The DMUj for which it applies is considered effective $E_j(\widehat{u_j}, \widehat{v_j}) = 1$ and u> 0, v> 0.

$$\max_{u \in R_+^s, v \in R_+^m} Y_j^T u - X_j^T v \quad (5)$$
$$Y_j^T u - X_j^T v \leq 0$$
$$u \geq 1, v \geq 1$$

The BCC DEA input model also focuses on a detailed analysis of inputs with both positive and negative trends. This model is calculated as the follows: (McDonald,2009; Shi et al., 2010):

$$\min_{\theta,\lambda,s,e} \theta - \epsilon(1^T s + 1^T e) \quad (6)$$
$$Y\lambda - s = Y_j$$
$$-X\lambda + \theta X_j - e = 0$$
$$1^T \lambda = 1$$
$$\lambda \geq 0, e \geq 1, s \geq 0$$

The result of solving n problems, but not necessarily n different levels, because the level that belongs to the effective DMUj may be the closest level for any with inefficient DMUj (Ramanathan,2011; Fernandes et al.,2018). The input CCR and BCC models assume the total independence of the inputs (or outputs) so the input (or output) of any given DMU does not affect the input (or output) of other units. However, this independence does not always exist, for example in a competitive market or in the case of constant demand for production - then it is appropriate to use the ZSG-DEA model.The monitored DMU reaches the effective limit just by changing the limit itself. The basic approach of this model is a proportional reduction of inputs. In particular, an inefficient DMU must lose a certain number of inputs (or receive a certain number of outputs). DMU is looking for an effective boundary, assuming that the sum of the inputs is constant. The mathematical entry is the following:

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Purpose function: min h_{R0}

$$h_{R0} x_0 \geq \sum_k \lambda_k x_k \left[1 + \frac{x_0 (1 - h_{R0})}{\sum_{k \neq 0} x_k}\right]; \qquad (7)$$

Restrictive conditions: $\sum_k \lambda_k y_k \geq y_0$

Non-negative condition: $\lambda_k \geq 0; \vee k$

4. Results

During the assessment of the efficiency of the given segment within the regions, we chose suitable DMU units from each region. It was a sample of 40 accommodation units as a random selection from all regions of Slovakia. We selected five accommodation facilities from each region of Slovakia that were comparable to each other and had the same parameters. This step was necessary to maintain the homogeneity of the individual DMUs. The next step in the implementation was the identification and quantification of the determined factors within the use of DEA methodology. The trend in our segment is to increase outputs while maintaining the same inputs, or increasing outputs when decreasing inputs.

We have chosen the following parameters for the input parameters: employees, receivables, external sources, total assets, inventories. The output variables we determined as the follows: total sales, equity, net profit. For clarity, we named the individual DMUs by region and serial number. Using correlations, we verified the relationships between the individual parameters of the model. In our case, in the table of the correlation matrix we present the relationship between the units such as inventories, receivables for this reason (Table 2.).

Table 2. Input correlations

	Resources	**Receivables**	**Liabilities**	**Employees**	**Assets**
Resources	1				
Receivables	0,15766	1			
Liabilities	0,10011	0,19871	1		
Employees	0,13131	0,15002	0,21421	1	
Assets	0,24581	0,384982	0,15926	0,25451	1

Source: own processing

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Model CCR-input

As it is important to monitor and examine the development of efficiency for the subjects examined individually, we will graphically display the results for all subjects during the research period 2013-2018. Figure 4. shows the development and quantitative expression of measured values in individual subjects, given the range of data. The horizontal axis does not include all years in the form of a legend, but the individual vertical columns present the trend of efficiency development by region.

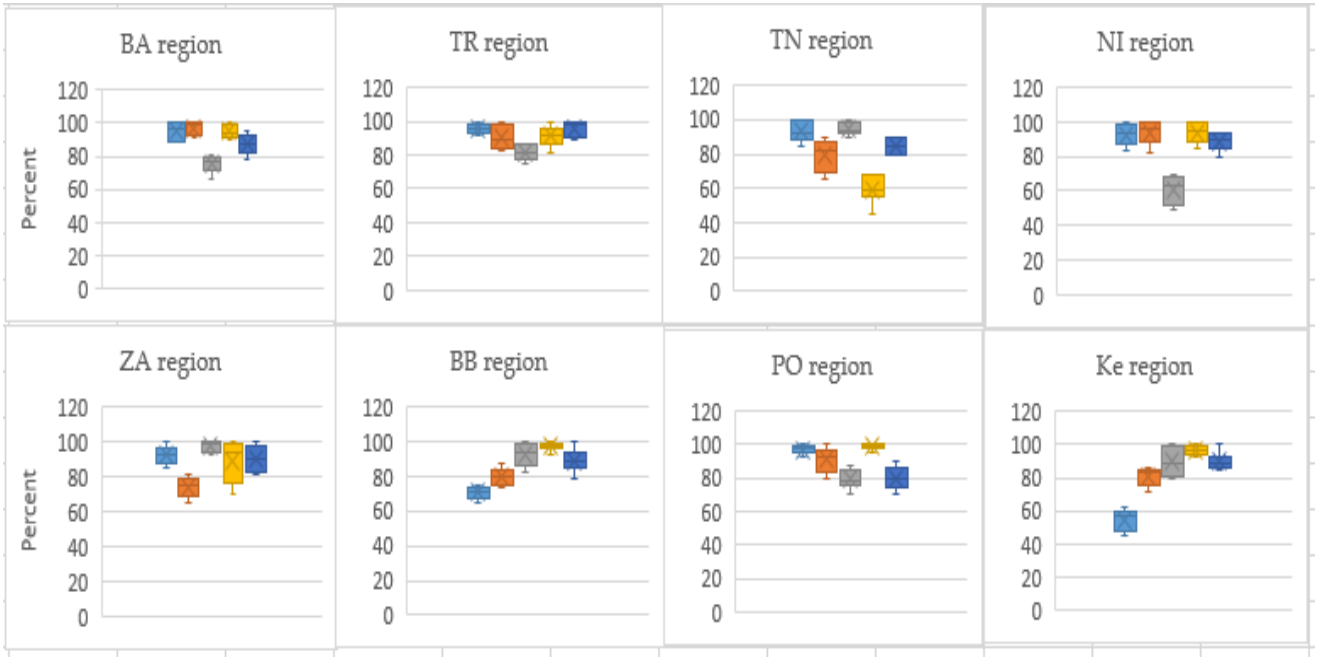

Figure 4. Result values of input oriented CCR-I model

Source: own processing

In 2018, we accurately evaluated the inputs that need to be reduced for individual entities and for DMUs that were inefficient. In the efficiency mode, there are 25 units, whose purpose function is on level 1. These units are declared as CCR-inputs efficient. We consider other units to be inefficient. Since we need to evaluate their status, we have quantified the unit for all units formed by the weighted sum of peer units. Due to the large scope of research, we present only the resulting λ for individual companies (Table 3.).

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Table 3. Sum of peer units for inefficient –DMUs

DMU	Suma λ
BA 5	0,164
NI 20	0,061
PO 35	0,045
TN 15	0,111
PO 33	0,035
TR8	0,245
TN 12	0,221
KE37	0,312
BB 27	0,041
ZA 22	0,054
BA 3	0,123
BB26	0,237
TN 14	0,201
NI 18	0,118
KE36	0,025

Source: own processing

An example is the analysis of the BA5 unit (Table 4.). As a result of accurate analysis, we concluded that the subject BA5, which is ineffective, has a total of four peer units. The inputs of this unit are listed in the table.

Table 4. Peer unit for the selected subject

DMU	Peer	λ	Peer	λ	Peer	λ	Peer	λ	SUM λ
BA5	**BA2**	**0,033**	**TN11**	**0,019**	**TR9**	**0,027**	**ZA24**	**0,085**	**0,164**

Source: own processing

The BA5 unit has a total of 4 peer units. For this DMU, the sum of the values of λ is equal to 0,164. The inputs of this unit should be 20.12% identical to the inputs of the BA2 unit, 11.59% identical to the inputs of the TN11 unit, 16.45% identical to the inputs of the TR9 unit and 51.82% identical to the inputs of the ZA24 unit.

According to the analysis, we can precisely determine the changes in inputs for individual entities. As a conclusion of the CCR-input model analysis, we state that in all units it is necessary to rapidly reduce inputs in order to get these units to a level that we consider effective. It is essential to regulate the entry of stocks and reduce them by up to 58%, then it is necessary to address the issue of human resources and overemployment. It is

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also important to eliminate overemployment in inefficient units by up to 49%, and the last very important item of change is the reduction of total assets by more than 51%.

Model BCC –input

This model is also focusing on input evaluation. In the variable-scale /variable yield assessment mode, 36 units reached the value of purpose function 1. It means 100%, so these units lie at the limit of production possibilities and are considered BCC-I effective. Figure 5. shows the development and amount of measured values in individual entities (2013-2018).

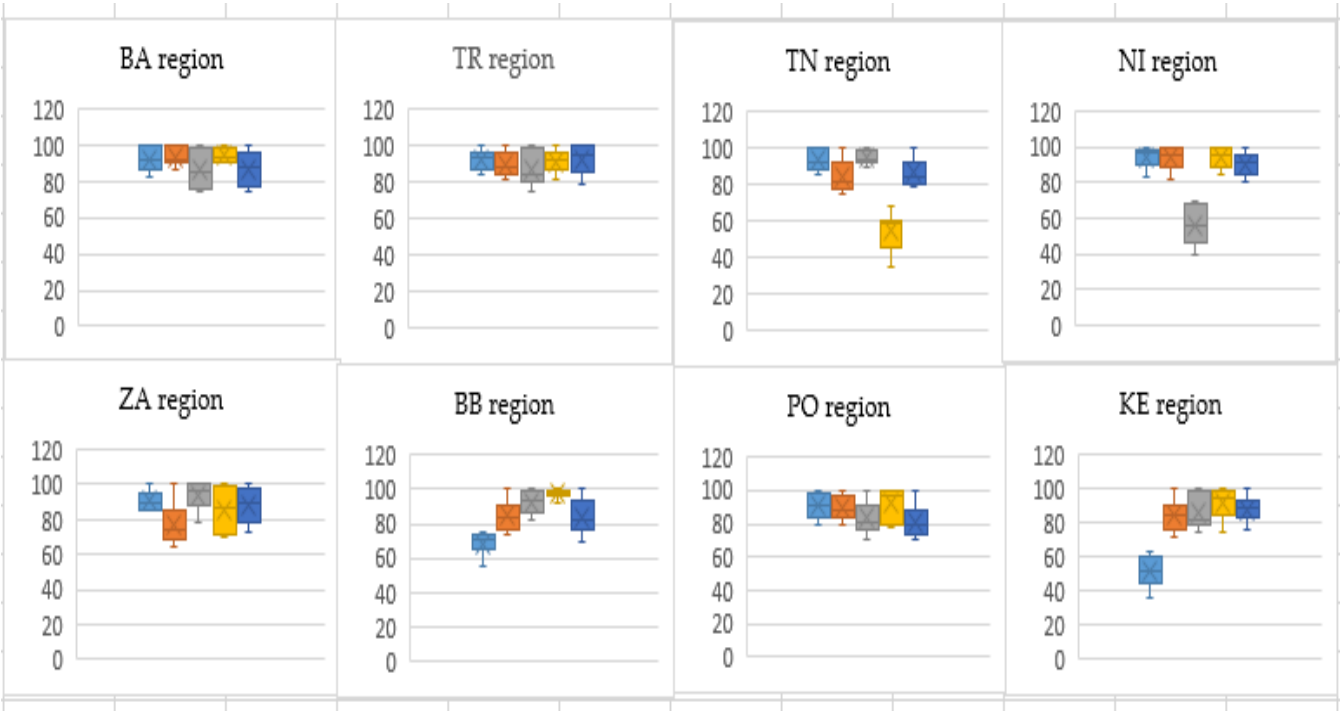

Figure 5. Result values of input oriented BCC-I model

Source: own processing

In 2018, we accurately evaluated the inputs that need to be reduced for individual entities and for DMUs that were inefficient. Thanks to the dual model, it is possible to read from the results not only the current efficiency level of individual DMUs, but also the extent to which individual inputs must be reduced, so that the unit reaches the efficiency limit. Specifically, it is about reducing the inputs of inefficient units, which are - TN14, NI18, BB26, KE36. We proceeded analogously as in the analysis of the CCR-input model, by calculating peer units for the inefficient subjects.
In the table we present the changes of individual inputs of inefficient units in percentage. These inputs with the stated value must be reduced. It can be said that all inputs must be reduced in the case of inefficient units, so that the individual DMUs reach the effective limit. It is necessary to reduce inventories by 55.95%, foreign sources by 53.21%, the number of employees by 35.61%, receivables by up to 67.18% and the least desirable is to reduce total assets (Table 6).

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Table 6. Reduction of items in ineffective units (%)

DMU	Total Assets	Resources	Receivables	Liabilities	Employees
TN14	26,31	55,12	15,12	45,56	**29,35**
NI18	18,23	61,23	14,23	56,23	**33,25**
BB26	31,42	49,24	18,31	61,21	**38,29**
KE36	17,21	58,23	19,52	49,85	**41,56**
Average	**23,29**	**55,95**	**67,18**	**53,21**	**35,61**

Own processing.

In this extensive analysis, we also used the ZSG-DEA model to verify the achieved results. The value of the purpose function 1, and thus reached 26 units out of the examined 40 units, which makes up 63% of the examined sample. 14 units are inefficient. Most of them can be found in the Trenčín and Prešov regions.

Conclusions

The research focuses on the evaluation of the impact of determinants on the effectiveness of individual entities. In this case, the dependent variable is the input CCR and BCC efficiencies adjusted by the double bootstrap method. Subsequently, we used the truncated regression based on their recommendations. The predictive power of the model is higher in the case of the BCC model based on the Log likelihodd and R-squared indicators, while this model describes 74.43% of the variability of the basic set. The CCR model describes 71.57% of the variability of the base set. For this reason, we have given the exact values of the change of individual inputs for inefficient DMUs in the BCC models. For the purposes of this analysis, we have provided specific rules for practice. Exact implementation of methodology DEA for individual regions of the Slovak Republic with input models CCR and BCC, ZSG-DEA models, units such as TN14, NI18, BB26 and KE36 are identified as ineffective in three models to determine efficiency. In this model, we determined the necessary change in the level of inventories, the number of employees and total assets. BCC-input model - draw attention to monitoring the level of receivables, inventories and liabilities. The most effective units were identified by the ZSG-DEA model, where we identified, from a regular aspect, a region where it is necessary to change the approach to the development of this segment. In the case of reducing total assets, it is appropriate to focus on reducing the amount of surplus tangible movable and immovable property such as land, buildings, machinery or cars. Another possibility is the rationalization of already used premises and their further lease to external entities. Smaller but regular deliveries are preferred to achieve the optimum level of stocks, and at the same time the maximum freshness of the raw materials used. When reducing the number of employees or the number of jobs, it is necessary to follow the defined legislative rules. Possible solutions include changing the duties of the current and new employees.

Income from tourism is an important contribution to GDP, foreign exchange incomes, as well as provides job opportunities and has the potential to play a significant role in the revitalization of the economically weaker regions. Tourism might become an accelerator of the regional development and according to Horvath, Mikus, (2016) is associated with the assumption of balancing regional disparities. Direct income is generated via consumption of visitors in the tourist destinations, as well as indirect revenue is generated by taxes (Rajić,

Milošević, 2016; Zsigmond et al., 2020), levies and various fees introduced in individual regions. Entrepreneurship in tourism helps to develop all regions of Slovakia in long term. In our work we wanted to identify the individual factors that affect the efficiency of the examined accommodation facilities in terms of all regions of Slovakia.

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Ladislav Mura is an Associate Professor, a Slovak expert on small and medium business, international business, and human resource management. He is the author of 3 domestic scientific monographs on the internationalization of business, small and medium enterprises, human resource management, co-author of foreign scientific monographs. He has published a lot of articles in various scientific journals.
ORCID: https://orcid.org/0000-0002-2453-8740

Zuzana Hajduová is an expert on statistical methods, mass data processing, combinatorial structures and systems theory, as well as their application in economic practice. She concentrates her empirical research on quality, focusing on Six Sigma. She has a rich and thematically extensive publishing activity. She is a member of many scientific committees of international and national conferences. She participated in several domestic and international projects (Interreg IV.C, V4, Horizont 2020).
ORCID: https://orcid.org/0000-0002-9381-776X

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A SYSTEMATIC THEORETICAL REVIEW ON SUSTAINABLE MANAGEMENT FOR GREEN COMPETITIVENESS

Nour Nassar [1*], Manuela Tvaronavičienė [2]

[1,2] Department of Business Technology and Entrepreneurship, Vilnius Gediminas Technical Iniversity (Vilnius Tech), Saulėtekio al. 11, Vilnius, Lithuania

E-mails: [1]Nour.Nassar@vilniustech.lt (Corresponding author); [2]manuela.tvaronaviciene@vilniustech.lt

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Abstract. Sustainable management for green competitiveness has been mentioned in the lasting researches based on various theories as to the transition theory, social responsibility theory (CSR), sustainable supply chain management theory (SSCM), the theory of planned behavior, and the contingency theory. Our purpose is to know which management theory is the most reliable in defining the intersection of management theories, sustainability, and green competitiveness. Therefore, a new interpretation must be parallel to cover all sustainability aspects: people, economics, and the environment. PRISMA-SCR (Preferred Reporting Items for Systematic reviews and Meta-Analyses for Scoping Reviews) methodology was used to develop a greater understanding of relevant terminology core concepts, and key items to report for scoping reviews.

Keywords: management theory; sustainable management; green competitiveness; competitiveness

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Jel Classification: M15, O32

1.Introduction

Sustainable management for green competitiveness has been mentioned in the lasting researches based on various theories.
We will discuss in part I the most mentioned theories related to green competitiveness and sustainability as the transition theory, Social responsibility theory (CSR), sustainable supply chain management theory (SSCM), the theory of planned behavior, and the contingency theory.

Moreover, the literature has highlighted the Resource-based view (RBV) theory which will be described separately in Part II due to its high importance.

In the third part of this paper, we will answer the following question:

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"Which management theory is the most reliable in defining the intersection of management theory, sustainability, and competitiveness?

2. Sustainable management for green competitiveness is based on various theoretical aspects

The previous literature emphasizes the main role of globalization in the success of small and small enterprises (Brodowska-Szewczuk, 2019; Castagna et al., 2020). Various factors preventing the internationalization of SMEs have been empirically studied to examine environmental, socioeconomic, operational, and organizational barriers. Previous research has found that small and medium-sized companies are more effective when they are using good internal capital or when they get benefits and/or funding from external sources (Castagna et al., 2020). Moreover, a new approach to research aims at exploring the main success factors which have a positive effect on the internationalization of SMEs brings up a discussion about the prospect of intensifying the mechanism of internationalization for SMEs based on daily business-to-business relations with corporations.

It is observed that the organizational dynamics of these companies have focused on the development of production, marketing, and competitiveness strategies to dominate the markets (Nevárez and Féliz, 2019).

It is in this scenario where social responsibility emerges as a proposal of differentiated management to be voluntary and establish a company-society relationship beyond the legal, focusing on the company recognizing its double act of both acceptance and negation, that is to say, accepts to promote the social good and refuses to harm (Nevárez and Féliz, 2019).

The theory of transition (Huguenin and Jeanneret) is not viewed as a modern philosophical growth paradigm rather as an interpretation and perceptual context from which traditional innovation theories and strategies can be reconsidered and extended based on a technology-producing and competitive approach to the development of society.

Although the transition theory (Huguenin and Jeannerat) can define the challenges and extent of a general shift, the innovation theory is also the practical and theoretical context for the recognition of resources. On the one hand, it can have a competitive and structural approach towards the production of social and economic benefits in markets that serve as knowledge and selection processes for supply-focused competition.

The transversal challenges (Huguenin and Jeannerat) of the global change of technology, economy, and society are captured in detail. It combines the straightforward, dynamic, multidimensional, co-evolutionary, and long-term aspects of sustainable goals within the current economic environment of competition, which is inevitably characterized by quantifiable growth objectives. Public policy should not only be seen as an exogenous catalyst of creativity (Huguenin and Jeannerat) but as an endogenous force for progress in value and growth that co-develops legitimizes, accepts, and enforces social values shared by social, economic, and political players. The theory of transition looks at long-range cycles of transformation involving a combination of technical, organizational, economic, social, cultural, and political changes. (Hermans, 1861) The innovation system perspective broadens the view beyond business actors directly involved in innovation processes, to a multitude of actors that can play a role within innovation processes such as governments, NGOs, research institutes but also consultancies, banks, and consumer organizations. Secondly, it pays particular attention to the influence of institutions (Hermans, 1861).

Valaei has proposed (Valaei, n.d.)A model of competitiveness for small and medium sized enterprises (SMEs) by exploring the systemic relationship between organizational structure, knowledge quality (KQ) dimensions, improvisational creativity, compositional creativity, and innovation in the emerging market in terms of sense-

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making and organizational improvisational theories. These sense-making practices are also beneficial to the improvisational imagination, compositional imagination, and creative skills of SMEs. Centered on the theory of sensemaking (Dervin, 1998, 1992), this analysis involves the usability of KQ as another substructure of the interpreted KQ and expands the body of KQ literature and the theory of sense-making. (Valarie, n.d.)

A sustainable competitive advantage for SMEs requires that an operational KQ is based on a minor decentralized and relational system. The author (Valaei, n.d.) Provided a competition model for small and medium-sized companies, exploring the structural link in sense-making and organizational improvisational theories between institutional structure, information content dimensions, improvisational creativity, structural creativity, and innovation in emerging markets.

On the human level, the way individuals perceive a problem in a specific context is the way they see it (Paul and Morris, 2011).

Dervin et al. (2003) suggest that a person is made to realize reality, as he is incorporated into a certain context and moves across space and time. The structure of the organization will positively affect company innovation.

For example, looking at the relationship between organizational structure and competitive strategy, Claver Cortés et al. (2012) found that centralization and formalization, and sophistication are positively linked to the hybrid competitive strategies.

They found that a lean system encourages the process of making sense and that new understandings can be accomplished, thereby achieving a high level of KQ that results in improvisational imagination, compositional creativity, and innovation.

Among the retaken constructs are the four theories of social responsibility: corporate citizen theory (CCT), corporate social performance theory (CSD), shareholder value theory (TVA), and stakeholder theory (TAI). These theories have different approaches that go from the perspective that the company's social responsibility is only to achieve economic benefits and its commitment is only with the shareholders (TVA), to retake the theory of corporate citizenship (TCC) in which considers that the organization has rights and obligations towards society, which is the most relevant in this investigation. The theories mentioned above are related to the dimensions proposed by Boston College: the concept of corporate citizenship, strategic initiative, leadership, structure, social issues, and relationship with stakeholders, and transparency(Nevárez and Féliz,2019).

Other researchers (Belen and Nuria, 2017) also explored when and how multinationals incorporate the principles of sustainability and CSR into the business strategy. They saw how firms interact with sustainability and CSR behavior and analyzed the effect of their contact.

The findings show that the management and coordination of the principles of the CSR contribute to the competitiveness of multinational firms in line with the CSR instrumental theory in considering stakeholders' global demands. The findings appear to demonstrate that there are dangers but also benefits with CSR's contact (Belen and Nuria, 2017). If CSR principles are a fruitful engagement strategy, the partnership with stakeholders gets improved and the firm's credibility and perceptions with internal and external stakeholders get better (Belen and Nuria, 2017).

The idea of sustainable supply chain (SSCM), due to its relevance to financial, social, and business accountability for economic success, has received attention from industry and academia (Sampurna Panigrahi, Bahinipati, and Jain, n.d.).

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As supply management is important for improving corporate productivity, a new analysis has evaluated the theoretical possibilities of SSCM and found that supply management is vital for enhancing organizational competitiveness.

Hence, sustainability concerns must be incorporated into the core functions of the, namely, purchasing, manufacturing, distributing, storing, warehousing, usage, recycling, and disposal (Linton et al., 2007). Business firms are under tremendous pressure to be able to sustain their existing SC due to recent trends of globalization, market changes, demand uncertainty, and economic challenges. Focusing only stressing on the internal efficiency of SC will be insufficient to gain a competitive advantage. If sustainability concepts are integrated into the core functions of a business firm's SC, it achieves a good market position in the global context (Khodakaramiet et al., 2015).

The writers have also taken economic aspects such as financial efficiency, expense minimization, strategic gains, and income into account (Winter and Knemeyer, 2013). Any key considerations, including collaborative knowledge exchange, optimized support for logistics, and viability, must be tackled to achieve economic resilience (Dubey et al. 2016). Many scholars have also indicated that the outlook of SCM is having a favorable impact on SSCM (Vachon and Klassen, 2008; Blome et al., 2014). SSCM is possible by financial stimuli, loans, and low pay intervals in the application of the SSCM energy-efficient activities. (Sampurna Panigrahi et al., n.d.)

Determining the cost across the sales cycle and long-term competitive approaches are cost-effective in defining, developing, and coordinating the SC goals and priorities of the business to their providers (Krause et al., 2009). Their findings have contributed to competitiveness advantages (Sampurna Panigrahi et al., n.d.)

Authors claimed that policymakers must encourage procurement from SMEs to boost local economic and social sustainable dimensions (Walker and Preuß 2008). Marketing campaigns need to be matched with SSCM strategies to build a sleek SC and resource performance (Brindley and Oxborrow 2014). The economic element is the judicious use of natural resources and a strong return on investment, relative to social and environmental considerations (Rumelt, 1974).

Ju, Wang, Cheng and Jia (2019) developed a research model for analyzing the sustainable efficiency effect factors of the supply chain logistics service. They were able to get the following unique results: the effect on the agility of the service supply chain on knowledge sharing lags and must mainly become the incorporation power of the supply chain. The findings show the value of the on-going exchange of information in LCCs. Logistics companies should develop a deep strategic relationship and form an association for knowledge sharing. Integrating skills is crucial to enhance the competitive efficiency of the supply chains, which are vulnerable to opportunistic behavior. Integrators should be prepared to enhance their actions and restrict opportunism.

To be able to achieve the highest consumer satisfaction with the lowest resource usage, they must improve the convergence of practical logistics firms, allowing the complete exercise of the strategy and cost advantages of various suppliers in their expertise. This will reduce the overall cost of transportation and increase the sustainable viability of the supply chain. Supporting logistics infrastructure building can by the government. The Government should have the necessary financial support of key logistics undertakings that meet the requirements for shipping, warehousing, storage, information facilities, and park infrastructure (Ju et al., 2019).

Contemporary international literature has highlighted the value of intellectual capital (IC), in particular in small and medium businesses because they have intangible assets as a foundation for their competitiveness as a core element of organizational performance (Asiaei and Jusoh, 2015; Jordão and Almeida, 2017; Novas et al., 2017), (Ngah and Ibrahim, 2009; Khalique et al., 2015; Vinícius, Jordão, Novas, and Gupta, 2020)

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Researchers (Vinícius et al., 2020) indicated that K-Network plays a key role in creating the IC and enhancing corporate efficiency in small and medium-sized businesses. The findings (Vinícius et al., 2020) have also shown the strategic importance of people-to-business ties to monitor the mechanism of information and knowledge development and exchanged in the examined network.

K-Networks help small and medium-sized companies accomplish their objectives and develop interorganizational partnerships to access new tools, markets, and competencies (knowledge, expertise, and attitudes) (Muhammad et al., 2011; Jardon and Martos, 2012; Rantala and Ukko, 2018; Leminen et al., 2019).

For small and medium-sized businesses, the dedication to business networking is of vital importance for their survival, growth, advancement and competitiveness, sustainability, and efficiency. Networks have been widely recognized in recent years for effective, sustainable, and creative business results. Small and medium-sized businesses, although, also face obstacles and consume capital that pursues outcomes that are at some point regulating. In theoretical terms, IC is a company that is implicit and known in strategic distinctions. In the literature, the consensus was reached on the three dimensions of the IC: human capital, institutional capital, and relation capital. (Vinícius et al., 2020)

Scholars note that the ability to mobilize, integrate, and use a tangible or intangible tool of an organization strategically is a critical factor in improving market differentiation and competitiveness. Jardon and Martos (2012) explain that core skills only help to produce IC when they allow the organization to compete more effectively than its rivals (Vinícius et al., 2020).

The conclusions showed that IC is formed (in its three dimensions) as a result of a strategic combination of SMEs in a K-network and that IC mediates the role of IC in supporting improving their organizational performance, taking account of the improved financial outcomes observed, marketing development, productivity, efficiency, creativity, and competitiveness (Vinícius et al., 2020).

One strategic strategy is to encourage the growth of new enterprises in the industry. One of Finland's leading fields in the large field of economy is bioenergy growth and processing. (Kokkonen and Ojanen, 2018)

High success in organizations with multiple facilitators can be seen as assets to be developed by companies. These qualities will help businesses achieve fast growth in a sense and thus reclaim the top slots in the international rankings that they once enjoyed. Highly high investment in R&D and the high technical and quality production capabilities of the Japanese business are important. This is very much in line with Japan's well-known ethos and history (Bhattacharya, Momaya, and Chandrasekhar Iyer, n.d.).

Previous researchers (Bezerra, Arruda, Laila, and Moroni, 2018) examined the value of sustainability practice as a moderator of the interactions between competition and efficiency in port operations, with growing exposure to sustainability in port operations.

Research findings (Bezerra et al., 2018) showed the role of SPs in providing outstanding port operations that dramatically moderate the relationship between productivity and efficiency and quality of service and production.

Other researchers (Huntley Lewis, 2019) highlighted the need for a speech about the successful use of environmental laws to affect the actions of industrial operators to achieve sustainable tourism. This dialogue is considered important in the sense of climate change and the challenge to tourism (Huntley Lewis, 2019). The stringency and value of legislation are often taken into account as it is logically believed that it will be an opportunity to keep firms successful if properly implemented (Huntley Lewis, 2019).

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The literature has said very little about it and the importance of various practices to support sustainable growth as well as improved competition is still minimal. Sustainability is a new focus (Camisón, 2020). This sustainability dimension is understood by allowing current and future generations to develop stable and prosperous societies where human well-being prospers in the area of processes. While the prevailing theory is in the academic literature that sustainability can lead to long-term changes in competition, comprehensive research case studies are also needed to validate the strategy and to provide a theoretical framework for public-private policies adopted by tourism organizations (Camisón, 2020).

3. Sustainable management for green competitiveness based on RBV theory and Porter's (1980) competitiveness, strategic theory, Dynamic capabilities (DC), and innovation

The innovation system perspective broadens the view beyond business actors directly involved in innovation processes, to a multitude of actors that can play a role within innovation processes such as governments, NGOs, research institutes but also consultancies, banks, and consumer organizations. It pays particular attention to the influence of institutions as one of the factors that influence how the innovation game is played in different contexts (Hermans, 1861).

System perspective is an empirical framework to research technological progress as a dynamic mechanism of behavior and interaction between a diverse community of players engaged in information creation, sharing, and use (Hermans, 1861).

Large businesses need to search for new capabilities to achieve radical progress that varies from their current skills and know-how (e.g., Dewar and Dutton, 1986; Ettie et al., 1984; Green, Gavin and Aiman-Smith, 1995). Therefore, radical innovation companies and different ventures in themselves must face challenges and discontinuities such as markets, technology, organizations, and capital (Kodama, 2017).

The importance of innovation based on RBV theory

Changes are becoming more prominent in the 21st century in market conditions affecting large businesses. Managers and company leaders face a wide range of challenges with the globalization of industry and the increasing number of operations in emerging markets, with disruptive technology, rapidly mature networking through economies and markets, and price and environmental problems. New business models that reform current regulations and fundamentally revitalize traditional goods and services are changing large companies' corporate strategy (Kodama, 2017).

Kodama introduces a strategic innovation model to achieve strategic innovation within a large organization, taking account of extensive DC studies, as the key driver of this framework is the idea of strategic innovation capabilities. (Kodama, 2017)

As strategy theory models for micro and organizational economics have been established resource-based theories focusing on autonomous capacity for businesses and organizations (e.g., Barney, 1991; Penrose, 1959; Richardson, 1972; Rumelt, 1984; Wernerfelt, 1984; Kodama, 2017).

Dynamically strategic innovation generates strategic placement by using new products, services, and business models and offers a complex view of a strategy that helps a large organization to preserve its competitiveness and generate sustainable growth (Kodama, 2017).

That is why big business must become creative companies that can improve their current roles (companies) through gradual innovation, while continuously renovating or destroying existing businesses through radical innovation.

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DC theory has been developed, strengthened, and has become a fundamental theory in recent years (e.g., Teece, Pisano, and Shuen, 1997; Teece, 2007, 2014) that clarifies the mechanisms of sustained development through corporate strategic innovation (Hermans, 1861). DC is characterized by Teece et al. (1997, p. 516) as the ability of the organization to incorporate, create, and reconfigure internal, external, and rapidly change-based environments. They say that DC thus represents the ability of the company given path dependencies and market position to achieve new and creative forms of competitive advantage (Leonard-Barton, 1992).

Moreover, this interest in strategic theory has grown, according to other researchers, into a complex framework that represents the company's actual market. For instance, the DC theory is valued by O'Connor (2008). Eisenhardt and Martin (2000) and list a large number of key developments, including progressive developments, which have been developed over several years to several decades for slow (or very slow) markets (Kodama, 2017).

DC must not be confined to brand new firms, fast shifting markets, or drastic changes.
Researchers have exposed strategic and sustainable directions under these circumstances (Wong, Soh, and Chong, 2016). Does SCP impact competition strongly and sustainably? An affirmative response to this is given by the composite strategic analysis model, backed by the Market-based view (MBV) and RBV theories (Wong et al., 2016).

Two key hypotheses are supporting the conceptual model.
Internal resources – RBV. To define internal resources, RBV is a helpful approach (Warren, 2002). It is important to identify skills that are essential to the comparative edge of business success (Day, 1994) (Teng and Cummings, 2002). The resources would only be able to contribute to the achievement of competitive advantage if they met the four resource requirements (valuable, rare, non-substituted, and inimitable) (Newbert, 2008). Such services are typically a dynamic collection of identifying resources across the organization and ensure the organization of practical activities (Day, 1994; Wong et al., 2016).

The RBV qualities of uncommon (Bharadwaj, 2000), non-substantiality (Barney, 1991), and inimitability also fulfill the practical interaction and IT capability and include the combination of three resource properties, special historical circumstances, causal uncertainty, and social complexity (Wade and Hulland, 2004). The output of these attributes qualifies RBV as variables for practical participation and IT capability (Wong et al., 2016).

External resources – MBV. Business forces of the organization are largely based on systemic concepts, and business conditions which create a precious basis for a corporation to achieve a strategic edge in a competitive environment (Makhija, 2003). The methods are focused on financial success and activities (Wong et al., 2016).

The two factors are widespread rivals (potential entrants, replacements, and competition) and negotiation capacity (customer and supplier). Huo et al. (2008) proposed the emphasis on low cost and the emphasis on the distinction in two aspects of operations in terms of corporate strategies. The emphasis on low costs is described as an organization competing as the lowest-cost supplier. The emphasis on differentiation is described as the gap between its services and the services of its competitors in areas like quality and versatility, while cost is not the main strategic priority. The two reasons are intense competitiveness and bargaining ability (potential entrants, substitutes, and rivalry) (customer and supplier). Huo et al. (2008) suggested a focus on low cost and a focus on differentiation as regards business policy in two areas of operations. The accent on low cost is represented as a competing company as the lowest-cost provider. The emphasis on distinction is defined by the divide between its services and the services of its rivals in areas such as efficiency, speed, and flexibility (Wong et al., 2016).

Prior contributions to conventional, firm-based economic growth capabilities tend to undermine their capacity to implement wider environmental policies. However, policy planning for sustainable growth will also have a

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positive impact on some of the investments in greenhouse gas mitigation initiatives. Besides, communities facing more competition for growth are more likely to combine strategy and success assessment to determine their environmental commitments. (Deslatte and Stokan, 2020)

Deslatte and Stokan found that city agencies can achieve improvements in sustainability by recognizing fungible operational skills that can be more readily reassigned to related roles. Moreover, strategic planning, which includes both economic growth and preservation efforts, will find further opportunities to exploit current capabilities. Moreover, cities situated in more dynamic urban growth environments should pay more attention to monitoring and controlling success to justify spending money on sustainable development efforts. Over-reliance on tax-incentive economic development strategies that also drain resource communities can weaken broader commitments to sustainable development (Deslatte and Stokan, 2020).

However, the analysis finds evidence that economic development strategic planning can positively influence some investments in GHG reduction efforts. Moreover, perceptions of competition for economic development positively mediate the relationship between the strategies governments develop to pursue sustainable economic development and the performance information they collect (Deslatte and Stokan, 2020).

Competitive competition between cities in metropolitan regions increases output assessment commitments (Deslatte and Stokan, 2017; Hawkins, 2014; Teske et al. 1993). Cities use sustainability investments to differentiate themselves from competitors; assessing the effect of these investments promotes branding and helps to validate actions by stakeholders. The ultimate hypothesis is that competitive competitiveness puts a higher emphasis on the demonstration of sustainability-related advantages, which could contribute to a better use of performance knowledge for decision-making on the distribution of capital. (Deslatte and Stokan, 2020)

Organizational synergies: the exploit the key competencies, assumption in public management research is that organizational capital can be diverted as administrators adjust current operations, efforts, energy, and resources to new priorities and activities (Frederickson 1996; Kearney and Meynhardt 2016; O'Toole and Meier 1999).

However, the existence of certain unique capital obligations makes them less adaptable. Levinthal and Wu (2010) suggest that the distinction between scale-free and non-scale-free capacities is an important way of interpreting organizational strategies. Scale-free capabilities, such as patents or computer operating systems, have low to no potential costs since having them in one way would not diminish the potential of anyone to do the same in another arena or operation. However, most operational capacities are non-scale-free and are congestible until dedicated (Deslatte and Stokan, 2020).

Competencies that can be extended to related tasks create beneficial synergies and are more likely to contribute to what Bryson, Ackermann, and Eden (2007) call central, distinctive competencies. Cities focus on non-scale-free skills as they employ employees or departmental staff to manage environmental programs through working groups or other structures (Feiock, Krause, and Hawkins, 2017; Krause 2013). Dedicated staff may prioritize and coordinate programs, co-ordinate departmental training on emerging technologies, promote stakeholder engagement, build success processes, and identify financing (Wang et al. 2012).

Prior analysis has found that strategic planning; involved and on-going administration is periodic rather than constant in policy development, execution, appraisal, and adaptation (Poister 2010). As a result, where success input is missing or disconnected from decision-makers, policy goals and objectives can be shelved. Bryson, Berry, and Yang (2010) also felt generic in this disconnect to obtain a strategic direction for work. Strategic management as a realistic philosophy needs further attention to the promotion of organizational learning and the acquisition of "strategic knowledge" (Bryson, Berry, and Yang 2010).

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Increasing demands for strategic management frameworks are articulated by local governments as 'strategic level success management' (Poister 2010). The theory of public organization, based on capital, may explain how tactics structure and impact the success of organizations (Andrews, Beynon, and McDermott 2016).

A better picture is taken of drivers and obstacles to diversification through the linkage of strategic management literature on company capacity and diversification with systems of opportunities faced by public policymakers and managers. (Deslatte and Stokan, 2020)

The world of today, characterized by competition, calls on firms and managers to consider the market rapidly and to deliver goods and services that not only satisfy their demands but also aim to surpass their expectations. In this sense, businesses can build not only commodities but also product-service networks that involve connectivity, personnel, and expertise as well as deals. Strategic and architecture philosophy is a theory with a tremendous potential that poses itself both as project and management approach capable of finding and seizing resources to further form the offers and providing value to the public and create economic growth for the whole production chain. Bezerra (Bezerra et al., 2018)aims to focus on the possibilities of strategic design and branding, through the use of a product that is identifiable and earns revenue for developing and promoting solutions that improve and value users' experience. (Bezerra et al., 2018)

There is a broad diversity of ideas related to uncertainty. According to some scholars, human actions and ambiguity are the principal drivers of complexity. This system of dynamic complexity may be an organization, technology, or people. Human emotional intelligence and interpersonal behavior (Love, Edwards, and Wood, 2011) will research the dynamic relationships between individuals within an organization or mission and its effect on competition.

In the background of a documentary about the competitiveness of various nations, Frans Hermans developed a structure known as Porter's Diamond.

The concept behind the diamond is that competition, efficiency, and economic development in a particular location depend on the market climate.
This local background can be divided between the four sides of the diamond into four main elements:
-Factor conditions: technologies, and capital.
-Demand conditions from (technically sophisticated) customers.
-Links to related and supporting industries.
-Firm strategies, structure, and rivalry (Hermans, 1861, 2018).

Further interactions between these four variables are formed and intense, the larger the productivity of the firms concerned. Porter noted in his work The Competitive Advantage of Nations that the most competitive firms in a country frequently concentrate geographically in several locations, clusters.

The creation of new clusters to promote generic competition and growth was a small move from this viewpoint: the geographical clustering of firms enhances the interaction of all four diamond elements and is thus thought to be advantageous for regional development. The reason for attracting unique industries in some regions starts with how the endowments of a country or area relate to the requirements of an industry. Such factors include natural conditions (climate, ore) and the production of endowments (capacity, resources, and infrastructure). However, the factors alone are not entirely clear regarding regional domination; to a degree, such factors are mobile or can be imitated by other countries or regions.

The essence and scale of demand in the home country is the second factor for Porter. Large domestic markets are an opportunity for the growth of the industry. And when a wide home market expands before it can take root in

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other parts of the world, experienced businesses are given enough opportunity to hunt for business abroad when saturation starts.

Competitiveness of the Home Industry, The fourth aspect of the "global diamond" model, is characterized by firm strategy, structure, and rivalry in the home industry.
This factor summarizes the competition structure of "five powers". The better the market at home, the more successful businesses would succeed worldwide.

This argument is proven by plenty of evidence. The fierce competition between German drug companies has made them a tremendous global market power.
And the solid domestic market share battle has enhanced Japanese car manufacturers' international competitive position(Hermans, 1861).

Critics and limits of RBV theory vs Organisational theory ((i.e., institutional theory and upper echelon theory)

The studies using RBV or CRBV to explain creative manufacturing activities or the distribution of TQMs usually do not capture the social context in which resource selection is set up, that is, in the field of corporate tradition and network relations and regulator pressures (Dubey et al., 2017).

Dubey adds research to the literature on motivations of adoption (Kennedy and Fiss 2009) from a sociological perspective, emphasizing the social integration of organizations and motivations which stem principally from a desire to appear legitimate to strong constituents and peer groups or external stakeholders.

His studies concentrate on the diffusion phases after adoption, however, and top managers must consider the degree of engagement they need, even after their company has effectively taken up TQM. In other words, once the complementation decision has been taken and the latest managerial innovation starts, top managers should remain involved until the innovation is completely disseminated by the company to produce the desired results.

Although Porter's work was very popular with politicians and professionals, in particular, the scientific community was considerably more critical. The lack of a consistent description of the borders of a cluster is one of the most frequently recorded criticisms of Porter's cluster theory. Clustering and agglomeration processes are partly natural processes when a set of sectors is formed in the vicinity of each other.

The cluster may be within one city (e.g., Wall, Street, the Financial Cluster) and may also cross urban, regional, and often even national geographical limits, depending on the form of economic operation. Thus, the choice of natural, geographical or administrative boundaries for a cluster is difficult and in many studies, it often results in arbitrary and arbitrative cluster limits.

Despite its analytical weaknesses, the existing bio-cluster policy literature treats bio-clusters like any other form of cluster. As a result, research focusing on competition, employment, and creativity dominates the literature. The view of bio clusters represents in this regard the more general view of the bioeconomy. The literature of Hermans concentrated on the mentioned bioeconomic aims such as developing awareness, jobs, and new business opportunities and disregarded sustainability issues and environmental advances which are also an indispensable part of the biological economy transition. The presence of transition theory in the study of bio clusters may provide an insight into this. (Hermans, 1861).

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4. Results and conclusion

To explore the world of competitiveness and sustainability, we adopted Preferred Reporting Items for Systematic reviews and Meta-Analyses for Scoping Reviews (PRISMA-SCR) to develop a greater understanding of relevant terminology core concepts, and key items to report for scoping reviews.

We started searching for the link between "sustainable management" and "management theory" using it as keywords and found 574 searches. Note that the Databases were exclusively WOS, KJD, RSCI, and SCIELO for the Timespan equal to the Last 5 years (2015 -2020) and we have limited our Search language to English. Since we got an important number of researches done in this field, we tried to go deeper to find the link between "management theory" "sustainable management "and "competitiveness".

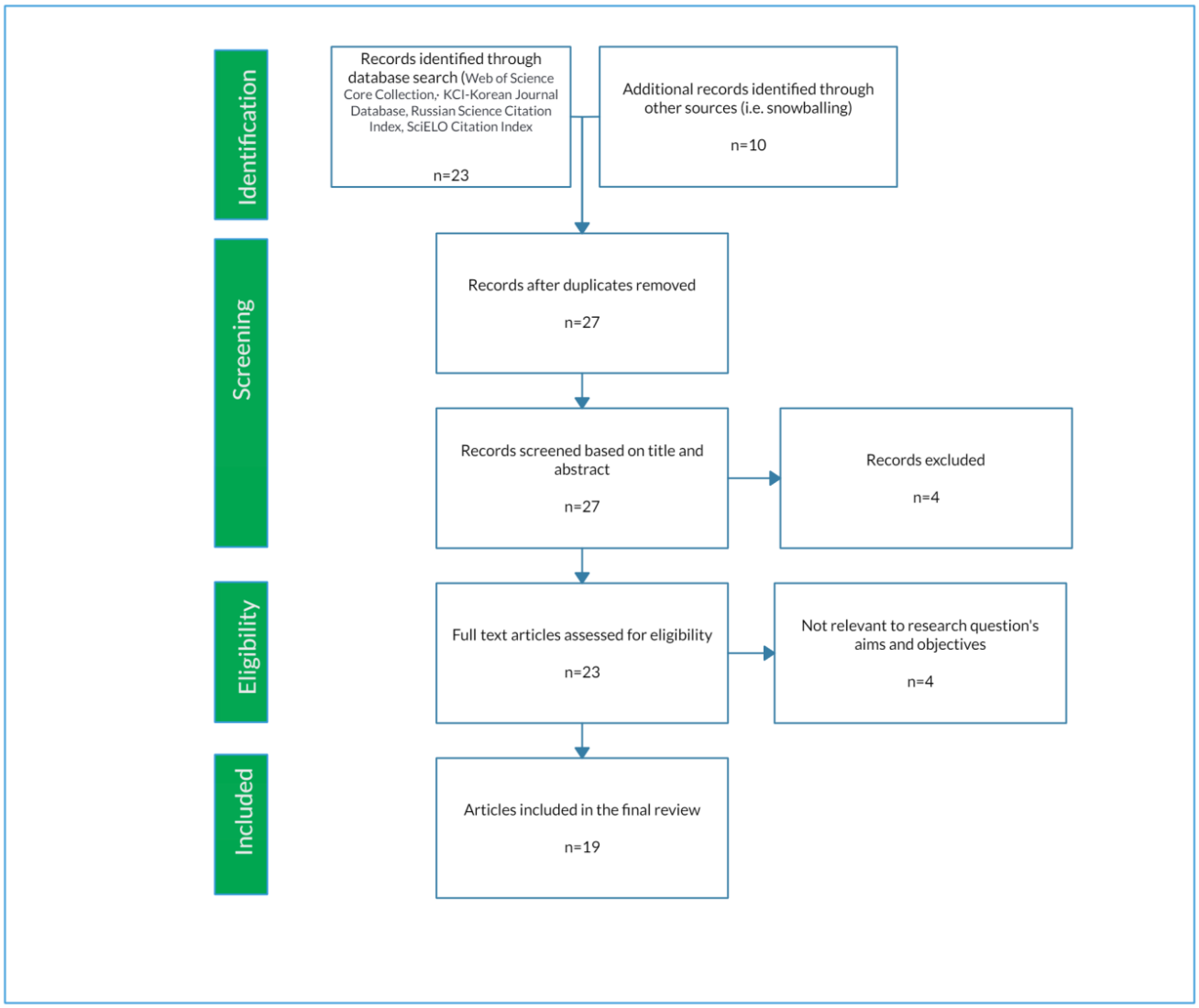

Figure 1. PRISMA-flow diagram – the link between management theory, sustainable management, and competitiveness created by the author. Note that the PRISMA 2009 Flow Diagram is From Moher D, Liberati A, Tetzlaff J, Altman D.G; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement (as well see Appendix A, Table 1)
Source: created by the authors

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Recent studies have highly focused on the intersection between management theory and sustainable management, where we found 574 results, which means 48%of the studies covered this topic. This indicates the importance of sustainable management from a theoretical viewpoint.

We could only detect the recent obvious management theories (46%); as a result, 54% of the sustainable management theories were left undetected.

Moreover, recent studies have also found a link between management theory and competitiveness. We could only detect the recent obvious management theories (46%); as a result, 54% of the sustainable management theories were left undetected.

Similarly, recent studies have also found a link between management theory and competitiveness.
Hence, which management theory, is the most reliable defining the intersection of management theories, sustainability, and green competitiveness?
Is it the administrative theory or another undetected management theory?
Based on the literature review that focused on systems management theory and sustainability, we found that out of the 46% detected management theories, the most studied management theories were consecutively Administrative theory 19%, Human relations theory12%, and Contingency management theory 7%.
We assumed at first that the administrative theory is the best describing the intersection between sustainability and competitiveness. Contrarily, our findings showed that RBV theory is the most significant management theory that contributes to sustainable management for green competitiveness as described in Fig 2. The percentages of management theories linked to sustainable competitiveness based on the latest literature review were RBV theory (40%), Contingency theory (13%), Administrative management theory (10%).

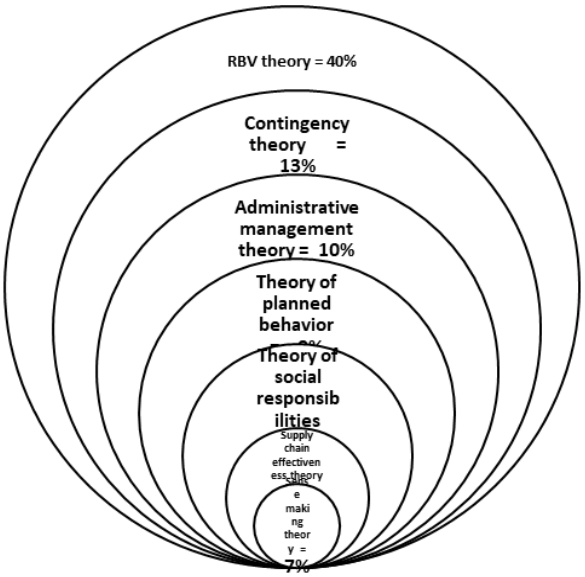

Figure 2. Percentages of management theories linked to sustainable competitiveness based on the latest literature review.
Source: created by the authors

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Note, that previous research studies that apply to my paper could be limited, depending on the nature of my research topic in addition to the databases that were exclusively WOS, KJD, RSCI, SCIELO for the timespan equal to the last 5 years (2015 -2020), in the English language.

Conducted research results have practical value for SME's as this study analyses the best sustainable strategic management orientation to achieve green competitiveness, which has an impact on organizational performance.

Since there are limited studies on this subject, a whole new typology of research needs to be created. The identification of a deficiency, in this case, can be seen as a significant opportunity to find new gaps in the preliminary literature and the need to grow more in the field of research.

Appendix A

Management theory detection based on the PRISMA diagram (Fig. 1)

Table 1. Management theory detection based on the PRISMA diagram (Fig. 1)

MNG theories and	**TS= ((SYSTEMS MANAGEMENT AND THEORIES*) +**	**(SUSTAINABLE* MANAGEMENT) *=266 results***	***+(competitiveness*) =10 results***	**MNG theories +sustainable management +competitiveness**
1184 sys management theories (100%)	*All systems management theories*	*266 (46%)*	*10*	*=23*
Competitiveness 146 (12%)	Contingency management theory	*42*	*3*	*10 competitiveness – specified systems management theories*
Sustainable management 574 (48%)	Theory XandY	*6*	*1*	*13 other management theories*
Undetected management theories =308 (54%)	Administrative theory *	*110*	*1*	
Detected SM Theories=266 results (46%)	Bureaucratic theory	*8*	*1*	
	Human relations theory	*73*	*1*	
	Douglas theory	*7*	*0*	
	mixed systems management theories	*20*	*3 Art1*	

Source: created by the authors

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Nour NASSAR
ORCID ID: orcid.org/0000-0003-0257-9186

Manuela TVARONAVIČIENE
ORCID ID: orcid.org/0000-0002-9667-3730

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CONDITIONS INFLUENCING THE CHANGE OF DEFENSE BUDGETS - THE CASE OF LITHUANIA

Gediminas Dubauskas

General Jonas Žemaitis Military Academy of Lithuania, Šilo st. 5a, Vilnius, LT-10322, Lithuania

E-mail: gediminas.dubauskas@lka.lt

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Abstract. During the so-called Cold War the financing of the defense budget was widely discussed. The issue of financing the defense budget was widely discussed during the arms race. Since the end of the Cold War, armed conflicts have become more complex, and their causes are even more diverse than during the Cold War. They were caused by the deterioration of inter-ethnic divisions, hybrid and cyber wars over energy resources and the activities of terrorist groups. Due to the changing security dimension, a new study was conducted examining the determinants of defense spending in a changing security environment: the creation of new islands in the South China Sea to expand China's military-political power in the region; the possibility of using North Korea's nuclear energy. weapons, Russia's military maneuver in the conflict in Ukraine, its naval operation in the Black Sea, the occupation of Crimea, military operations in Syria, a change in U.S. military doctrine. The state that has spent the most military spending is returning to the creation of large military units, and to do so, the country needs to increase defense spending. Looking at how these world events work, we see one component that connects them. Strong force, expressed in military action, is used to achieve their political goals. Military power is gaining more and more influence in the formation of foreign policy, therefore the defense budget, as an instrument of foreign policy expressed in military power, is becoming an increasingly relevant object of research. Lithuania's defense budget is not as important to world politics as the United States, China or other major countries in the world, but it is relevant and significant in its region. Expenditures on the Lithuanian military budget began to increase significantly by two thousand and fourteen. It can be argued that the factor that has now influenced cost growth is Russia's military aggression in Ukraine. Nevertheless, in 2008 Russia's aggression in Georgia did not affect the growth of Lithuania's defense budget. 2008 The economic crisis may have influenced Lithuania's decision not to increase military spending. Some pressure on the country's defense budget is also related to the 2020 Pandemic crisis. The question arises as to why seemingly similar conflicts affect Lithuanian political decisions differently.

Keywords: North Atlantic Treaty Organization; Defence Spending; Sustainability; Security; Financial Management

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1. Introduction

This publication shortly overviews how economic, external threats, North Atlantic Treaty Organization membership, and political factors determine changes in defense spending. The impact of these factors on Lithuania's defense spending in peacetime is analyzed. For the study of the external and internal factors of the Lithuanian defense budget and the comparison of their significance, the period of the beginning of the twenty-first century until nowadays is chosen to be analyzed. During this period, five cycles of Seimas elections took place, so based on the periods of different ideological views of the parties in power, it was analyzed how internal factors influenced the change in military budget expenditures.

There are many attempts in research to assess and identify factors influencing the military budget (Blum, 2019). Among Lithuanian authors, defense spending is examined by Jokubauskas (2015), reviewing the financing of the Lithuanian Armed Forces from the restoration of independence until the mid-twenties of the twenty first century. Sandler and George (2016), Hyde-Price (2006), and other authors examine how external threats expressed through military aggression affect states to increase power through increased funding for military spending. One of the factors chosen in the analysis of the case of Lithuania is an external threat. The paper examines its influence on the change of state defense expenditure.

In the North Atlantic Treaty Organization context, Olson and Zeckhauser (1966) began to study the phenomenon of "free riding" from the 1960s. Similar issues were analyzed by Becker and Malesky (2017), George and Sandler (2018) and many other authors. Taking into account the general theory of the financial and security burden sharing of the military alliance, this work will examine how North Atlantic Treaty Organization membership has affected the change in Lithuania's defense budget.

There are many theories examining the causality of defense budget expenditures, but taking into account the Lithuanian economy's elements and the historical context of the overviewed period, theories emphasizing internal and external factors determining the change in the defense budget were discussed. As mentioned earlier on those topics there is an internal impact of economic change and the political parties' position. In addition, there are also external threats and the impact of the North Atlantic Treaty Organization membership. A task of the paper could be to reveal the significance of factors determining the change of Lithuania's defense budget. Recent data on the growth of the country's debt in the event of a pandemic also reveal possible economic and public finance pressures on cuts in the state defense budget.

In order to implement the tasks and achieve the goal, the scientific literature of various Lithuanian and foreign authors, statistical databases, articles published on the Internet and in the press, and other relevant sources were used. Research methods used: analysis of scientific literature, analysis of statistical data, comparative research.

2. The Influence of North Atlantic Treaty Organization Membership on the Change of Lithuanian Defense Expenditures

Historically, the methods of collecting defense spending have varied, but the principle has remained the same to this day. As the state engages in military conflict, defense spending increases as the military campaign needs to be sustained and decreases accordingly until the state reaches its normal state, the time of peace. Citizens always pay taxes. Taxes are a means of maintaining the state and a legal obligation. Then the state, as the successor to the satisfaction of human needs, performs the necessary collective functions necessary for the existence of society. This functional relationship can be illustrated as follows: citizen - tax - government - citizen. The state budget must meet the needs necessary for the state to exist. One of the main services of this public state is to ensure the security of the citizens of the state and the integrity of the territory by protecting it from external aggression. Collectively, such national appropriations are called defense expenditures. The possible principle of operation of

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defense expenditures is set out in the theory of public finances. The selfish pursuit of one's own desires creates connections between people. Thus, it is possible that a person and their group create a state to satisfy their needs, the state takes care of human security, receiving a share of the citizen's income for it. When a citizen's share of income belongs to the state and is regulated by law, it becomes a tax. The portion of taxes allocated to ensure the security of the people of the state and the integrity of the theory is called defense spending.

Hence, this section provides an overview of how Lithuania's membership in the North Atlantic Treaty Organization military alliance influenced the increase in defense spending. Taking into account the "free riding" theory, it will be examined whether in the period 2004-2018 Lithuania used the set of security measures developed by other military alliance countries, expressed in defense expenditures, and North Atlantic Treaty Organization membership allocated less to defense expenditures than North Atlantic Treaty Organization partners.

Analyzing the defense expenditures of North Atlantic Treaty Organization countries in 2004-2018, expressed as a percentage of Gross domestic product (Table 1), we see that Lithuania's defense expenditures were lower than the average in comparison with other North Atlantic Treaty Organization countries in the study period. However, taking into account North Atlantic Treaty Organization countries' aspirations to allocate two percent to defense expenditures from Gross domestic product, the North Atlantic Treaty Organization average actually is below this indicator. Nevertheless, Estonia, Greece, Latvia, Poland, UK, Lithuania and the USA have reached two percent defense expenditures from the Gross domestic product in 2018, i.e. the defense expenditure target. There also could be seen the difference between the defense spending of the US, which spends the most on defense spending, and that of Luxembourg, which spends the least, as a percentage of Gross domestic product.

Table 1. Dynamics of North Atlantic Treaty Organization defense spending as a percentage of Gross domestic product

Year	Lithuania's defence spending as percent from the Gross domestic product	North Atlantic Treaty Organization average defence spending as percent from the Gross domestic product	North Atlantic Treaty Organization recommendations for defence spending as percent from the Gross domestic product	USA defence spending as percent from the Gross domestic product	Luxemburg's defence spending as percent from the Gross domestic product
2004	1.30	1.81	2.0	4.0	0.7
2005	1.20	1.73	2.0	4.0	0.8
2006	1.20	1.73	2.0	4.1	0.6
2007	1.20	1.67	2.0	4.2	0.6
2008	1.10	1.71	2.0	5.04	0.4
2009	1.10	1.74	2.0	5.32	0.5
2010	0.88	1.60	2.0	4.81	0.47
2011	0.79	1.52	2.0	4.77	0.39
2012	0.76	1.47	2.0	4.41	0.38
2013	0.76	1.42	2.0	4.07	0.38
2014	0.88	1.39	2.0	3.76	0.38

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2105	1.14	1.42	2.0	3.55	0.44
2016	1.48	1.46	2.0	3.55	0.40
2017	1.72	1.50	2.0	3.34	0.52
2018	2.00	1.58	2.0	3.39	0.54

Source: North Atlantic Treaty Organization database (North Atlantic Treaty Organization, 2019) and author's calculations

The North Atlantic Treaty Organization Alliance has a common goal of ensuring the security of its members, but North Atlantic Treaty Organization members have different positions on their national security and the means by which they seek to do so. Despite declaratory agreements to increase defense spending to two percent of Gross domestic product, at least twenty percent of defense spending to new weapons and innovation, countries differ due to differing perceptions of security, differences in national public spending priorities depending on the domestic microclimate and prevailing social and economic conditions. and other significant developments influencing the holistic dimension of the country make different levels of defense spending. The "free ride" is the behavior of North Atlantic Treaty Organization members as they begin to take advantage of the security environment created by other Alliance defense capabilities. Meanwhile, for some reason, state defense spending is below the average for North Atlantic Treaty Organization defense spending. The increase in defense spending and the factor of North Atlantic Treaty Organization affiliation will be addressed through the principle of connecting factors. Whether Lithuania's membership in the North Atlantic Treaty Organization is a factor, increasing defense spending was examined using the regression method when assessing the "free riding" effect (Pauliukaitis, 2019).

In order to answer the question whether Lithuania is a "free rider", it is necessary to examine the funds allocated by Lithuania and other North Atlantic Treaty Organization countries for defense (Dubauskas, 2013). Using the method used by Murdoch and Sandler, the annual averages of defense expenditures allocated by North Atlantic Treaty Organization countries will be estimated and compared with Lithuania's defense expenditures. If Lithuania's defense expenditures are lower than the average of other North Atlantic Treaty Organization members, it will mean that Lithuania used the security dimension created by other members of the Alliance in that year, and vice versa, when Lithuania's defense expenditures are higher than the average of other North Atlantic Treaty Organization members (Murdoch, Sandler, 1984). For the comparison of defense expenditures of North Atlantic Treaty Organization countries and Lithuania, taking into account the specifics of the examined defense expenditure indicators, an indicator expressed as a percentage of defense expenditures of Gross domestic product is chosen, which enables the analysis of defense expenditures of economically different developed countries.

If a country has benefited from the North Atlantic Treaty Organization Alliance during the year and has been affected by the "free ride" effect, a coefficient of one is applied, if it has not used "free ride", a coefficient of zero is assigned, i.e., an event where costs were below the North Atlantic Treaty Organization average. The North Atlantic Treaty Organization Alliance Influence Expenditure Factor will reveal the significance of the 2004-2018 factor over the observed fifteen year period, ranging from plus one to zero, and will allow the North Atlantic Treaty Organization Alliance factor to be compared with external threat, political and economic factors.

Taking into account the defense expenditures of North Atlantic Treaty Organization countries in 2004-2018, expressed as a percentage of Gross domestic product, it is possible to calculate the total coefficient of the North Atlantic Treaty Organization Alliance's influence on defense expenditures. Such a simple statistical analysis reveals that for most of the period under review, Lithuania has benefited from the defense expenditures of North Atlantic Treaty Organization members. By examining regression analysis of Lithuanian defense expenditures from Gross domestic product and averages of North Atlantic Treaty Organization defense expenditures expressed as a percentage of Gross domestic product in 2004-2018. over the period, the relationship confirms that there is a

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strong positive correlation between these variables. The Pearson correlation coefficient r = 0.93 was obtained, indicating that in 93 percent of the compared cases Lithuania used the benefits provided by the members of the North Atlantic Treaty Organization Alliance. The value of p describing the statistical significance of the correlation is less than 0.05 so the value is reliable. Taking into account these indicators of statistical analysis, it can be stated that Lithuania's membership in the North Atlantic Treaty Organization had a statistically very strong connection with the "less spending" behaviours (Pauliukaitis, 2019).

The factor of Lithuania's membership in the North Atlantic Treaty Organization, expressed through the phenomenon of "free riding", is significantly correlated with defense spending, expressed as a percentage of Gross domestic product. Lithuania has used the set of security measures created by other military alliance countries, expressed in defense expenditures, and by using North Atlantic Treaty Organization membership, it has allocated less to defense expenditures than North Atlantic Treaty Organization partners. It could be concluded that Lithuania's membership in the North Atlantic Treaty Organization in 2004-2018 significantly reduced defense spending.

3. Influence of public debt to the defence expenditures

The correlation of defense spending with the size of the country's debt is also visible. In Lithuania, borrowing grew during the first crisis (Table 1) and also during the pandemic, as shown in Table 2. As a result of the first crisis, defense funding has declined, so pressure to reduce defense spending during a pandemic can also be expected.

Table 2. Lithuania's Debt to Gross domestic product 2008-2020 (percent)

Lithuania's Debt to Gross domestic product, percent	Lithuania's Debt to Gross domestic product percent change, year by year	Year
14.6	0	2008
28	13.4	2009
36.2	8.2	2010
37.2	1	2011
39.2	2	2012
38.7	-0.5	2013
40.5	1.8	2014
42.7	2.2	2015
39.7	-3	2016
39.1	-0.6	2017
33.7	-5.4	2018
35.9	2.2	2019
47.3	11.4	2020

Source: Trading Economics (2021) and author's calculations

A comparison of lending in 2008-2009 shows a clear increase in debt, and a comparison (Table 1) shows a clear decline in defense spending for less than one per cent of Gross domestic product in after crisis years, however, with a one or two years delay. At the same time, the growth of borrowing in 2020 is likely to lead to similar trends in declining defense spending, and we will feel the possible consequences a little later, given the delay effect. Such a delay effect is also examined in the works of some authors (Bove, 2017). Moreover Caruso results show that the debt burden of European countries is positively associated with the military burden of the United States and negatively associated with the average military burden of other European countries (Caruso, 2017). Thus, the defense spending of European North Atlantic Treaty Organization countries is strongly related to the defense

spending of the United States, which in turn correlates with the volume of borrowing by the United States. Returning to Lithuania's defense expenditure, as already mentioned, there is a visible negative correlation with aggregate public debt. Therefore, it can be assumed that if the impact of the pandemic on the economy decreases in the coming years, the pressure to reduce defense spending may be felt even in 2023-2025.

4. Conclusions

After analyzing the theories of defense expenditure, it can be stated that the causality of defense expenditure is ambiguous with the theory of realism. The change in the defense expenditure is significantly influenced by the principle of operation of the country's defense expenditure set out in the theory of public finances. The hedonistic connection to satisfy desires creates connections between people. Man creates a state to meet his needs, the state takes care of human security by receiving a share of human income for it. When the share of human income that goes to the state is determined and regulated by law, it becomes a tax. The part of the tax that is spent on ensuring the security of the people of the state and the integrity of the territory is called defense spending.

Lithuania's membership in the North Atlantic Treaty Organization has a very strong impact on Lithuania's defense spending by reducing it. The North Atlantic Treaty Organization membership factor, expressed through the 'bunny' phenomenon, correlates significantly with defense spending as a percentage of Gross domestic product. During the research period 2004-2018, Lithuania used the set of security measures created by other military alliance countries, expressed in defense expenditures, and by using North Atlantic Treaty Organization membership, it devoted less to defense expenditures than North Atlantic Treaty Organization partners. The North Atlantic Treaty Organization membership factor reduced Lithuania's defense spending. Examining the relationship between Gross domestic product as an independent variable and dependent variables (defense expenditure in euro terms and defense expenditure as a percentage of Gross domestic product per year), Gross domestic product dynamics do not affect defense expenditure as a percentage of Gross domestic product, but have a strong relationship with defense expenditure. expenditure expressed in euro as a whole. The analysis of Lithuania's defense expenditure and 3-year average Gross domestic product change indicators confirmed that Gross domestic product growth has a positive effect on state defense expenditure, but is dependent on the response time of the political apparatus to changes, and therefore reflects the country's economic changes with a delay.

In addition, the increase in public debt in 2020 is likely to trigger the trends of the financial crisis of 2008-2009, which will require cuts in defense spending, and the countries will feel the possible consequences a little later, given the lag effect.

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Prof. Gediminas DUBAUSKAS Dr.Sc. is a professor at the Defence Economics and Management Research group of the General Jonas Žemaitis Military Academy of Lithuania, Lithuania. Scientific field: Finance, Defence Economics, Financial Management.
ORCID ID: orcid.org/0000-0001-7789-4792